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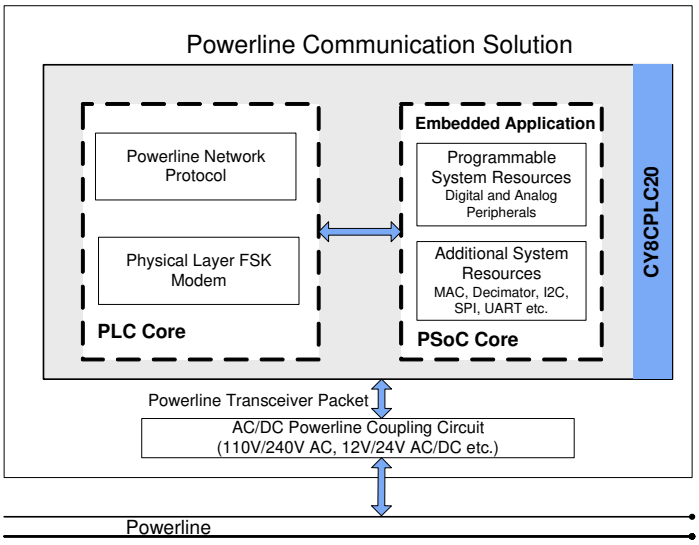
CY8CPLC20 Datasheet

Powerline Communication Solution

Features

- Powerline communication solution
  - Integrated powerline modem PHY
  - Frequency shift keying modulation
  - Configurable baud rates up to 2400 bps
  - Powerline optimized network protocol
  - Integrates data link, transport, and network layers
  - Supports bidirectional half duplex communication
  - 8-bit CRC error detection to minimize data loss
  - I^2C enabled powerline application layer
  - Supports I^2C frequencies of 50, 100, and 400 kHz
  - Reference designs for 110 V/240 V AC and 12 V/24 V AC/DC Powerlines
  - Reference designs comply with CENELEC EN 50065-1:2001 and FCC Part 15
- Powerful Harvard-architecture Processor
  - M8C processor speeds to 24 MHz
  - Two 8x8 multiply, 32-bit accumulate
- Programmable system resources (PSoC® Blocks)
  - 12 Rail-to-Rail Analog PSoC Blocks provide:
    - Up to 14-bit ADCs
    - Up to 9-bit DACs
    - Programmable gain amplifiers
    - Programmable filters and comparators
  - 16 Digital PSoC Blocks provide:
    - 8 to 32-bit Timers, Counters, and PWMs
    - CRC and PRS Modules
    - Up to four full duplex UARTs
    - Multiple SPI™ masters or slaves
    - Connectable to all GPIO Pins
  - Complex peripherals by combining blocks
- Flexible on-chip memory
  - 32 KB flash program storage 50,000 erase or write cycles
  - 2 KB SRAM data storage
  - EEPROM emulation in flash
- Programmable pin configurations
  - 25 mA sink, 10 mA source on all GPIOs
  - Pull-up, Pull-down, high Z, strong, or open drain drive Modes on all GPIO
  - Up to 12 analog inputs on all GPIOs
  - Configurable interrupt on all GPIOs
- Additional system resources
  - I^2C slave, master, and multi-master to 400 kHz
  - Watchdog and sleep timers
  - User-configurable low-voltage detection
  - Integrated supervisory circuit
  - On-chip precision voltage reference
- Complete development tools
  - Free development software (PSoC Designer™)
  - Full-featured in-circuit emulator (ICE) and programmer
  - Full-speed emulation
  - Complex breakpoint structure
  - 128 KB trace memory
  - Complex events
  - C Compilers, assembler, and linker

Logic Block Diagram



More Information

Cypress provides a wealth of data at www.cypress.com to help you to select the right PSoC device for your design, and to help you to quickly and effectively integrate the device into your design. For a comprehensive list of resources, see the knowledge base article "How to Design with PSoC® 1, PowerPSoC®, and PLC – KBA88292". Following is an abbreviated list for PSoC 1:

- Overview: PSoC Portfolio, PSoC Roadmap
- Product Selectors: PSoC 1, PSoC 3, PSoC 4, PSoC 5LP
- In addition, PSoC Designer includes a device selection tool.
- Application notes: Cypress offers a large number of PSoC application notes covering a broad range of topics, from basic to advanced level. Recommended application notes for getting started with PSoC 1 are:
  - Getting Started with PSoC® 1 – AN75320
  - PSoC® 1 - Getting Started with GPIO – AN2094
  - PSoC® 1 Analog Structure and Configuration – AN74170
  - PSoC® 1 Switched Capacitor Analog Blocks – AN2041
  - Selecting Analog Ground and Reference – AN2219

Note: For CY8CPLC20 devices related Application note please click here.

- Development Kits:
  - CY3210-PSoCEval1 supports all PSoC 1 Mixed-Signal Array families, including automotive, except CY8C25/26xxx devices. The kit includes an LCD module, potentiometer, LEDs, and breadboarding space.
  - CY3214-PSoCEvalUSB features a development board for the CY8C24x94 PSoC device. Special features of the board include USB and CapSense development and debugging support.

Note: For CY8CPLC20 devices related Development Kits please click here.

The MiniProg1 and MiniProg3 devices provide interfaces for flash programming and debug.

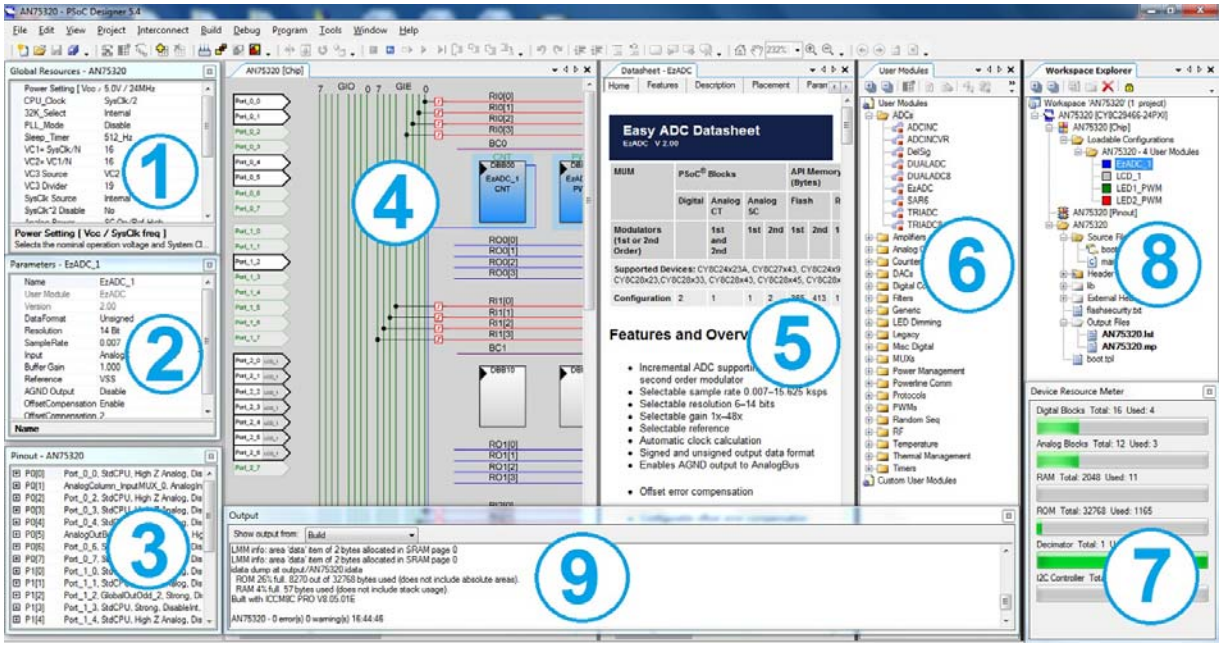
PSoC Designer

PSoC Designer is a free Windows-based Integrated Design Environment (IDE). Develop your applications using a library of pre-characterized analog and digital peripherals in a drag-and-drop design environment. Then, customize your design leveraging the dynamically generated API libraries of code. Figure 1 shows PSoC Designer windows. **Note:** This is not the default view.

1. **Global Resources –** all device hardware settings.
2. **Parameters –** the parameters of the currently selected User Modules.
3. **Pinout –** information related to device pins.
4. **Chip-Level Editor –** a diagram of the resources available on the selected chip.
5. **Datasheet –** the datasheet for the currently selected UM
6. **User Modules –** all available User Modules for the selected device.
7. **Device Resource Meter –** device resource usage for the current project configuration.
8. **Workspace –** a tree level diagram of files associated with the project.
9. **Output –** output from project build and debug operations.

Note: For detailed information on PSoC Designer, go to PSoC® Designer > Help > Documentation > Designer Specific Documents > IDE User Guide.

Figure 1. PSoC Designer Layout



Contents

PLC Functional Overview

The CY8CPLC20 is an integrated powerline communication (PLC) chip with the powerline modem PHY and network protocol stack running on the same device. Apart from the PLC core, the CY8CPLC20 also offers Cypress's revolutionary PSoC technology that enables system designers to integrate multiple functions on the same chip.

