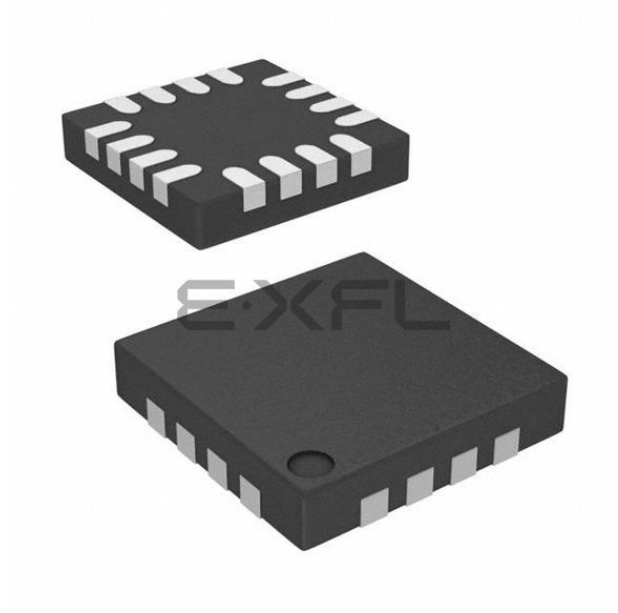

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What is "Embedded - Microcontrollers"?

"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	24MHz
Connectivity	I²C, SPI
Peripherals	LVD, POR, WDT
Number of I/O	13
Program Memory Size	8KB (8K x 8)
Program Memory Type	FLASH
EEPROM Size	-
RAM Size	1K x 8
Voltage - Supply (Vcc/Vdd)	1.71V ~ 3.6V
Data Converters	A/D 1x10b
Oscillator Type	Internal
Operating Temperature	0°C ~ 70°C (TA)
Mounting Type	Surface Mount
Package / Case	16-UFQFN
Supplier Device Package	16-QFN (3x3)
Purchase URL	https://www.e-xfl.com/product-detail/infineon-technologies/cy7c60413-16lkxc

The basic I²C features include:

- Slave, transmitter, and receiver operation
- Byte processing for low CPU overhead
- Interrupt or polling CPU interface
- Support for clock rates of up to 400 kHz
- 7- or 10-bit addressing (through firmware support)
- SMBus operation (through firmware support)

Enhanced features of the I²C Slave Enhanced Module include:

- Support for 7-bit hardware address compare
- Flexible data buffering schemes
- A 'no bus stalling' operating mode
- A low power bus monitoring mode

The I²C block controls the data (SDA) and the clock (SCL) to the external I²C interface through direct connections to two dedicated GPIO pins. When I²C is enabled, these GPIO pins are not available for general purpose use. The enCoRe V LV CPU firmware interacts with the block through I/O register reads and writes, and firmware synchronization is implemented through polling and/or interrupts.

In the default operating mode, which is firmware compatible with previous versions of I²C slave modules, the I²C bus is stalled upon every received address or byte, and the CPU is required to read the data or supply data as required before the I²C bus continues. However, this I²C Slave Enhanced module provides new data buffering capability as an enhanced feature. In the EZI²C buffering mode, the I²C slave interface appears as a 32-byte RAM buffer to the external I²C master. Using a simple predefined protocol, the master controls the read and write pointers into the RAM. When this method is enabled, the slave never stalls the bus. In this protocol, the data available in the RAM (this is managed by the CPU) is valid.

Additional System Resources

System Resources, some of which have been previously listed, provide additional capability useful to complete systems. Additional resources include low voltage detection and power on reset. The following statements describe the merits of each system resource:

- 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.
- The 3.6 V maximum input, 1.8, 2.5, or 3 V selectable output, low dropout regulator (LDO) provides regulation for I/Os. A register controlled bypass mode enables the user to disable the LDO.
- Standard Cypress PSoC IDE tools are available for debugging the enCoRe V LV family of parts.

Getting Started

The quickest way to understanding the enCoRe V silicon is by reading this datasheet and using the PSoC Designer Integrated Development Environment (IDE). This datasheet is an overview of the enCoRe V integrated circuit and presents specific pin, register, and electrical specifications. For in-depth information, along with detailed programming information, refer to the *PSoC Programmable System-on-Chip Technical Reference Manual*, for CY8C28xxx PSoC devices.

For up-to-date ordering, packaging, and electrical specification information, reference the latest enCoRe V device datasheets on the web at http://www.cypress.com.

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.

