CY3274

Cypress High Voltage Programmable Powerline Communication Development Kit Guide

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Contents

Safety Information

The “High Voltage Programmable Power Line Communication Development Kit” CY3274 is intended for use as a development platform for hardware or software in a laboratory environment. The board is an open system design, which does not include a shielded enclosure. Due to this reason the board may cause interference to other electrical or electronic devices in close proximity. In a domestic environment, this product may cause radio interference. In such cases, the user may be required to take adequate preventive measures. Also, this board should not be used near any medical equipment or RF devices.

Attaching additional wiring to this product or modifying the product operation from the factory default may affect its performance and cause interference with other apparatus in the immediate vicinity. If such interference is detected, suitable mitigating measures should be taken.

	**CAUTION: High Voltage (Risk of Electric Shock)** Extreme care is necessary when you work with powerline communication equipment. Use caution when using power supplies or power related equipment. Use the board with expert technical supervision. There is high voltage (110-V, 240-V AC) power on the board. ■ Accidental human contact with high voltage is dangerous. ■ The capacitors on the board can be energized even after disconnecting the board from the main power supply. Be careful not to touch any parts on the board immediately after you disconnect the main power supply. ■ Safety plastic casing is provided on the top of the high voltage section. Do not touch the protected area during live operation for debugging, probing, or for any other purpose. Cypress bears no responsibility for any consequences that may result from the improper or hazardous use of this board.
	The kit CY3274 contains electrostatic discharge (ESD) sensitive devices. Electrostatic charges readily accumulate on the human body and any equipment, and can discharge without detection. Permanent damage may occur on devices subjected to high-energy discharges. Proper ESD precautions are recommended to avoid performance degradation or loss of functionality. Store unused CY3274 boards in the protective shipping package.
	End-of-Life / Product Recycling This Kit has an end-of-life cycle after five years from the date of manufacturing mentioned on the back side of the box. Please contact your nearest recycler for discarding the kit.

General Safety Instructions

ESD Protection

ESD can damage boards and associated components. Cypress recommends that the user perform procedures only at an ESD workstation. If ESD workstation is not available, use appropriate ESD protection by wearing an antistatic wrist strap attached to the chassis ground (any unpainted metal surface) on the board when handling parts.

Handling Boards

CY3274 boards are sensitive to ESD. Hold the board only by its edges. After removing the board from its box, place it on a grounded, static free surface. Use a conductive foam pad if available. Do not slide board over any surface.

1. Introduction

1.1 Kit Contents

Figure 1-1. Kit Contents

The CY3274 PLC HV development kit contains:

- CY3274 quick start guide
- CY3274 PLC HV development board
- AC power cable
- MiniProg1 to program CY8CPLC20
- 25 jumper wires
- LCD module
- USB-I2C bridge
- USB A to mini B cable
- Five CY8CPLC20-28PVXI Device Samples

1.2 Using the PLC Kit

Cypress's Powerline Communication Solution (PLC) makes it possible to transmit and receive data and control data over high voltage and low voltage powerlines. This solution is developed for low bandwidth powerline communication.

The CY3274 PLC high voltage (HV) PLC development kit provides the capability to develop an application on the Cypress CY8CPLC20 device that can transmit and receive data over high voltage (110 V to 240 V AC) powerlines.

- Introduction chapter on page 7 provides a brief overview of the Cypress PLC solution. It describes the contents of the CY3274 development kits and lists special features of the kit.
- Getting Started chapter on page 13 provides information on kit software and process for its installation as well as hardware connections.
- PLC Development Board chapter on page 41 gives the functional overview of the PLC board and describes the operating procedure of PLC HV board. It provides a high level hardware description of the board.
- Code Examples chapter on page 51 provides explanation on the example projects and working.
- Appendix chapter on page 69 contains the schematics, layout, and bill of materials.

1.3 The Cypress PLC Solution

Powerlines are available everywhere in the world. This makes them one of the most widely available communication media. The pervasiveness of powerlines also makes it difficult to predict their characteristics and noise. Because of the variability of powerline quality, implementing robust communication over powerline has been an engineering challenge for years. With this in mind, the Cypress PLC solution is designed to enable secure, reliable, and robust communication over powerlines.

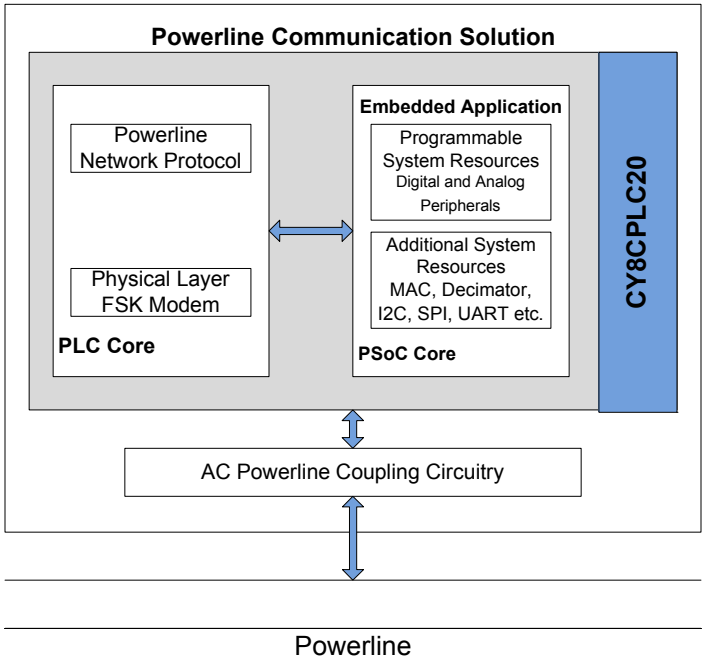
The key features of the Cypress PLC solution are:

- An integrated powerline PHY modem with optimized filters and amplifiers that work with rugged high and low voltage powerlines
- Powerline optimized network protocol that supports bidirectional communication with acknowledgement based signaling and multiple retries
- Support for 8-bit packet CRC and 4-bit header CRC for error detection and data packet retransmission
- Carrier Sense Multiple Access (CSMA) scheme that minimizes collisions between packet transmissions on the powerline

The Cypress PLC solution consists of three key elements as shown in Figure 1-2.

- Powerline network protocol layer
- Physical layer FSK modem
- Power amplification and coupling circuits

Figure 1-2. Cypress PLC Solution Block Diagram



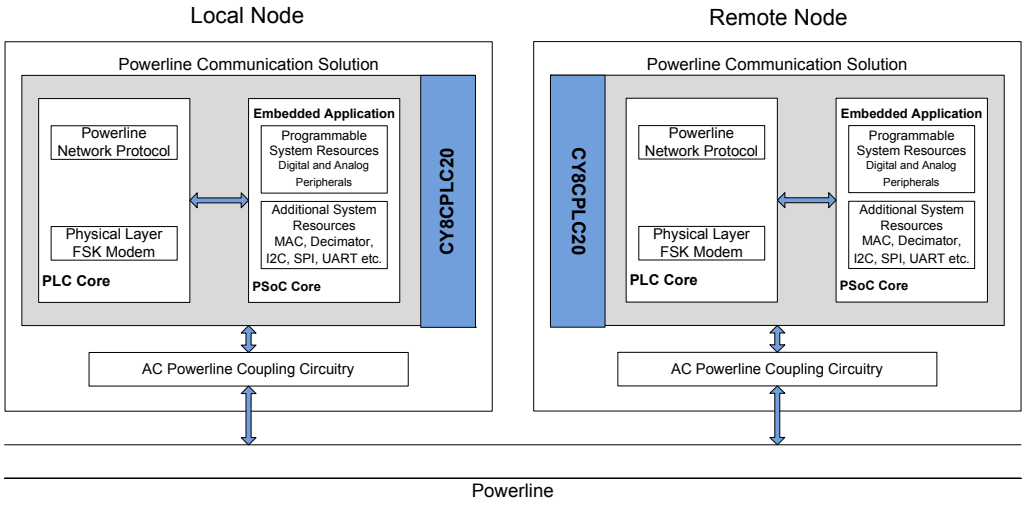
The powerline network protocol layer and the physical layer FSK modem are implemented on the CY8CPLC20 chip. The chip also contains a PSoC core in addition to the PLC core. The CY3274 board contains the CY8CPLC20 device along with the power amplification and coupling circuit for communicating on high voltage (110-240 V AC) powerlines. For a detailed description of the design parameters for the circuit, refer to the application note Cypress Powerline Communication Board Design Analysis - AN55427.

The network protocol layer allows for the addressing of multiple nodes on the network. This enables point-to-multipoint communication. The protocol layer also provides a defined packet structure for transmitting data packets from one node to the other as well as error detection and packet retransmit functionalities. The chip contains a PSoC core in addition to the PLC core. The PSoC core includes configurable blocks of analog and digital logic, and programmable interconnects. This architecture enables you to create customized peripheral configurations that match the requirements of each individual application. A fast CPU, flash program memory, SRAM data memory, and configurable I/Os are also included.

A two-node system level diagram is shown in Figure 1-3. To evaluate this kit, follow the steps in the quick start guide, which is provided in the kit.

Note To evaluate this kit, a second high voltage PLC kit is required. The compatible kit is CY3274, with EZ-Color. For information on this kit, visit http://www.cypress.com/go/CY3274.

Figure 1-3. PLC System Level Block Diagram – Two Nodes



1.4 Additional Learning Resources

Visit http://www.cypress.com/go/plc for additional learning resources in the form of datasheets, technical reference manuals, and application notes.

- CY3274 Schematic.pdf
- CY3274 Board Layout.zip
- CY3274 Kit documentation
  http://www.cypress.com/go/CY3274
- For a list of PSoC Designer-related trainings, see
  http://www.cypress.com/?rID=40543
- CY8CPLC20 data sheet
  http://www.cypress.com/?rID=38201
- For more information regarding PSoC Designer functionality and releases, refer to the user guide and release notes on the PSoC Designer web page:
  www.cypress.com/go/psocdesigner
- For more information regarding PSoC Programmer, supported hardware, and COM layer, go to the PSoC Programmer web page:
  www.cypress.com/go/psocprogrammer
- AN54416, Using CY8CPLC20 in Powerline Communication (PLC) Applications
  http://www.cypress.com/?rID=37951

1.5 Acronyms

Table 1-1. Acronyms Used in this Document

Acronym	Description
AC	Alternating Current
BIU	Band-In-Use
CPU	Central Processing Unit
CSMA	Carrier Sense Multiple Access
DC	Direct Current
DIP	Dual In-line Package
FSK	Frequency-Shift Keying
GPIO	General-Purpose Input/Output
GUI	Graphical User Interface
HV	High Voltage
I^2C	Inter-Integrated Circuit
I/O	Input/Output
ISR	Interrupt Service Routine
LCD	Liquid-Crystal Display
LED	Light-Emitting Diode
OCD	On-Chip Debug
PLC	Powerline Communication
PLT	Powerline Transceiver
PSoC	Programmable System-on-Chip
QFN	Quad-Flat No-leads
RH	Relative Humidity
SMPS	Switched-Mode Power Supply
SRAM	Static Random-Access Memory
USB	Universal Serial Bus

1.6 Documentation Conventions

Table 1-2. Document Conventions for Guides

Convention	Usage
`Courier New`	Displays file locations, user entered text, and source code: `C:\ ...cd\icc\`
Italics	Displays file names and reference documentation: Read about the *sourcefile.hex* file in the *PSoC Designer User Guide*.
[**Bracketed, Bold**]	Displays keyboard commands in procedures: [**Enter**] or [**Ctrl**] [**C**]
File > Open	Represents menu paths: File > Open > New Project
Bold	Displays commands, menu paths, and icon names in procedures: Click the **File** icon and then click **Open**.
Times New Roman	Displays an equation: 2 + 2 = 4
Text in gray boxes	Describes cautions or unique functionality of the product.

1.7 Technical Reference

For a real-time list of knowledge base articles for the CY3274 Kit, refer to our Online Knowledge Base.

For any help with the installation of the control panel, refer to the Control Panel User Guide available on our website. You can download the latest revision of the GUI setup and user guide from www.cypress.com/go/plc.

1.8 Technical Support

For assistance, go to our support: http://www.cypress.com/support web page, or contact our customer support at +1(800) 541-4736 Ext. 2 (in the USA), or +1 (408) 943-2600 Ext. 2 (International).

2. Getting Started

This chapter describes how to install and configure the CY3274-HV PLC Development Kit.

2.1 Software Installation

2.1.1 Before You Begin

All Cypress software installations require administrator privileges; however, this is not required to run the installed software.

- Shutdown any Cypress software that is currently running.
- Disconnect any Cypress devices (USB-I2C bridge, ICE Cube, or MiniProg) from your computer.
- If you have a previous installation of the PLC Control Panel GUI, uninstall it first. To uninstall the software, go to Start > Control Panel > Add or Remove Programs (for XP)/Programs and Features (for Win 7) and click the Remove/Uninstall button adjacent to the particular software. Follow the instructions to uninstall.

2.1.2 Prerequisites

The PLC Control Panel GUI requires the 3.5 SP1 or later version of Microsoft .NET Framework, Adobe Acrobat Reader, and a Windows Installer.

2.1.3 Installing PLC Control Panel Independently

2.1.3.1 Before You Begin

All Cypress software installations require administrator privileges; but this is not required to run the installed software.

- Shut down any Cypress software that is currently running.
- Disconnect any ICE-Cube, USB-I2C Bridge, or MiniProg devices from your computer.
- If you have a previous installation of the PLC Control Panel GUI, uninstall it first. To uninstall the software, go to Start > Control Panel > Add or Remove Programs (for XP)/Programs and Features (for Win 7) and click the Remove/Uninstall button adjacent to the particular software. Follow the instructions to uninstall.

2.1.3.2 Prerequisites

The following software is required for the PLC Control Panel:

Microsoft .NET Framework 3.5 SP1 or later

To check if this software is installed, go to Start> Control Panel> Add/Remove Programs(for XP)/ Programs and Features (for Win 7). This software can be downloaded from: http://www.microsoft.com/downloads/details.aspx?Fami-lyID=AB99342F-5D1A-413D-8319-81DA479AB0D7&displaylang=en

Windows Installer 3.1 or later

To check if this software is installed, go to Start> Control Panel> Add/Remove Programs. This software can be downloaded from: http://www.microsoft.com/downloads/details.aspx?Fami-lyID=889482FC-5F56-4A38-B838-DE776FD4138C&displaylang=en

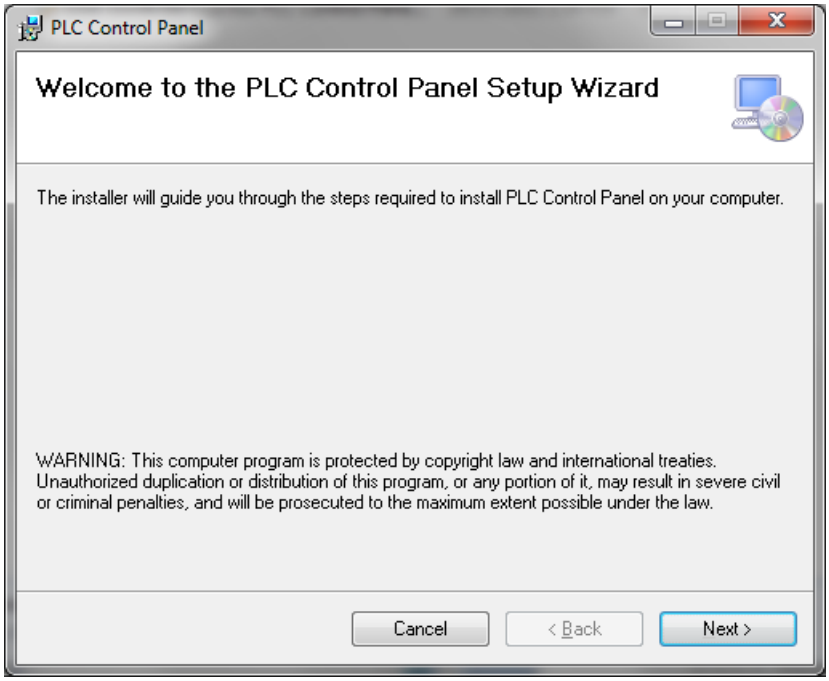
2.1.3.3 Installing PLC Control Panel Software

When installing the PLC Control Panel, the installer checks if the prerequisites - Windows Installer, Windows.NET, and Acrobat Reader - are installed in your PC. If these applications are not installed, then the installer prompts you to install them.

1. Download the PLC Control Panel GUI.zip from http://www.cypress.com/?rID=38135 and extract it.
2. Run the setup.exe file to start the installer.

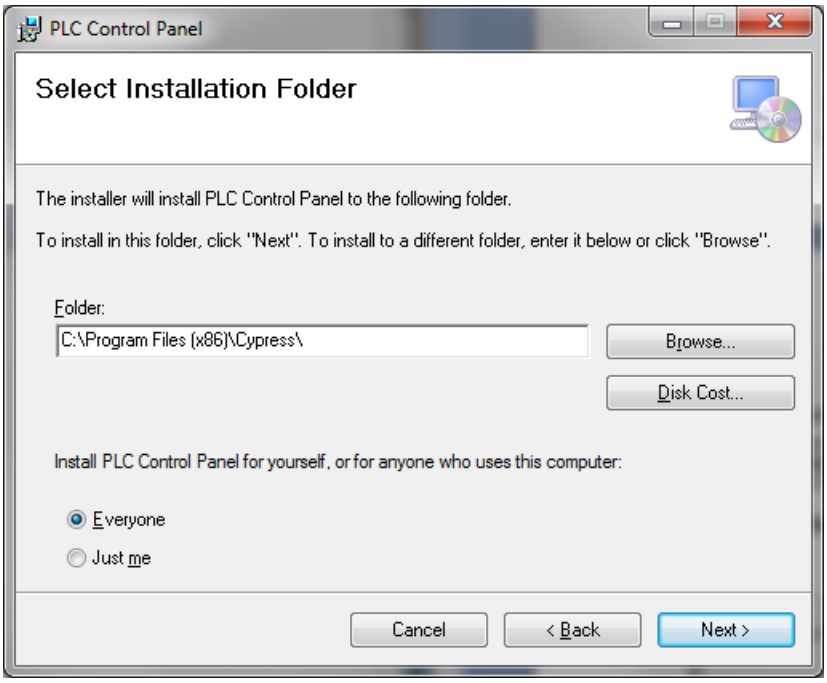
3. As specified, this installation process first determines if you have all prerequisite software. Follow the on-screen dialogs to complete all required installations.

Figure 2-1. Installation Wizard



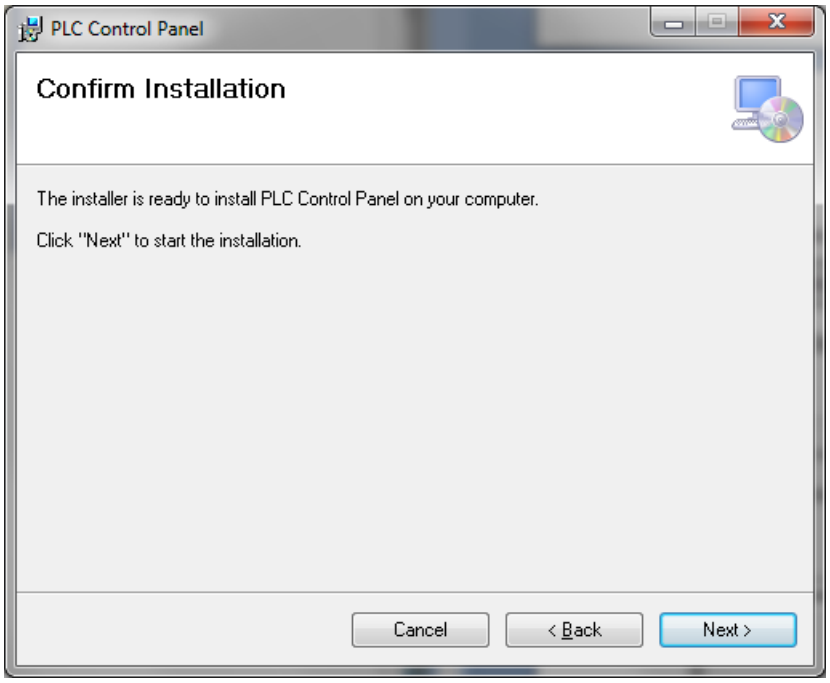
4. Click the Next button in Figure 2-1.

Figure 2-2. Select Installation Folder



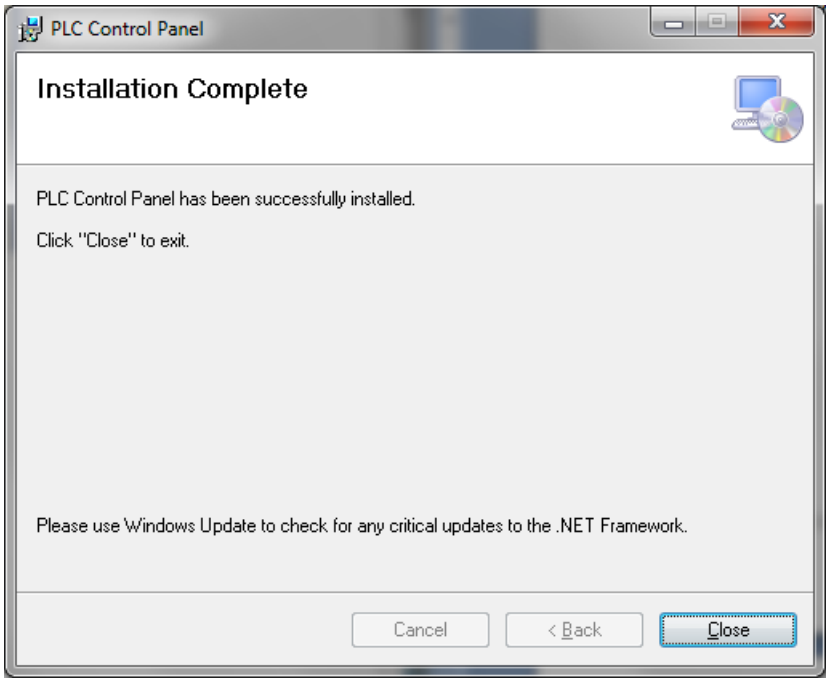
5. Click Browse to select Installation Folder and then click the Next button in Figure 2-2.

Figure 2-3. Confirm Installation



6. Click the Next button in Figure 2-3.

Figure 2-4. End of Installation Wizard



7. Click the Close button in Figure 2-4.
8. Verify your installation and setup by opening the PLC Control Panel. To open the PLC Control Panel, click Start> All Programs> Cypress> PLC Control Panel> PLC Control Panel.

9. Continue to the next section to learn how to evaluate the PLC Control Panel with two PLC evaluation or development kits.

After installing PLC Control Panel, refer to the documentation as needed:

```
<Install_Dir>\PLC Control Panel\PLC Control Panel Release Notes.pdf
<Install_Dir>\PLC Control Panel\User Guide for Cypress PLC Control Panel GUI.pdf
```

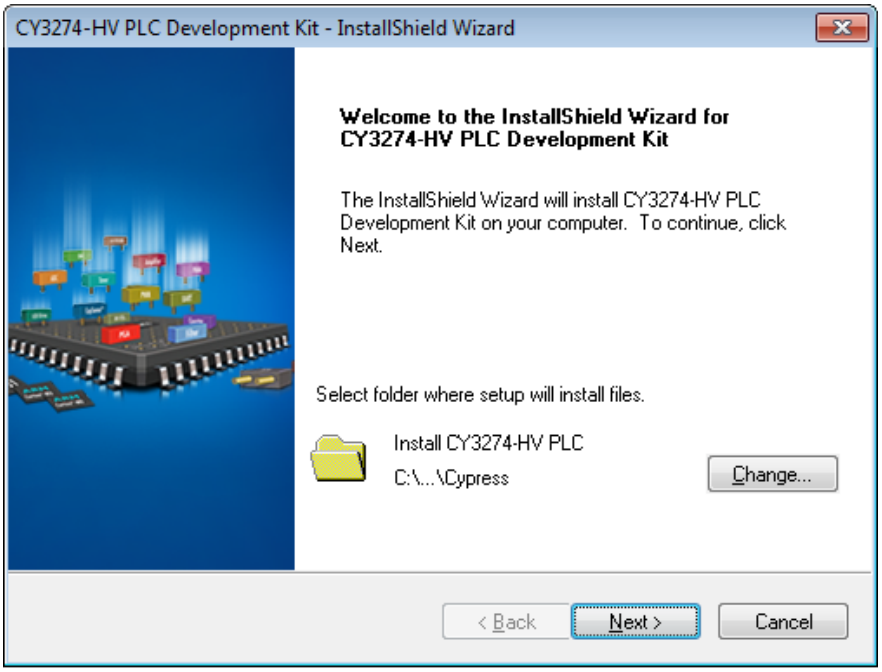
The PLC Control Panel user guide is also available in the installation directory. It contains extra information about installation and how to set up the kit to work with the GUI. It can also be accessed from the Help menu in the PLC Control Panel GUI.