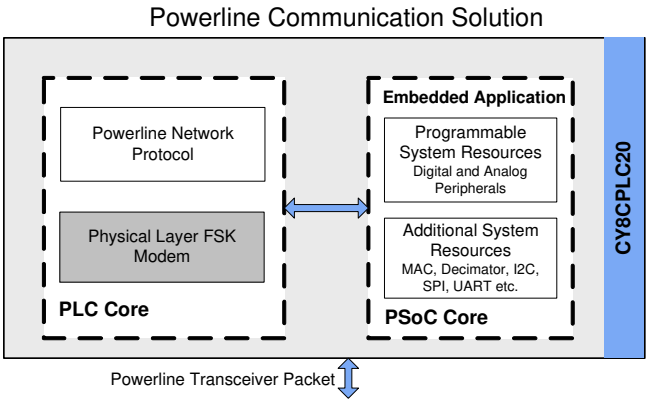
Robust Communication using Cypress's PLC Solution

Powerlines are available everywhere in the world and are a widely available communication medium for PLC technology. The pervasiveness of powerlines also makes it difficult to predict the characteristics and operation of PLC products. Because of the variable quality of powerlines around the world, implementing robust communication has been an engineering challenge for years. The Cypress PLC solution enables secure and reliable communications. Cypress PLC features that enable robust communication over powerlines include:

- Integrated Powerline PHY modem with optimized filters and amplifiers to work with lossy high voltage and low voltage powerlines.
- Powerline optimized network protocol that supports bidirectional communication with acknowledgement-based signaling. In case of data packet loss due to bursty noise on the powerline, the transmitter has the capability to retransmit data.
- The powerline network protocol also supports an 8-bit CRC for error detection and data packet retransmission.
- A Carrier sense multiple access (CSMA) scheme is built into the network protocol that minimizes collisions between packet transmissions on the powerline and supports multiple masters and reliable communication on a bigger network.

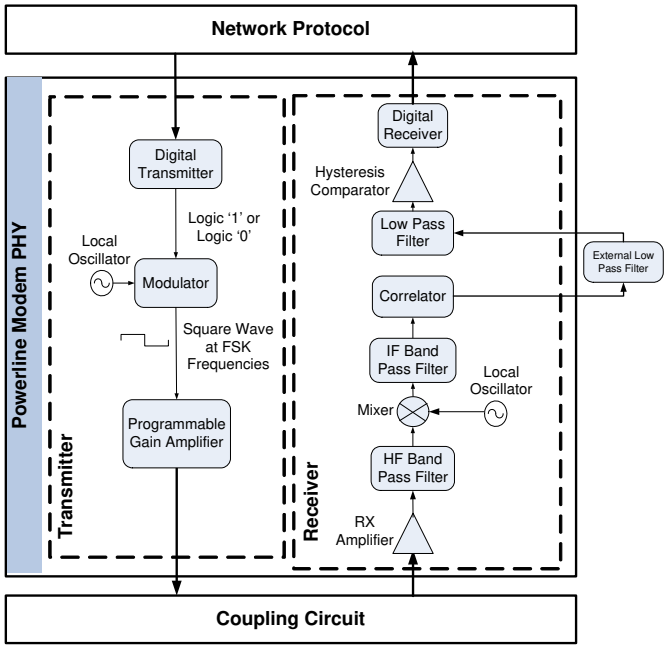
Powerline Modem PHY

Figure 2. Physical Layer FSK Modem



The physical layer of the Cypress PLC solution is implemented using an FSK modem that enables half duplex communication on any high voltage and low voltage powerline. This modem supports raw data rates up to 2400 bps. A block diagram is shown in Figure 3.

Figure 3. Physical Layer FSK Modem Block Diagram



Transmitter Section

Digital data from the network layer is serialized by the digital transmitter and fed as input to the modulator. The modulator divides the local oscillator frequency by a definite factor depending on whether the input data is high level logic '1' or low level logic '0'. It then generates a square wave at 133.3 kHz (logic '0') or 131.8 kHz (logic '1'), which is fed to the Programmable Gain Amplifier to generate FSK modulated signals. This enables tunable amplification of the signal depending on the noise in the channel. The logic '1' frequency can also be configured as 130.4 kHz for wider FSK deviation.

Receiver Section

The incoming FSK signal from the powerline is input to a high frequency (HF) band pass filter that filters out-of-band frequency components and outputs a filtered signal within the desired spectrum of 125 kHz to 140 kHz for further demodulation. The mixer block multiplies the filtered FSK signals with a locally generated signal to produce heterodyned frequencies.

The intermediate frequency (IF) band pass filters further remove out-of-band noise as required for further demodulation. This signal is fed to the correlator, which produces a DC component (consisting of logic '1' and '0') and a higher frequency component.

The output of the correlator is fed to a low pass filter (LPF) that outputs only the demodulated digital data at 2400 baud and suppresses all other higher frequency components generated in the correlation process. The output of the LPF is digitized by the

hysteresis comparator. This eliminates the effects of correlator delay and false logic triggers due to noise. The digital receiver deserializes this data and outputs to the network layer for interpretation.

Coupling Circuit Reference Design

The coupling circuit couples low voltage signals from the CY8CPLC20 to the powerline. The topology of this circuit is determined by the voltage on the powerline and design constraints mandated by powerline usage regulations.

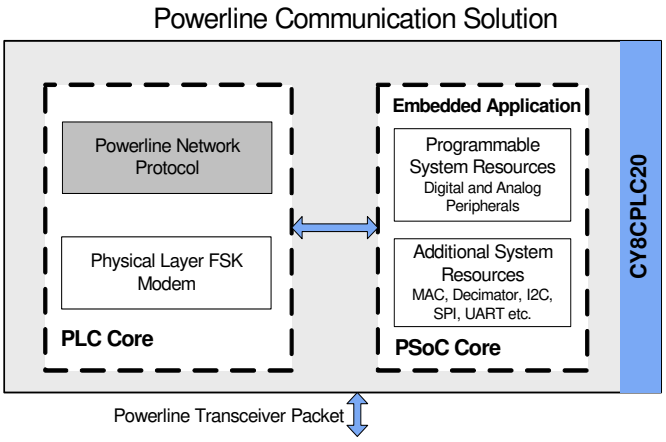
Cypress provides reference designs for a range of powerline voltages including 110 V/240 V AC and 12 V/24 V AC/DC. The CY8CPLC20 is capable of data communication over other AC/DC Powerlines as well with the appropriate external coupling circuit. The 110 V AC and 240 V AC designs are compliant to the following powerline usage regulations:

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

Network Protocol

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

Figure 4. Powerline Network Protocol



The network protocol implemented on the CY8CPLC20 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

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) in which 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 dBmVrms 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.

Powerline Transceiver Packet

The powerline network protocol defines a powerline transceiver (PLT) packet structure, which is used for data transfer between nodes across the powerline. Packet formation and data transmission across the powerline network are implemented internally in CY8CPLC20.

A PLT packet is divided into a variable length header (minimum 6 bytes to maximum 20 bytes, depending on address type), a 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 Table 1 on page 5.

Table 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							

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 2 describes the PLT packet header fields in detail.

Table 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

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.

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.

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 is re-transmitted (if TX_Retry > 0) with the same sequence number. If in unacknowledged mode, the packet is 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.

Addressing

The CY8CPLC20 has three modes of addressing:

- Logical addressing: Every CY8CPLC20 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 CY8CPLC20 has a unique 64-bit physical address.
- Group addressing: This is explained in the next section.

Group Membership

Group membership enables the user to multicast messages to select groups. The CY8CPLC20 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 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.

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 automatically processes the packet (if Lock_Configuration is '0'), responds to the initiator, and notifies 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 replies 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 notifies 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 notifies the host of the successful transmission and reception. If the response command is not received by the initiator within 1.5s, it notifies 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 3 with the respective Command IDs.

