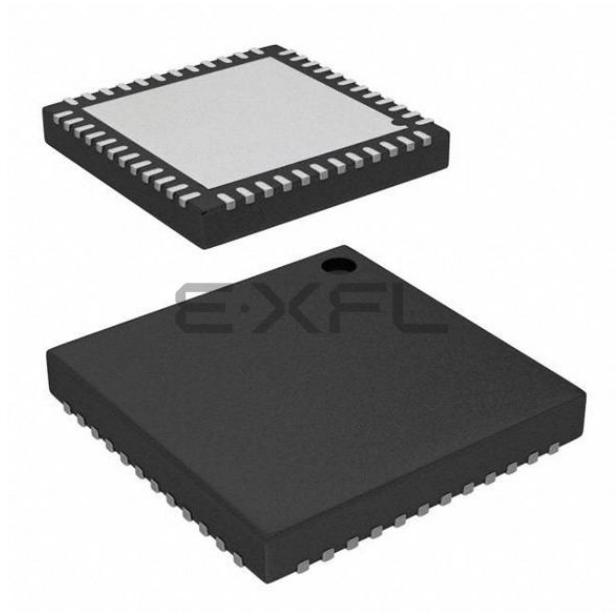

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What Are Embedded - Microcontrollers - Application Specific?

Application-specific microcontrollers are engineered to

Details	
Product Status	Obsolete
Applications	Powerline Communication
Core Processor	M8C
Program Memory Type	FLASH (32KB)
Controller Series	CY8CLED
RAM Size	2K x 8
Interface	I²C, IrDA, SPI, UART/USART
Number of I/O	44
Voltage - Supply	4.75V ~ 5.25V
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/cy8cled16p01-48ltxi

1.2.3 Coupling Circuit Reference Design

The coupling circuit couples low voltage signals from the CY8CLED16P01 to the powerline. The topology of this circuit is determined by the voltage on the powerline and design constraints mandated by powerline usage regulations.

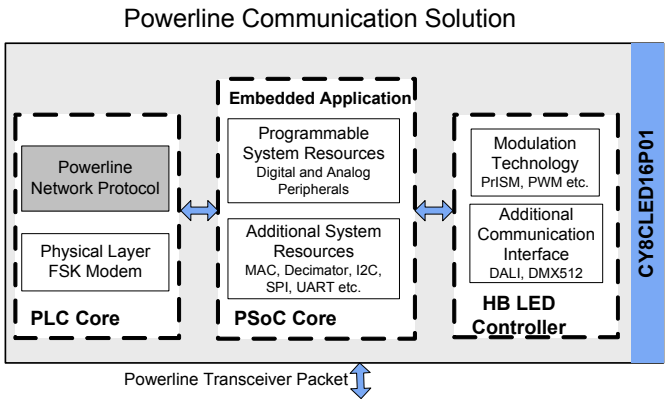
Cypress provides reference designs for a range of powerline voltages including 110V/240V AC and 12V/24V AC/DC. The CY8CLED16P01 is capable of data communication over other AC/DC Powerlines as well with the appropriate external coupling circuit. The 110V AC and 240V AC designs are compliant to the following powerline usage regulations:

- FCC Part 15 for North America
- EN 50065-1:2001 for Europe

1.3 Network Protocol

Cypress's powerline optimized network protocol performs the functions of the data link, network, and transport layers in an ISO/OSI-equivalent model.

Figure 1-3. Powerline Network Protocol



The network protocol implemented on the CY8CLED16P01 supports the following features:

- Bidirectional half duplex communication
- Master-slave or peer-to-peer network topologies
- Multiple masters on powerline network
- 8-bit logical addressing supports up to 256 powerline nodes
- 16-bit extended logical addressing supports up to 65536 powerline nodes
- 64-bit physical addressing supports up to 2^{64} powerline nodes
- Individual, broadcast or group mode addressing
- Carrier Sense Multiple Access (CSMA)
- Full control over transmission parameters
  - Acknowledged
  - Unacknowledged
  - Repeated Transmit

1.3.1 CSMA and Timing Parameters

- CSMA – The protocol provides the random selection of a period between 85 and 115 ms (out of seven possible values in this range). Within this period, the Band-In-Use (BIU) detector must indicate that the line is not in use, before attempting a transmission.
- BIU – A Band-In-Use detector, as defined under CENELEC EN 50065-1, is active whenever a signal that exceeds 86 dBμVrms anywhere in the range 131.5 kHz to 133.5 kHz is present for at least 4 ms. This threshold can be configured for different end-system applications not requiring CENELEC compliance.The modem tries to retransmit after every 85 to 115 ms when the band is in use. The transmitter times out after 1.1 seconds to 3 seconds (depending on the noise on the Powerline) and generates an interrupt to indicate that the transmitter was unable to acquire the powerline.

1.3.2 Powerline Transceiver Packet

The powerline network protocol defines a Powerline Transceiver (PLT) packet structure, which is used for data transfers between nodes across the powerline. Packet formation and data transmission across the powerline network is implemented internally in the CY8CLED16P01.

A PLT packet is divided into a variable length header (minimum 6 bytes to maximum 20 bytes, depending on address type), variable length payload (minimum 0 bytes to maximum 31 bytes), and a packet CRC byte.

This packet (preceded by a one byte preamble "0xAB") is then transmitted by the powerline modem PHY and the external coupling circuit across the powerline.

The format of the PLT packet is shown in the following table.

Table 1-1. Powerline Transceiver (PLT) Packet Structure

Byte Offset	Bit Offset							
	7	6	5	4	3	2	1	0
0x00	SA Type	DA Type		Service Type	RSVD	RSVD	Response	RSVD
0x01	Destination Address (8-Bit Logical, 16-Bit Extended Logical or 64-Bit Physical)							
0x02	Source Address (8-Bit Logical, 16-Bit Extended Logical or 64-Bit Physical)							
0x03	Command							
0x04	RSVD			Payload Length				
0x05	Seq Num				Powerline Packet Header CRC			
0x06	Payload (0 to 31 Bytes)							
	Powerline Transceiver Packet CRC							

1.3.3 Packet Header

The packet header contains the first 6 bytes of the packet when 1-byte logical addressing is used. When 8-byte physical addressing is used, the source and destination addresses each contain 8 bytes. In this case, the header can consist of a maximum of 20 bytes. Unused fields marked RSVD are for future expansion and are transmitted as bit 0. Table 1-2 describes the PLT packet header fields in detail.

Table 1-2. Powerline Transceiver (PLT) Packet Header

Field Name	No. of Bits	Tag	Description
SA Type	1	Source Address Type	0 – Logical Addressing 1 – Physical Addressing
DA Type	2	Destination Address Type	00 – Logical Addressing 01 – Group Addressing 10 – Physical Addressing 11 – Invalid
Service Type	1		0 – Unacknowledged Messaging 1 – Acknowledged Messaging
Response	1	Response	0 - Not an acknowledgement or response packet 1 - Acknowledgement or response packet
Seq Num	4	Sequence Number	4-bit unique identifier for each packet between source and destination.
Header CRC	4		4-bit CRC value. This enables the receiver to suspend receiving the rest of the packet if its header is corrupted

1.3.4 Payload

The packet payload has a length of 0 to 31 bytes. Payload content is user defined and can be read or written through I^2C.

1.3.5 Packet CRC

The last byte of the packet is an 8-bit CRC value used to check packet data integrity. This CRC calculation includes the header and payload portions of the packet and is in addition to the powerline packet header CRC.

1.3.6 Sequence Numbering

The sequence number is increased for every new unique packet transmitted. If in acknowledged mode and an acknowledgment is not received for a given packet, that packet will be re-transmitted (if TX_Retry > 0) with the same sequence number. If in unacknowledged mode, the packet will be transmitted (TX_Retry + 1) times with the same sequence number.

If the receiver receives consecutive packets from the same source address with the same sequence number and packet CRC, it does not notify the host of the reception of the duplicate packet. If in acknowledged mode, it still sends an acknowledgment so that the transmitter knows that the packet was received.

1.3.7 Addressing

The CY8CLED16P01 has three modes of addressing:

- Logical addressing: Every CY8CLED16P01 node can have either a 8-bit logical address or a 16-bit logical address. The logical address of the PLC Node is set by the local application or by a remote node on the Powerline.
- Physical addressing: Every CY8CLED16P01 has a unique 64-bit physical address.
- Group addressing: This is explained in the next section.