2.2 Kit Installation

To install the kit software, follow these steps:

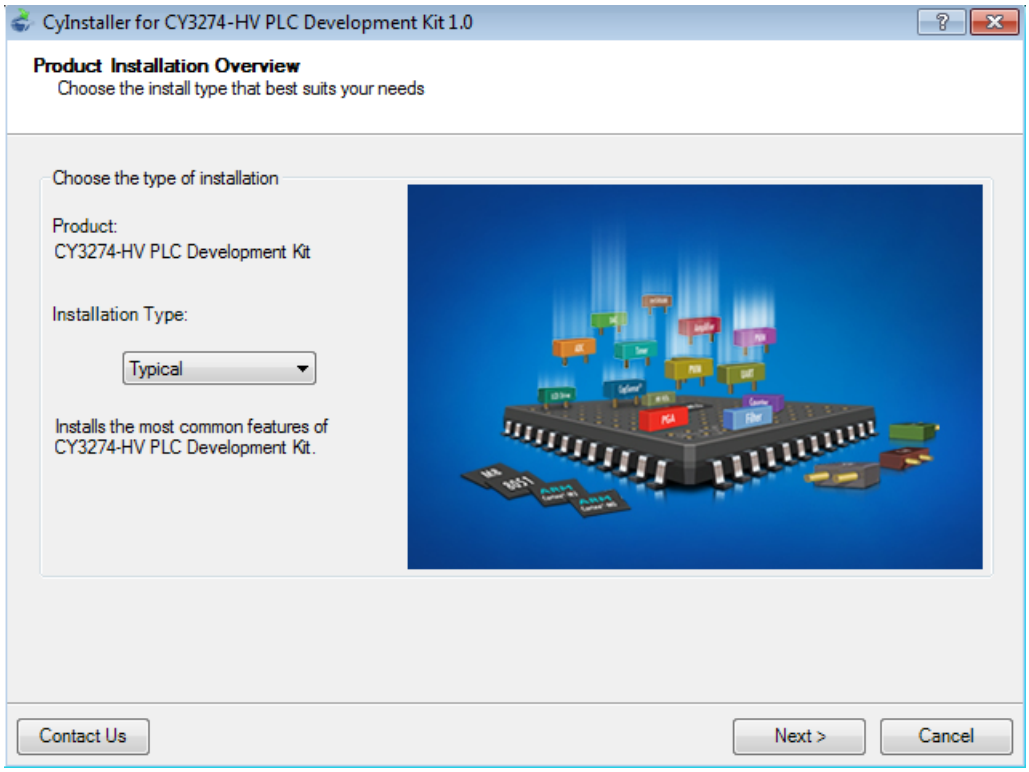
1. Download CY3274 kit installer from http://www.cypress.com/go/CY3274 and start installation.
3. The **CY3274-HV PLC Development Kit - InstallShield Wizard** screen appears. Choose the folder location to install the setup files. You can change the location of the folder using **Change**.
4. Click **Next** to launch the kit installer.

Figure 2-5. CY3274-HV PLC Development Kit - InstallShield Wizard



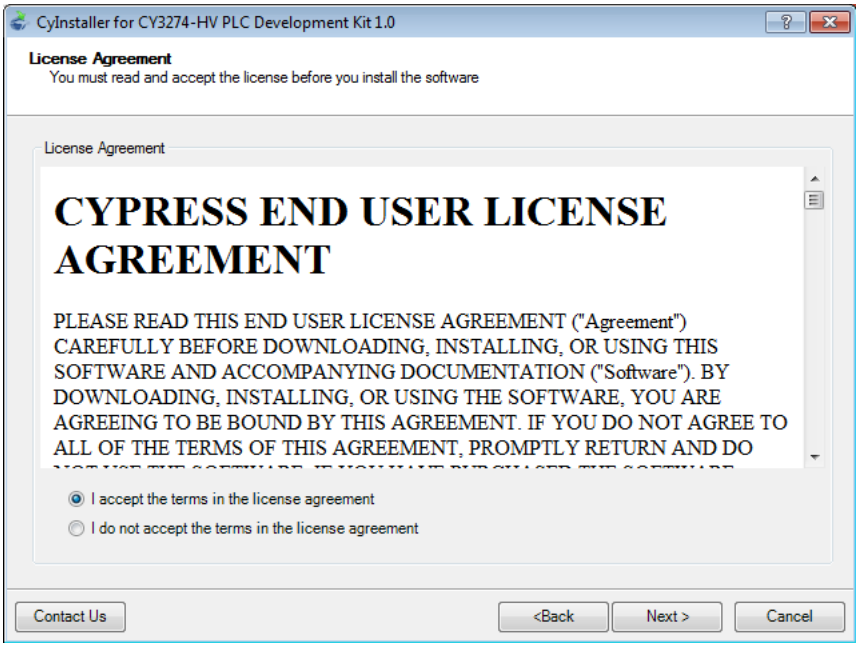
5. On the **Product Installation Overview** screen, select the installation type that best suits your requirement. The drop-down menu has the options **Typical**, **Complete**, and **Custom**, as shown in Figure 2-6.

Figure 2-6. Installation Type Options



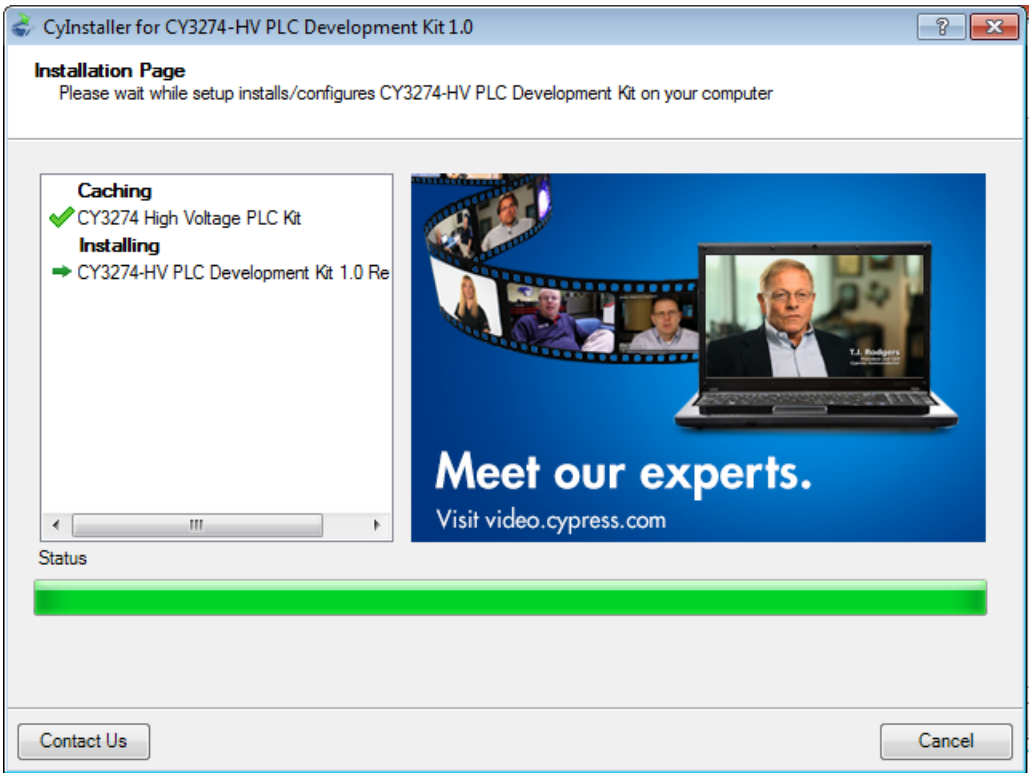
6. Click **Next** in Figure 2-6 to go to Figure 2-7.

Figure 2-7. Cypress End User License Agreement



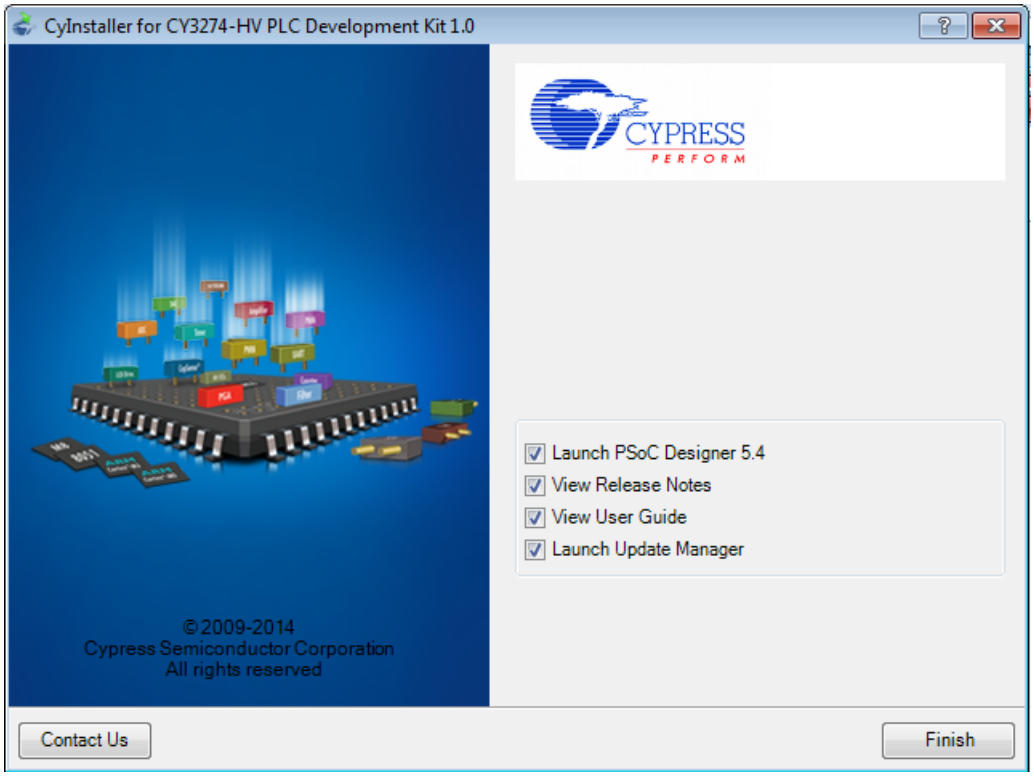
7. Select “I accept the terms in the license agreement” and then click **Next** in Figure 2-7 to start the installation.
8. When the installation begins, a list of all packages appears on the **Installation Page**.
9. A green check mark appears next to every package that is downloaded and installed.

Figure 2-8. Installation Page



10. Click **Finish** to complete the installation.

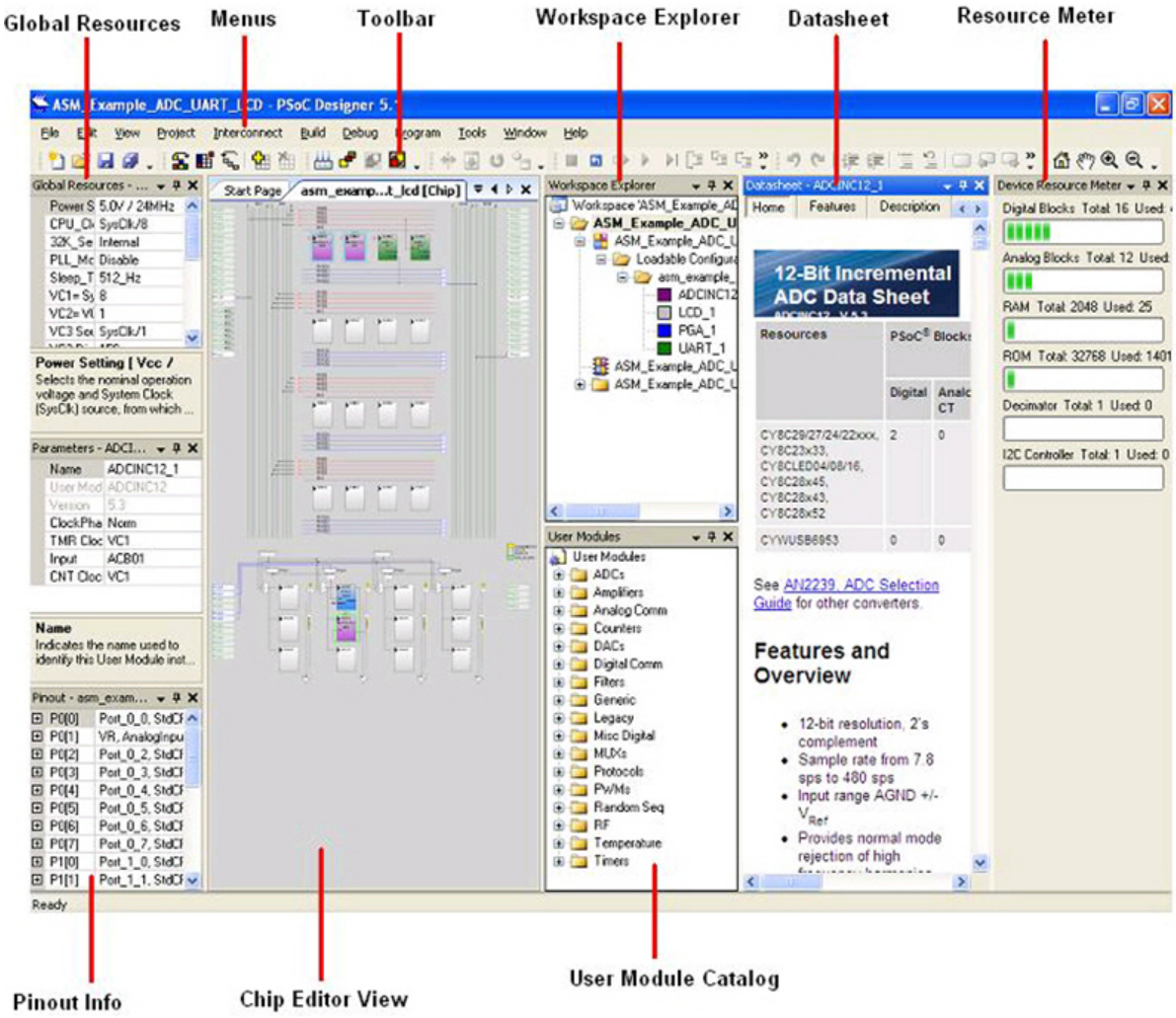
Figure 2-9. Installation Completion Page



2.3 PSoC Designer

1. Click **Start** > **All Programs** > **Cypress** > **PSoC Designer <version>** > **PSoC Designer <version>**.
2. Click **File** > **New Project** to create a new project on the PSoC Designer menu or go to File > **Open Project/Workspace** to work with the existing project on the PSoC Designer menu

Figure 2-10. PSoC Designer Interconnect View



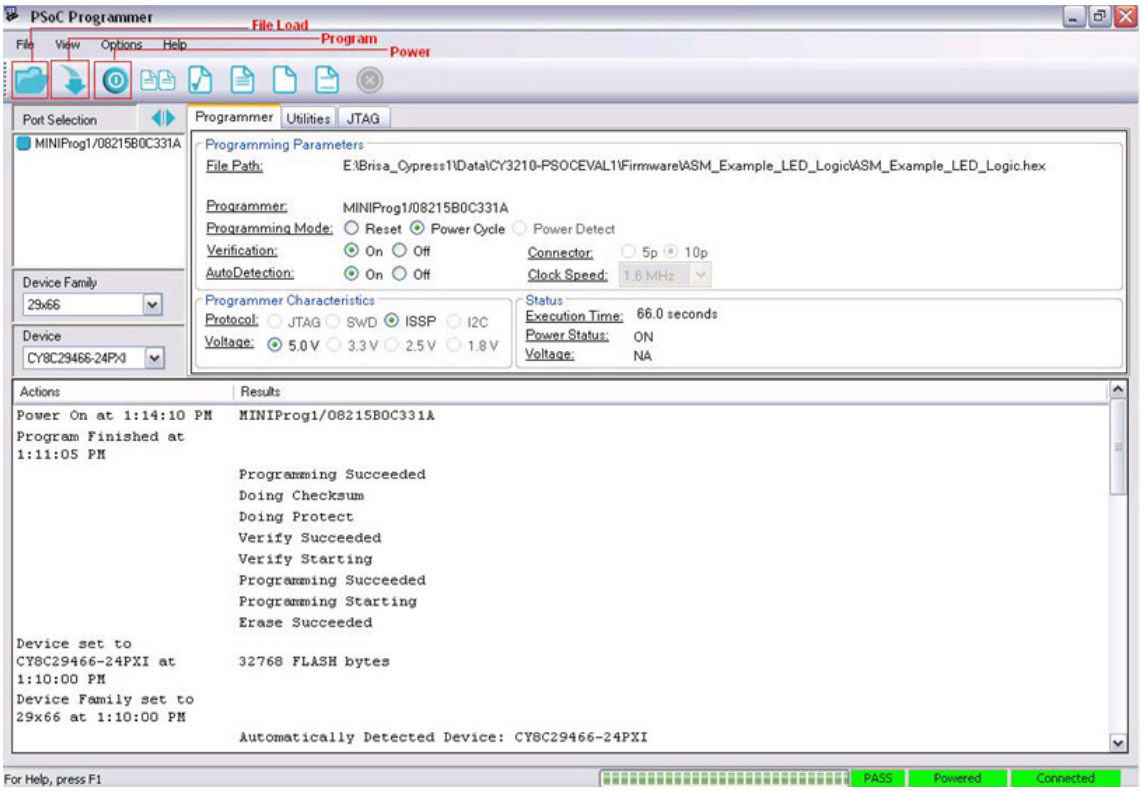
3. For more details on PSoC Designer, go to **Help Topics** from the following directory:

```
<Install_Dir>\Cypress\PSoC Designer\<version>\PSoC Designer 5\Help\PSoCDesigner
(Compiled HTML Help file)
```

2.4 PSoC Programmer

1. Click **Start** > **All Programs** > **Cypress** > **PSoC Programmer <version>** > **PSoC Programmer <version>**.
2. Connect the MiniProg from **Port Selection**.

Figure 2-11. PSoC Programmer Window



3. Click the File Load button to load the hex file.
4. Use the Program button to program the hex file on to the chip.
5. When the file is successfully programmed, Programming Succeeded appears on the Action pane.
6. Close PSoC Programmer.

Note For more details on PSoC Programmer, go to **Help Topics** from the following path: `<Install_Dir>\Cypress\Programmer\<version>\PSoC_Programmer(Compiled HTML Help file)`

2.5 Uninstall Software

2.5.1 Uninstalling the PLC Control Panel Software

The PLC Control Panel GUI supports un-installation through either the Add/Remove Programs tool in the Control Panel for MS Windows or the shortcut provided in the Start menu.

3. Kit Operation and PLC Control Panel GUI

This chapter explains kit operation and PLC Control Panel GUI.

3.1 Theory of Operation

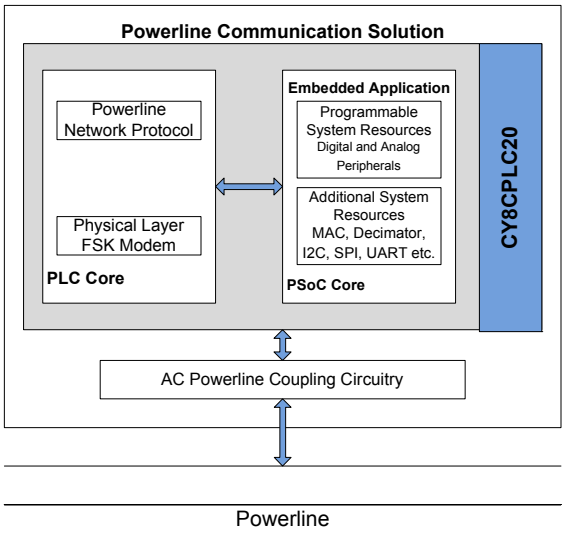
The Cypress PLC family is a single chip solution for powerline communication (PLC). The solution has a robust FSK modem with a user-friendly powerline network protocol. CY3274 has a simple powerline coupling circuit to create a low-cost communication interface using the existing power lines. This interface can be used for intelligent command and control systems such as:

- Lighting control
- Automatic meter reading
- Home automation

Figure 3-1 shows a block diagram of the Cypress CY8CPLC20 PLC Solution. To interface the CY8CPLC20 device to the powerline, a coupling circuit is required.

Complete PLC evaluation and development kits, compliant with PLC standards in Europe and North America, are available at www.cypress.com/go/plc.

Figure 3-1. CY3274 PSoC1 PLC Solution



3.1.1 CY8CPLC20 Device Description

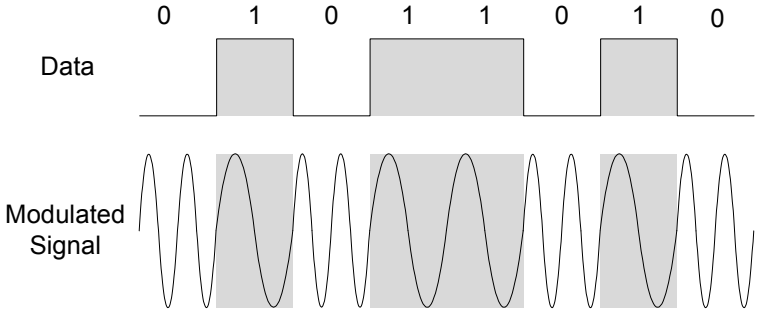
The CY8CPLC20 is a Programmable Powerline Communication chip with

- Powerline FSK Modem PHY
- Powerline Network Protocol Stack.

3.1.1.1 *Powerline FSK Modem PHY*

The heart of the CY8CPLC20 device is the frequency shift keying (FSK) modem. The FSK modulator sends digital data through two distinct frequencies; one frequency represents a digital 1 and the other represents a digital 0 (see Figure 3-2). The FSK demodulator must receive the transmitted analog signals and demodulate them to determine the correct sequence of 1s and 0s.

Figure 3-2. Sample FSK Waveform



Note: This diagram is only for conceptual understanding and is not to scale.

3.1.1.2 *Powerline Network Protocol Stack*

The network protocol that runs on the processor supports

- Bidirectional half-duplex communication
- Master-slave or peer-to-peer network topologies
- Multiple masters on powerline network
- Addressing
  - 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 264 Powerline nodes
  - Individual broadcast or group mode addressing
- Carrier Sense Multiple Access (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.
- Band-In-Use (BIU)

  A BIU detector, as defined under CENELEC EN 50065-1, is active whenever a signal that exceeds 86 dB µVrms 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 3.5 seconds (depending on the noise on the Powerline) and generates an interrupt to indicate that the transmitter was unable to acquire the Powerline.

  Note that for non-CENELEC compliant systems, the BIU interval can be modified for improved performance by modifying the Timing_Config register. Refer the PLT UM datasheet for more details.
- Verifies address and packet integrity (CRC) of received packets
- Transmits acknowledgments after receiving a valid packet, and automatically retransmits if a packet is dropped.

3.2 Functional Description

The CY3274 PLC development board is designed as a product development platform for low bandwidth (up to 2400 bps) powerline communication.

The user-written application running on the CY8CPLC20 generates the data. The PLC core encapsulates this data into a PLC network packet. The FSK modem then modulates this packet and the coupling circuitry incorporates the resulting sinusoidal waveform on to the existing waveform on the high voltage bus.

3.2.1 Operating Conditions

- Input voltage: 110 V AC/240 V AC
- Input current: 100 mA/50 mA
- Operating temperature: 0 °C to 40 °C
- Operating humidity condition: 5% to 95% relative humidity (RH), non-condensing

This document provides instructions to install and uninstall Cypress's Powerline Communication (PLC) solution. It describes how to set up the boards and includes detailed descriptions of all tabs in the PLC Control Panel.

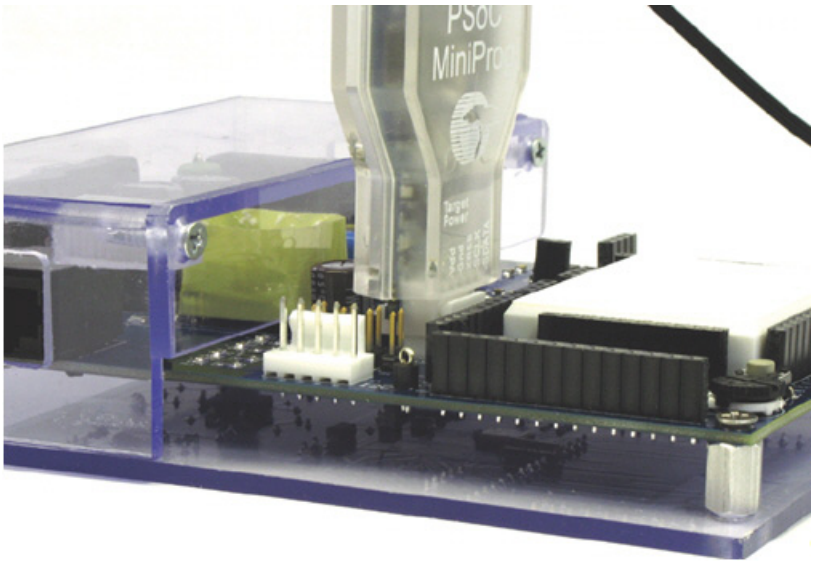
3.3 PLC Control Panel GUI

3.3.1 Program CY3274 Boards with I^{2}C-PLC Interface

Follow these steps to configure the boards:

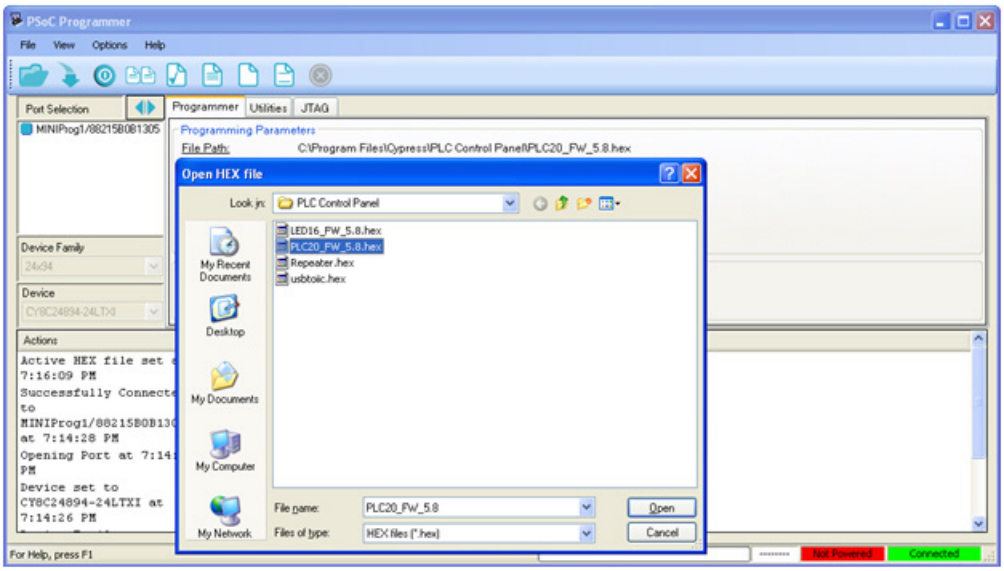
1. Connect a USB A to mini B cable from the PC to the MiniProg programmer, which is included in the kit.
2. Connect the MiniProg to the ISSP 5-pin header on the board.