Table 3. Remote Commands

Cmd ID	Command Name	Description	Payload (TX Data)	Response (RX Data)
0x01	SetRemote_TXEnable	Sets the TX Enable bit in the PLC Mode Register. Rest of the PLC Mode register is unaffected	0 - Disable Remote TX 1 - Enable Remote TX	If Remote Lock Config = 0, Response = 00 (Success) If Remote Lock Config = 1, Response = 01 (Denied)
0x03	SetRemote_ExtendedAddr	Set the Addressing to Extended Addressing Mode	0 - Disable Extended Addressing 1 - Enable Extended Addressing	If Remote Lock Config = 0, Response = 00 (Success) If Remote Lock Config = 1, Response = 01 (Denied)
0x04	SetRemote_LogicalAddr	Assigns the specified logical address to the remote PLC node	If Ext Address = 0, Payload = 8-bit Logical Address If Ext Address = 1, Payload = 16-bit Logical Address	If Remote Lock Config = 0, Response = 00 (Success) If Remote Lock Config = 1, Response = 01 (Denied)
0x05	GetRemote_LogicalAddr	Get the Logical Address of the remote PLC node	None	If Remote TX Enable = 0, Response = None If Remote TX Enable = 1, {If Ext Address = 0, Response = 8-bit Logical Address If Ext Address = 1, Response = 16-bit Logical Address}
0x06	GetRemote_PhysicalAddr	Get the Physical Address of the remote PLC node	None	If Remote TX Enable = 0, Response = None If Remote TX Enable = 1, Response = 64-bit Physical Address
0x07	GetRemote_State	Request PLC_Mode Register content from a Remote PLC node	None	If Remote TX Enable = 0, Response = None If Remote TX Enable = 1, Response = Remote PLC Mode register
0x08	GetRemote_Version	Get the Version Number of the Remote Node	None	If TX Enable = 0, Response = None If TX Enable = 1, Response = Remote Version register
0x09	SendRemote_Data	Transmit data to a Remote Node.	Payload = Local TX Data	If Local Service Type = 0, Response = None If Local Service Type = 1, Response = Ack
0x0A	RequestRemote_Data	Request data from a Remote Node	Payload = Local TX Data	If Local Service Type = 1, Response = Ack Then, the remote node host must send a ResponseRemote_Data command. The response must be completely transmitted within 1.5s of receiving the request. Otherwise, the requesting node will time out.
0x0B	ResponseRemote_Data	Transmit response data to a Remote Node.	Payload = Local TX Data	None
0x0C	SetRemote_BIU	Enables/Disables BIU functionality at the remote node	0 - Enable Remote BIU 1 - Disable Remote BIU	If Remote Lock Config = 0, Response = 00 (Success) If Remote Lock Config = 1, Response = 01 (Denied)

Table 3. Remote Commands *(continued)*

Cmd ID	Command Name	Description	Payload (TX Data)	Response (RX Data)
0x0D	SetRemote_ThresholdValue	Sets the Threshold Value at the Remote node	3-bit Remote Threshold Value	If Remote Lock Config = 0, Response = 00 (Success) If Remote Lock Config = 1, Response = 01 (Denied)
0x0E	SetRemote_GroupMembership	Sets the Group Membership of the Remote node	Byte0 - Remote SIngle Group Membership Address Byte1- Remote Multiple Group Membership Address	If Remote Lock Config = 0, Response = 00 (Success) If Remote Lock Config = 1, Response = 01 (Denied)
0x0F	GetRemote_GroupMembership	Gets the Group Membership of the Remote node	None	If Remote TX Enable = 0, Response = None If Remote TX Enable = 1, Response = Byte0 - Remote SIngle Group Membership Address Byte1- Remote Multiple Group Membership Address
0x10–0x2F	Reserved			
0x30–0xFF	User Defined Command Set			

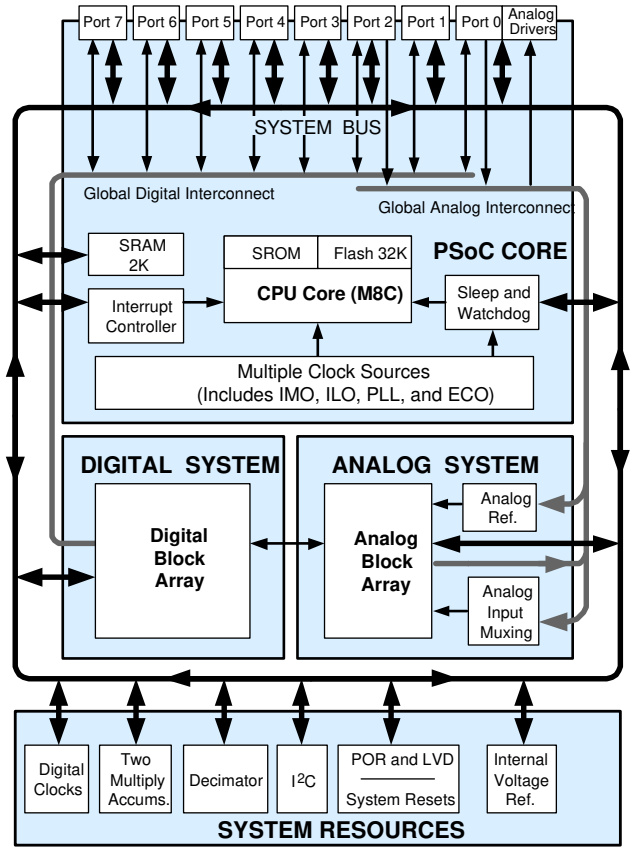
PSoC Core

The CY8CPLC20 is based on the Cypress PSoC® 1 architecture. The PSoC platform consists of many *Programmable System-on-chip Controller* devices. These devices are designed to replace multiple traditional MCU-based system components with one, low-cost single-chip programmable device. PSoC devices include configurable blocks of analog and digital logic, and programmable interconnects. This architecture enables the user to create customized peripheral configurations that match the requirements of each individual application. Additionally, a fast CPU, flash program memory, SRAM data memory, and configurable I/Os are included in a range of convenient pinouts and packages.

The PSoC architecture, as shown in Figure 5, consists of four main areas: PSoC Core, digital system, analog system, and system resources. Configurable global busing enables all the device resources to be combined into a complete custom system. The CY8CPLC20 family can have up to five I/O ports that connect to the global digital and analog interconnects, providing access to 16 digital blocks and 12 analog blocks.

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

Figure 5. PSoC Core



The M8C CPU core is a powerful processor with speeds up to 24 MHz, providing a 4 MIPS 8-bit Harvard architecture microprocessor. The CPU uses an interrupt controller with 25 vectors, to simplify programming of realtime embedded events. Program execution is timed and protected using the included Sleep and Watchdog timers (WDT).

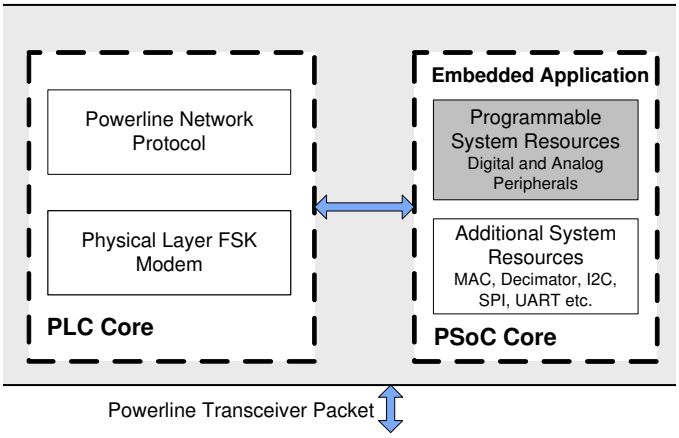
Memory encompasses 32 KB of Flash for program storage, 2 KB of SRAM for data storage, and up to 2 KB of EEPROM emulated using Flash. Program Flash uses four protection levels on blocks of 64 bytes, enabling customized software IP protection.

The PSoC device incorporates flexible internal clock generators, including a 24 MHz internal main oscillator (IMO) accurate to 2.5 percent over temperature and voltage. The 24 MHz IMO can also be doubled to 48 MHz for the digital system use. A low power 32 kHz internal low speed oscillator (ILO) is provided for the sleep timer and WDT. If crystal accuracy is desired, the ECO (32.768 kHz external crystal oscillator) is available for use as a real time clock (RTC) and can optionally generate a crystal-accurate 24 MHz system clock using a PLL. When operating the powerline transceiver (PLT) user module, the ECO must be selected to ensure accurate protocol timing. The clocks, together with programmable clock dividers (as a System Resource), provide the flexibility to integrate almost any timing requirement into the PSoC device.

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

Programmable System Resources

Figure 6. Programmable System Resources



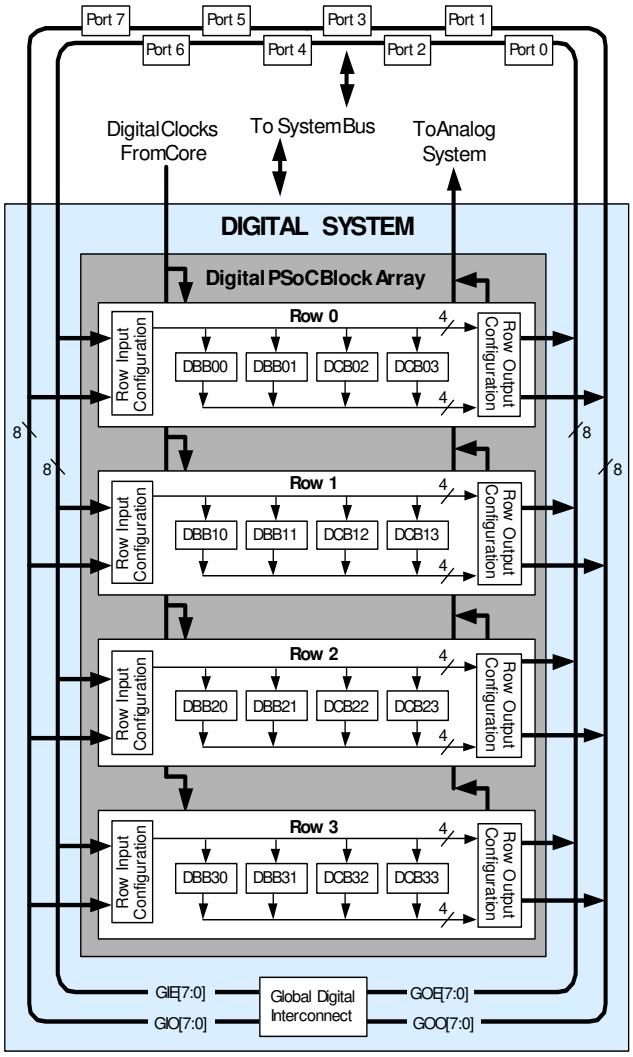
The Digital System

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 modules. 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 four)
- 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 7. Digital System Block Diagram