1.3.8 Group Membership

Group membership enables the user to multicast messages to select groups. The CY8CLED16P01 supports two types of group addressing:

- Single Group Membership – The network protocol supports up to 256 different groups on the network in this mode. In this mode, each PLC node can only be part of a single group. For example, multiple PLC nodes can be part of Group 131.
- Multiple Group Membership – The network protocol supports eight different groups in this mode and each PLC node can be a part of multiple groups. For example, a single PLC node can be a part of Group 3, Group 4, and Group 7 at the same time.

Both of these membership modes can also be used together for group membership. For example, a single PLC node can be a part of Group 131 and also multiple groups such as Group 3, Group 4, and Group 7.

The group membership ID for broadcasting messages to all nodes in the network is 0x00.

The service type is always set to Unacknowledgment Mode in Group Addressing Mode. This is to avoid acknowledgment flooding on the powerline during multicast.

1.3.9 Remote Commands

In addition to sending normal data over the Powerline, the CY8CPLC10 can also send (and request) control information to (and from) another node on the network. The type of remote command to transmit is set by the TX_CommandID register and when received, is stored in the RX_CommandID register.

When a control command (Command ID = 0x01 - 0x08 and 0x0C - 0x0F) is received, the protocol will automatically process the packet (if Lock_Configuration is '0'), respond to the initiator, and notify the host of the successful transmission and reception.

When the send data command (ID 0x09) or request for data command (ID 0x0A) is received, the protocol will reply with an acknowledgment packet (if TX_Service_Type = '1'), and notify the host of the new received data. If the initiator doesn't receive the acknowledgment packet within 500ms, it will notify the host of the no acknowledgment received condition.

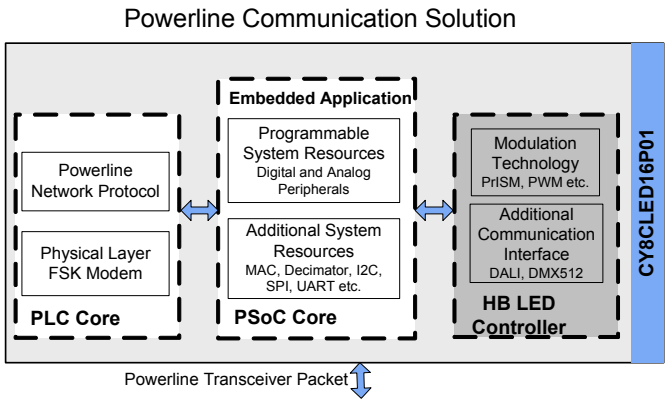
When a response command (ID 0x0B) is received by the initiator within 1.5s of sending the request for data command, the protocol will notify the host of the successful transmission and reception. If the response command is not received by the initiator within 1.5s, it will notify the host of the no response received condition.

The host is notified by updating the appropriate values in the INT_Status register (including Status_Value_Change).

The command IDs 0x30-0xff can be used for custom commands that would be processed by the external host (e.g. set an LED color, get a temperature/voltage reading). The available remote commands are described in Table 1-3 on page 5 with the respective Command IDs.

2. High Brightness (HB) LED Controller

Figure 2-1. CY8CLED16P01: HB LED Controller



The HB LED Controller is based on Cypress's EZ-Color™ technology. EZ-Color offers the ideal control solution for high brightness (HB) LED applications requiring intelligent dimming control. EZ-Color devices combine the power and flexibility of PSoC (Programmable System-on-Chip) with Cypress's PrISM™ (Precise Illumination Signal Modulation) modulation technology providing lighting designers a fully customizable and integrated lighting solution platform.

The CY8CLED16P01 supports up to 16 independent LED channels with up to 32 bits of resolution per channel, giving lighting designers the flexibility to choose the LED array size and color quality. PSoC Designer software, with lighting-specific user modules, significantly cuts development time and simplifies implementation of fixed color points through temperature and LED binning compensation. EZ-Color's virtually limitless analog and digital customization enable simple integration of features in addition to intelligent lighting, such as battery charging, image stabilization, and motor control during the development process. These features, along with Cypress's best-in-class quality and design support, make EZ-Color the ideal choice for intelligent HB LED control applications.

The list of functions that EZ-Color devices implement are:

- LED Dimming Modulation
- Pulse Density Modulation Techniques
  - DMX512
  - DALI
- Digital Communication for Lighting
- LED Temperature Compensation
- 3- and 4-Channel Color Mixing
  - Including LED Binning Compensation
- Optical Feedback Algorithms

2.1 LED Dimming Modulation

The LED Dimming modulators are an important part of any HB LED application. All EZ-Color controllers are capable of three primary types of LED dimming modulations. These are:

- Pulse Width Modulation (PWM)
- Precise Illumination Signal Modulation (PrISM)
- Delta Sigma Modulated PWM (DSPWM)

PWM is among the most commonly used and conventional methods of modulation. It is straightforward to use and effective in practice. There are two additional techniques of modulation supported by EZ-Color that are superior to using the PWM alone:

- PrISM is a modulation technique that is developed and patented by Cypress. It results in reduced EMI as compared to the PWM technique while still providing adequate dimming control for LEDs.
- The Delta Sigma Modulated PWM technique provides higher resolution while using the same hardware resources as a conventional PWM.

LED dimming modulators use digital block resources. Digital blocks are configurable 8-bit digital peripherals. There are two types of digital blocks in the CY8CLED16P01: basic and communication. Usually, there are equal numbers of each. Any communication functions must be implemented using communication blocks but basic, noncommunication functions are implemented using either kind of block.

PWM and DSPWM modulators can have a dimming resolution of up to 16 bits. A PrISM modulator can theoretically have a dimming resolution of up to 32 bits, but the maximum recommended resolution for these modulators is 13 bits. This is because the output signal of a PrISM modulator has a frequency output range that increases with the resolution of the modulator. This increase in frequency output range is undesirable as it goes beyond the switching frequency of the current driver. Therefore, a resolution of 13 bits or lower is recommended for a PrISM modulator. Refer to application note AN47372, *PrISM Technology for LED Dimming* on http://www.cypress.com, for details.

To determine the number of digital blocks used by one PWM or PrISM modulator, use Equation 1. Note that a partial digital block cannot be used, so the result must always be rounded up. In Equation 1, n is the dimming resolution of the modulator. The resolution of dimming is determined by the color accuracy needed for the end application.

$$DigBlocks_{PWM,PRISM} = \frac{n}{8} \qquad \text{Equation 1}$$

Equations 2 and 3 are used to determine how many digital blocks are needed by a DSPWM. The total dimming resolution of a DSPWM modulator is the total of the hardware PWM modulation resolution and extra resolution added by Delta Sigma modulation in the software. Equation 3 shows that the number of digital blocks needed is only determined by the hardware resolution.

$$DigBlocks_{DSPWM} = \frac{n_{HW}}{8} \quad \text{Equation 2}$$

$$n_{Total} = n_{SW} + n_{HW} \quad \text{Equation 3}$$

These equations show that more dimming resolution is achieved with a DSPWM modulator than with a PWM or PrISM modulator. A DSPWM modulator requires more code space and execution time to use.

Equations 1, 2, and 3 determine the number of digital blocks required by one modulator. The total number of blocks for all modulators is determined by adding up the digital blocks needed by each modulator used in the device.

The CY8CLED16P01 device has a variety of LED dimming configurations. Because it has 16 digital blocks, it can implement eight 16-bit PWM modulators, eight 12-bit PrISM modulators, or sixteen 12-bit DSPWM modulators (assuming the software resolution is 4 bits). As another example, it can implement four 10-bit PrISM modulators and still have 8 digital blocks left over to implement other digital functions.

The CY8CLED16P01 is a one-device solution for powerline communication and HB LED control. For an application that runs powerline communication and HB LED control simultaneously, the CY8CLED16P01 can implement four 16-bit PWM modulators, four 12-bit PrISM modulators, or eight 12-bit DSPWM modulators (assuming the software resolution is 4 bits).

2.2 Color Mixing Algorithm

Code algorithms to implement color mixing functionality work well with EZ-Color controllers. Color mixing algorithms convert a set of color coordinates that specify a color into the appropriate 8-bit dimming values for the LED dimming modulators. This enables the EZ-Color controller to be communicated on a higher level and maintain desired color and brightness levels.