Designing with PSoC Designer

The development process for the PSoC device differs from that of a traditional fixed-function microprocessor. The configurable analog and digital hardware blocks give the PSoC architecture a unique flexibility that pays dividends in managing specification change during development and lowering inventory costs. These configurable resources, called PSoC blocks, have the ability to implement a wide variety of user-selectable functions. The PSoC development process is:

1. Select user modules.
2. Configure user modules.
3. Organize and connect.
4. Generate, verify, and debug.

Select User Modules

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

Configure User Modules

Each user module that you select establishes the basic register settings that implement the selected function. They also provide parameters and properties that allow you to tailor their precise configuration to your particular application. For example, a PWM User Module configures one or more digital PSoC blocks, one for each eight bits of resolution. Using these parameters, you can establish the pulse width and duty cycle. Configure the parameters and properties to correspond to your chosen application. Enter values directly or by selecting values from drop-down menus. All of the user modules are documented in datasheets that may be viewed directly in PSoC Designer or on the Cypress website. These user module datasheets explain the internal operation of the user module and provide performance specifications. Each datasheet describes the use of each user module parameter, and other information that you may need to successfully implement your design.

Organize and Connect

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

Generate, Verify, and Debug

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

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

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

32-Pin Part Pinout

Figure 6. CY7C60445 32-Pin enCoRe V LV Device

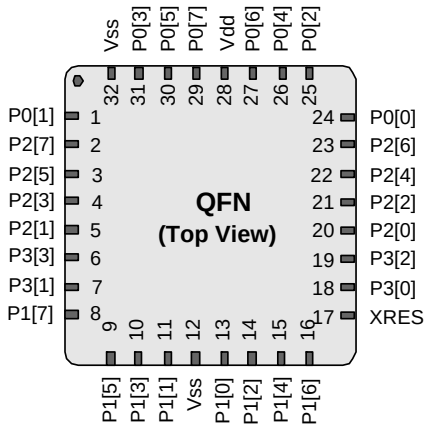


Table 2. 32-Pin Part Pinout (QFN)

Pin No.	Type	Name	Description
1	IOH	P0[1]	Digital I/O
2	I/O	P2[7]	Digital I/O
3	I/O	P2[5]	Digital I/O, crystal out (Xout)
4	I/O	P2[3]	Digital I/O, crystal in (Xin)
5	I/O	P2[1]	Digital I/O
6	I/O	P3[3]	Digital I/O
7	I/O	P3[1]	Digital I/O
8	IOHR	P1[7]	Digital I/O, I^2C SCL, SPI SS
9	IOHR	P1[5]	Digital I/O, I^2C SDA, SPI MISO
10	IOHR	P1[3]	Digital I/O, SPI CLK
11	IOHR	P1[1][1,2]	Digital I/O, ISSP CLK, I^2C SCL, SPI MOSI
12	Power	Vss	Ground connection
13	IOHR	P1[0][1,2]	Digital I/O, ISSP DATA, I^2C SDA, SPI CLK
14	IOHR	P1[2]	Digital I/O
15	IOHR	P1[4]	Digital I/O, optional external clock input (EXTCLK)
16	IOHR	P1[6]	Digital I/O
17	Reset Input	XRES	Active high external reset with internal pull-down
18	I/O	P3[0]	Digital I/O
19	I/O	P3[2]	Digital I/O
20	I/O	P2[0]	Digital I/O
21	I/O	P2[2]	Digital I/O
22	I/O	P2[4]	Digital I/O
23	I/O	P2[6]	Digital I/O
24	IOH	P0[0]	Digital I/O
25	IOH	P0[2]	Digital I/O
26	IOH	P0[4]	Digital I/O
27	IOH	P0[6]	Digital I/O

Table 2. 32-Pin Part Pinout (QFN) (continued)

Pin No.	Type	Name	Description
28	Power	Vdd	Supply voltage
29	IOH	P0[7]	Digital I/O
30	IOH	P0[5]	Digital I/O
31	IOH	P0[3]	Digital I/O
32	Power	Vss	Ground connection
CP	Power	Vss	Center pad must be connected to ground

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

48-Pin Part Pinout

Figure 7. CY7C60455/CY7C60456 48-Pin enCoRe V LV Device

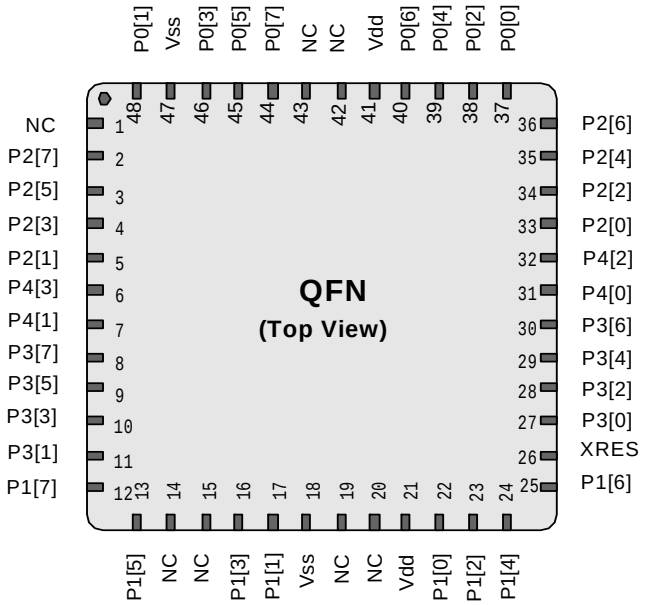


Table 3. 48-Pin Part Pinout (QFN)

