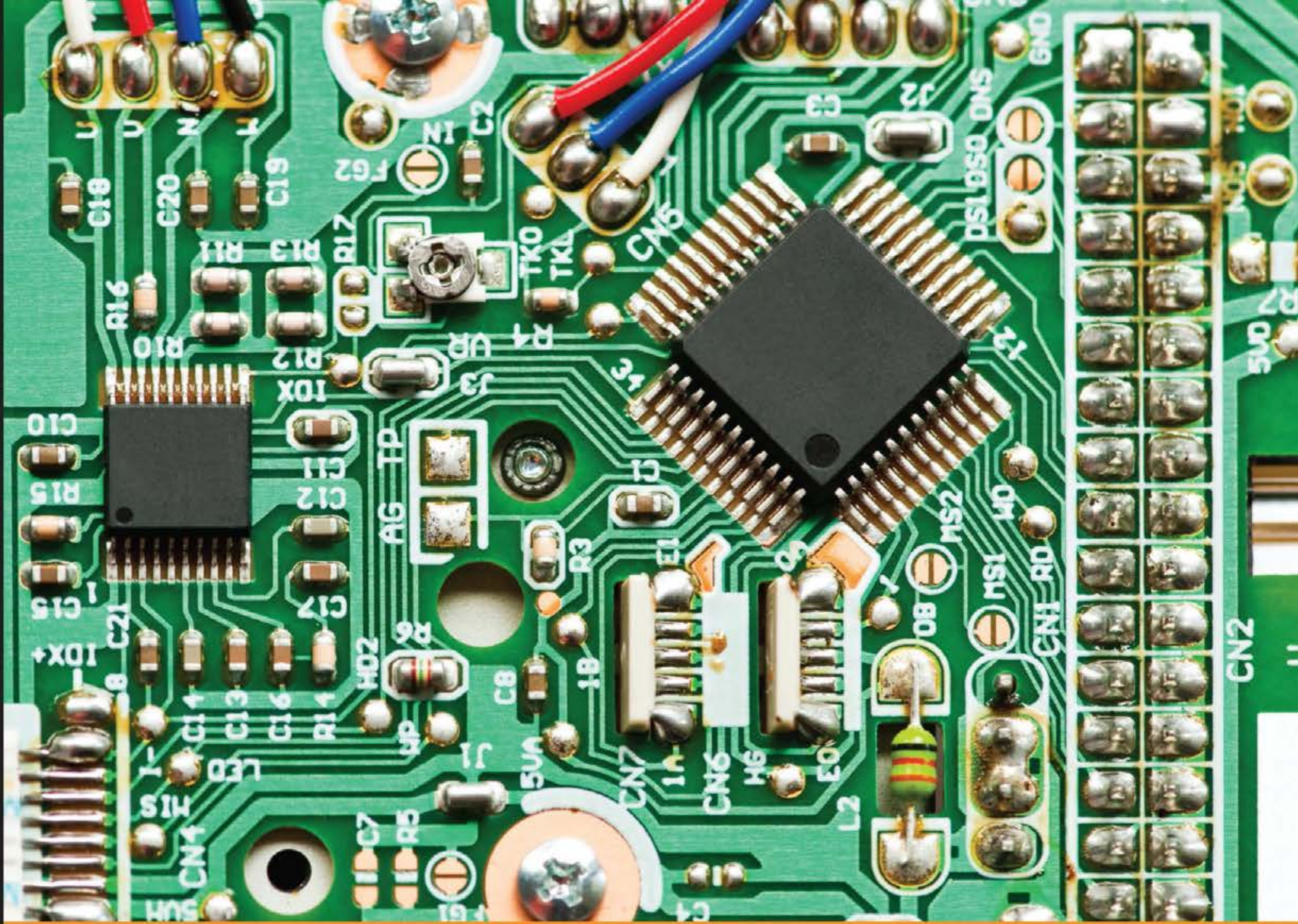

Community Experience Distilled

Internet of Things with Arduino Blueprints

Develop interactive Arduino-based Internet projects with Ethernet and Wi-Fi

Pradeeka Seneviratne

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community experience distilled
PUBLISHING

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First published: October 2015

Production reference: 1201015

Published by Packt Publishing Ltd.
Livery Place
35 Livery Street
Birmingham B3 2PB, UK.

ISBN 978-1-78528-548-6

www.packtpub.com

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About the Author

Pradeeka Seneviratne is a software engineer with over 10 years of experience in computer programming and systems designing. 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.

About the Reviewers

Francesco Azzola is an electronics engineer with more than 15 years of experience in the architecture and development of JEE applications. He has a deep knowledge of mobile messaging, smart cards, and mobile applications. He enjoys building Android apps and experimenting with the IoT ecosystem using Arduino and Android. He is a Sun Certified Enterprise Architect (SCEA), SCWCD, SCJP, Prince2 (Foundation), and VCA-DCV. In his spare time, he runs a blog about Android and IoT (`http://www.survivingwithandroid.com/`).

Paul Deng is a senior software engineer with over 8 years of experience in IoT app design and development. He has been working with the Arduino platform since its early days in 2008.

His past experience involves end-to-end IoT app design and development, including embedded devices, large-scale machine learning, and cloud and web apps. Paul holds software algorithm patents and was a finalist of the Shell Australian Innovation Challenge 2011. He has authored several publications on IoT and sensor networks.

Paul is an open source contributor and active blogger. He is also an AWS Certified Solutions Architect and Developer with a master's degree in distributed computing from the University of Melbourne.

He lives in Melbourne, Australia with his wife, Cindy, and son, Leon. You can visit his website at `http://dengpeng.de/` to see what he is currently exploring and to learn more about him.

Paul Massey has worked in computer programming for over 20 years, 11 years of which have been as a CEO of Scriptwerx (`http://ghost.scriptwerx.io/`). He is an expert in JavaScript and mobile technologies, as well as working with the Arduino platform (and similar platforms). He has worked on this platform for a number of years, creating hardware and software projects for Internet of Things, audio-visual, and automotive technologies.

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Preface

Arduino is a small single-chip computer board that can be used for a wide variety of creative hardware projects. The hardware consists of a simple microcontroller, board, and chipset. It comes with a Java-based IDE that allows creators to program the board. Arduino is the ideal open hardware platform to experiment with the world of Internet of Things. The credit card-sized Arduino board can be used via the Internet to make useful and interactive Internet of Things (IoT) projects.

Internet of Things with Arduino Blueprints is a project-based book that begins with projects based on IoT and cloud computing concepts. This book covers up to eight projects that will allow devices to communicate with each other, access information over the Internet, store and retrieve data, and interact with users—creating smart, pervasive, and always connected environments. It explains how wired and wireless Internet connections can be used with projects and explains the use of various sensors and actuators. The main aim of this book is to teach you how Arduino can be used for Internet-related projects so that users are able to control actuators, gather data from various kinds of sensors, and send and receive data wirelessly across HTTP and TCP protocols.

Finally, you can use these projects as blueprints for many other IoT projects and put them to good use. By the end of the book, you will be an expert in the use of IoT with Arduino to develop a set of projects that can relate very well to IoT applications in the real world.

What this book covers

Chapter 1, *Internet-Controlled PowerSwitch*, briefly introduces Arduino UNO and Arduino Ethernet shield basics while focusing on building an Internet-controlled PowerSwitch using Arduino UNO, the Arduino Ethernet shield, and PowerSwitch Tail to turn electrical appliances on/off through the Internet via a web-based user interface. Also, you will learn how to increase the complexity of PowerSwitch by adding a circuit to track the mains electricity.

Chapter 2, *Wi-Fi Signal Strength Reader and Haptic Feedback*, briefly introduces Arduino Wi-Fi shield basics, vibration motors, and haptic feedback. You will learn how to make advanced vibration patterns using vibration motors with a haptic motor controller and the Adafruit haptic library according to the Wi-Fi signal strength received by the Arduino Wi-Fi shield.

Chapter 3, *Internet-Connected Smart Water Meter*, focuses on building a flow sensor-based water meter in conjunction with the Arduino Ethernet shield to measure water flow rate and volume, and then display them on an LCD screen. In addition, you will learn how to convert this water meter to a web server and request readings through the Internet of Ethernet.

Chapter 4, *Arduino Security Camera with Motion Detection*, explains how to incrementally develop a Arduino Ethernet shield-based security camera with the Adafruit TTL Serial JPEG camera and the VC0706 camera library. In addition, you will learn how to add motion detection functionality and upload the captured images to Flickr.

Chapter 5, *Solar Panel Voltage Logging with NearBus Cloud Connector and Xively*, briefly introduces the NearBus cloud connector and Xively, while focusing on building a solar panel voltage logger with the Arduino Ethernet shield with a few electronic components. Also, you will learn how to log the output voltage of a solar panel in combination with NearBus and Xively, and then display real-time data that can be viewed through a web browser.

Chapter 6, *GPS Location Tracker with Temboo, Twilio, and Google Maps,* briefly introduces the GPS shield and how to use the TinyGPSPlus library and the Google JavaScript API library to build a real-time location tracker to display the current location of the GPS shield on Google Maps. You will also learn the basics of Temboo and Twilio cloud services.

Chapter 7, *Tweet-a-Light – Twitter-Enabled Electric Light*, introduces Python, a more powerful programming language that can be used to read Twitter tweets and write data to a computer's serial port accordingly. Finally, you will learn to build an electric light switch that can be controlled using Twitter tweets to turn the switch on and off.

Chapter 8, *Controlling Infrared Devices Using IR Remote*, focuses on building an infrared remote control with the Arduino Ethernet shield and a few electronic components that can be controlled through the Ethernet or Internet to control IR-enabled devices remotely. You will learn how to record and reproduce IR commands using the Arduino IR remote library. In addition, you will learn how to add IR functionality to non-IR enabled devices.

What you need for this book

This book has been written and tested on the Windows environment and uses various software components with Arduino. It would be great if you could prepare your development environment before proceeding with the sample code provided along with each chapter. The following list briefly gives you the details about the software requirements that you should have to set up your PC for each chapter:

- The Arduino software: This is the main development environment that you will use to write, verify, and run your sketches in every chapter of this book. The latest Arduino installer for Windows can be downloaded from `https://www.arduino.cc/en/Main/Software`. Throughout this book, we will write and test Arduino sketches in the Windows environment.
- A web browser: Normally, every PC has a default web browser, such as Microsoft Internet Explorer (or Microsoft Edge in Windows 10), Google Chrome, or Mozilla Firefox.
- The Adafruit DRV2605 library: You need this library to control vibrators (that is, vibration motors) with the Adafruit DRV2605 haptic controller in *Chapter 2*, *Wi-Fi Signal Strength Reader and Haptic Feedback*. You can download this library from `https://github.com/adafruit/Adafruit_DRV2605_Library`.
- The Adafruit VC0706 camera library: You will need this library to interface the Adafruit VC0706 Serial JPEG camera with Arduino in *Chapter 4*, *Arduino Security Camera with Motion Detection*. You can download this library from `https://github.com/adafruit/Adafruit-VC0706-Serial-Camera-Library`.
- NearBus Agent (An Arduino library for Ethernet): You will need this library to connect the Arduino Ethernet shield with the NearBus cloud connector for Arduino memory mapping with NearBus in *Chapter 5*, *Solar Panel Voltage Logging with NearBus Cloud Connector and Xively*. You can download this library from `http://www.nearbus.net/downloads/NearBusEther_v16.zip`.
- FlexiTimer2: This will make sure that Arduino correctly functions with the NearBus Agent library in *Chapter 5*, *Solar Panel Voltage Logging with NearBus Cloud Connector and Xively*. You can download it from `http://github.com/wimleers/flexitimer2/zipball/v1.1`.
- The TinyGPSPlus library: This will be required to work with the SparkFun GPS shield in *Chapter 6*, *GPS Location Tracker with Temboo, Twilio, and Google Maps* and can be downloaded from `https://github.com/mikalhart/TinyGPSPlus/archive/master.zip`.

- Python: You can download Python from `https://www.python.org/`, and the instructions about the download and installation can be found in *Chapter 7, Tweet-a-Light – Twitter-Enabled Electric Light*.
- The Arduino IR remote library: You will need this library to send and receive and extract IR commands in *Chapter 8, Controlling Infrared Devices Using IR Remote*. You can download it from `https://github.com/z3t0/Arduino-IRremote`.

Who this book is for

This book is intended for those who want to learn more about Arduino and make Internet-based interactive projects with Arduino. If you are an experienced software developer who understands the basics of electronics, then you can quickly learn how to build the Arduino projects explained in this book.

Conventions

In this book, you will find a number of text styles that distinguish between different kinds of information. Here are some examples of these styles and an explanation of their meaning.

Code words in text, database table names, folder names, filenames, file extensions, pathnames, dummy URLs, user input, and Twitter handles are shown as follows: "Copy the following `index.html` file from the code folder of `Chapter 5` to your computer's hard drive."

A block of code is set as follows:

```
// Set the picture size - you can choose one of 640x480, 320x240 or
160x120
 // Remember that bigger pictures take longer to transmit!
 cam.setImageSize(VC0706_640x480);  // biggest
 //cam.setImageSize(VC0706_320x240);  // medium
 //cam.setImageSize(VC0706_160x120);   // small
```

When we wish to draw your attention to a particular part of a code block, the relevant lines or items are set in bold:

```
int32_t WiFiDrv::getCurrentRSSI()
{
  startScanNetworks();
  WAIT_FOR_SLAVE_SELECT();
  // Send Command
  SpiDrv::sendCmd(GET_CURR_RSSI_CMD, PARAM_NUMS_1);
```

Any command-line input or output is written as follows:

```
>python your_python_script.py
```

New terms and **important words** are shown in bold. Words that you see on the screen, for example, in menus or dialog boxes, appear in the text like this: "Click on the **Create an App** link if it is not selected by default."

> Warnings or important notes appear in a box like this.

> Tips and tricks appear like this.

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1
Internet-Controlled PowerSwitch

For many years, people physically interacted with electrical appliances using hardware switches. Now that things have changed, thanks to the advances in technology and hardware, controlling a switch over the Internet without any form of physical interaction has become possible.

In this chapter, we will incrementally build a web server-enabled smart power switch that can be controlled through the Internet with a wired Internet connection. Let's move to Arduino's **IoT** (**Internet of Things**).

In this chapter, you will do the following:

- Learn about Arduino UNO and Arduino Ethernet Shield basics
- Learn how to connect a PowerSwitch Tail with Arduino UNO
- Build a simple web server to handle client requests and control the PowerSwitch accordingly
- Build a simple mains electricity (general purpose alternating current) sensor with 5V DC wall power supply
- Develop a user friendly **UI** (**User Interface**) with **HTML** (**Hyper Text Markup Language**) and Metro UI **CSS** (**Cascade Style Sheet**)

Getting started

This project consists of a **DC** (**Direct Current**) activated relay switch with an embedded web server that can be controlled and monitored through the Internet and the integrated mains electricity sensor that can be used to get the status of the availability of mains electricity. The possible applications are:

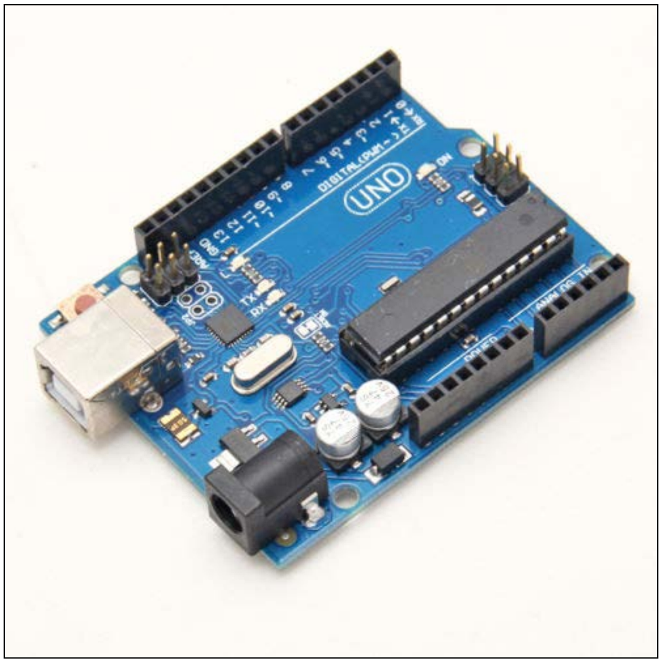
- Controlling electrical devices such as lamp posts, water pumps, gates, doors, and so on, in remote locations
- Sensing the availability of mains electricity in houses, offices, and factories remotely
- Detecting whether a door, window, or gate is open or shut

Hardware and software requirements

All the hardware and software requirements are mentioned within each experiment. Most of the hardware used in this project are open source, which allows you to freely learn and hack them to make more creative projects based on the blueprints of this chapter.

Arduino Ethernet Shield

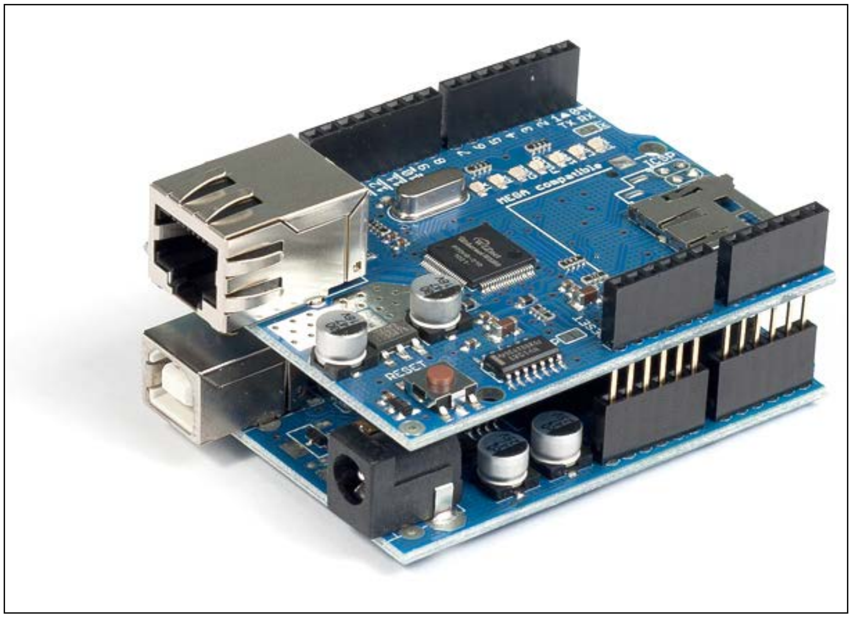
Arduino Ethernet Shield is used to connect your Arduino UNO board to the Internet. It is an open source piece of hardware and is exactly the same size as the Arduino UNO board. The latest version of the Arduino Ethernet Shield is **R3** (**Revision 3**). The official Arduino Ethernet Shield is currently manufactured in Italy and can be ordered through the official Arduino website (`https://store.arduino.cc`). Also, there are many Arduino Ethernet Shield clones manufactured around the world that may be cheaper than the official Arduino Ethernet Shield. This project is fully tested with a clone of Arduino Ethernet Shield manufactured in China.



Arduino UNO R3 (Front View)

Arduino Ethernet Shield R3 (Front View)

Plug your Arduino Ethernet Shield into your Arduino UNO board using wire wrap headers so that it's exactly intact with the pin layout of the Arduino UNO board. The following image shows a stacked Arduino UNO and Arduino Ethernet Shield together:



Arduino Ethernet Shield R3 (top) is stacked with Arduino UNO R3 (bottom) (Front View)

Arduino Ethernet Shield consists of an Ethernet controller chip—WIZnet W5100—the only proprietary hardware used with the shield. The WIZnet W5100 includes a fully hardwired TCP/IP stack, integrated Ethernet **MAC** (**Media Access Control**), and **PHY** (**Physical Layer**).

The hardwired TCP/IP stack supports the following protocols:

- **TCP** (**Transport Control Protocol**)
- **UDP** (**User Datagram Protocol**)
- **IPv4** (**Internet Protocol Version 4**)
- **ICMP** (**Internet Control Message Protocol**)
- **ARP** (**Address Resolution Protocol**)
- **IGMP** (**Internet Group Management Protocol**)
- **PPPoE** (**Point-to-Point Protocol over Ethernet**)

The WIZnet W5100 Ethernet controller chip also simplifies the Internet connectivity without using an operating system.

The WIZnet W5100 Ethernet controller (Top View)

Throughout this chapter, we will only work with TCP and IPv4 protocols.

The Arduino UNO board communicates with the Arduino Ethernet Shield using digital pins 10, 11, 12, and 13. Therefore, we will not use these pins in our projects to make any external connections. Also, digital pin 4 is used to select the SD card that is installed on the Arduino Ethernet Shield, and digital pin 10 is used to select the Ethernet controller chip. This is called **SS** (**Slave Select**) because the Arduino Ethernet Shield is acting as the slave and the Arduino UNO board is acting as the master.

However, if you want to disable the SD card and use digital pin 4, or disable the Ethernet controller chip and use digital pin 10 with your projects, use the following code snippets inside the `setup()` function:

1. To disable the SD card:

   ```
   pinMode(4,OUTPUT);
   digitalWrite(4, HIGH);
   ```

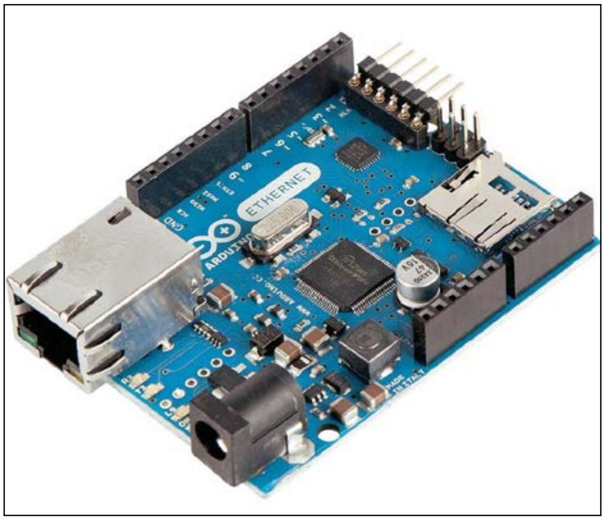
2. To disable the Ethernet Controller chip:

   ```
   pinMode(10,OUTPUT);
   digitalWrite(10, HIGH);
   ```

The Arduino Ethernet board

The Arduino Ethernet board is a new version of the Arduino development board with the WIZnet Ethernet controller built into the same board. The USB to serial driver is removed from the board to keep the board size the same as Arduino UNO and so that it can be stacked with any Arduino UNO compatible shields on it.

You need an FTDI cable compatible with 5V to connect and program your Arduino Ethernet board with a computer.



The Arduino Ethernet board (Front View)

FTDI cable 5V (Source: `https://commons.wikimedia.org/wiki/File:FTDI_Cable.jpg`)

You can visit the following links to get more information about the Arduino Ethernet board and FTDI cable:

- The Arduino Ethernet board (`https://store.arduino.cc/product/A000068`)
- FTDI cable (`https://www.sparkfun.com/products/9717`)

You can build all the projects that are explained within this chapter and other chapters throughout the book with the Arduino Ethernet board using the same pin layout.

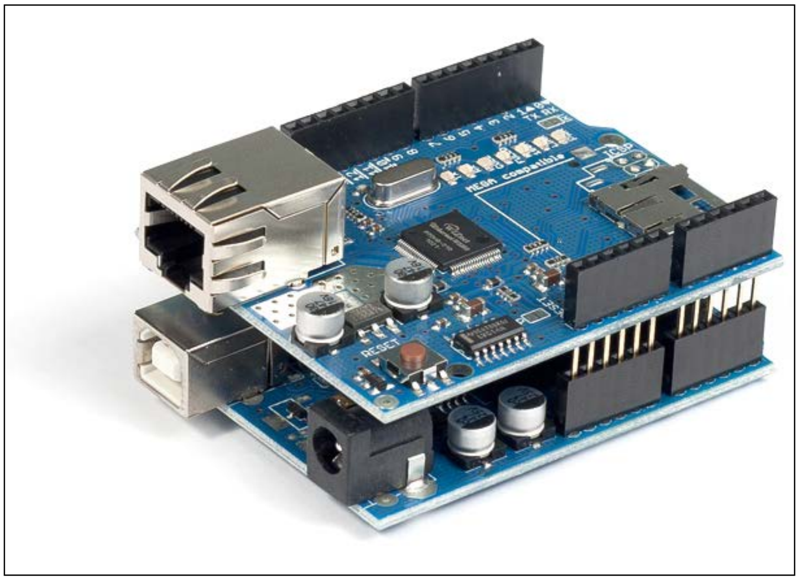
Connecting Arduino Ethernet Shield to the Internet

To connect your Ethernet shield to the Internet, you require the following hardware:

- An Arduino UNO R3 board (`https://store.arduino.cc/product/A000066`)
- A 9VDC 650mA wall adapter power supply. The barrel connector of the power supply should be center positive 5.5 x 2.1 mm. (Here is the link for a perfect fit: `https://www.sparkfun.com/products/298`)
- A USB A-to-B male/male-type cable. These types of cables are usually used for printers (`https://www.sparkfun.com/products/512`)
- A Category 6 Ethernet cable (`https://www.sparkfun.com/products/8915`)
- A router or switch with an Internet connection

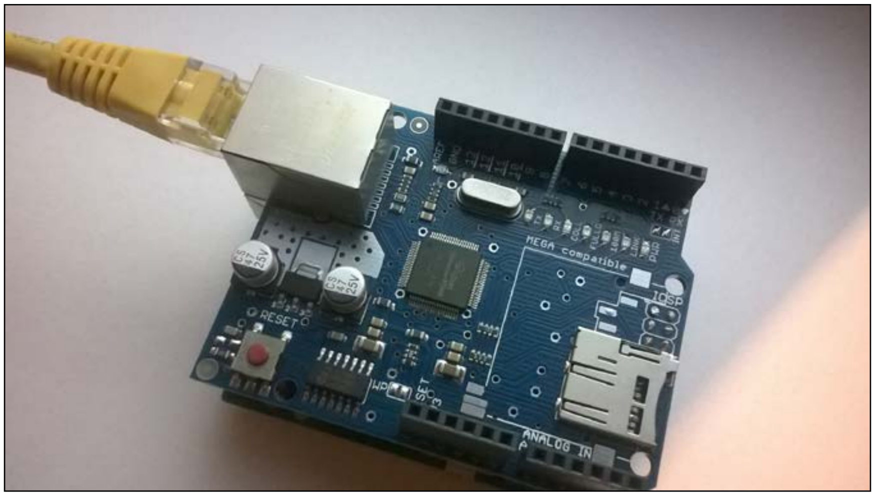
Use the following steps to make connections between each hardware component:

1. Plug your Ethernet shield into your Arduino board using soldered wire wrap headers:



Fritzing representation of Arduino and Ethernet shield stack

2. Get the Ethernet cable and connect one end to the Ethernet jack of the Arduino Ethernet Shield.

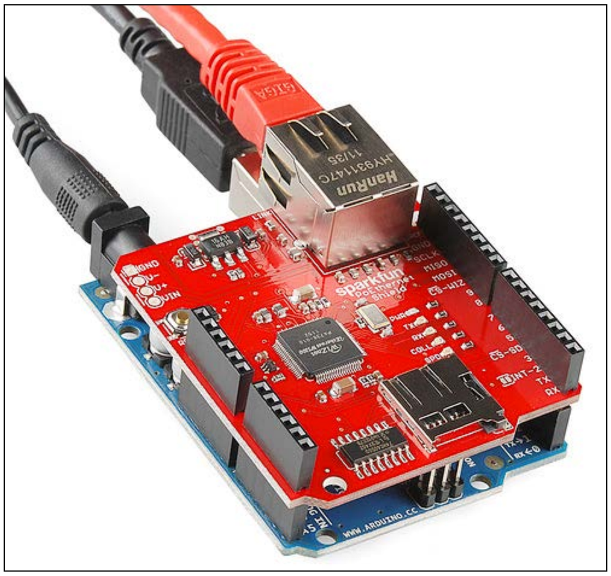


One end of the Ethernet cable is connected to the Arduino Ethernet board

3. Connect the other end of the Ethernet cable to the Ethernet jack of the network router or switch.

The other end of the Ethernet cable is connected to the router/switch

4. Connect the 9VDC wall adapter power supply to the DC barrel connector of the Arduino board.
5. Use the USB A-to-B cable to connect your Arduino board to the computer. Connect the type A plug end to the computer and the type B plug end to the Arduino board.

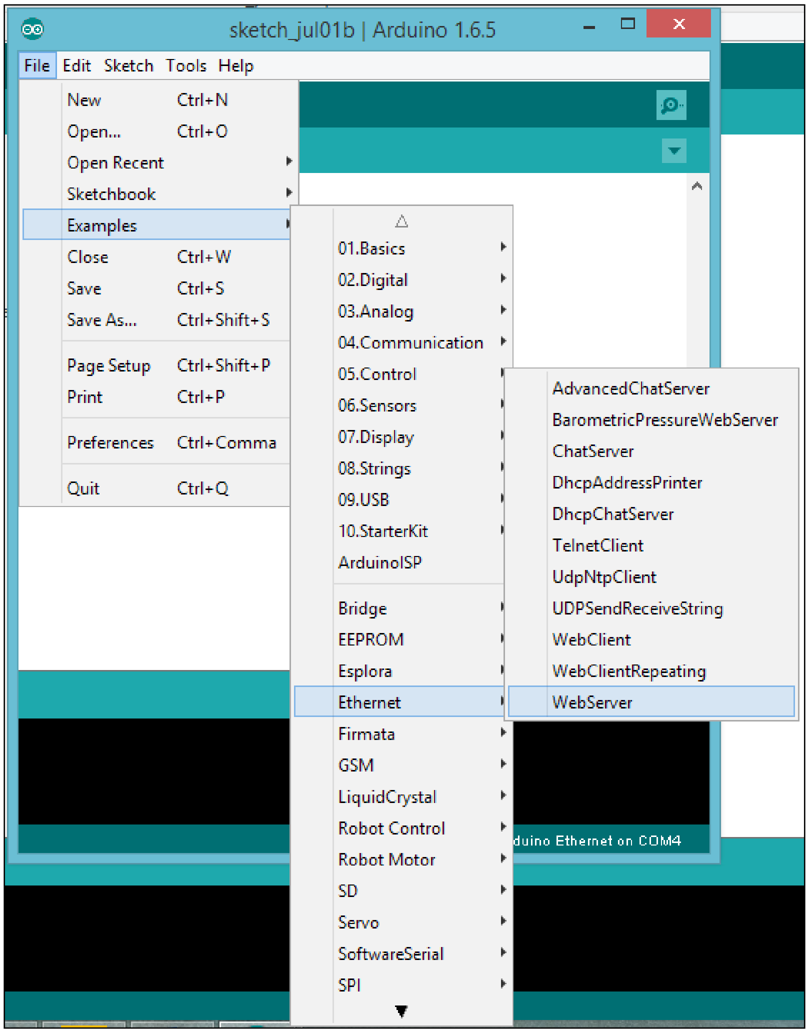


One end of the Ethernet cable is connected to the Ethernet shield (top) and the power connector and USB cable are connected to the Arduino board (bottom) Image courtesy of SparkFun Electronics (`https://www.sparkfun.com`)

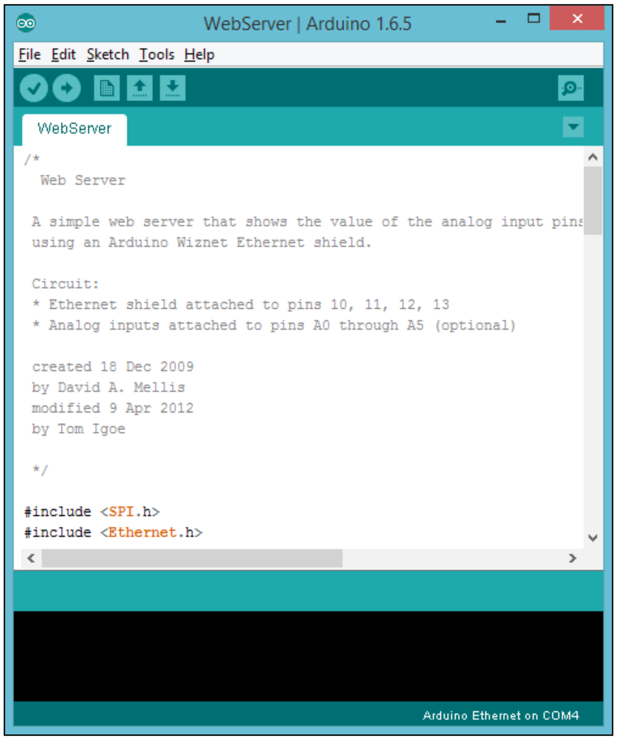
Testing your Arduino Ethernet Shield

To test you Arduino Ethernet Shield, follow these steps:

1. Open your Arduino IDE and navigate to **File** | **Examples** | **Ethernet** | **WebServer**:



2. The sample sketch **WebServer** will open in a new Arduino IDE:



```
/*
  Web Server

 A simple web server that shows the value of the analog input pins
 using an Arduino Wiznet Ethernet shield.

 Circuit:
 * Ethernet shield attached to pins 10, 11, 12, 13
 * Analog inputs attached to pins A0 through A5 (optional)

 created 18 Dec 2009
 by David A. Mellis
 modified 9 Apr 2012
 by Tom Igoe

 */

#include <SPI.h>
#include <Ethernet.h>
```

3. You can also paste the code from the sketch named `B04844_01_01.ino` from the code folder of this chapter. The following header files should be included for serial communication and Ethernet communication in the beginning of the sketch:

```
#include <SPI.h> //initiates Serial Peripheral Interface
#include <Ethernet.h> //initiates Arduino Ethernet library
```

4. Replace the MAC address with your Ethernet shield's MAC address if you know it. You can find the printed sticker of the MAC address affixed to the back of your Ethernet shield. (Some clones of Arduino Ethernet Shield don't ship with a MAC address affixed on them). If you don't know the MAC address of your Arduino Ethernet Shield, use the one mentioned in the sample code or replace it with a random one. But don't use network devices with the same MAC address on your network; it will cause conflicts and your Ethernet shield will not function correctly. (Read *Finding the MAC address and obtaining a valid IP address* for more information on MAC addresses).

```
byte mac[] = {0xDE, 0xAD, 0xBE, 0xEF, 0xFE, 0xED};
```

5. Replace the IP address with a static IP in your local network IP range. (Read the *Finding the MAC address and obtaining a valid IP address* section for selecting a valid IP address).

   ```
   IPAddress ip(192, 168, 1, 177);
   ```

6. Then, create an instance of the Arduino Ethernet Server library and assign port number 80 to listen to incoming HTTP requests.

   ```
   EthernetServer server(80);
   ```

7. Inside the `setup()` function, open the serial communications and wait for the port to open. The computer will communicate with Arduino at a speed of 9600 bps.