The basic 3-channel color mixing firmware performing 8-bit LED dimming requires three 8-bit dimming blocks. The discussion on LED dimming modulation implies that it consumes three digital blocks. The addition of a simple temperature compensation algorithm using a thermistor consumes an additional digital block and analog block (for the ADC).

If the dimming resolution is increased, the number of digital blocks needed should be calculated accordingly.

2.3 LED Temperature Compensation

Many HB LED systems need to measure analog signals. One or more thermistors are often present to measure temperatures of the system and the LEDs. The CY8CLED16P01 measures an analog signal with an analog-to-digital converter (ADC). The device can implement a variety of flexible ADC implementations. The ADCs cover a wide range of resolutions and techniques and use varied number of digital and analog block resources. For help in selecting from this multitude of ADCs, refer to application note AN2239, *Analog – ADC Selection* on http://www.cypress.com. When designing with an EZ-Color device, the number of digital and analog blocks used by an ADC must be factored into the total number of digital and analog blocks that are used.

In a typical case, such as the 3-channel color mixing firmware IP developed by Cypress, the simple 8-bit incremental ADC is used. This module occupies one digital and one switched capacitor analog block.

Analog blocks come in two types: continuous time and switched capacitor blocks. The former enables continuous time functions such as comparators and programmable gain amplifiers. The switched capacitor blocks enable functions such as ADCs and filters.

Temperature sensors with an I^2C interface can also be used instead of raw thermistors, thereby eliminating the need for ADCs and complicated processing.

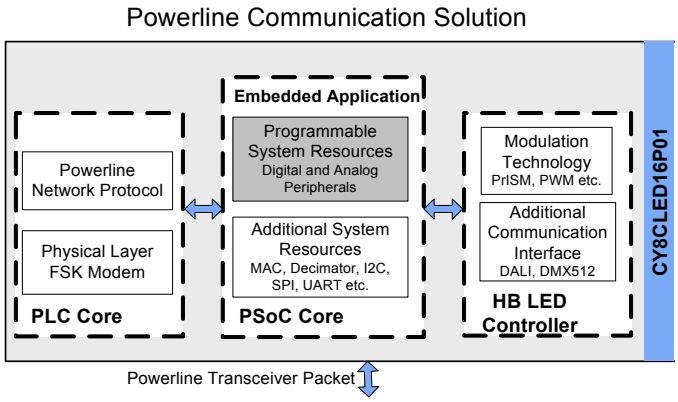
2.4 ColorLock Algorithm

ColorLock functionality uses feedback from an optical sensor in the system to adjust the LED dimming modulators correctly to “lock on” to a target color. This is similar to the concept of temperature compensation because it compensates for change in color. Instead of indirectly measuring change in color through temperature, it senses actual change in color and compensates for it.

The ColorLock algorithm implemented by Cypress requires the use of 10 digital blocks. Due to a 9-bit PrISM implementation, 6 digital blocks are used for dimming as in Equation 1. A 16-bit PWM and two 8-bit timers are also used to form the frame generator, pulse counter, and debounce counter.

3.1 Programmable System Resources

Figure 3-2. Programmable System Resources



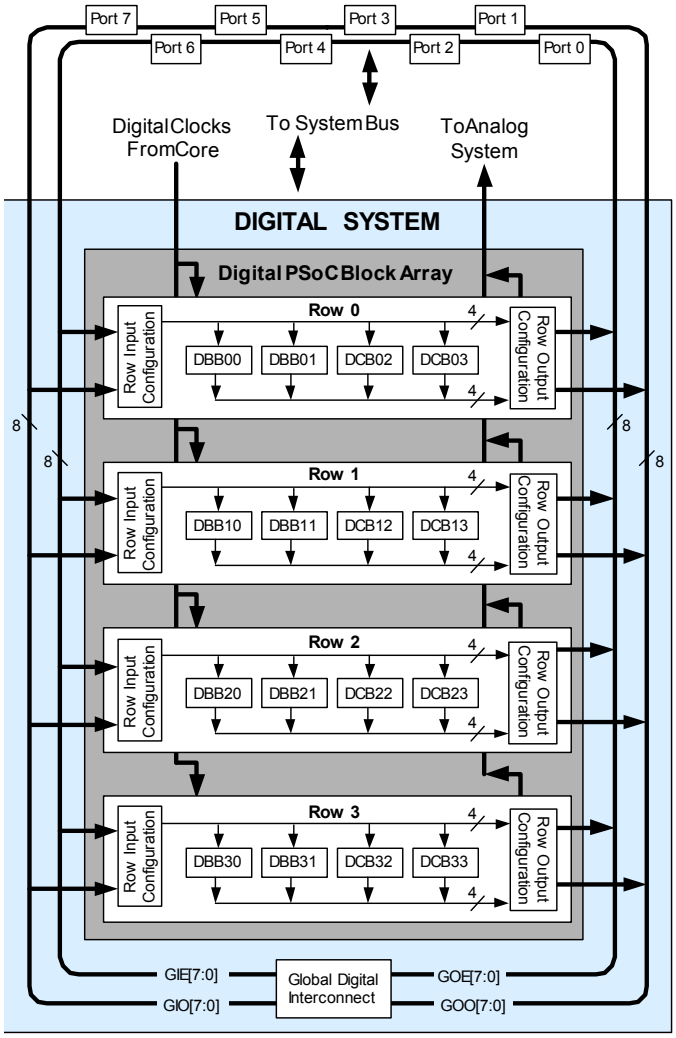
3.1.1 The Digital System

The digital system contains 16 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 called user module references. Digital peripheral configurations include:

- PWMs (8 to 32 bit)
- PWMs with Dead Band (8 to 32 bit)
- Counters (8 to 32 bit)
- Timers (8 to 32 bit)
- UART 8 bit with selectable parity (up to four)
- SPI master and slave (up to four each)
- I^2C slave and multi-master (one available as a System Resource)
- Cyclical Redundancy Checker and Generator (8 to 32 bit)
- IrDA (up to 4)
- 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 enable signal multiplexing and perform logic operations. This configurability frees your designs from the constraints of a fixed peripheral controller.

Figure 3-3. Digital System Block Diagram



5. Development Tools

PSoC Designer is a Microsoft® Windows-based, integrated development environment for the Programmable System-on-Chip (PSoC) devices. The PSoC Designer IDE runs on Windows XP or Windows Vista.

This system provides design database management by project, an integrated debugger with In-Circuit Emulator, in-system programming support, and built in support for third party assemblers and C compilers.

PSoC Designer also supports C language compilers developed specifically for the devices in the PSoC family.

5.1 PSoC Designer Software Subsystems

5.1.1 System-Level View

A drag-and-drop visual embedded system design environment based on PSoC Express. In the system level view you create a model of your system inputs, outputs, and communication interfaces. You define when and how an output device changes state based upon any or all other system devices. Based upon the design, PSoC Designer automatically selects one or more PSoC Programmable System-on-Chip Controllers that match your system requirements.

PSoC Designer generates all embedded code, then compiles and links it into a programming file for a specific PSoC device.

5.1.2 Chip-Level View

The chip-level view is a more traditional integrated development environment (IDE) based on PSoC Designer 4.4. Choose a base device to work with and then select different onboard analog and digital components called user modules that use the PSoC blocks. Examples of user modules are ADCs, DACs, Amplifiers, and Filters. Configure the user modules for your chosen application and connect them to each other and to the proper pins. Then generate your project. This prepopulates your project with APIs and libraries that you can use to program your application.

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

5.1.3 Hybrid Designs

You can begin in the system-level view, allow it to choose and configure your user modules, routing, and generate code, then switch to the chip-level view to gain complete control over on-chip resources. All views of the project share a common code editor, builder, and common debug, emulation, and programming tools.

5.1.4 Code Generation Tools

PSoC Designer supports multiple third party C compilers and assemblers. The code generation tools work seamlessly within the PSoC Designer interface and have been tested with a full range of debugging tools. The choice is yours.

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

C Language Compilers. C language compilers are available that support the PSoC family of devices. The products allow you to create complete C programs for the PSoC family devices.