Pin No.	Type	Name	Description
1	NC	NC	No connection
2	I/O	P2[7]	Digital I/O
3	I/O	P2[5]	Digital I/O, crystal out (Xout)
4	I/O	P2[3]	Digital I/O, crystal in (Xin)
5	I/O	P2[1]	Digital I/O
6	I/O	P4[3]	Digital I/O
7	I/O	P4[1]	Digital I/O
8	I/O	P3[7]	Digital I/O
9	I/O	P3[5]	Digital I/O
10	I/O	P3[3]	Digital I/O
11	I/O	P3[1]	Digital I/O
12	IOHR	P1[7]	Digital I/O, I^2C SCL, SPI SS
13	IOHR	P1[5]	Digital I/O, I^2C SDA, SPI MISO
14	NC	NC	No connection
15	NC	NC	No connection
16	IOHR	P1[3]	Digital I/O, SPI CLK
17	IOHR	P1[1][1,2]	Digital I/O, ISSP CLK, I^2C SCL, SPI MOSI
18	Power	Vss	Supply ground
19	NC	NC	No connection
20	NC	NC	No connection
21	Power	Vdd	Supply voltage

Table 3. 48-Pin Part Pinout (QFN) (continued)

Pin No.	Type	Name	Description
22	IOHR	P1[0][1,2]	Digital I/O, ISSP DATA, I2C SDA, SPI CLK
23	IOHR	P1[2]	Digital I/O
24	IOHR	P1[4]	Digital I/O, optional external clock input (EXTCLK)
25	IOHR	P1[6]	Digital I/O
26	XRES	Ext Reset	Active high external reset with internal pull-down
27	I/O	P3[0]	Digital I/O
28	I/O	P3[2]	Digital I/O
29	I/O	P3[4]	Digital I/O
30	I/O	P3[6]	Digital I/O
31	I/O	P4[0]	Digital I/O
32	I/O	P4[2]	Digital I/O
33	I/O	P2[0]	Digital I/O
34	I/O	P2[2]	Digital I/O
35	I/O	P2[4]	Digital I/O
36	I/O	P2[6]	Digital I/O
37	IOH	P0[0]	Digital I/O
38	IOH	P0[2]	Digital I/O
39	IOH	P0[4]	Digital I/O
40	IOH	P0[6]	Digital I/O
41	Power	Vdd	Supply voltage
42	NC	NC	No connection
43	NC	NC	No connection
44	IOH	P0[7]	Digital I/O
45	IOH	P0[5]	Digital I/O
46	IOH	P0[3]	Digital I/O
47	Power	Vss	Supply ground
48	IOH	P0[1]	Digital I/O
CP	Power	Vss	Center pad must be connected to ground

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

Table 6. Register Map Bank 1 Table: Configuration Space

Name	Addr (1,Hex)	Access	Name	Addr (1,Hex)	Access	Name	Addr (1,Hex)	Access	Name	Addr (1,Hex)	Access
PRT0DM0	00	RW		40			80			C0	
PRT0DM1	01	RW		41			81			C1	
	02			42			82			C2	
	03			43			83			C3	
PRT1DM0	04	RW		44			84			C4	
PRT1DM1	05	RW		45			85			C5	
	06			46			86			C6	
	07			47			87			C7	
PRT2DM0	08	RW		48			88			C8	
PRT2DM1	09	RW		49			89			C9	
	0A			4A			8A			CA	
	0B			4B			8B			CB	
PRT3DM0	0C	RW		4C			8C			CC	
PRT3DM1	0D	RW		4D			8D			CD	
	0E			4E			8E			CE	
	0F			4F			8F			CF	
PRT4DM0	10	RW		50			90			D0	
PRT4DM1	11	RW		51			91			D1	
	12			52			92			D2	
	13			53			93			D3	
	14			54			94			D4	
	15			55			95			D5	
	16			56			96			D6	
	17			57			97			D7	
	18			58			98			D8	
	19			59			99			D9	
	1A			5A			9A			DA	
	1B			5B			9B			DB	
	1C			5C			9C		IO_CFG	DC	RW
	1D			5D			9D		OUT_P1	DD	RW
	1E			5E			9E			DE	
	1F			5F			9F			DF	
	20			60			A0		OSC_CR0	E0	RW
	21			61			A1		ECO_CFG	E1	#
	22			62			A2		OSC_CR2	E2	RW
	23			63			A3		VLT_CR	E3	RW
	24			64			A4		VLT_CMP	E4	R
	25			65			A5			E5	
	26			66			A6			E6	
	27			67			A7			E7	
	28			68			A8		IMO_TR	E8	W
SPI_CFG	29	RW		69			A9		ILO_TR	E9	W
	2A			6A			AA			EA	
	2B			6B			AB		SLP_CFG	EB	RW
	2C		TMP_DR0	6C	RW		AC		SLP_CFG2	EC	RW
	2D		TMP_DR1	6D	RW		AD		SLP_CFG3	ED	RW
	2E		TMP_DR2	6E	RW		AE			EE	
	2F		TMP_DR3	6F	RW		AF			EF	
	30			70			B0			F0	
	31			71			B1			F1	
	32			72			B2			F2	
	33			73			B3			F3	
	34			74			B4			F4	
	35			75			B5			F5	
	36			76			B6			F6	
	37			77			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			FE	
	3F			7F			BF			FF	

Gray fields are reserved and should not be accessed. # Access is bit specific.