   ```
   Serial.begin(9600);
   ```

8. The following code block will start the Ethernet connection by using the MAC address and IP address (we have assigned a static IP address) of the Arduino Ethernet Shield and start the server. Then it will print the IP address of the server on Arduino Serial Monitor using `Ethernet.localIP()`:

   ```
   Ethernet.begin(mac, ip);
   server.begin();
   Serial.print("server is at ");
   Serial.println(Ethernet.localIP());
   ```

9. Inside the `loop()` function, the server will listen for incoming clients.

   ```
   EthernetClient client = server.available();
   ```

10. If a client is available, the server will connect with the client and read the incoming HTTP request. Then, reply to the client by the standard HTTP response header. The output can be added to the response header using the `EthernetClient` class's `println()` method:

    ```
      if (client) {
        Serial.println("new client");
        // an http request ends with a blank line
        boolean currentLineIsBlank = true;
        while (client.connected()) {
          if (client.available()) {
            char c = client.read();
            Serial.write(c);
            // if you've gotten to the end of the line
            (received a newline
            // character) and the line is blank, the http
            request has ended,
            // so you can send a reply
            if (c == '\n' && currentLineIsBlank) {
    ```

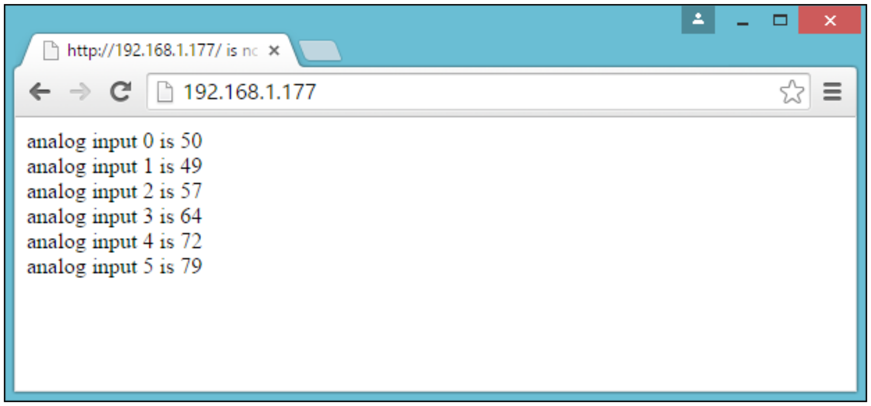
```
     // send a standard http response header
     client.println("HTTP/1.1 200 OK");
     client.println("Content-Type: text/html");
     client.println("Connection: close");  // the
     connection will be closed after completion of the
     response
     client.println("Refresh: 5");  // refresh the
     page automatically every 5 sec
     client.println();
     client.println("<!DOCTYPE HTML>");
     client.println("<html>");
     // output the value of each analog input pin
     for (int analogChannel = 0; analogChannel < 6;
     analogChannel++) {
       int sensorReading = analogRead(analogChannel);
       client.print("analog input ");
       client.print(analogChannel);
       client.print(" is ");
       client.print(sensorReading);
       client.println("<br />");
     }
     client.println("</html>");
     break;
    }
    if (c == '\n') {
     // you're starting a new line
     currentLineIsBlank = true;
    }
    else if (c != '\r') {
     // you've gotten a character on the current line
     currentLineIsBlank = false;
    }
   }
  }
  // give the web browser time to receive the data
  delay(1);
```

11. Finally, close the connection from the client using the `EthernetClient` class's `stop()` method:

```
client.stop();
Serial.println("client disconnected");
```

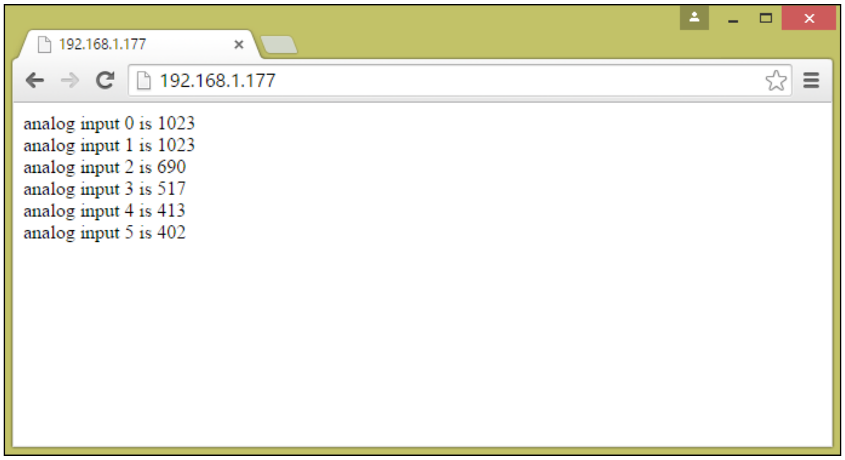
12. Verify the sketch by clicking on the **Verify** button located in the toolbar.
13. On the menu bar, select the board by navigating to **Tools** | **Board** | **Arduino UNO**. If you are using an Arduino Ethernet board, select **Tools** | **Board** | **Arduino Ethernet**.
14. On the menu bar, select the **COM** port by navigating to **Tools** | **Port** and then selecting the port number.
15. Upload the sketch into your Arduino UNO board by clicking on the **Upload** button located in the toolbar.
16. Open your Internet browser (such as Google Chrome, Mozilla Firefox, or Microsoft Internet Explorer) and type the IP address (`http://192.168.1.177/`) assigned to your Arduino Ethernet Shield in the sketch (in Step 4), and hit the *Enter* key.
17. The web browser will display analog input values (impedance) of all the six analog input pins (A0-A5). The browser will refresh every 5 seconds with the new values. Use following code to change the automatic refresh time in seconds:

```
client.println("Refresh: 5");
```



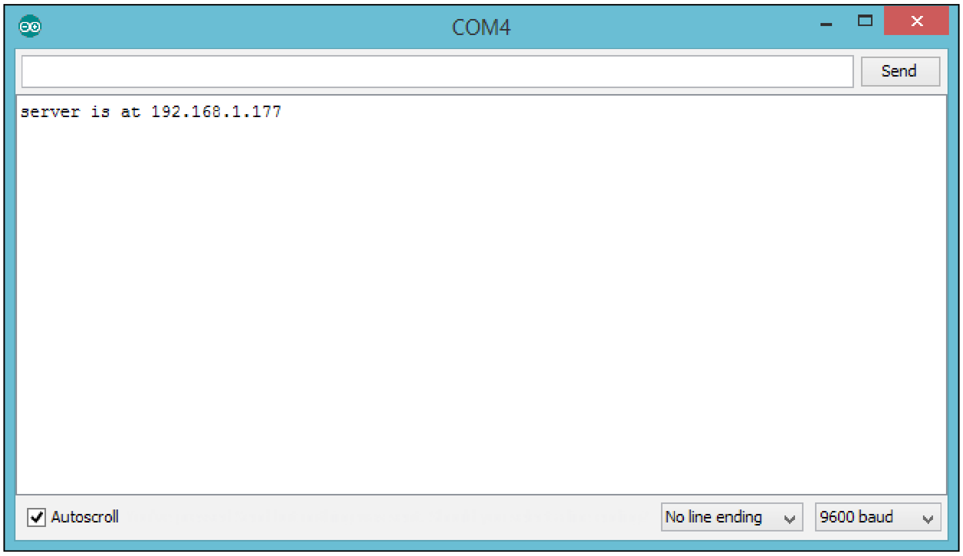
```
analog input 0 is 50
analog input 1 is 49
analog input 2 is 57
analog input 3 is 64
analog input 4 is 72
analog input 5 is 79
```

Output for Arduino Ethernet board: Analog input values are displaying on the Google Chrome browser, refreshing every 5 seconds



```
analog input 0 is 1023
analog input 1 is 1023
analog input 2 is 690
analog input 3 is 517
analog input 4 is 413
analog input 5 is 402
```

Output for Arduino UNO + Arduino Ethernet Shield: Analog input values are displaying on the Google Chrome browser, refreshing every 5 seconds



```
server is at 192.168.1.177
```

Arduino Serial Monitor prints the static IP address of Arduino Ethernet Shield

18. To make your sketch more stable and to ensure that it does not hang, you can do one of the following:

    - Remove the SD card from the slot.
    - Add the following two lines inside your `setup()` function:

      ```
      pinMode(4,OUTPUT);
      digitalWrite(4, HIGH);
      ```

Now you can be assured that your Arduino Ethernet Shield is working properly and can be accessed through the Internet.

Selecting a PowerSwitch Tail

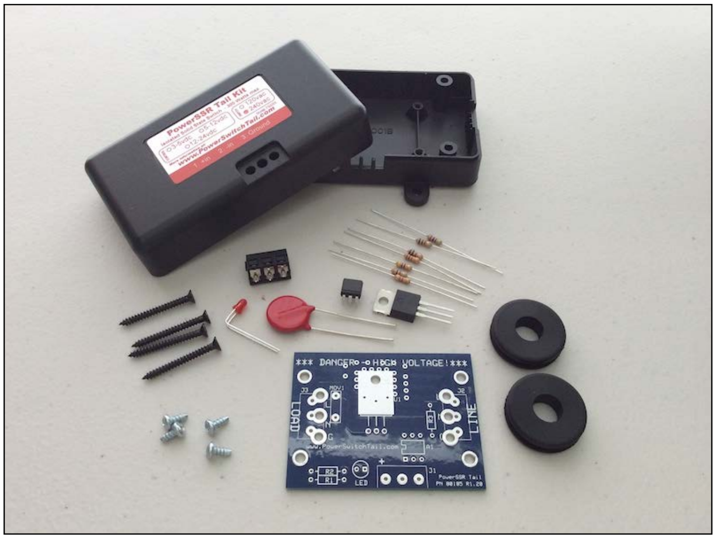
PowerSwitch Tail has a built-in AC relay that is activated between 3-12 VDC. This is designed to easily integrate with many microcontroller platforms, such as Arduino, Raspberry Pi, BeagleBone, and so on. Usually, Arduino digital output provides 5VDC that allows it to activate the **AC** (**Alternative Current**) relay inside the PowerSwitch Tail. Using a PowerSwitch Tail with your microcontroller projects provides safety since it distinguishes between AC and DC circuitry by using an optocoupler which is an optically activated switch.

PowerSwitch Tail ships in several variants. At the time of writing this book, the product website lists various PowerSwitch Tails, assembled and in kit form, that can be used with this project.

To build this project, we will use a 240V AC PowerSwitch Tail that can be purchased as a kit and assembled.

PN PSSRKT-240

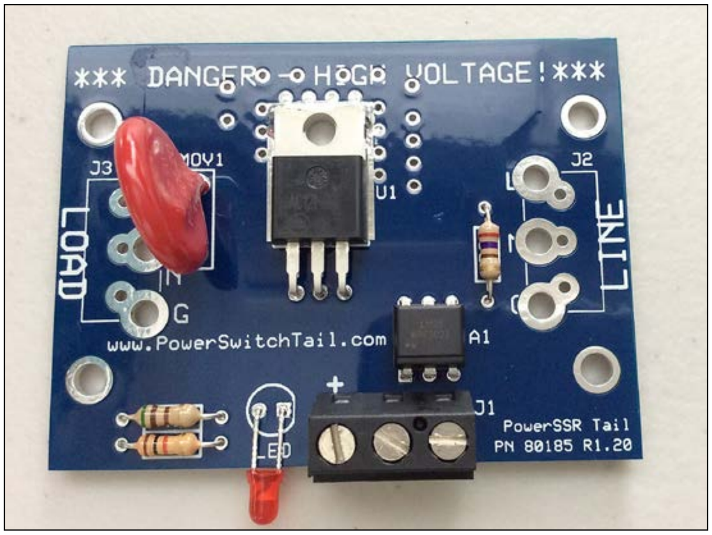
Refer to `http://www.powerswitchtail.com/Pages/PowerSwitchTail240vackit.aspx`.



PN PSSRKT-240 Normally Open (NO) version—240V AC Image courtesy of PowerSwitchTail.com, LLC (`http://www.powerswitchtail.com`)

Here, we will not cover the assembly instructions about the PN PSSRKT-240 kit. However, you can find the assembly instructions at `http://www.powerswitchtail.com/Documents/PSSRTK%20Instructions.pdf`.

The following image shows an assembled PN PSSRKT-240 kit:



PN PSSRKT-240 Normally Open (NO) version—240V Image courtesy of PowerSwitchTail.com, LLC (`http://www.powerswitchtail.com`)

PN PSSRKT-240 Normally Open (NO) version—240V Image courtesy of PowerSwitchTail.com, LLC (`http://www.powerswitchtail.com`)

If you are in a country that has a 120V AC connection, you can purchase an assembled version of the PowerSwitch Tail.

PN80135

Refer to `http://www.powerswitchtail.com/Pages/default.aspx`.

PN80135 Normally Open (NO) version—120V AC (left-hand side plug for LOAD and right-hand side plug for LINE) Image courtesy of SparkFun Electronics (`https://www.sparkfun.com`)

Wiring PowerSwitch Tail with Arduino Ethernet Shield

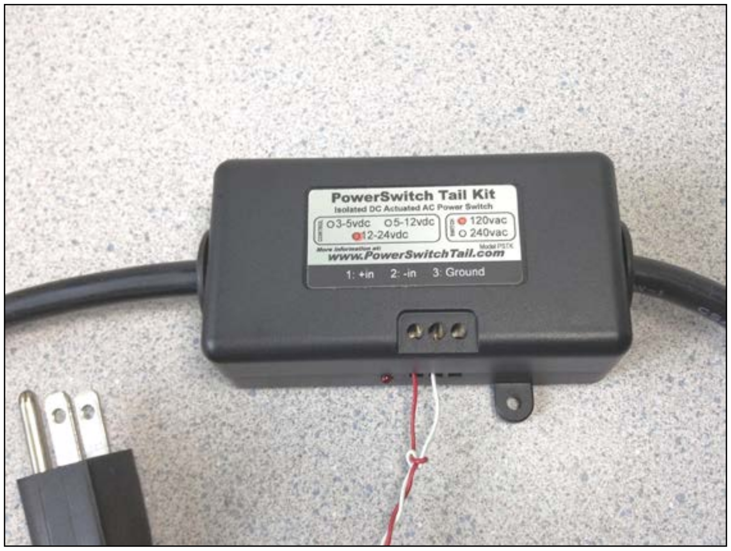
Wiring the PowerSwitch Tail with Arduino is very easy. Use any size of wire range between gauge #14-30 AWG to make the connection between Arduino and PowerSwitch Tail.

PowerSwitch Tail has a terminal block with three terminals. Use a small flat screwdriver and turn the screws **CCW** (**Counter Clock Wise**) to open the terminal contacts.

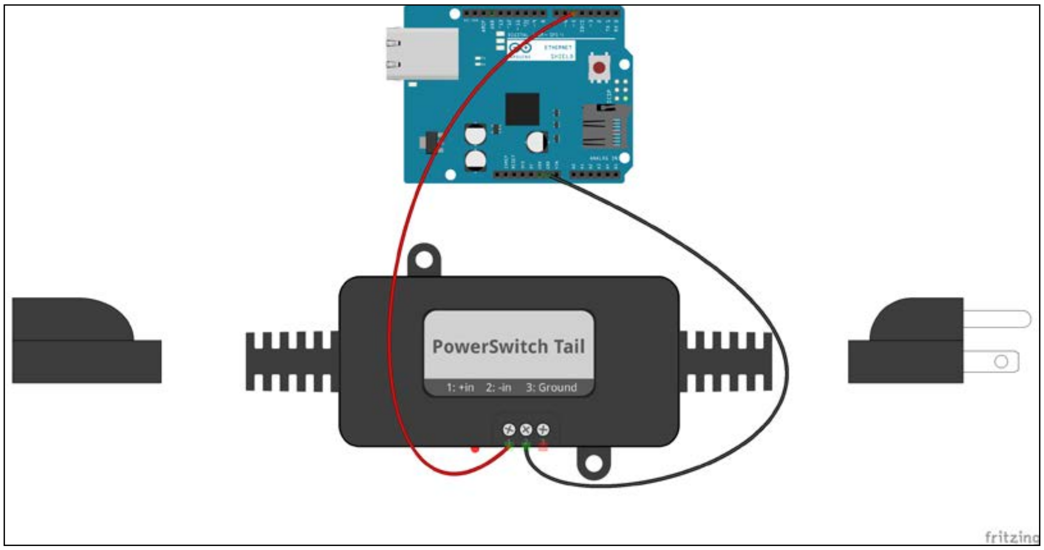
With the Arduino Ethernet Shield mounted on the Arduino UNO board, do the following:

1. Use the red hookup wire to connect the positive terminal of the PowerSwitch Tail to digital pin 5 on your Arduino.
2. Use the black hookup wire to connect the negative terminal of the PowerSwitch Tail to the GND pin on your Arduino.

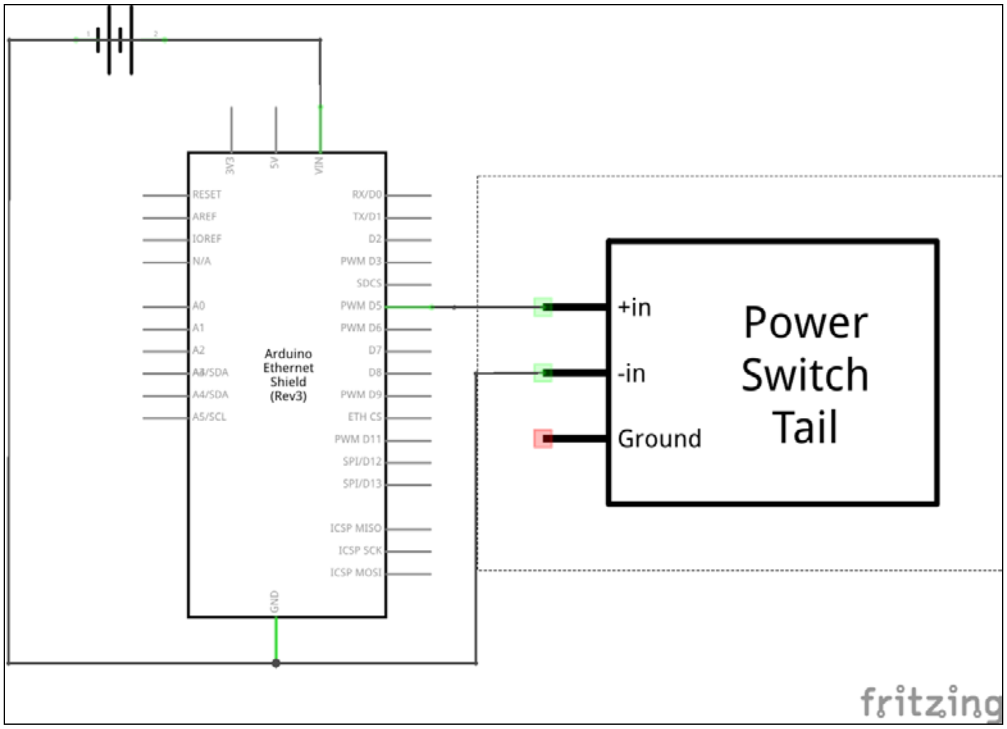
3. Connect the wall adapter power supply (9V DC 650mA) to the DC power jack on your Arduino board. The ground terminal is connected internally to the AC-side electrical safety ground (the green conductor) and can be used if needed.



Two wires from Arduino connected to the PowerSwitch Tail Image courtesy of PowerSwitchTail.com, LLC (`http://www.powerswitchtail.com`)



PowerSwitch Tail connected to the Ethernet Shield—Fritzing representation



PowerSwitch Tail connected to the Ethernet Shield—Schematic

Turning PowerSwitch Tail into a simple web server

In this topic, we will look into how to convert our Arduino connected PowerSwitch Tail into a simple web server to handle client requests, such as the following:

- Turn ON the PowerSwitch Tail
- Turn OFF the PowerSwitch Tail

And other useful information such as:

- Display the current status of the PowerSwitch Tail
- Display the presence or absence of the main electrical power

What is a web server?

A web server is a piece of software which serves to connected clients. An Arduino web server uses HTTP on top of TCP and UDP. But remember, the Arduino web server can't be used as a replacement for any web server software running on a computer because of the lack of processing power and limited number of multiple client connectivity.

A step-by-step process for building a web-based control panel

In this section ,you will learn how to build a web-based control panel for controlling the PowerSwitch Tail through the Internet.

We will use the Arduino programming language and HTML that's running on the Arduino web server. Later, we will add HTML radio button controls to control the power switch.

Handling client requests by HTTP GET

Using the HTTP GET method, you can send a query string to the server along with the URL.

The query string consists of a name/value pair. The query string is appended to the end of the URL and the syntax is `http://example.com?name1=value1`.

Also, you can add more name/value pairs to the URL by separating them with the `&` character, as shown in the following example:

`http://example.com?name1=value1&name2=value2`.

So, our Arduino web server can actuate the PowerSwitch Tail using the following URLs:

- To turn ON the PowerSwitch Tail: `http://192.168.1.177/?switch=1`
- To turn OFF the PowerSwitch Tail: `http://192.168.1.177/?switch=0`

The following sketch can be used by the web server to read the incoming client requests, process them, and actuate the relay inside the PowerSwitch Tail:

1. Open your Arduino IDE and type or paste the code from the `B04844_01_02.ino` sketch.
2. In the sketch, replace the MAC address with your Arduino Ethernet Shield's MAC address:

   ```
   byte mac[] = { 0x90, 0xA2, 0xDA, 0x0B, 0x00 and 0xDD };
   ```

3. Replace the IP address with an IP valid static IP address in the range of your local network:

   ```
   IPAddress ip(192,168,1,177);
   ```

4. If you want the IP address dynamically assigned by the DHCP to the Arduino Ethernet Shield, do the following:
   1. Comment the following line in the code:

      ```
      //IPAddress ip(192,168,1,177);
      ```

   2. Comment the following line in the code:

      ```
      //Ethernet.begin(mac, ip);
      ```

   3. Uncomment the following line in the code:

      ```
      Ethernet.begin(mac);
      ```

5. The following two lines will read the incoming HTTP request from the client using the `EthernetClient` class's `read()` method and store it in a string variable `http_Request`:

   ```
   char c = client.read();
   http_Request += c;
   ```

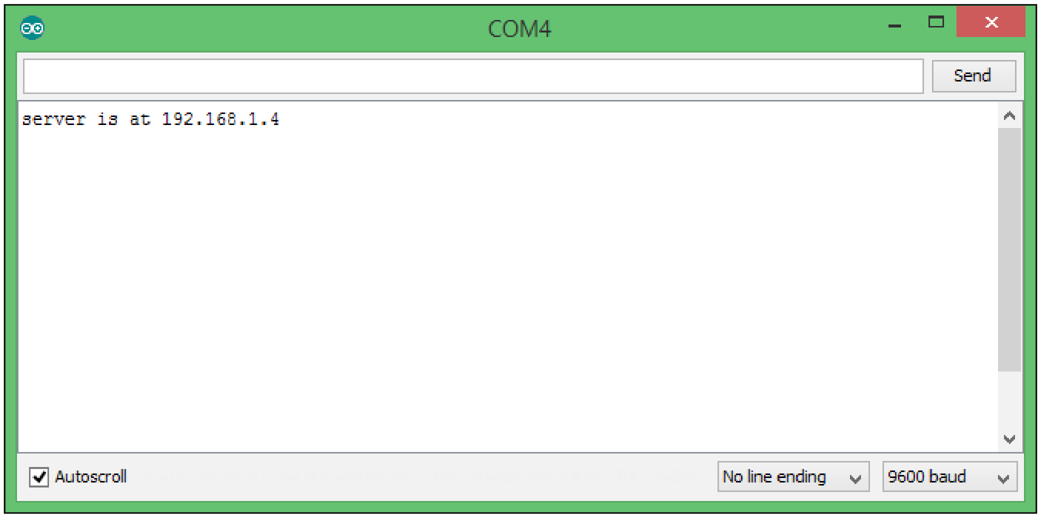
6. The following code snippet will check whether the HTTP request string contains the query string that is sent to the URL. If found, it will turn on or off the PowerSwitch Tail according to the name/value pair logically checked inside the sketch.

   The `indexOf()` function can be used to search for the string within another string. If it finds the string `switch=1` inside the HTTP request string, the Arduino board will turn digital pin 5 to the HIGH state and turn on the PowerSwitch Tail. If it finds the text `switch=0`, the Arduino board will turn the digital pin 5 to the LOW state and turn off the PowerSwitch Tail.

   ```
   if (httpRequest.indexOf("GET /?switch=0 HTTP/1.1") > -1) {
               relayStatus = 0;
               digitalWrite(5, LOW);
   ```

```
          Serial.println("Switch is Off");
        } else if (httpRequest.indexOf("GET /?switch=1
        HTTP/1.1") > -1) {
          relayStatus = 1;
          digitalWrite(5, HIGH);
          Serial.println("Switch is On");
        }
```

7. Select the correct Arduino board and COM port from the menu bar.
8. Verify and upload the sketch into your Arduino UNO board (or the Arduino Ethernet board).
9. If you have to choose DHCP to assign an IP address to your Arduino Ethernet Shield, it will be displayed on the Arduino Serial Monitor. On the menu bar, go to **Tools** | **Serial Monitor**. The Arduino Serial Monitor window will be displayed with the IP address assigned by the DHCP.

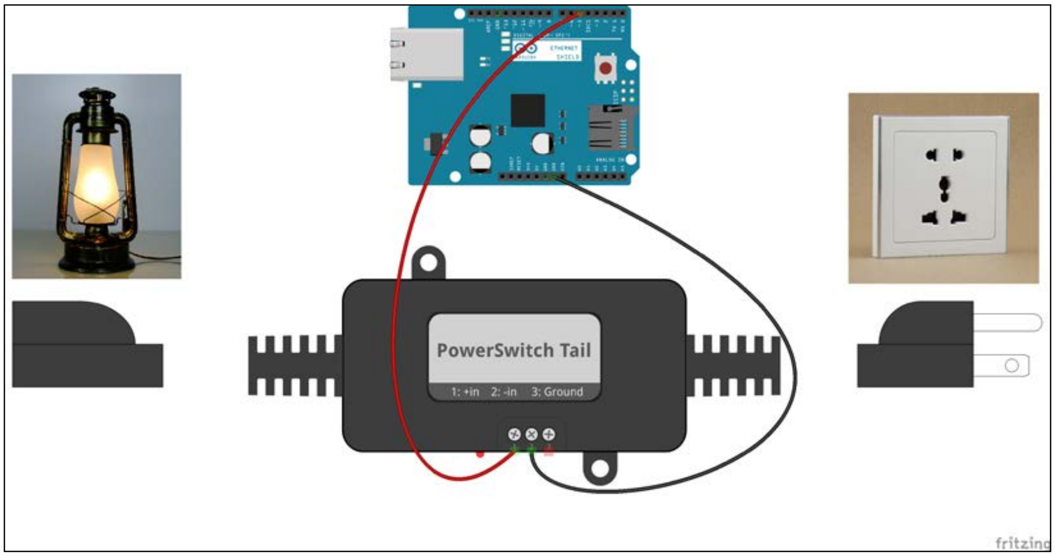


```
server is at 192.168.1.4
```

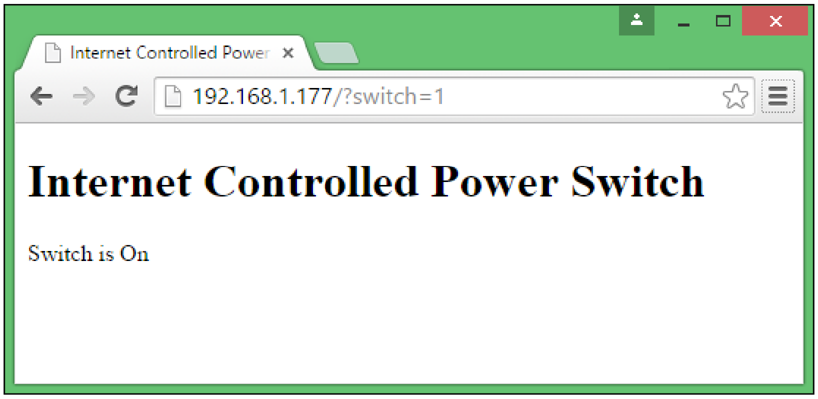
The IP address assigned by the DHCP

10. Plug the PowerSwitch Tail LINE side into the wall power socket and connect the lamp into the LOAD side of the PowerSwitch Tail. Make sure that the lamp switch is in the ON position and all the switches of the wall power socket are in the ON position.
11. Open your Internet browser and type the IP address of your Arduino Ethernet Shield with HTTP protocol. For our example it is `http://192.168.1.177`. Then hit the *Enter* key on your keyboard.

12. The web browser sends an HTTP request to the Arduino web server and the web server returns the processed web content to the web browser. The following screen capture displays the output in the web browser.
13. Type `http://192.168.1.177/?switch=1` and hit the *Enter* key. The lamp will turn on.
14. Type `http://192.168.1.177/?switch=0` and hit the *Enter* key. The lamp will turn off.
15. If you have connected your Arduino Ethernet Shield to your home wireless network, you can test your PowerSwitch Tail using your Wi-Fi connected smartphone as well. If you have the idea to add port forwarding to your router, you can then control your switch from anywhere in the world. Explaining about port forwarding is out of scope of this book.



Electric lamp controlled by PowerSwitch Tail



Internet Controlled Power Switch

Switch is On

PowerSwitch Tail control panel accessed by Google Chrome browser

Sensing the availability of mains electricity

You can sense the availability of mains electricity in your home and read the status before actuating the PowerSwitch Tail.

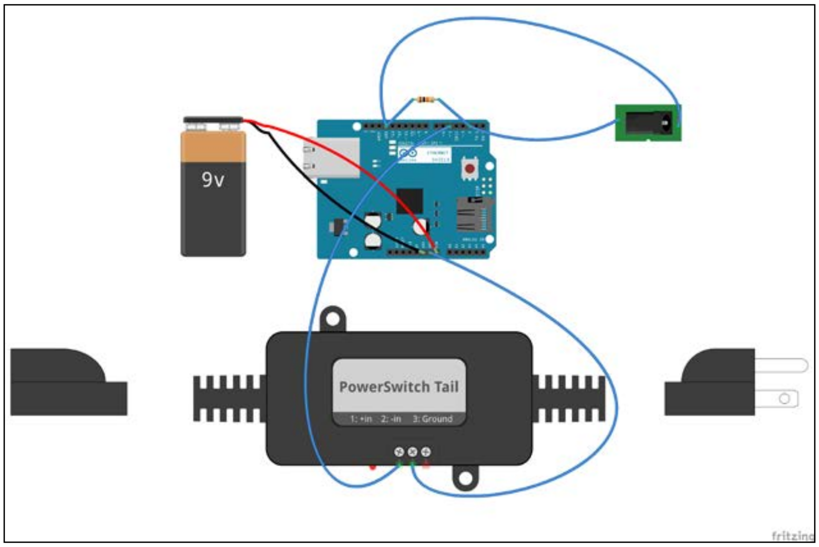
You will need the following hardware to build the sensor:

- A 5VDC 2A wall adapter power supply (`https://www.sparkfun.com/products/12889`)
- A 10 kilo Ohm resistor (`https://www.sparkfun.com/products/8374`)

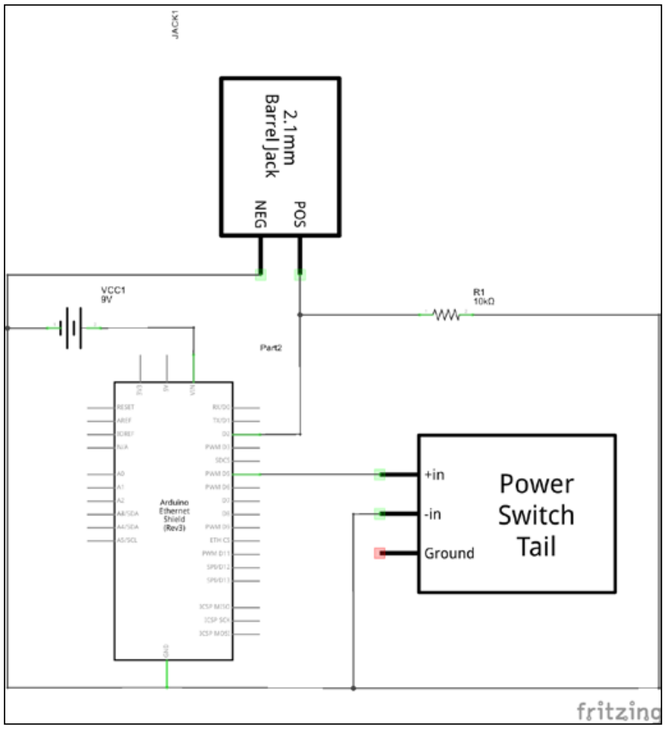
Follow the next steps to attach the sensor to the Arduino Ethernet Shield:

1. Connect the positive wire of the 5V DC wall adapter power supply to the Ethernet shield digital pin 2.
2. Connect the negative wire of the wall adapter power supply to the Ethernet shield GND pin.
3. Connect the 10 kilo ohm resistor between the Ethernet shield digital pin 2 and the GND pin.

4. Plug the wall adapter power supply into the wall.



A wiring diagram



Schematic

Testing the mains electricity sensor

The previous sketch is modified to check the availability of the mains electricity and operate PowerSwitch Tail accordingly. The 5V DC wall adapter power supply plugged into the wall keeps the Arduino digital pin 2 in the HIGH state if mains electricity is available. If mains electricity is not available, the digital pin 2 switches to the LOW state.

1. Open your Arduino IDE and paste the code from the sketch named `B04844_01_03.ino` from the code folder of this chapter.
2. Power up your Arduino Ethernet Shield with 9V battery pack so that it will work even without mains electricity.
3. The Arduino digital pin 2 is in its HIGH state if mains electricity is available. The `hasElectricity` boolean variable holds the state of availability of the electricity.
4. If only the mains electricity is available, the PowerSwitch Tail can be turned ON. If not, the PowerSwitch Tail is already in its OFF state.

Building a user-friendly web user interface

The following Arduino sketch adds two radio buttons to the web page so the user can easily control the switch without typing the URL with the query string into the address bar of the web browser. The radio buttons will dynamically build the URL with the query string depending on the user selection and send it to the Arduino web server with the HTTP request.

1. Open your Arduino IDE and paste the code from the sketch named `B04844_01_04.ino` from the code folder of this chapter.
2. Replace the IP address with a new IP address in your local area network's IP address range.

   ```
   IPAddress ip(192,168,1,177);
   ```

3. Verify and upload the sketch on your Arduino UNO board.
4. Open your web browser and type your Arduino Ethernet Shield's IP address into the address bar and hit the *Enter* key.

5. The following code snippet will submit your radio button selection to the Arduino web sever as an HTTP request using the HTTP GET method. The radio button group is rendered inside the `<form method="get"></form>` tags.

```
client.println("<form method=\"get\">");
if (httpRequest.indexOf("GET /?switch=0
HTTP/1.1") > -1) {
  relayStatus = 0;
  digitalWrite(9, LOW);
  Serial.println("Off Clicked");
} else if (httpRequest.indexOf("GET /?switch=1
HTTP/1.1") > -1) {
  relayStatus = 1;
  digitalWrite(9, HIGH);
  Serial.println("On Clicked");
}

if (relayStatus) {
  client.println("<input type=\"radio\"
  name=\"switch\" value=\"1\" checked>ON");
  client.println("<input type=\"radio\"
  name=\"switch\" value=\"0\"
  onclick=\"submit();\" >OFF");
}
else {
  client.println("<input type=\"radio\"
  name=\"switch\" value=\"1\"
  onclick=\"submit();\" >ON");
  client.println("<input type=\"radio\"
  name=\"switch\" value=\"0\" checked>OFF");
}
client.println("</form>");
```

Also, depending on the radio button selection, the browser will re-render the radio buttons using the server response to reflect the current status of the PowerSwitch Tail.

Adding a Cascade Style Sheet to the web user interface

Cascade Style Sheet (**CSS**) defines how HTML elements are to be displayed. Metro UI CSS (`https://metroui.org.ua/`) is a cascade style sheet that can be used to apply Windows 8-like style to your HTML elements.