Figure 3-3. MiniProg connected to ISSP 5-pin header



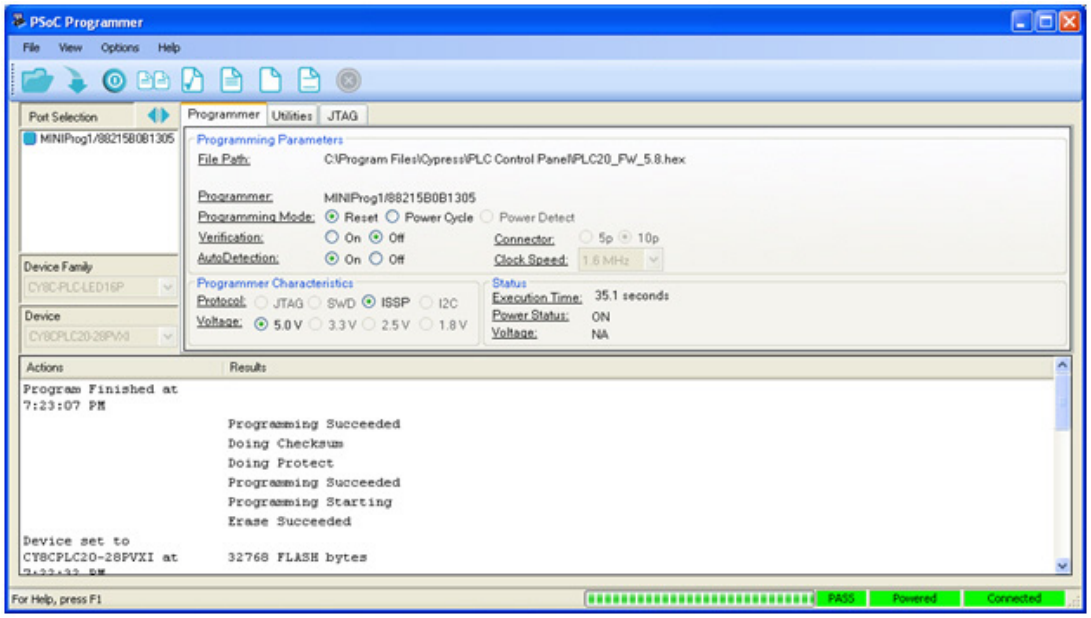
3. Open PSoC Programmer from Start Menu.
4. Click the File Load button or click File > File Load… (F4). Navigate to the folder C:\Program Files (x86)\Cypress\PLC Control Panel\ and open PLC20_FW_5.8.hex.

Figure 3-4. Opening PLC20_FW_5.8.hex



5. If the board is powered, then set Programming Mode to Reset in the Programming Parameters section. If the board is not powered, set Programming Mode to Power Cycle. Then, set Verification to Off (faster programming times, checksum still performed) and AutoDetection to On.
6. Click the Program Part button. The status window should show Programming Starting. If it does not, make sure that the Programming Mode is set correctly (see step 5) and the MiniProg is connected to the ISSP connector on the PLC board (see the kit user guide for location of the connector). If set up correctly, the status window shows Programming Succeeded in less than a minute.

Figure 3-5. PSoC Programmer



7. Remove the MiniProg from the ISSP header and press the RESET push-button on the PLC.
8. Follow the steps 1 to 7 on another PCL node.

3.3.2 PLC Control Panel Quick Start

This section describes how to set up two PLC boards and transmit a packet from one board to the other.

1. Connect the two PLC nodes to the powerline. A blue LED glows on the PLC boards when they are connected to the powerline.
2. Connect five pin header of the CY3240 USB-I^{2}C bridge to the I^{2}C header (J15) on the PLC kit and other end of the bridge to the computer's USB port. Make sure that a jumper shunt is connected across J1 on the bridge. When the bridge is connected to the USB port, the green LED turns on.
3. Make sure there are no jumpers placed on the PLC board.
4. Open the Control Panel from **Start > All Programs > Cypress> PLC Control Panel**.
5. The connected bridge appears in the USB-I^{2}C bridges list under the main menu of the GUI. Select the bridge from the list and click on Connect. Make sure that the **+5 V PWR** option is selected and the slave address is 0x01. The I^{2}C frequency can be any of the available options.

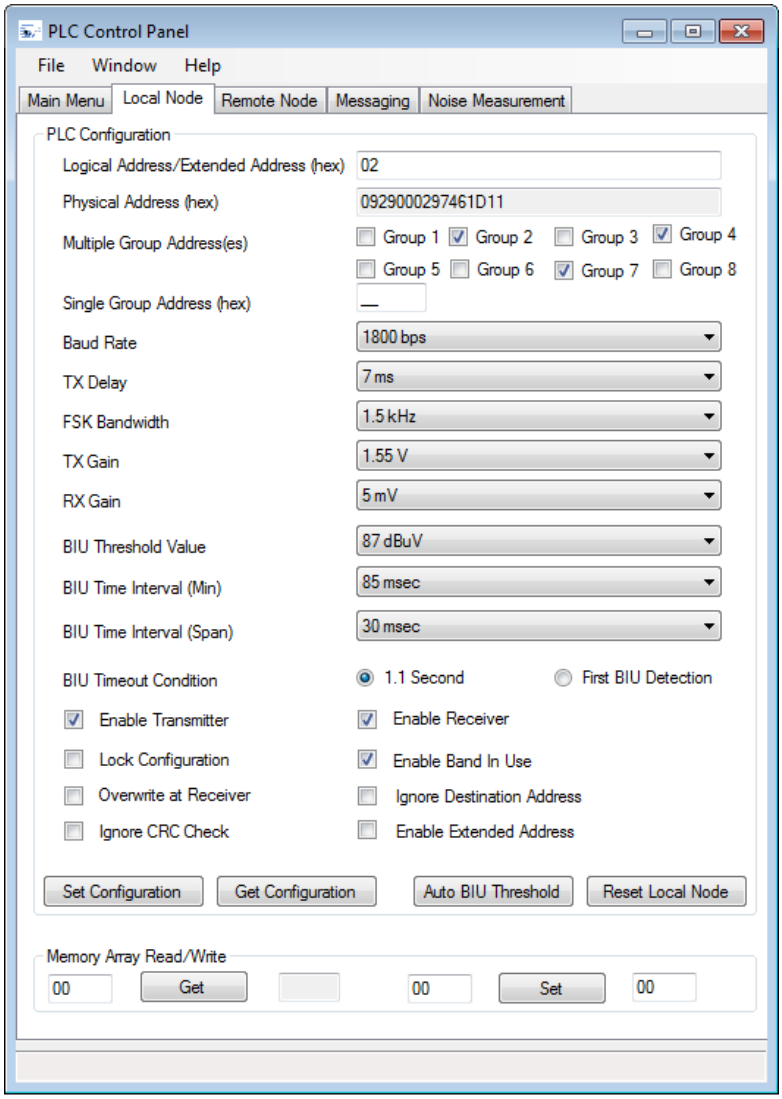
   The red LED lights up on the bridge if the connections are correct. The GUI indicates successful connection by briefly stating “PLC #0 Connected” in the status bar on the bottom left.

Figure 3-6. Connected Bridge

6. If there is a connection error, remove the bridge from the computer, close the GUI window, and repeat steps (1) to (4).

7. In the Local Node tab, choose a unique logical address for the node.

Figure 3-7. Local Node Tab



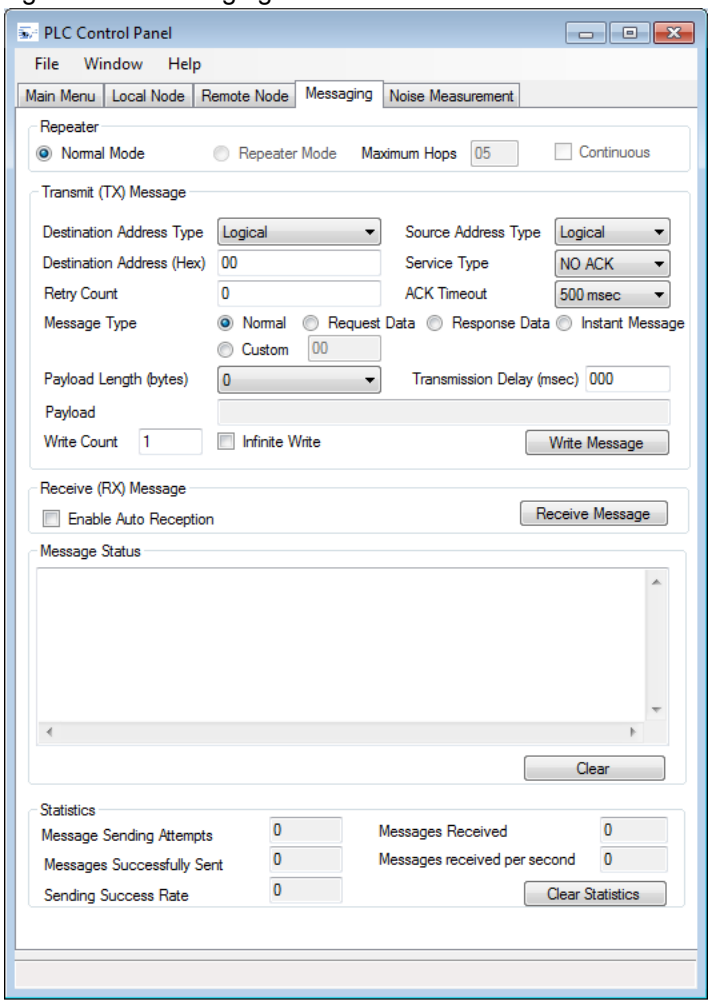
8. Set RX Gain to **250 µV**. All other drop-down menus can be left with their default values.
9. Enable the transmitter by checking **Enable Transmitter**.
10. Enable the receiver by checking **Enable Receiver**.
11. Select **Overwrite at Receiver**.
12. Click on **Set Configuration**. This writes the configuration into the PLC node. To verify, click on **Get Configuration**; the configuration values remain as they were set. If either of these commands are not successful, an error message is displayed.
13. Perform steps (1) to (10) for the second node. This node must be given a different logical address than the first node.
14. To send and receive messages between the boards, click on the Messaging tab in both GUIs.

Let us refer to the two GUIs as GUI A and GUI B for further discussion. If using one USB-I^{2}C bridge, complete the Write Message step first, then move the USB-I2C bridge to the other node and read the received message.

In GUI A, under the Messaging tab, set:

- Source Address Type and Destination Address Type - Logical
- Destination Address - Logical address of the node that will receive the message
- Service Type - ACK
- Retry Count - 1
- Message Type - Normal
- Payload Length - Choose a value between 1 and 31. The Payload option automatically configures for the chosen size.
- Payload - Enter the data to be sent here. Note that only hexadecimal values are allowed.
- Click on Write Message. The Message Status window should show “Sending Successful”. If it shows “BIU Timeout”, go to the Local Node tab and increase the BIU Threshold Value, then retry this step. If it shows “No ACK Received”, first make sure that the receiving node is configured correctly and that the Destination Address matches the address of the remote node. If it still does not work, go to the Local Node tab and change the value of RX Gain. In higher noise environments, a higher RX Gain threshold value is better.

Figure 3-8. Messaging Tab



In GUI B, under the Messaging tab, select the Enable Auto Reception. The message should appear in the Message Status window.

3.3.2.1 *Additional Options*

- Check Infinite Write in A and then click Write Message. The same message is transmitted continuously until the Infinite Write is unchecked.
- Set the Write Count to a value greater than 1. Click Write Message. This is the number of times the same message is sent by A to B.
- Set the message type to Instant Message. The Payload field now accepts ASCII characters. Type any message in the field and click Write Message. The message appears on B as text. The setup works similar to an instant messenger.
- To send messages in both directions, set up the parameters in B similar to the setting for A described earlier.
- Select the Enable Auto Reception in A. Now messages may be sent bi-directionally by typing in the message in the Payload field and clicking the Write Message button.
- The remote node configurations are retrieved and set in the Remote Node tab. To get the configurations, set the address and click Get Configuration. To change the configurations, make the changes in the corresponding fields and click Set Configuration.

3.3.3 PLC Control Panel Tabs

3.3.3.1 *Main Menu Tab*

Connect CY3240 USDB-I2C Bridge

Figure 3-9. Connect USB-I2C Bridge

Blink GRN LED

This button blinks the green LED on the bridge to help identify which bridge is currently selected.

Connect

Click Connect to connect the PLC device to the computer. If you try to connect to a bridge that is not connected to a PLC device, you see an error message. The power mode, slave address, and clock rate are set according to the selections made in the radio buttons.

Note If the USB-I2C bridge is powered by external power (that is, a jumper is connected across the ‘PWR’ pin on the PLC board), do not select +5 V power as the power mode.

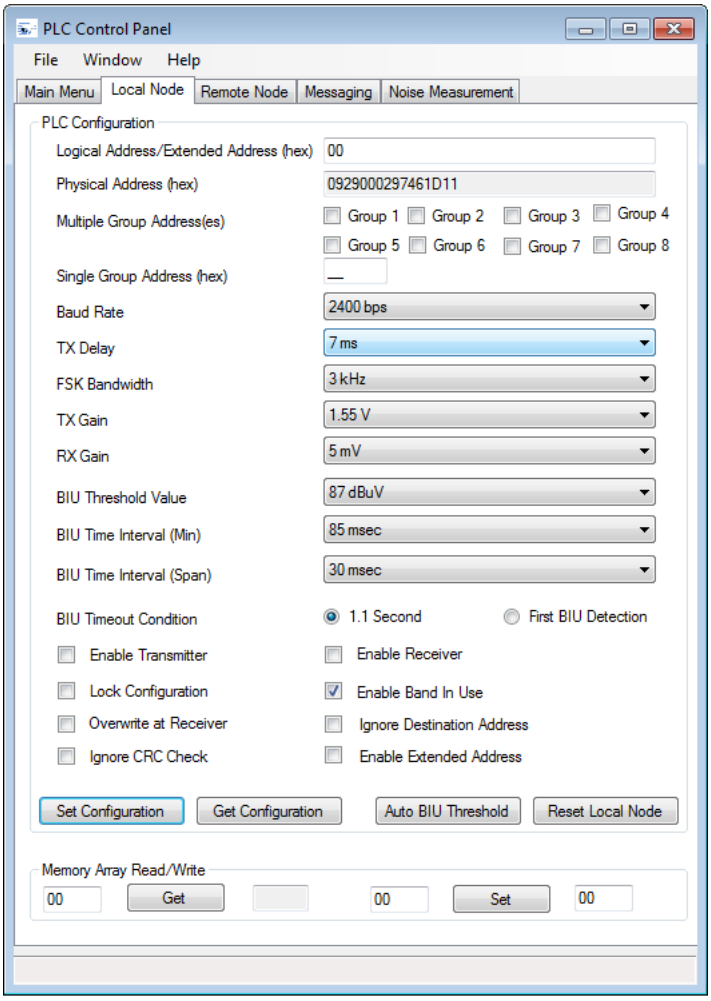
3.3.3.2 *Local Node Tab*

This tab allows you to view and change the PLC node settings when the node is directly connected to the computer using the bridge. The software application GUI gets data from the PLC node and displays it in the respective fields. You may also change the parameters and save it to the local node by clicking Set Configuration.

Get Configuration

Clicking this button retrieves all configuration values from the local node and displays them on the screen.

Figure 3-10. Local Node



The options available for Get Configuration are:

- Logical Address/Extended Address

  This field is the logical or extended address of the node depending on the addressing scheme followed.

- Physical Address

  This field is the 64-bit physical address of the PLC node. It cannot be changed by the user.

- Group Address(es)

  This field displays the groups to which the node belongs. The local node belongs to a group if its corresponding checkbox is selected or the Group ID is mentioned in the Single Group Address field.

- Baud Rate

  This field gives the baud rate of the local node. The possible baud rates are 600, 1200, 1800, and 2400 bps.

- TX Delay

  This field sets the amount of delay from when the transmission is initiated to when the data starts being Output from the Transmit Programmable Gain Amplifier. The possible delay durations are 7, 13, 19, and 25 ms.

- FSK Bandwidth

  This parameter is used to set the separation of the FSK signals representing logic '1' and logic '0'. It can either be set to a deviation of 1.5 kHz or 3 kHz. The logic '0' frequency is always 133.3 kHz. The logic '1' frequency can be configured to either 131.8 kHz or 130.4 kHz.

- TX Gain

  This determines the gain of the transmitter's programmable gain amplifier. The possible output signal amplitude values using the Tx Gain are 55 mV, 75 mV, 100 mV, 125 mV, 180 mV, 250 mV, 360 mV, 480 mV, 660 mV, 900 mV, 1.25 V, 1.55 V, 2.25 V, 3.0 V, and 3.5 V.

- RX Gain

  This determines the minimum amplitude of the signal required to get demodulated. The different values are (in RMS) 5 mV, 2.5 mV, 1.25 mV, 600 µV, 350 µV, 250 µV, and 125 µV.

- BIU Threshold Value

  This field sets the threshold for the Band-In-Use detection circuit. This is only applicable when the Enable Band In Use checkbox is selected. The transmitter does not transmit a packet unless the level of power line signal on the powerline is less than this threshold. It should be set higher than the noise on the line, which can be determined by measuring the noise in the Noise Measurement tab of this GUI.

  The possible threshold values are: 70, 75, 80, 87, 90, 93, 96, and 99 dBµV. There are six additional thresholds (103, 106, 109, 112, 115, and 118 dBµV) for the CY8CPLC20 device with PSoC Designer 5.1 or later versions.

- BIU Time Interval (Min)

  This parameter sets the minimum time interval for which the PLC node scans the powerline before transmitting a packet. The possible values are 85, 50, 20, and 10 msec. For CENELEC standard compliance, the setting should be 85 msec. This feature is only available with the CY8CPLC20 device with PSoC Designer 5.1 or later versions.

- BIU Time Interval (Span)

  This parameter sets the span from the lowest possible interval to the highest possible interval. The possible values are 30, 15, and 5 msec. For CENELEC standard compliance, the setting should be 30 msec. This feature is only available with the CY8CPLC20 device with PSoC Designer 5.4 or later versions.

- BIU Timeout Condition

  This parameter sets the BIU timeout condition to either 1.1 second or timeout on first BIU detection. When this option is set to ‘1.1 second’, if the modem detects the BIU, it still tries to acquire powerline until the powerline is free or up to a maximum of 1.1 second. If this option is set to ‘first BIU detection’, then the modem returns BIU error on first BIU detection. This feature is only available with the CY8CPLC20 device with PSoC Designer 5.1 or later versions.

- Enable Transmitter

  This field enables the transmitter. If the transmitter on the local PLC node is disabled, the node does not transmit any data packet but continues to transmit acknowledgement packets.
- Enable Receiver

  This field enables the receiver. If the receiver on the local PLC node is disabled, the node does not receive any data packet but continues to receive acknowledgement packets.
- Lock Configuration

  This field indicates whether the local node's configuration may be altered by another node via remote node configuration commands. If this option is selected, the remote node cannot change the configuration of the local node.
- Enable Band In Use

  This gives the "Band In Use" function to the local PLC node. When selected and a packet transmission is initiated, the PLC node first tests the line to see if it is free. The threshold to detect a band in use condition is set by the BIU Threshold Value field.
- Overwrite at Receiver

  If this option is selected, the PLC node's RX buffer is overwritten whenever a new packet is received. If this option is not selected, the RX buffer retains the last unread packet until the host reads the message. The message is read in the Messaging tab by clicking Receive Message or Enable Auto Reception.
- Ignore Destination Address

  If this option is selected, the local node accepts all messages that are CRC verified irrespective of the destination address. Otherwise, the receiver only accepts packets addressed to it.
- Ignore CRC Check

  If this option is selected, the node ignores the CRC and accepts all received messages if the destination address matches its local address.
- Enable Extended Addressing

  If this option is selected, the local node uses the 16-bit extended logical addressing to communicate on the powerline. A node only communicates with other nodes that use the same logical addressing mode.

Set Configuration

This button saves the values in the local node fields onto the local PLC node. All fields except the physical address field can be edited.

For the node to receive and transmit, the following changes must be made:

- Change the logical address of the node to a value other than 00.
- Enable the transmitter.
- Enable the receiver.
- Enable overwrite at receiver.

Reset Local Node

This button loads the default configuration on to the local PLC node. This preserves the logical address, group address, PLC Mode, and Noise Threshold register. All the other bits are reset.

Auto BIU Threshold

This button automatically sets BIU threshold and updates the BIU threshold value in the configuration accordingly.

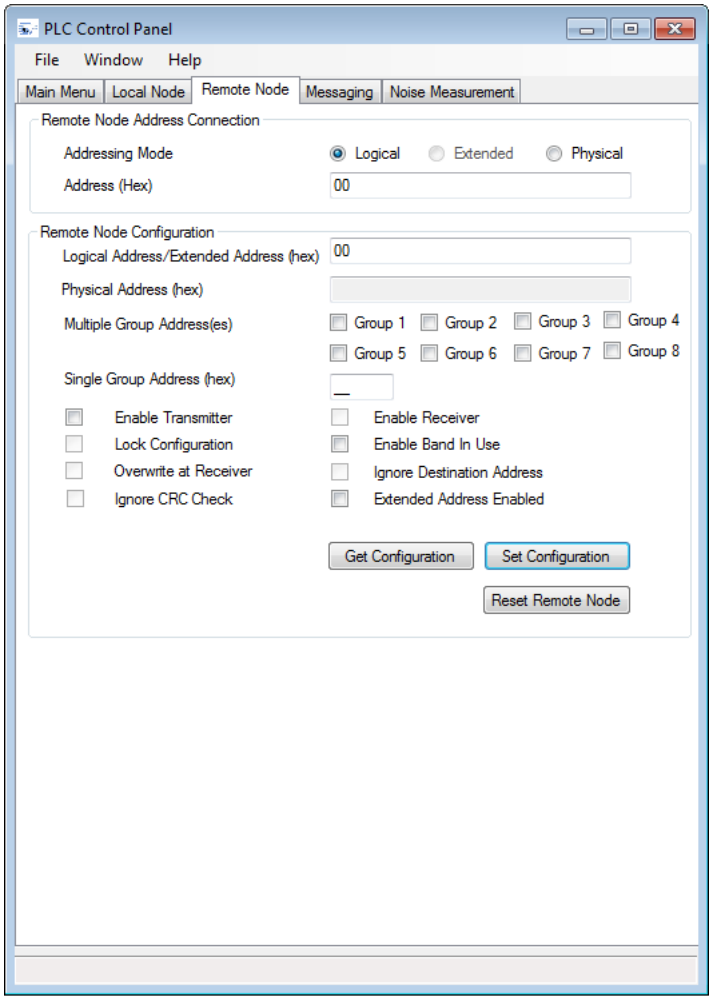
Memory Array Read/Write

- Get: This button reads the value from the memory array offset specified by the user (the field to the left of the Get button). The value is displayed in the field to the right of the Get button.
- Set: This button writes the value to the memory array. The memory array offset (in the field to the left of the Set button) and value (in the field to the right of the Set button) is user specified.

3.3.3.3 Remote Node Tab

Using this tab, the configuration of the Remote PLC Node can be retrieved and changed.

Figure 3-11. Remote Node



Remote Node Address Connection

This section enables selecting the addressing mode of the remote PLC node. The addressing modes available are:

- Logical Addressing
- Extended Addressing
- Physical Addressing

Get Configuration

When this button is clicked, the remote node configuration is retrieved and shown in the corresponding fields. The correct address of the remote node must be set for successful retrieval.

The field descriptions are the same as those for the local node but apply specifically to the remote node.

Set Configuration

This option sets the updated changes on to the remote PLC node. Only the logical address, group address, transmitter state, band in use state, and the extended address state are altered by the local node. The changes are only applied to the remote node if its Lock Configuration setting is disabled.

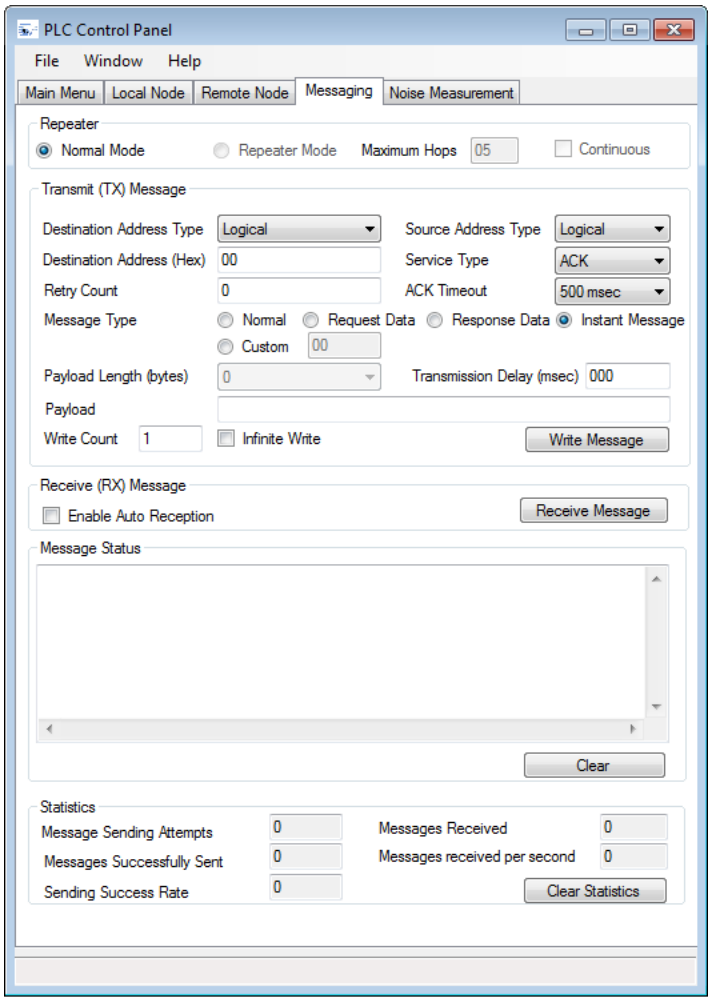
Reset Remote Node

Similar to the local node, this button allows the user to load the default configurations to the remote PLC node. Resetting the PLC node to default state preserves the logical address, group address, PLC Mode, and Threshold register. All other values are reset. The remote node resets only if its Lock Configuration setting is disabled.