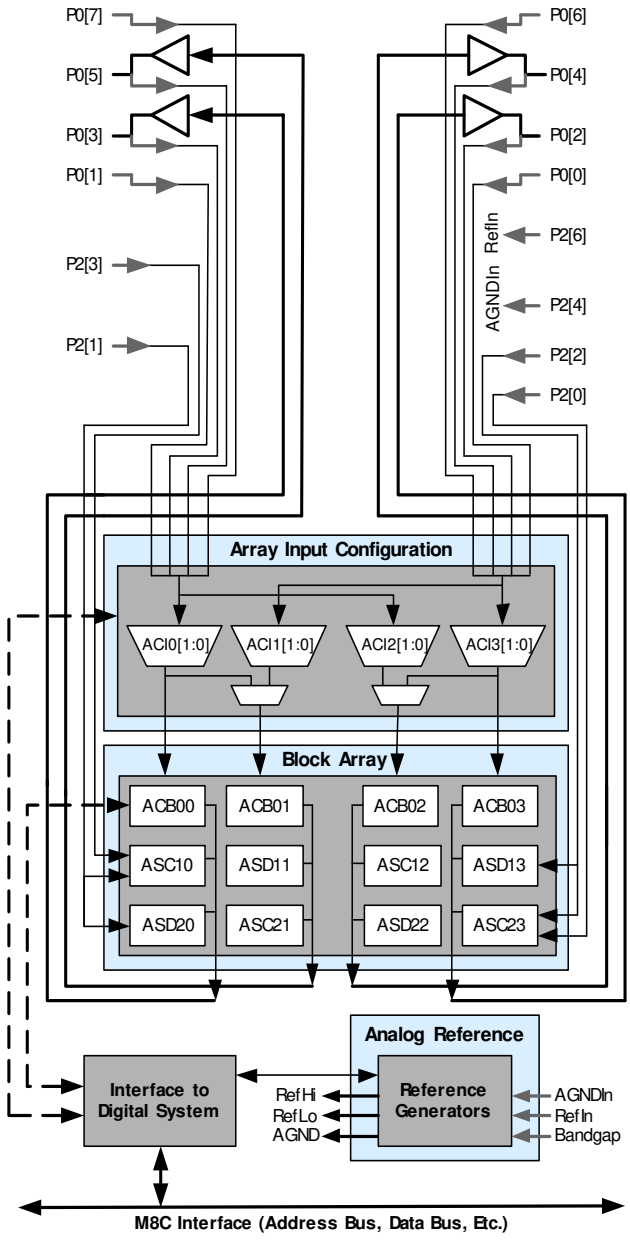
The Analog System

The analog system contains 12 configurable blocks, each containing an opamp circuit, enabling the creation of complex analog signal flows. Analog peripherals are very flexible and can be customized to support specific application requirements. Some of the more common PSoC analog functions (most available as user modules) are:

- Analog-to-digital converters (up to four, with 6- to 14-bit resolution, selectable as Incremental, Delta Sigma, and SAR)
- Filters (2, 4, 6, or 8 pole band pass, low pass, and notch)
- Amplifiers (up to four, with selectable gain to 48x)
- Instrumentation amplifiers (up to two, with selectable gain to 93x)
- Comparators (up to four, with 16 selectable thresholds)
- DACs (up to four, with 6- to 9-bit resolution)
- Multiplying DACs (up to four, with 6- to 9-bit resolution)
- High current output drivers (4 with 40 mA drive as a Core Resource)
- 1.3 V reference (as a System Resource)
- DTMF Dialer
- Modulators
- Correlators
- Peak detectors
- Many other topologies possible

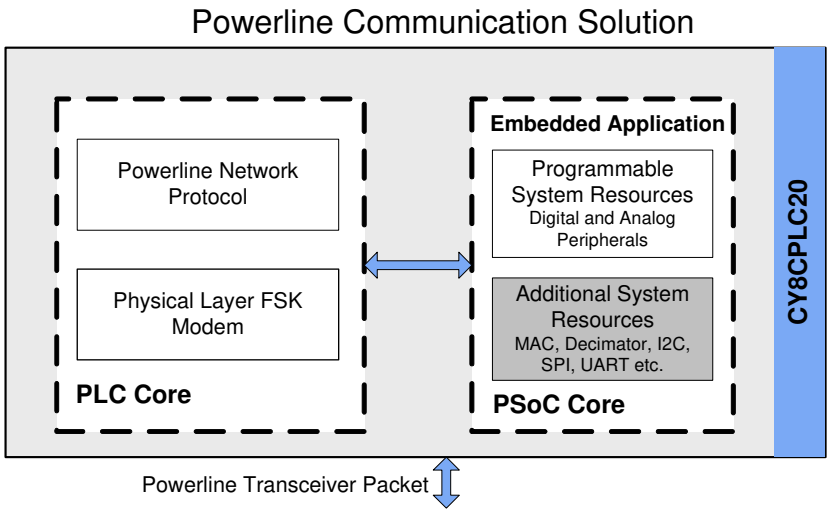
Analog blocks are provided in columns of three, which includes one continuous time (CT) and two switched capacitor (SC) blocks, as shown in the Figure 8.

Figure 8. Analog System Block Diagram



Additional System Resources

Figure 9. CY8CPLC20: Additional System Resources



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

- Digital clock dividers provide three customizable clock frequencies for use in applications. The clocks can be routed to both the digital and analog systems. Additional clocks are generated using digital PSoC blocks as clock dividers.
- Multiply accumulate (MAC) provides a fast 8-bit multiplier with 32-bit accumulate, to assist in general math and digital filters.
- The decimator provides a custom hardware filter for digital signal processing applications including the creation of Delta Sigma ADCs.
- The I^2C module provides 100 and 400 kHz communication over two wires. Slave, master, and multi-master modes are supported.
- Low-voltage detection (LVD) interrupts signal the application of falling voltage levels, while the advanced Power On Reset (POR) circuit eliminates the need for a system supervisor.
- An internal 1.3 V reference provides an absolute reference for the analog system, including ADCs and DACs.

Development Tools

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

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

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

PSoC Designer Software Subsystems

Design Entry

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

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

Code Generation Tools

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

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

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

Debugger

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

Online Help System

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

In-Circuit Emulator

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

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

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.

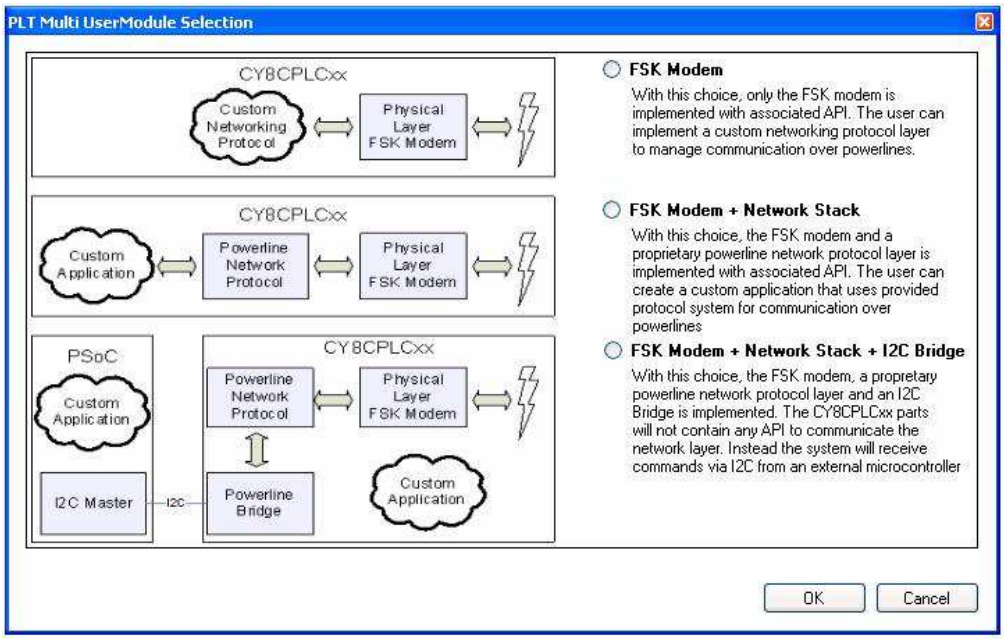
PLC User Modules

Powerline transceiver (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 enables 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 enables the user to interface the CY8CPLC20 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 10 on page 14 shows the starting window for the PLT UM with the three implementation modes from which the user can choose.