The optimizing C compilers provide all the features of C tailored to the PSoC architecture. They come complete with embedded libraries providing port and bus operations, standard keypad and display support, and extended math functionality.

5.1.5 Debugger

The PSoC Designer Debugger subsystem provides hardware in-circuit emulation, allowing you to test the program in a physical system while providing an internal view of the PSoC device. Debugger commands allow 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.

5.1.6 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.

5.2 In-Circuit Emulator (ICE)

A low cost, high functionality In-Circuit Emulator (ICE) 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 operates with all PSoC devices. Emulation pods for each device family are available separately. The emulation pod takes the place of the PSoC device in the target board and performs full speed (24 MHz) operation.

6. 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.

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

1. Select Components
2. Configure Components
3. Organize and Connect
4. Generate, Verify, and Debug

6.1 Select Components

Both the system-level and chip-level views provide a library of prebuilt, pretested hardware peripheral components. In the system-level view, these components are called “drivers” and correspond to inputs (a thermistor, for example), outputs (a brushless DC fan, for example), communication interfaces (I^2C-bus, for example), and the logic to control how they interact with one another (called valuators).

In the chip-level view, the components are called “user modules”. User modules make selecting and implementing peripheral devices simple, and come in analog, digital, and programmable system-on-chip varieties.

6.2 Configure Components

Each of the components 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 Pulse Width Modulator (PWM) 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. Configure the parameters and properties to correspond to your chosen application. Enter values directly or by selecting values from drop-down menus.

Both the system-level drivers and chip-level user modules are documented in data sheets that are viewed directly in the PSoC Designer. These data sheets explain the internal operation of the component and provide performance specifications. Each data sheet describes the use of each user module parameter or driver property, and other information you may need to successfully implement your design.

6.3 Organize and Connect

You can build signal chains at the chip level by interconnecting user modules to each other and the IO pins, or connect system level inputs, outputs, and communication interfaces to each other with valuator functions.

In the system-level view, selecting a potentiometer driver to control a variable speed fan driver and setting up the valuators to control the fan speed based on input from the pot selects, places, routes, and configures a programmable gain amplifier (PGA) to buffer the input from the potentiometer, an analog to digital converter (ADC) to convert the potentiometer’s output to a digital signal, and a PWM to control the fan.

In the chip-level view, perform the selection, configuration, and routing so that you have complete control over the use of all on-chip resources.

6.4 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 Application” step. This causes PSoC Designer to generate source code that automatically configures the device to your specification and provides the software for the system.

Both system-level and chip-level designs generate software based on your design. The chip-level design provides application programming interfaces (APIs) with high level functions to control and respond to hardware events at run time and interrupt service routines that you can adapt as needed. The system-level design also generates a C `main()` program that completely controls the chosen application and contains placeholders for custom code at strategic positions allowing you to further refine the software without disrupting the generated code.

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

The last step in the development process takes place inside the PSoC Designer’s Debugger subsystem. The Debugger downloads the HEX image to the 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.

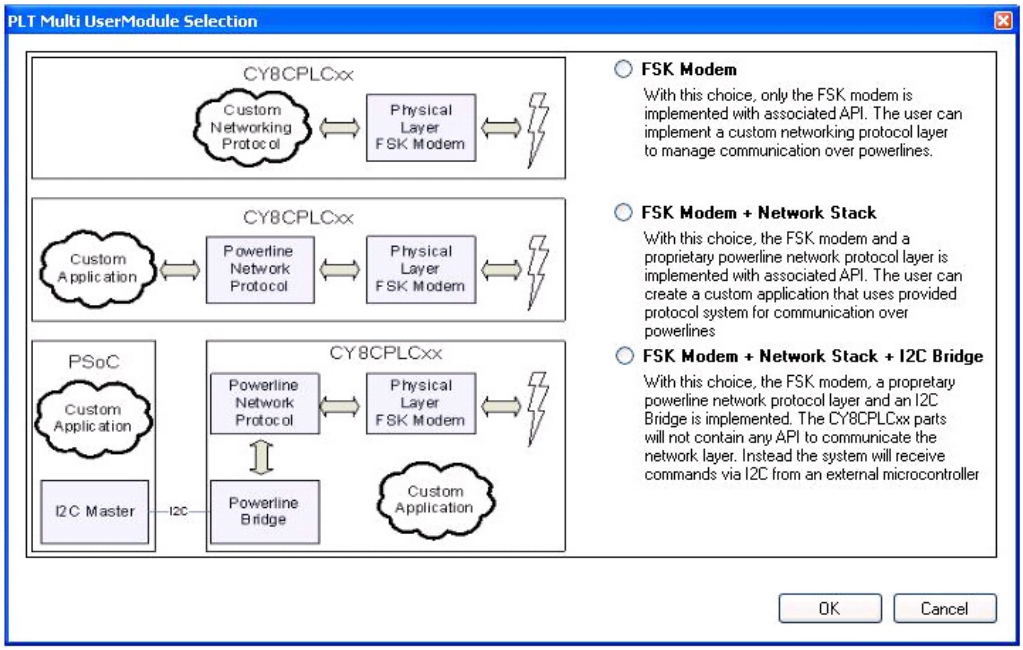
6.5 PLC User Modules

The CY8CLEDP01 has the Powerline Transceiver (PLT) User Module in PSoC Designer 5.0 SP5 or later. The PLT User Module (UM) enables data communication over powerlines up to baud rates of 2400 bps. This UM also exposes all the APIs from the network protocol for ease of application development. The UM, when instantiated, provides the user with three implementation modes:

- **FSK Modem Only** – This mode enables the user to use the raw FSK modem and build any network protocol or application with the help of the APIs generated by the modem PHY.
- **FSK Modem + Network Stack** – This mode allows the user to use the Cypress network protocol for PLC and build any application with the APIs provided by the network protocol.
- **FSK Modem + Network Stack + I2C** – This mode allows the user to interface the CY8CLEDP01 with any other microcontroller or PSoC device. Users can also split the application between the PLC device and the external microcontroller. If the external microcontroller is a PSoC device, then the I2C UMs can be used to interface it with the PLC device.

Figure 6-1. shows the starting window for the PLT UM with the three implementation modes from which the user can choose.

Figure 6-1. PLT User Module



Refer to the application note AN55403 - "Estimating CY8CPLC20/CY8CLED16P01 Power Consumption" to determine the power consumption estimate of the CY8CLED16P01 chip with the PLT User Module, loaded along with the other User Modules.

6.1 Intelligent Lighting User Modules

The CY8CLED16P01 has the intelligent lighting control user modules along with the PLC user modules. These user modules enable the user to do the following:

- Control multiple channels, anywhere between 1 and 16.
- Enable temperature compensation and color feedback
- Provide algorithms for high CRI
- Control color with 1931 or 1976 gamuts and through CCT
- Provide additional communication interfaces such as DALI and DMX512

8. Pin Information

The CY8CLED16P01 PLC device is available in a variety of packages which are listed and illustrated in the following tables. Every port pin (labeled with a “P”) is capable of Digital I/O. However, Vss, Vdd, and XRES are not capable of Digital I/O.

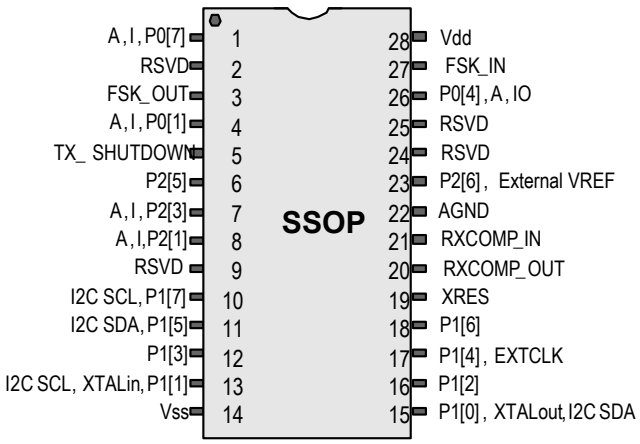
8.1 28-Pin Part Pinout

Table 8-1. 28-Pin Part Pinout (SSOP)