3.3.3.4 Messaging Tab

The characteristics of the data packet or message are configured using this tab.

Figure 3-12. Messaging Tab



Write Message

When this button is pressed, a packet is sent according to the repeater mode, source address type, destination address type, destination address, service type, payload length, and payload.

- Repeater Mode

  If the repeater mode is selected, then the packet is prepared and sent according to the repeater algorithm. If the normal mode is selected, then the packet is transmitted without using repeater algorithm. Note that the repeater option is enabled only if the connected PLC node is repeater compatible. For more information on the repeater, see the application note AN62487.
- Number of Hops

  When using the repeater mode, this field sets the maximum number of hops that the packet can be repeated. If the “Continuous” option is selected, then the packet can be repeated for infinite number of hops. For more information on the repeater, see the application note Powerline Communication (PLC) Repeater Implementation.
- Destination Address Type

  The options available are logical (or extended), physical or group.
- Source Address Type

  The options available are logical (or extended) or physical.
- Destination Address

  This is the node to which the message is sent.
- Retry Count

  This is the maximum number of times a message is sent again by the transmitter if it does not get an acknowledgement for the transmitted packet.
- ACK Timeout

  This parameter sets the maximum time the node waits for the acknowledgement. The possible values are 500 msec, Auto + 100 msec, Auto + 50 msec, and Auto + 20 msec. The "Auto" value is the amount of time the acknowledgement takes if the receiver processes the packet immediately.
- Message Types
  - Normal: Normal messaging using only hexadecimal characters.
  - Request Data: A hexadecimal message that expects a response from the receiver.
  - Response Data: A hexadecimal message sent in response to a request.
  - Instant Message: A text message (ASCII characters) to be sent.
  - Custom - A hexadecimal message with specified custom command ID.
- Payload

  This is the actual data to be sent.

  Note If using the GUI in a normal mode with a repeater enabled PLC device, the first two bits of the payload must be 00; otherwise, the PLC Control Panel GUI shows an error.
- Payload Length

  This is the length of the payload in bytes. Values can be in the range 0 to 31 in normal mode. In the repeater mode, the maximum payload length automatically varies from 13 to 27 depending on the source and destination address type.
- Infinite Write

  If this option is selected, the same message is continuously sent to the remote node until this option is cleared.

- Transmission Delay

  The GUI inserts the specified delay (0 to 999 msec) between two consecutive successful transmissions.

Receive Message

This button checks the receive buffer for a new message. If a message is present in the receive buffer, it is shown in the Message Status window and the node stops receiving. If the buffer has no new messages, the Message Status window is not updated.

Enable Auto Reception

Auto reception sets the node to the receiver mode. It displays messages in the Message Status window as soon as they arrive. In this mode, packets are not dropped. The node continuously polls for new messages.

Clear

Clicking this button clears all status messages from the Message Status window.

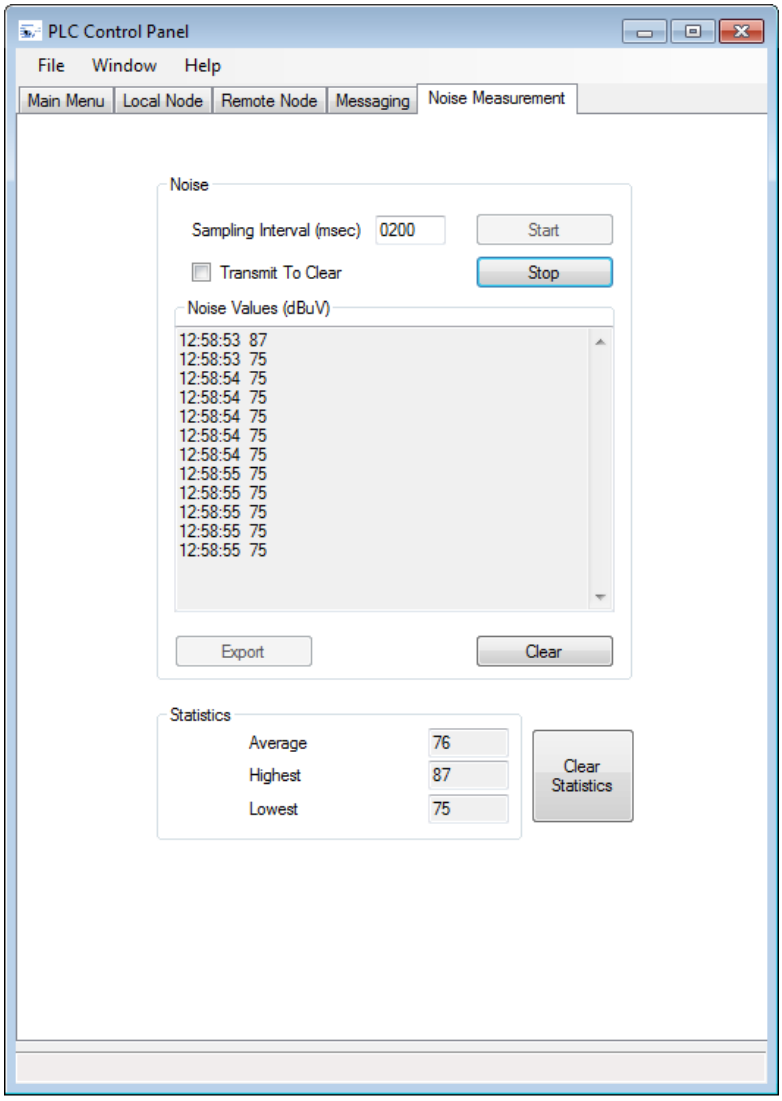
Statistics

This section displays information on the packets sent over the powerline, packets sent successfully, and the success rate percentage. It also provides the number of messages received and rate of message reception. To clear the statistics, click on Clear Statistics. This resets all values.

3.3.3.5 *Noise Measurement Tab*

This tab allows scanning the powerline for a particular time interval and capturing the noise levels in dBµV.

Figure 3-13. Noise Measurement Tab



Noise

- **Start** - When this button is pressed, the PLC node starts scanning the powerline.
- **Stop** - When this button is pressed, the PLC node stops scanning the powerline.
- **Sampling Interval (msec)** - This field specifies the duration between two consecutive samples. The minimum value required is 200 msec and maximum is 2000 msec.
- **Transmit to Clear** - When this checkbox is selected, the PLC device transmits a packet in unacknowledgement mode so that the other nodes do not transmit any packet for at least the minimum BIU interval. This is recommended for systems that may have other PLC devices transmitting while the noise is being measured. After this device transmits, the line is free while all the devices wait to acquire the line (BIU detection interval). For correct operation, the minimum BIU time interval should be atleast 50 msec.
- **Noise Values (dBµV)** - This window displays the noise values sampled.
- **Export** - When this button is pressed, the noise values are exported to a MS Excel spreadsheet.
- **Clear** - This button clears the Noise Values window

Statistics

- **Average** - This field shows the average of the noise values.
- **Highest** - This field shows the highest noise value sampled.
- **Lowest** - This field shows the lowest noise value sampled.
- **Clear Statistics** - When this button is pressed, the statistics are reset.

4. PLC Development Board

This chapter explains the key features of the CY3274 development board.

4.1 Board Details

The key features of the CY3274 development board are:

- User friendly PLC Control Panel application
- CY8CPLC20-OCD – 100-pin TQFP on-chip debug (OCD) device that allows quick design and debug of a PLC application.

  The CY8CPLC20 100-pin TQFP is available for debug purpose only. For production quantities, CY8CPLC20 is available in 28-pin SSOP and 48-pin QFN packages.
- Chip power supply derived from 110 V to 240 V AC
- User configurable general purpose LEDs
- General purpose 8-position DIP switch
- On board surge protection and isolation circuit
- RJ45 connector to use ICE debugger
- RS232 COM port for communication
- Header to attach the LCD card
- I^2C header for communicating to external device
- ISSP header for programming the CY8CPLC20
  Note: For more details on ISSP, please visit http://www.cypress.com/?rID=40048.

4.2 CY3274 PLC Development Board Functional Overview

The CY3274 PLC development board is designed as a product development platform for low bandwidth (up to 2400 bps) powerline communication.

The user-written application running on the CY8CPLC20 generates the data. The PLC core encapsulates this data into a PLC network packet. The FSK modem then modulates this packet and the coupling circuitry incorporates the resulting sinusoidal waveform on to the existing waveform on the high voltage bus.

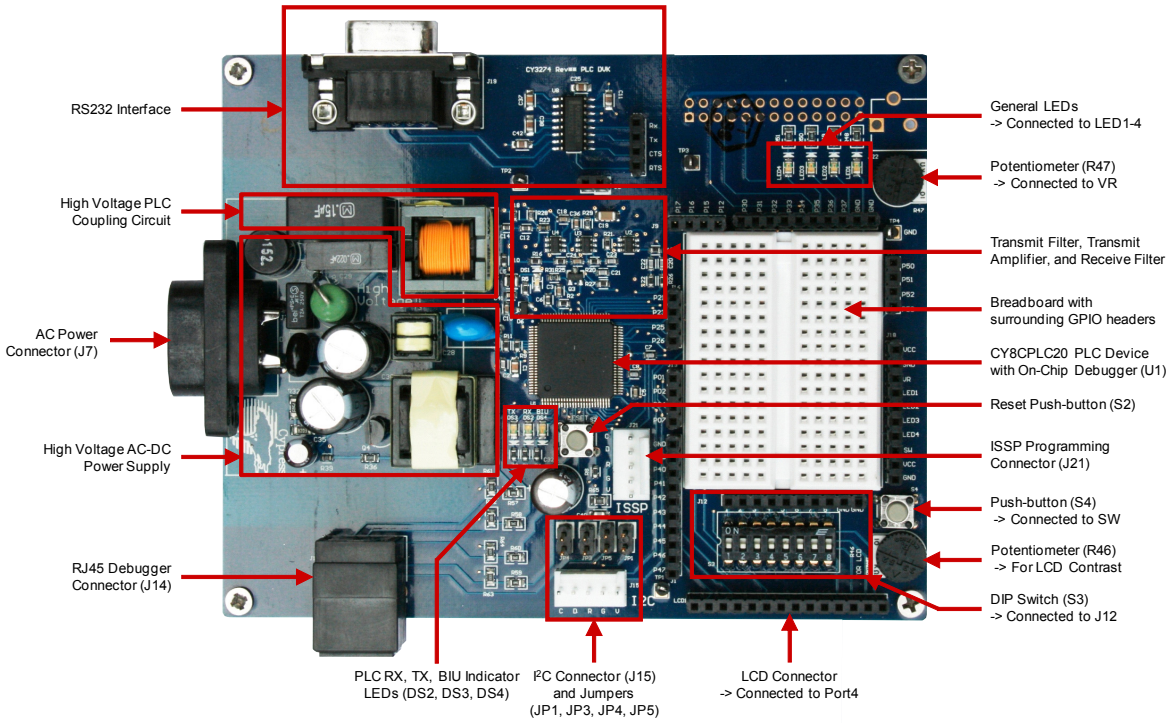
4.2.1 Operating Conditions

- Input voltage: 110 V AC/240 V AC
- Input current: 100 mA/50 mA
- Operating temperature: 0 °C to 40 °C
- Operating humidity condition: 5% to 95% relative humidity (RH), non-condensing

4.3 Hardware Description

The programmable high voltage PLC development board is shown in Figure 4-1. Key sections on the board are highlighted.

Figure 4-1. Front View of Cypress Programmable PLC HV Development Board



The core of the PLC HV board is the CY8CPLC20 chip. The communication signal flows on this HV board as follows:

Transmit: CY8CPLC20 TX pin (FSK_OUT) → Transmitter Filter Circuitry → Power Amplifier Circuitry → High Voltage Powerline Coupling Circuitry → High Voltage Powerline (110 V to 240 V AC)

Receive: High Voltage Powerline (110 V to 240 V AC) → High Voltage Powerline Coupling Circuitry → Passive Low Pass Filtering → Vdd/2 Biasing → CY8CPLC20 RX pin (FSK_IN)

The CY3274 board can be divided into seven main sections:

- Development
- LCD daughter card
- RJ45 connector for debugging
- RS232 COM port
- High voltage with SMPS (This acts as the built in Power adaptor.)
- Transmit amplifier and filtering
- High voltage coupling circuit

4.3.1 Development

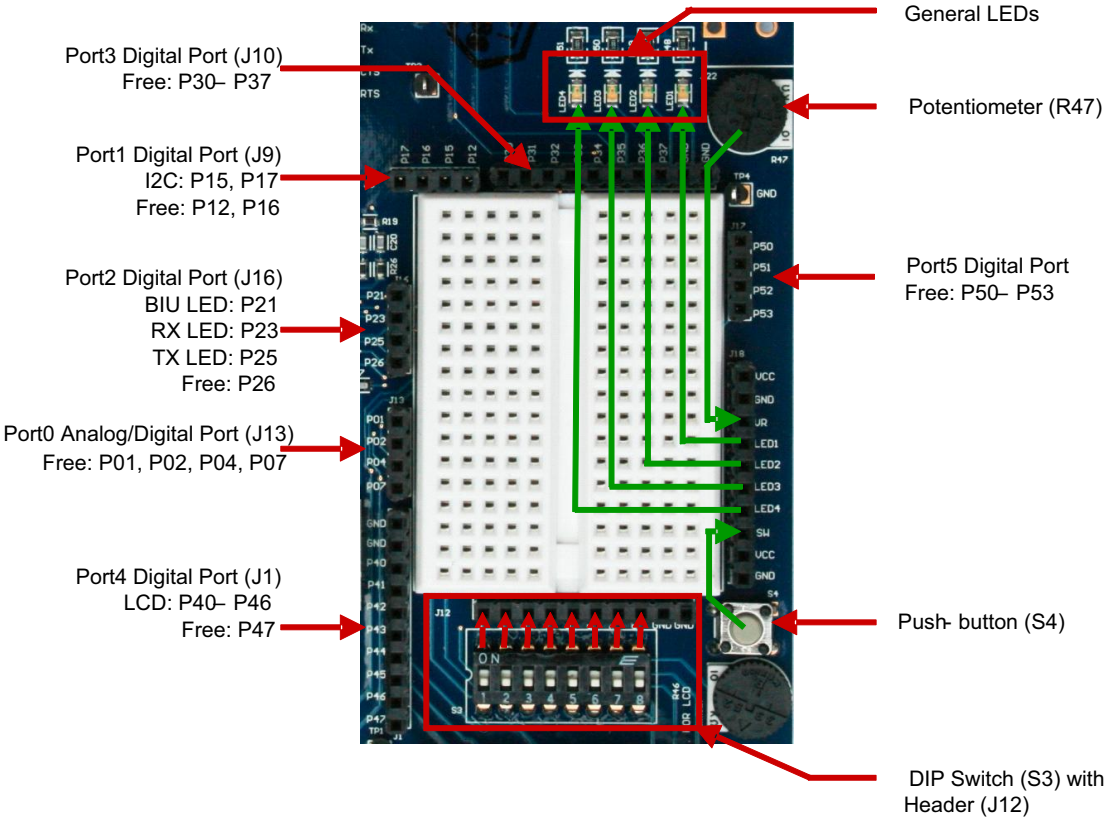
4.3.1.1 User I/Os, Bread Board and GPIO Headers

This is the area where you make custom designs. All GPIO pins excluding those required for PLC communication are routed to this area for ease of access. Some of the pins are shared for other purposes (for example, the port 4 pins P4[6:0] are also connected to the LCD connector).

Header J18 has pins that are connected to user I/Os (potentiometer, push-button, and LEDs). In Figure 4-2, these connections are represented by the green arrows. To connect one of these user I/Os to a CY8CPLC20 pin, connect a jumper wire between the respective header pins. For example, to connect the push-button S4 to pin P1[6], place a jumper wire in SW on header J18 and the other end in P16 on header J9.

The DIP switch bank S3 is not connected directly to any of the CY8CPLC20 pins. The DIP switch is connected to header J12, so that a jumper wire can be connected to any of the pins. The DIP switch is active LOW (connected to GND when in the ON position).

Figure 4-2. Bread Board



4.3.1.2 *CY8CPLC20 PLC Device*

This section has the CY8CPLC20-OCD device, which has the integrated transmit and receive modem and network protocol. It also has the I²C header for optional communication with an external host processor. The ISSP header is provided to program the device. The device also has built-in debug support using the RJ45 connector for use with the ICE debugger. There are also three dedicated LEDs, which can be used to indicate communication on the powerline: green LED for TX, red LED for RX, and yellow LED for BIU.

Figure 4-3. The Development Section

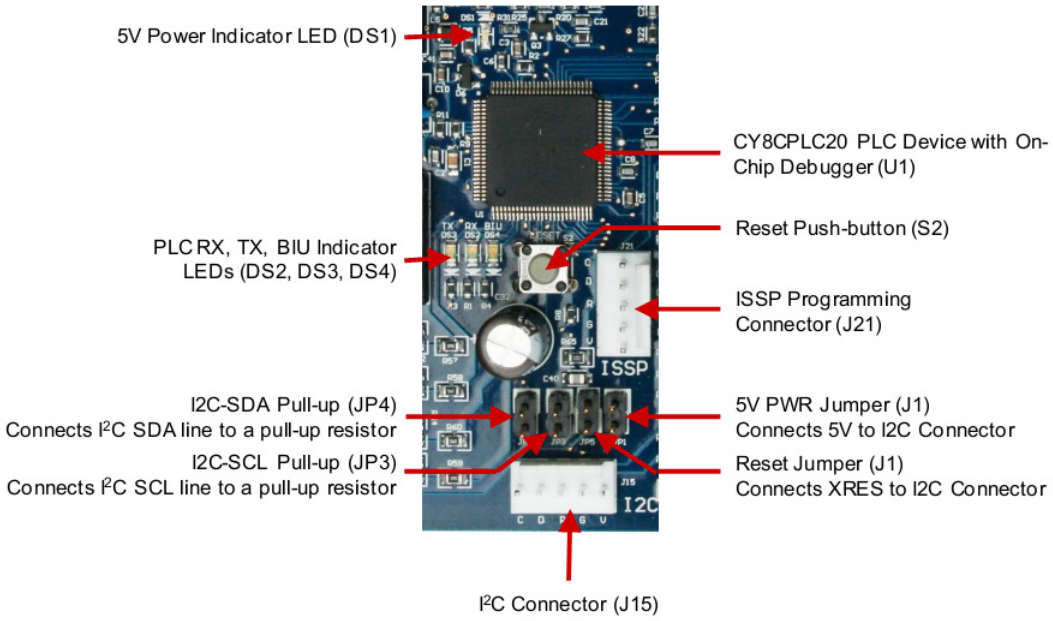


Table 4-1. Headers and Jumpers

Headers and Jumpers	Description
BIU LED[DS4]	Yellow LED that can be used to indicate when the transmit frequency band is in use.
CY8CPLC20-OCD	Cypress Powerline transceiver chip. It is a 100-pin on-chip debugger (OCD) device.
J8	Two-pin header for connecting to Vcc and Gnd for debug. Do not use these pins to power an external board.
JP1 (PWR)	This jumper should be connected to power an external board. After this jumper is connected, power for the external board can be derived from the V (V_{DD}) and G (Gnd) connectors on the I2C header (J15). The CY3274 board can provide a maximum of 50 mA at 5 V to an external board through the V and G pins on the I2C header (J15).
JP5 (Reset)	The jumper enables the reset of the PLC device through an external board. After this jumper is connected, the external board reset can be connected to the R (Reset) pin on the I2C header (J15).

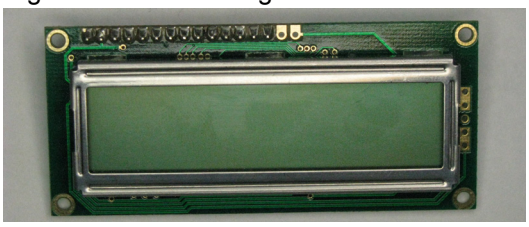
Headers and Jumpers	Description
JP4 (I2C-SDA)	This is a pull-up jumper. While communicating through I2C (J15), one side has to pull up the line. When the jumper is connected, the SDA line is pulled high. This needs to be done when the user wants the I2C link to be pulled up by the CY3274 board. This jumper does not need to be placed if the USB-I2C bridge is used for communication to the host.
JP3 (I2C-SCL)	This is a pull-up jumper. While communicating through I2C (J15), one side has to pull up the line. When the jumper is connected, the SCL line is pulled high. This needs to be done when the user wants the I2C link to be pulled up by the CY3274 board. This jumper does not need to be placed if the USB-I2C bridge is used for communication to the host.
J15	V – V_{DD}. This pin can provide a maximum of 50 mA at 5 V to an external board. This pin is only to source the current. DO NOT SUPPLY POWER TO THIS PIN FOR POWERING CY8CPLC20 DEVICE. Note that the PWR jumper (JP1) needs to be connected to enable this functionality.
	G – Gnd. The Gnd pin can provide the ground reference to an external board. This pin connects to the ground plane of the CY3274 board.
	D – I^2C data (SDA). The I^2C data pin is the data line for the I2C communication. This pin is directly connected to the CY8CPLC20 device. See appropriate I2C-SDA jumper (JP4) settings before connecting I2C bus to this pin.
	C – I^2C clock (SCL). The I^2C clock pin is the clock line for the I2C communication. This pin is directly connected to the CY8CPLC20 device. See appropriate I2C-SCL jumper (JP3) settings before connecting I2C bus to this pin.
	R – Reset. Connecting this pin to an external board enables the CY8CPLC20 chip to be reset by an external board. Note that the RES jumper (JP5) needs to be connected to enable this functionality.
LCD Contrast[R46]	Adjusting this potentiometer adjusts the contrast on the LCD Daughter Card.
LED1-LED4	Headers connected to general purpose configurable LEDs.
PWR LED[DS1]	Blue LED that glows when the board is powered on.
P01, P02, P04, P07	Free analog/digital port pins
P15	Port pin connected to SDA for I2C
P16, P12	Free port pins
P17	Port pin connected to SCL for I2C
P21	Port pin connected to yellow LED for BIU
P23	Port pin connected to red LED for RX
P25	Port pin connected to green LED for TX
P26	Free port pin
P30, P31, P32, P33, P34, P35, P36, P37	Free port pins
P40-P46	Port pins connected to LCD card
P47	Free port pin
P50, P51, P52, P53	Free port pins

Headers and Jumpers	Description
R47	This is a variable resistor (potentiometer) that connects to the VR header. It can be used to generate a voltage between +5 V and GND.
RX LED[DS2]	Red LED that can be used to indicate when the board is receiving data
S2	Reset switch for resetting the CY8CPLC20-OCD chip
S3[7-0]	These dip switches are general purpose and can be routed to any port of the CY8CPLC20 chip.
SW	Header connected to the switch S4. S4 is a general purpose switch. Active HIGH (connected to V_{DD} when pressed).
TP1, TP2, TP3, TP4	Grounded test points to facilitate probing/debugging. These test points connect to the board ground plane.
TX LED[DS3]	Green LED that can be used to indicate when the board is transmitting data on to the powerline
VR	Header connected to the potentiometer R47

4.3.2 LCD Daughter Card

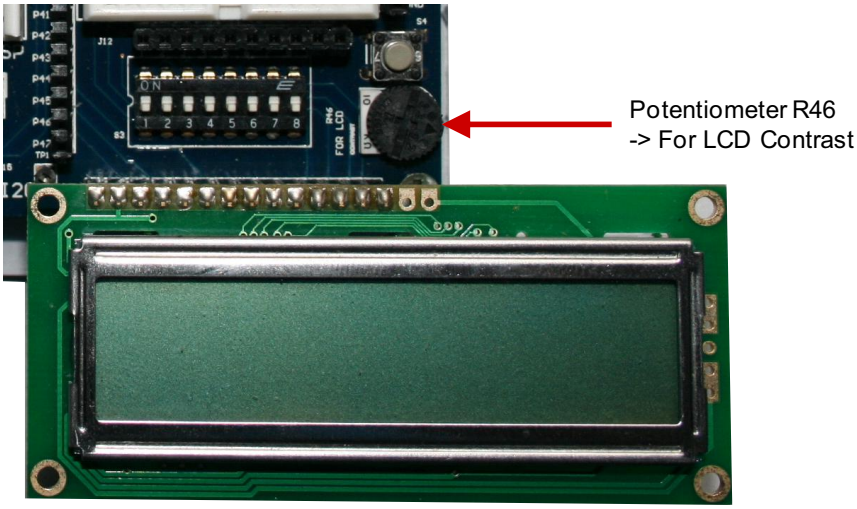
The LCD module is connected to header LCD1 and controlled with the CY8CPLC20 port 4 pins P4[6:0].

Figure 4-4. LCD Daughter Card



Connect the LCD daughter card to the main board as shown in Figure 4-5. LCD contrast is controlled by the potentiometer R46.

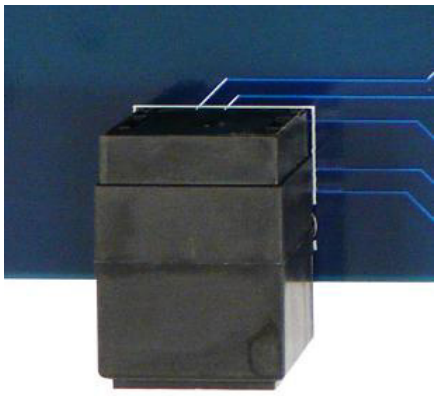
Figure 4-5. LCD Daughter Card Board Connection



4.3.3 RJ45 Connector for Debugging

The RJ45 ICE Cube Emulation Connector (J14) provides a debug interface between the CY8CPLC20 device and the ICE Cube emulation tool using the PSoC Designer software application. A CY3215-DK In-Circuit Emulation Development kit is required to interface the PC to this board. It can be purchased at http://www.cypress.com/go/CY3215-DK.

Figure 4-6. RJ45 Connector



4.3.4 RS232 COM Port

The RS232 COM Port can be used with a standard RS232 cable to connect two RS232 capable devices together. The RS232 (J20) header is a four pin header that has connections for the RX, TX, RTS, and CTS lines. These need to be wired to port pins to connect the device to the respective pins on the RS232 DB9 port.

