

Building Arduino PLCs

The essential techniques you need to
develop Arduino-based PLCs

—
Pradeeka Seneviratne



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About the Author



Pradeeka Seneviratne is a software engineer with over 10 years of experience in computer programming and systems design. He loves programming embedded systems such as Arduino and Raspberry Pi. Pradeeka started learning about electronics when he was at primary college by reading and testing various electronic projects found in newspapers, magazines, and books.

Pradeeka is currently a full-time software engineer who works with highly scalable technologies. Previously, he worked as a software engineer for several IT infrastructure and technology servicing companies, and he was also a teacher for information technology and Arduino development.

He researches how to make Arduino-based unmanned aerial vehicles and Raspberry Pi-based security cameras.

Pradeeka is also the author of the *Internet of Things with Arduino Blueprints*, Packt Publishing.

About the Technical Reviewer

Jayakarthigeyan Prabakar is an electrical and electronics engineer with more than four years of experience in real-time embedded systems development. He loves building cloud-connected physical computing systems using Arduino, MSP430, Raspberry Pi, BeagleBone Black, Intel Edison, ESP8266, and more.

Jayakarthigeyan started understanding how computing devices and operating systems work when he started repairing his personal computer in middle school. That was when he first got his hands on electronics.

From his third year in the undergraduate degree program, he started building prototypes for various startups around the world as a freelancer. Currently, Jayakarthigeyan is a full-time technical lead of the R&D division in a home automation startup and works as a consultant to many other companies involved in robotics, industrial automation, and other IoT solutions. He helps build prototypes to bring their ideas to reality.

CHAPTER 1



Getting Ready for the Development Environment

A **Programmable Logic Controller (PLC)** is a *digital computer* that continuously monitors or scans the state of input devices and controls the state of output devices based on a custom program. A basic industrial PLC typically consists of an embedded computer, inputs, outputs, and a power supply with battery backup. They usually automate *industrial electromechanical processes*.

Figure 1-1 presents an industrial PLC mounted on a **DIN rail**. This unit consists of separate elements, including a *power supply*, *controller*, and unit for handling inputs and outputs. Typically for high voltage levels, the input unit consists of optically isolated inputs and output unit consists of *optically isolated* relay outputs. The passive components are enclosures, terminal block connectors, and DIN rails.

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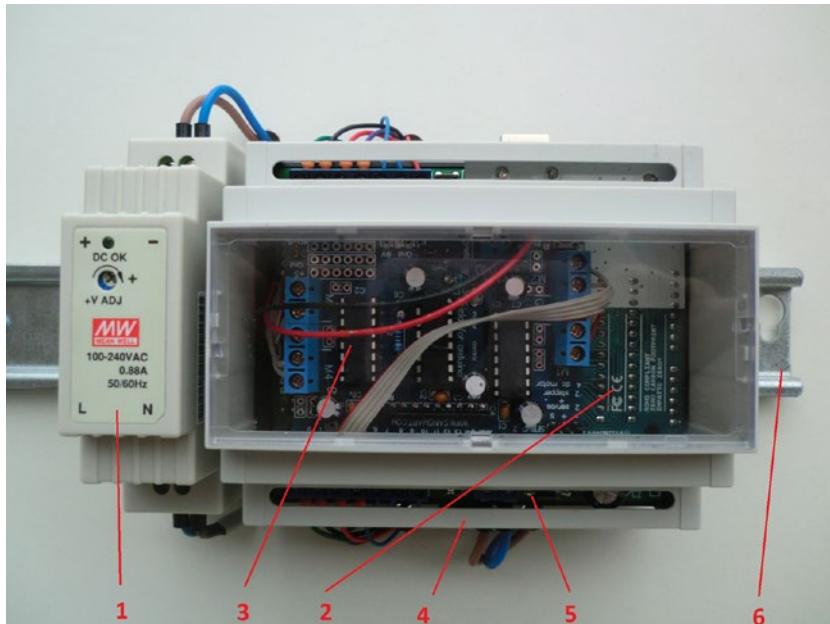


Figure 1-1. Modules of an Arduino-based PLC
Image courtesy of Hartmut Wendt at www.hwhardsoft.de

The following are the major components that can be identified in the Figure 1-1.

1. Power supply
2. Controller
3. Relay/non-relay unit for input and output
4. Enclosure
5. Terminal block connectors
6. DIN rail

Arduino Development Environment can be used to build functional PLCs that can be used with some industrial automation and process control. You'll learn how to choose appropriate components for various parts of the PLC, such as the CPU, inputs, outputs, network interfaces, power supplies, and battery backups.

This chapter provides a comprehensive shopping guide to purchasing various assembled printed circuit boards, some of the hardware components (*active and passive*), and setting up your development environment to make all the projects discussed in the chapters in the book.