The following Arduino sketch applies Windows 8-like style to the radio button group:

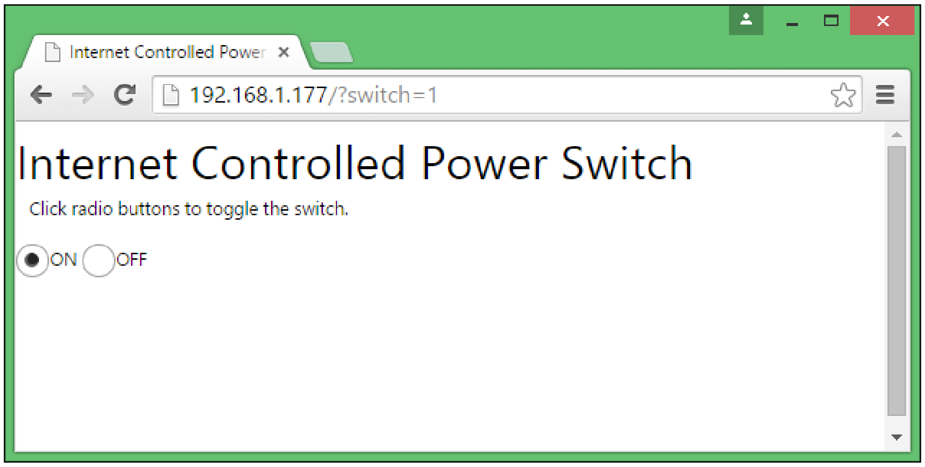
1. Open your Arduino IDE and paste the code from the sketch named `B04844_01_05.ino` from the code folder of this chapter.
2. Between the `<head></head>` tags we have first included the JQuery library which consists of a rich set of JavaScript functions:

   ```
   client.println("<script
   src=\"https://metroui.org.ua/js/jquery-
   2.1.3.min.js\"></script>");
   ```

3. Then, we have included `metro.js` and `metro.css` from the `https://metroui.org.ua` website:

   ```
   client.println("<script
   src=\"https://metroui.org.ua/js/metro.js\"></script>");
   client.println("<link rel=\"stylesheet\"
   href=\"https://metroui.org.ua/css/metro.css\">");
   ```

Upload the sketch on your Arduino board and play with the new look and feel. You can modify the other HTML elements and even use the radio buttons by referring to the MetroUI CSS website documentation at `https://metroui.org.ua/`.



Internet Controlled Power Switch

Click radio buttons to toggle the switch.

● ON ○ OFF

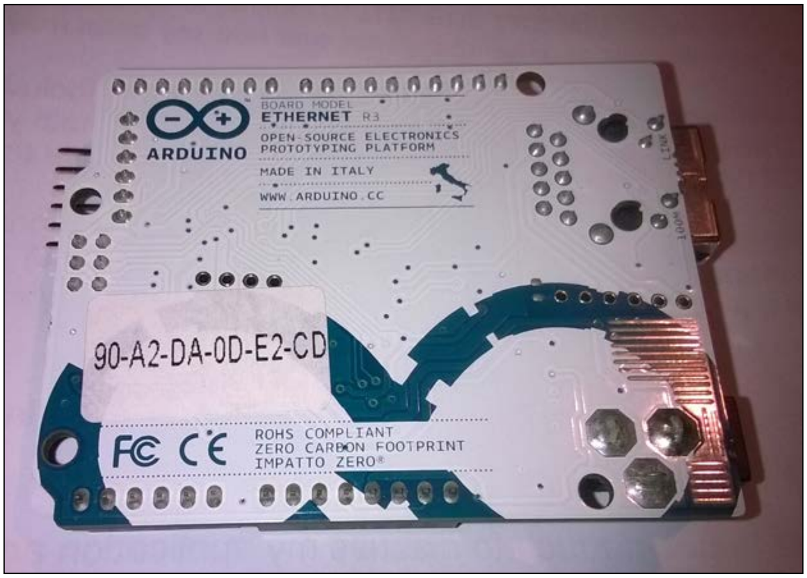
MetroUI CSS style applied to radio buttons

Finding the MAC address and obtaining a valid IP address

To work with this project, you must know your Arduino Ethernet Shield's MAC address and IP address to communicate properly over the Internet.

Finding the MAC address

Current Arduino Ethernet Shields come with a dedicated and uniquely assigned 48-bit MAC (Media Access Control) address which is printed on the sticker. Write down your Ethernet shield's MAC address so you can refer to it later. The following image shows an Ethernet shield with the MAC address of **90-A2-DA-0D-E2-CD**:



You can rewrite your Arduino Ethernet Shield's MAC address using hexadecimal notations, as in `0x90`, `0xA2`, `0xDA`, `0x0D`, `0xE2` and `0xCD`, with the leading `0x` notation recognized by C compilers (remember that the Arduino programming language is based on C) and assembly languages.

If not present, you can use one that does not conflict with your network.
For example:

```
byte mac[] = { 0xDE, 0xAD, 0xBE, 0xEF, 0xFE, 0xED };
```

Obtaining an IP address

You can assign an IP address to your Arduino Ethernet Shield by one of the following methods:

- Using the network router or switch to assign a static IP address to your Ethernet shield.
- Using DHCP (Dynamic Host Configuration Protocol) to dynamically assign an IP address to your Ethernet shield. In this chapter, we will only discuss how to assign an IP address using DHCP.

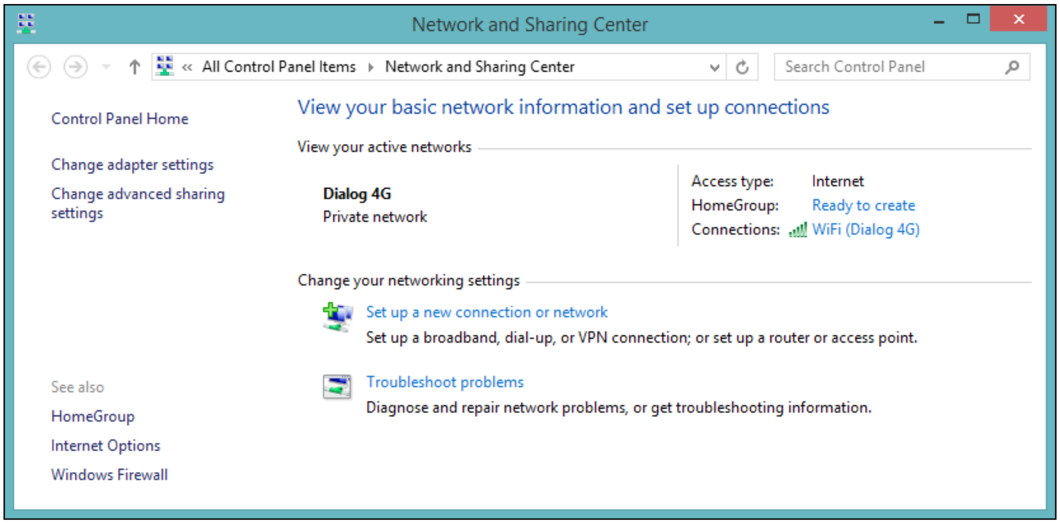
The network devices we will use for this experiment are the following:

- Huawei E517s-920 4G Wi-Fi Router
- DELL computer with Windows 8.1 installed and Wi-Fi connected
- Nokia Lumia phone with Windows 8.1 installed and Wi-Fi connected
- Arduino Ethernet Shield connected to the Wi-Fi router's LAN port using an Ethernet cable

Assigning a static IP address

The following steps will explain how to determine your network IP address range with a Windows 8.1 installed computer, and select a valid static IP address.

1. Open **Network and Sharing Center** in Control Panel:



Network and Sharing Center

« All Control Panel Items › Network and Sharing Center

Search Control Panel

Control Panel Home

Change adapter settings

Change advanced sharing settings

See also

HomeGroup

Internet Options

Windows Firewall

View your basic network information and set up connections

View your active networks

Dialog 4G
Private network

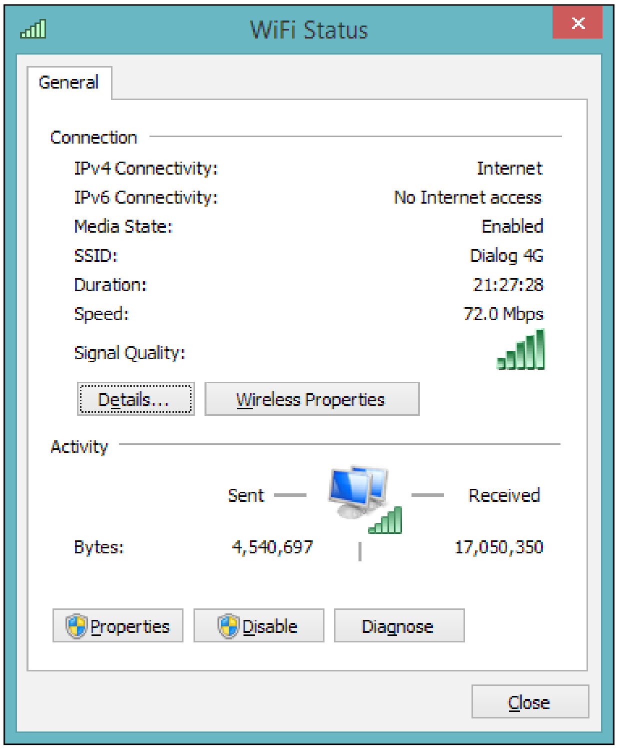
Access type: Internet
HomeGroup: Ready to create
Connections: WiFi (Dialog 4G)

Change your networking settings

Set up a new connection or network
Set up a broadband, dial-up, or VPN connection; or set up a router or access point.

Troubleshoot problems
Diagnose and repair network problems, or get troubleshooting information.

2. Click on **Connections**. The **Connection Status** dialog box will appear, as shown here:



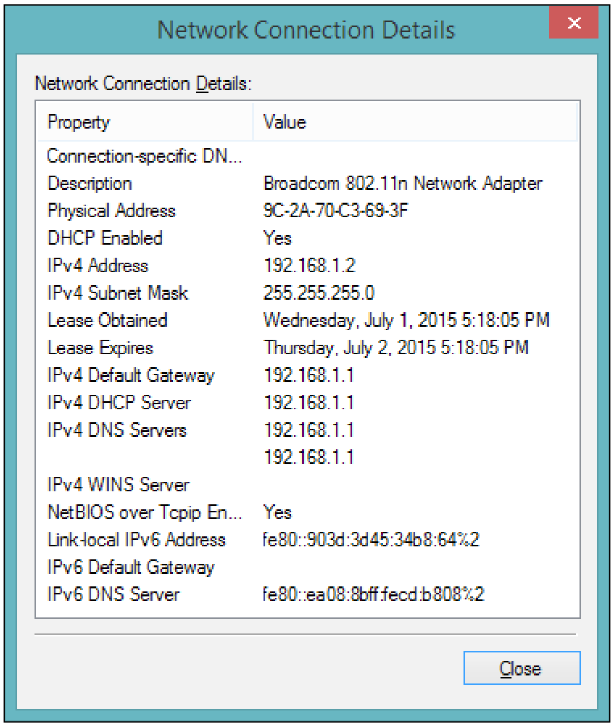
Connection

IPv4 Connectivity: Internet
IPv6 Connectivity: No Internet access
Media State: Enabled
SSID: Dialog 4G
Duration: 21:27:28
Speed: 72.0 Mbps
Signal Quality:

Activity

Sent — — Received
Bytes: 4,540,697 17,050,350

3. Click on the **Details…** button. The **Network Connection Details** dialog box will appear, as shown in the following screenshot:

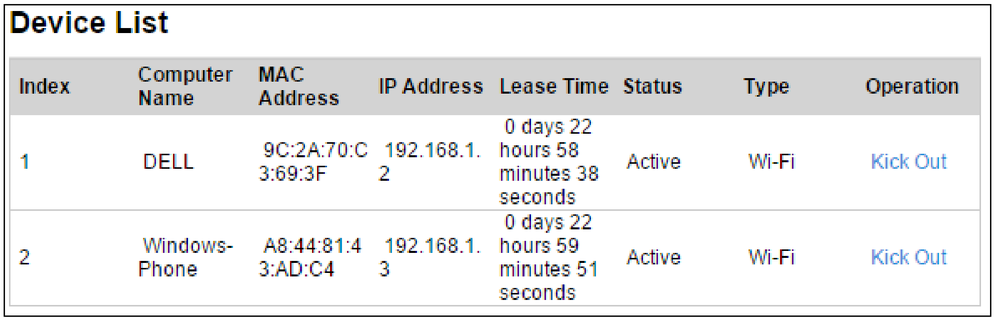


Network Connection Details:

Property	Value
Connection-specific DN...	
Description	Broadcom 802.11n Network Adapter
Physical Address	9C-2A-70-C3-69-3F
DHCP Enabled	Yes
IPv4 Address	192.168.1.2
IPv4 Subnet Mask	255.255.255.0
Lease Obtained	Wednesday, July 1, 2015 5:18:05 PM
Lease Expires	Thursday, July 2, 2015 5:18:05 PM
IPv4 Default Gateway	192.168.1.1
IPv4 DHCP Server	192.168.1.1
IPv4 DNS Servers	192.168.1.1
	192.168.1.1
IPv4 WINS Server	
NetBIOS over Tcpip En...	Yes
Link-local IPv6 Address	fe80::903d:3d45:34b8:64%2
IPv6 Default Gateway	
IPv6 DNS Server	fe80::ea08:8bff:fecd:b808%2

4. The IPv4 address assigned to the Windows 8.1 computer by the Wireless router is 192.168.1.2. The IPv4 subnet mask is 255.255.255.0. So, the IP address range should be 192.168.1.0 to 192.168.1.255.

5. The Wi-Fi network used in this example currently has two devices connected, that is, a Windows 8.1 computer, and a Windows phone. After logging in to the wireless router product information page, under the device list, all the IP addresses currently assigned by the router to the connected devices can be seen, as shown here:

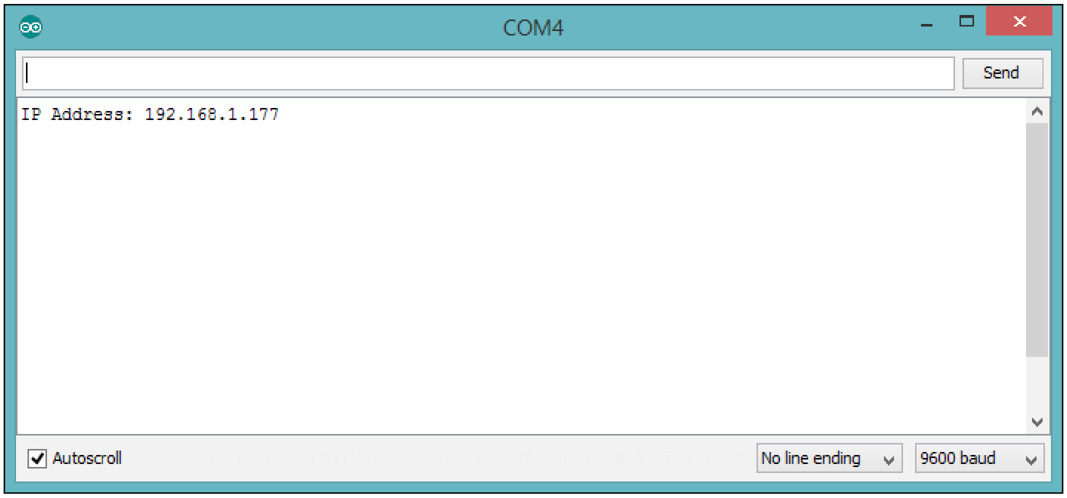


Device List

Index	Computer Name	MAC Address	IP Address	Lease Time	Status	Type	Operation
1	DELL	9C:2A:70:C3:69:3F	192.168.1.2	0 days 22 hours 58 minutes 38 seconds	Active	Wi-Fi	Kick Out
2	Windows-Phone	A8:44:81:43:AD:C4	192.168.1.3	0 days 22 hours 59 minutes 51 seconds	Active	Wi-Fi	Kick Out

6. Now, we can choose any address except 192.168.1.1, 192.168.1.2, and 192.168.1.3.
7. Let's assign 192.168.1.177 to the Arduino Ethernet Shield as a static IP address using the following sketch. Upload the following sketch into your Arduino board and open the Serial Monitor to verify the static IP address assigned.
8. Open your Arduino IDE and type or paste the following code from the sketch named `B04844_01_06.ino` from the code folder of this chapter.

```
#include <SPI.h>
#include <Ethernet.h>

byte mac[] = { 0xDE, 0xAD, 0xBE, 0xEF, 0xFE, 0xED };
byte ip[] = { 192, 168, 1, 177 };

EthernetServer server(80);

void setup()
{
  Serial.begin(9600);

  Ethernet.begin(mac, ip);
  server.begin();
  Serial.print("IP Address: ");
  Serial.println(Ethernet.localIP());

}

void loop () {}
```



```
IP Address: 192.168.1.177
```

A static IP address

Obtaining an IP address using DHCP

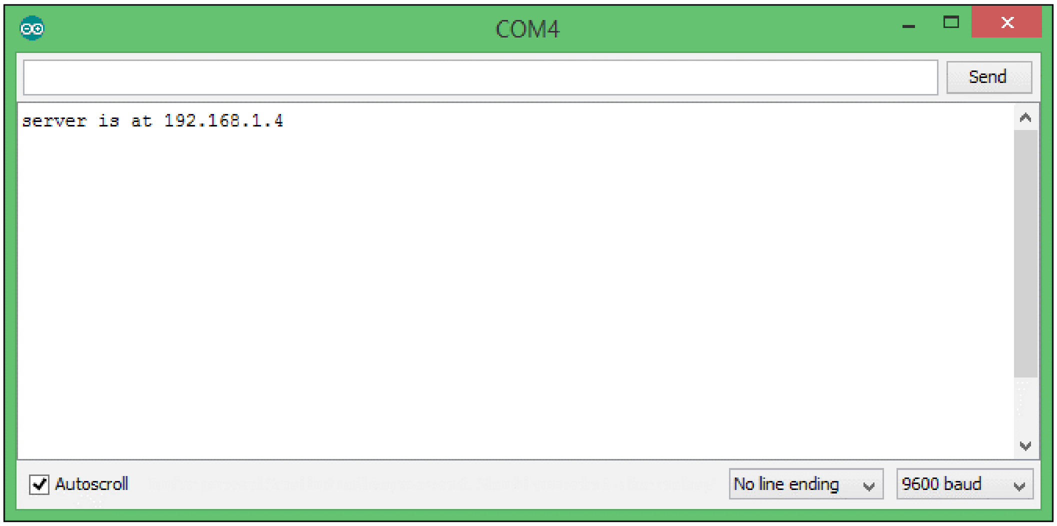
The DHCP can be used to automatically assign a valid IP address to the Arduino Ethernet Shield. The only address you need is the MAC address of the Ethernet shield. Pass the MAC address as a parameter to the `Ethernet.begin()` method.

Upload the following Arduino sketch to your Arduino board, and open the Arduino Serial Monitor to see the auto-assigned IP address by the DHCP. Use this IP address to access your Ethernet shield through the Internet. Remember, this IP address may be changed at the next start up or reset.

Open your Arduino IDE and type or paste the following code from the sketch named `B04844_01_07.ino` from the code folder of this chapter:

```
#include <SPI.h>
#include <Ethernet.h>

byte mac[] = { 0xDE, 0xAD, 0xBE, 0xEF, 0xFE, 0xED };

EthernetServer server(80);

void setup()
{
  Serial.begin(9600);

  Ethernet.begin(mac);
  server.begin();
```

```
    Serial.print("IP Address: ");
    Serial.println(Ethernet.localIP());

  }

  void loop () {}
```



```
server is at 192.168.1.4
```

DHCP assigned IP address

Summary

In this chapter, you have gained a lot, and built your first Arduino **Internet of Things** (**IoT**) project, an internet controlled power switch, which is very smart. Using your creative knowledge, you can take this project to a more advanced level by adding many more functionalities, such as an LCD screen to the switch to display the current status and received user requests, or a feedback LED to show different statuses, and so on.

In the next chapter, you will learn how to build a Wi-Fi signal strength notification system using Arduino wearable and Internet of Things. Use the basic knowledge about Arduino IoT gained from this chapter to build the next project more successfully. Always be creative!

2
Wi-Fi Signal Strength Reader and Haptic Feedback

When designing an embedded system with Internet connectivity using Wi-Fi, reading the Wi-Fi connections receiving signal allows the user to determine the available Internet connectivity and signal strength. Most devices show the signal strength to the consumer using a simple bar graph or something similar. In this project, however, we look into how to notify the signal strength level using a different kind of mechanism to the user: the haptic feedback.

Another technique is to send the Wi-Fi signal strength level over the Internet, which allows you to measure signal strength even in unreachable locations. In the previous chapter, you learned about Arduino Ethernet Web server. Here, similar implementations will be used.

In this chapter, you will do the following:

- Learn about Arduino WiFi Shield basics and stacking with an Arduino UNO board
- Learn how to read the receiving radio signal strength level using RSSI
- Learn about vibration motors and haptic feedback
- Learn about haptic motor controllers and the Adafruit haptic library
- Write a simple web server to display the strength level of the received radio signal using a simple HTML web page

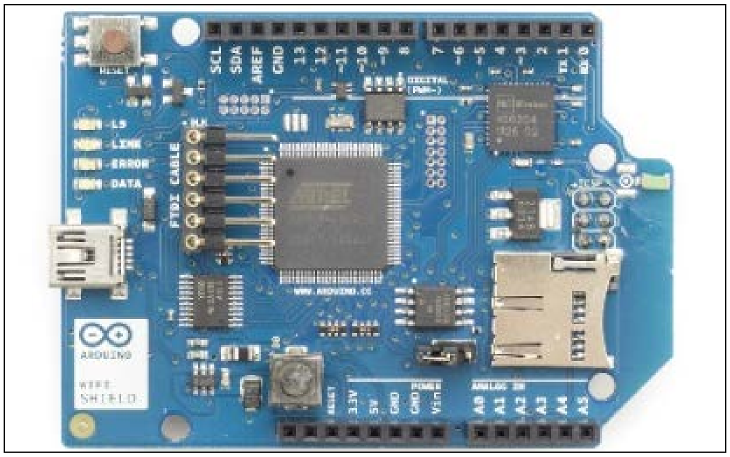
Prerequisites

To complete this project, you may require some open source hardware, software, tools, and good soldering skills. Let's dive in one step at a time.

- Arduino UNO board (`http://store.arduino.cc/product/A000066`)
- Arduino WiFi Shield (`http://store.arduino.cc/product/A000058`)
- Vibrating Mini Motor Disc (`http://www.adafruit.com/product/1201`)
- Adafruit DRV2605L Haptic Motor Controller (`http://www.adafruit.com/product/2305`)
- USB A to B cable
- Wall adapter power supply 9V DC 650mA

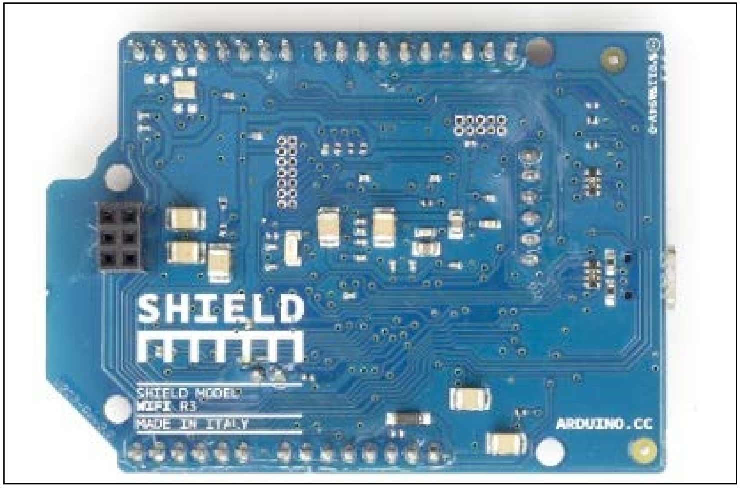
Arduino WiFi Shield

Arduino WiFi Shield allows you to connect your Arduino board to the Internet wirelessly. In the previous chapter, you learned how to connect the Arduino board to the Internet using an Ethernet shield with a wired connection. Unlike a wired connection, a wireless connection provides us with increased mobility within the Wi-Fi signal range, and the ability to connect to other Wi-Fi networks automatically, if the current network loses connection or has insufficient radio signal strength. Most of the mechanisms can be manipulated using the Arduino Wi-Fi library, a well-written piece of program sketch. The following image shows the top view of an Arduino WiFi Shield. Note that two rows of wire wrap headers are used to stack with the Arduino board.



Arduino WiFi Shield (top view) Image courtesy of Arduino (`https://www.arduino.cc`) and license at `http://creativecommons.org/licenses/by-sa/3.0/`

The following image shows the bottom view of an Arduino WiFi Shield:



Arduino WiFi Shield (bottom view) Image courtesy of Arduino (`https://www.arduino.cc`) and license at `http://creativecommons.org/licenses/by-sa/3.0/`

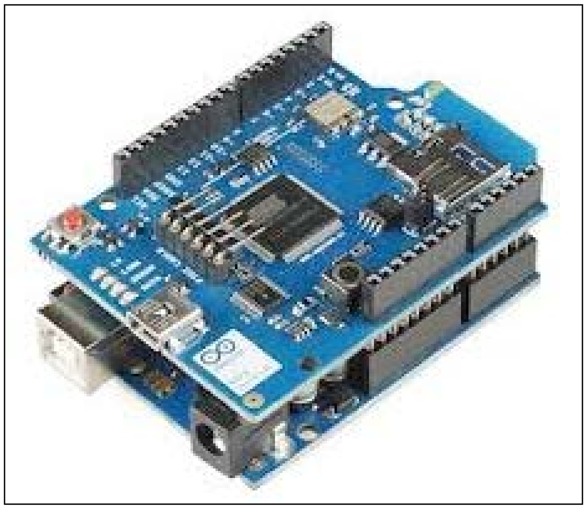
Firmware upgrading

Before using the Arduino WiFi Shield with this project, upgrade its firmware to version 1.1.0 or greater, as explained in the following official Arduino page at `https://www.arduino.cc/en/Hacking/WiFiShieldFirmwareUpgrading`.

The default factory-loaded firmware version 1.0.0 will not work properly with some of the Arduino sketches in this chapter.

Stacking the WiFi Shield with Arduino

Simply plug in to your Arduino WiFi Shield on top of the Arduino board using wire wrap headers so the pin layout of the Arduino board and the WiFi Shield will be exactly intact together.



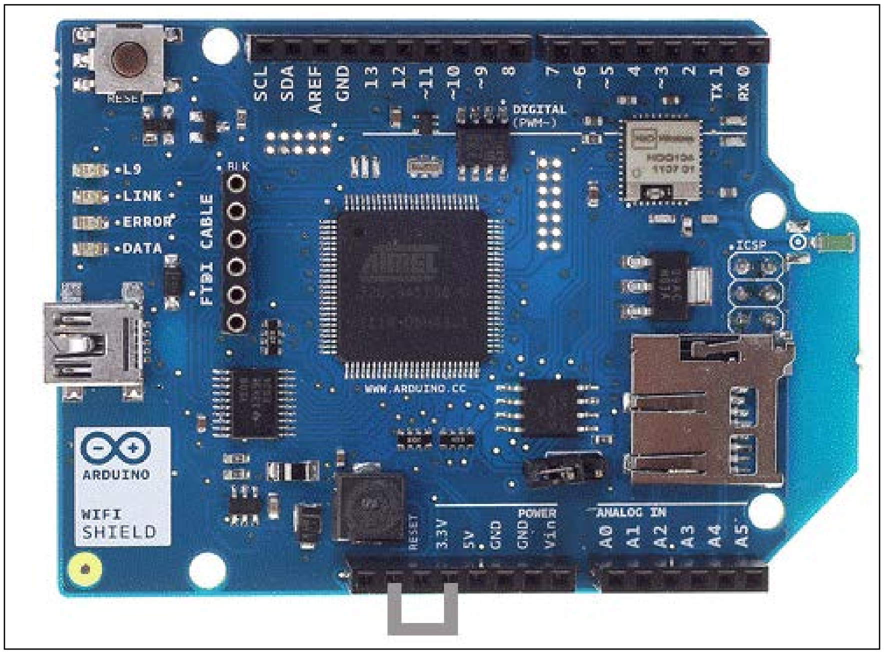
Arduino WiFi Shield is stacked with Arduino UNO

Hacking an Arduino earlier than REV3

You can use the Arduino UNO REV3 board directly without any hacking for this project. However, you can still use an Arduino UNO board earlier than REV3 with a simple hack.

First, stack your Wi-Fi shield on the Arduino board, and then connect your Wi-Fi shield's IOREF pin to the 3.3V pin using a small piece of jumper wire.

The following image shows a wire connection from the **3.3V** pin to the **IOREF** pin.



A jumper wire attached from 3.3V TO IOREF Image courtesy of Arduino (`https://www.arduino.cc`) and license at `http://creativecommons.org/licenses/by-sa/3.0/`

> **Warning!**
>
> Later, when you stack the hacked WiFi shield on an Arduino REV3 board, remember to remove the jumper wire. Otherwise, you will be shorting 3.3V to 5V through the **IOREF** pin.

Knowing more about connections

Your WiFi shield may have an SD card slot that communicates with your Arduino board via the digital pin 4. Arduino UNO communicates with the WiFi shield using digital pins 11, 12, and 13 over SPI bus. Also, the digital pin 10 is used as SS. Therefore, we will not use these pins with our project. However, you can use the digital pin 4 by using the following software hack.

```
pinMode(4, output);
digitalWrite(4, HIGH);
```

Fixing the Arduino WiFi library

Before getting started with the WiFi library, you have to apply the following fixes to some of the files inside the Arduino WiFi library:

1. Navigate to the `WiFi` folder in the libraries folder
2. Open the `wifi_drv.cpp` file located in the `utility` folder under `src`.
3. Find the `getCurrentRSSI()` function and modify it as follows:

```
int32_t WiFiDrv::getCurrentRSSI()
{
  startScanNetworks();
  WAIT_FOR_SLAVE_SELECT();
  // Send Command
  SpiDrv::sendCmd(GET_CURR_RSSI_CMD, PARAM_NUMS_1);

  uint8_t _dummy = DUMMY_DATA;
  SpiDrv::sendParam(&_dummy, 1, LAST_PARA);

  //Wait the reply elaboration
  SpiDrv::waitForSlaveReady();

  // Wait for reply
  uint8_t _dataLen = 0;
  int32_t rssi = 0;
  SpiDrv::waitResponseCmd(GET_CURR_RSSI_CMD, PARAM_NUMS_1,
  (uint8_t*)&rssi, &_dataLen);

  SpiDrv::spiSlaveDeselect();

  return rssi;
}
```

4. Save and close the file.

Connecting your Arduino to a Wi-Fi network

To connect your Arduino WiFi shield to a Wi-Fi network, you should have the SSID of any available Wi-Fi network. **SSID** (**Service Set Identifier**) is the name of the Wi-Fi network that you want to connect to your Arduino WiFi shield. Some Wi-Fi networks require a password to connect it with and some are not, which means open networks.

The Arduino WiFi library provides an easy way to connect your WiFi shield to a Wi-Fi network with the `WiFi.begin()` function. This function can be called in different ways depending on the Wi-Fi network that you want to connect to.

`WiFi.begin();` is only for initializing the Wi-Fi shield and called without any parameters.

1. `WiFi.begin(ssid);` connects your WiFi shield to an `Open Network` using only the `SSID` of the network, which is the name of the network. The following Arduino sketch will connect your Arduino WiFi shield to an open Wi-Fi network which is not password protected and anyone can connect. We assume that you have a Wi-Fi network configured as `OPEN` and named as `MyHomeWiFi`. Open a new Arduino IDE and copy the sketch named `B04844_02_01.ino` from the `Chapter 2` sample code folder.

   ```
   #include <SPI.h>
   #include <WiFi.h>

   char ssid[] = "MyHomeWiFi";
   int status = WL_IDLE_STATUS;

   void setup(){
     Serial.begin(9600);
   if (WiFi.status() == WL_NO_SHIELD){
     Serial.println("No WiFi shield found");  while(true);
   }

   while ( status != WL_CONNECTED){
     Serial.print("Attempting to connect to open SSID: ");
     Serial.println(ssid);
     status = WiFi.begin(ssid);

     delay(10000);
   }

   Serial.print("You're connected to the network");
   }

   void loop (){

   }
   ```

2. Modify the following line of the code according to your Wi-Fi network's name.

   ```
   char ssid[] = "MyHomeWiFi";
   ```

3. Now verify and upload the sketch in to your Arduino board and then open the Arduino Serial Monitor. The Arduino Serial Monitor will display the status about the connection at the time it was connected similar to follows.

   ```
   Attempting to connect to open SSID: MyHomeWiFi
   You're connected to the network
   ```

`WiFi.begin(ssid,pass);` connects your WiFi shield to a **WPA2** (**Wi-Fi Protected Access II**) personal encrypted secured Wi-Fi network using SSID and password. The shield will not connect to Wi-Fi networks that are encrypted using WPA2 Enterprise Encryption. We assume that you have a Wi-Fi network configured as `WAP2` and named as `MyHomeWiFi`.

1. Open a new Arduino IDE and copy the sketch named `B04844_02_02.ino` from the `Chapter 2` sample code folder.

   ```
   #include <SPI.h>
   #include <WiFi.h>

   char ssid[] = "MyHomeWiFi";
   char pass[] = "secretPassword";
   int status = WL_IDLE_STATUS;

   void setup(){
   Serial.begin(9600);
   if (WiFi.status() == WL_NO_SHIELD) {
   Serial.println("WiFi shield not present");
   while(true);
     }
   while ( status != WL_CONNECTED) {Serial.print("Attempting to
   connect to WPA SSID: ");
   Serial.println(ssid);

   status = WiFi.begin(ssid, pass);

   delay(10000);
     }

   Serial.print("You're connected to the network");

   }
   ```

```
void loop(){

}
```

2. Modify the following line of the code according to your Wi-Fi network's name.

   ```
   char ssid[] = "MyHomeWiFi";
   ```

3. Now verify and upload the sketch in to your Arduino board and then open the Arduino Serial Monitor. The Arduino Serial Monitor will display the status about the connection at the time it was connected similar to follows.

   ```
   Attempting to connect to WPA SSID: MyHomeWiFi
   You're connected to the network
   ```

`WiFi.begin(ssid, keyIndex, key);` is only for use with WEP encrypted Wi-Fi networks. WEP networks can have up to four passwords in hexadecimals that are known as keys. Each key is assigned a `Key Index` value. Configure your Wi-Fi network as a WEP encryption and upload the following sketch into your Arduino board. But remember the WEP is not secure at all and don't use it with your Wi-Fi networks. Instead of that use WPA2 encryption which is highly recommended.

1. We assume that you have a Wi-Fi network configured as `WPE` and named as `MyHomeWiFi`. Change the configuration back to the WPA2 as quickly as possible after testing the following code snippet. Open a new Arduino IDE and copy the sketch named `B04844_02_03.ino` from the `Chapter 2` sample code folder.

   ```
   #include <SPI.h>
   #include <WiFi.h>

   char ssid[] = "MyHomeWiFi";
   char key[] = "D0D0DEADF00DABBADEAFBEADED";
   int keyIndex = 0;
   int status = WL_IDLE_STATUS;

   void setup(){

     Serial.begin(9600);
     if (WiFi.status() == WL_NO_SHIELD)  {
       Serial.println("WiFi shield not present");       while(true);
     }
     while ( status != WL_CONNECTED)  {    Serial.print("Attempting
   to connect to WEP network, SSID: ");
   ```

```
      Serial.println(ssid);
      status = WiFi.begin(ssid, keyIndex, key);
         delay(10000);
    }

    Serial.print("You're connected to the network");
   }

  void loop(){

  }
```

2. Modify the following line of the code according to your Wi-Fi network's name:

   ```
   char ssid[] = "MyHomeWiFi";
   ```

3. Now verify and upload the sketch in to your Arduino board and then open the Arduino Serial Monitor. The Arduino Serial Monitor will display the status about the connection at the time it was connected similar to follows.

   ```
   Attempting to connect to WEP network, SSID: MyHomeWiFi
   You're connected to the network
   ```

Wi-Fi signal strength and RSSI

The Arduino WiFi library provides us with a simple way to get the Wi-Fi signal strength in decibels ranging from 0 to -100 (minus 100). You can use the `WiFi.RSSI()` function to get the radio signal strength of the currently connected network or any specified network. You can read more about **Received Signal Strength Indication** (**RSSI**) at `https://en.wikipedia.org/wiki/Received_signal_strength_indication`.