Figure 10. PLT User Module



The power consumption estimate of the CY8CPLC20 chip with the PLT User Module loaded along with the other User Modules can be determined using the application note AN54416 titled “Using CY8CPLC20 in Powerline Communication (PLC) Applications” at http://www.cypress.com.

Pin Information

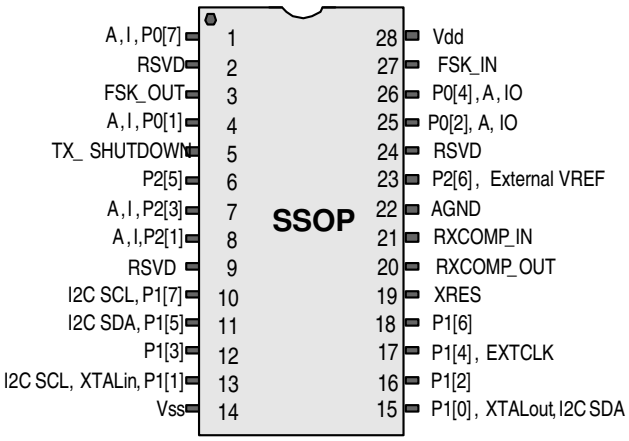
The CY8CPLC20 PLC device is available in a variety of packages which are listed and illustrated in the following tables. Every port pin (labeled with a “P”) is capable of Digital I/O. However, Vss, V_{DD} and XRES are not capable of Digital I/O.

28-Pin Part Pinout

Table 4. 28-Pin Part Pinout (SSOP)

Pin No.	Type		Pin Name	Description
	Digital	Analog		
1	I/O	I	P0[7]	Analog column mux input
2	Reserved		RSVD	Reserved
3		O	FSK_OUT	Analog FSK Output
4	I/O	I	P0[1]	Analog column mux input
5	O		TX_SHUTDOWN	Output to disable PLC transmit circuitry in receive mode Logic ‘0’ - When the Modem is transmitting Logic ‘1’ - When the Modem is not transmitting
6	I/O		P2[5]	
7	I/O	I	P2[3]	Direct switched capacitor block Input
8	I/O	I	P2[1]	Direct switched capacitor block Input
9	Reserved		RSVD	Reserved
10	I/O		P1[7]	I^2C Serial clock (SCL)
11	I/O		P1[5]	I^2C Serial data (SDA)
12	I/O		P1[3]	XTAL_STABILITY. Connect a 0.1 µF capacitor between the pin and Vss.
13	I/O		P1[1]	Crystal (XTALin[2]), ISSP-SCLK[1], I^2C SCL
14	Power		Vss	Ground Connection
15	I/O		P1[0]	Crystal (XTALout[2]), ISSP-SDATA[1], I^2C SDA
16	I/O		P1[2]	
17	I/O		P1[4]	Optional External Clock Input (EXTCLK[2])
18	I/O		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. Connect a 1.0 µF capacitor between the pin and Vss.
23	I/O		P2[6]	External Voltage Reference (VREF)
24	Reserved		RSVD	Reserved
25	I/O	I/O	P0[2]	Analog column mux input and column output
26	I/O	I/O	P0[4]	Analog column mux input and column output
27		I	FSK_IN	Analog FSK Input
28	Power		V_{DD}	Supply Voltage

Figure 11. CY8CPLC20 28-Pin PLC Device



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

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 enable the PLL Mode or select the external 24 MHz on P1[4]. Do not use the IMO.

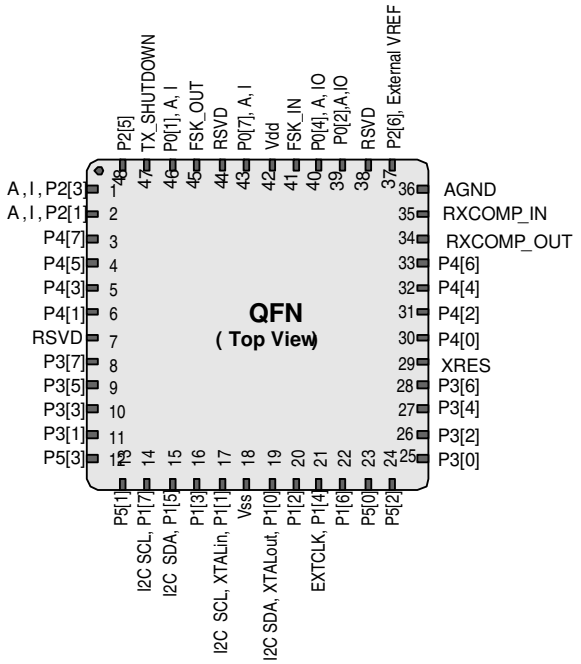
48-Pin Part Pinout

Table 5. 48-Pin Part Pinout (QFN)[3]

Pin No.	Type		Pin Name	Description
	Digital	Analog		
1	I/O	I	P2[3]	Direct switched capacitor block input
2	I/O	I	P2[1]	Direct switched capacitor block input
3	I/O		P4[7]	
4	I/O		P4[5]	
5	I/O		P4[3]	
6	I/O		P4[1]	
7	Reserved		RSVD	Reserved
8	I/O		P3[7]	
9	I/O		P3[5]	
10	I/O		P3[3]	
11	I/O		P3[1]	
12	I/O		P5[3]	
13	I/O		P5[1]	
14	I/O		P1[7]	I^2C Serial clock (SCL)
15	I/O		P1[5]	I^2C Serial data (SDA)
16	I/O		P1[3]	XTAL_STABILITY. Connect a 0.1 µF capacitor between the pin and Vss.
17	I/O		P1[1]	Crystal (XTALin[2]), I^2C Serial Clock (SCL), ISSP-SCLK[1]
18	Power		Vss	Ground Connection
19	I/O		P1[0]	Crystal (XTALout[2]), I^2C Serial Data (SDA), ISSP-SDATA[1]
20	I/O		P1[2]	
21	I/O		P1[4]	Optional External clock input (EXTCLK[2])
22	I/O		P1[6]	
23	I/O		P5[0]	
24	I/O		P5[2]	
25	I/O		P3[0]	
26	I/O		P3[2]	
27	I/O		P3[4]	
28	I/O		P3[6]	
29	Input		XRES	Active high external reset with internal pull-down
30	I/O		P4[0]	
31	I/O		P4[2]	
32	I/O		P4[4]	
33	I/O		P4[6]	
34		O	RXCOMP_OUT	Analog output to external Low Pass Filter Circuitry
35		I	RXCOMP_IN	Analog input from external Low Pass Filter Circuitry
36	Analog Ground		AGND	Analog ground. Connect a 1.0 µF capacitor between the pin and Vss.
37	I/O		P2[6]	External Voltage Reference (VREF)
38	Reserved		RSVD	Reserved
39	I/O	I/O	P0[2]	Analog column mux input and column output
40	I/O	I/O	P0[4]	Analog column mux input and column output
41		I	FSK_IN	Analog FSK Input
42	Power		V_{DD}	Supply Voltage
43	I/O	I	P0[7]	Analog Column Mux Input
44	Reserved		RSVD	Reserved
45		O	FSK_OUT]	Analog FSK Output
46	I/O	I	P0[1]	Analog Column Mux Input
47	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
48	I/O		P2[5]	

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

Figure 12. CY8CPLC20 48-Pin PLC Device



Note
3. The QFN package has a center pad that must be connected to ground (Vss).

100-Pin Part Pinout (On-Chip Debug)