We'll provide an array of manufacturers and suppliers, but the products may have same core functionalities and slightly different features. A good example is the Arduino UNO board that comes with different features depending on the manufacturer, but uses the same Arduino **bootloader**.

Note This guide is only limited to the major hardware components that will be needed to build projects discussed in this book. The information presented here gives you a basic idea when it comes to purchasing those products from various vendors and manufacturers. The detailed technical guide will provide all the information about the products discussed in the respective chapters.

Buying an Arduino

Arduino comes with different flavors, including boards, modules, shields, and kits. The examples and projects discussed in this book use the Arduino UNO board, which is the basic board of the entire Arduino family. There are plenty of Arduino UNO clones and derived boards available and you may be confused about which one to buy. Following are some popular boards that can be used to start building your development environment, and buying one of them is necessary.

Arduino UNO and Genuino UNO

The Arduino online store is a very good way to purchase an Arduino UNO board. Currently, there are two brands available for Arduino. The Arduino UNO is now available for sale (store-usa.arduino.cc) in the United States only and the Genuino UNO is available for sale (store.arduino.cc) in the rest of the world.

Arduino UNO

You can purchase an Arduino UNO Rev3 board (see Figure 1-2) from the official Arduino store, which is a Dual Inline Package (DIP) type of ATmega328P microcontroller preloaded with Arduino UNO bootloader (it's about \$24.95; <http://store-usa.arduino.cc/products/a000066> and <https://www.sparkfun.com/products/11021>).



Figure 1-2. Arduino UNO Rev3 board. Image courtesy of arduino.cc

Also, the SMD version (Rev3) of this board is also available at the following stores if you'd like to purchase it.

- **Arduino.org:** about €20.90—<http://world.arduino.org/en/arduino/arduino-uno-smd-rev3.html>
- **SparkFun'** about \$29.95—<https://www.sparkfun.com/products/11224>

Genuino UNO

Genuino UNO (see Figure 1-3) is identical to the Arduino UNO except the brand name with the same revision that is Rev3. The board is based on the DIP type of ATmega328P microcontroller. (about €20; <https://store.arduino.cc/product/GBX00066>).

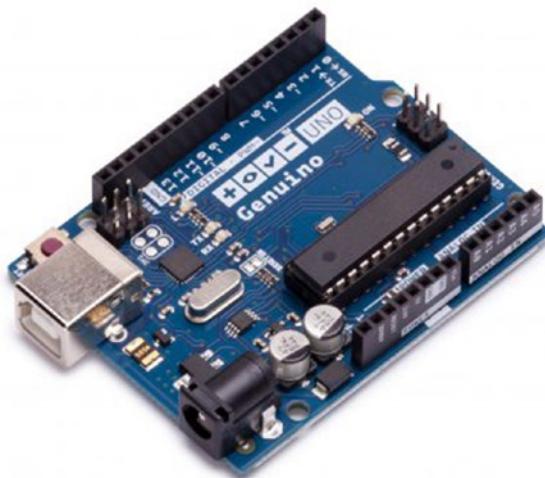


Figure 1-3. Genuino UNO Rev3 board. Image courtesy of arduino.cc

Cable and Power Supply

Don't forget to buy a USB cable and a power supply to work with the Arduino board.

USB Cable

You can use one of the following **USB cables** or a similar cable to work with Arduino.

- Adafruit - USB Cable - Standard A-B - 3 ft/1m (about \$3.95; <https://www.adafruit.com/products/62>)
- SparkFun - USB Cable A to B - 6 Foot (about \$3.95; <https://www.sparkfun.com/products/512>)

Power Supply

The Arduino board can be supplied with power between **7-12V** from the DC power jack. Choosing a 9V power supply is sufficient to function the Arduino board properly. Here are some of the power packs that are ready to work with Arduino.

- Adafruit -9 VDC 1000mA regulated switching power adapter; UL listed (about \$6.95; <https://www.adafruit.com/product/63>)
- SparkFun - Wall Adapter Power Supply - 9VDC 650mA (about \$5.95; <https://www.sparkfun.com/products/298>)

Arduino UNO Clones and Derived Boards

There are plenty of Arduino UNO clones and derived boards (also known as *derivatives*) available from various manufacturers. The exact replicas of the Arduino boards with different branding are called clones. Arduino derivatives are different from clones, because they are derived from the Arduino hardware design but provide a different layout and a set of features (i.e., Teensy by PJRC and Flora by Adafruit), often to better serve a specific market. One of the following is a great choice for an alternative Arduino UNO board.

Seeeduino (Figure 1-4) from Seeed Development Limited is a derivative Arduino board that can be used to build Arduino projects instead of using the official Arduino board (about \$19.95; <https://www.seeedstudio.com/Seeeduino-V4.2-p-2517.html>).