The `WiFi.RSSI()` function can be called with following parameters:

- `WiFi.RSSI();`:This will return the signal strength of the currently connected Wi-Fi network.
- `WiFi.RSSI(WiFi Access Point);`: This will return the signal strength of a specified Wi-Fi network. Wi-Fi Access Point is the name of the Wi-Fi network. For example, `MyHomeWiFi`.

Reading the Wi-Fi signal strength

Now we will write an Arduino sketch to get the RSSI value of the currently connected Wi-Fi network.

1. Open a new Arduino IDE and copy the sketch named `B04844_02_04.ino` from the `Chapter 2` sample code folder.

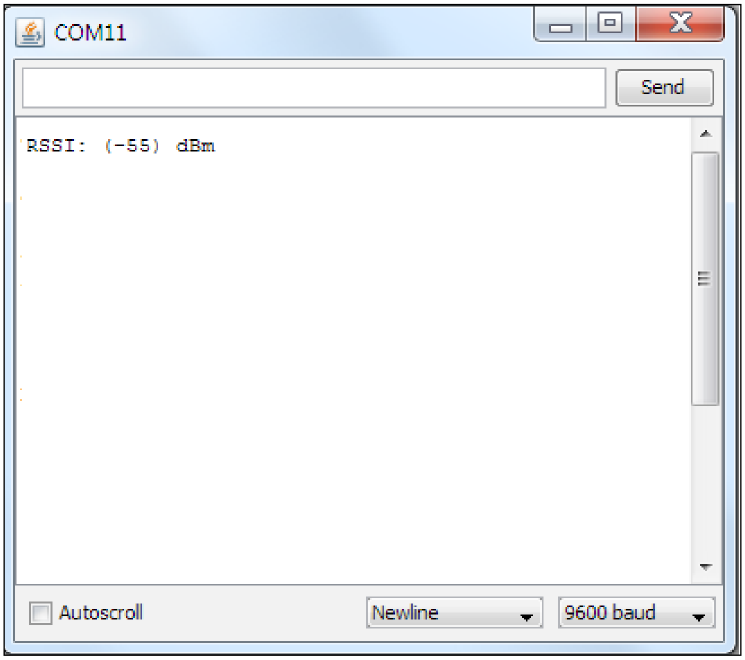
```
#include <SPI.h>
#include <WiFi.h>

char ssid[] = "MyHomeWiFi";
char pass[] = "secretPassword";

void setup()
{
  WiFi.begin(ssid, pass);
   if (WiFi.status() != WL_CONNECTED)    {      Serial.
println("Couldn't get a wifi connection");
      while(true);
    }       else
         {
      long rssi = WiFi.RSSI();
      Serial.print("RSSI: ");
      Serial.print(rssi);
      Serial.println(" dBm");
    }
  }

void loop (){
}
```

2. Modify the following line of the code according to your Wi-Fi network's name.

```
char ssid[] = "MyHomeWiFi";
```

3. Now verify and upload the sketch in to your Arduino board and then open the Arduino Serial Monitor.

4. The Arduino Serial Monitor will display the received signal in dBm (decibel-milliwatts) for the currently connected Wi-Fi network similar to the following:



```
RSSI: (-55) dBm
```

However, note that this will only provide the signal strength at the moment the WiFi shield was connected to the Wi-Fi network.

In the next Arduino sketch, we are going to look at how to display the Wi-Fi signal strength and update it periodically.

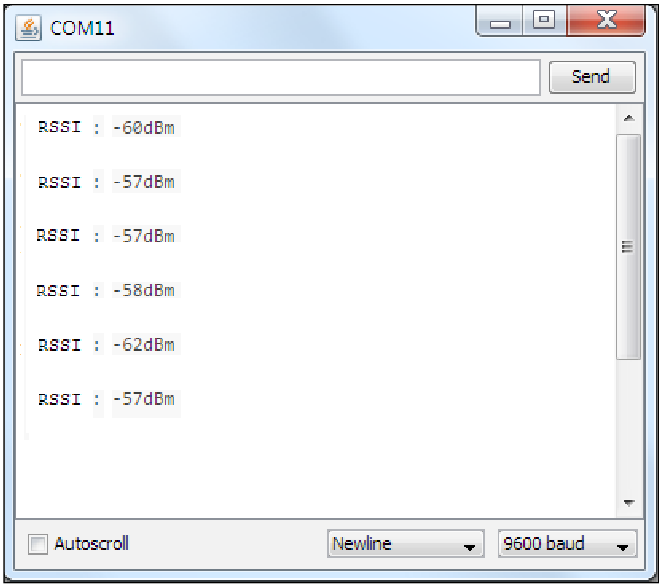
1. Open a new Arduino IDE and copy the sketch named `B04844_02_05.ino` from the `Chapter 2` sample code folder.

```
#include <SPI.h>
#include <WiFi.h>

char ssid[] = "MyHomeWiFi";
char pass[] = "secretPassword";

void setup()
{
WiFi.begin(ssid, pass);
}

void loop (){
  if (WiFi.status() != WL_CONNECTED)    {    Serial.
println("Couldn't get a wifi connection");
    while(true);
    }
  else
     {
    long rssi = WiFi.RSSI();
    Serial.print("RSSI: ");
    Serial.print(rssi);
    Serial.println(" dBm");
    }

delay(10000);//waits 10 seconds and update

}
```

2. Modify the following line of the code according to your WiFi network's name:

```
char ssid[] = "MyHomeWiFi";
```

3. Now verify and upload the sketch in to your Arduino board and then open the Arduino Serial Monitor.
4. The Arduino Serial Monitor will display the received signal in dBm (decibel-milliwatts) for the currently connected Wi-Fi network similar to the following:



```
RSSI : -60dBm

RSSI : -57dBm

RSSI : -57dBm

RSSI : -58dBm

RSSI : -62dBm

RSSI : -57dBm
```

□ Autoscroll   Newline   9600 baud

In the next section of this chapter, we will look at how to integrate a vibrator to the Arduino WiFi shield and output advanced vibration patterns according to the current RSSI value.

Haptic feedback and haptic motors

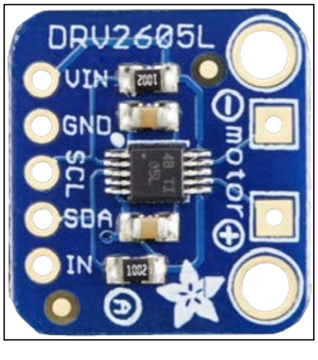
Haptic feedback is the way to convey information to users using advanced vibration patterns and waveforms. Earlier consumer electronic devices communicated with their users using audible and visual alerts, but now things have been replaced with vibrating alerts through haptic feedback.

In a haptic feedback system, the vibrating component can be a vibration motor or a linear resonant actuator. The motor is driven by a special hardware called the haptic controller or haptic driver. Throughout this chapter we use the term **vibrator** for the vibration motor.

Getting started with the Adafruit DRV2605 haptic controller

Adafruit DRV2605 haptic controller is an especially designed motor controller for controlling haptic motors. With a haptic controller, you can make various effects using a haptic motor such as:

- Ramping the vibration level up and down
- Click, double-click, and triple-click effects
- Pulsing effects
- Different buzzer levels
- Vibration following a musical/audio input

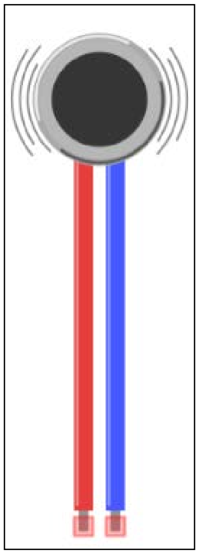


The DRV2605 breakout board (top view) Image courtesy of Adafruit Industries (`https://www.adafruit.com`)

Selecting a correct vibrator

Vibrators come with various shapes and driving mechanisms. Some of them support haptic feedback while some do not. Before purchasing a vibrator, check the product details carefully to determine whether it supports haptic feedback. For this project, we will be using a simple vibrating mini motor disc, which is a small disc-shaped motor. It has negative and positive leads to connect with the microcontroller board.

The following image shows a vibrator with positive and negative wires soldered:



Fritzing representation of a vibrator

Connecting a haptic controller to Arduino WiFi Shield

Use the following steps to connect the DRV2605 haptic controller to Arduino WiFi Shield:

1. Solder headers to the DRV2605 breakout board, connect it to a breadboard and then user jumper wires for the connection to the Arduino.
2. Connect the **VIN** pin of the DRV2605 breakout board to the **5V** pin of the Arduino WiFi Shield.
3. Connect the **GND** pin of the DRV2605 breakout to the **GND** pin of the Arduino WiFi Shield.

4. Connect the **SCL** pin of the DRV2605 breakout board to the Analog 5 (**A5**) pin of the Arduino WiFi Shield.
5. Finally, connect the **SDA** pin of the DRV2605 breakout board to the Analog 4 (**A4**) pin of the Arduino WiFi Shield.

The following image shows the connection between DRV2605 breakout board and Arduino WiFi shield:

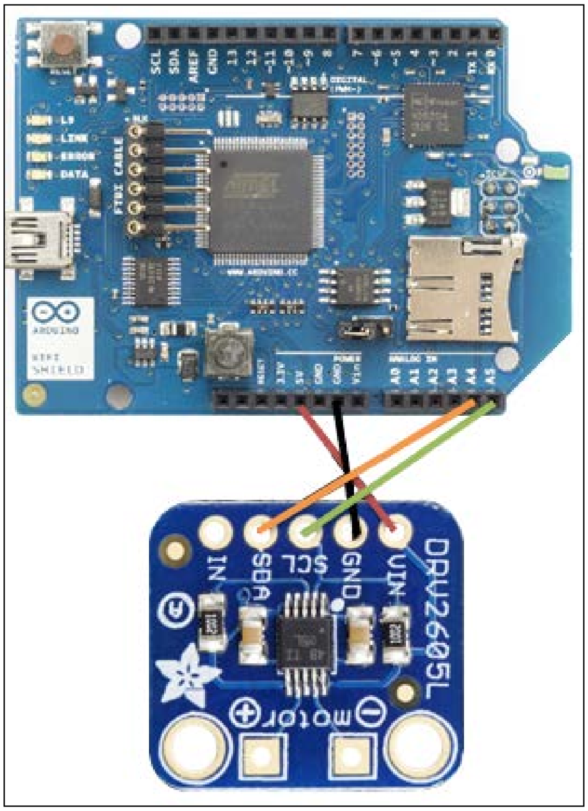


Image courtesy of Arduino (`https://www.arduino.cc`) and license at `http://creativecommons.org/licenses/by-sa/3.0/`, and Adafruit Industries (`https://www.adafruit.com`)

Soldering a vibrator to the haptic controller breakout board

On the DRV2605 breakout board, you can see two square shaped soldering pads marked as + and - along with the **motor** text label. This is the place where we are going to solder the vibrator. Generally vibrators have two presoldered wires, red and black.

- Solder the red wire of the vibrator to the + soldering pad of the breakout board
- Solder the blue wire of the vibrator to the – soldering pad of the breakout board

The following image shows the final connection between DRV2605 breakout board, Arduino WiFi shield and the vibrator:

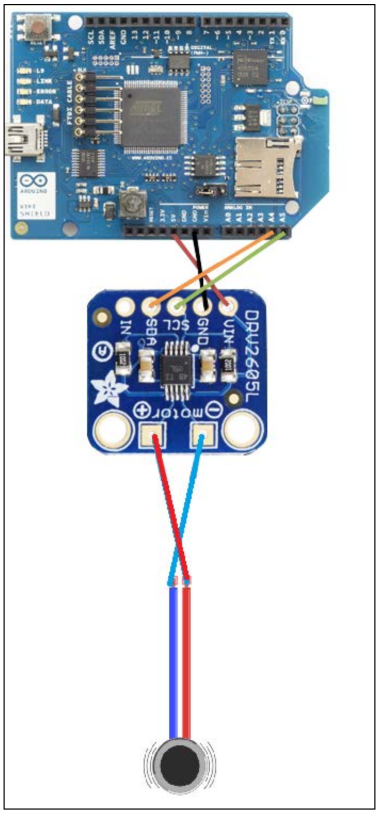
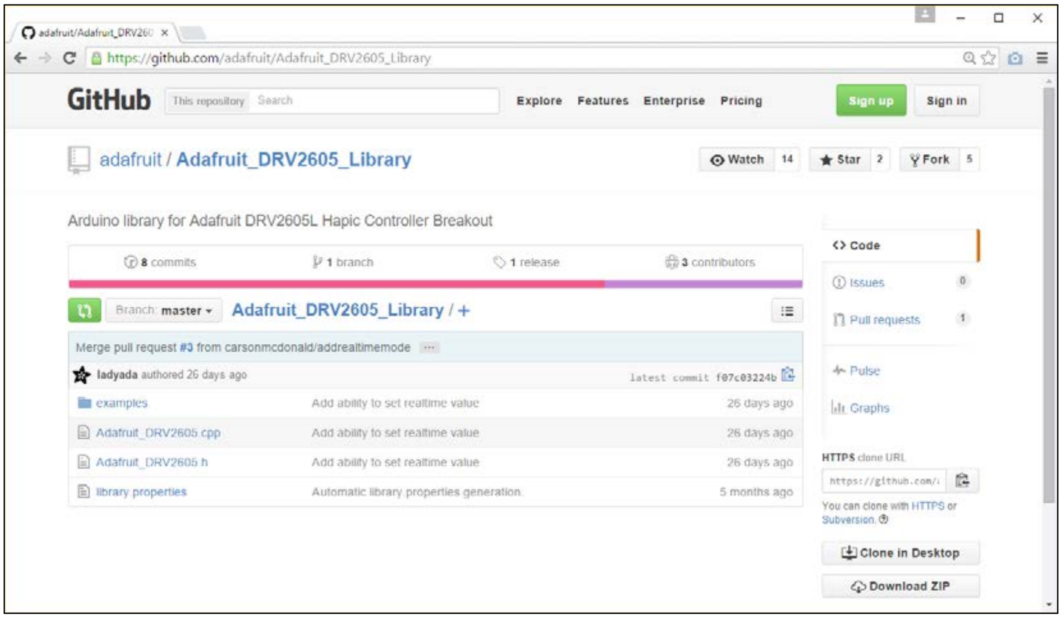


Image courtesy of Arduino (`https://www.arduino.cc`) and license at `http://creativecommons.org/licenses/by-sa/3.0/`, and Adafruit Industries (`https://www.adafruit.com`)

Downloading the Adafruit DRV2605 library

You can download the latest version of the Adafruit DRV2605 library from the GitHub repository by navigating to the following URL: `https://github.com/adafruit/Adafruit_DRV2605_Library`.



Arduino library for Adafruit DRV2605L Hapic Controller Breakout

Merge pull request #3 from carsonmcdonald/addrealtimemode …

ladyada authored 26 days ago latest commit f07c03224b

examples	Add ability to set realtime value	26 days ago
Adafruit_DRV2605.cpp	Add ability to set realtime value	26 days ago
Adafruit_DRV2605.h	Add ability to set realtime value	26 days ago
library.properties	Automatic library.properties generation	5 months ago

The Adafruit DRV2605 library at GitHub

After navigating to the earlier URL, follow these steps to download Adafruit DRV2605 library:

1. Click on the **Download Zip** button.
2. After downloading the ZIP file, extract it to your local drive and rename it as `Adafruit_DRV2605`. Then copy or move the folder inside the Arduino libraries folder. Finally, restart the Arduino IDE.
3. Open the sample sketch included with the library by clicking on **File** | **Examples** | **Adafruit_DRV2605** | **basic** and upload it to your Arduino board. The sketch will play 116 vibration effects defined in the DRV2605 library from effect number 1 to 116 in order.

You can download the datasheet for DRV2605 Haptic Driver from `http://www.ti.com/lit/ds/symlink/drv2605.pdf` and refer to pages 55-56 for the full set of 123 vibration effects. The DRV2605 haptic driver is manufacturing by Texas Instruments.

Making vibration effects for RSSI

Now, we will learn how to make different vibration effects depending on the **Received Signal Strength Indication** (**RSSI**). Typically, RSSI value rages from 0 to -100. The higher the value, the stronger the signal reception where 0 is the highest value. Therefore, we can logically check the RSSI value return by the `WiFi.RSSI()` function and play vibration effects accordingly.

In the following example, we will play the first 10 vibration effects according to the RSSI value output by the Arduino WiFi shield. See the following chart for the RSSI value range for each vibration effect:

Effect Number	**RSSI**	
1	0	-10
2	-11	-20
3	-21	-30
4	-31	-40
5	-41	-50
6	-51	-60
7	-61	-70
8	-71	-80
9	-81	-90
10	-91	-100

Following steps shows how to generate different vibration effects according to the RSSI strength of the currently connected Wi-Fi network.

1. Open a new Arduino IDE and copy the sketch named `B04844_02_06.ino` from the `Chapter 2` sample code folder.
2. Modify the following line of the code according to your Wi-Fi network's name:

   ```
   char ssid[] = "MyHomeWiFi";
   ```

3. Following line maps RSSI output to the value range from 1 to 10 using the `map()` function:

   ```
   int range = map(rssi, -100, 0, 1, 10);
   ```

4. Set the vibration effect using the `setWaveform(slot, effect)` function by passing the parameters such as slot number and effect number. Slot number starts from 0 and effect number can be found in the waveform library effect list.

5. Finally call the `go()` function to play the effect.

   The following code block shows first how to set and play the waveform `double click – 100%`:

   ```
   drv.setWaveform(0, 10);  // play double click - 100%drv.
   setWaveform(1, 0);   // end waveform
   drv.go(); // play the effect!
   ```

6. Verify and upload the sketch in to your Arduino board. Now touch the vibrator and feel the different vibration effects according to the variations of WiFi signal strength of the currently connected network. You can test this by moving your Wi-Fi router away from the Arduino WiFi shield.

> **Downloading the example code**
>
> You can download the example code files from your account at `http://www.packtpub.com` for all the Packt Publishing books you have purchased. If you purchased this book elsewhere, you can visit `http://www.packtpub.com/support` and register to have the files e-mailed directly to you.

Implementing a simple web server

The Arduino WiFi Shield can also be configured and programmed as a web server to serve client requests similar to the Arduino Ethernet shield. In the next step, we will be making a simple web server to send Wi-Fi signal strength over the Internet to a client. This requires that the WiFi shield has 1.1.0 firmware to work. The default factory loaded version 1.0.0 will not work. (See the *Firmware upgrading* section.)

Reading the signal strength over Wi-Fi

To read the signal strength over Wi-Fi:

1. Open a new Arduino IDE and copy the sketch named `B04844_02_07.ino` from the `Chapter 2` sample code folder.
2. Verify and upload the Arduino sketch in to the Arduino board. Type the IP address of your WiFi shield in your web browser and hit the *Enter* key. The web page will load and display the current RSSI of the Wi-Fi network and refresh every 20 seconds. If you don't know the IP address of your Arduino WiFi shield assigned by the DHCP, open the Arduino Serial Monitor and you can find it from there.

Summary

In this chapter, we learnt how to read Wi-Fi signal strength with a WiFi shield and make haptic feedback using a vibration motor according to the Wi-Fi signal strength. Further, we learned to use haptic feedback libraries to make feedback patterns.

In the next chapter, we will learn how to select and use a water flow sensor, and then connect it with Arduino and calibrate it, and also how to calculate and display the values on a LCD screen and store data in the cloud.

3
Internet-Connected Smart Water Meter

For many years and even now, water meter readings have been collected manually. To do this, a person has to visit the location where the water meter is installed. In this chapter, you will learn how to make a smart water meter with an LCD screen that has the ability to connect to the internet and serve meter readings to the consumer through the Internet.

In this chapter, you shall do the following:

- Learn about water flow sensors and its basic operation
- Learn how to mount and plumb a water flow meter on and into the pipeline
- Read and count the water flow sensor pulses
- Calculate the water flow rate and volume
- Learn about LCD displays and connecting with Arduino
- Convert a water flow meter to a simple web server and serve meter readings through the Internet

Prerequisites

- An Arduino UNO R3 board (`http://store.arduino.cc/product/A000066`)
- Arduino Ethernet Shield R3 (`https://www.adafruit.com/products/201`)
- A liquid flow sensor (`http://www.futurlec.com/FLOW25L0.shtml`)
- A Hitachi HD44780 DRIVER compatible LCD Screen (16 x 2) (`https://www.sparkfun.com/products/709`)

- A 10K ohm resistor
- A 10K ohm potentiometer (`https://www.sparkfun.com/products/9806`)
- Few Jumper wires with male and female headers (`https://www.sparkfun.com/products/9140`)
- A breadboard (`https://www.sparkfun.com/products/12002`)

Water flow sensors

The heart of a water flow sensor consists of a Hall effect sensor (`https://en.wikipedia.org/wiki/Hall_effect_sensor`) that outputs pulses for magnetic field changes. Inside the housing, there is a small pinwheel with a permanent magnet attached to it. When the water flows through the housing, the pinwheel begins to spin, and the magnet attached to it passes very close to the Hall effect sensor in every cycle. The Hall effect sensor is covered with a separate plastic housing to protect it from the water. The result generates an electric pulse that transitions from low voltage to high voltage, or high voltage to low voltage, depending on the attached permanent magnet's polarity. The resulting pulse can be read and counted using the Arduino.

For this project, we will use a Liquid Flow sensor from *Futurlec* (`http://www.futurlec.com/FLOW25L0.shtml`). The following image shows the external view of a Liquid Flow Sensor:

Liquid flow sensor – the flow direction is marked with an arrow

The following image shows the inside view of the liquid flow sensor. You can see a pinwheel that is located inside the housing.

Pinwheel attached inside the water flow sensor

Wiring the water flow sensor with Arduino

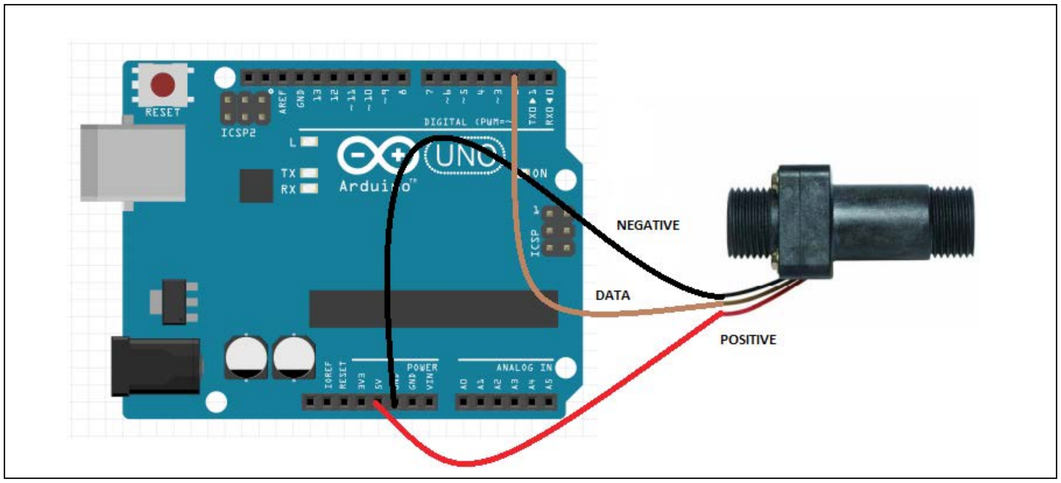
The water flow sensor that we are using with this project has three wires, which are the following:

- Red (or it may be a different color) wire, which indicates the Positive terminal
- Black (or it may be a different color) wire, which indicates the Negative terminal
- Brown (or it may be a different color) wire, which indicates the DATA terminal

All three wire ends are connected to a JST connector. Always refer to the datasheet of the product for wiring specifications before connecting them with the microcontroller and the power source.

When you use jumper wires with male and female headers, do the following:

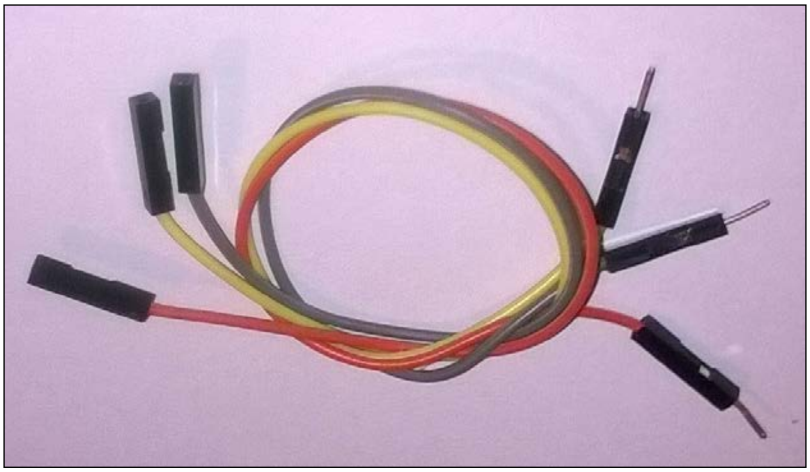
1. Connect positive terminal of the water flow sensor to Arduino **5V**.
2. Connect negative terminal of the water flow sensor to Arduino **GND**.
3. Connect DATA terminal of the water flow sensor to Arduino digital pin **2**.



Water flow sensor connected with Arduino Ethernet Shield using three wires

You can directly power the water flow sensor using Arduino since most residential type water flow sensors operate under 5V and consume a very low amount of current. Read the product manual for more information about the supply voltage and supply current range to save your Arduino from high current consumption by the water flow sensor. If your water flow sensor requires a supply current of more than 200mA or a supply voltage of more than 5v to function correctly, then use a separate power source with it.

The following image illustrates jumper wires with male and female headers:



Jumper wires with male and female headers

Reading pulses

The water flow sensor produces and outputs digital pulses that denote the amount of water flowing through it. These pulses can be detected and counted using the Arduino board.

Let's assume the water flow sensor that we are using for this project will generate approximately 450 pulses per liter (most probably, this value can be found in the product datasheet). So 1 pulse approximately equals to [1000 ml/450 pulses] 2.22 ml. These values can be different depending on the speed of the water flow and the mounting polarity of the water flow sensor.

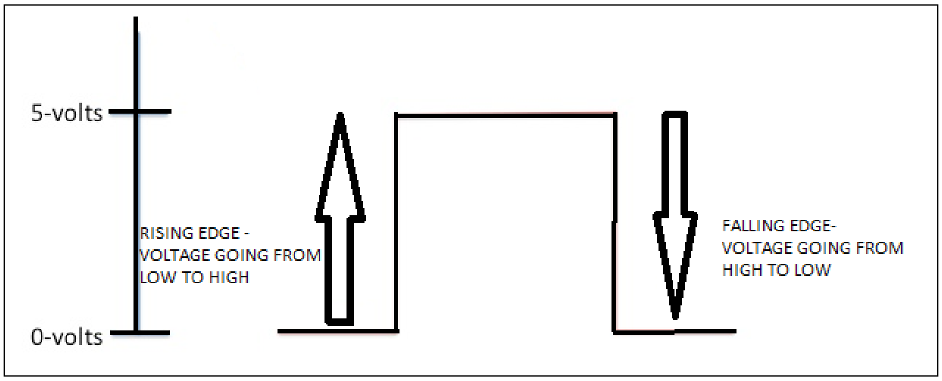
Arduino can read digital pulses generating by the water flow sensor through the DATA line.

Rising edge and falling edge

There are two type of pulses, as listed here:.

- **Positive-going pulse**: In an idle state, the logic level is normally LOW. It goes HIGH state, stays there for some time, and comes back to the LOW state.
- **Negative-going pulse**: In an idle state, the logic level is normally HIGH. It goes LOW state, stays LOW state for time, and comes back to the HIGH state.

The rising and falling edges of a pulse are vertical. The transition from LOW state to HIGH state is called **rising edge** and the transition from HIGH state to LOW state is called **falling edge**.


5-volts
0-volts
RISING EDGE - VOLTAGE GOING FROM LOW TO HIGH
FALLING EDGE- VOLTAGE GOING FROM HIGH TO LOW

Representation of Rising edge and Falling edge in digital signal

You can capture digital pulses using either the rising edge or the falling edge. In this project, we will use the rising edge.

Reading and counting pulses with Arduino

In the previous step, you attached the water flow sensor to Arduino UNO. The generated pulse can be read by Arduino digital pin 2 and the interrupt 0 is attached to it.

The following Arduino sketch will count the number of pulses per second and display it on the Arduino Serial Monitor:

1. Open a new Arduino IDE and copy the sketch named `B04844_03_01.ino` from the `Chapter 3` sample code folder.

2. Change the following pin number assignment if you have attached your water flow sensor to a different Arduino pin:

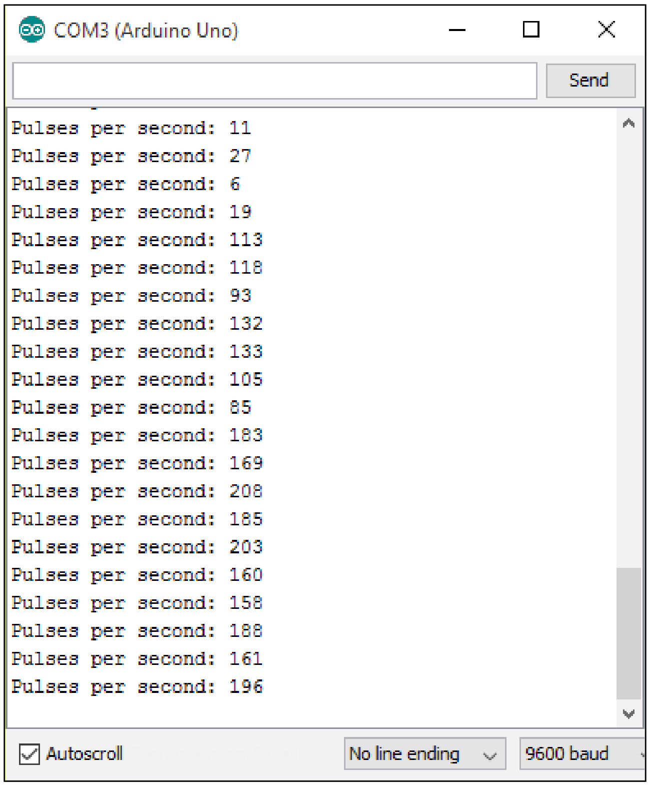
   ```
   int pin = 2;
   ```

3. Verify and upload the sketch on the Arduino board:

   ```
   int pin = 2; //Water flow sensor attached to digital pin 2
   volatile unsigned int pulse;
   const int pulses_per_litre = 450;

   void setup()
   {
      Serial.begin(9600);

      pinMode(pin, INPUT);
      attachInterrupt(0, count_pulse, RISING);
   }

   void loop()
   {
       pulse = 0;
       interrupts();
       delay(1000);
       noInterrupts();

       Serial.print("Pulses per second: ");
       Serial.println(pulse);
   }

   void count_pulse()
   {
       pulse++;
   }
   ```

4. Open the Arduino Serial Monitor and blow air through the water flow sensor using your mouth.

5. The number of pulses per second will print on the Arduino Serial Monitor for each loop, as shown in the following screenshot:



```
Pulses per second: 11
Pulses per second: 27
Pulses per second: 6
Pulses per second: 19
Pulses per second: 113
Pulses per second: 118
Pulses per second: 93
Pulses per second: 132
Pulses per second: 133
Pulses per second: 105
Pulses per second: 85
Pulses per second: 183
Pulses per second: 169
Pulses per second: 208
Pulses per second: 185
Pulses per second: 203
Pulses per second: 160
Pulses per second: 158
Pulses per second: 188
Pulses per second: 161
Pulses per second: 196
```

Pulses per second in each loop

The `attachInterrupt()` function is responsible for handling the `count_pulse()` function. When the `interrupts()` function is called, the `count_pulse()` function will start to collect the pulses generated by the liquid flow sensor. This will continue for 1000 milliseconds, and then the `noInterrupts()` function is called to stop the operation of `count_pulse()` function. Then, the pulse count is assigned to the pulse variable and prints it on the serial monitor. This will repeat again and again inside the loop() function until you press the reset button or disconnect the Arduino from the power.

Calculating the water flow rate

The water flow rate is the amount of water flowing in at a given point of time and can be expressed in gallons per second or liters per second. The number of pulses generated per liter of water flowing through the sensor can be found in the water flow sensor's specification sheet. Let's say there are *m* pulses per liter of water.

You can also count the number of pulses generated by the sensor per second: Let's say there are *n* pulses per second.

The water flow rate *R* can be expressed as:

$$R = \frac{\text{n (pulse per second)}}{\text{m (pulse per litre)}}$$

In liters per second

Also, you can calculate the water flow rate in liters per minute using the following formula:

$$R = \frac{\text{n} * \text{60 (pulse per minute)}}{\text{m (pulse per litre)}}$$

For example, if your water flow sensor generates 450 pulses for one liter of water flowing through it, and you get 10 pulses for the first second, then the elapsed water flow rate is:

10/450 = 0.022 liters per second or *0.022 * 1000 = 22* milliliters per second.