Pin No.	Type		Pin Name	Description
	Digital	Analog		
1	IO	I	P0[7]	Analog Column Mux Input
2	Reserved		RSVD	Reserved
3		O	FSK_OUT	Analog FSK Output
4	IO	I	P0[1]	Analog Column Mux Input
5	O		TX_SHUT DOWN	Output to disable PLC transmit circuitry in receive mode Logic ‘0’ - When the Modem is trans-mitting Logic ‘1’ - When the Modem is not transmitting
6	IO		P2[5]	
7	IO	I	P2[3]	Direct switched capacitor block input
8	IO	I	P2[1]	Direct switched capacitor block input
9	Reserved		RSVD	Reserved
10	IO		P1[7]	I2C Serial Clock (SCL)
11	IO		P1[5]	I2C Serial Data (SDA)
12	IO		P1[3]	XTAL_STABILITY. Connect a 0.1 uF capacitor between the pin and VSS.
13	IO		P1[1]	Crystal (XTALin)[2], ISSP-SCLK[1], I2C SCL
14	Power		Vss	Ground connection.
15	IO		P1[0]	Crystal (XTALout)[2], ISSP-SDATA[1], I2C SDA
16	IO		P1[2]	
17	IO		P1[4]	Optional External Clock Input (EXTCLK)[2]
18	IO		P1[6]	
19	Input		XRES	Active high external reset with internal pull down
20		O	RXCOMP_ OUT	Analog Output to external Low Pass Filter Circuitry
21		I	RXCOMP_ IN	Analog Input from the external Low Pass Filter Circuitry
22	Analog Ground		AGND	Analog Ground
23	IO		P2[6]	External Voltage Reference (VREF)
24	Reserved		RSVD	Reserved
25	Reserved		RSVD	Reserved
26	IO	IO	P0[4]	Analog column mux input and column output
27		I	FSK_IN	Analog FSK Input
28	Power		Vdd	Supply Voltage

LEGEND: A = Analog, I = Input, O = Output, and RSVD = Reserved (should be left unconnected).

Figure 8-1. CY8CLED16P01 28-Pin PLC Device



Notes
1. These are the ISSP pins, which are not High Z at POR (Power On Reset). See the *PSoC Technical Reference Manual* for details.
2. When using the PLT user module, the external crystal is always required for protocol timing. For the FSK modem, either the PLL Mode should be enabled or the external 24MHz on P1[4] should be selected. The IMO should not be used.

8.1 100-Pin Part Pinout (On-Chip Debug)

The 100-pin TQFP part is for the CY8CLED16P01-OCD On-Chip Debug PLC device. Note that the OCD parts are only used for in-circuit debugging. OCD parts are not available for production.

Table 8-3. 100-Pin OCD Part Pinout (TQFP)

Pin No.	Digital	Analog	Name	Description	Pin No.	Digital	Analog	Name	Description
1			NC	No Connection	51			NC	No Connection
2			NC	No Connection	52	IO		P5[0]	
3	IO	I	P0[1]	Analog Column Mux Input	53	IO		P5[2]	
4	O		TX_SHUTDOWN	Output to disable transmit circuitry in receive mode Logic '0' - When the Modem is transmitting Logic '1' - When the Modem is not transmitting	54	IO		P5[4]	
5	IO		P2[5]		55	IO		P5[6]	
6	IO	I	P2[3]	Direct switched capacitor block input	56	IO		P3[0]	
7	IO	I	P2[1]	Direct switched capacitor block input	57	IO		P3[2]	
8	IO		P4[7]		58	IO		P3[4]	
9	IO		P4[5]		59	IO		P3[6]	
10	IO		P4[3]		60			HCLK	OCD high speed clock output
11	IO		P4[1]		61			CCLK	OCD CPU clock output
12			OCDE	OCD even data I/O	62	Input		XRES	Active high pin reset with internal pull down
13			OCDO	OCD odd data output	63	IO		P4[0]	
14	Reserved		RSVD	Reserved	64	IO		P4[2]	
15	Power		Vss	Ground Connection	65	Power		Vss	Ground Connection
16	IO		P3[7]		66	IO		P4[4]	
17	IO		P3[5]		67	IO		P4[6]	
18	IO		P3[3]		68		O	RXCOMP_OUT	Analog Output to external Low Pass Filter Circuitry
19	IO		P3[1]		69		I	RXCOMP_IN	Analog Input from external Low Pass Filter Circuitry
20	IO		P5[7]		70	Ground		AGND	Analog Ground
21	IO		P5[5]		71			NC	No Connection
22	IO		P5[3]		72	IO		P2[6]	External Voltage Reference (VREF) input
23	IO		P5[1]		73			NC	No Connection
24	IO		P1[7]	I2C Serial Clock (SCL)	74	Reserved		RSVD	Reserved
25			NC	No Connection	75			NC	No Connection
26			NC	No Connection	76			NC	No Connection
27			NC	No Connection	77	Reserved		RSVD	Reserved
28	IO		P1[5]	I2C Serial Data (SDA)	78			NC	No Connection
29	IO		P1[3]	I_{FMTEST}, XTAL_STABILITY. Connect a 0.1 uF capacitor between the pin and VSS.	79	IO	IO	P0[4]	Analog column mux input and column output, VREF
30	IO		P1[1]*	Crystal (XTALin)[2], I2C Serial Clock (SCL), TC SCLK	80			NC	No Connection
31			NC	No Connection	81		I	FSK_IN	Analog FSK Input
32	Power		Vdd	Supply Voltage	82	Power		Vdd	Supply Voltage
33			NC	No Connection	83	Power		Vdd	Supply Voltage
34	Power		Vss	Ground Connection	84	Power		Vss	Ground Connection
35			NC	No Connection	85	Power		Vss	Ground Connection
36	IO		P7[7]		86	IO		P6[0]	
37	IO		P7[6]		87	IO		P6[1]	
38	IO		P7[5]		88	IO		P6[2]	
39	IO		P7[4]		89	IO		P6[3]	
40	IO		P7[3]		90	IO		P6[4]	
41	IO		P7[2]		91	IO		P6[5]	
42	IO		P7[1]		92	IO		P6[6]	
43	IO		P7[0]		93	IO		P6[7]	
44	IO		P1[0]*	Crystal (XTALout)[2], I2C Serial Data (SDA), TC SDATA	94			NC	No Connection
45	IO		P1[2]	V_{FMTEST}	95	IO	I	P0[7]	Analog Column Mux Input
46	IO		P1[4]	Optional External Clock Input (EXTCLK)[2]	96			NC	No Connection
47	IO		P1[6]		97	Reserved		RSVD	Reserved
48			NC	No Connection	98			NC	No Connection
49			NC	No Connection	99		O	FSK_OUT	Analog FSK Output
50			NC	No Connection	100			NC	No Connection

LEGEND A = Analog, I = Input, O = Output, NC = No Connection, TC/TM: Test, TC/TM: Test, RSVD = Reserved (should be left unconnected).

10.3.3 DC Operational Amplifier Specifications

The following tables list guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 85°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

The Operational Amplifier is a component of both the Analog Continuous Time PSoC blocks and the Analog Switched Capacitor PSoC blocks. The guaranteed specifications are measured in the Analog Continuous Time PSoC block. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 10-6. 5V DC Operational Amplifier Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
V_{OSOA}	Input Offset Voltage (Absolute Value) Power = Low, Opamp Bias = High Power = Medium, Opamp Bias = High Power = High, Opamp Bias = High	 – – –	 1.6 1.3 1.2	 10 8 7.5	 mV mV mV	
TCV_{OSOA}	Average Input Offset Voltage Drift	–	7.0	35.0	µV/°C	
I_{EBOA}	Input Leakage Current (Port 0 Analog Pins)	–	200	–	pA	Gross tested to 1 µA.
C_{INOA}	Input Capacitance (Port 0 Analog Pins)	–	4.5	9.5	pF	Package and pin dependent. Temp = 25°C.
V_{CMOA}	Common Mode Voltage Range. All cases, except highest. Power = High, Opamp Bias = High	0.0 0.5	– –	Vdd Vdd - 0.5	V V	
$CMRR_{OA}$	Common Mode Rejection Ratio	60	–	–	dB	
G_{OLOA}	Open Loop Gain	80	–	–	dB	
$V_{OHIGHOA}$	High Output Voltage Swing (Internal Signals)	Vdd - 0.01	–	–	V	
V_{OLOWOA}	Low Output Voltage Swing (Internal Signals)	–	–	0.1	V	
I_{SOA}	Supply Current (including associated AGND buffer) Power = Low, Opamp Bias = Low Power = Low, Opamp Bias = High Power = Medium, Opamp Bias = Low Power = Medium, Opamp Bias = High Power = High, Opamp Bias = Low Power = High, Opamp Bias = High	 – – – – – –	 150 300 600 1200 2400 4600	 200 400 800 1600 3200 6400	 µA µA µA µA µA µA	
$PSRR_{OA}$	Supply Voltage Rejection Ratio	67	80	–	dB	Vss ≤ VIN ≤ (Vdd - 2.25) or (Vdd - 1.25V) ≤ VIN ≤ Vdd.