Figure 1-4. Seeeduino v4.2. Image courtesy of Seeed Development Limited

You will also need a **micro-USB cable** to program this board (about \$2.5; <https://www.seeedstudio.com/Micro-USB-Cable-48cm-p-1475.html>).

SparkFun RedBoard

SparkFun RedBoard (see Figure 1-5) is also a goof solution to use as an alternative Arduino board to build Arduino-based projects (about \$19.95; <https://www.sparkfun.com/products/12757>). This shield brings some favorite features like UNO's optiboot bootloader, the stability of the FTDI, and the R3 shield compatibility.

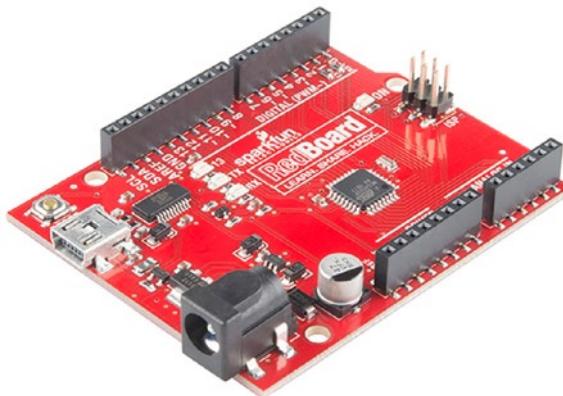


Figure 1-5. SparkFun RedBoard. Image From SparkFun Electronics; Photo taken by Juan Peña

You also need a **USB Mini-B cable** to program this board (about \$3.95; <https://www.sparkfun.com/products/11301>). You can power the board over **USB** or through the **barrel jack**.

Buying an Arduino Ethernet Shield

The main functionality of **Arduino Ethernet Shield** is to connect your Arduino board to the Internet. You only need an **Arduino Ethernet Shield** if you are planning to build a **cloud-connected PLC** that will be discussing in **Chapter 8, “Mapping PLCs into the Cloud Using a NearBus Cloud Connector”**.

Arduino Ethernet Shield 2

This is the latest version of the **Arduino Ethernet Shield** (Figure 1-6) manufactured by arduino.org at the time of this writing. It is based on the **Wiznet W5500** Ethernet chip. The shield has a standard **RJ-45** jack, on board **micro-SD card slot**, and six **TinkerKit** connectors. You learn more about Arduino Ethernet in **Chapter 2, “Arduino, Ethernet, and WiFi”** (about €22; <http://world.arduino.org/en/arduino-ethernet-shield-2.html>).

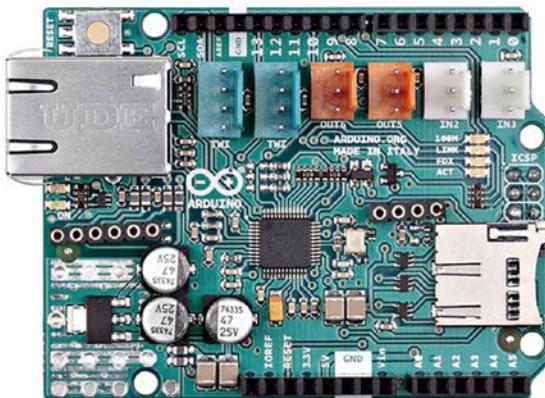


Figure 1-6. Arduino Ethernet Shield 2. Image courtesy of arduino.org

Alternatively, the POE (Power Over Ethernet) version of this board is also available at <http://world.arduino.org/en/arduino-ethernet-shield-2-with-poe.html> and is about €35.20.

However, you can use the previous version of Arduino Ethernet Shield (Figure 1-7) based on the **Wiznet W5100** Ethernet chip, provided that you already have one and it works well with the projects discussed in this book.

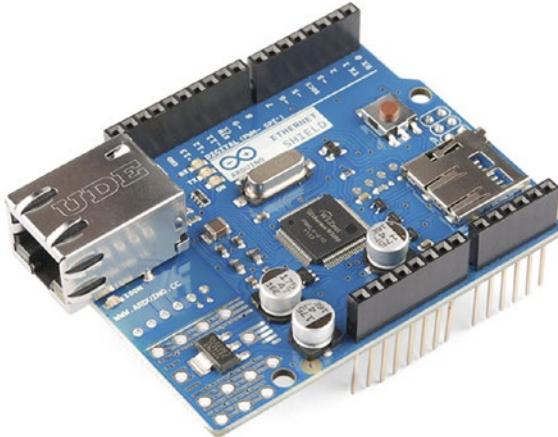


Figure 1-7. Arduino Ethernet Shield (previous version). Image from SparkFun Electronics; photo taken by Juan Peña