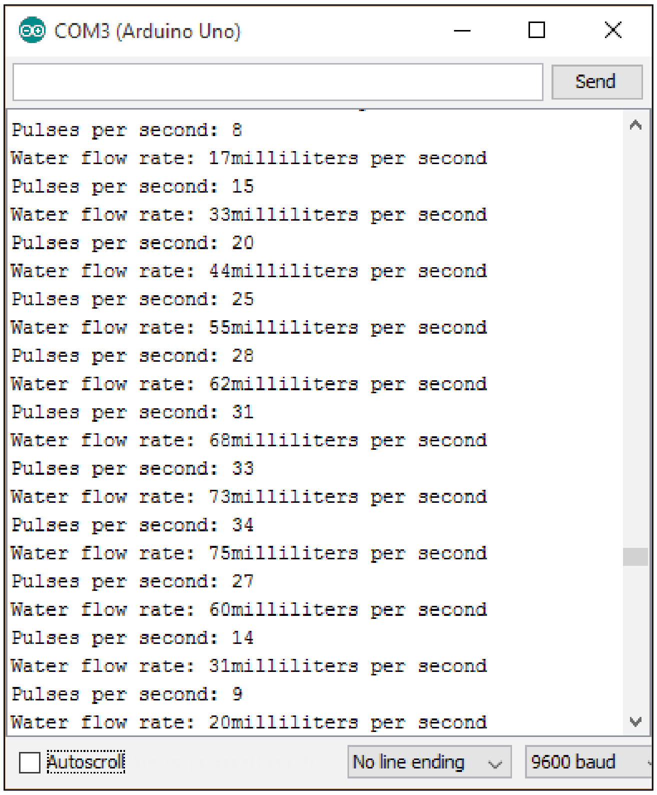
The following steps will explain you how to calculate the water flow rate using a simple Arduino sketch:

1. Open a new Arduino IDE and copy the sketch named `B04844_03_02.ino` from the `Chapter 3` sample code folder.
2. Verify and upload the sketch on the Arduino board.
3. The following code block will calculate the water flow rate in milliliters per second:

   ```
   Serial.print("Water flow rate: ");
   Serial.print(pulse * 1000/pulses_per_litre);
   Serial.println("milliliters per second");
   ```

4. Open the Arduino Serial Monitor and blow air through the water flow sensor using your mouth.

5. The number of pulses per second and the water flow rate in milliliters per second will print on the Arduino Serial Monitor for each loop, as shown in the following screenshot:



```
Pulses per second: 8
Water flow rate: 17milliliters per second
Pulses per second: 15
Water flow rate: 33milliliters per second
Pulses per second: 20
Water flow rate: 44milliliters per second
Pulses per second: 25
Water flow rate: 55milliliters per second
Pulses per second: 28
Water flow rate: 62milliliters per second
Pulses per second: 31
Water flow rate: 68milliliters per second
Pulses per second: 33
Water flow rate: 73milliliters per second
Pulses per second: 34
Water flow rate: 75milliliters per second
Pulses per second: 27
Water flow rate: 60milliliters per second
Pulses per second: 14
Water flow rate: 31milliliters per second
Pulses per second: 9
Water flow rate: 20milliliters per second
```

Pulses per second and water flow rate in each loop

Calculating the water flow volume

The water flow volume can be calculated by summing up the product of flow rate and the time interval:

$$\mathit{Volume} = \sum \mathit{Flow\ Rate} * \mathit{Time\_Interval}$$

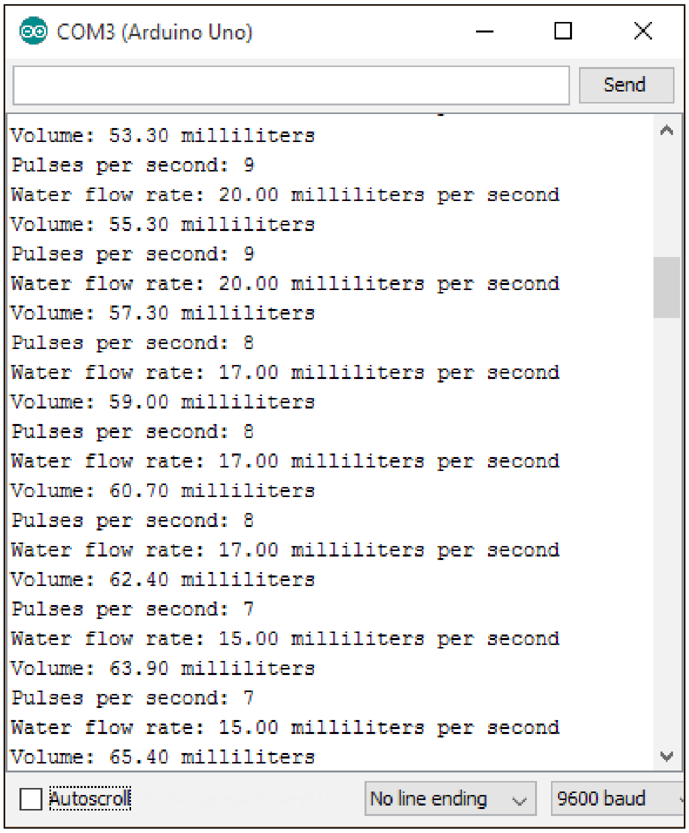
The following Arduino sketch will calculate and output the total water volume since the device startup:

1. Open a new Arduino IDE and copy the sketch named `B04844_03_03.ino` from the `Chapter 3` sample code folder.

2. The water flow volume can be calculated using following code block:

```
volume = volume + flow_rate * 0.1; //Time Interval is 0.1 second

Serial.print("Volume: ");
Serial.print(volume);
Serial.println(" milliliters");
```

3. Verify and upload the sketch on the Arduino board.
4. Open the Arduino Serial Monitor and blow air through the water flow sensor using your mouth.
5. The number of pulses per second, water flow rate in milliliters per second, and total volume of water in milliliters will be printed on the Arduino Serial Monitor for each loop, as shown in the following screenshot:



```
Volume: 53.30 milliliters
Pulses per second: 9
Water flow rate: 20.00 milliliters per second
Volume: 55.30 milliliters
Pulses per second: 9
Water flow rate: 20.00 milliliters per second
Volume: 57.30 milliliters
Pulses per second: 8
Water flow rate: 17.00 milliliters per second
Volume: 59.00 milliliters
Pulses per second: 8
Water flow rate: 17.00 milliliters per second
Volume: 60.70 milliliters
Pulses per second: 8
Water flow rate: 17.00 milliliters per second
Volume: 62.40 milliliters
Pulses per second: 7
Water flow rate: 15.00 milliliters per second
Volume: 63.90 milliliters
Pulses per second: 7
Water flow rate: 15.00 milliliters per second
Volume: 65.40 milliliters
```

Pulses per second, water flow rate and in each loop and sum of volume

To accurately measure water flow rate and volume, the water flow sensor needs to be carefully calibrated. The hall effect sensor inside the housing is not a precision sensor, and the pulse rate does vary a bit depending on the flow rate, fluid pressure, and sensor orientation. This topic is beyond the scope of this book.

Adding an LCD screen to the water meter

You can add an LCD screen to your newly built water meter to display readings, rather than displaying them on the Arduino serial monitor. You can then disconnect your water meter from the computer after uploading the sketch on to your Arduino.

Using a Hitachi HD44780 driver compatible LCD screen and Arduino Liquid Crystal library, you can easily integrate it with your water meter. Typically, this type of LCD screen has 16 interface connectors. The display has two rows and 16 columns, so each row can display up to 16 characters.

The following image represents the top view of a Hitachi HD44760 driver compatible LCD screen. Note that the 16-pin header is soldered to the PCB to easily connect it with a breadboard.

Hitachi HD44780 driver compatible LCD screen (16 x 2)—Top View

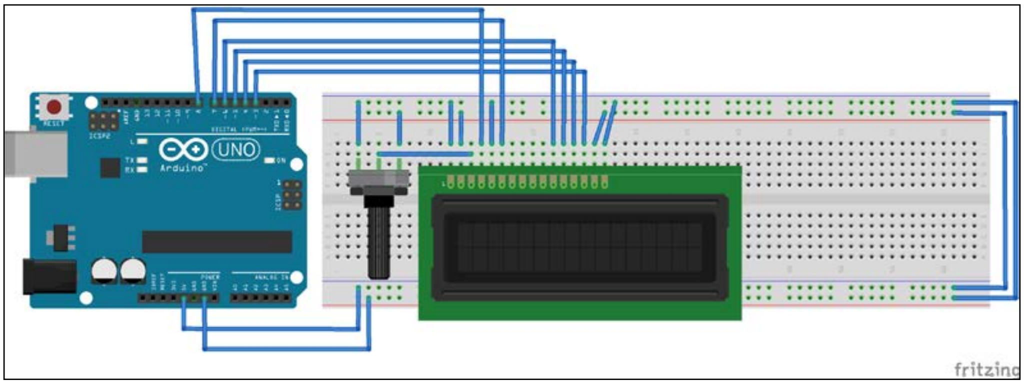
The following image represents the bottom view of the LCD screen. Again, you can see the soldered 16-pin header.

Hitachi HD44780 driver compatible LCD screen (16x2)—Bottom View

Wire your LCD screen with Arduino as shown in the next diagram. Use the 10k potentiometer to control the contrast of the LCD screen. Now, perform the following steps to connect your LCD screen with your Arduino:

1. LCD RS pin (pin number 4 from left) to Arduino digital pin 8.
2. LCD ENABLE pin (pin number 6 from left) to Arduino digital pin 7.
3. LCD READ/WRITE pin (pin number 5 from left) to Arduino GND.
4. LCD DB4 pin (pin number 11 from left) to Arduino digital pin 6.
5. LCD DB5 pin (pin number 12 from left) to Arduino digital pin 5.
6. LCD DB6 pin (pin number 13 from left) to Arduino digital pin 4.
7. LCD DB7 pin (pin number 14 from left) to Arduino digital pin 3.
8. Wire a 10K pot between Arduino +5V and GND, and wire its wiper (center pin) to LCD screen V0 pin (pin number 3 from left).
9. LCD GND pin (pin number 1 from left) to Arduino GND.
10. LCD +5V pin (pin number 2 from left) to Arduino 5V pin.

11. LCD Backlight Power pin (pin number 15 from left) to Arduino 5V pin.
12. LCD Backlight GND pin (pin number 16 from left) to Arduino GND.



Fritzing representation of the circuit

13. Open a new Arduino IDE and copy the sketch named `B04844_03_04.ino` from the `Chapter 3` sample code folder.
14. First initialize the Liquid Crystal library using following line:

```
#include <LiquidCrystal.h>
```

15. To create a new LCD object with following parameters, the syntax is `LiquidCrystal lcd (RS, ENABLE, DB4, DB5, DB6, DB7)`:

```
LiquidCrystal lcd(8, 7, 6, 5, 4, 3);
```

16. Then initialize number of rows and columns in the LCD. Syntax is `lcd.begin(number_of_columns, number_of_rows)`:

```
lcd.begin(16, 2);
```

17. You can set the starting location to print a text on the LCD screen using following function, syntax is `lcd.setCursor(column, row)`:

```
lcd.setCursor(7, 1);
```

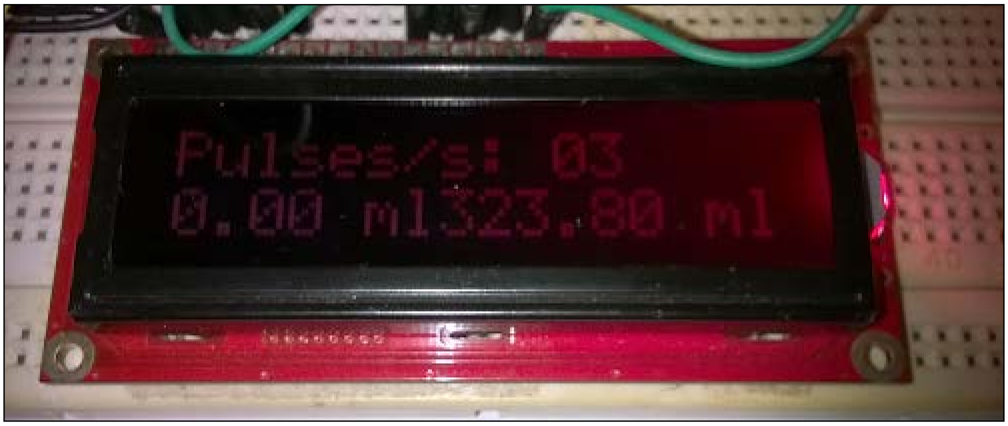
> Note that the column and row numbers are 0 index based and the following line will start to print a text in the intersection of the 8th column and 2nd row.

18. Then, use the `lcd.print()` function to print some text on the LCD screen:

```
lcd.print(" ml/s");
```

19. Verify and upload the sketch on the Arduino board.
20. Blow some air through the water flow sensor using your mouth.

You can see some information on the LCD screen such as pulses per second, water flow rate, and total water volume from the beginning of the time:



```
Pulses/s: 03
0.00 ml323.80 ml
```

LCD screen output

Converting your water meter to a web server

In the previous steps, you learned how to display your water flow sensor's readings and calculate water flow rate and total volume on the Arduino serial monitor. In this step, you will learn how to integrate a simple web server to your water flow sensor and remotely read your water flow sensor's readings.

You can make an Arduino web server with Arduino WiFi Shield or Arduino Ethernet shield. The following steps will explain how to convert the Arduino water flow meter to a web server with Arduino Wi-Fi shield:

1. Remove all the wires you have connected to your Arduino in the previous sections in this chapter.
2. Stack the Arduino WiFi shield on the Arduino board using wire wrap headers. Make sure the Arduino WiFi shield is properly seated on the Arduino board.
3. Now, reconnect the wires from water flow sensor to the Wi-Fi shield. Use the same pin numbers as used in the previous steps.
4. Connect the 9VDC power supply to the Arduino board.

5. Connect your Arduino to your PC using the USB cable and upload the next sketch. Once the upload is completed, remove your USB cable from the Arduino.
6. Open a new Arduino IDE and copy the sketch named `B04844_03_05.ino` from the `Chapter 3` sample code folder.
7. Change the following two lines according to your WiFi network settings, as shown here:

```
char ssid[] = "MyHomeWiFi";
char pass[] = "secretPassword";
```

8. Verify and upload the sketch on the Arduino board.
9. Blow the air through the water flow sensor using your mouth, or it would be better if you can connect the water flow sensor to a water pipeline to see the actual operation with the water.
10. Open your web browser, type the WiFi shield's IP address assigned by your network, and hit the *Enter* key:

```
http://192.168.1.177
```

11. You can see your water flow sensor's pulses per second, flow rate, and total volume on the Web page. The page refreshes every 5 seconds to display updated information.
12. You can add an LCD screen to the Arduino WiFi shield as discussed in the previous step. However, remember that you can't use some of the pins in the Wi-Fi shield because they are reserved for SD (pin 4), SS (pin 10), and SPI (pin 11, 12, 13). We have not included the circuit and source code here in order to make the Arduino sketch simple.

A little bit about plumbing

Typically, the direction of the water flow is indicated by an arrow mark on top of the water flow meter's enclosure. Also, you can mount the water flow meter either horizontally or vertically according to its specifications. Some water flow meters can mount both horizontally and vertically.

You can install your water flow meter to a half-inch pipeline using normal BSP pipe connectors. The outer diameter of the connector is 0.78" and the inner thread size is half-inch.

The water flow meter has threaded ends on both sides. Connect the threaded side of the PVC connectors to both ends of the water flow meter. Use a thread seal tape to seal the connection, and then connect the other ends to an existing half-inch pipeline using PVC pipe glue or solvent cement.

Make sure that you connect the water flow meter with the pipe line in the correct direction. See the arrow mark on top of the water flow meter for flow direction.

BNC pipe line connector made by PVC

Securing the connection between the water flow meter and BNC pipe connector using thread seal

PVC solvent cement. Image taken from `https://www.flickr.com/photos/ttrimm/7355734996/`

Summary

In this chapter, you gained hands-on experience and knowledge about water flow sensors and counting pulses while calculating and displaying them. Finally, you made a simple web server to allow users to read the water meter through the Internet. You can apply this to any type of liquid, but make sure to select the correct flow sensor because some liquids react chemically with the material that the sensor is made of. You can Google and find which flow sensors support your preferred liquid type.

The next chapter will help you to make your own security camera with motion detection based on Arduino and Ethernet shield. You will be monitoring your home surroundings remotely in no time.

4
Arduino Security Camera with Motion Detection

Security is a concern for everyone. If you want to capture and record any activity within your home or office for security purposes, thousands of security camera models are available to fulfill the task. You can, however, make your own security camera, complete with Internet feedback and motion detection, and you can also access the camera images from your mobile's browser from anywhere in the world.

In this chapter, you will learn the following:

- How to use **TTL** (**Through The Lens**) Serial Camera directly with NTSC video screen. You can read more about TTL at `https://en.wikipedia.org/wiki/Through-the-lens_metering`.
- How to connect TTL Serial Camera to Arduino and Ethernet Shield.
- How to capture images with TTL Serial Camera.
- How to create Flickr and Temboo accounts and configure with Arduino Ethernet Shield.
- How to upload images to the Flickr using the Temboo cloud service.
- How to capture images with built-in motion sensor and upload them to the Flickr.

Prerequisites

The following materials will be needed to get started with the chapter:

- Arduino UNO Rev3 board (`https://store.arduino.cc/product/A000066`).
- Arduino Ethernet Shield Rev3 (`https://store.arduino.cc/product/A000072`).
- Arduino Ethernet board (optional)— if you use an Arduino Ethernet board, you do not need an Arduino UNO board. Arduino Ethernet board is a compact collection of an Arduino board and Ethernet Shield. (`https://www.sparkfun.com/products/11229`).
- Micro SD Card—Use 4GB Class 4 SDHC. (`https://www.adafruit.com/products/102`).
- TTL Serial Camera (`http://www.adafruit.com/products/397`).
- 9V DC power supply (`https://www.sparkfun.com/products/10273`).
- USB A-to-B cable (`https://www.sparkfun.com/products/512`).
- RCA jack (`https://www.sparkfun.com/products/8631`).
- Ethernet Cable (`https://www.sparkfun.com/products/8915`).
- Optional - NTSC/PAL TFT display – 4.3" Diagonal (`http://www.adafruit.com/product/946`).
- Jumper wires.
- Wire Strippers (`https://www.sparkfun.com/products/12630`).
- Soldering iron (EU:230V AC: `https://www.sparkfun.com/products/11650`, US 110V AC: `https://www.sparkfun.com/products/9507`).

Getting started with TTL Serial Camera

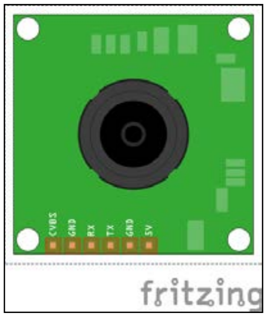
The heart of the TTL Serial Camera module (the product page at Adafruit named it as TTL Serial JPEG Camera) is the VIMICRO VC0706 Digital video Processor. The following are some of the features that a VC0706 digital video processor has:

- CMOS sensor interface and digital video input interface, so it can capture video using the CMOS sensor or external TV decoder
- Embedded TV encoder and video DAC, so it can directly output NTSC/PAL video streams to TV monitors and other 75 ohm display devices

- Preimage processing and M-JPEG compression ability
- NTSC video output resolution up to 712 x 486
- PAL video output resolution up to 704 x 576
- Maximum frame rate; 60fps @ 27MHz in NTSC and 50fps @ 27MHz in PAL
- Ability to change the brightness, saturation, and hue of images
- Auto brightness and auto contrast adjustment
- Motion detection

The VC0706 chipset specification mentioned that it supports both NTSC and PAL but the TTL Serial Camera module only implemented NTSC.

The TTL Serial Camera is only just a breakout board and has no wires, so you need to solder wires into the connection pads. It has five connection pads, which are 2mm apart from each other.



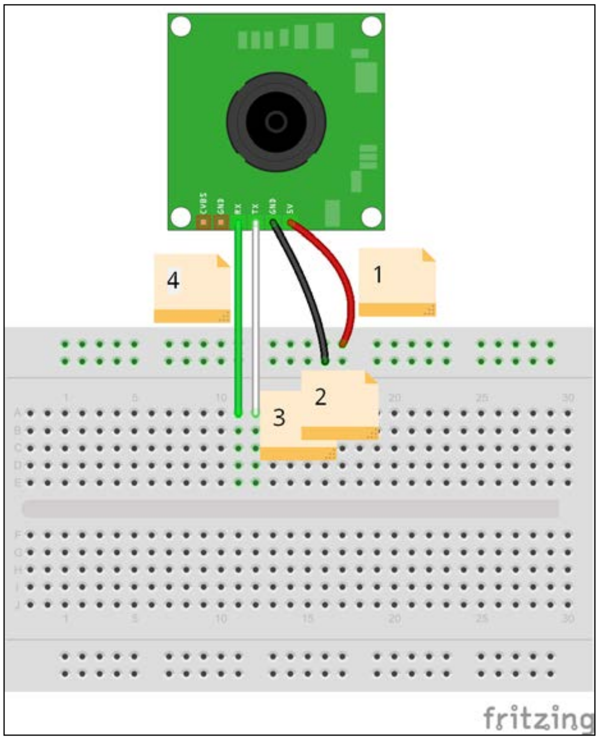
A Fritzing representation of TTL Serial Camera—top view

The pin labels and their core operation is listed as follows:

- **CVBS**: Outputs NTSC monochrome video stream
- **GND**: This is the NTSC video ground, located next to the CVBS pad
- **TX**: Data transmits from the module
- **RX**: Data reception to the module
- **GND**: Negative
- **+5V**: Positive

Wiring the TTL Serial Camera for image capturing

You need four wires if you are only planning to capture color images with a TTL serial camera.



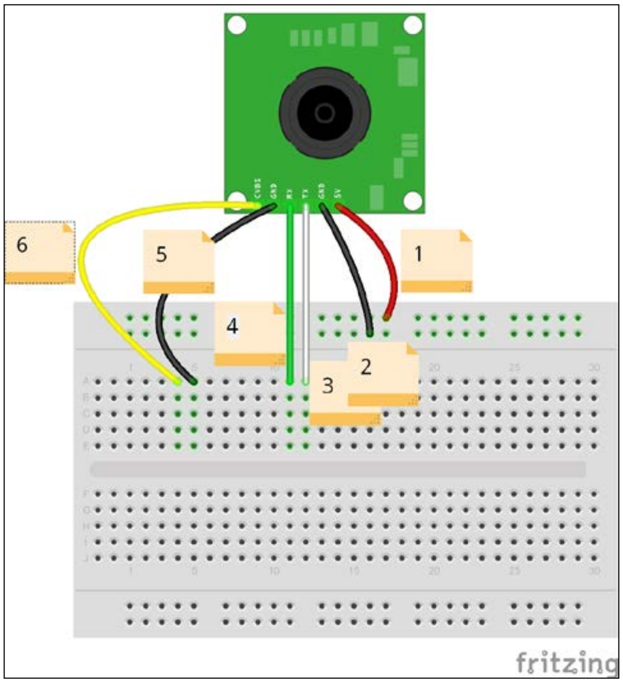
Wiring for image capturing in the JPEG format

Solder wires to the connection pads are mentioned as:

- Solder wire **1** (red) into the +5v connector pad
- Solder wire **2** (black) into the GND connector pad
- Solder wire **3** (white) into the TX connector pad
- Solder wire **4** (green) into the RX connector pad

Wiring the TTL Serial Camera for video capturing

The TTL Serial Camera board only supports NTSC video output and cannot be used as PAL. Now, solder two additional wires as shown in the following diagram:



Wiring for video capturing with NTSC monochrome

Solder additional wires to the connection pads are mentioned as:

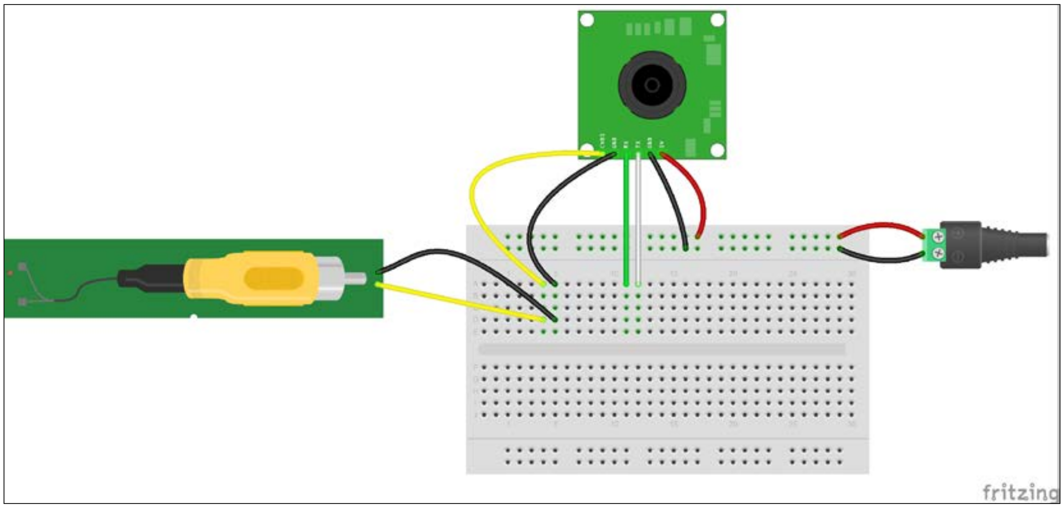
- Solder wire **5** (black) into the GND connector pad
- Solder wire **6** (yellow) into the CVBS connector pad

Testing NTSC video stream with video screen

Use an RCA jack and solder two wires, as stated here:

- Solder a yellow wire to the center terminal
- Solder a black wire to the outer terminal

Then make the other connections as follows:



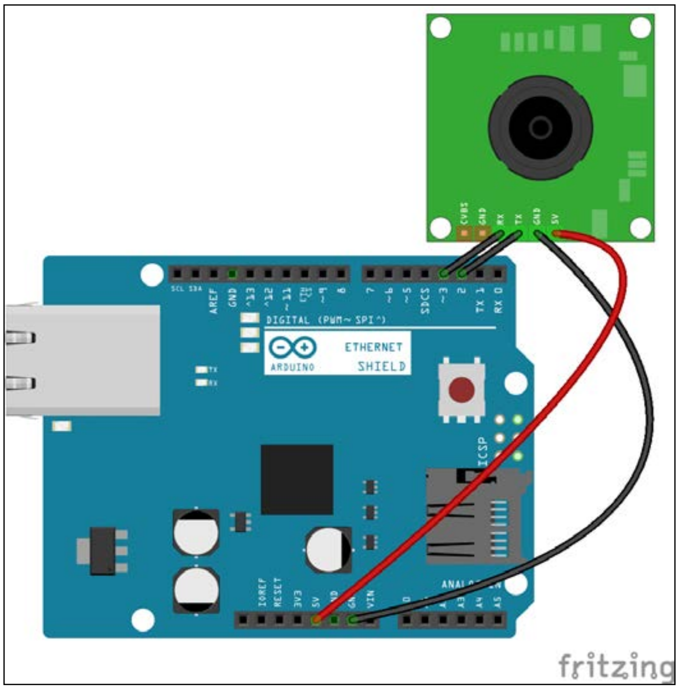
1. Connect the yellow wire to the RCA jack's signal terminal.
2. Connect the black wire to the RCA jack's ground terminal.
3. Now, connect the TTL serial camera to a regulated 5V power source, the red wire to positive, and the black wire to negative. You can use an Arduino board to get the regulated 5V power. Connect the red wire to Arduino 5V pin and the black wire to Arduino GND pin, and connect Arduino to the 9v power supply.
4. Finally, connect the soldered RCA jack to the NTSC monitor using an RCA video cable. If you are living in a region that does not support the NTSC broadcasting system, then you have to purchase a basic NTSC/PAL monitor. But some televisions support both NTSC and PAL broadcasting systems. Check your television's user manual for more information. If it does not support NTSC, then you have to purchase an NTSC- supported monitor from Adafruit (`http://www.adafruit.com/product/946`), or search eBay for a cheaper one.

Now, power up the monitor. You can see the monochrome video that has been captured by the TTL Serial Camera module. Next, we will move on to the most difficult part.

Connecting the TTL Serial Camera with Arduino and Ethernet Shield

Stack up your Arduino Ethernet Shield with the Arduino board as you did in the previous chapters and perform the following steps:

1. Connect your TTL Serial Camera module with the Arduino and Ethernet Shield as shown in the diagram below. Here, we will use two Arduino digital pins and a Software Serial port to communicate with the camera.

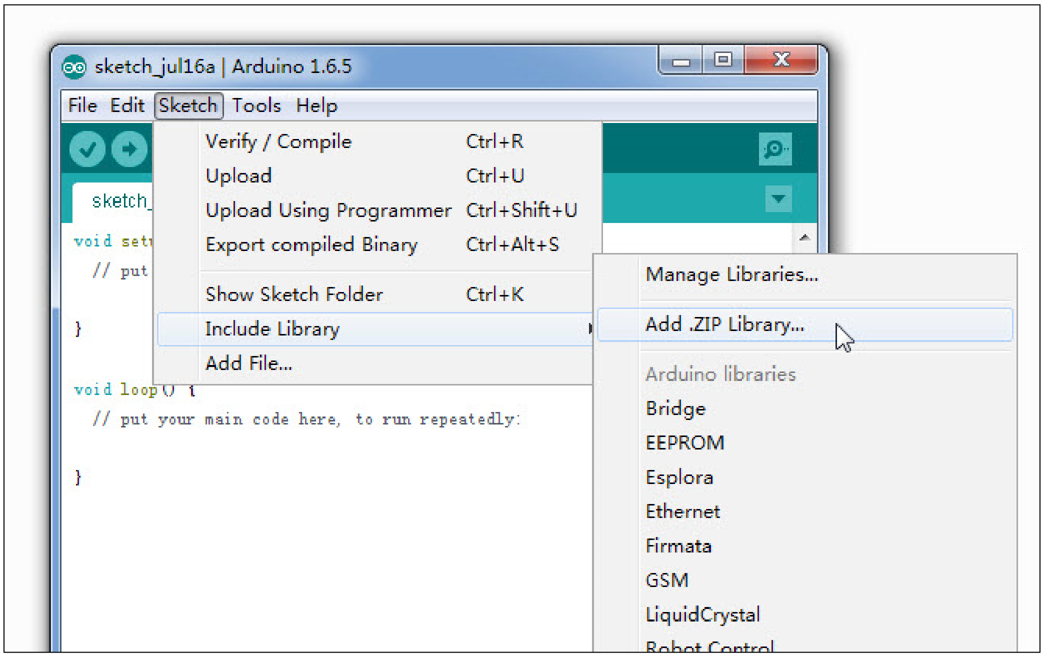


The Adafruit VC0706 Serial JPEG Camera is connected with Arduino Ethernet Shield

2. Connect camera TX to Arduino digital pin **2** and camera RX to Arduino digital pin **3**.
3. Connect camera **GND** to Arduino **GND** and camera **5V** to Arduino **5V**.
4. Now insert a Micro SD card into the SD card connector on the Ethernet shield. Remember the Arduino communicates with the SD card using digital pin **4**.

5. Download the Adafruit VC0706 camera library from GitHub by navigating to `https://github.com/adafruit/Adafruit-VC0706-Serial-Camera-Library`. After it has been downloaded, extract the ZIP file into your local drive.
6. Next, rename the folder `Adafruit-VC0706-Serial-Camera-Library` to `Adafruit_VC0706`, and move the renamed `Adafruit_VC0706` folder to the libraries folder. Note that the libraries folder resides in the Arduino IDE folder.

   Alternatively, in the recent version of Arduino IDE, you can add a new library ZIP file by navigating to **Sketch** | **Include Library** | **Add .ZIP Library…**. Then, browse the ZIP file and click on the **Open** button. This will add the particular library to the Arduino libraries folder.



```
void sett
  // put

}

void loop() {
  // put your main code here, to run repeatedly:

}
```

Including a new library by a ZIP file

7. Finally, restart the Arduino IDE.

The Adafruit VC0706 camera library includes sample sketches for image capturing and motion detection. You can verify them by navigating to **File** | **Examples** | **Adafruit VC0706 Serial Camera Library**.

Image capturing with Arduino

You can capture and save images in a Micro SD card using the Adafruit VC0706 camera library. Use the following steps to play with the sample sketches that ship with the Adafruit VC0706 camera library:

1. Open the Arduino IDE and go to **File | Example | Adafruit_VC0706 | Snapshot**.
2. Upload the code on your Arduino board. (Also, you can copy the code `B04844_04_01.ino` from the `Chapter 4` code folder)
3. Once uploaded, the camera will capture and save an image in the SD card with a resolution of 640 x 480. On the Arduino serial monitor, you can see some useful information about the image that is taken, such as the image resolution, image size in bytes, and the number of seconds taken to capture and save the image, which is in the JPG format.

Press the Arduino RESET button to capture the next image. You can use the RESET button to capture any subsequent images. But this sketch is limited to capturing images up to 100 times.

Insert your Micro SD card into the card reader of your PC, browse the SD card, and open the images using any image viewer installed in your computer. Cool!

Now, we will look into some important points of this sample code in the next section so that we can modify the code according to our requirements.

The Software Serial library

Arduino comes with hardware serial enabled, where pins 0 and 1 can be used to communicate with the serial devices. Pin 0 transmits (TX) the data to out and pin 1 receives (RX) data to in. However, using the Software Serial library, you can convert any digital pin in to TX or RX. For this project, we will use digital pins 2 for RX and 3 for TX.

```
SoftwareSerial(RX, TX)
```

The following code snippet shows how to use the Software Serial library to convert Arduino digital pin 2 as RX and digital pin 3 as TX:

```
// On Uno: camera TX connected to pin 2, camera RX to pin 3:
SoftwareSerial cameraconnection = SoftwareSerial(2, 3);
```

How the image capture works

The following code snippets show the important sections of the Arduino sketch.

To create a new object using the `Adafruit_VC0706` class, write a code line similar to the following. This will create the object `cam`:

```
Adafruit_VC0706 cam = Adafruit_VC0706(&cameraconnection);
```

The camera module can be used to take images in three different sizes. The largest size of the image we can take is 640 x 480. In the following code snippet, the camera will capture images in resolutions of 640 x 480. Uncomment the line you want to set as the image size.

```
// Set the picture size - you can choose one of 640x480, 320x240 or
160x120
 // Remember that bigger pictures take longer to transmit!
 cam.setImageSize(VC0706_640x480);  // biggest
 //cam.setImageSize(VC0706_320x240);  // medium
 //cam.setImageSize(VC0706_160x120);   // small
```

The `takePicture()` function of the `cam` object can be used to take a picture from the camera.

```
if (! cam.takePicture())
    Serial.println("Failed to snap!");
  else
    Serial.println("Picture taken!");
...
```

Then, create a filename for the new file by looking at the existing files stored in the SD card.

Finally, write the new image file on the SD card. This process is quite complicated and time consuming.

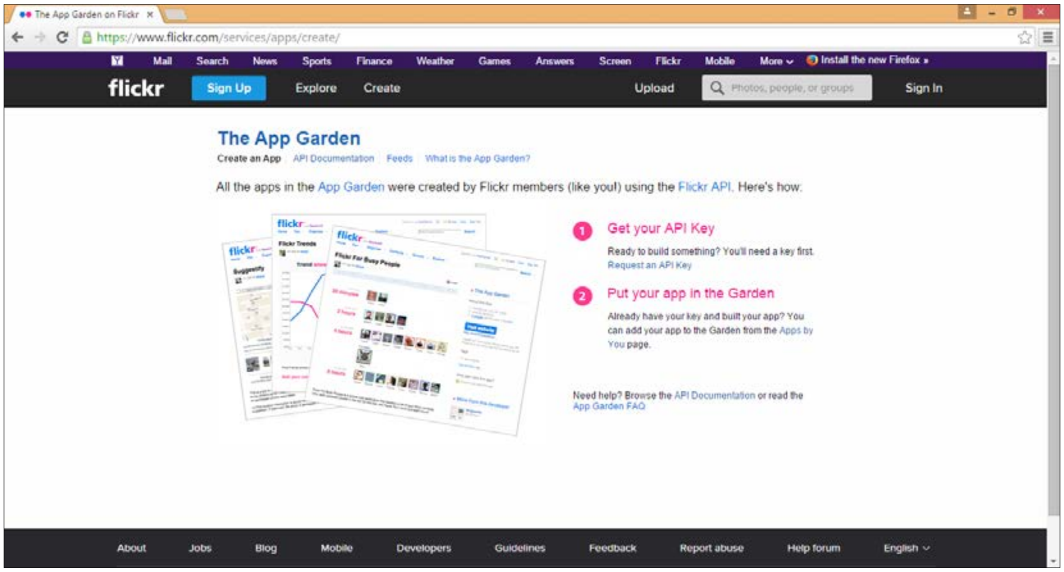
Uploading images to Flickr

Rather than saving the captured image in an SD card, we can automatically upload the image to Flickr. In the next section, we will learn how to do this with Flickr and Temboo cloud service.

Creating a Flickr account

Follow these steps to create a Flickr account:

1. Open your Internet browser, navigate to `https://www.flickr.com/`.
2. Click on the **Sign In** link in the top-right corner of the page. If you already have a Yahoo account, you can use the same login credentials to log in to Flickr.
3. If you don't have a Yahoo account, click on **Sign Up** in the top-left corner of the page, or on the **Sign up with Yahoo** button in the center of the page and follow the instructions to create a new Yahoo account.
4. After you have successfully logged in to Flickr, click on the **Explore** menu in the top, and in the resulting drop-down menu, click on **App Garden**.
5. **The App Garden** page will appear, as shown in the following screenshot:



The App Garden

All the apps in the App Garden were created by Flickr members (like you!) using the Flickr API. Here's how:

1 Get your API Key

Ready to build something? You'll need a key first.
Request an API Key

2 Put your app in the Garden

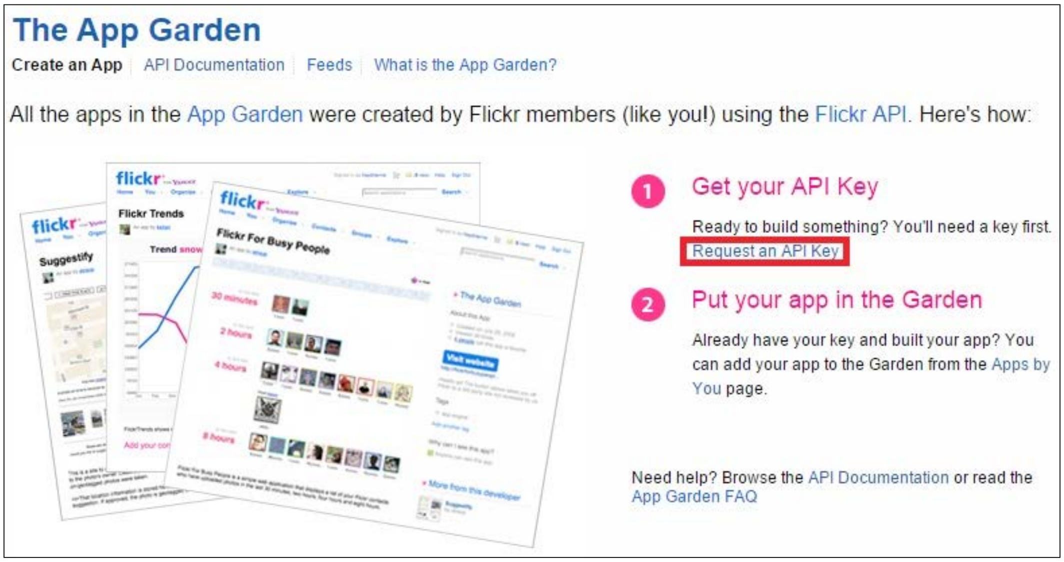
Already have your key and built your app? You can add your app to the Garden from the Apps by You page.