Figure 4-7. RS232-COM

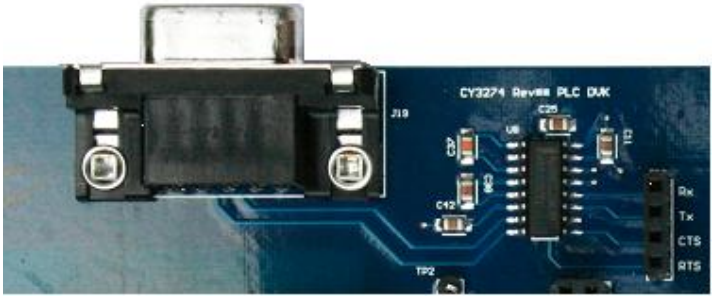


Table 4-2. Controls Associated with Port

Control	Description
RX	The board receives the RS232 information through this pin.
TX	The board transmits RS232 information through this pin.
RTS	The host asks the chip if it can send information through this pin.
CTS	The chip signals that it is ready to accept information through RX.

4.3.5 High Voltage with Switched Mode Power Supply (SMPS)

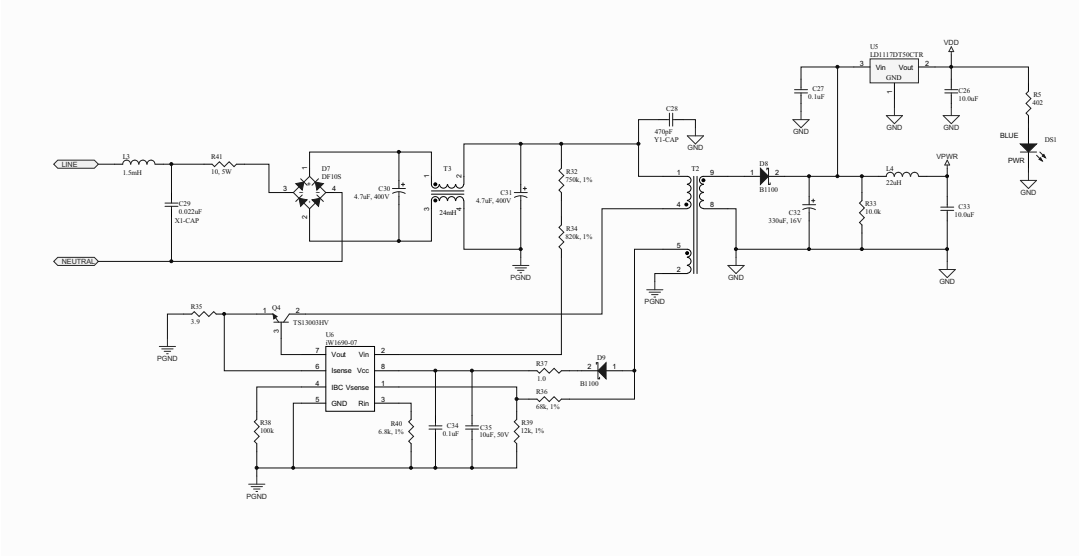
This section takes the power from the powerline and generates necessary low DC voltage for the operation of the PLC transceiver and other components on the chip.

Table 4-3. Key High Voltage with SMPS Components

Component	Description
J7	This is the two pin connector where the AC cable hooks up to the powerline.
F1	Protection fuse for the circuit.
D7	Full wave bridge rectifier diode IC.
T3	Common mode choke.
U6	iW1690-07 – iWatt high performance AC/DC power supply controller.
T2	Flyback transformer.
U5	5-V regulator.

The key components are circled in the following schematic

Figure 4-8. Power Supply Schematic



4.3.6 Transmit Filter, Transmit Amplifier, and Receive Filter

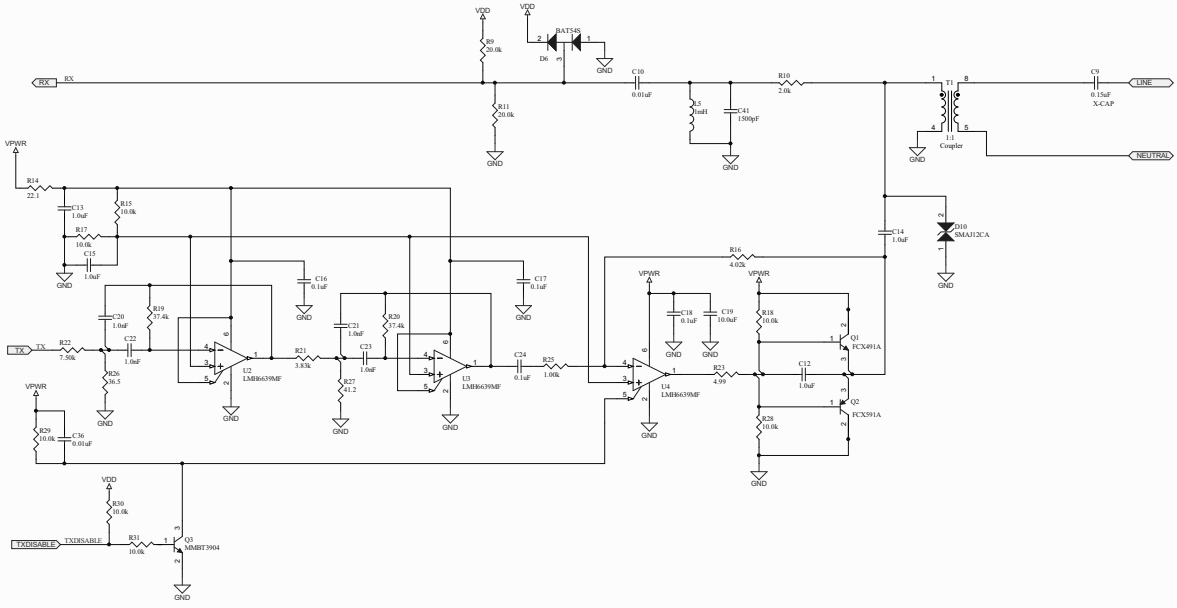
The transmit signal from the FSK_OUT pin of the CY8CPLC20 device is filtered (for FCC and CENELEC compliance) and amplified (for driving the signal on the powerline). The passive receive filter prepares the signal for the FSK_IN pin of the CY8CPLC20 device.

Table 4-4. Key Transmit Amplifier and Filtering Components

Component	Description
U2, U3	These opamps filter the signal from the CY8CPLC20 removing the harmonics. The filter stages are only required to meet FCC Part 15 and/or European CENELEC EN50065-1:2001 signaling specifications. They are not required to achieve robust PLC communication.
U4, Q1, Q2	These opamp and high gain transistors are used for the power amplification stage.

The key components are circled in the following schematic.

Figure 4-9. Transmit Filter, Transmit Amplifier, and Receive Filter



4.3.7 High Voltage Coupling Circuit

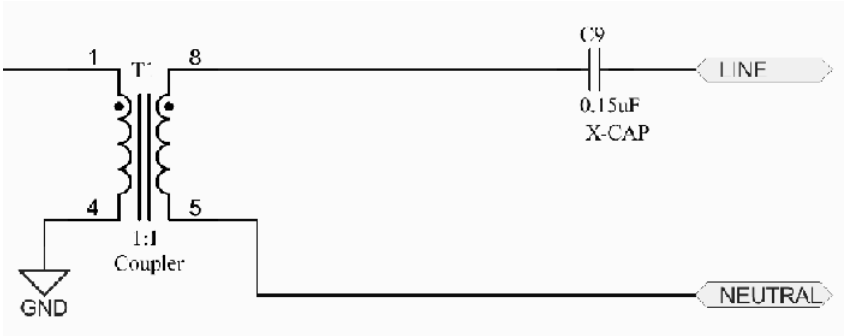
This circuit couples the signal from the board on to the powerline. On the receive side, the same circuit couples the carrier on the powerline into the board, while rejecting the actual 50-Hz and 60-Hz power. The isolation transformer in the circuit is required for safety.

Table 4-5. Key Transmit and Receive Components

Component	Description
T1	This is the isolation transformer that isolates the HV and LV sections of the board. It has a 1:1 turns ratio.
C9	This is the coupling capacitor that couples the communication signal to the powerline and rejects low frequency noise. The voltage rating and X1/X2 safety ratings of this component are important parameters.

The key components are circled in the following figure.

Figure 4-10. Coupling Circuit



5. Code Examples

5.1 Code Example

The CY3274 kit is designed for systems that require a communication interface over commercial high-voltage Powerlines. The CY8CPLC20 device combines the robustness and ease-of-use of the PLC solution with the configurability and flexibility of the PSoC core. The CY8CPLC20 device provides the ability to run your own application. The PLT User Module manages the network protocol and the physical layer FSK modem, which transmits and receives messages over the powerline. For more information on this user module, see AN54416, Using CY8CPLC20 in Powerline Communication (PLC) Applications.

5.2 PLC Demo

The PLT User Module can be implemented on the device CY8CPLC20. This section describes how to develop a PLC application to communicate between two nodes with the device CY8CPLC20.

The user is expected to know how to use PSoC Designer. To learn more about PSoC Designer, you can see the link http://www.cypress.com/?id=1162.

5.2.1 Software Requirements

To use the PLT User Module, you must have the following software installed:

- PSoC Designer 5.4 or higher
- PSoC Programmer 3.20.1 or higher

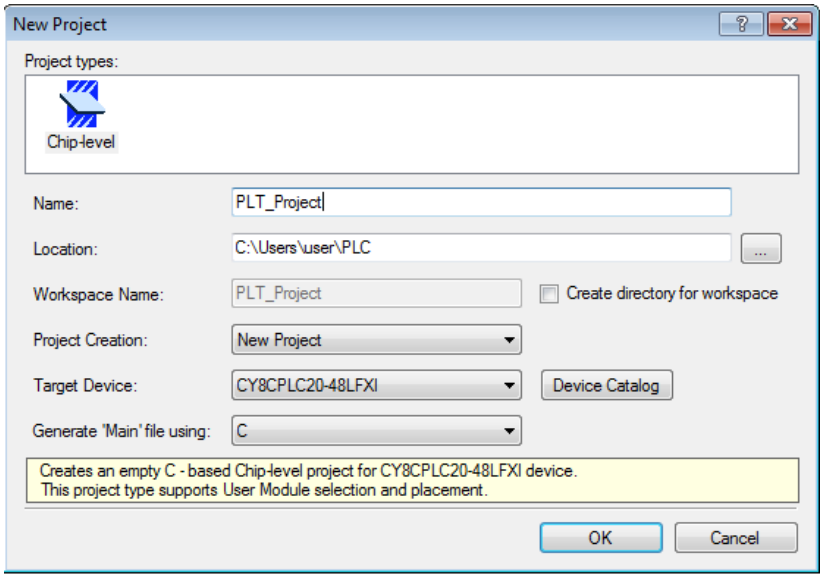
Both of these software tools can be downloaded from http://www.cypress.com/psocdesigner.

5.2.2 Using the PLT User Module in an Example Project

This section provides a guide to get started with the PLT User Module. This section provides all of the individual steps for making your first project. This section is intended to provide more background on how to develop any project. The general steps are:

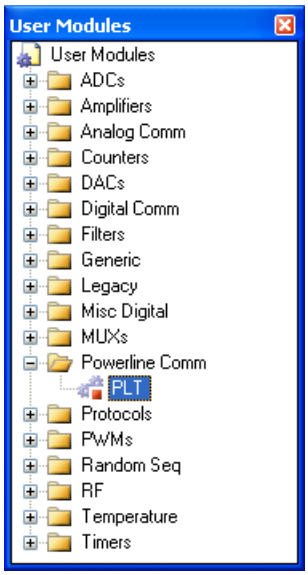
1. Open PSoC Designer and create a new chip-level Project.
2. Select a CY8CPLC20 device (-28PVXI for 28-pin SSOP or -48LFXI for 48-pin QFN) as shown in Figure 5-1. Both devices have the same number of available hardware blocks and memory, but the 48-pin device has more I/Os.

Figure 5-1. Select Project Type



3. The CY8CPLC20 device provides the capability to use the PLT User Modules in addition to all the user modules in a standard PSoC design. In the User Modules window, open the Powerline Communication folder and double-click the PLT user module to place it as shown in Figure 5-2.

Figure 5-2. CY8CPLC20 User Modules



When placing the PLT User Module, a window pops up, showing three options (see Figure 5-3).

a. “FSK Modem”

With this choice only the FSK Modem is implemented. The user can implement a custom networking protocol to manage the communication over the powerline.

b. “FSK Modem + Network Stack”

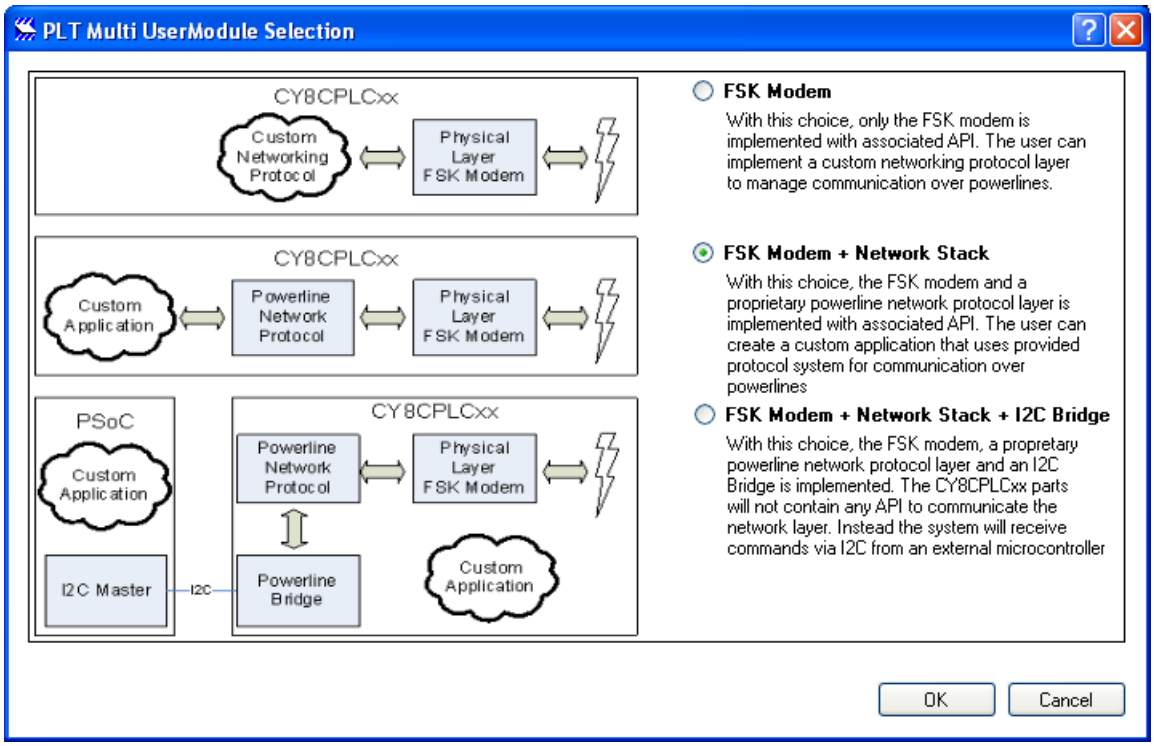
With this option the FSK modem and a proprietary network protocol layer is implemented. The user needs to create a custom application that uses the provided protocol to communicate over the powerline.

c. “FSK Modem + Network Stack + I^2C Bridge”

With this option, the FSK modem a proprietary network protocol layer and an I2C bridge is implemented. There are no APIs to communicate with the network layer; instead the system will receive commands from the external I2C host. For detailed steps on how to implement this, see I^2C Interface for CY8CPLC20.

Select the “FSK Modem + Network Stack” option. With this option FSK modem and the proprietary Cypress network protocol is implemented. This allows the user to focus on your custom application, while the network protocol manages the CSMA, transmission, reception and error detection. For details regarding the other two options refer to the PLT UM datasheet.

Figure 5-3. PLT Multi-User Module Selection Window



4. To configure the PLT UM properties open the PLT Configuration Wizard and set the properties shown in Figure 5-4 and Table 5-1. Note that these properties can also be set in the application code using the PLT memory array.

Figure 5-4. PLT Config Wizard

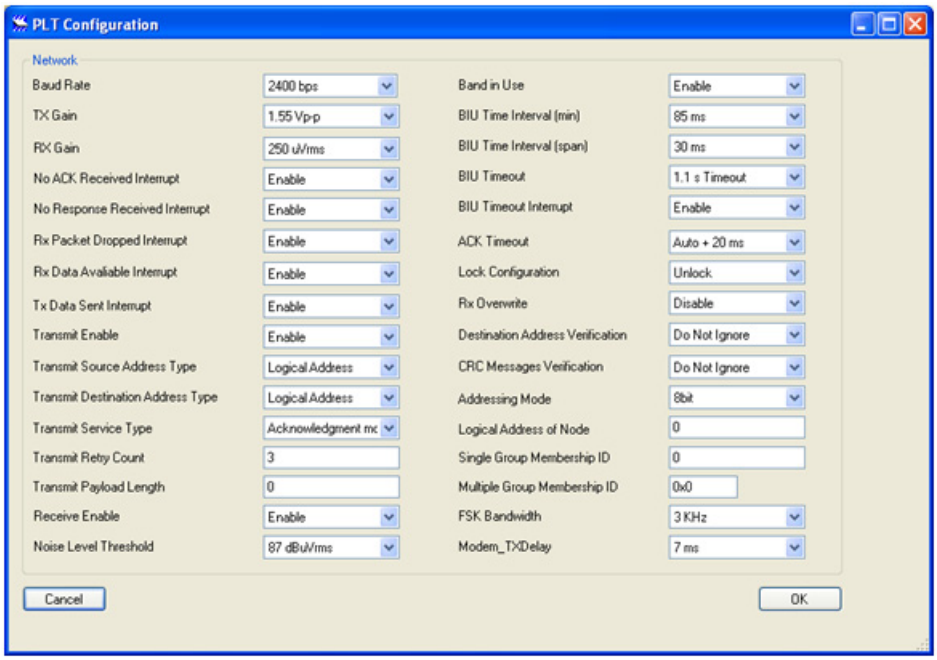


Table 5-1. PLT UM Configuration

No.	Property	Register	Value	Details
1	Baud Rate	Modem_Config	2400 bps (default)	Sets the baud rate for the PLC PHY
2	Tx Gain	TX_Gain	1.55 V_{p-p} (default)	Set to 1.55 V_{p-p}. Set to 125 mV_{p-p} (for CENELEC).
3	Rx Gain	Rx_Gain	250 uVrms	Sets the minimum input sensitivity for the receiver
4	No ACK Received Interrupt	INT_Enable	Enable	Enable Interrupt for no acknowledgment received after if Service Type = 1 (ACK Mode)
5	No Response Received Interrupt	INT_Enable	Enable	Enable Interrupt for No Response Received
6	Rx Packet Dropped Interrupt	INT_Enable	Enable	Enable Interrupt when RX Packet is dropped because RX Buffer is full
7	Rx Data Available Interrupt	INT_Enable	Enable	Enable Interrupt when RX buffer has new data
8	Tx Data Sent Interrupt	INT_Enable	Enable	Enable Interrupt when TX data is sent successfully
9	Transmit Enable	PLC_Mode	Enable	Enables Transmit Mode

Table 5-1. PLT UM Configuration *(continued)*

No.	Property	Register	Value	Details
10	Transmit Source Address Type	TX_Config	Logical Address (default)	provides option to choose between logical or physical address for transmitter source
11	Transmit Destination Address Type	TX_Config	Logical Address (default)	Provides option to choose between logical or physical address as transmitter destination address type
12	Transmit Service Type	TX_Config	Acknowledgement Mode	Transmissions are acknowledged
13	Transmit Retry Count	TX_Config	3	Number of times a transmitter should retry before sending a new packet
14	Transmit Payload Length	TX_Message_Length	0	Length of the payload
15	Receive Enable	PLC_Mode	Enable	Enable Receiver Mode
16	Noise Threshold Value	Threshold_Noise	87 dBuV (default)	Threshold for BIU detection (set to 87 dBuV for CENELEC)
17	Band In Use	PLC_Mode	Enable (default)	Allows option to only send data when no other node is using the powerline for its communication
18	BIU Time Interval (min)	Timing_Config	85 ms (default)	Set BIU Time interval
19	BIU Time Interval (span)	Timing_Config	30 ms (default)	Set time interval span
20	BIU Timeout	Timing_Config	1.1 s Timeout (default)	Set BIU Timeout value
21	BIU Timeout Interrupt	INT_Enable	Enable (default)	Enable Interrupt for BIU Timeout and the Modem is unable to Transmit, if Disable BIU = 0
22	ACK Timeout	Timing_Config	Auto +20 ms	Time for which Transmitter waits for ACK after Auto set time.
23	Lock Configuration	PLC_Mode	Unlock (default)	Allow device to be configured remotely
24	Rx Overwrite	PLC_Mode	Disable (default)	If RX Buffer is full, new RX Message is dropped.
25	Destination Address Verification	PLC_Mode	Do not Ignore	Check if the Destination Address is a match before processing the packet
26	CRC Address Verification	PLC_Mode	Do not Ignore	Drop the packet if CRC fails
27	Addressing Mode	PLC_Mode	8 bit	Select between 8 bit and 16 bit

Table 5-1. PLT UM Configuration *(continued)*

No.	Property	Register	Value	Details
28	Logical Address of Node	Local_LA_LSB Local_LA_MSB	0	In this project, Logical Address is set in the code.
29	Single Group Membership ID	Local_Group	0	For this example project Group Membership is not used
30	Multiple Group Membership ID	Local_Group_Hot	0x0	For this example project Group Membership is not used
31	FSK Bandwidth	Modem_ Config	3 kHz (default)	Separation of FSK signals for logic ‘1’ and ‘0’
32	Modem Tx Delay	Modem_ Config	7 ms (default)	This value is dependent on the BAUD rate

Note The above settings can also be done with the following application code, as shown below:

```
/* Set the baud  rate to 2400bps with a 3kHz deviation */
PLT_Memory_Array[Modem_Config] = (Modem_FSKBW_3M | Modem_BPS_2400);
/* Enable the PLC Transmitter and Receiver*/
PLT_Memory_Array[PLC_Mode] = (TX_Enable | RX_Enable);
/* Enable Acknowledgement and 3 retries*/
PLT_Memory_Array[TX_Config] = (TX_Service_Type | 0x03);
/* Set the transmitter gain to 1.55Vp-p.*/
PLT_Memory_Array[TX_Gain] = 0x0b;
/* Set the receiver gain to 250uVrms */
PLT_Memory_Array[RX_Gain] = 0x06;
/* Set the length of the transmit buffer to 0x00 */
PLT_Memory_Array[TX_Message_Length] = 0x00;
/* Enable Interrupt reporting for all events */
PLT_Memory_Array[INT_Enable] = (INT_UnableToTX | INT_TX_NO_ACK |
INT_TX_NO_RESP | INT_RX_Packet_Dropped | INT_RX_Data_Available |
INT_TX_Data_Sent);
```

5. Place a Timer8 user module with the parameters as shown below. This Timer is used to provide the timing for several operations such as switch debounce and time interval between changes in LCD display.

Table 5-2. Parameters

Name	TickTimer
Clock	VC3
Capture	Low
TerminalCountOut	None
CompareOut	None
Period	192
CompareValue	100
CompareType	Less Than or Equal

Table 5-2. Parameters

Name	TickTimer
InterruptType	Terminal Count
ClockSync	Sync to SysClk
TC_PulseWidth	Full Clock
InvertCapture	Normal

6. Generate the configuration by clicking on the menu Build -> Generate Configuration (Ctrl + F6). This will generate all of the user module assembly and C code needed for the application. Place an LCD UM and 3 LED UM with the following parameters:
   a. LCD UM
      i. Name = “LCD” LCD_Port = “Port_4”.
      A LCD can be directly connected to the available LCD port.
   b. 3 x LED UM (The corresponding LEDs are already hardwired to the respective pins on the Cypress PLC Development Kits CY3274)
      i. Name = “BIU_LED”, Port = “Port_2”, Pin = “Port_2_1”, Drive = “Active High”
      ii. Name = “RX_LED”, Port = “Port_2”, Pin = “Port_2_3”, Drive = “Active High”
      iii. Name = “TX_LED”, Port = “Port_2”, Pin = “Port_2_5”, Drive = “Active High”
   c. Update the BIU, TX and RX ISR code snippets in PLT_1INT.asm from the PLT_1INT.asm file in the CY3274_PC_Demo example project inside **<Install_Directory> -> Firmware**. Each ISR enables the appropriate LED when the status is active (for example, turn on TX_LED when transmitting) or disables the appropriate LED when the status is complete.
      i. PLT_BIU_Active_ISR: This ISR is called when the Band In Use is active
      ii. PLT_BIU_Complete_ISR: This ISR is called when the Band In Use is no longer set
      iii. PLT_TX_Active_ISR: This ISR is called when the Transmitter is actively sending a message
      iv. PLT_TX_Complete_ISR: This ISR is called when the Transmitter has completed sending the message
      v. PLT_RX_Active_ISR: This ISR is called when the Receiver is in process of receiving a packet
      vi. PLT_RX_Complete_ISR: This ISR is called when the Receiver is no longer receiving a packet
   d. Buttons
      i. Set P0[4] according to the settings shown below. This pin is used to select the Local Logical Address of device during the boot up of the device from reset.

Name	ADD_Select
Port	P0[4]
Port	StdCPU
Drive	Pull Up
Interrupt	DisableInt
Initial Value	1

      ii. Set P0[7] according to the settings shown below. This pin is used to select the mode of operation (transmitter or receiver) during the boot up of the device from reset.

Name	MODE_Select
Port	P0[7]
Port	StdCPU
Drive	Pull Up
Interrupt	DisableInt
Initial Value	1

iii. Set P0[1] according to the settings shown below. A switch connected to this pin will be used to start, halt, resume or restart transmission if the kit is selected to be in transmitter mode (by P0[7]) or to reset the received packet count if the kit is selected to be in receiver mode.