Electrical Specifications

This section presents the DC and AC electrical specifications of the enCoRe V LV devices. For the most up to date electrical specifications, verify that you have the most recent datasheet available by visiting the company web site at http://www.cypress.com.

Figure 8. Voltage versus CPU Frequency

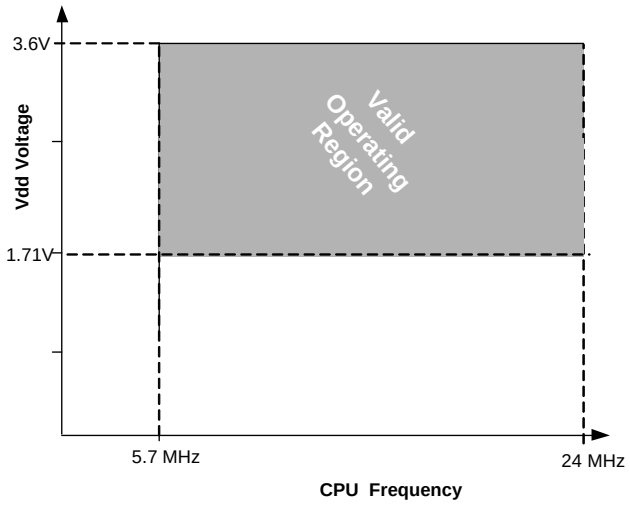
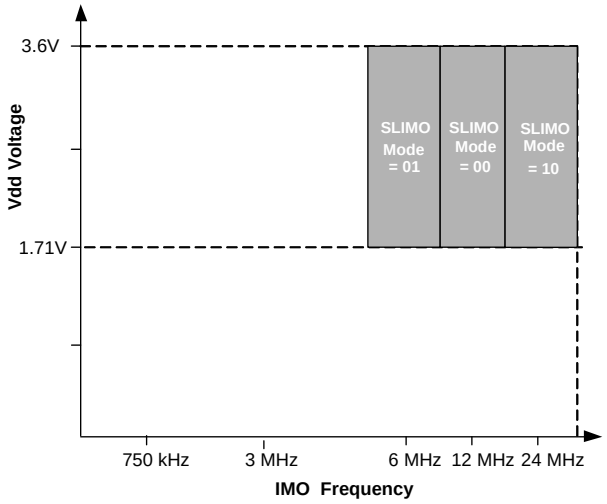


Figure 9. IMO Frequency Trim Options



DC Electrical Characteristics

DC Chip Level Specifications

Table 9 lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

Table 9. DC Chip Level Specifications

Symbol	Description	Conditions	Min	Typ	Max	Units
Vdd[5, 6]	Supply voltage	See table titled DC POR and LVD Specifications on page 22.	1.71	–	3.6	V
I_{DD24}	Supply current, IMO = 24 MHz	Conditions are Vdd ≤ 3.0 V, T_A = 25 °C, CPU = 24 MHz No I2C/SPI	–	2.9	4.0	mA
I_{DD12}	Supply current, IMO = 12 MHz	Conditions are Vdd ≤ 3.0 V, T_A = 25 °C, CPU = 12 MHz No I2C/SPI	–	1.7	2.6	mA
I_{DD6}	Supply current, IMO = 6 MHz	Conditions are Vdd ≤ 3.0 V, T_A = 25 °C, CPU = 6 MHz No I2C/SPI	–	1.2	1.8	mA
I_{SB1}	Standby current with POR, LVD, and Sleep timer	Vdd ≤ 3.0V, T_A = 25 °C, I/O regulator turned off	–	1.1	1.5	µA
I_{SB0}	Deep sleep current	Vdd ≤ 3.0 V, T_A = 25 °C, I/O regulator turned off	–	0.1	–	µA

Notes

5. When Vdd 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 µsec to avoid triggering POR. The only other restriction on slew rates for any other voltage range or transition is the SR_{POWER_UP} parameter.
6. If powering down in standby sleep mode, to properly detect and recover from a VDD brown out condition any of the following actions must be taken:
   - ❒ Bring the device out of sleep before powering down.
   - ❒ Assure that VDD falls below 100 mV before powering backup.
   - ❒ Set the No Buzz bit in the OSC_CR0 register to keep the voltage monitoring circuit powered during sleep.
   - ❒ Increase the buzz rate to assure that the falling edge of VDD is captured. The rate is configured through the PSSDC bits in the SLP_CFG register.

   For the referenced registers, refer to the enCoRe V Technical Reference Manual. In deep sleep mode, additional low power voltage monitoring circuitry allows VDD brown out conditions to be detected for edge rates slower than 1 V/ms.