Need help? Browse the API Documentation or read the App Garden FAQ

Flickr: The App Garden page

6. Click on the **Create an App** link if it is not selected by default.

7. Under **Get your API Key**, click on **Request an API Key**, as shown in the following screenshot:



The App Garden

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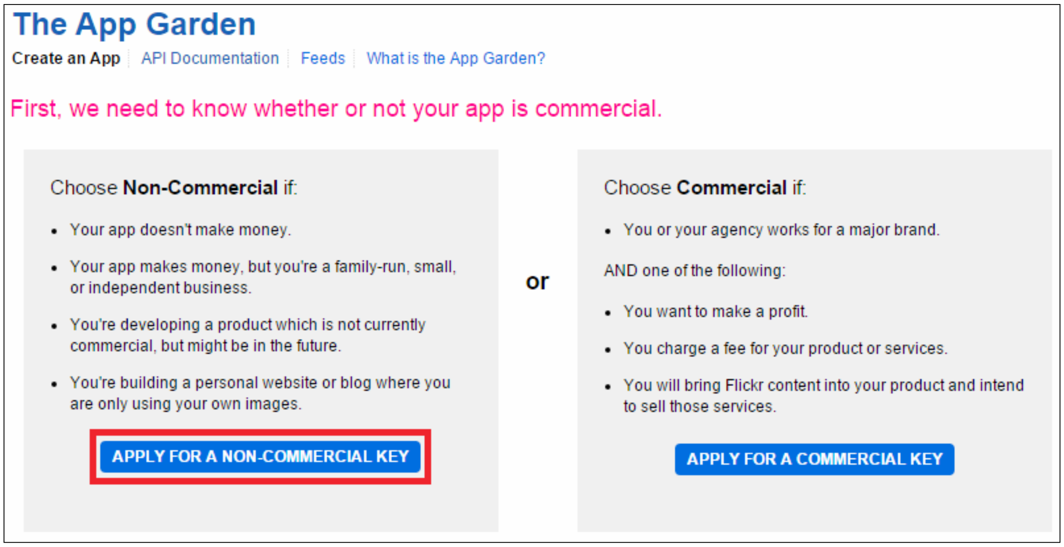
Need help? Browse the API Documentation or read the App Garden FAQ

Flickr: The App Garden page

8. Click on the **APPLY FOR A NON-COMMERCIAL KEY** button, as shown here:



The App Garden

First, we need to know whether or not your app is commercial.

Choose **Non-Commercial** if:

- Your app doesn't make money.
- Your app makes money, but you're a family-run, small, or independent business.
- You're developing a product which is not currently commercial, but might be in the future.
- You're building a personal website or blog where you are only using your own images.

APPLY FOR A NON-COMMERCIAL KEY

or

Choose **Commercial** if:

- You or your agency works for a major brand.

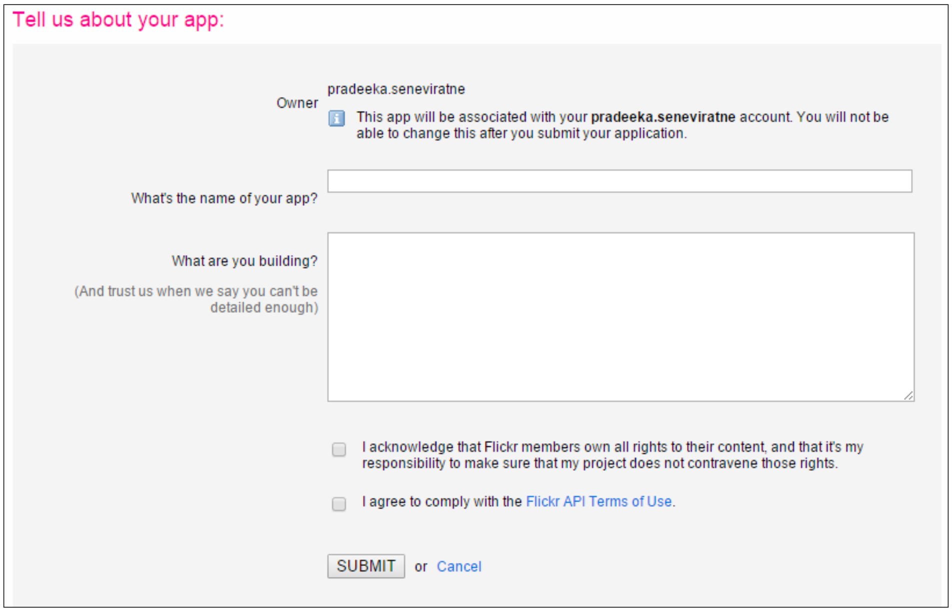
AND one of the following:

- You want to make a profit.
- You charge a fee for your product or services.
- You will bring Flickr content into your product and intend to sell those services.

APPLY FOR A COMMERCIAL KEY

Flickr: The App Garden page

9. The **Tell us about your app** page will appear, as shown in the following screenshot:



Tell us about your app:

Owner pradeeka.seneviratne

This app will be associated with your **pradeeka.seneviratne** account. You will not be able to change this after you submit your application.

What's the name of your app?

What are you building?

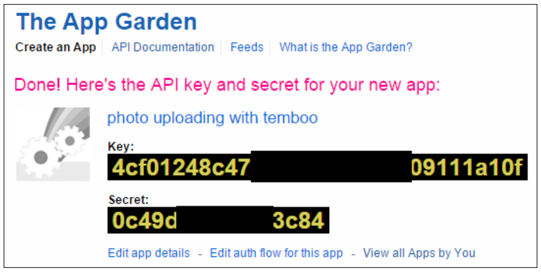
(And trust us when we say you can't be detailed enough)

□ I acknowledge that Flickr members own all rights to their content, and that it's my responsibility to make sure that my project does not contravene those rights.

□ I agree to comply with the Flickr API Terms of Use.

Flickr: The App Garden page

10. Fill the following text boxes:
    - **What's the name of your app?**: Give a short name for your app
    - **What are you building?**: Give a brief description about your app and its purpose
11. Check the two checkboxes.
12. Click on the **SUBMIT** button.
13. The API **Key** and **Secret** for your new app will be displayed in the next page, as shown here:



The App Garden

Create an App | API Documentation | Feeds | What is the App Garden?

Done! Here's the API key and secret for your new app:

photo uploading with temboo

Key:
4cf01248c47 [redacted] 09111a10f

Secret:
0c49d [redacted] 3c84

Edit app details - Edit auth flow for this app - View all Apps by You

Flickr: The App Garden page

Copy and paste the API Key and Secret into a notepad, if you think it will be easy for your reference later.

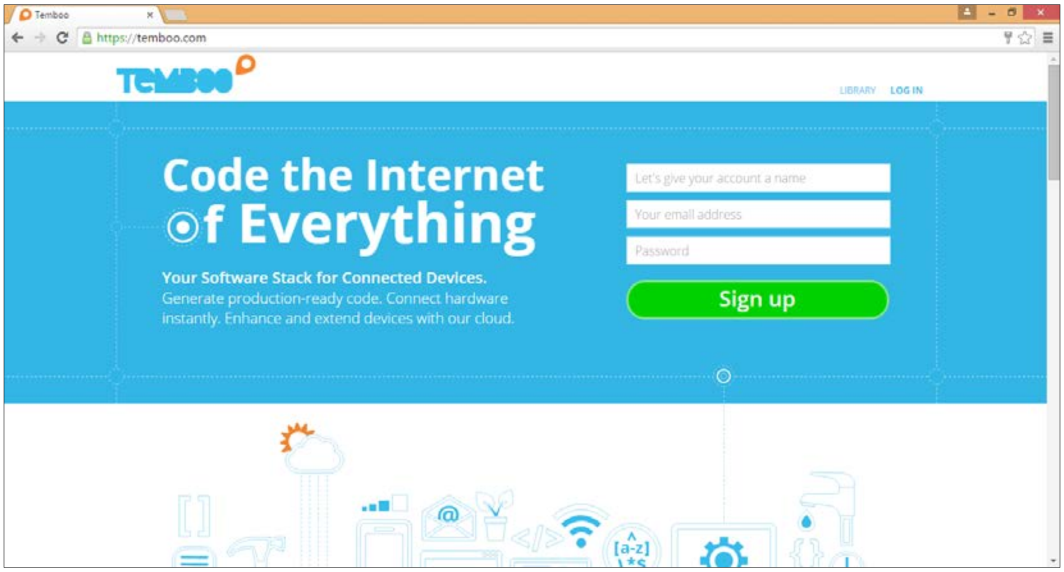
That's it for the moment. Later, you have to again visit the Flickr website, so don't sign out from Flickr. To access Flickr services, we have to create a Temboo account and make some configurations.

Creating a Temboo account

Temboo provides normalized access to 100+ APIs and databases. It provides code-based, task-specific code components called **Choreos** that can be used with the Arduino language to simplify the complex tasks such as uploading images to Flickr, sending SMS, sending Twitter tweets, and many more.

Let's look at how to create a new Temboo account, so you can use this account for experimenting with Temboo and Arduino.

1. First, navigate to `https://temboo.com/` using your Internet browser.



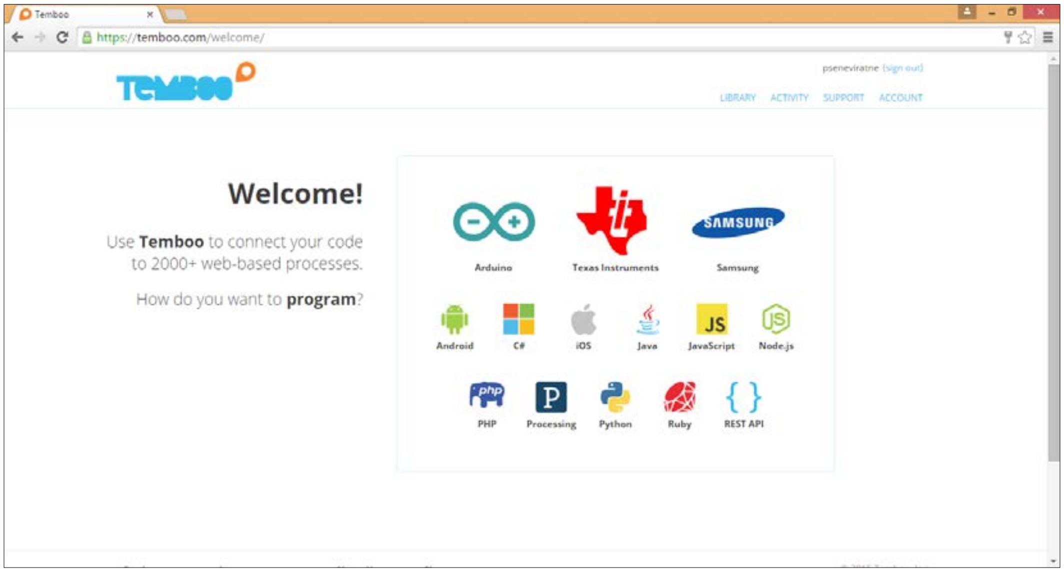
Code the Internet of Everything

Your Software Stack for Connected Devices.
Generate production-ready code. Connect hardware instantly. Enhance and extend devices with our cloud.

The Temboo home page

2. Then, you have to create a new user account in Temboo.

3. In the top-right corner of the page, there is a section for **Sign up**. Enter a name for your account, a valid e-mail address, and a password (which must have eight characters, at least one letter, and one number); agree with Temboo terms and click on the **Sign up** button. The **Welcome** page will appear, as shown here:



Welcome!

Use **Temboo** to connect your code to 2000+ web-based processes.

How do you want to **program**?

The Temboo Welcome page

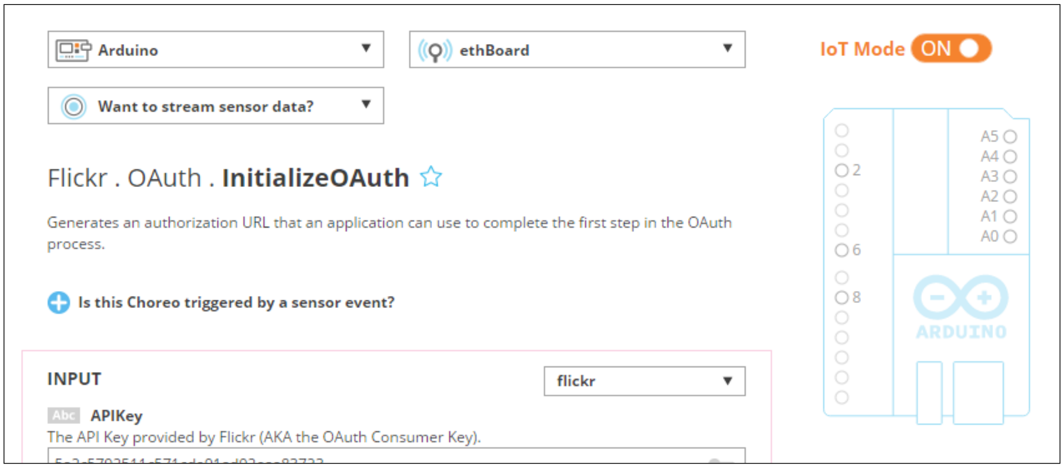
Creating your first Choreo

Now, we are ready to create our first Choreo. To do this, we need to complete a series of configurations and processing steps with Temboo.

Initializing OAuth

In the top-right of the Temboo web page, click on **LIBRARY**. The **LIBRARY** page will appear. Under the **CHOREOS** pane (listed in the left-hand side of the page) go to **Flickr** | **OAuth** by clicking on the down arrow signs, and finally, click on **InitializeOAuth**.

First, enable **IoT Mode,** as shown in the following screenshot:



Arduino ▼ ethBoard ▼

IoT Mode ON

Want to stream sensor data? ▼

Flickr . OAuth . **InitializeOAuth** ☆

Generates an authorization URL that an application can use to complete the first step in the OAuth process.

Is this Choreo triggered by a sensor event?

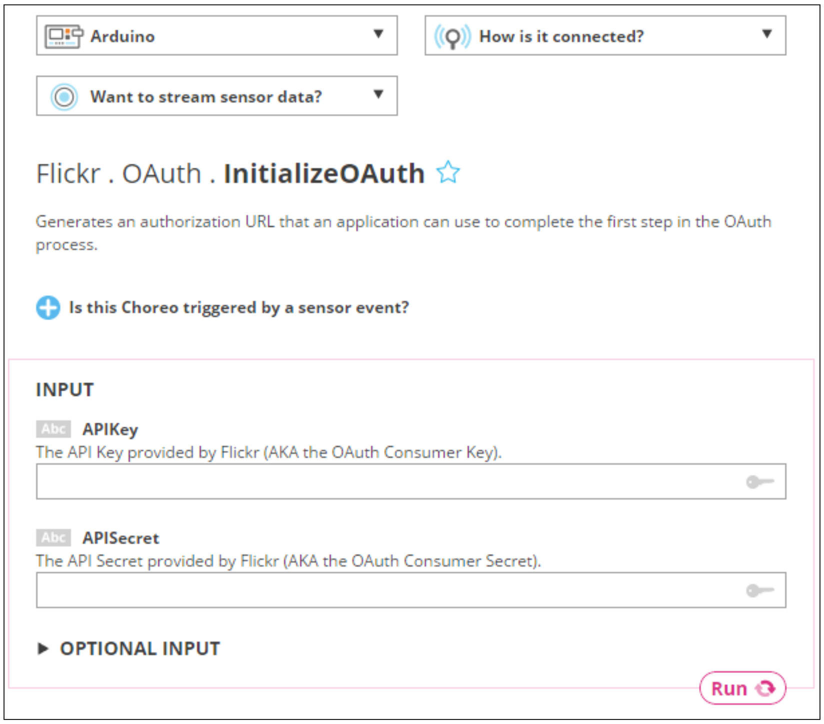
INPUT flickr ▼

Abc **APIKey**

The API Key provided by Flickr (AKA the OAuth Consumer Key).

Enabling IoT mode

Then, configure the form as shown in the following steps:



Arduino ▼ How is it connected? ▼

Want to stream sensor data? ▼

Flickr . OAuth . **InitializeOAuth** ☆

Generates an authorization URL that an application can use to complete the first step in the OAuth process.

Is this Choreo triggered by a sensor event?

INPUT

Abc **APIKey**

The API Key provided by Flickr (AKA the OAuth Consumer Key).

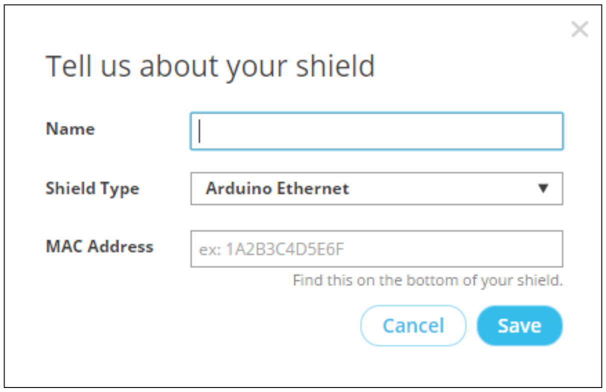
Abc **APISecret**

The API Secret provided by Flickr (AKA the OAuth Consumer Secret).

▶ **OPTIONAL INPUT**

Initialize OAuth for Flicker

1. Select **Arduino** from the left drop-down menu. The default is **Arduino Yún**.
2. Select **Arduino Ethernet** from the **How is it connected?** drop-down menu. The **Tell us about your shield** dialog box will appear.



Tell us about your shield

Name:

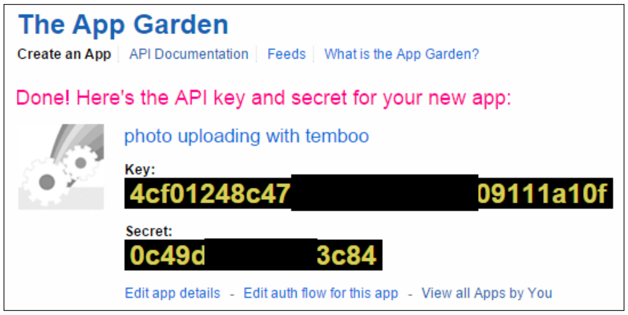
Shield Type: Arduino Ethernet

MAC Address: ex: 1A2B3C4D5E6F

Find this on the bottom of your shield.

Tell us about your shield dialog box

3. Type a name for your shield and type the MAC address of your shield in the **MAC Address** field without any spaces. Then, click on the **Save** button.
4. Under the **INPUT** section, enter the following:
    - **APIKey**: Enter the API key provided by Flickr
    - **APISecret**: Enter the API Secret provided by Flickr



The App Garden

Create an App
API Documentation
Feeds
What is the App Garden?

Done! Here's the API key and secret for your new app:

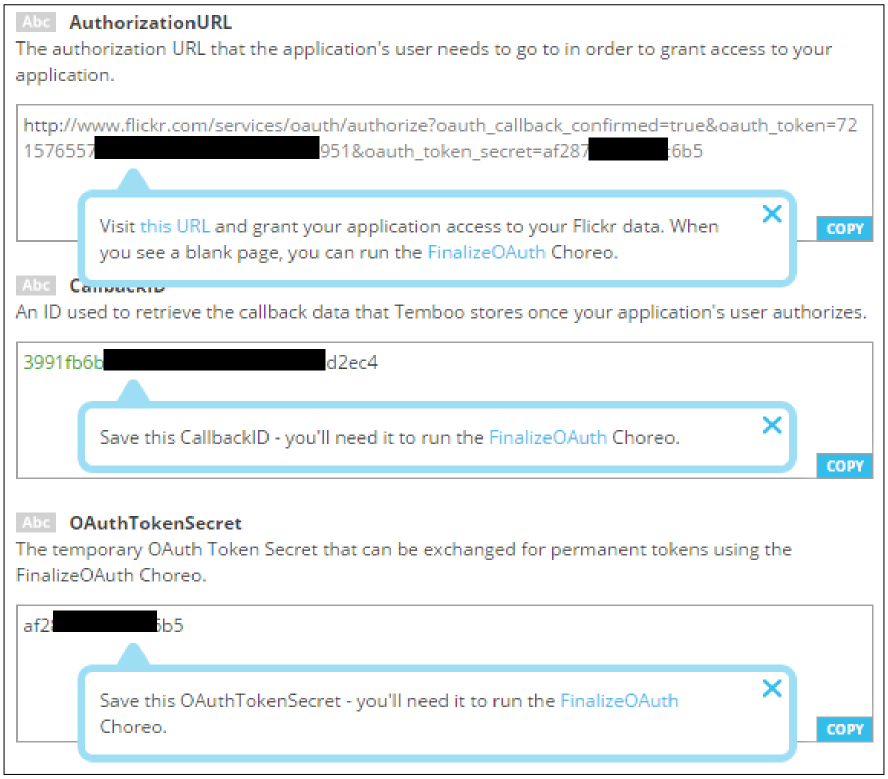
photo uploading with temboo

Key: 4cf01248c47[redacted]09111a10f

Secret: 0c49d[redacted]3c84

Edit app details - Edit auth flow for this app - View all Apps by You

5. Click on the **Run** button to process the OAuth initialization. In a few seconds, the process will generate following output:



Abc **AuthorizationURL**

The authorization URL that the application's user needs to go to in order to grant access to your application.

http://www.flickr.com/services/oauth/authorize?oauth_callback_confirmed=true&oauth_token=72 1576557[redacted]951&oauth_token_secret=af287[redacted]6b5

Visit this URL and grant your application access to your Flickr data. When you see a blank page, you can run the FinalizeOAuth Choreo.

Abc **CallbackID**

An ID used to retrieve the callback data that Temboo stores once your application's user authorizes.

3991fb6b[redacted]d2ec4

Save this CallbackID - you'll need it to run the FinalizeOAuth Choreo.

Abc **OAuthTokenSecret**

The temporary OAuth Token Secret that can be exchanged for permanent tokens using the FinalizeOAuth Choreo.

af2[redacted]6b5

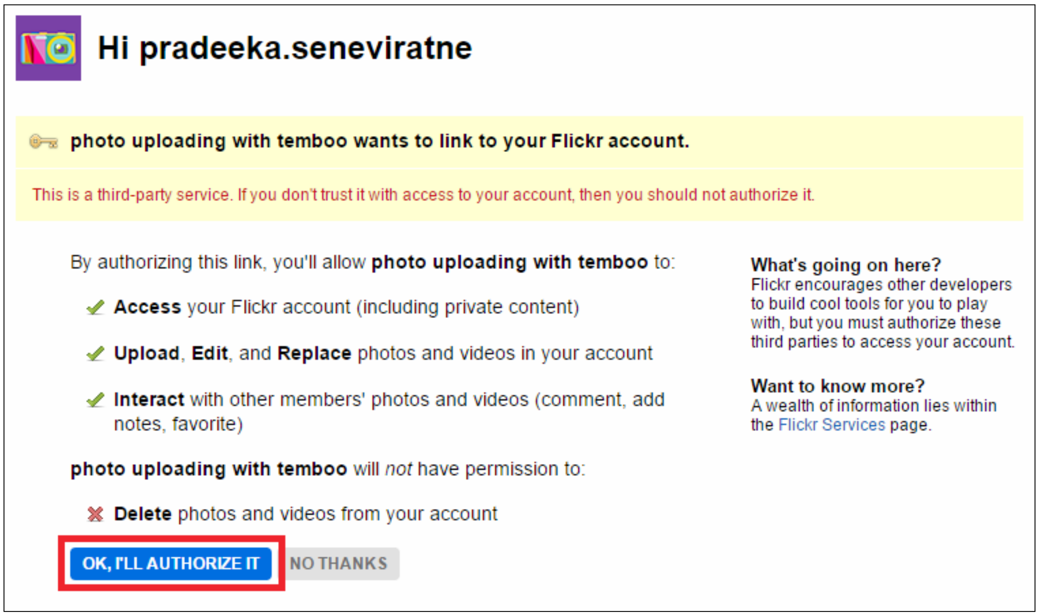
Save this OAuthTokenSecret - you'll need it to run the FinalizeOAuth Choreo.

Output after the process of OAuth initialization for Flickr

The following listing of information is extracted from the preceding output. The information will differ according to your setup.

- **Authorization URL**: `http://www.flickr.com/services/oauth/authorize?oauth_callback_confirmed=true&oauth_token=7215xxxxxxxxxxxxxxxxxxxxx951&oauth_token_secret=af287xxxxxxxxc6b5`
- **CallbackID**: `3991fb6b-xxxxxxxxxxxxxxxx-b83e453d2ec4`
- **OAuthTokenSecret**: `af287xxxxxxxxc6b5`

6. Open a new browser tab and paste the authorization URL into the address bar and press the *Enter* key on your key board. A page will appear for authorization confirmation, as shown here:



Hi pradeeka.seneviratne

photo uploading with temboo wants to link to your Flickr account.

This is a third-party service. If you don't trust it with access to your account, then you should not authorize it.

By authorizing this link, you'll allow **photo uploading with temboo** to:

- ✓ **Access** your Flickr account (including private content)
- ✓ **Upload**, **Edit**, and **Replace** photos and videos in your account
- ✓ **Interact** with other members' photos and videos (comment, add notes, favorite)

photo uploading with temboo will *not* have permission to:

- ✗ **Delete** photos and videos from your account

What's going on here?
Flickr encourages other developers to build cool tools for you to play with, but you must authorize these third parties to access your account.

Want to know more?
A wealth of information lies within the Flickr Services page.

A Flicker user account authorization page

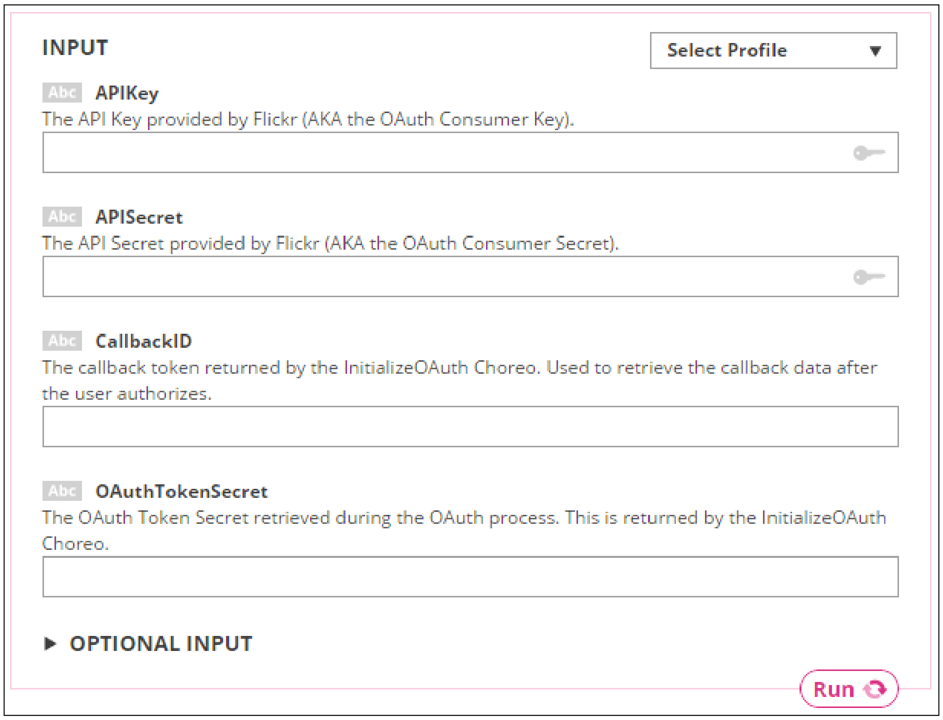
7. Click on the **OK, I'LL AUTHORIZE IT** button. Now, you will be navigated to a blank web page.

Finally, you have successfully authorized your app.

Finalizing OAuth

Perform the following steps to finalize OAuth:

1. Click on **FinalizeOAuth** after navigating to **Flickr | OAuth**. The **FinalizeOAuth** page will appear, as shown in the following screenshot:



INPUT

Select Profile ▼

Abc APIKey

The API Key provided by Flickr (AKA the OAuth Consumer Key).

Abc APISecret

The API Secret provided by Flickr (AKA the OAuth Consumer Secret).

Abc CallbackID

The callback token returned by the InitializeOAuth Choreo. Used to retrieve the callback data after the user authorizes.

Abc OAuthTokenSecret

The OAuth Token Secret retrieved during the OAuth process. This is returned by the InitializeOAuth Choreo.

▶ OPTIONAL INPUT

Run

FinalizeOAuth for Flickr

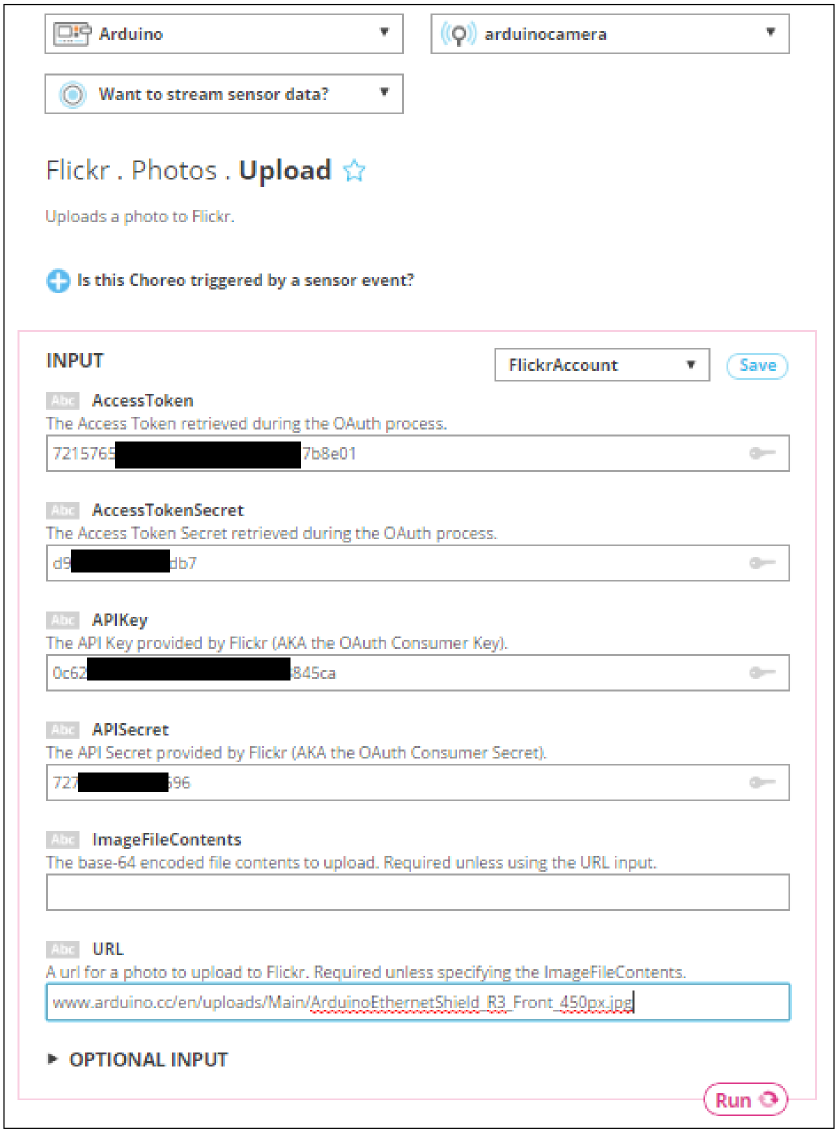
2. Fill the following text boxes with the relevant information:
    - **APIKey**: The API Key provided by Flicker for your app
    - **APISecret**: The API secret provided by Flickr for your app
    - **CallbackID**: The callback token returned by the InitializeOAuth process
    - **OAuthTokenSecret**: The OAuth Token Secret retrieved during the OAuth process

3. Click on the **Run** button to process. Now you have finalized the OAuth process for your Flickr app.

Generating the photo upload sketch

In this section, you will learn how to generate the photo upload sketch. To achieve this, you need to perform the following steps:

1. Under **CHOREOS** go to **Flickr | Photos** and then click on **Upload**. The following screen will appear:



Flickr . Photos . **Upload** ☆

Uploads a photo to Flickr.

Is this Choreo triggered by a sensor event?

INPUT

FlickrAccount ▼

AccessToken

The Access Token retrieved during the OAuth process.

7215765[redacted]7b8e01

AccessTokenSecret

The Access Token Secret retrieved during the OAuth process.

d9[redacted]db7

APIKey

The API Key provided by Flickr (AKA the OAuth Consumer Key).

0c62[redacted]845ca

APISecret

The API Secret provided by Flickr (AKA the OAuth Consumer Secret).

727[redacted]96

ImageFileContents

The base-64 encoded file contents to upload. Required unless using the URL input.

URL

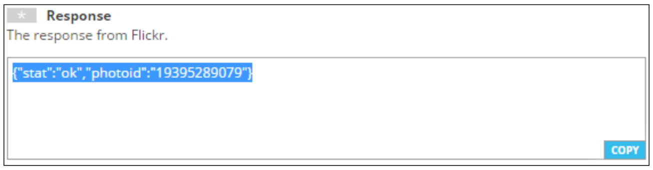
A url for a photo to upload to Flickr. Required unless specifying the ImageFileContents.

www.arduino.cc/en/uploads/Main/ArduinoEthernetShield_R3_Front_450px.jpg

A Flicker photo upload Choreo

2. Fill the textboxes with the following information:
   - **AccessToken**: The Access Token retrieved during the OAuth process.
   - **AccessTokenSecret**: The AccessTokenSecret retrieved during the OAuth process.
   - **APIKey**: The API Key provided by Flickr.
   - **APISecret**: The API Secret provided by Flickr.
   - **ImageFileContents**: Keep this field blank.
   - **URL**: Any valid image URL. (for example, use `https://www.arduino.cc/en/uploads/Main/ArduinoEthernetFront450px.jpg`). Note that this specified image will be uploaded to your Flickr account for testing.