Name	Trigger
Port	P0[1]
Port	StdCPU
Drive	Pull Down
Interrupt	Falling Edge
Initial Value	0

7. Open the PSoCGPIOInt.asm file and TickTimerINT.asm file located in the Workspace explorer under the folder lib->Library Source Files.
   Add the instruction “ljmp _Trigger_Int” between the custom user code banners present under the label “PSoC_GPIO_ISR:” in PSoCGPIOInt.asm file.
   Similarly, add the instruction “ljmp _TickTimer_Int” between the custom user code banners present under the label “_TickTimer_ISR:” in TickTimerINT.asm file.
8. The main.c code from the attached code example should be copied into this project’s main.c. Also, create 2 new files “PLC_Demo.c” and “PLC_Demo.h” in the project (by clicking on menu File >> New File). The contents of the files “PLC_Demo.c” and “PLC_Demo.h” from the attached code example (CY3274_PLC_Demo) should be copied and pasted into these files. A high-level description of the code is as follows:
   a. The PLT and LCD User Modules are initialized. The global interrupts are enabled. The PLT UM is configured.
   b. The state of the MODE_Select Pin is checked, and based on this the mode of the device is assigned as either Transmitter or Receiver.
   c. The state of the ADD_Select Pin is checked, and based on this a logical address of the node is chosen.
   d. When the pin “Trigger” transitions from '1' to '0' in a kit that is in “Transmitter mode”, the Powerline Transceiver (PLT) transmits data to the other node, or halts transmission if it had previously been transmitting, or resumes transmission if it had previously been halted.
   e. When the pin “Trigger” transitions from '1' to '0' in a kit that is in “Receiver mode”, the Received packet count is reset.
   f. The statistics and instructions are displayed on the LCD.

5.2.3 Evaluating the Example Project on Hardware

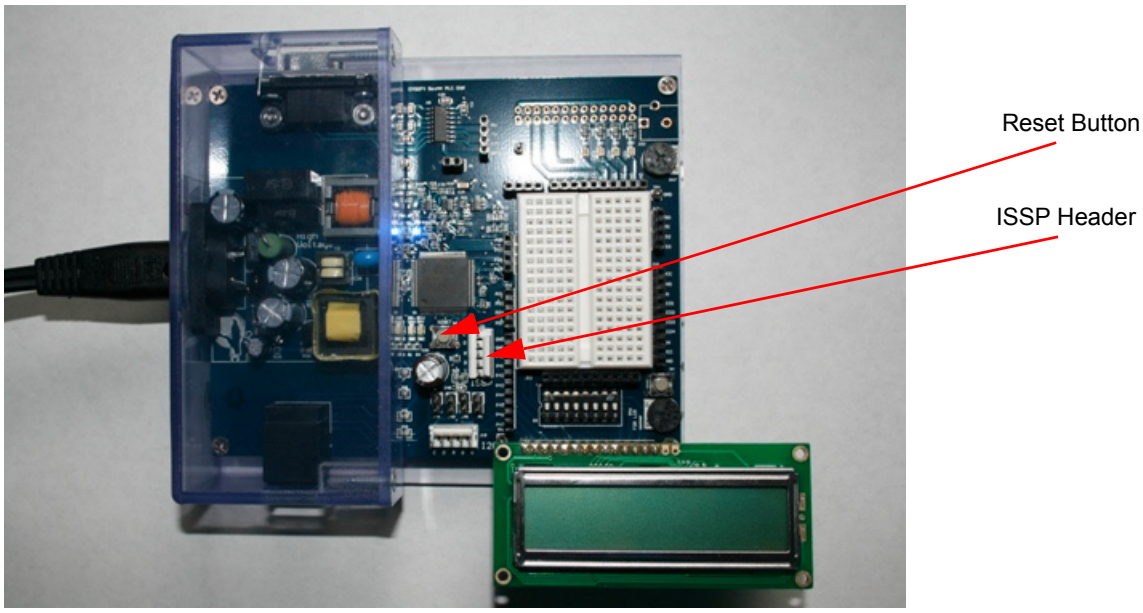
Once the application example projects are built, they can be evaluated in a powerline system. This example is designed to run on the CY3274 high-voltage PLC DVK. The BIU, RX, and TX LEDs on the board are hardwired to P2[1], P2[3], and P2[5], respectively.

5.2.3.1 *Programming the Boards*

Follow these steps to set up the boards:

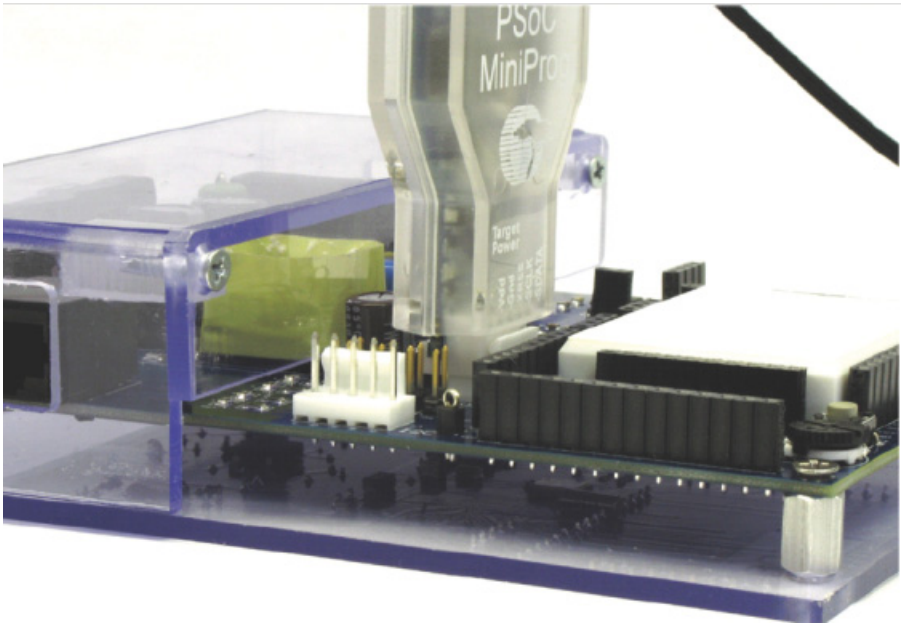
1. Connect the LCD daughter card to the LCD connector.

Figure 5-5. Hardware Setup for the CY3274



2. Attach one end of the MiniProg programmer to the ISSP header and the other end to the PC through the USB cable.

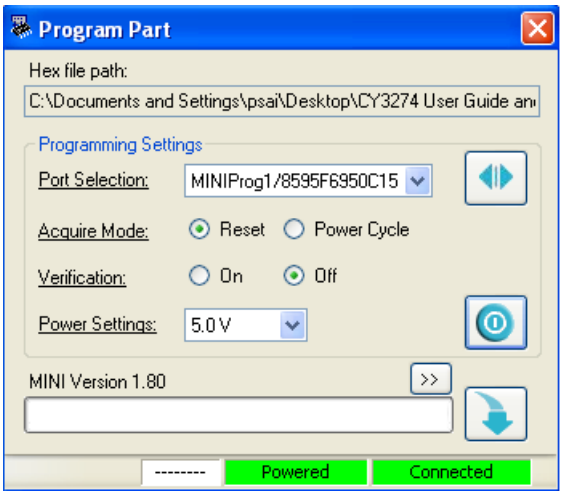
Figure 5-6. Connecting the MiniProg Programmer



3. You can either test the project created by you based on the guidelines in the above section or directly use the ready sample project “CY3274_PLC_Demo” available in the Firmware folder of the installation directory of CY3274 kit.

4. Once the project is opened in PSoC Designer, build the project by clicking **Build > Generate/Build Project**. The project should build with 0 errors and 0 warnings.
5. In the menu, click Program > Program Part. This will open the Program Part window.
6. Set the “Acquire Mode” property as “Reset”, and press the “Toggle Power” button to power ON the board. (The “toggle power” button need not be pressed if the board is already connected and powered through the power line.)

Figure 5-7. Programming Settings

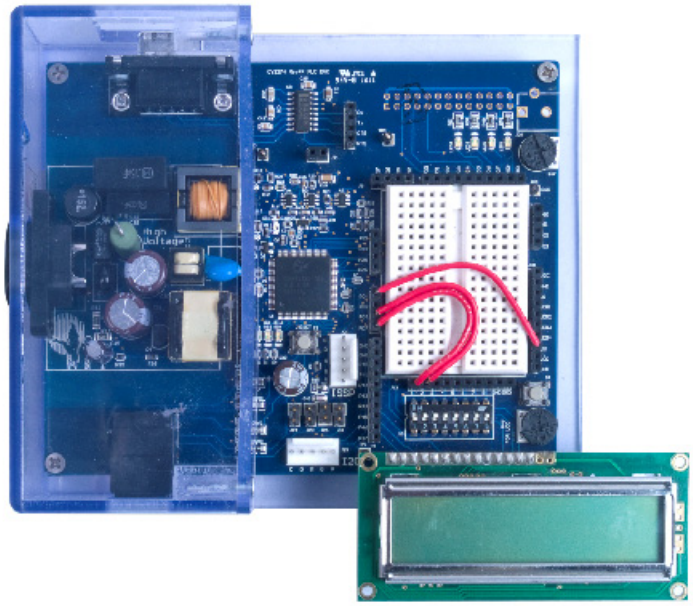


7. Click the arrow in the bottom right corner to start programming. After the progress bar is complete, the status should say ‘Programming Successful’.
8. Remove the MiniProg from the ISSP header and press the RESET pushbutton to reset the device.
9. Repeat the above steps to program another board.

5.2.4 Hardware Setup

Follow the steps below to setup the board as shown in Figure 5-8.

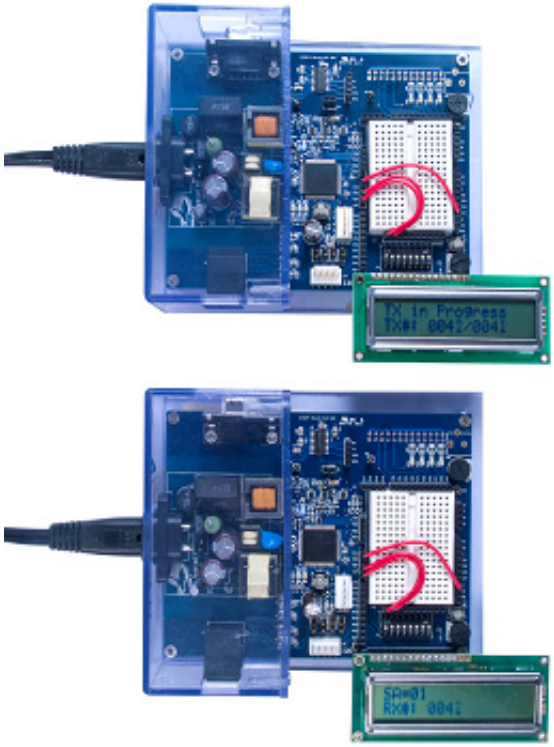
Figure 5-8. Hardware Setup for the CY3274



1. Connect a jumper wire from SW (on J18) to P0[1].
2. Connect a second jumper wire from P0[4] to one of the 8 DIP switches on J12 (the 8 DIP switch array on S3 is connected to J12).
3. Connect a third jumper wire from P0[7] to another DIP switch.
   On device reset, P0[4] input decides the logical address of the PLC node (kit), and P0[7] input decides whether the PLC node(kit) acts as transmitter or receiver. Pressing a switch connected to P0[1] is used to start/halt/restart transmission on the transmitter node, where as it used to reset the received packet count in the receiver node.
4. Do the above connections on the second kit as well.
5. Put the 2 DIP switches (on S3) in one kit to a different position compared to the corresponding DIP switch on the other kit, so that one kit acts as transmitter and the other as receiver, and each have different logical addresses.
6. Connect the power cable from the AC mains to the AC power connector on the first CY3274 kit. The blue LED turns on. Repeat the same for the second CY3274 kit.
7. Push the reset button S2 on both nodes. A message “PLC_Demo” initially appears on the LCD.
8. Subsequest LCD message on one kit indicates the kit is a transmitter. Subsequent LCD message on the other kit indicates the kit is a receiver.

9. When you press the push button (S4) on transmitter, packets start getting transmitted from the transmitter kit to the receiver kit up to a packet count of 1000. The LCDs on the kits shows transmission statistics.

Figure 5-9. Transmitter and Receiver board LCD displays when transmission is in progress



10. Transmission can be started or halted (if transmission is in progress) or resumed (if transmission is halted) or restarted (when the packet count of 1000 is completed) by pressing the push button (S4) on the transmitter kit.

Figure 5-10. Transmitter board LCD when Tx is halted

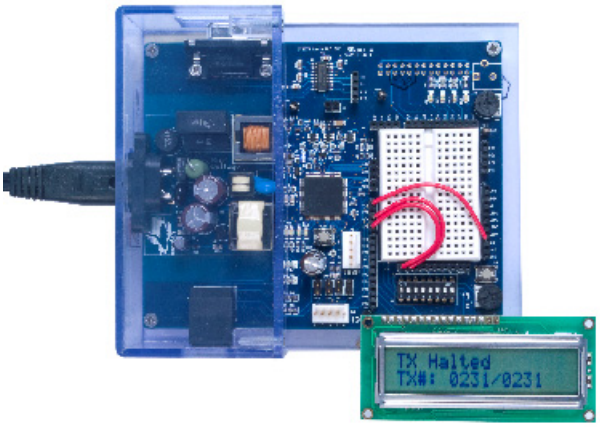
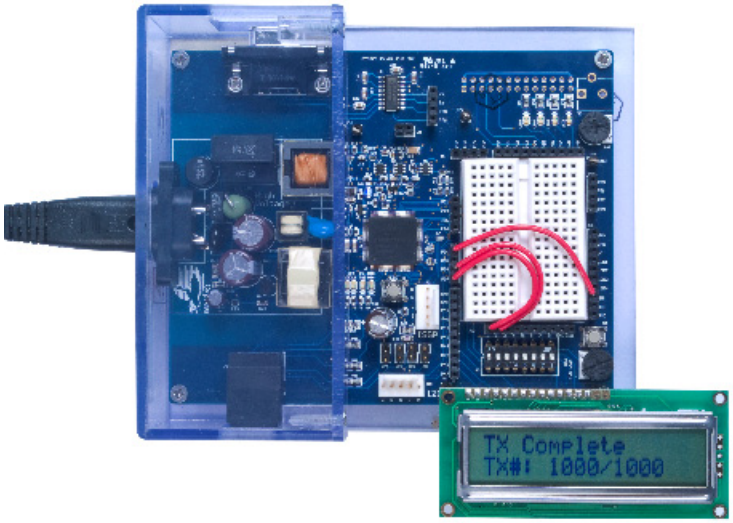
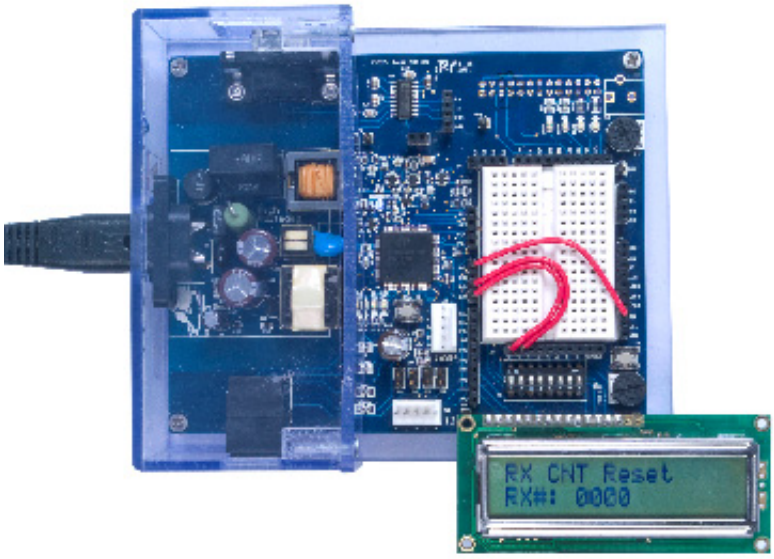


Figure 5-11. Transmitter board LCD when Tx is complete



11. Received packet count can be reset by pressing the push button (S4) on the receiver kit.

Figure 5-12. Receiver board LCD when Rx Packet Count is Reset



5.3 Using CY3274 with PLC Control Panel using CY3240 I2USB Bridge

This section describes how the I^2C interface is developed. The I^2C interface is compatible with the Cypress PLC control panel GUI, which can be downloaded here. This section explains the I^2C configuration, packet structure, application, and provides an example algorithm for how the host communicates with the CY8CPLC20 device.

Example project with this functionality is present in present inside the firmware folder of the kit installation.

5.3.1 Software Requirements

To use the PLT User Module, you must have the following software installed:

- PSoC Designer 5.4 or higher (http://www.cypress.com/psocdesigner)
- PSoC Programmer 3.20.1 or higher (http://www.cypress.com/go/psocprogrammer)
- PLC Control Panel GUI (http://www.cypress.com/?rID=38135)

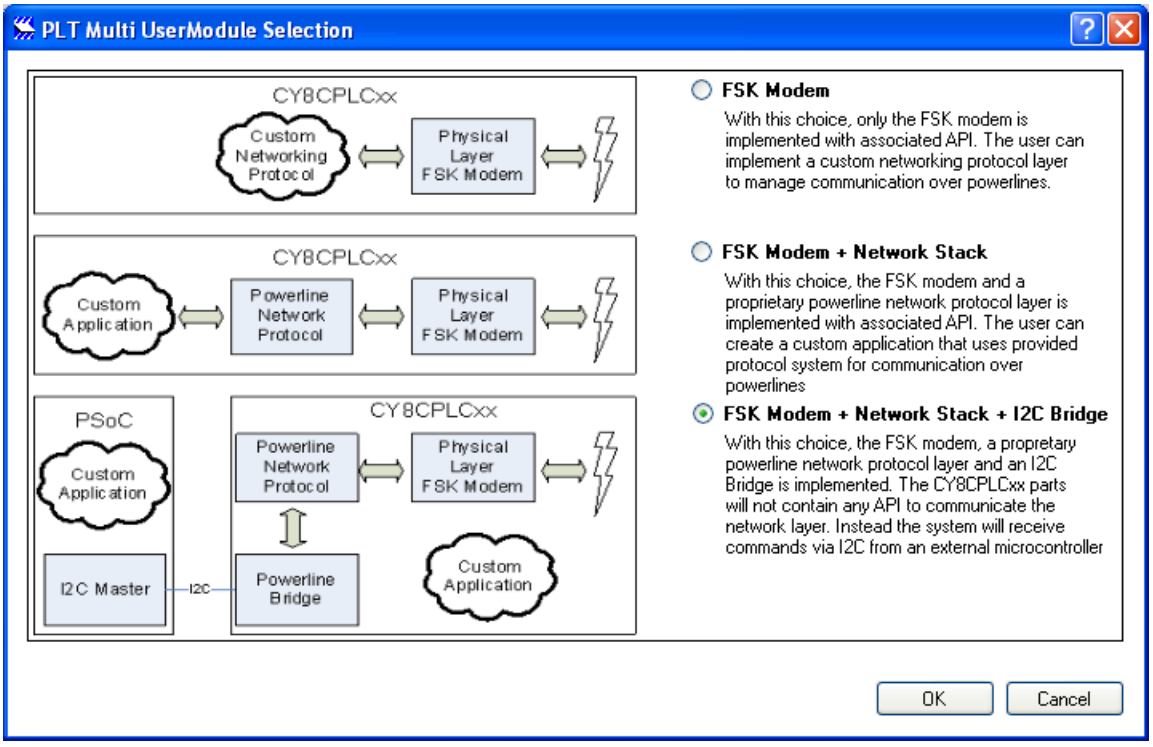
5.3.2 PLT Configuration

You can either follow the below steps for developing the project for I^2C interface with PLC or you can directly use the “CY3274_PLC_Control_Panel” project present in the Firmware folder of the CY3274 kit installation location. The “CY3274_PLC_Control_Panel” project has been created by following the below procedure.

Follow these steps to set up the PLT UM with I^2C interface:

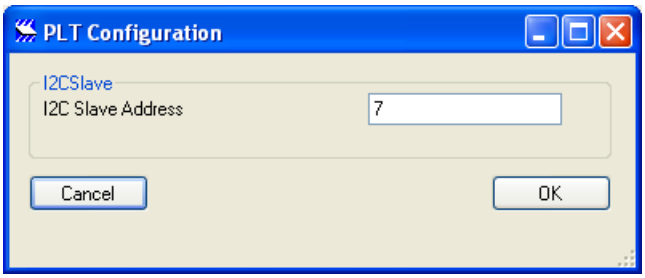
1. Place the PLT UM and Select the “FSK Modem + Network Stack + I2C Bridge” option as shown in Figure 5-13.

Figure 5-13. Select Option “FSK Modem + Network Stack + I^2C Bridge”



2. Set the I²C address in the PLT Configuration window. Note that all the other parameters are set by the Host.

Figure 5-14. PLT Configuration



3. Copy the sample code below for “FSK Modem + Network Stack + I²C Bridge”.

```
#include <m8c.h>
// part specific constants and macros
#include "PSoCAPI.h"      // PSoC API definitions for all user modules
void main(void)
{
    PLT_Start();
//Initialize the PLT module
    do
    {
    PLT_Check_I2C_Activity();       //Act on any I2C activity
        PLT_Poll();                // Run the network protocol
    }while(1);
}
```

4. 3 x LED UM (The corresponding LEDs are already hardwired to the respective pins on the Cypress PLC Development Kits CY3274)
   a. Name = “BIU_LED”, Port = “Port_2”, Pin = “Port_2_1”, Drive = “Active High”
   b. Name = “RX_LED”, Port = “Port_2”, Pin = “Port_2_3”, Drive = “Active High”
   c. Name = “TX_LED”, Port = “Port_2”, Pin = “Port_2_5”, Drive = “Active High”
5. Update the BIU, TX and RX ISR code snippets in PLT_1INT.asm from Appendix A - BIU, TX, RX Interrupt Service Routines (Section of PLT_1INT.asm). Each ISR enables the appropriate LED when the status is active (for example, turn on TX_LED when transmitting) or disable the appropriate LED when the status is complete.
   a. PLT_BIU_Active_ISR: This ISR is called when the Band In Use is active
   b. PLT_BIU_Complete_ISR: This ISR is called when the Band In Use is no longer set
   c. PLT_TX_Active_ISR: This ISR is called when the Transmitter is actively sending a message
   d. PLT_TX_Complete_ISR: This ISR is called when the Transmitter has completed sending the message
   e. PLT_RX_Active_ISR: This ISR is called when the Receiver is in process of receiving a packet
   f. PLT_RX_Complete_ISR: This ISR is called when the Receiver is no longer receiving a packet

5.3.3 I²C Interface Write Packet Structure

The I²C interface follows the packet structure defined by the I²C specification. The write packet is as follows. The master always sends the entire packet.

	7	6	5	4	3	2	1	0
Byte 0	I2C Address (0b0000001)							0
Byte 1	Offset							
Byte 2+	Data from host to CY8CPLC20 (Optional)							

5.3.4 I²C Interface Read Packet Structure

The I²C interface follows the packet structure defined by the I²C specification. The read packet is as follows. The master sends the first byte. The offset is set by sending a write packet for that offset (sending data is not necessary).

	7	6	5	4	3	2	1	0
Byte 0	I2C Address (0b0000001)							1
Byte 1+	Data from CY8CPLC20 to host							

5.3.5 I²C Application

The I²C write and read messages are processed automatically by the EzI2Cs user module by the ISRs associated with the user module. It is important to note that I²C interrupts are disabled by the PLT user module when it is transmitting. During this time, if the host initiated an I²C message, the CY8CPLC20 device holds the SCL bus low until it finishes transmitting the PLC packet. It then resumes processing the I²C message.

5.3.6 I²C Host Example

An example algorithm of a host trying to tell the CY8CPLC20 message (I²C address 0x01) to send a PLC message would be (Note that the I²C address is shifted left by one bit):

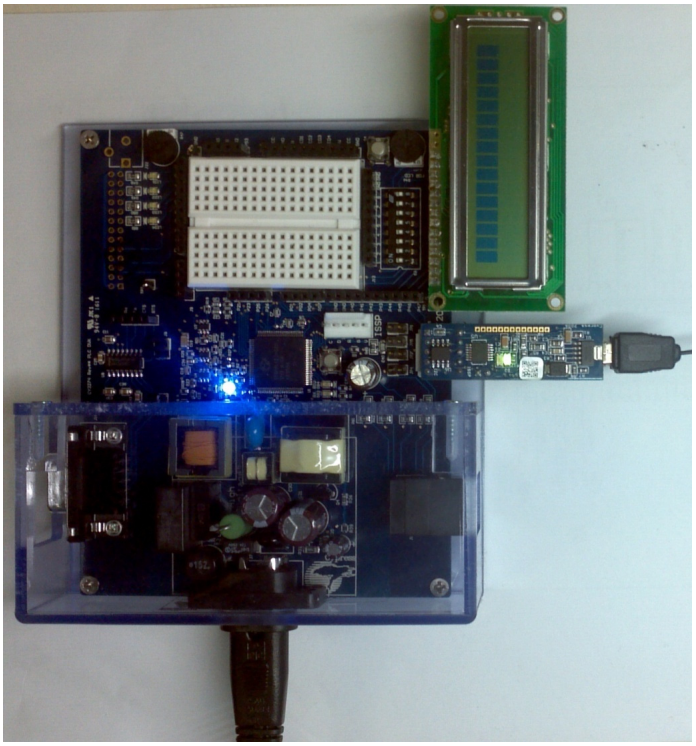
1. Send {0x02, 0x06, 0x81} which writes the value 0x81 to the PLT_Memory_Array[0x06] to send a one-byte message
2. Send {0x03, 0x69} which reads from the PLT_Memory_Array[0x69] to read the status of transmission
3. Read one byte of data
4. If the received byte contains an event update of the transmission, it is done. Otherwise, repeat step 2.