DC General Purpose I/O Specifications [7]

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 1.71 V to 3.6 V and 0 °C ≤ T_A ≤ 70 °C. Typical parameters apply to 3.3 V at 25 °C. These are for design guidance only.

Table 10. 3.0 V to 3.6 V DC GPIO Specifications

Symbol	Description	Conditions	Min	Typ	Max	Units
R_{PU}	Pull-up resistor	–	4	5.6	8	kΩ
V_{OH1}	High output voltage Port 2 or 3 pins	IOH ≤ 10 µA, maximum of 10 mA source current in all I/Os	Vdd – 0.2	–	–	V
V_{OH2}	High output voltage Port 2 or 3 pins	IOH = 1 mA, maximum of 20 mA source current in all I/Os	Vdd – 0.9	–	–	V
V_{OH3}	High output voltage Port 0 or 1 pins with LDO regulator disabled for Port 1	IOH < 10 µA, maximum of 10 mA source current in all I/Os	Vdd – 0.2	–	–	V
V_{OH4}	High output voltage Port 0 or 1 pins with LDO regulator disabled for Port 1	IOH = 5 mA, maximum of 20 mA source current in all I/Os	Vdd – 0.9	–	–	V
V_{OH5}	High output voltage Port 1 pins with LDO regulator enabled for 3 V out	IOH < 10 µA, Vdd > 3.1 V, maximum of 4 I/Os all sourcing 5 mA	2.85	3.00	3.3	V
V_{OH6}	High output voltage Port 1 pins with LDO regulator enabled for 3 V out	IOH = 5 mA, Vdd > 3.1 V, maximum of 20 mA source current in all I/Os	2.20	–	–	V
V_{OH7}	High output voltage Port 1 pins with LDO enabled for 2.5 V out	IOH < 10 µA, Vdd > 2.7 V, maximum of 20 mA source current in all I/Os	2.35	2.50	2.75	V
V_{OH8}	High output voltage Port 1 pins with LDO enabled for 2.5 V out	IOH = 2 mA, Vdd > 2.7 V, maximum of 20 mA source current in all I/Os	1.90	–	–	V
V_{OH9}	High output voltage Port 1 pins with LDO enabled for 1.8 V out	IOH < 10 µA, Vdd > 2.7 V, maximum of 20 mA source current in all I/Os	1.60	1.80	2.1	V
V_{OH10}	High output voltage Port 1 pins with LDO enabled for 1.8 V out	IOH = 1 mA, Vdd > 2.7 V, maximum of 20 mA source current in all I/Os	1.20	–	–	V
V_{OL}	Low output voltage	IOL = 25 mA, Vdd > 3.3 V, maximum of 60 mA sink current on even port pins (for example, P0[2] and P1[4]) and 60 mA sink current on odd port pins (for example, P0[3] and P1[5])	–	–	0.75	V
V_{IL}	Input low voltage	–	–	–	0.80	V
V_{IH}	Input high voltage	–	2.00	–	–	V
V_H	Input hysteresis voltage	–	–	80	–	mV
I_{IL}	Input leakage (absolute value)	–	–	0.001	1	µA
C_{PIN}	Pin capacitance	Package and pin dependent Temp = 25 °C	0.5	1.7	5	pF

Note

7. Errata: P1[3], P1[6], and P1[7] pins are susceptibleto latch up when the I/O sink current exceeds 25 mA per pin on these pins. Add a series resistor > 300 Ω to P1[3], P1[6], and P1[7] pins to restrict current to within latch up limits. For more information please refer to "Errata" on page 33.

ADC Electrical Specifications

Table 13.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 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)	–	–	–	ksps
S10	10-bit sample rate	Data Clock set to 6 MHz. Sample Rate = 0.001/ (2^Resolution/Data Clock)	–	5.859	–	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	3.2	19.2	LSB
		10-bit resolution	0	12.8	76.8	LSB
E_{gain}	Gain error	For any resolution	–5	–	+5	%FSR
Power						
I_{ADC}	Operating current	–	–	2.1	2.6	mA
PSRR	Power supply rejection ratio	PSRR (Vdd > 3.0 V)	–	24	–	dB
		PSRR (Vdd < 3.0 V)	–	30	–	dB

AC Electrical Characteristics

AC Chip Level Specifications

Table 16 lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

Table 16. AC Chip Level Specifications

Symbol	Description	Conditions	Min	Typ	Max	Units
F_{CPU}	Processing frequency		5.7	–	25.2	MHz
F_{32K1}	Internal low speed oscillator frequency	Trimmed for 3.3 V operation using factory trim values	19	32	50	kHz
F_{32K_U}	Internal low speed oscillator (ILO) untrimmed frequency)	–	13	32	82	kHz
F_{32K2}	Internal low speed oscillator frequency	Untrimmed	13	32	82	kHz
F_{IMO24}	Internal main oscillator stability for 24 MHz ± 5%	–	22.8	24	25.2	MHz
F_{IMO12}	Internal main oscillator stability for 12 MHz	–	11.4	12	12.6	MHz
F_{IMO6}	Internal main oscillator stability for 6 MHz	–	5.7	6.0	6.3	MHz
DC_{IMO}	Duty Cycle of IMO	–	40	50	60	%
DC_{ILO}	Internal low speed oscillator duty cycle	–	40	50	60	%
SR_{POWER_UP}	Power supply slew rate	–	–	–	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[17]	Applies after part has booted	10	–	–	µs

Note
17. The minimum required XRES pulse length is longer when programming the device (see Table 19 on page 25).