3. Click on the **Run** button to process the image upload to Flickr. If everything is correct, you will get a response, as shown in the following screenshot:

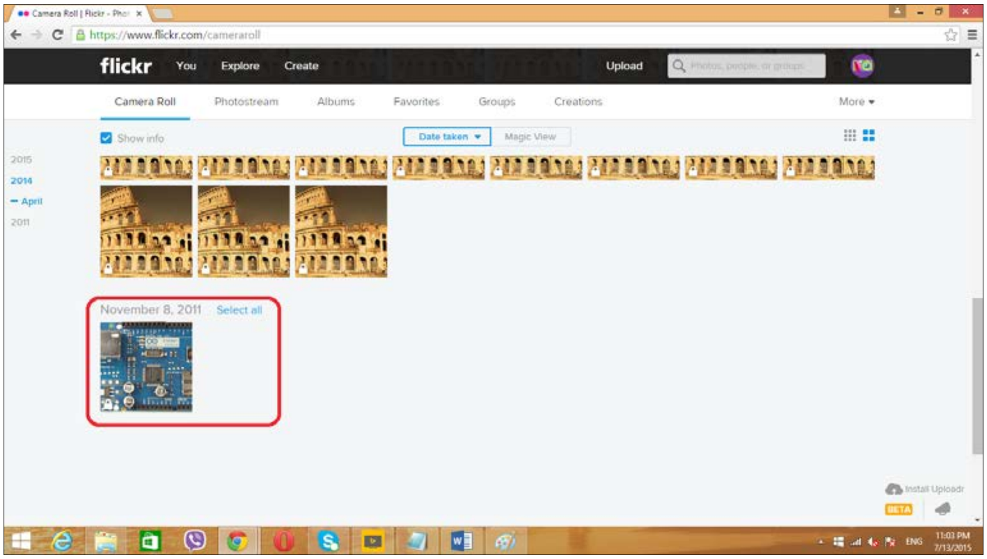


Response

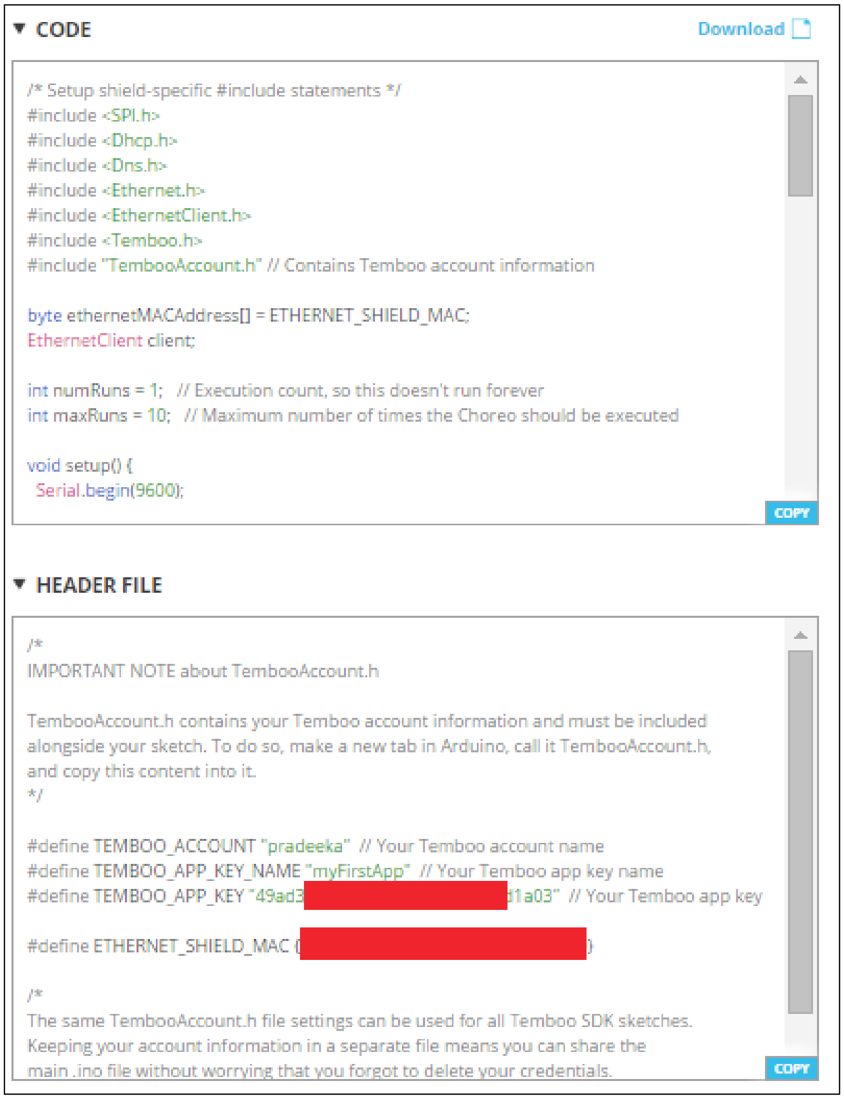
The response from Flickr.

```
{"stat":"ok","photoid":"19395289079"}
```

4. To verify the uploaded image, sign in to your Flickr account. On the Flickr web page, click go to **You** | **Camera Roll**. You can see the uploaded image by the Temboo cloud service, as shown here:



5. Continue with step 3, and scroll down the page. You can see two sections, **CODE** and **HEADER FILE**:



```
/* Setup shield-specific #include statements */
#include <SPI.h>
#include <Dhcp.h>
#include <Dns.h>
#include <Ethernet.h>
#include <EthernetClient.h>
#include <Temboo.h>
#include "TembooAccount.h" // Contains Temboo account information

byte ethernetMACAddress[] = ETHERNET_SHIELD_MAC;
EthernetClient client;

int numRuns = 1;   // Execution count, so this doesn't run forever
int maxRuns = 10;   // Maximum number of times the Choreo should be executed

void setup() {
  Serial.begin(9600);
```

```
/*
IMPORTANT NOTE about TembooAccount.h

TembooAccount.h contains your Temboo account information and must be included
alongside your sketch. To do so, make a new tab in Arduino, call it TembooAccount.h,
and copy this content into it.
*/

#define TEMBOO_ACCOUNT "pradeeka"  // Your Temboo account name
#define TEMBOO_APP_KEY_NAME "myFirstApp"  // Your Temboo app key name
#define TEMBOO_APP_KEY "49ad3[redacted]1a03"  // Your Temboo app key

#define ETHERNET_SHIELD_MAC {[redacted]}

/*
The same TembooAccount.h file settings can be used for all Temboo SDK sketches.
Keeping your account information in a separate file means you can share the
main .ino file without worrying that you forgot to delete your credentials.
```

6. Now open a new Arduino IDE and copy and paste the generated code inside the **CODE** box.

7. Create a folder and rename it to **TembooAccount** inside your Arduino installation directory, and then under the **Libraries** folder. Copy the code inside the **HEADER FILE** box and paste it to a new Notepad file. Save the file as `TembooAccount.h` inside the `TembooAccount` folder.

8. Then, verify the code and upload it into your Arduino board.
9. Open the Arduino Serial Monitor. You can see the image upload status and it will upload your same image 10 times on Flickr. Open your Flickr's camera roll and verify the uploaded images.
10. The following Arduino sketch will upload an image (`https://www.arduino.cc/en/uploads/Main/ArduinoEthernetFront450px.jpg`) maximum of 10 times on Flickr. The sample sketch for this named `B04844_04_02.ino` can be copied from the `Chapter 4` code folder. Also, modify the API key values according to your Flickr and Temboo accounts.

The Arduino sketch for the `B04844_04_02.ino` file is:

```
/* Setup shield-specific #include statements */
#include <SPI.h>
#include <Dhcp.h>
#include <Dns.h>
#include <Ethernet.h>
#include <EthernetClient.h>
#include <Temboo.h>
#include "TembooAccount.h" // Contains Temboo account information

byte ethernetMACAddress[] = ETHERNET_SHIELD_MAC;
EthernetClient client;

int numRuns = 1;  // Execution count, so this doesn't run forever
int maxRuns = 10;  // Maximum number of times the Choreo should be
executed

void setup() {
  Serial.begin(9600);

  // For debugging, wait until the serial console is connected
  delay(4000);
  while(!Serial);

  Serial.print("DHCP:");
  if (Ethernet.begin(ethernetMACAddress) == 0) {
    Serial.println("FAIL");
    while(true);
  }
  Serial.println("OK");
  delay(5000);

  Serial.println("Setup complete.\n");
}
```

```
void loop() {
 if (numRuns <= maxRuns) {
  Serial.println("Running Upload - Run #" + String(numRuns++));

  TembooChoreo UploadChoreo(client);

  // Invoke the Temboo client
  UploadChoreo.begin();

  // Set Temboo account credentials
  UploadChoreo.setAccountName(TEMBOO_ACCOUNT);
  UploadChoreo.setAppKeyName(TEMBOO_APP_KEY_NAME);
  UploadChoreo.setAppKey(TEMBOO_APP_KEY);

  // Set Choreo inputs
  String APIKeyValue = "0c62beaaxxxxxxxxxxxxxxxxe3845ca";
  UploadChoreo.addInput("APIKey", APIKeyValue);
  String AccessTokenValue = "7215xxxxxxxxxxxxxxxxxxxxxx7b8e01";
  UploadChoreo.addInput("AccessToken", AccessTokenValue);
  String AccessTokenSecretValue = "d95exxxxxxxxfddb7";
  UploadChoreo.addInput("AccessTokenSecret",
  AccessTokenSecretValue);
  String APISecretValue = "7277dxxxxxxxxx7d696";
  UploadChoreo.addInput("APISecret", APISecretValue);
  String URLValue = "https://www.arduino.cc/en/uploads/Main/
  ArduinoEthernetFront450px.jpg";
  UploadChoreo.addInput("URL", URLValue);

  // Identify the Choreo to run
  UploadChoreo.setChoreo("/Library/Flickr/Photos/Upload");

  // Run the Choreo; when results are available, print them to
  serial
  UploadChoreo.run();

  while(UploadChoreo.available()) {
   char c = UploadChoreo.read();
   Serial.print(c);
  }
  UploadChoreo.close();
  }

  Serial.println("\nWaiting...\n");
  delay(30000); // wait 30 seconds between Upload calls
}
```

Connecting the camera output with Temboo

In the previous step, we successfully uploaded an image, which is in a remote server, on Flickr. Now, we are going to upload an image on Flickr, which is captured by the camera.

To do this, first we need to convert the image binary data stream to the base 64 stream.

Download the `base64.h` library from `https://github.com/adamvr/arduino-base64` and extract it inside to the `Libraries` folder.

Copy and paste the `B04844_04_03.ino` code from the sketches folder of this chapter and upload it on your Arduino board.

For every 30 seconds, your camera will capture an image and upload on Flickr.

Motion detection

Adafruit TTL serial camera has built-in motion detection capability. Using the VC0706 library, we can capture and upload the detected image to the Flickr. Here, we have used more similar code implementation as explained in the previous section of Motion Detection.

1. Open a new Arduino IDE and copy and paste the code `B04844_04_04.ino` from the `Chapter 4` code folder. Verify and upload the code on your Arduino board.
2. To test the motion, move an object in front of the camera. Wait nearly 30 seconds.
3. To verify the captured image, sign in to your Flickr account, and then, on the Flickr web page, go to **You | Camera Roll**. You can see the newly uploaded image by the Temboo cloud service.

Let's look at some important points in motion detection that are related to the Arduino sketch.

To enable the motion detection functionality on the VC0706 Camera module, you can use the following code line and set the parameter to `true`. The default is `false`. Note that the `cam` is the object of the `VC0706` class.

```
cam.setMotionDetect(true);
```

The motion is detected by the following function and it will return `true` when the motion is detected by the camera module.

```
cam.motionDetected();
```

Summary

Throughout this chapter, you learned how to build an Arduino security camera from scratch. Later, you can buy a dummy CCTV camera housing and secure your newly-built camera (Arduino and VC0706 Camera Module) by attaching it inside the housing. It will protect the electronic components from weather and any physical damages.

Further, you can modify the project with an Arduino WiFi shield or Cellular shield to make it wireless. Add a solar panel with a charger if you want to use it in a rural area that doesn't have electricity.

If you want more creativity, you can make a portable handheld camera for image capturing. Remember, you can use the Arduino **RESET** button to click!

In the next chapter, you will learn how to connect your Arduino to NearBus cloud using NearBus cloud connector, logging solar panel voltage data to the cloud, and displaying live data on the web browser.

5
Solar Panel Voltage Logging with NearBus Cloud Connector and Xively

Do you want to synchronize your Arduino board memory with cloud memory? Then this is the solution for memory mapping between Arduino and cloud. The memory mapping is done by mirroring or replicating a small part of Arduino's memory into the cloud's memory. So, reading or writing on the cloud's memory will have the same effect as reading or writing directly into the Arduino's memory.

The objective of this project is to log the voltage values generated by a solar cell against the time.

In this chapter, you will learn:

- About NearBus Cloud connector
- How to wire a solar cell with Arduino, and the use of the voltage divider
- How to install and use NearAgent with Arduino
- How to configure Xively with Arduino Ethernet
- How to combine NearBus with Xively
- How to display real time voltage logging with Xively
- How to write a simple HTML web page to display real time voltage logging that can be run on your mobile phone

Connecting a solar cell with the Arduino Ethernet board

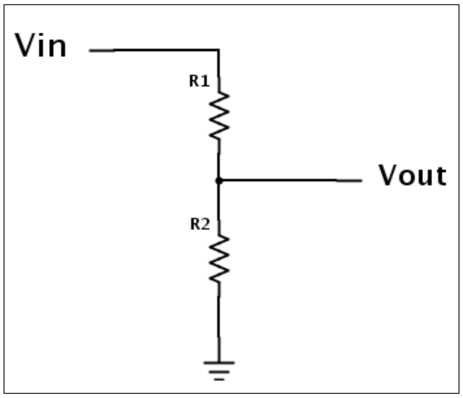
We will use the following hardware to build the circuit:

- Arduino Ethernet board (`https://www.sparkfun.com/products/11229`) or Arduino UNO (`https://www.sparkfun.com/products/11021`), with Arduino Ethernet Shield (`https://www.adafruit.com/products/201`)
- A solar cell (`https://www.sparkfun.com/products/7840`)
- Two resistors (resistor values should be calculated on the open voltage of the solar cell); take a look at the *Building a voltage divider* section that follows for the calculation of values and color codes
- Some hook-up wires
- A 9V DC 650mA wall adapter power supply (`https://www.sparkfun.com/products/10273`)
- DC barrel jack adapter (`https://www.sparkfun.com/products/10811`)
- An Ethernet cable (`https://www.sparkfun.com/products/8915`)

Also, you will need a computer with an Arduino IDE installed.

Building a voltage divider

A voltage divider is a simple circuit that can be used to turn higher voltage into lower voltage through a series of two resistors. The resistor values depend on the input voltage and the mapped output voltage:



For this project, we are using Sparkfun Solar Cell Large—2.5W (PRT07840). The open voltage of this solar cell is 9.15V (take a look at the datasheet for open voltage specification).

SparkFun Solar Cell Large - 2.5W Image courtesy of SparkFun Electronics (`https://www.sparkfun.com`)

So, we can calculate the resistor values for the voltage divider by using the following equation:

$$V_{out} = V_{in} \cdot \frac{R_2}{R_1 + R_2}$$

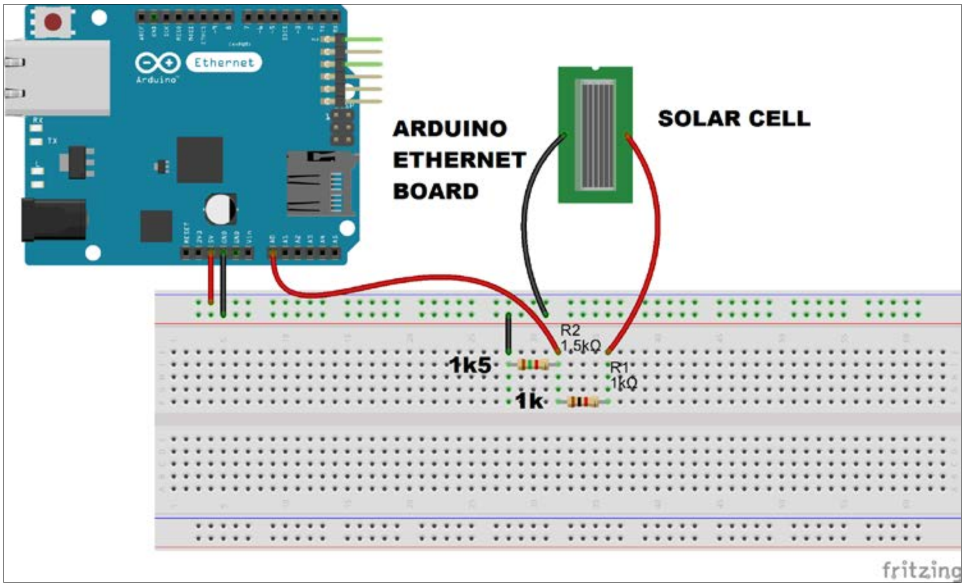
- V_{out} is 5V (the input voltage to Arduino)
- V_{in} is 9.15V (the output voltage from the solar cell)

Therefore, the following can be derived:

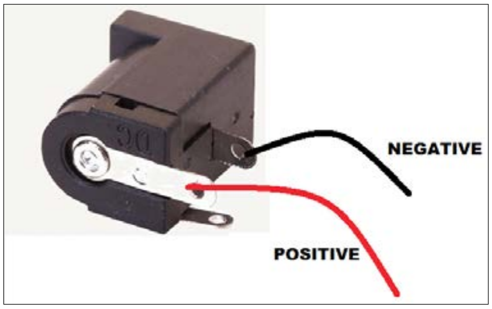
- *R1* = 1200 Ohm = 1.2k (brown, red, red)
- *R2* = 1500 Ohm = 1.5k (brown, green, red)

Building the circuit with Arduino

The following Fritzing diagram shows how to connect the voltage divider and solar cell with the Arduino Ethernet board. Now, start building the circuit according to the following diagram and steps provided:



This particular solar cell comes with a DC barrel jack plug attached, and it is center positive. Plug it to the DC barrel jack adapter. Now solder two wires to the positive and negative terminals of the DC barrel jack adapter, as shown in the following image:



Connect the other wires as explained in the following steps:

1. Connect the voltage divider's output (V_{out}) with the Arduino analog pin 0 (A0).
2. Connect the solar cell's positive wire with voltage divider's V_{in}.
3. Connect the solar cell's negative wire to Arduino GND.
4. Connect the Arduino Ethernet board to a network switch or router using an Ethernet cable.
5. Power the Arduino Ethernet board using a 9V DC 650mA wall adapter power supply.

Now, the circuit and hardware setup is complete, and in the next section you will learn how to set up a NearBus account and connect your Arduino Ethernet shield to the NearBus Cloud for solar cell voltage logging.

Setting up a NearBus account

Setting up a NearBus account is simple. Visit the NearBus home page at `http://www.nearbus.net/` and click on **Sign Up** in the main menu. This will navigate you to the new user signup page with a simple form to enter your registration information. Enter your information as described in following steps:

1. **E-mail**: Type a valid e-mail address.
2. **User name**: Type your preferred name for the NearBus account.
3. **Password**: Type a secret word and don't share it with others.
4. Then, click on the checkbox of the captcha section to verify that you are a human.
5. Finally, click on the **Sign Up** button.

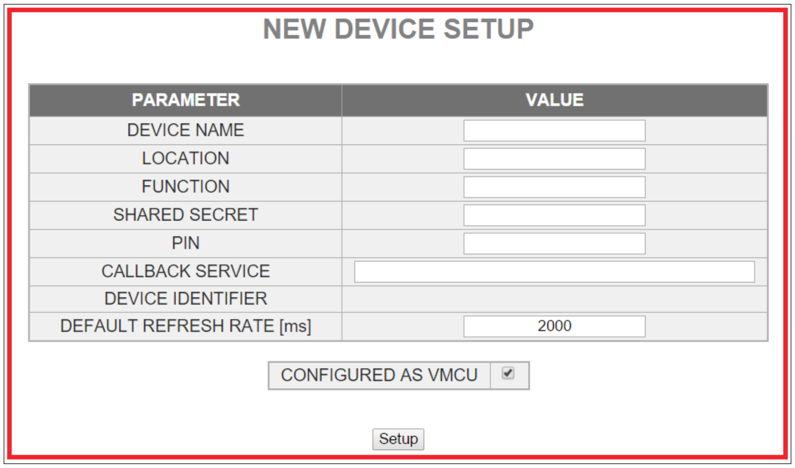
Now you have successfully registered with the NearBus website and you will be navigated to the **Login** page. Now, enter the following information to log in.

1. **Username**: Type your user name.
2. **Password**: Type your password.
3. Click on the **Login** button.

Defining a new device

Now, you can define a new device with the NearBus cloud connector. In this chapter, we will work with the Arduino Ethernet board. If you have an Arduino Ethernet Shield, you can stack it with an Arduino board and test it with the samples provided in this chapter.

1. On the NearBus website menu bar, click on **New Device**. You will be navigated to the **NEW DEVICE SETUP** page.



NEW DEVICE SETUP

PARAMETER	VALUE
DEVICE NAME	
LOCATION	
FUNCTION	
SHARED SECRET	
PIN	
CALLBACK SERVICE	
DEVICE IDENTIFIER	
DEFAULT REFRESH RATE [ms]	2000

CONFIGURED AS VMCU ☑

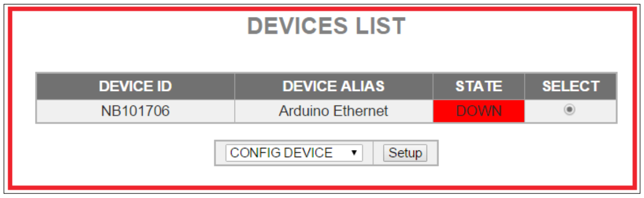
2. You can enter a value for each parameter and the only mandatory field is **SHARED SECRET**. It is eight characters long. Other fields are optional.

DEVICE NAME (Maximum 18 characters)	`Arduino Ethernet`
LOCATION	
FUNCTION	
SHARED SECRET	`12345678`
PIN	
CALLBACK SERVICE	
DEVICE IDENTIFIER	
DEFAULT REFRESH RATE [ms]	

3. Click on the **Setup** button.

Examining the device lists

After setting up the new device, you will navigate to the **DEVICE LIST** page. The NearBus system will assign a **DEVICE ID** to your new device and display your device name under the device alias. However, your new device will not have been mapped with NearBus. The mapped status shows as **DOWN,** which is highlighted in the following:



DEVICES LIST

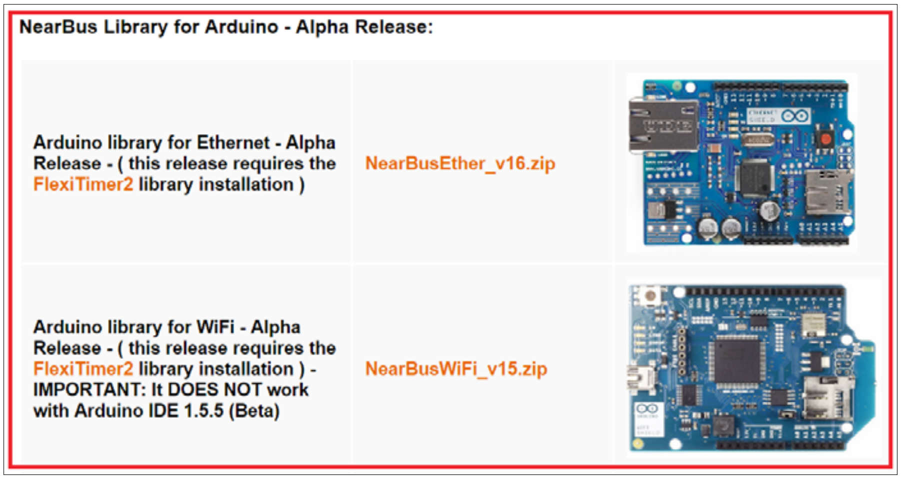
DEVICE ID	DEVICE ALIAS	STATE	SELECT
NB101706	Arduino Ethernet	DOWN	◉

You will need this **DEVICE ID** when you write an Arduino sketch for this device.

Later, you can visit to the device list page by clicking on **Device List** on the menu bar.

Downloading the NearBus agent

To use your Arduino Ethernet Shield, or Arduino Ethernet board with the NearBus cloud connector, you must download and install the NearAgent code library. You can download the latest version of the NearBus library for Arduino at `http://www.nearbus.net/v1/downloads.html`. Also, you can visit the download page by clicking on **Downloads** on the NearBus web page menu bar. The following screenshot shows the **Download** page:

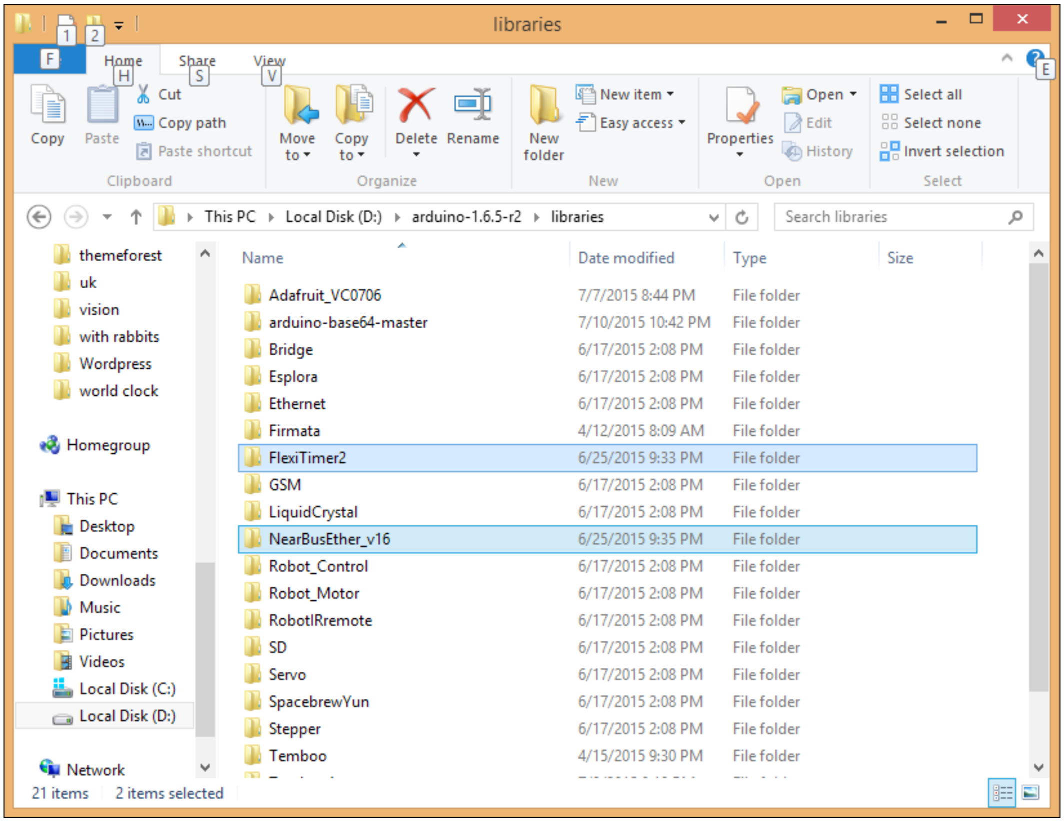


NearBus Library for Arduino - Alpha Release:

Arduino library for Ethernet - Alpha Release - (this release requires the FlexiTimer2 library installation)	NearBusEther_v16.zip	
Arduino library for WiFi - Alpha Release - (this release requires the FlexiTimer2 library installation) - IMPORTANT: It DOES NOT work with Arduino IDE 1.5.5 (Beta)	NearBusWiFi_v15.zip	

For this project, we need Arduino library for Ethernet, and the latest version is 16. Click on the **NearBusEther_v16.zip** link to download the library, or type `http://www.nearbus.net/downloads/NearBusEther_v16.zip` on your browser's address bar and hit *Enter* to download it on your computer's hard drive. Then, extract the downloaded ZIP file into the Arduino libraries folder.

Also, you need to download the FlexiTimer2 from `http://github.com/wimleers/flexitimer2/zipball/v1.1` and extract the ZIP file into the Arduino libraries folder. You can read more about the FlexiTimer2 at `https://github.com/wimleers/flexitimer2`, which is the GitHub page, and you can even download it from there.



Name	Date modified	Type	Size
Adafruit_VC0706	7/7/2015 8:44 PM	File folder	
arduino-base64-master	7/10/2015 10:42 PM	File folder	
Bridge	6/17/2015 2:08 PM	File folder	
Esplora	6/17/2015 2:08 PM	File folder	
Ethernet	6/17/2015 2:08 PM	File folder	
Firmata	4/12/2015 8:09 AM	File folder	
FlexiTimer2	6/25/2015 9:33 PM	File folder	
GSM	6/17/2015 2:08 PM	File folder	
LiquidCrystal	6/17/2015 2:08 PM	File folder	
NearBusEther_v16	6/25/2015 9:35 PM	File folder	
Robot_Control	6/17/2015 2:08 PM	File folder	
Robot_Motor	6/17/2015 2:08 PM	File folder	
RobotIRremote	6/17/2015 2:08 PM	File folder	
SD	6/17/2015 2:08 PM	File folder	
Servo	6/17/2015 2:08 PM	File folder	
SpacebrewYun	6/17/2015 2:08 PM	File folder	
Stepper	6/17/2015 2:08 PM	File folder	
Temboo	4/15/2015 9:30 PM	File folder	

Perform the following steps to modify the sample code to read the voltage:

1. Open your Arduino IDE.
2. In the menu bar, click on **File | Examples | NearBusEther_v16 | Hello_World_Ether**. The sample code will load into the Arduino IDE. Also, you can copy and paste the sample sketch, `B04844_05_01.ino`, into your Arduino IDE which is located in the code folder of `Chapter 5`.
3. Save the sketch in another location by selecting **File | Save As** from the menu bar. Now, make the following modifications to the sample code to work with your Arduino Ethernet board or Ethernet Shield.
4. Modify the following code lines with your NearBus configuration's Device ID and Shared Secret. The Device ID can be found at the Device List page:

   ```
   char deviceId []     = "NB101706"; // Put here the device_ID
   generated by the NearHub ( NB1xxxxx )

   char sharedSecret[] = "12345678"; // (IMPORTANT: mandatory
   8 characters/numbers) - The same as you configured in the
   NearHub
   ```

5. Replace the MAC address with your Arduino Ethernet board's MAC address:

   ```
   byte mac[6] = { 0x90, 0xA2, 0xDA, 0x0D, 0xE2, 0xCD };  //
   Put here the Arduino's Ethernet MAC
   ```

6. Comment the following line:

   ```
       //pinMode(3, OUTPUT);
   ```

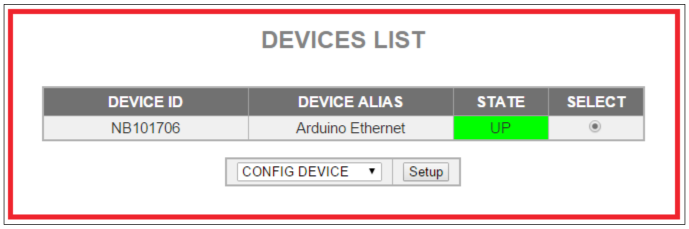
7. Then, uncomment the following line:

   ```
   ///////////////////////////////////
       // Example 1 - Analog Input
       // Mode: TRNSP
       ///////////////////////////////////
       A_register[0] = analogRead(0); // PIN A0
   ```

   Remember, our solar panel is connected to the Arduino analog pin, 0 (A0). But you can attach it to another analog pin and make sure that the pin number is modified in the sketch.

8. That's all. Now, connect your Arduino Ethernet board with the computer using an FTDI cable.

9. Select the board type as Arduino Ethernet (**Tools** | **Board** | **Arduino Ethernet**), and select the correct COM port (**Tools** | **Port**).
10. Verify and upload the sketch into your Arduino Ethernet board.
11. Now, revisit the **DEVICE LIST** page. You can see the Device's **STATE** is changed to **UP** and highlighted:



DEVICES LIST

DEVICE ID	DEVICE ALIAS	STATE	SELECT
NB101706	Arduino Ethernet	UP	●

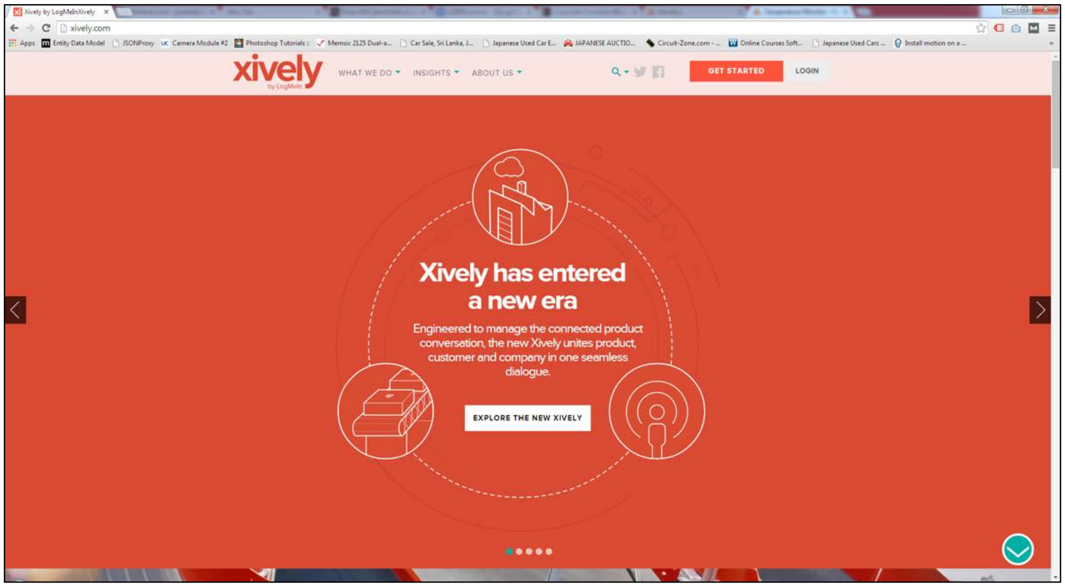
Now, your Arduino Ethernet Shield's internal memory is correctly mapped with the NearBus cloud.

In the next section, we shall learn how to feed our solar panel voltage readings to the Xively and display the real time data on a graph.

Creating and configuring a Xively account

Xively (formerly known as Cosm and Pachube) is a cloud-based platform that provides remote access to devices like Arduino and many more. You can read condensed information about Xively by visiting `https://en.wikipedia.org/wiki/Xively`.

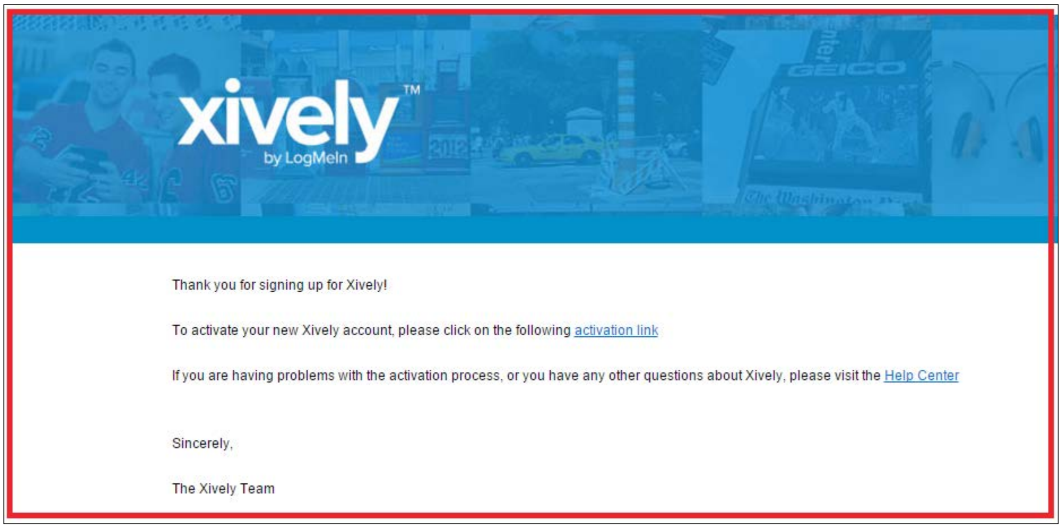
Using your web browser, visit `http://xively.com/`:



Engineered to manage the connected product conversation, the new Xively unites product, customer and company in one seamless dialogue.

There is no link label to sign up in the web page, so type `https://personal.xively.com/signup` in your web browser's address bar and directly visit the **Sign Up** page.

After a successful sign up with Xively, you will get an e-mail with an activation link. Click on the activation link.



Thank you for signing up for Xively!