5.3.7 Evaluating the Example Project on Hardware with PLC Control Panel GUI

Program 2 PLC CY3274 DVKs with the project developed in the PLT Configuration on page 65 (or you can directly use the “CY3274_PLC_Control_Panel” project present in the Firmware folder of the CY3274 kit installation location). You can use the same steps in Programming the Boards on page 60 for programming the boards.

On the PLC DVKs, to connect the CY8CPLC20 device to the PC, a CY3240 Cypress USB-I2C bridge can be connected to the 5-pin I²C header, as shown in Figure 5-15.

Figure 5-15. I²C Hardware Connection

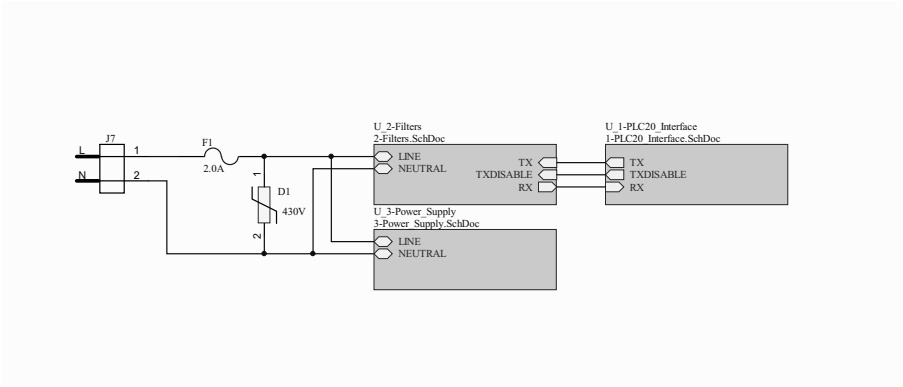


After this, please follow the steps mentioned in PLC Control Panel Quick Start on page 27 to test the working of the boards using the PLC Control Panel GUI.