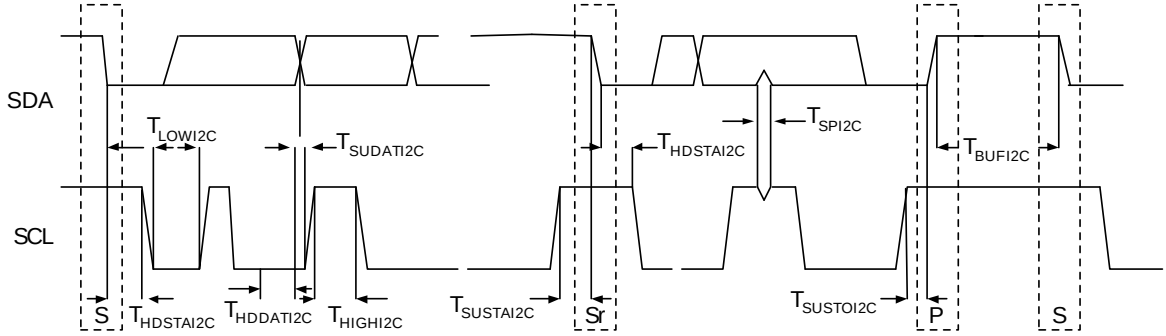
AC I²C Specifications

Table 20 lists guaranteed maximum and minimum specifications for the entire voltage and temperature ranges.

Table 20. 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	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
$T_{SUSTAI2C}$	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[18]	–	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 12. Definition of Timing for Fast/Standard Mode on the I²C Bus



Note

18. A fast mode I2C bus device can be used in a standard mode I2C bus system, but the requirement $t_{SU;DAT}$ Š 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 $t_{rmax} + t_{SU;DAT}$ = 1000 + 250 = 1250 ns (according to the standard mode I2C bus specification) before the SCL line is released.

Table 21. 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_HIGH}	MOSI high time	–	40	–	–	ns

Table 22.SPI Slave 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	–	–	12 6	MHz
T_{LOW}	SCLK low time	–	41.67	–	–	ns
T_{HIGH}	SCLK high time	–	41.67	–	–	ns
T_{SETUP}	MOSI to SCLK setup time	–	30	–	–	ns
T_{HOLD}	SCLK to MOSI hold time	–	50	–	–	ns
T_{SS_MISO}	SS high to MISO valid	–	–	–	153	ns
T_{SCLK_MISO}	SCLK to MISO valid	–	–	–	125	ns
T_{SS_HIGH}	SS high time	–	–	–	50	ns
T_{SS_CLK}	Time from SS low to first SCLK	–	2/SCLK	–	–	ns
T_{CLK_SS}	Time from last SCLK to SS high	–	2/SCLK	–	–	ns

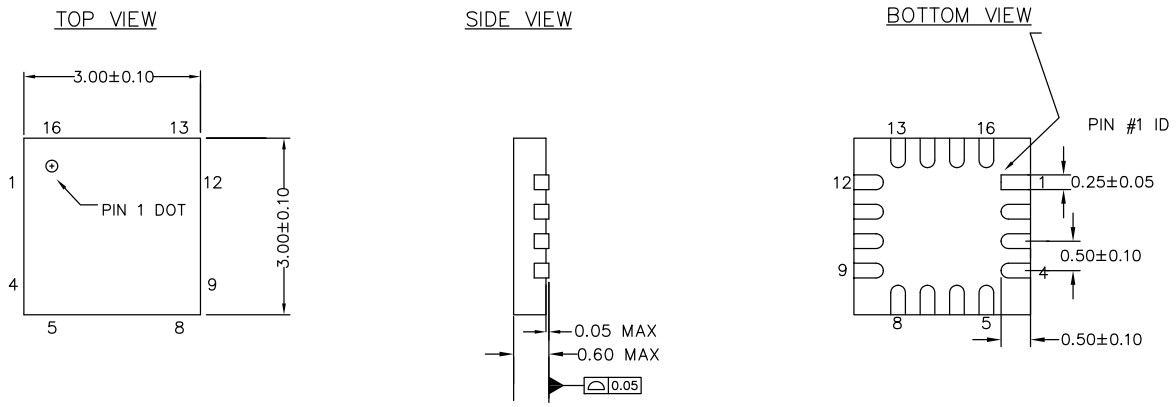
Package Diagram

This section illustrates the packaging specifications for the enCoRe V LV device, along with the thermal impedances for each package.