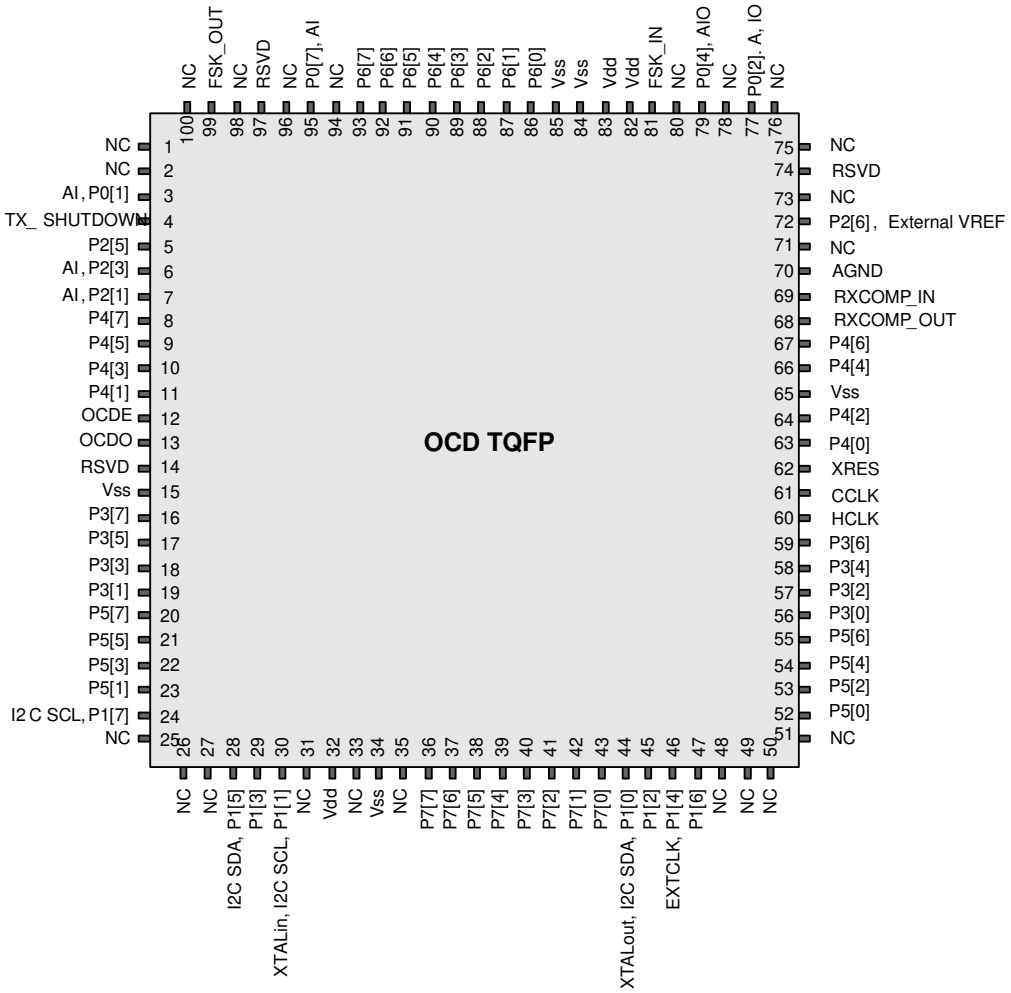
The 100-pin TQFP part is for the CY8CPLC20-OCD On-Chip Debug PLC device. Note that the OCD parts are only used for in-circuit debugging. OCD parts are NOT available for production.

Table 6. 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	I/O		P5[0]	
3	I/O	I	P0[1]	Analog column mux input	53	I/O		P5[2]	
4	O		TX_SHUT DOWN	Output to disable transmit circuitry in receive mode Logic '0' - When the Modem is transmitting Logic '1' - When the Modem is not transmitting	54	I/O		P5[4]	
5	I/O		P2[5]		55	I/O		P5[6]	
6	I/O	I	P2[3]	Direct switched capacitor block input	56	I/O		P3[0]	
7	I/O	I	P2[1]	Direct switched capacitor block input	57	I/O		P3[2]	
8	I/O		P4[7]		58	I/O		P3[4]	
9	I/O		P4[5]		59	I/O		P3[6]	
10	I/O		P4[3]		60			HCLK	OCD high speed clock output
11	I/O		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	I/O		P4[0]	
14	Reserved		RSVD	Reserved	64	I/O		P4[2]	
15	Power		Vss	Ground connection	65	Power		Vss	Ground connection
16	I/O		P3[7]		66	I/O		P4[4]	
17	I/O		P3[5]		67	I/O		P4[6]	
18	I/O		P3[3]		68		O	RXCOMP _OUT	Analog output to external low pass filter circuitry
19	I/O		P3[1]		69		I	RXCOMP _IN	Analog Input from external low pass filter circuitry
20	I/O		P5[7]		70	Ground		AGND	Analog ground. connect a 1.0 µF capacitor between the pin and Vss.
21	I/O		P5[5]		71			NC	no connection
22	I/O		P5[3]		72	I/O		P2[6]	external voltage reference (vref) input
23	I/O		P5[1]		73			NC	No connection
24	I/O		P1[7]	I^2C 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	I/O	I/O	P0[2]	Analog column mux input and column output
28	I/O		P1[5]	I^2C serial data (SDA)	78			NC	No Connection
29	I/O		P1[3]	XTAL_STABILITY. Connect a 0.1 µF capacitor between the pin and Vss.	79	I/O	I/O	P0[4]	Analog column mux input and column output, VREF
30	I/O		P1[1]*	Crystal (XTALin[2]), I^2C Serial Clock (SCL), TC SCLK	80			NC	No Connection
31			NC	No connection	81		I	FSK_IN	Analog FSK Input
32	Power		V_{DD}	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	I/O		P7[7]		86	I/O		P6[0]	
37	I/O		P7[6]		87	I/O		P6[1]	
38	I/O		P7[5]		88	I/O		P6[2]	
39	I/O		P7[4]		89	I/O		P6[3]	
40	I/O		P7[3]		90	I/O		P6[4]	
41	I/O		P7[2]		91	I/O		P6[5]	
42	I/O		P7[1]		92	I/O		P6[6]	
43	I/O		P7[0]		93	I/O		P6[7]	
44	I/O		P1[0]*	Crystal (XTALout[2]), I^2C Serial Data (SDA), TC SDATA	94			NC	No connection
45	I/O		P1[2]		95	I/O	I	P0[7]	Analog column mux input
46	I/O		P1[4]	Optional External Clock Input (EXTCLK[2])	96			NC	No Connection
47	I/O		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, RSVD = Reserved (should be left unconnected).

Figure 13. CY8CPLC20-OCD



Not for Production

Register Reference

This section lists the registers of the CY8CPLC20 PLC device. For detailed register information, reference the *PLC Technical Reference Manual*.

Register Conventions

Abbreviations Used

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

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

Register Mapping Tables

The CY8CPLC20 device has a total register address space of 512 bytes. The register space is referred to as I/O space and is divided into two banks, Bank 0 and Bank 1. The XOI bit in the Flag register (CPU_F) determines which bank the user is currently in. When the XOI bit is set the user is in Bank 1.