10.3.4 DC Low Power Comparator 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. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 10-7. DC Low Power Comparator Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
V_{REFLPC}	Low Power Comparator (LPC) Reference Voltage Range	0.2	–	Vdd - 1	V	
I_{SLPC}	LPC Supply Current	–	10	40	µA	
V_{OSLPC}	LPC Voltage Offset	–	2.5	30	mV	

10.3.9 DC Programming Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 85°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 10-12. DC Programming Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
I_{DDP}	Supply Current During Programming or Verify	–	10	30	mA	
V_{ILP}	Input Low Voltage During Programming or Verify	–	–	0.8	V	
V_{IHP}	Input High Voltage During Programming or Verify	2.2	–	–	V	
I_{ILP}	Input Current when Applying V_{ILP} to P1[0] or P1[1] During Programming or Verify	–	–	0.2	mA	Driving internal pull down resistor
I_{IHP}	Input Current when Applying V_{IHP} to P1[0] or P1[1] During Programming or Verify	–	–	1.5	mA	Driving internal pull down resistor
V_{OLV}	Output Low Voltage During Programming or Verify	–	–	Vss + 0.75	V	
V_{OHV}	Output High Voltage During Programming or Verify	Vdd - 1.0	–	Vdd	V	
$Flash_{ENPB}$	Flash Endurance (per block)	50,000	–	–	–	Erase/write cycles per block
$Flash_{ENT}$	Flash Endurance (total)[5]	1,800,000	–	–	–	Erase/write cycles
$Flash_{DR}$	Flash Data Retention	10	–	–	Years	

10.4 AC Electrical Characteristics

10.4.1 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. Typical parameters apply to 5V at 25°C and are for design guidance only.

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

Table 10-13. AC Chip-Level Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
F_{IMO24}	Internal Main Oscillator Frequency for 24 MHz	23.4	24	24.6	MHz	Trimmed for 5V operation using factory trim values. SLIMO Mode = 0.
F_{IMO6}	Internal Main Oscillator Frequency for 6 MHz	5.5	6	6.5[6]	MHz	Trimmed for 5V operation using factory trim values. SLIMO Mode = 1.
F_{CPU1}	CPU Frequency (5V Nominal)	0.93	24	24.6[6]	MHz	
F_{48M}	Digital PSoC Block Frequency	0	48	49.2[6, 7]	MHz	Refer to the AC Digital Block Specifications below.
F_{32K1}	Internal Low Speed Oscillator Frequency	15	32	64	kHz	
F_{32K2}	External Crystal Oscillator	–	32.768	–	kHz	Accuracy is capacitor and crystal dependent. 50% duty cycle.

Notes
5. A maximum of 36 x 50,000 block endurance cycles is allowed. This may be balanced between operations on 36x1 blocks of 50,000 maximum cycles each, 36x2 blocks of 25,000 maximum cycles each, or 36x4 blocks of 12,500 maximum cycles each (to limit the total number of cycles to 36x50,000 and that no single block ever sees more than 50,000 cycles). For the full industrial range, the user must employ a temperature sensor user module (FlashTemp) and feed the result to the temperature argument before writing. Refer to the Flash APIs Application Note AN2015 at http://www.cypress.com under Application Notes for more information.
6. Accuracy derived from Internal Main Oscillator with appropriate trim for Vdd range.
7. See the individual user module data sheets for information on maximum frequencies for user modules.

Figure 10-2. PLL Lock for Low Gain Setting Timing Diagram

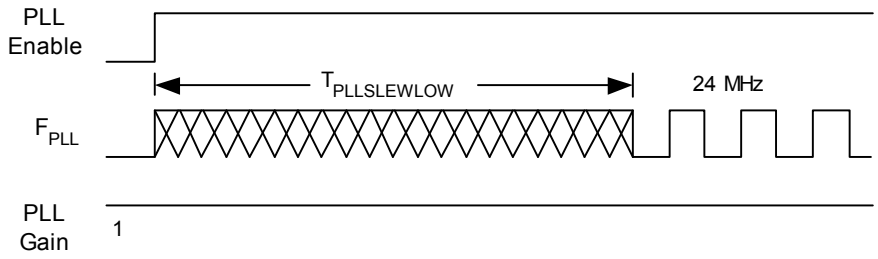


Figure 10-3. External Crystal Oscillator Startup Timing Diagram

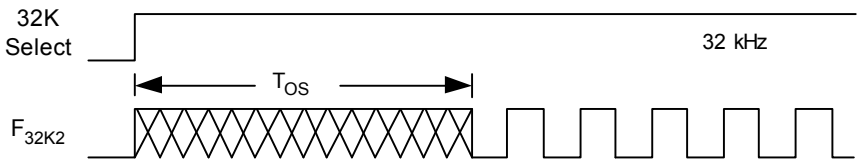


Figure 10-4. 24 MHz Period Jitter (IMO) Timing Diagram

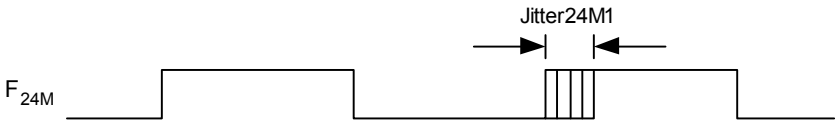
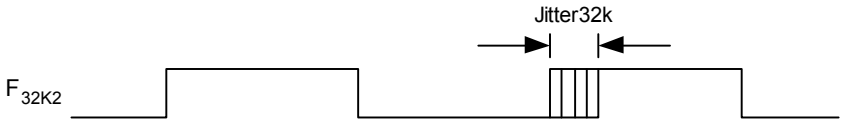


Figure 10-5. 32 kHz Period Jitter (ECO) Timing Diagram



10.4.2 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 ≤ T_A ≤ 85°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 10-14. AC GPIO Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
F_{GPIO}	GPIO Operating Frequency	0	–	12.3	MHz	Normal Strong Mode
TRiseF	Rise Time, Normal Strong Mode, Cload = 50 pF	3	–	18	ns	10% - 90%
TFallF	Fall Time, Normal Strong Mode, Cload = 50 pF	2	–	18	ns	10% - 90%
TRiseS	Rise Time, Slow Strong Mode, Cload = 50 pF	10	27	–	ns	10% - 90%
TFallS	Fall Time, Slow Strong Mode, Cload = 50 pF	10	22	–	ns	10% - 90%

10.4.5 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. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 10-17. AC Digital Block Specifications

Function	Description	Min	Typ	Max	Units	Notes
All Functions	Maximum Block Clocking Frequency			49.2	MHz	
Timer	Capture Pulse Width	50[9]	–	–	ns	
	Maximum Frequency, No Capture	–	–	49.2	MHz	
	Maximum Frequency, With Capture	–	–	24.6	MHz	
Counter	Enable Pulse Width	50[9]	–	–	ns	
	Maximum Frequency, No Enable Input	–	–	49.2	MHz	
	Maximum Frequency, Enable Input	–	–	24.6	MHz	
Dead Band	Kill Pulse Width:					
	Asynchronous Restart Mode	20	–	–	ns	
	Synchronous Restart Mode	50[9]	–	–	ns	
	Disable Mode	50[9]	–	–	ns	
	Maximum Frequency	–	–	49.2	MHz	
CRCPRS (PRS Mode)	Maximum Input Clock Frequency	–	–	49.2	MHz	
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[8]	–	–	ns	
Transmitter	Maximum Input Clock Frequency Vdd ≥ 4.75V, 2 Stop Bits	– –	– –	24.6 49.2	MHz MHz	Maximum data rate at 3.08 MHz due to 8 x over clocking. Maximum data rate at 6.15 MHz due to 8 x over clocking.
Receiver	Maximum Input Clock Frequency Vdd ≥ 4.75V, 2 Stop Bits	– –	– –	24.6 49.2	MHz MHz	Maximum data rate at 3.08 MHz due to 8 x over clocking. Maximum data rate at 6.15 MHz due to 8 x over clocking.