Important Note Emulation tools may require a larger area on the target PCB than the chip's footprint. For a detailed description of the enCoRe V LV emulation tools and their dimensions, refer to the development kit.

Packaging Dimensions

Figure 13. 16-pin Chip-On-Lead (3 × 3 × 0.6 mm) LG16A/LD16A (Sawn) Package Outline, 001-09116



NOTES
1. REFERENCE JEDEC # MO−220
2. ALL DIMENSIONS ARE IN MILLIMETERS

001-09116 *I

Package Handling

Some IC packages require baking before they are soldered onto a PCB to remove moisture that may have been absorbed after leaving the factory. A label on the package has details about the actual bake temperature and the minimum bake time to remove this moisture. The maximum bake time is the aggregate time that the parts exposed to the bake temperature. Exceeding this exposure may degrade device reliability.

Table 23.Package Handling

Parameter	Description	Minimum	Typical	Maximum	Unit
TBAKETEMP	Bake Temperature	–	125	See package label	°C
TBAKETIME	Bake Time	See package label	–	72	hours

Thermal Impedances

Package	Typical θ_{JA} (19)
16 QFN	32.69 °C/W
32 QFN(20)	19.51 °C/W
48 QFN(20)	17.68 °C/W

Capacitance on Crystal Pins

Table 24. Typical Package Capacitance on Crystal Pins

Package	Package Capacitance
32 QFN	3.2 pF
48 QFN	3.3 pF

Solder Reflow Peak Temperature

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

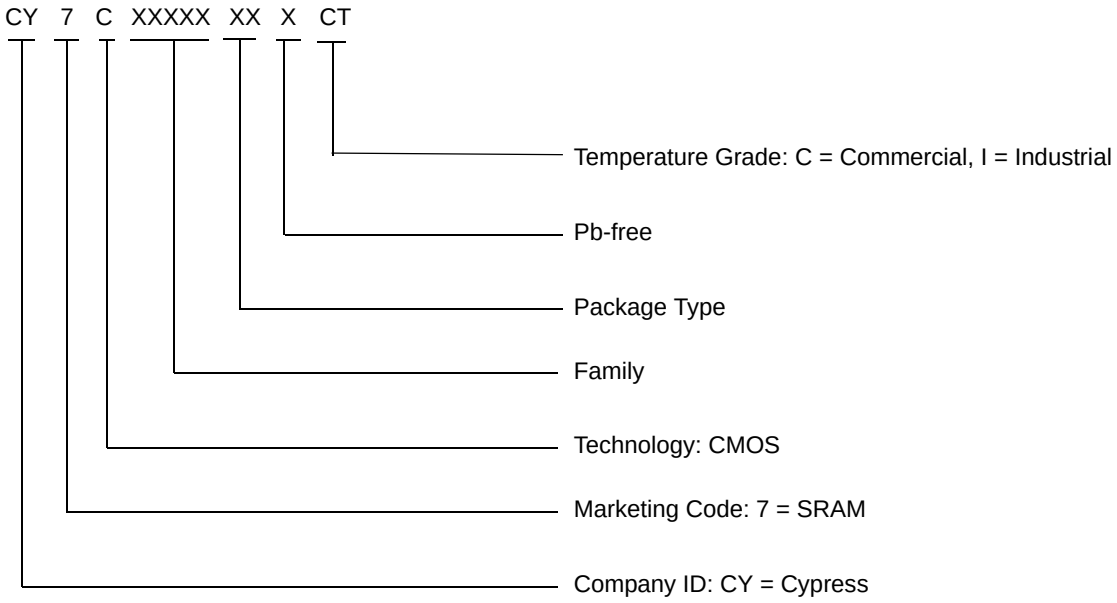
Package	Minimum Peak Temperature(21)	Maximum Peak Temperature
16 QFN	240 °C	260 °C
32 QFN	240 °C	260 °C
48 QFN	240 °C	260 °C

Notes
19. $T_J = T_A$ + Power x θ_{JA}.
20. To achieve the thermal impedance specified for the package, solder the center thermal pad to the PCB ground plane.
21. Higher temperatures may be required based on the solder melting point. Typical temperatures for solder are 220 ± 5 °C with Sn-Pb or 245 ± 5 °C with Sn-Ag-Cu paste. Refer to the solder manufacturer specifications.