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

Table 7. Register Map Bank 0 Table: User Space

Name	Addr (0,Hex)	Access	Name	Addr (0,Hex)	Access	Name	Addr (0,Hex)	Access	Name	Addr (0,Hex)	Access
PRT0DR	00	RW	DBB20DR0	40	#	ASC10CR0	80	RW	RDI2RI	C0	RW
PRT0IE	01	RW	DBB20DR1	41	W	ASC10CR1	81	RW	RDI2SYN	C1	RW
PRT0GS	02	RW	DBB20DR2	42	RW	ASC10CR2	82	RW	RDI2IS	C2	RW
PRT0DM2	03	RW	DBB20CR0	43	#	ASC10CR3	83	RW	RDI2LT0	C3	RW
PRT1DR	04	RW	DBB21DR0	44	#	ASD11CR0	84	RW	RDI2LT1	C4	RW
PRT1IE	05	RW	DBB21DR1	45	W	ASD11CR1	85	RW	RDI2RO0	C5	RW
PRT1GS	06	RW	DBB21DR2	46	RW	ASD11CR2	86	RW	RDI2RO1	C6	RW
PRT1DM2	07	RW	DBB21CR0	47	#	ASD11CR3	87	RW		C7	
PRT2DR	08	RW	DCB22DR0	48	#	ASC12CR0	88	RW	RDI3RI	C8	RW
PRT2IE	09	RW	DCB22DR1	49	W	ASC12CR1	89	RW	RDI3SYN	C9	RW
PRT2GS	0A	RW	DCB22DR2	4A	RW	ASC12CR2	8A	RW	RDI3IS	CA	RW
PRT2DM2	0B	RW	DCB22CR0	4B	#	ASC12CR3	8B	RW	RDI3LT0	CB	RW
PRT3DR	0C	RW	DCB23DR0	4C	#	ASD13CR0	8C	RW	RDI3LT1	CC	RW
PRT3IE	0D	RW	DCB23DR1	4D	W	ASD13CR1	8D	RW	RDI3RO0	CD	RW
PRT3GS	0E	RW	DCB23DR2	4E	RW	ASD13CR2	8E	RW	RDI3RO1	CE	RW
PRT3DM2	0F	RW	DCB23CR0	4F	#	ASD13CR3	8F	RW		CF	
PRT4DR	10	RW	DBB30DR0	50	#	ASD20CR0	90	RW	CUR_PP	D0	RW
PRT4IE	11	RW	DBB30DR1	51	W	ASD20CR1	91	RW	STK_PP	D1	RW
PRT4GS	12	RW	DBB30DR2	52	RW	ASD20CR2	92	RW		D2	
PRT4DM2	13	RW	DBB30CR0	53	#	ASD20CR3	93	RW	IDX_PP	D3	RW
PRT5DR	14	RW	DBB31DR0	54	#	ASC21CR0	94	RW	MVR_PP	D4	RW
PRT5IE	15	RW	DBB31DR1	55	W	ASC21CR1	95	RW	MVW_PP	D5	RW
PRT5GS	16	RW	DBB31DR2	56	RW	ASC21CR2	96	RW	I2C_CFG	D6	RW
PRT5DM2	17	RW	DBB31CR0	57	#	ASC21CR3	97	RW	I2C_SCR	D7	#
PRT6DR	18	RW	DCB32DR0	58	#	ASD22CR0	98	RW	I2C_DR	D8	RW
PRT6IE	19	RW	DCB32DR1	59	W	ASD22CR1	99	RW	I2C_MSCR	D9	#
PRT6GS	1A	RW	DCB32DR2	5A	RW	ASD22CR2	9A	RW	INT_CLR0	DA	RW
PRT6DM2	1B	RW	DCB32CR0	5B	#	ASD22CR3	9B	RW	INT_CLR1	DB	RW
PRT7DR	1C	RW	DCB33DR0	5C	#	ASC23CR0	9C	RW	INT_CLR2	DC	RW
PRT7IE	1D	RW	DCB33DR1	5D	W	ASC23CR1	9D	RW	INT_CLR3	DD	RW
PRT7GS	1E	RW	DCB33DR2	5E	RW	ASC23CR2	9E	RW	INT_MSK3	DE	RW
PRT7DM2	1F	RW	DCB33CR0	5F	#	ASC23CR3	9F	RW	INT_MSK2	DF	RW
DBB00DR0	20	#	AMX_IN	60	RW		A0		INT_MSK0	E0	RW
DBB00DR1	21	W		61			A1		INT_MSK1	E1	RW
DBB00DR2	22	RW		62			A2		INT_VC	E2	RC
DBB00CR0	23	#	ARF_CR	63	RW		A3		RES_WDT	E3	W
DBB01DR0	24	#	CMP_CR0	64	#		A4		DEC_DH	E4	RC
DBB01DR1	25	W	ASY_CR	65	#		A5		DEC_DL	E5	RC
DBB01DR2	26	RW	CMP_CR1	66	RW		A6		DEC_CR0	E6	RW
DBB01CR0	27	#		67			A7		DEC_CR1	E7	RW
DCB02DR0	28	#		68		MUL1_X	A8	W	MUL0_X	E8	W
DCB02DR1	29	W		69		MUL1_Y	A9	W	MUL0_Y	E9	W
DCB02DR2	2A	RW		6A		MUL1_DH	AA	R	MUL0_DH	EA	R
DCB02CR0	2B	#		6B		MUL1_DL	AB	R	MUL0_DL	EB	R
DCB03DR0	2C	#	TMP_DR0	6C	RW	ACC1_DR1	AC	RW	ACC0_DR1	EC	RW
DCB03DR1	2D	W	TMP_DR1	6D	RW	ACC1_DR0	AD	RW	ACC0_DR0	ED	RW
DCB03DR2	2E	RW	TMP_DR2	6E	RW	ACC1_DR3	AE	RW	ACC0_DR3	EE	RW
DCB03CR0	2F	#	TMP_DR3	6F	RW	ACC1_DR2	AF	RW	ACC0_DR2	EF	RW
DBB10DR0	30	#	ACB00CR3	70	RW	RDI0RI	B0	RW		F0	
DBB10DR1	31	W	ACB00CR0	71	RW	RDI0SYN	B1	RW		F1	
DBB10DR2	32	RW	ACB00CR1	72	RW	RDI0IS	B2	RW		F2	
DBB10CR0	33	#	ACB00CR2	73	RW	RDI0LT0	B3	RW		F3	
DBB11DR0	34	#	ACB01CR3	74	RW	RDI0LT1	B4	RW		F4	
DBB11DR1	35	W	ACB01CR0	75	RW	RDI0RO0	B5	RW		F5	
DBB11DR2	36	RW	ACB01CR1	76	RW	RDI0RO1	B6	RW		F6	
DBB11CR0	37	#	ACB01CR2	77	RW		B7		CPU_F	F7	RL
DCB12DR0	38	#	ACB02CR3	78	RW	RDI1RI	B8	RW		F8	
DCB12DR1	39	W	ACB02CR0	79	RW	RDI1SYN	B9	RW		F9	
DCB12DR2	3A	RW	ACB02CR1	7A	RW	RDI1IS	BA	RW		FA	
DCB12CR0	3B	#	ACB02CR2	7B	RW	RDI1LT0	BB	RW		FB	
DCB13DR0	3C	#	ACB03CR3	7C	RW	RDI1LT1	BC	RW		FC	
DCB13DR1	3D	W	ACB03CR0	7D	RW	RDI1RO0	BD	RW		FD	
DCB13DR2	3E	RW	ACB03CR1	7E	RW	RDI1RO1	BE	RW	CPU_SCR1	FE	#
DCB13CR0	3F	#	ACB03CR2	7F	RW		BF		CPU_SCR0	FF	#

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

Table 8. 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	DBB20FN	40	RW	ASC10CR0	80	RW	RDI2RI	C0	RW
PRT0DM1	01	RW	DBB20IN	41	RW	ASC10CR1	81	RW	RDI2SYN	C1	RW
PRT0IC0	02	RW	DBB20OU	42	RW	ASC10CR2	82	RW	RDI2IS	C2	RW
PRT0IC1	03	RW		43		ASC10CR3	83	RW	RDI2LT0	C3	RW
PRT1DM0	04	RW	DBB21FN	44	RW	ASD11CR0	84	RW	RDI2LT1	C4	RW
PRT1DM1	05	RW	DBB21IN	45	RW	ASD11CR1	85	RW	RDI2RO0	C5	RW
PRT1IC0	06	RW	DBB21OU	46	RW	ASD11CR2	86	RW	RDI2RO1	C6	RW
PRT1IC1	07	RW		47		ASD11CR3	87	RW		C7	
PRT2DM0	08	RW	DCB22FN	48	RW	ASC12CR0	88	RW	RDI3RI	C8	RW
PRT2DM1	09	RW	DCB22IN	49	RW	ASC12CR1	89	RW	RDI3SYN	C9	RW
PRT2IC0	0A	RW	DCB22OU	4A	RW	ASC12CR2	8A	RW	RDI3IS	CA	RW
PRT2IC1	0B	RW		4B		ASC12CR3	8B	RW	RDI3LT0	CB	RW
PRT3DM0	0C	RW	DCB23FN	4C	RW	ASD13CR0	8C	RW	RDI3LT1	CC	RW
PRT3DM1	0D	RW	DCB23IN	4D	RW	ASD13CR1	8D	RW	RDI3RO0	CD	RW
PRT3IC0	0E	RW	DCB23OU	4E	RW	ASD13CR2	8E	RW	RDI3RO1	CE	RW
PRT3IC1	0F	RW		4F		ASD13CR3	8F	RW		CF	
PRT4DM0	10	RW	DBB30FN	50	RW	ASD20CR0	90	RW	GDI_O_IN	D0	RW
PRT4DM1	11	RW	DBB30IN	51	RW	ASD20CR1	91	RW	GDI_E_IN	D1	RW
PRT4IC0	12	RW	DBB30OU	52	RW	ASD20CR2	92	RW	GDI_O_OU	D2	RW
PRT4IC1	13	RW		53		ASD20CR3	93	RW	GDI_E_OU	D3	RW
PRT5DM0	14	RW	DBB31FN	54	RW	ASC21CR0	94	RW		D4	
PRT5DM1	15	RW	DBB31IN	55	RW	ASC21CR1	95	RW		D5	
PRT5IC0	16	RW	DBB31OU	56	RW	ASC21CR2	96	RW		D6	
PRT5IC1	17	RW		57		ASC21CR3	97	RW		D7	
PRT6DM0	18	RW	DCB32FN	58	RW	ASD22CR0	98	RW		D8	
PRT6DM1	19	RW	DCB32IN	59	RW	ASD22CR1	99	RW		D9	
PRT6IC0	1A	RW	DCB32OU	5A	RW	ASD22CR2	9A	RW		DA	
PRT6IC1	1B	RW		5B		ASD22CR3	9B	RW		DB	
PRT7DM0	1C	RW	DCB33FN	5C	RW	ASC23CR0	9C	RW		DC	
PRT7DM1	1D	RW	DCB33IN	5D	RW	ASC23CR1	9D	RW	OSC_GO_EN	DD	RW
PRT7IC0	1E	RW	DCB33OU	5E	RW	ASC23CR2	9E	RW	OSC_CR4	DE	RW
PRT7IC1	1F	RW		5F		ASC23CR3	9F	RW	OSC_CR3	DF	RW
DBB00FN	20	RW	CLK_CR0	60	RW		A0		OSC_CR0	E0	RW
DBB00IN	21	RW	CLK_CR1	61	RW		A1		OSC_CR1	E1	RW
DBB00OU	22	RW	ABF_CR0	62	RW		A2		OSC_CR2	E2	RW
	23		AMD_CR0	63	RW		A3		VLT_CR	E3	RW
DBB01FN	24	RW		64			A4		VLT_CMP	E4	R
DBB01IN	25	RW		65			A5			E5	
DBB01OU	26	RW	AMD_CR1	66	RW		A6			E6	
	27		ALT_CR0	67	RW		A7		DEC_CR2	E7	RW
DCB02FN	28	RW	ALT_CR1	68	RW		A8		IMO_TR	E8	W
DCB02IN	29	RW	CLK_CR2	69	RW		A9		ILO_TR	E9	W
DCB02OU	2A	RW		6A			AA		BDG_TR	EA	RW
	2B			6B			AB		ECO_TR	EB	W
DCB03FN	2C	RW	TMP_DR0	6C	RW		AC			EC	
DCB03IN	2D	RW	TMP_DR1	6D	RW		AD			ED	
DCB03OU	2E	RW	TMP_DR2	6E	RW		AE			EE	
	2F		TMP_DR3	6F	RW		AF			EF	
DBB10FN	30	RW	ACB00CR3	70	RW	RDI0RI	B0	RW		F0	
DBB10IN	31	RW	ACB00CR0	71	RW	RDI0SYN	B1	RW		F1	
DBB10OU	32	RW	ACB00CR1	72	RW	RDI0IS	B2	RW		F2	
	33		ACB00CR2	73	RW	RDI0LT0	B3	RW		F3	
DBB11FN	34	RW	ACB01CR3	74	RW	RDI0LT1	B4	RW		F4	
DBB11IN	35	RW	ACB01CR0	75	RW	RDI0RO0	B5	RW		F5	
DBB11OU	36	RW	ACB01CR1	76	RW	RDI0RO1	B6	RW		F6	
	37		ACB01CR2	77	RW		B7		CPU_F	F7	RL
DCB12FN	38	RW	ACB02CR3	78	RW	RDI1RI	B8	RW		F8	
DCB12IN	39	RW	ACB02CR0	79	RW	RDI1SYN	B9	RW		F9	
DCB12OU	3A	RW	ACB02CR1	7A	RW	RDI1IS	BA	RW	FLS_PR1	FA	RW
	3B		ACB02CR2	7B	RW	RDI1LT0	BB	RW		FB	
DCB13FN	3C	RW	ACB03CR3	7C	RW	RDI1LT1	BC	RW		FC	
DCB13IN	3D	RW	ACB03CR0	7D	RW	RDI1RO0	BD	RW		FD	
DCB13OU	3E	RW	ACB03CR1	7E	RW	RDI1RO1	BE	RW	CPU_SCR1	FE	#
	3F		ACB03CR2	7F	RW		BF		CPU_SCR0	FF	#