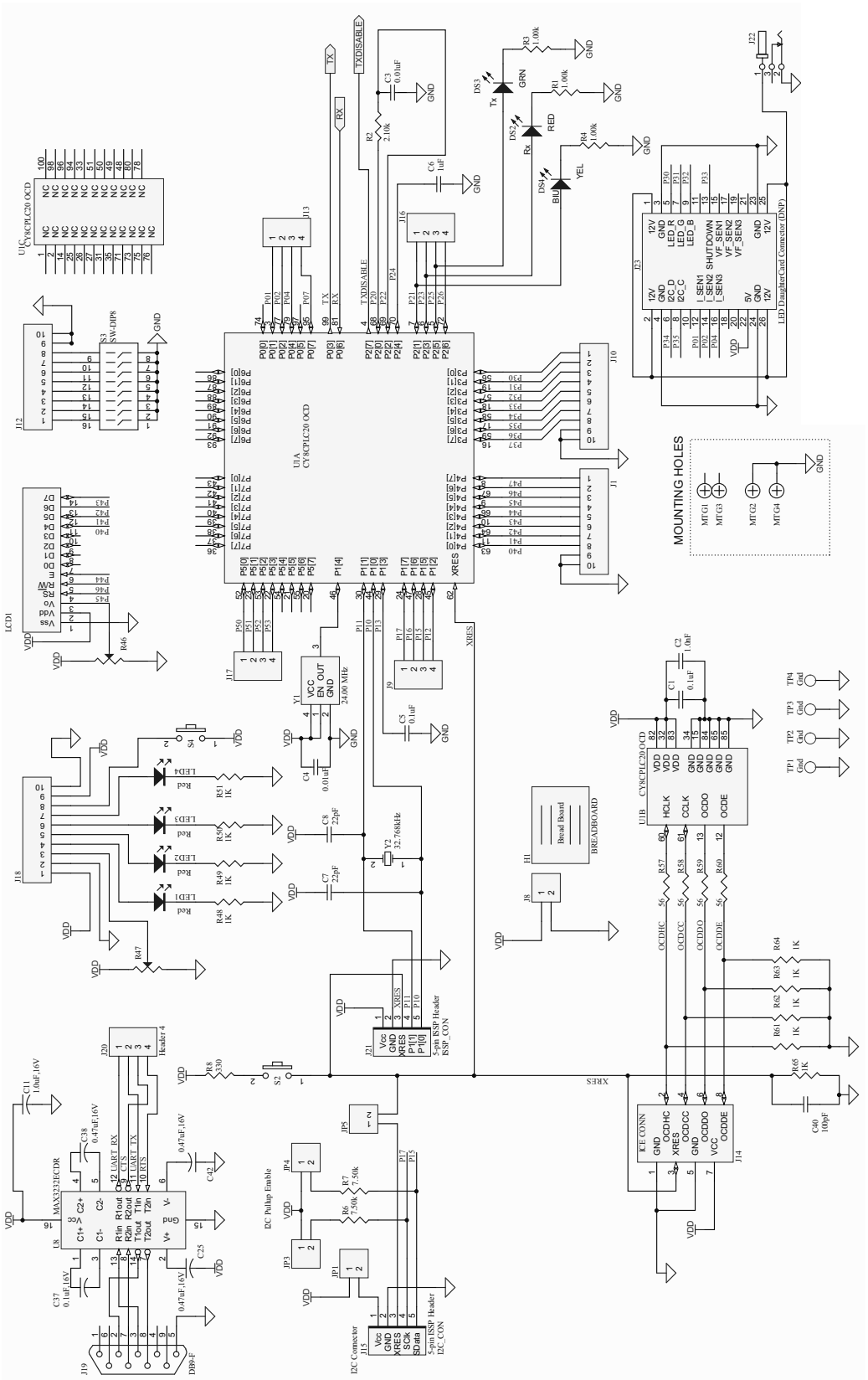
A. Appendix

A.1 Schematics

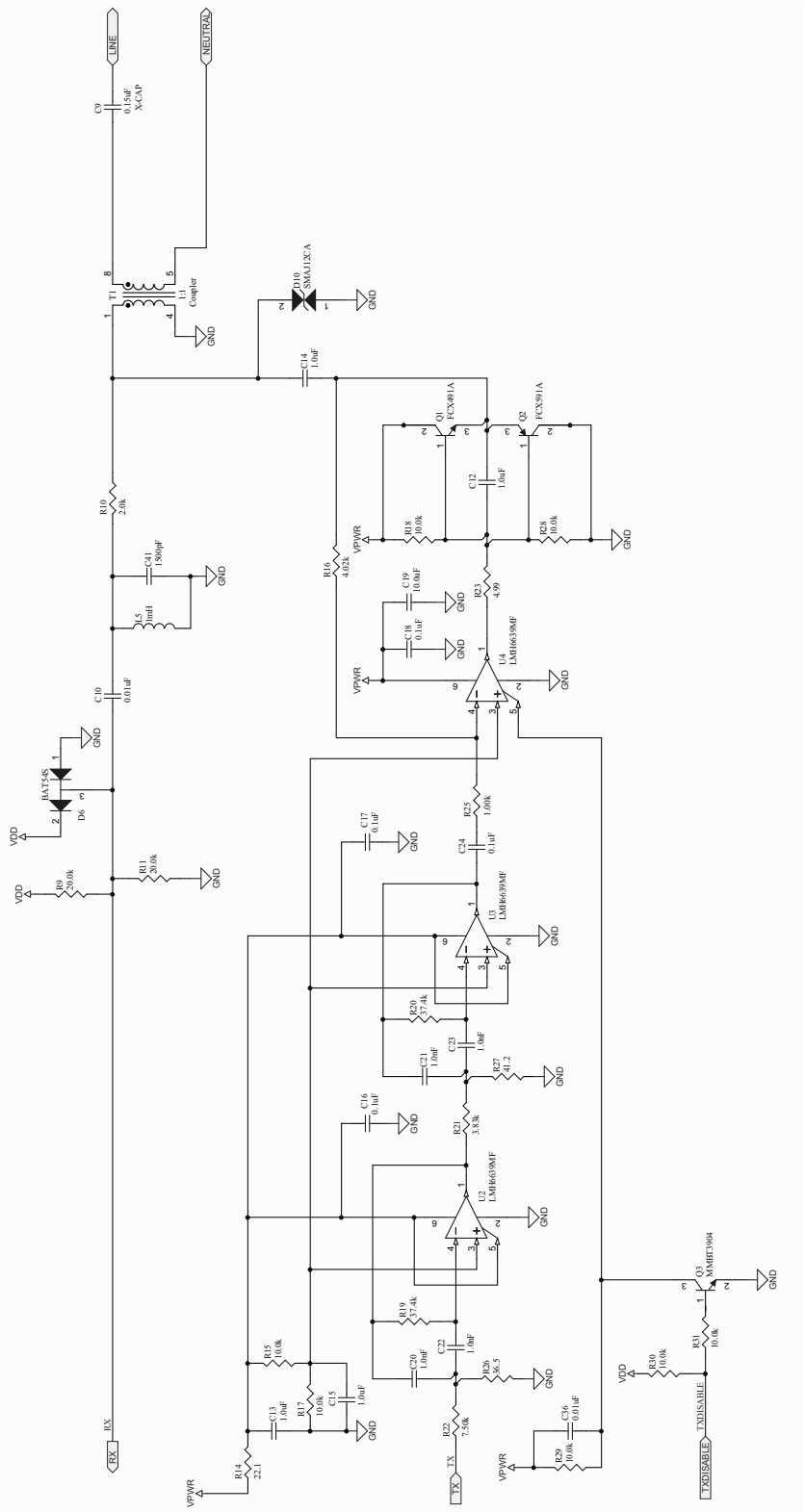
A.1.1 Board Overview



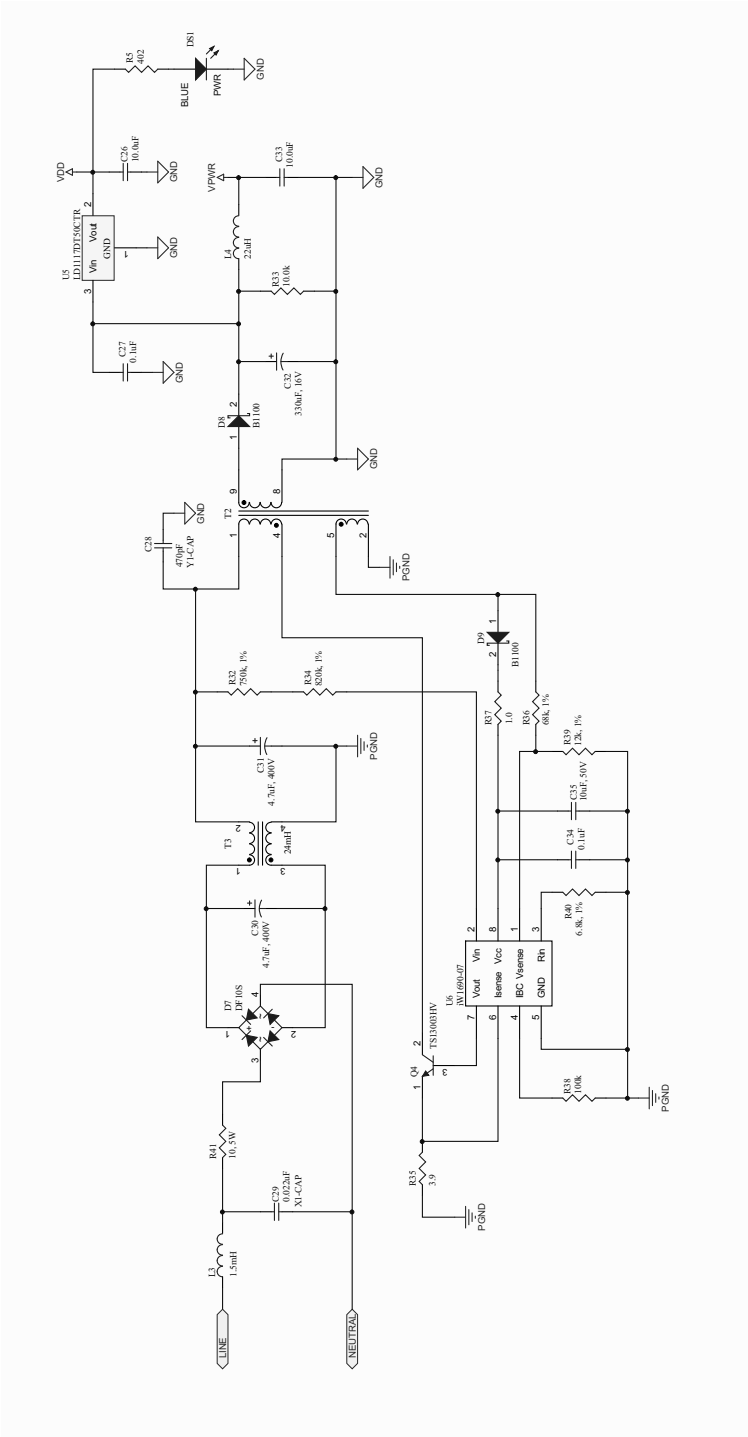
A.1.2 User Interface



A.1.3 Transmit and Receive Filters and Coupling

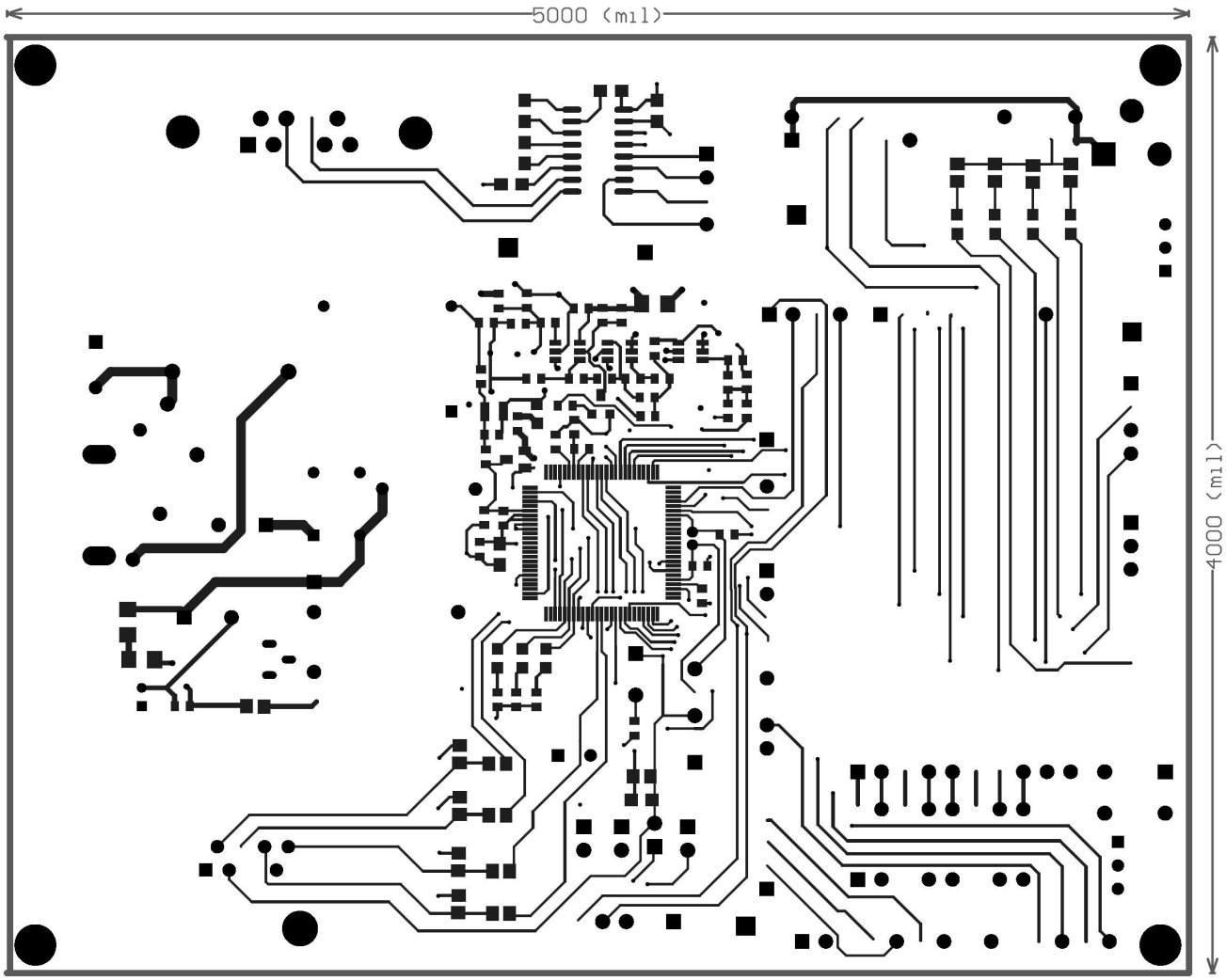


A.1.4 Power Supply

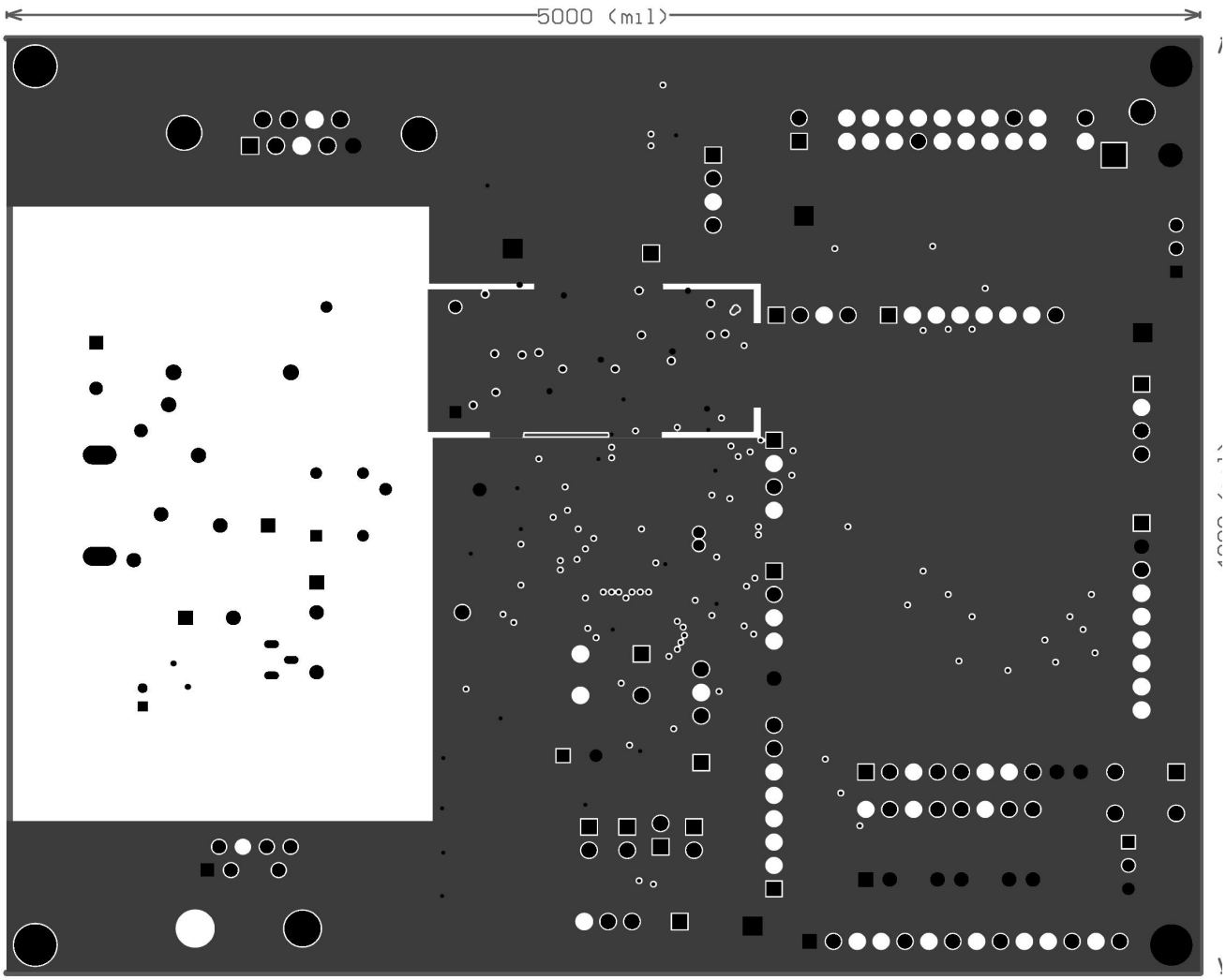


A.2 Layout

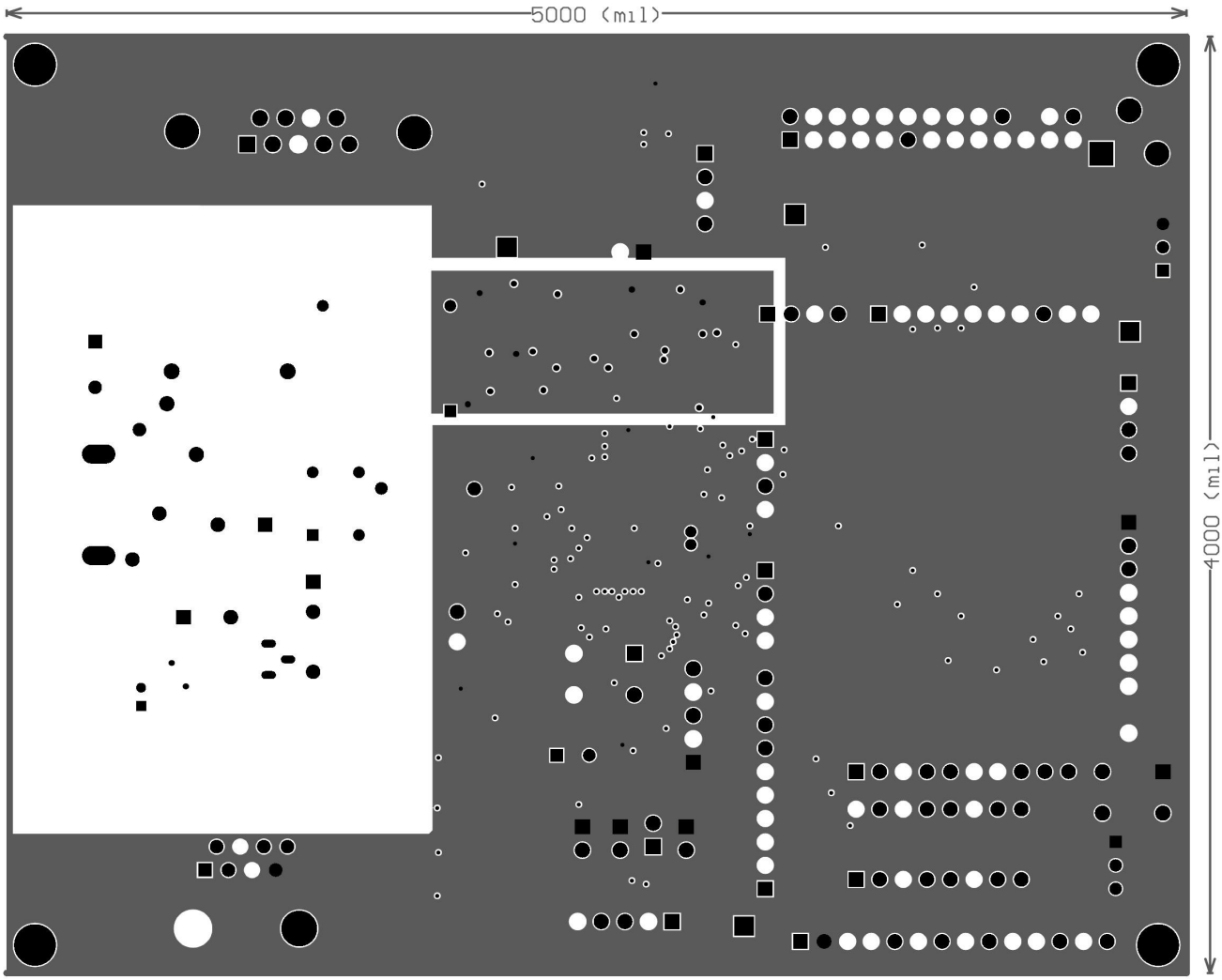
A.2.1 Top Layer



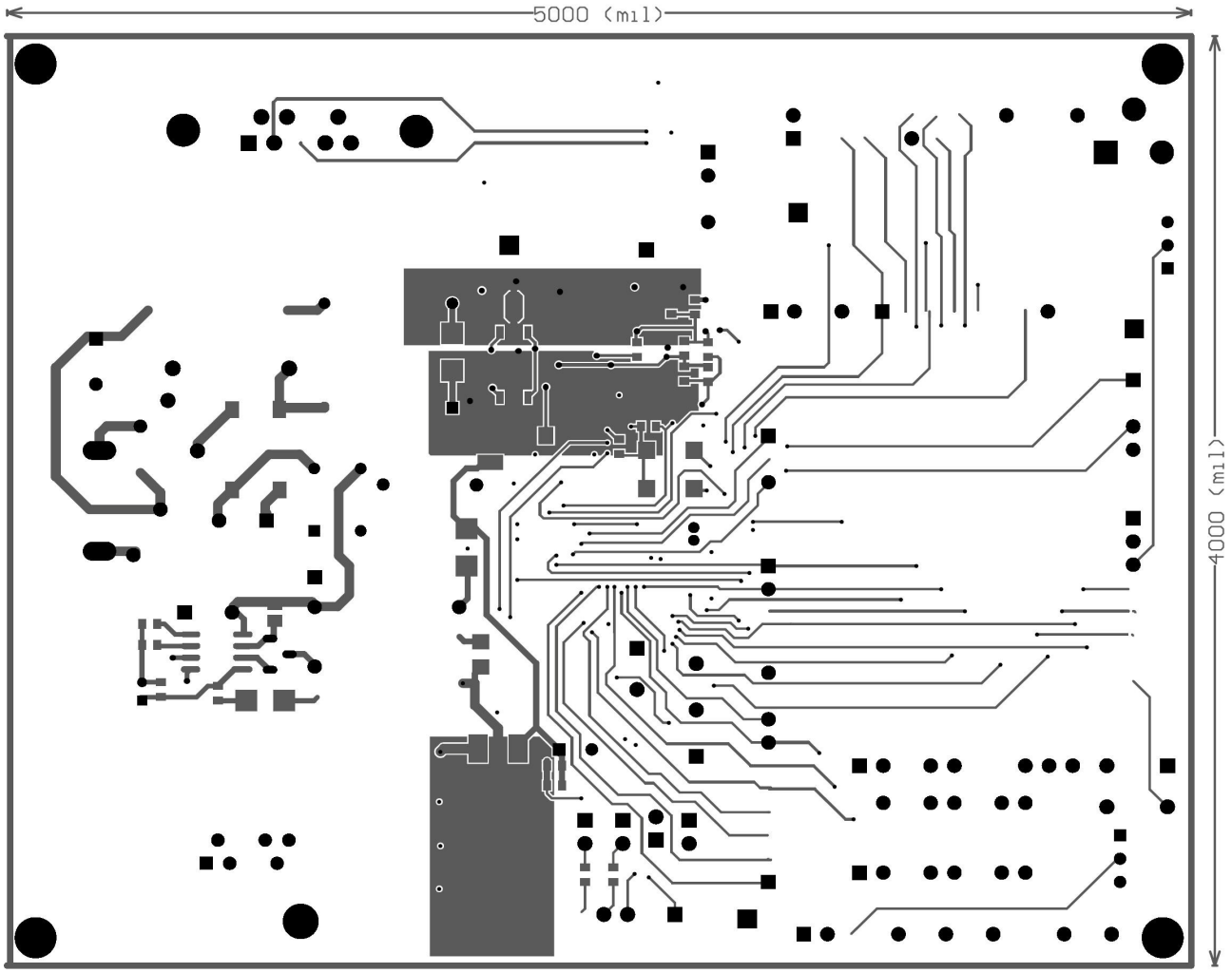
A.2.2 Ground Layer



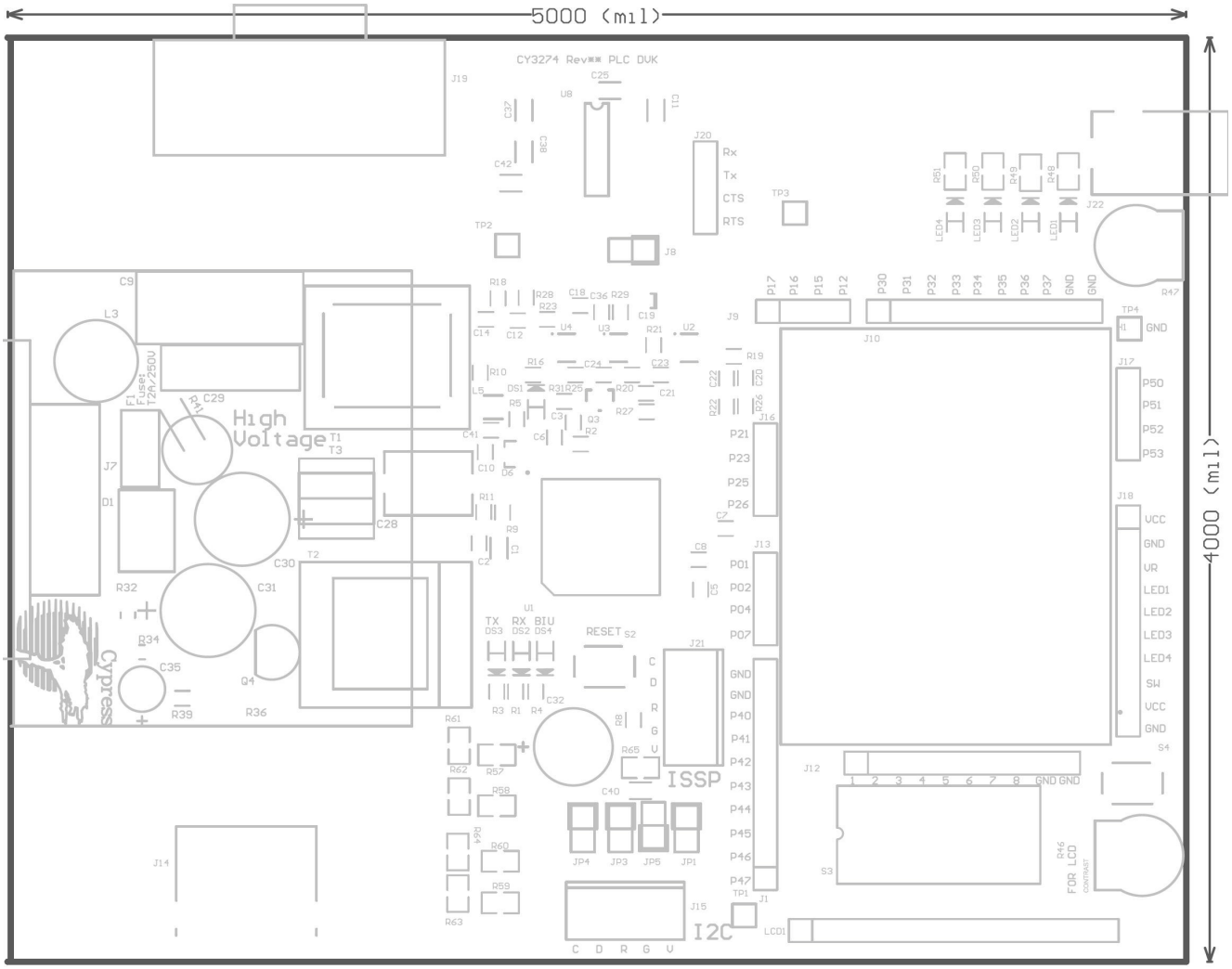
A.2.3 Power Layer



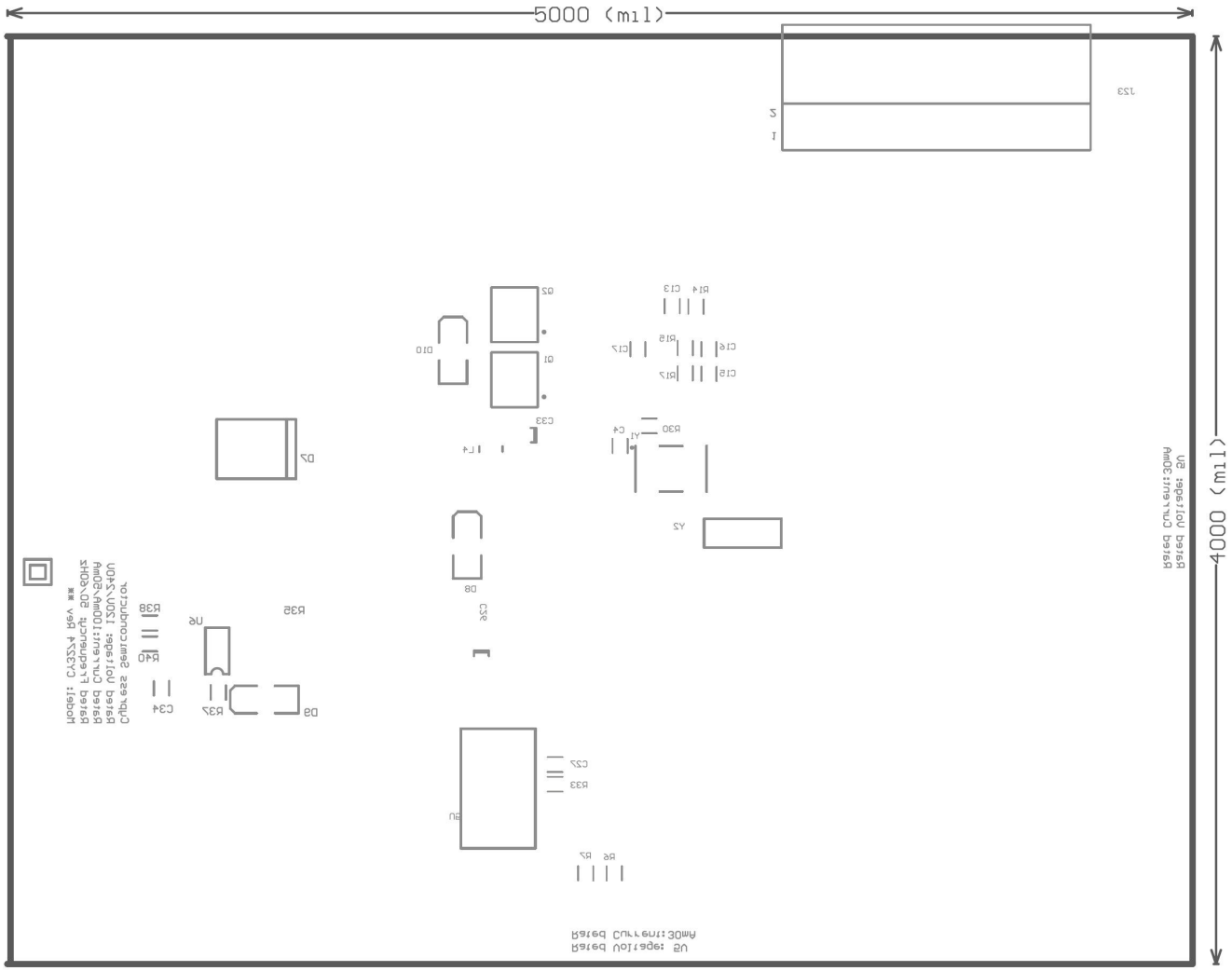
A.2.4 Bottom Layer



A.2.5 Top Silkscreen



A.2.6 Bottom Silkscreen



A.3 Bill of Materials

Description	Designator	Quantity	Value	Manufacturer	Manufacturer Part#	Digi-Key#
Capacitor 0.1 µF	C1	1	0.1 µF			PCC1864TR-ND
Capacitor Ceramic 1.0 nF X7R 10% 25V C0603	C2	1	1.0nF	Murata	GRM033R71E102KA01D	490-3184-1-ND
Capacitor Ceramic 0.01 µF 25V X7R 0603	C3, C4, C10, C36	4	0.01 µF	AVX	06033C103JAT2A	06033C103JAT2A-ND
Capacitor Ceramic 0.1 µF 25V X7R 0603	C5	1	0.1 µF	AVX	06033C104JAT2A	478-3713-1-ND
Capacitor Ceramic 1.0 µF 16V X7R 0603	C6, C12, C13, C14, C15	5	1.0 µF, 1 µF	Taiyo Yuden	EMK107B7105KA-T	587-1241-1-ND
Capacitor Ceramic 22 pF 100V C0G 0603	C7, C8	2	22pF	Murata	GRM1885C2A220JA01D	490-1335-1-ND
CAP .15UF 300VAC INTER SUPP X1	C9	1	0.15 µF	Murata	ECQ-U3A154MG	P11117-ND
Capacitor 1.0 µF, 16V	C11	1	1.0 µF, 16V			PCC1849TR-ND
CAP CERM 0.10 UF 10% 16V X7R 0603	C16, C17, C18, C24, C27, C34	6	0.1 µF	Panasonic	ECJ-1VB1C104K	PCC1762CT-ND
CAP CERM 10.0 UF 10% 25V X5R 1206	C19, C26, C33	3	10.0 µF	Taiyo Yuden	TMK316BJ106KL-T	587-1337-1-ND
Capacitor Ceramic 1000 PF 1% 5V NP0 0603	C20, C21, C22, C23	4	1.0nF	AVX	06033A102FAT2A	06033A102FAT2A-ND
Capacitor 0.47 µF, 16V	C25, C38, C42	3	0.47 µF, 16V			PCC1847TR-ND
Capacitor Ceramic 470 PF 250VAC X1Y1 RAD	C28	1	470pF	TDK	CD95-B2GA471KYNS	445-2407-ND
CAP .022UF 300VAC INTER SUPP X1	C29	1	0.022 µF	Panasonic	ECQ-U3A223MG	P11112-ND
Capacitor Electrolytic 4.7 µF, 400V	C30, C31	2	4.7 µF, 400V	Nichicon	UVR2G4R7MPD	493-1229-ND
	C30, C31 (2nd Source, 105C rated)		4.7 µF, 400V	United Chemi-Con	EKMG401ELL4R7MJ16S	565-1411-ND
Capacitor Electrolytic 330 µF 16V 20%	C32	1	330 µF, 16V	Nichicon	UPW1C331MPD	493-1784-ND

Description	Designator	Quantity	Value	Manufacturer	Manufacturer Part#	Digi-Key#
Capacitor Electrolytic 10 µF 50V 20%	C35	1	10 µF, 50V	Nichicon	UPW1H100MDD	493-1890-ND
Capacitor 0.1 µF, 16V	C37	1	0.1 µF,16V			PCC1864TR-ND
Capacitor 100 pF	C40	1	100pF			399-1121-2-ND
Capacitor Ceramic 1500 pF 10% 50V X7R 0603	C41	1	1500pF	Yageo	CC0603KRX7R9BB152	311-1184-2-ND
Transorb Voltage Suppressor 430 V 1250A ZNR	D1	1	430V	Panasonic	ERZ-V07D431	P7251-ND
Dual Schottky Diode	D6	1		ST Micro	BAT54SFILM	497-2522-1-ND
Full Wave Diode Bridge	D7	1		Fairchild	DF10S	DF10SCT-ND
Schottky Diode 100 V 1A SMA	D8, D9	2		Diodes Inc	B1100-13-F	B1100-FDICT-ND
Transient Voltage Suppressor 400 W 12 V BIDIRECT SMA	D10	1		Micro Commercial Co	SMAJ12CA-TP	SMAJ12CA-TPMSCT-ND
LED Blue Clear 0603	DS1	1		Rohm	SML-E12BC7TT86	511-1589-1-ND
LED Red Clear 0805	DS2	1		Lite-On	LTST-C170KRKT	160-1415-1-ND
LED Green Clear 0805	DS3	1		Lite-On	LTST-C170KGKT	160-1414-1-ND
LED Yellow Clear 0805	DS4	1		Lite-On	LTST-C170KSKT	160-1416-1-ND
Fuse 2A Slow Blow 250 V AC	F1	1	2.0A	Bel Fuse	RST 2	507-1179-ND
3M solderless breadboard super strip	H1	1		Parallax	700-00012	923273-ND
Header, 10-Pin	J1, J10, J12, J18	4	10			929850E-01-36-ND
AC Power Connector	J7	1		Schurter	4300.0097	
Header, 2-Pin, Female	J8	1	2	Generic Components		929850E-01-36-ND
Header, 4-Pin	J9, J13, J17, J20	4	4			929850E-01-36-ND
ICE Connection	J14	1		Tyco	5557785-1	A31457-ND
5-pin ISSP Header	J15, J21	2		Molex	22-23-2051	WM4203-ND

Description	Designator	Quantity	Value	Manufacturer	Manufacturer Part#	Digi-Key#
Header, 4-Pin	J16	1	4			929850E-01-36-ND
Female DB-9	J19	1	DB9-F			A23301-ND
(DO NOT POPULATE) Power Connector Jack 2.1mm PCB	J22					
(DO NOT POPULATE) Right Angle 2X13 header 0.1" Spacing	J23					
Header, 2-Pin, Male	JP1, JP3, JP4, JP5	4	2	Generic Components		S1011E-36-ND
Inductor 1500 µH 0.2A 5% Radial	L3	1	1.5mH	Taiyo Yuden	LHL08TB152J	LHL08TB152J-ND
Inductor 22 µH 20% 1210	L4	1	22 µH	Taiyo Yuden	CBC3225T220MR	587-1626-1-ND
Inductor 1 mH 10% 1007	L5	1	1mH	Taiyo Yuden	CB2518T102K	587-2195-1-ND
14-Pin header, Female	LCD1	1	14	3M/ESD	929850-01-36-RA	929850E-01-36-ND
Red LED	LED1, LED2, LED3, LED4	4	Red	Lumex Opto	SML-LXT0805IW-TR	67-1552-2-ND
Mounting Holes	MTG1, MTG2, MTG3, MTG4	4				
Transistor NPN HV 40 V 1A SOT-89	Q1	1		Zetex	FCX491ATA	FCX491ACT-ND
Transistor PNP HV 40 V 1A SOT-89	Q2	1		Zetex	FCX591A	FCX591ACT-ND
Transistor NPN SOT-23	Q3	1		Fairchild	MMBT3904LT1	MMBT3904LT1INCT-ND
NPN Silicon Planar Medium Power High-Gain Transistor	Q4	1		TSC	TS13003HVCT	
	Q4 (2nd source)			ST Micro	STX616-AP	497-7625-1-ND
Resistor 1.00k 1% 1/10 W 0603	R1, R3, R4, R25	4	1.00k	Yageo	RC0603FR-071KL	311-1.00KHRTR-ND

Description	Designator	Quantity	Value	Manufacturer	Manufacturer Part#	Digi-Key#
Resistor 2.1k 1% 1/ 10 W 0603	R2	1	2.10k	Rohm	MCR03EZPFX2 101	RHM2.10KHCT-ND
Resistor 402 1% 1/ 10 W 0603	R5	1	402	Yageo	RC0603FR-07402RL	311-402HRTR-ND
Resistor 7.50k 1% 1/ 10 W 0603	R6, R7, R22	3	7.50k	Yageo	RC0603FR-077K5L	311-7.50KHRTR-ND
Resistor 330 Ohm 1% 1/10 W 0603	R8	1	330	Rohm	MCR03EZPFX3 300	RHM330HCT-ND
Resistor 20.0 k 1% 1/ 10 W 0603	R9, R11	2	20.0k	Yageo	RC0603FR-0720KL	311-20.0KHRCT-ND
Resistor 2.0k 1% 1/ 10 W 0603	R10	1	2.0k	Yageo	RC0603FR-072KL	311-2.00KHRCT-ND
Resistor 22.1 1% 1/ 10 W 0603	R14	1	22.1	Yageo	RC0603FR-0722R1L	311-22.1HRCT-ND
Resistor 10.0k 1% 1/ 10 W 0603	R15, R17, R18, R28, R29, R30, R31, R33	8	10.0k	Yageo	RC0603FR-0710KL	311-10.0KHRTR-ND
Resistor 4.02k 1% 1/ 10W 0603	R16	1	4.02k	Yageo	RC0603FR-072K02L	311-4.02KHRTR-ND
Resistor 37.4k 1% 1/ 10 W 0603	R19, R20	2	37.4k	Yageo	RC0603FR-0737K4L	311-37.4KHRCT-ND
Resistor 3.83k 1% 1/ 10 W 0603	R21	1	3.83k	Yageo	RC0603FR-073K83L	311-3.83KHRCT-ND
Resistor 4.99 1% 1/ 10 W 0603	R23	1	4.99	Yageo	RC0603FR-074R99L	311-4.99HRCT-ND
Resistor 36.5 1% 1/ 10 W 0603	R26	1	36.5	Yageo	RC0603FR-0736R5L	311-36.5HRCT-ND
Resistor 41.2 1% 1/ 10 W 0603	R27	1	41.2	Yageo	RC0603FR-0741R2L	311-41.2HRCT-ND
750 k 1% Resistor 1206	R32	1	750k, 1%	Yageo	RC1206FR-07750KL	311-750KFRCT-ND
820 k 1% Resistor 1206	R34	1	820k, 1%	Yageo	RC1206FR-07820KL	311-820KFRCT-ND
3.9 Ohm 1% Resistor 0805	R35	1	3.9	Yageo	RC0805FR-073R9L	311-3.90CRCT-ND
RES 68.0 K OHM 1/8W 1% 0805 SMD	R36	1	68k, 1%	Yageo	RC0805FR-0768KL	311-68.0KCRTR-ND
RES 1.00 OHM 1/10W 1% 0603 SMD	R37	1	1.0	Yageo	RC0603FR-071RL	311-1.00HRCT-ND

Description	Designator	Quantity	Value	Manufacturer	Manufacturer Part#	Digi-Key#
RES 100 k OHM 1/10W 1% 0603 SMD	R38	1	100k	Yageo	RC0603FR-07100KL	311-100KHRTR-ND
RES 12.0 K OHM 1/ 10W 1% 0603 SMD	R39	1	12k, 1%	Yageo	RC0603FR-0712KL	311-12.0KHRCT-ND
6.8k, 1% Resistor 0603	R40	1	6.8k, 1%	Yageo	RC0603FR-076K8L	311-6.80KHRTR-ND
RESISTOR 10.0 OHM 5W 5% WIREWND	R41	1	10, 5W	Vishay	AC0500000100 9JAC00	PPC5W10.0CT-ND
Potentiometer	R46, R47	2		Bourns Inc	3352T-1-103LF	3352T-103LF-ND
Resistor 1.0 K, SMT	R48, R49, R50, R51, R61, R62, R63, R64, R65	9	1K	Panasonic	ERJ-6GEYJ102V	P1.0KACT-ND
Resistor 56 Ohm, SMT	R57, R58, R59, R60	4	56			P56ACT-ND
Swtich, SPST	S2, S4	2		Omron	B3F-1022	SW403-ND
4009 Series DIP Switch, Raised actuator	S3	1		ESwitch	KAJ08LAGT	EG4441-ND
Isolation Transformer	T1	1		Precision Components	0505-0821G	
Power Trasnsformer EE-16	T2	1	3.2mH	Shenzen Goldenway	EE-16 (5+5) (rev-A)	
	T2 (2nd Source)	1		Renco Electronics	RLCY-1014	
24 mH Common Mode Choke	T3	1	24mH	Shenzen Goldenway	EE8.3(2+2)-hori, (rev-A)	
	T3 (2nd Source)	1		Renco Electronics	RLCY-1013	
Simple Test point	TP1, TP2, TP3, TP4	4				5006K-ND
CY8CPLC20 OCD Part	U1	1		Cypress	CY8CPLC20-OCD	
Op-Amp 190 MHz	U2, U3, U4	3		National Semiconductor	LMH6639MF/ NOPB	LMH6639MFCT-ND
Voltage Regulator 5 V	U5	1		ST Micro	LD1117DT50CTR	497-1237-1-ND
Off-Line Switcher	U6	1		iWatt	iW1690-07	

Description	Designator	Quantity	Value	Manufacturer	Manufacturer Part#	Digi-Key#
RS-232 tranceiver (1.0 µF Caps)	U8	1			MAX3232ECDR	296-19851-2-ND
Oscillator	Y1	1	24.00 MHz	Crystek	C3290-24.000	C3290-24.000-ND
	Y1 (2nd Source)			Citizen	CSX750FCC24.000M-UT	300-7214-2-ND
Crystal 32.768 kHz 12.5 pF	Y2	1	32.768k Hz	ECS Inc.	ECS-3X8X	X1123-ND
LCD Module	LCD1	1		Cypress Semiconduc-tor	1187-00003	

Revision History

Document Revision History

Document Title: CY3274 Cypress High Voltage Programmable Powerline Communication Development Kit Guide Document Number: 001-53598				
Revision	**ECN#**	**Issue Date**	**Origin of Change**	**Description of Change**
**	2752289	8/14/09	IUS	New kit guide.
*A	2759193	9/3/09	IUS	Rework for external release.
*B	2825364	12/10/09	RARP	Content updates.
*C	3040868	09/28/10	RKPM	Updated Introduction chapter on page 7: Added "Technical Reference" on page 12. Updated Getting Started chapter on page 13: Added "Software Installation" on page 13. Updated PLC Development Board chapter on page 41: Updated "Hardware Description" on page 42: Added schematic s (Figure 4-8, Figure 4-9, Figure 4-10). Added "Code Example" on page 30.
*D	3190764	03/08/2011	FRE	Updated Introduction chapter on page 7: Updated "The Cypress PLC Solution" on page 8: Added references to the compatible high voltage PLC kits. Updated PLC Development Board chapter on page 41: Updated "Hardware Description" on page 42: Updated "RJ45 Connector for Debugging" on page 47: Added a reference to the quick start guide for evaluation. Added clarifications to the text throughout.
*E	3403015	10/12/2011	ADIY	Removed references of CY3276 and CY8CLED16P01 in all instances across the document. Updated Introduction chapter on page 7: Updated "The Cypress PLC Solution" on page 8: Updated Figure 1-3. Updated hyperlinks in Note above Figure 1-3. Added "Additional Learning Resources" on page 10 Added Getting Started chapter on page 13.
*F	4120074	09/11/2013	ADIY	No technical updates. Completing Sunset Review.

Document Revision History *(continued)*

Document Title: CY3274 Cypress High Voltage Programmable Powerline Communication Development Kit Guide Document Number: 001-53598				
Revision	**ECN#**	**Issue Date**	**Origin of Change**	**Description of Change**
*G	4473372	08/13/2014	ROIT	Removed references of CY3272 kit in all instances across the document as CY3272 kit is obsolete. Updated Introduction chapter on page 7: Updated "Kit Contents" on page 7: Added Figure 1-1. Updated description. Updated "The Cypress PLC Solution" on page 8: Updated Figure 1-2, Figure 1-3. Added "Acronyms" on page 11. Updated "Technical Reference" on page 12: Updated description. Updated Getting Started chapter on page 13: Updated "Software Installation" on page 13: Updated "Prerequisites" on page 13: Updated description. Removed the section "Installing PLC Control Panel Software". Updated "Installing PLC Control Panel Independently" on page 14: Updated "Installing PLC Control Panel Software" on page 14: Updated description. Updated "Kit Installation" on page 17: Updated description. Removed figure "Kit Installer Startup Screen". Removed figure "Root Directory of CD". Added Figure 2-7. Updated Figure 2-5, Figure 2-6, Figure 2-8, Figure 2-9. Added Kit Operation and PLC Control Panel GUI chapter on page 23. Updated PLC Development Board chapter on page 41: Updated "Board Details" on page 41: Updated description. Updated "Hardware Description" on page 42: Updated "High Voltage with Switched Mode Power Supply (SMPS)" on page 48: Updated Figure 4-8. Updated "Transmit Filter, Transmit Amplifier, and Receive Filter" on page 48: Updated Figure 4-9. Updated "High Voltage Coupling Circuit" on page 49: Updated Figure 4-10. Added Code Examples chapter on page 51. Updated Appendix chapter on page 69: Updated "Schematics" on page 69: Updated "Board Overview" on page 69. Updated "User Interface" on page 70. Updated "Transmit and Receive Filters and Coupling" on page 71. Updated "Power Supply" on page 72. Completing Sunset Review.
Distribution: External **Posting**: None				