Note
8. 50 ns minimum input pulse width is based on the input synchronizers running at 24 MHz (42 ns nominal period).

10.4.6 AC Analog Output Buffer 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. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 10-18. 5V AC Analog Output Buffer Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
T_{ROB}	Rising Settling Time to 0.1%, 1V Step, 100 pF Load Power = Low Power = High	 – –	 – –	 4 4	 µs µs	
T_{SOB}	Falling Settling Time to 0.1%, 1V Step, 100 pF Load Power = Low Power = High	 – –	 – –	 3.4 3.4	 µs µs	
SR_{ROB}	Rising Slew Rate (20% to 80%), 1V Step, 100 pF Load Power = Low Power = High	 0.5 0.5	 – –	 – –	 V/µs V/µs	
SR_{FOB}	Falling Slew Rate (80% to 20%), 1V Step, 100 pF Load Power = Low Power = High	 0.55 0.55	 – –	 – –	 V/µs V/µs	
BW_{OB}	Small Signal Bandwidth, 20mV_{pp}, 3 dB BW, 100 pF Load Power = Low Power = High	 0.8 0.8	 – –	 – –	 MHz MHz	
BW_{OB}	Large Signal Bandwidth, 1V_{pp}, 3 dB BW, 100 pF Load Power = Low Power = High	 300 300	 – –	 – –	 kHz kHz	

10.4.7 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. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 10-19. 5V AC External Clock Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
F_{OSCEXT}	Frequency	0.093	–	24.6	MHz	
–	High Period	20.6	–	5300	ns	
–	Low Period	20.6	–	–	ns	
–	Power Up IMO to Switch	150	–	–	µs	

10.4.8 AC Programming Specifications

The following table lists guaranteed maximum and minimum specifications for the voltage and temperature ranges: 4.75V to 5.25V and -40°C ≤ T_A ≤ 85°C. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 10-20. AC Programming Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
T_{RSCLK}	Rise Time of SCLK	1	–	20	ns	
T_{FSCLK}	Fall Time of SCLK	1	–	20	ns	
T_{SSCLK}	Data 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)	–	10	–	ms	
T_{WRITE}	Flash Block Write Time	–	40	–	ms	

Table 10-20. AC Programming Specifications (continued)

Symbol	Description	Min	Typ	Max	Units	Notes
T_{DSCLK}	Data Out Delay from Falling Edge of SCLK	–	–	45	ns	
$T_{ERASEALL}$	Flash Erase Time (Bulk)	–	80	–	ms	Erase all Blocks and protection fields at once
$T_{PROGRAM\_HOT}$	Flash Block Erase + Flash Block Write Time	–	–	100[9]	ms	0°C <= Tj <= 100°C
$T_{PROGRAM\_COLD}$	Flash Block Erase + Flash Block Write Time	–	–	200[9]	ms	-40°C <= Tj <= 0°C

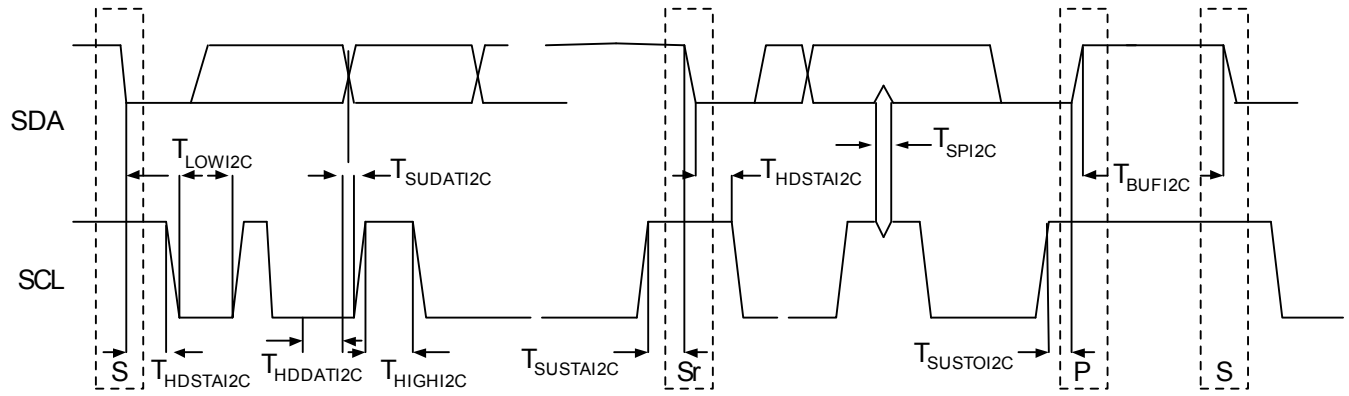
10.4.9 AC I²C Specifications

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. Typical parameters apply to 5V at 25°C and are for design guidance only.

Table 10-21. AC Characteristics of the I²C SDA and SCL Pins

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	
$T_{SUSTAI2C}$	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[10]	–	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	

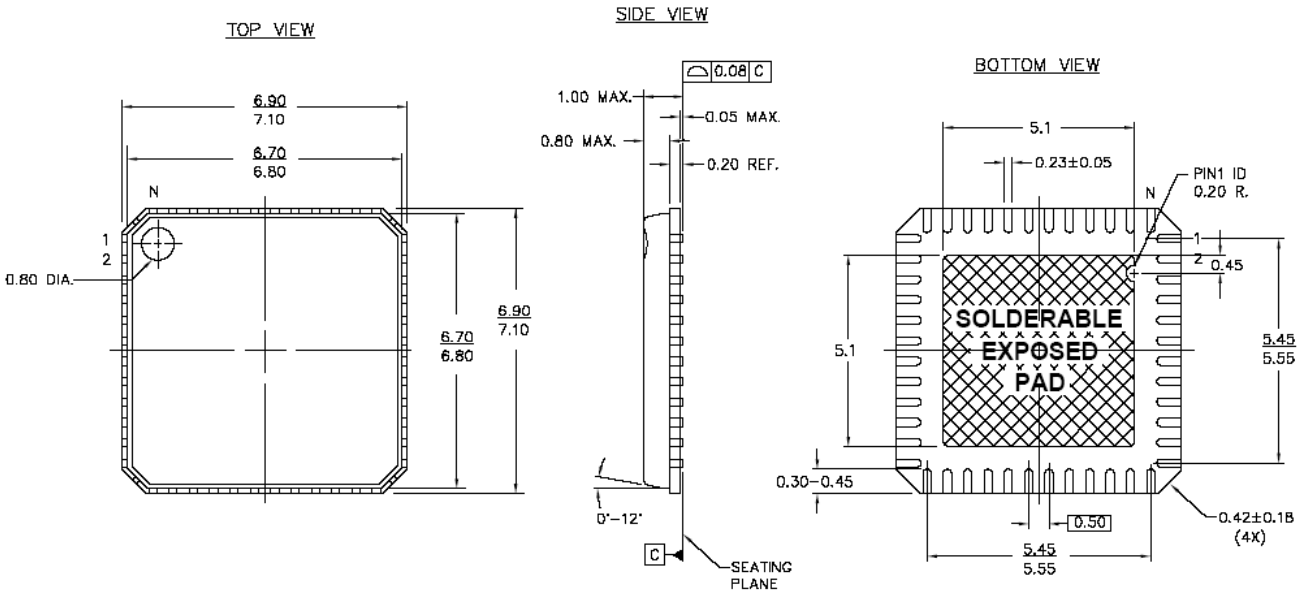
Figure 10-9. Definition for Timing for Fast/Standard Mode on the I²C Bus Packaging Dimensions



Notes

9. For the full industrial range, the user must employ a temperature sensor user module (FlashTemp) and feed the result to the temperature argument before writing. Refer to the Flash APIs Application Note AN2015 at http://www.cypress.com for more information.
10. 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 is automatically the case if the device does not stretch the LOW period of the SCL signal. If this 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 11-2. 48-Pin (7x7 mm) QFN



NOTES:

1. HATCH AREA IS SOLDERABLE EXPOSED METAL.
2. REFERENCE JEDEC#: MO-220
3. PACKAGE WEIGHT: 0.13g
4. ALL DIMENSIONS ARE IN MM [MIN/MAX]
5. PACKAGE CODE

PART #	DESCRIPTION
LF48A	STANDARD
LY48A	LEAD FREE

001-12919 *A

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

Important Note Pinned vias for thermal conduction are not required for the low-power PSoC devices.