Blank 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 CY8CPLC20 device. For the most up-to-date electrical specifications, confirm that you have the most recent data sheet by going to the web at http://www.cypress.com.

Specifications are valid for –40 °C ≤ T_A ≤ 85 °C and T_J ≤ 100 °C, except where noted.

Absolute Maximum Ratings

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

Table 9. Absolute Maximum Ratings

Symbol	Description	Min	Typ	Max	Units	Notes
T_{STG}	Storage temperature	–55	25	+100	°C	Higher storage temperatures reduce data retention time. Recommended storage temperature is +25 °C ± 25 °C. Extended duration storage temperatures above 65 °C degrade reliability.
$T_{BAKETEMP}$	Bake temperature	–	125	See package label	°C	
$T_{BAKETIME}$	Bake time	See package label	–	72	Hours	
T_A	Ambient temperature with power applied	–40	–	+85	°C	
V_{DD}	Supply voltage on V_{DD} relative to Vss	–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 Tri-state	V_{SS} - 0.5	–	V_{DD} + 0.5	V	
I_{MIO}	Maximum current into any port pin	–25	–	+50	mA	
I_{MAIO}	Maximum current into any port pin configured as analog Driver	–50	–	+50	mA	
ESD	Electro static discharge voltage	2000	–	–	V	Human Body Model ESD.
LU	Latch-up Current	–	–	200	mA	

Operating Temperature

Table 10. Operating Temperature

Symbol	Description	Min	Typ	Max	Units	Notes
T_A	Ambient temperature	–40	–	+85	°C	
T_J	Junction temperature	–40	–	+100	°C	The temperature rise from ambient to junction is package specific. See Thermal Impedances on page 44.The user must limit the power consumption to comply with this requirement.

DC Electrical Characteristics

Low Power Operation

The CY8CPLC20 device can be operated in a low power listen mode. Full details on the power numbers and associated firmware is present in Using CY8CPLC20 in Powerline Communication (PLC) Applications - AN54416.

DC Chip-Level Specifications

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

Table 11. DC Chip-Level Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
V_{DD}	Supply Voltage	4.75	–	5.25	V	
I_{DD}	Supply Current	–	8	14	mA	Conditions are 5.0 V, T_A = 25 °C, CPU = 3 MHz, SYSCLK doubler disabled, VC1 = 1.5 MHz, VC2 = 93.75 kHz, VC3 = 0.366 kHz
V_{REF}	Reference Voltage (Bandgap)	1.28	1.3	1.32	V	Trimmed for appropriate V_{DD}

DC GPIO Specifications

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

Table 12. DC GPIO Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
R_{PU}	Pull-up resistor	4	5.6	8	kΩ	
R_{PD}	Pull-down resistor	4	5.6	8	kΩ	
V_{OH}	High output level	V_{DD} - 1.0	–	–	V	IOH = 10 mA, (8 total loads, 4 on even port pins (for example, P0[2], P1[4]), 4 on odd port pins (for example, P0[3], P1[5])). 80 mA maximum combined IOH budget.
V_{OL}	Low output level	–	–	0.75	V	IOL = 25 mA, (8 total loads, 4 on even port pins (for example, P0[2], P1[4]), 4 on odd port pins (for example, P0[3], P1[5])). 150 mA maximum combined IOL budget.
I_{OH}	High level source current	10	–	–	mA	VOH = V_{DD}-1.0 V. See the limitations of the total current in the Note for VOH.
I_{OL}	Low level sink current	25	–	–	mA	VOL = 0.75 V. See the limitations of the total current in the Note for VOL.
V_{IL}	Input low level	–	–	0.8	V	
V_{IH}	Input high level	2.1	–		V	
V_H	Input hysterisis	–	60	–	mV	
I_{IL}	Input leakage (Absolute Value)	–	1	–	nA	Gross tested to 1 μA.
C_{IN}	Capacitive Load on Pins as Input	–	3.5	10	pF	Package and pin dependent. Temp = 25 °C.
C_{OUT}	Capacitive load on pins as output	–	3.5	10	pF	Package and pin dependent. Temp = 25 °C.

DC Operational Amplifier Specifications

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

Table 13. 5-V DC Operational Amplifier Specifications

Symbol	Description	Min	Typ	Max	Unit	Notes
V_{OSOA}	Input offset voltage (absolute value) 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	 – – – – – –	 1.6 1.6 1.6 1.6 1.6 1.6	 10 10 10 10 10 10	 mV mV mV mV mV mV	
TCV_{OSOA}	Average input offset voltage drift	–	4	23	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 Power = High, Opamp bias = High) Common mode voltage range (Power = High, Opamp bias = High)	0 0.5	– –	V_{DD} V_{DD} – 0.5	V V	The common-mode input voltage range is measured through an analog output buffer. The specification includes the limitations imposed by the characteristics of the analog output buffer.
CMRROA	Common mode rejection ratio	60	–	–	dB	
GOLOA	Open loop gain	80	–	–	dB	
$V_{OHIGHOA}$	High output voltage swing (internal signals)	V_{DD} – 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	$V_{SS} \le V_{IN} \le (V_{DD} – 2.25)$ or $(V_{DD} – 1.25\ V) \le V_{IN} \le V_{DD}$.

DC Low Power Comparator Specifications

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

Table 14. DC Low Power Comparator Specifications

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

DC Analog Output Buffer Specifications

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

Table 15. DC Analog Output Buffer Specifications

Symbol	Description	Min	Typ	Max	Units	Notes
C_L	Load capacitance	–	–	200	pF	This specification applies to the external circuit driven by the analog output buffer.
V_{OSOB}	Input offset voltage (Absolute Value) Power = Low, Opamp bias = Low Power = Low, Opamp bias = High Power = High, Opamp bias = Low Power = High, Opamp bias = High	 – – – –	 3.2 3.2 3.2 3.2	 18 18 18 18	 mV mV mV mV	
TCV_{OSOB}	Average input offset voltage drift	–	5.5	26	µV/°C	
V_{CMOB}	Common-mode input voltage range	0.5	–	V_{DD} – 1.0	V	
R_{OUTOB}	Output resistance Power = Low Power = High	 – –	 – –	 1 1	 W W	
$V_{OHIGHOB}$	High output voltage swing (Load = 32 ohms to V_{DD}/2) Power = Low Power = High	 0.5 x V_{DD} + 1.3 0.5 x V_{DD} + 1.3	 – –	 – –	 V V	
V_{OLOWOB}	Low output voltage swing (Load = 32 ohms to V_{DD}/2) Power = Low Power = High	 – –	 – –	 0.5 x V_{DD} - 1.3 0.5 x V_{DD} - 1.3	 V V	
I_{SOB}	Supply current including bias Cell (No Load) Power = Low Power = High	 – –	 1.1 2.6	 2 5	 mA mA	
$PSRR_{OB}$	Supply voltage rejection ratio	40	64	–	dB	