Ordering Information

Ordering Code	Package Information	Flash	SRAM	No. of GPIOs	Target Applications
CY7C60413-16LKXC	16-Pin QFN (3x3 mm)	8 K	1 K	13	Feature-rich wireless mouse
CY7C64013-16LKXCT	16-Pin QFN - (Tape and Reel) (3X3 mm)	8 K	1 K	13	Feature-rich wireless mouse
CY7C60445-32LQXC	32-Pin QFN (5x5x0.55 mm)	16 K	1 K	28	Feature-rich wireless mouse
CY7C60445-32LQXCT	32-Pin QFN - (Tape and Reel) (5x5x0.55 mm)	16 K	1 K	28	Feature-rich wireless mouse
CY7C60455-48LTXC	48-Pin QFN (7x7x0.9 mm)	16 K	1 K	36	Mid-tier wireless keyboard
CY7C60455-48LTXCT	48-Pin QFN - (Tape and Reel) (7x7x0.9 mm)	16 K	1 K	36	Mid-tier wireless keyboard
CY7C60456-48LTXC	48-Pin QFN (7x7x0.9 mm)	32 K	2 K	36	Feature-rich wireless keyboard
CY7C60456-48LTXCT	48-Pin QFN - (Tape and Reel) (7x7x0.9 mm)	32 K	2 K	36	Feature-rich wireless keyboard

Ordering Code Definitions



Errata

This section describes the errata for the enCoRe V – CY7C643xx and enCoRe V LV – CY7C604xx. Details include errata trigger conditions, scope of impact, available workaround, and silicon revision applicability.

Contact your local Cypress Sales Representative if you have questions.

CY7C604xx Errata Summary

The following Errata item applies to the **CY7C643xx** and **CY7C604xx** data sheets.

1. Latch up susceptibility when maximum I/O sink current exceeded

- **PROBLEM DEFINITION**
  P1[3], P1[6], and P1[7] pins are susceptible to latch up when the I/O sink current exceeds 25 mA per pin on these pins.
- **PARAMETERS AFFECTED**
  LU – Latch up current. Per JESD78A, the maximum allowable latch up current per pin is 100 mA. Cypress internal specification is 200 mA latch up current limit.
- **TRIGGER CONDITIONS**
  Latch up occurs when both the following conditions are met:
  A. The offending I/O is externally connected to a voltage higher than the I/O high state, causing a current to flow into the pin that exceeds 25 mA.
  B. A Port1 I/O (P1[1], P1[4], and P1[5] respectively) adjacent to the offending I/O is connected to a voltage lower than the I/O low state. This causes a signal that drops below Vss (signal undershoot) and a current greater than 200 mA to flow out of the pin.
- **SCOPE OF IMPACT**
  The trigger conditions outlined in this item exceed the maximum ratings specified in the CY7C643xx and CY7C604xx data sheets.
- **WORKAROUND**
  Add a series resistor > 300 Ω to P1[3], P1[6], and P1[7] pins to restrict current to within latch up limits.
- **FIX STATUS**
  This issue will be corrected in the next new silicon revision.

Document History Page

Document Title: CY7C604XX, enCoRe™ V Low Voltage Microcontroller Document Number: 001-12395				
Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	626516	TYJ	See ECN	New data sheet
*A	735721	TYJ / ARI	See ECN	Added new block diagram, replaced TBDs, corrected values, updated pinout information, changed part number to reflect new specifications.
*B	1120504	ARI	See ECN	Corrected the description to pin 29 on Table 1, the Typ/Max values for I_{SB0} on the DC chip-level specifications, and the Min voltage value for Vdd_{IWRITE} in the DC Programming Specifications table. Corrected Flash Write Endurance minimum value in the DC Programming Specifications table. Corrected the Flash Erase Time max value and the Flash Block Write Time max value in the AC Programming Specifications table. Implemented new latest template.
*C	1225864	AESA / ARI	See ECN	Corrected the description to pin 13, 29 on Table 1 and 22,44 on Table 2. Added sections Register Reference, Register Conventions and Register Mapping Tables. Corrected Max values on the DC Chip-Level Specifications table.
*D	1446763	AESA	See ECN	Changed T_{ERASEB} parameter, max value to 18ms in Table 13, AC Programming Specification.
*E	1639963	AESA	See ECN	Post to www.cypress.com
*F	2138889	TYJ / PYRS	See ECN	Updated Ordering Code table: - Ordering code changed for 32-QFN package: From -32LKXC to -32LTXC - Added a new package type – “LTXC” for 48-QFN - Included Tape and Reel ordering code for 32-QFN and 48-QFN packages Changed active current values at 24, 12 and 6MHz in table “DC Chip-Level Specifications” - IDD24: 2.15 to 3.1mA - IDD12: 1.45 to 2.0mA - IDD6: 1.1 to 1.5mA Added information on using P1[0] and P1[1] as the I2C interface during POR or reset events

Document History Page (continued)

Document Title: CY7C604XX, enCoRe™ V Low Voltage Microcontroller Document Number: 001-12395				
Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
*N	3980412	CSAI	04/24/2013	Updated Packaging Dimensions: spec 001-09116 – Changed revision from *E to *H. spec 001-42168 – Changed revision from *D to *E. spec 001-13191 – Changed revision from *E to *G. Added Errata.
*O	4074141	CSAI	07/23/2013	Added Errata footnote (Note 7). Updated Electrical Specifications: Updated DC Electrical Characteristics: Updated DC General Purpose I/O Specifications [7]: Added Note 7 and referred the same note in the heading. Updated Errata. Updated in new template.
*P	4189348	CSAI	11/12/2013	Updated Packaging Dimensions: spec 001-09116 – Changed revision from *H to *I. Completing Sunset Review.