12.3 Evaluation Kits

The evaluation kits do not have on-board powerline capability, but can be used with a PLC kit for evaluation purposes. All evaluation tools are sold at the Cypress Online Store.

12.3.1 CY3210-MiniProg1

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

- MiniProg Programming Unit
- MiniEval Socket Programming and Evaluation Board
- 28-Pin CY8C29466-24PXI PDIP PSoC Device Sample
- 28-Pin CY8C27443-24PXI PDIP PSoC Device Sample
- PSoC Designer Software CD
- Getting Started Guide
- USB 2.0 Cable

12.3.2 CY3210-PSoCEval1

The CY3210-PSoCEval1 kit features an evaluation board and the MiniProg1 programming unit. The evaluation board includes an LCD module, potentiometer, LEDs, and plenty of bread boarding space to meet all of your evaluation needs. The kit includes:

- Evaluation Board with LCD Module
- MiniProg Programming Unit
- 28-Pin CY8C29466-24PXI PDIP PSoC Device Sample (2)
- PSoC Designer Software CD
- Getting Started Guide
- USB 2.0 Cable

12.3.3 CY3214-PSoCEvalUSB

The CY3214-PSoCEvalUSB evaluation kit features a development board for the CY8C24794-24LFXI PSoC device. Special features of the board include both USB and capacitive sensing development and debugging support. This evaluation board also includes an LCD module, potentiometer, LEDs, an enunciator, and plenty of bread boarding space to meet all of your evaluation needs. The kit includes:

- PSoCEvalUSB Board
- LCD Module
- MIniProg Programming Unit
- Mini USB Cable
- PSoC Designer and Example Projects CD
- Getting Started Guide
- Wire Pack

12.4 Device Programmers

All device programmers are purchased from the Cypress Online Store.

12.4.1 CY3216 Modular Programmer

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

- Modular Programmer Base
- Three Programming Module Cards
- MiniProg Programming Unit
- PSoC Designer Software CD
- Getting Started Guide
- USB 2.0 Cable

12.4.2 CY3207 ISSP In-System Serial Programmer (ISSP)

The CY3207ISSP is a production programmer. It includes protection circuitry and an industrial case that is more robust than the MiniProg in a production programming environment.

Note that CY3207ISSP needs special software and is not compatible with PSoC Programmer. The kit includes:

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

12.4.3 Third Party Tools

Several tools are specially designed by the following third party vendors to accompany PSoC devices during development and production. Specific details of each of these tools are found at http://www.cypress.com under Support.

12.4.4 Build a PSoC Emulator into Your Board

For details on emulating the circuit before going to volume production using an on-chip debug (OCD) non-production PSoC device, see Application Note AN2323 *Debugging - Build a PSoC Emulator into Your Board* at http://www.cypress.com/design/AN2323.

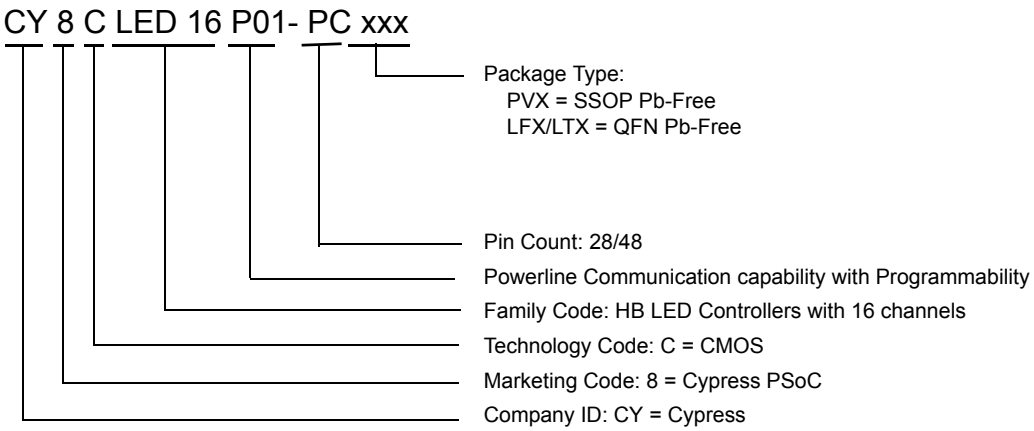
13. Ordering Information

The following table lists the CY8CLED16P01 PLC device family key package features and ordering codes.

Table 13-1. CY8CLED16P01 PLC Device Key Features and Ordering Information

Package	Ordering Code	Flash (Bytes)	RAM (Bytes)	Temperature Range	Digital PSoC Blocks	Analog PSoC Blocks	Digital IO Pins	Analog Inputs	Analog Outputs	XRES Pin
28-Pin (210 Mil) SSOP	CY8CLED16P01-28PVXI	32K	2K	-40°C to +85°C	16	12	24	12	4	Yes
28-Pin (210 Mil) SSOP (Tape and Reel)	CY8CLED16P01-28PVXIT	32K	2K	-40°C to +85°C	16	12	24	12	4	Yes
48-Pin QFN	CY8CLED16P01-48LFXI	32K	2K	-40°C to +85°C	16	12	44	12	4	Yes
48-Pin QFN (Sawn)	CY8CLED16P01-48LTXI	32K	2K	-40°C to +85°C	16	12	44	12	4	Yes
48-Pin QFN (Sawn) (Tape and Reel)	CY8CLED16P01-48LTXIT	32K	2K	-40°C to +85°C	16	12	44	12	4	Yes
100-Pin OCD TQFP[14]	CY8CLED16P01-OCD	32K	2K	-40°C to +85°C	16	12	64	12	4	Yes

14. Ordering Code Definitions



Note
14. This part may be used for in-circuit debugging. It is not available for production.

15. Document History Page

Document Title: CY8CLED16P01 Powerline Communication Solution Document Number: 001-49263				
Rev.	**ECN No.**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	2575716	GHH/PYRS	10/01/08	New Datasheet
*A	2731927	GHH/HMT/ DSG	07/06/09	Added - Configurable baud rates and FSK Frequencies - PLC Pod Kits for development purposes Modified - Pin information for all packages
*B	2748537	GHH	See ECN	Added Sections on ‘Getting Started’ and ‘Document Conventions’ Modified the following Electrical Parameters - FIMO6 Min: Changed from 5.75 MHz to 5.5 MHz - FIMO6 Max: Changed from 6.35 MHz to 6.5 MHz - SPIS (Maximum input clock frequency): Changed from 4.1 ns to 4.1 MHz - TWRITE (Flash Block Write Time): Changed from 40 ms to 10 ms
*C	2752799	GHH	08/17/09	Posting to external web.
*D	2759000	GHH	09/02/2009	Fixed typos in the data sheet. Updated Figure 1-2. on page 2 and Figure 3-1. on page 10.
*E	2778970	FRE	10/05/2009	Added a table for DC POR and LVD Specifications Updated DC GPIO, AC Chip-Level, and AC Programming Specifications as follows: - Modified FIMO6, TWRITE, and Power Up IMO to Switch specifications - Added IOH, IOL, DCILO, F32K_U, TPOWERUP, TERASEALL, and SRPOWER_UP specifications Added 48-Pin QFN (Sawn) package diagram and CY8CLED16P01-48LTXI and CY8CLED16P01-48LTXIT part details in the Ordering Information table Updated section 5 and Tables 10-1, 10-2, and 10-3 to state the requirement to use the external crystal for PLC protocol timing Table 10-1 and Figure 10-1: Changed pins 9 and 25 from NC to RSVD Table 10-2 and Figure 10-2: Changed pins 7 and 39 from NC to RSVD Table 10-3 and Figure 10-3: Changed pins 14 and 77 from NC to RSVD Tables 10-1, 10-2, 10-3: Added explanation to Connect a 0.1 uF capacitor between XTAL_Stability and VSS. Fixed minor typos