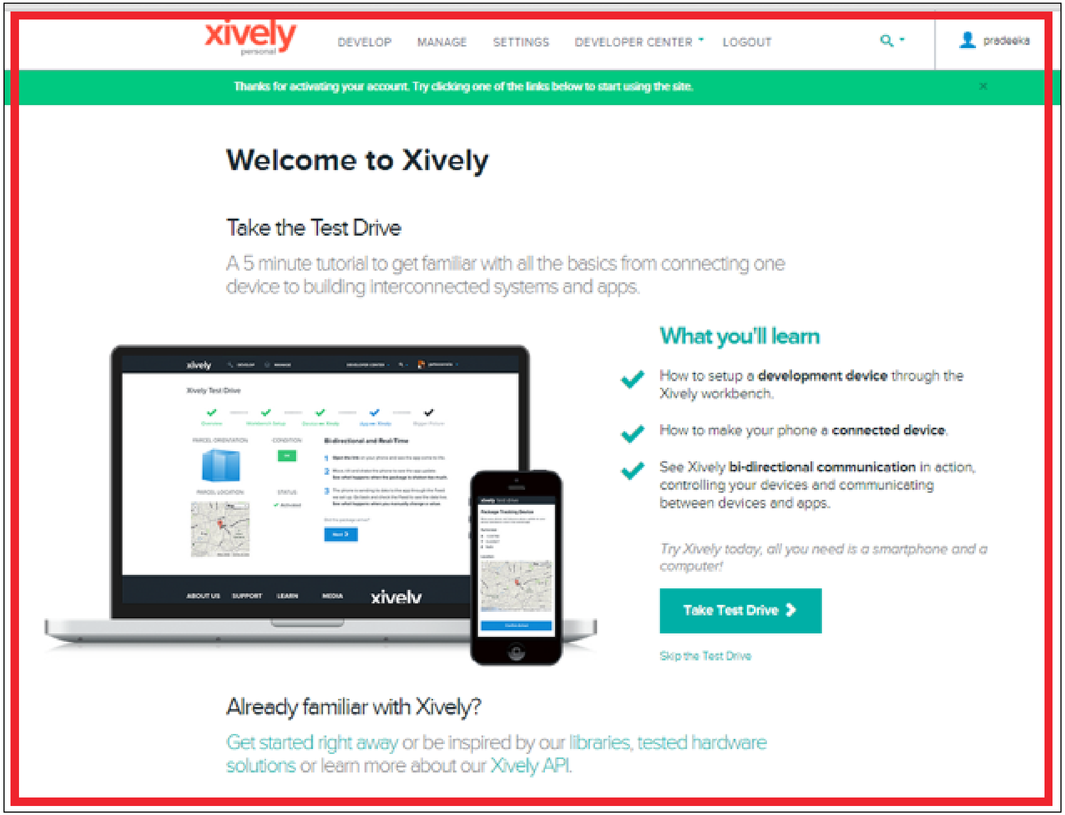
To activate your new Xively account, please click on the following activation link

If you are having problems with the activation process, or you have any other questions about Xively, please visit the Help Center

Sincerely,

The Xively Team

You will be redirected to the **Welcome to Xively** web page:



Thanks for activating your account. Try clicking one of the links below to start using the site.

Welcome to Xively

Take the Test Drive

A 5 minute tutorial to get familiar with all the basics from connecting one device to building interconnected systems and apps.

What you'll learn

✓ How to setup a **development device** through the Xively workbench.

✓ How to make your phone a **connected device**.

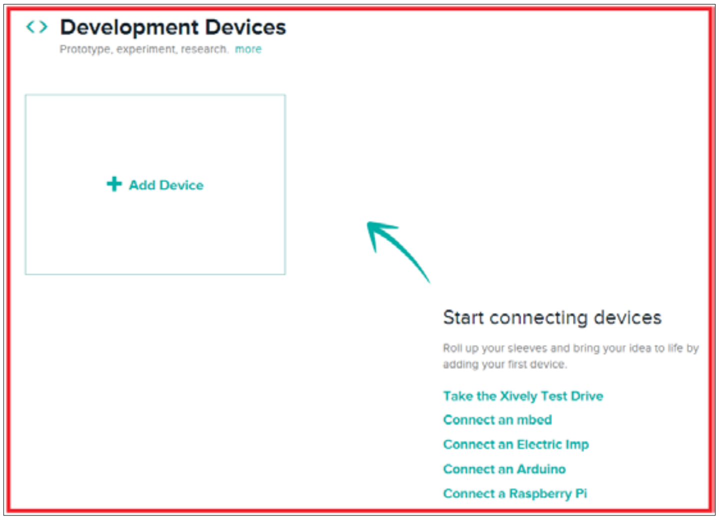
✓ See Xively **bi-directional communication** in action, controlling your devices and communicating between devices and apps.

Try Xively today, all you need is a smartphone and a computer!

Already familiar with Xively?

Get started right away or be inspired by our libraries, tested hardware solutions or learn more about our Xively API.

Click on **DEVELOP** from the top menu bar. The **Development Devices** page will appear:



<> Development Devices

Prototype, experiment, research. more

+ Add Device

Start connecting devices

Roll up your sleeves and bring your idea to life by adding your first device.

Take the Xively Test Drive

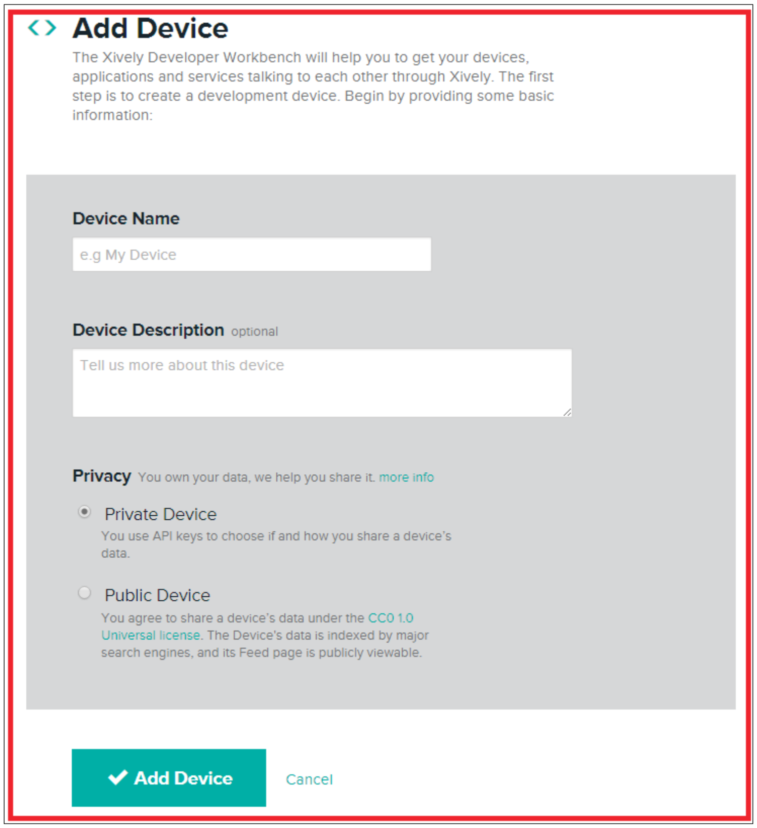
Connect an mbed

Connect an Electric Imp

Connect an Arduino

Connect a Raspberry Pi

Click on **+Add Device**. The **Add Device** page will appear:



<> Add Device

The Xively Developer Workbench will help you to get your devices, applications and services talking to each other through Xively. The first step is to create a development device. Begin by providing some basic information:

Device Name

e.g My Device

Device Description optional

Tell us more about this device

Privacy You own your data, we help you share it. more info

● Private Device

You use API keys to choose if and how you share a device's data.

○ Public Device

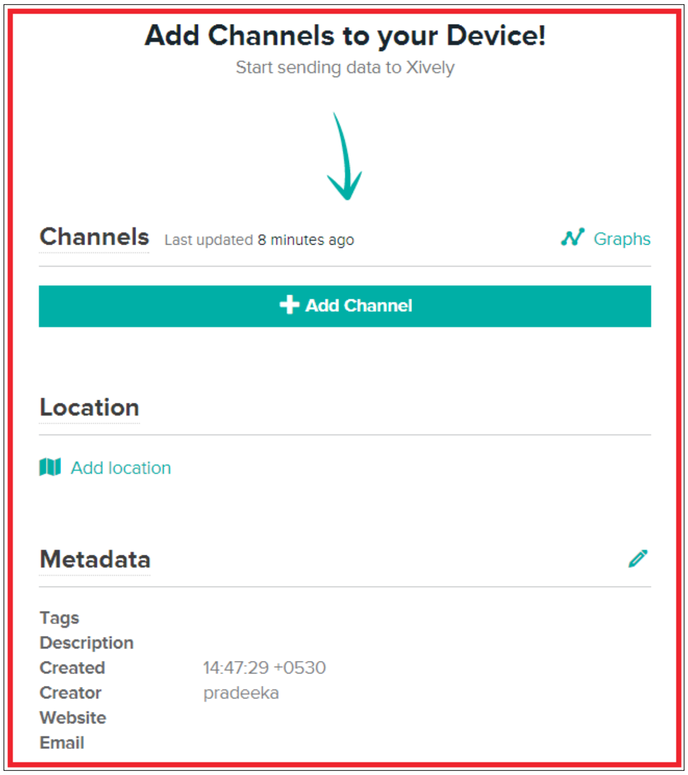
You agree to share a device's data under the CC0 1.0 Universal license. The Device's data is indexed by major search engines, and its Feed page is publicly viewable.

✓ Add Device

Cancel

Fill the following textboxes with relevant information:

- **Device Name**: Give a name for your device, for example, Voltage Logger.
- **Device Description**: Give a brief description of your device, for example, Logging solar panel voltage.
- Click on the **Private Device** option radio button.
- Click on the **Add Device** button. The following web page will appear:



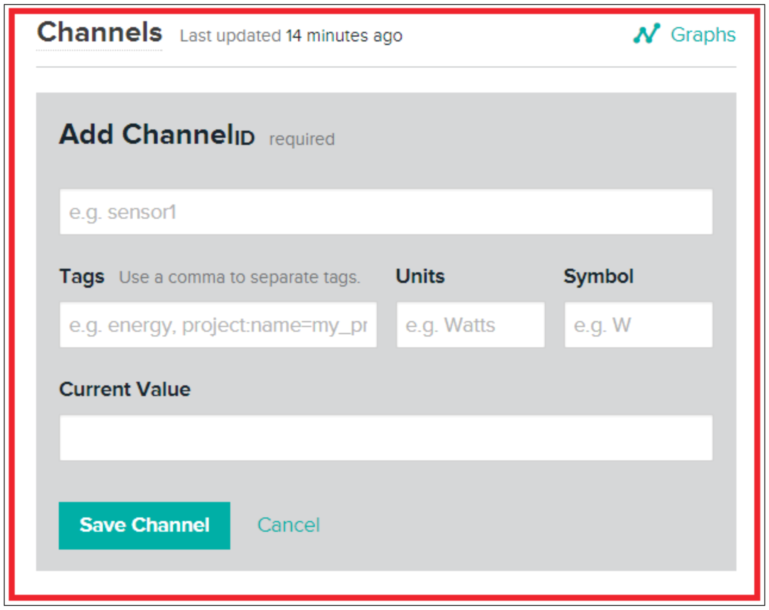
Add Channels to your Device!

Start sending data to Xively

Channels Last updated 8 minutes ago

Tags	
Description	
Created	14:47:29 +0530
Creator	pradeeka
Website	
Email	

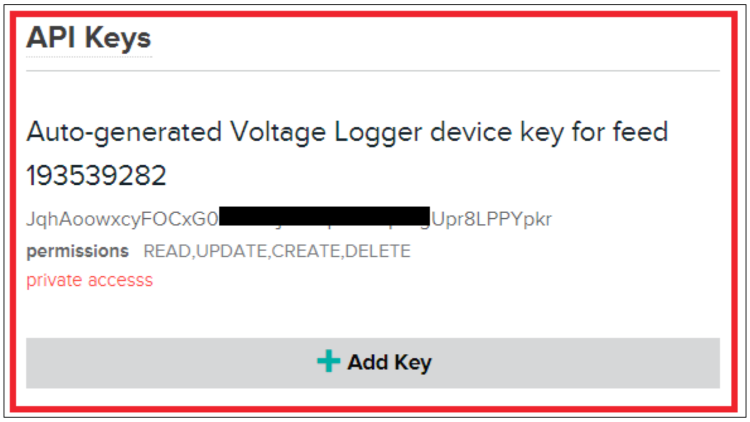
Click on the **+Add Channel** button:


Channels Last updated 14 minutes ago
Graphs
Add ChannelID required
e.g. sensor1
Tags Use a comma to separate tags.
Units
Symbol
e.g. energy, project:name=my_pr
e.g. Watts
e.g. W
Current Value
Save Channel
Cancel

To add a channel, follow these steps:

1. Fill in the following information:
    - **Channel ID**: 1 (but you can use any name, for example, `sensor1` or `logger1`)
    - **Units**: Volts
    - **Symbol**: V
    - **Current Value**: Leave it blank or type `0`
2. Click on the **Save Channel** button to save the channel.

3. On the right-hand side of the page, under **API Keys**, you can find out the Xively **API Key** and **Feed ID** for this device.



API Keys

Auto-generated Voltage Logger device key for feed 193539282

JqhAoowxcyFOCxG0[redacted]Upr8LPPYpkr

permissions READ,UPDATE,CREATE,DELETE

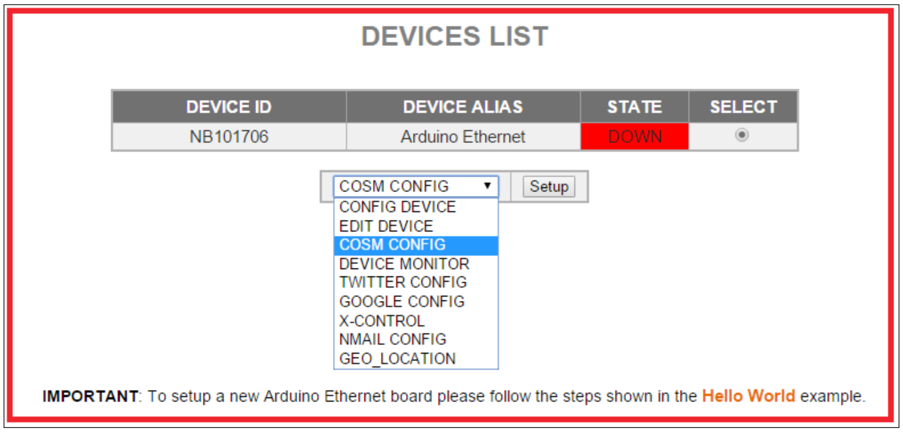
private accesss

- **API Key: GE0sSoyHziZ3Pxxxxxxxxxxxxxxqb7adMUA5yaVUu5psjs**
- **Feed ID: 1913539282**

Configuring the NearBus connected device for Xively

Perform the following steps to configure the NearBus connected device for Xively:

1. Log in to your NearBus account.
2. Click on the **DEVICE LIST** menu. The **DEVICE LIST** page will appear:

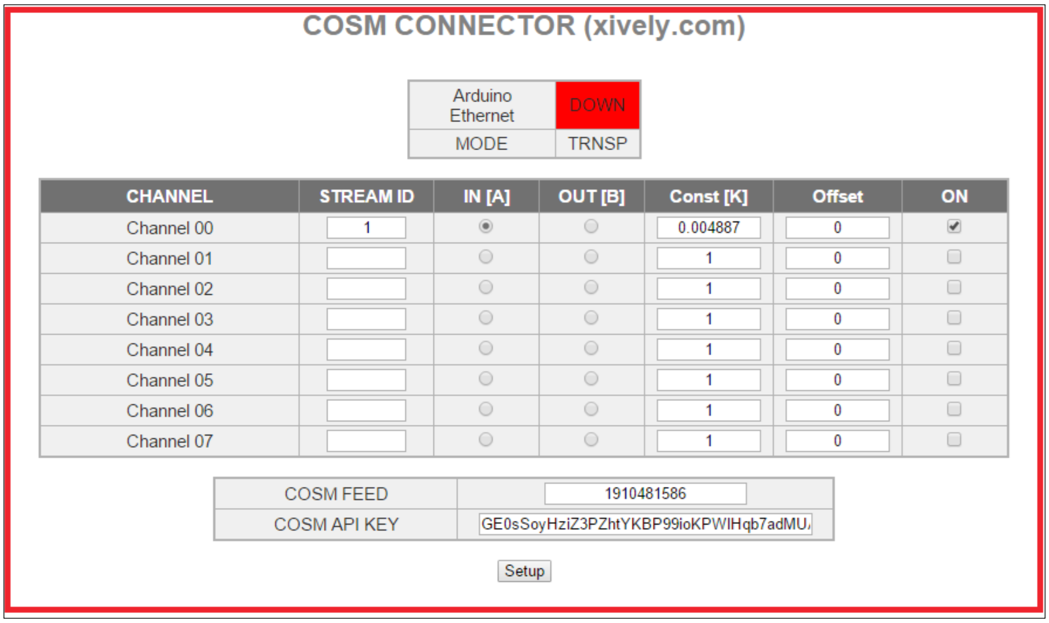


DEVICES LIST

DEVICE ID	DEVICE ALIAS	STATE	SELECT
NB101706	Arduino Ethernet	DOWN	●

IMPORTANT: To setup a new Arduino Ethernet board please follow the steps shown in the **Hello World** example.

3. From the drop-down menu, select **COSM CONFIG**.
4. Click on the **Setup** button. The **COSM CONNECTOR (xively.com)** page will appear:



COSM CONNECTOR (xively.com)

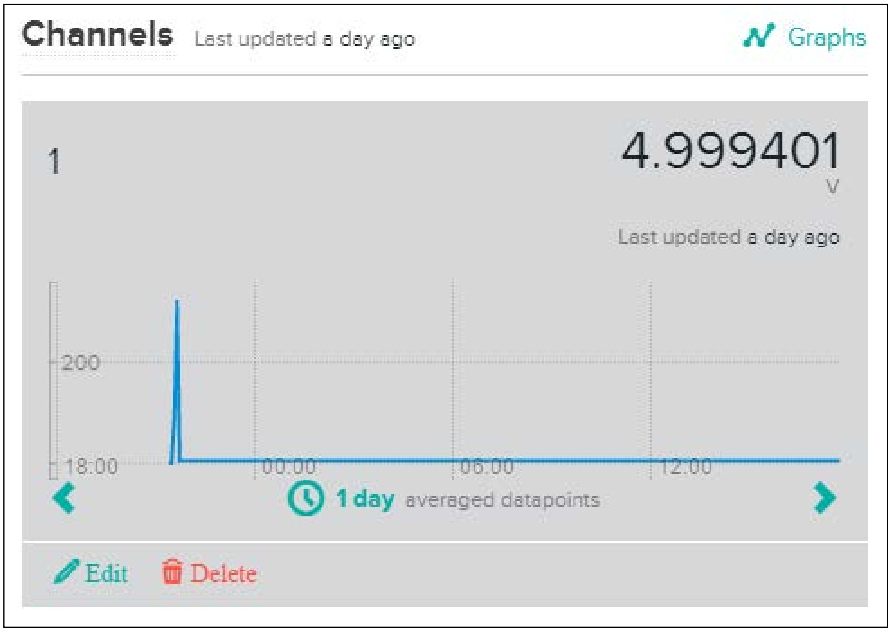
Arduino Ethernet	DOWN
MODE	TRNSP

CHANNEL	STREAM ID	IN [A]	OUT [B]	Const [K]	Offset	ON
Channel 00	1	●	○	0.004887	0	☑
Channel 01		○	○	1	0	□
Channel 02		○	○	1	0	□
Channel 03		○	○	1	0	□
Channel 04		○	○	1	0	□
Channel 05		○	○	1	0	□
Channel 06		○	○	1	0	□
Channel 07		○	○	1	0	□

COSM FEED	1910481586
COSM API KEY	GE0sSoyHziZ3PZhtYKBP99ioKPWIHqb7adMU

5. In this page, you have to enter some configuration settings in order to work your Arduino with NearBus and Xively. Here, we are using the NearBus channel 0 to communicate with our device. So, configure the following entries for the channel 0 entry using the **CMOS CONNECTOR (xively.com)** page:
   - **STREAM ID**: `1`.
   - **IN[A]**: Click to enable.
   - **Const[K]**: `0.004887` (Arduino analog input can accept values from 0-1023, so we need to map the input voltage (in this case 5v) with it). Divide 5V by 1024, then you will get 0.0048828125. Copy and paste it to the **Const[K]** textbox.
   - **Offset**: `0`.
   - **ON**: Click on the checkbox to check.
   - **COSM FEED**: Type the Feed ID generated by the Xively.
   - **COSM API KEY**: Type the API Key generated by the Xively.

6. Click on the **Setup** button.
7. Now, switch to your Xively web page. On the left-hand side of the page, you can see a graph displaying your solar cell voltage with time. If you can't see the graph, click on the channel ID to expand the graph:



Developing a web page to display the real-time voltage values

Use the following chart to find the time zone for your device. The following two examples will show you how to find the correct time zone value:

- **Example 1:** Let's assume your device is located in Sri Jayawardenepura, the time zone is 5.5, that is, UTC +05:30 (Chennai, Kolkata, Mumbai, New Delhi, Sri Jayawardenepura)

- **Example 2**: If it is located in Newfoundland, the time zone is -3.5, that is, UTC -03:30 Newfoundland

Zone	**Place names**
UTC -11:00	International Date Line West, Midway Island, Samoa
UTC -10:00	Hawaii
UTC -09:00	Alaska
UTC -08:00	Pacific Time (US & Canada), Tijuana
UTC -07:00	Arizona, Chihuahua, Mazatlan, Mountain Time (US & Canada)
UTC -06:00	Central America, Central Time (US & Canada), Guadalajara, Mexico City, Monterrey, Saskatchewan
UTC -05:00	Bogota, Eastern Time (US & Canada, Indiana (East)), Lima, Quito
UTC -04:30	Caracas
UTC -04:00	Atlantic Time (Canada), La Paz, Santiago
UTC -03:30	Newfoundland
UTC -03:00	Brasilia, Buenos Aires, Georgetown, Greenland
UTC -02:00	Mid-Atlantic
UTC -01:00	Azores, Cape Verde Is.
UTC +00:00	Casablanca, Dublin, Edinburgh, Lisbon, London, Monrovia
UTC +01:00	Amsterdam, Belgrade, Berlin, Bern, Bratislava, Brussels, Budapest, Copenhagen, Ljubljana, Madrid, Paris, Prague, Rome, Sarajevo, Skopje, Stockholm, Vienna, Warsaw, West Central Africa, Zagreb
UTC +02:00	Athens, Bucharest, Cairo, Harare, Helsinki, Istanbul, Jerusalem, Kyev, Minsk, Pretoria, Riga, Sofia, Tallinn, Vilnius
UTC +03:00	Baghdad, Kuwait, Moscow, Nairobi, Riyadh, St. Petersburg, Volgograd
UTC +03:30	Tehran
UTC +04:00	Abu Dhabi, Baku, Muscat, Tbilisi, Yerevan
UTC +04:30	Kabul
UTC +05:00	Ekaterinburg, Islamabad, Karachi, Tashkent
UTC +05:30	Chennai, Kolkata, Mumbai, New Delhi, Sri Jayawardenepura
UTC +05:45	Kathmandu
UTC +06:00	Almaty, Astana, Dhaka, Novosibirsk
UTC +06:30	Rangoon
UTC +07:00	Bangkok, Hanoi, Jakarta, Krasnoyarsk
UTC +08:00	Beijing, Chongqing, Hong Kong, Irkutsk, Kuala Lumpur, Perth, Singapore, Taipei, Ulaan Bataar, Urumqi

Zone	Place names
UTC +09:00	Osaka, Sapporo, Seoul, Tokyo, Yakutsk
UTC +09:30	Adelaide, Darwin
UTC +10:00	Brisbane, Canberra, Guam, Hobart, Melbourne, Port Moresby, Sydney, Vladivostok
UTC +11:00	Magadan, New Caledonia, Solomon Is.
UTC +12:00	Auckland, Fiji, Kamchatka, Marshall Is., Wellington
UTC +13:00	Nuku'alofa

Displaying data on a web page

Now, we will look at how to display the temperature data on a web page using HTML and JavaScript by connecting to the Xively cloud.

1. Copy the following `index.html` file from the code folder of `Chapter 5` to your computer's hard drive.
2. Using a text editor (Notepad or Notepad++), open the file and edit the highlighted code snippets using your NearBus and Xively device configuration values. Modify the device ID, user, and password:

   ```
   var device_id = "NB101706"; // Your device ID
   var user = "****"; // Your NearBus Web user
   var pass = "****"; // Your NearBus Web password
   ```

   Following are the variables:

   ° `device_id`: Your NearBus device ID

   ° `user`: Your NearBus user name

   ° `pass`: Your NearBus password

3. Replace `1` with your NearBus channel ID:

   ```
   ret = NearAPIjs( "ADC_INPUT", device_id , 1, 0, "RONLY" );
   ```

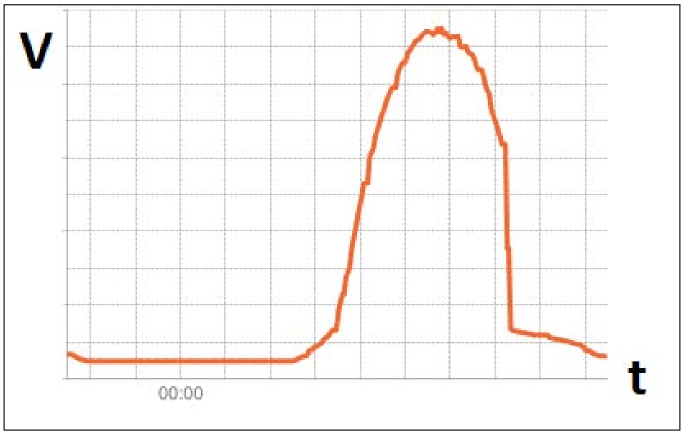
4. Replace `1910481586` with your Xively device Feed ID, `1.png` with your NearBus channel ID (only replace the number part) and `5.5` with your time zone.

   ```
   <div id="div_temp_chart_cm"> <img
   src="https://api.cosm.com/v2/feeds/1910481586/datastreams/1
   .png?width=750&height=400&colour=%23f15a24&duration=3hours&
   show_axis_labels=true&detailed_grid=true&timezone=5.5" >
   </div>
   ```

You can also modify the cosm to Xively in the preceding URL because both are working. The modified URL can be written as follows:

```
<div id="div_temp_chart_cm"> <img
src="https://api.xively.com/v2/feeds/1910481586/datastreams
/1.png?width=750&height=400&colour=%23f15a24&duration=3hour
s&show_axis_labels=true&detailed_grid=true&timezone=5.5" >
</div>
```

5. Now, save and close the file. Then, open the file using your preferred web browser. You will see a graph displaying the real-time voltage values against the time which is continuously updating.
6. Also, you can copy the file into your smart phone's SD card or its internal memory, and then open it with the mobile web browser to see the real time graph.
7. The following image shows a real time graph that is plotting the output voltage of a solar cell, where the *x* axis represents the time (**t**) and the *y* axis represents the voltage (**V**):



Summary

In this chapter, you have learned how to log your solar cell voltage using the NearBus and Xively cloud platforms and access them remotely from anywhere in the world using a mobile device. You can modify this project to log data from any type of sensor and also add more channels to display multiple data streams on a single graph.

In the next chapter, you will learn how to work with GPS and combine it with the Internet. Also, you will learn how to plot locations using Google Maps.

6
GPS Location Tracker with Temboo, Twilio, and Google Maps

Location tracking is important when you want to find the exact location of movable objects, such as vehicles, pets, or even people. GPS technology is very helpful in getting precise locations, which makes it possible to create real-time tracking devices.

In this chapter you will learn:

- How to connect the Arduino GPS shield with the Arduino Ethernet board
- How to install and use TinyGPSPlus library with the Arduino Ethernet board
- How to extract location data and time with Arduino GPS shield in conjunction with TinyGPSPlus library
- About Google Maps JavaScript API that displays the current location on Google Maps with GPS data
- How to get GPS location data by SMS with Twilio and Temboo

Hardware and software requirements

You will need the following hardware and software to complete this project:

Hardware requirements

- Arduino Ethernet board (`https://www.sparkfun.com/products/11229`)
- SparkFun GPS Shield kit (`https://www.sparkfun.com/products/13199`)
- FTDI Cable 5V (`https://www.sparkfun.com/products/9718`)
- 9V DC 650mA wall adapter power supply (`https://www.sparkfun.com/products/10273`)

Software requirements

- TinyGPSPlus library (`https://github.com/mikalhart/TinyGPSPlus/archive/master.zip`)

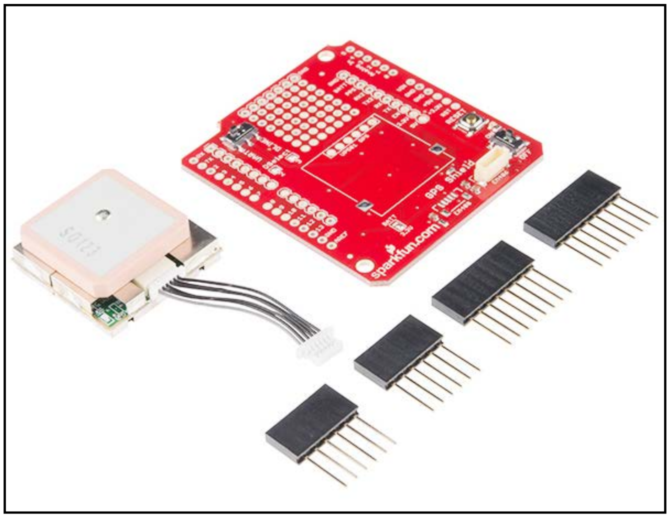
Getting started with the Arduino GPS shield

Arduino GPS shield lets your Arduino board receive information from the **GPS** (**Global Positioning System**). The GPS is a satellite-based navigation system made up of a network of 24 satellites.

Arduino GPS shield consists of a GPS receiver that can be used to receive accurate time signals from the GPS satellite network and calculate its own position.

Arduino GPS Shield is currently manufactured by various electronics kit suppliers. The most popular manufacturers are SparkFun Electronics and Adafruit. Throughout this project, we will use the SparkFun GPS Shield kit (`https://www.sparkfun.com/products/13199`).

The kit comes with an EM-506 GPS module and the Arduino stackable header kit. Click on **Assembly Guide** (`https://learn.sparkfun.com/tutorials/gps-shield-hookup-guide`) in the product page, and follow the instructions to solder the headers and GPS module to the shield.



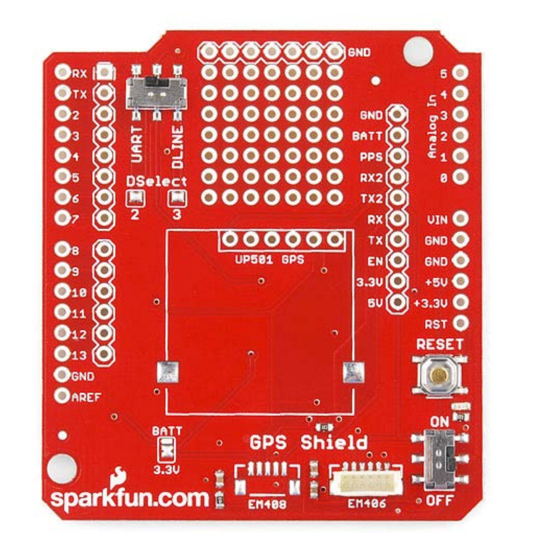
The Arduino GPS shield kit: Image taken from SparkFun Electronics Image courtesy of SparkFun Electronics (`https://www.sparkfun.com`)

Connecting the Arduino GPS shield with the Arduino Ethernet board

To connect the Arduino GPS shield with the Arduino Ethernet board, perform the following steps:

1. Stack your Arduino GPS shield with the Arduino Ethernet board.
2. Move the **UART/DLINE** switch to the **DLINE** position. This is a two-way switch that can be used to select the **UART** or **DLINE** mode to communicate GPS shield with Arduino.
    - **UART**: This connects the GPS module's serial lines to Arduino hardware serial (D0/RX and D1/TX).

- **DLINE**: This connects the GPS module's serial lines to the Arduino software serial (D2 and D3). See the solder marks label next to the UART/DLINE switch.



The Arduino GPS shield PCB: Image courtesy of SparkFun Electronics (`https://www.sparkfun.com`)

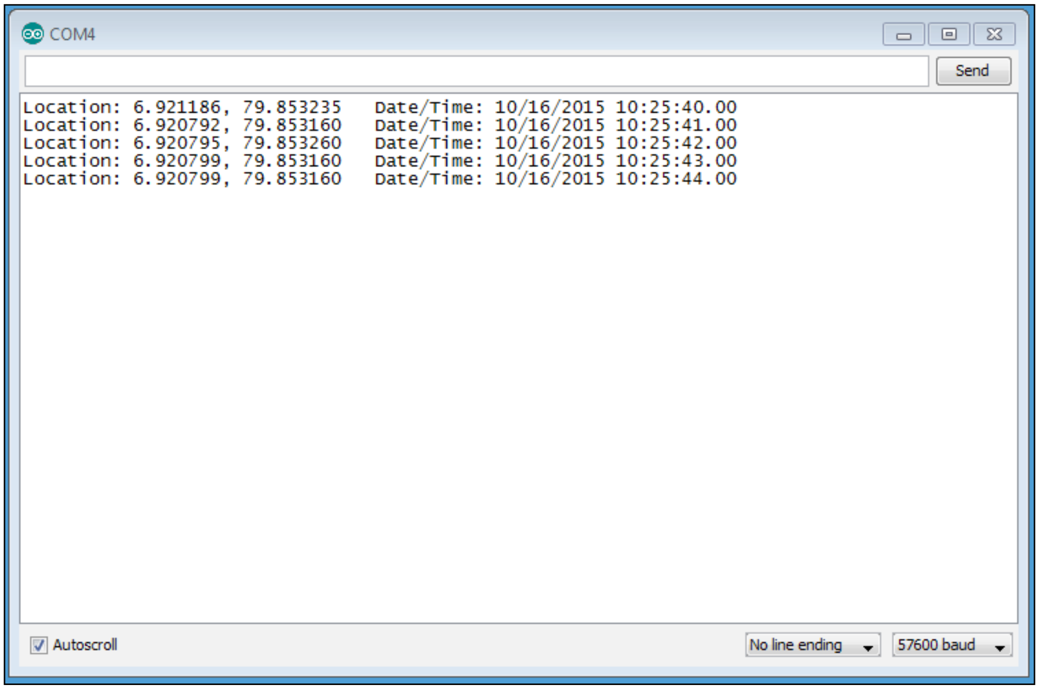
3. Connect the 9V DC power supply to your Arduino Ethernet board. Then, connect the Arduino Ethernet board to the computer with an FTDI cable a USB to Serial (TTL Level) converter.
4. Now, download the TinyGPSPlus library from `https://github.com/mikalhart/TinyGPSPlus/archive/master.zip` and extract it to your Arduino Installation's libraries folder.

Testing the GPS shield

Follow these steps to test the GPS shield:

1. Open a new Arduino IDE, then copy and paste the sample code `B04844_06_01.ino` from the `Chapter 6` code folder of this book. (Note that this is the sample code included with the TinyGPSPlus library to display the current location by latitude and longitude with date and time). You can also open this sketch by navigating to **File** | **Examples** | **TinyGPSPlus** | **DeviceExample** on the menu bar.
2. Verify and upload the sketch to your Arduino board or Arduino Ethernet board.

3. Open the Arduino Serial Monitor by going to **Tools | Serial Monitor**. The following output will be displayed:



```
Location: 6.921186, 79.853235   Date/Time: 10/16/2015 10:25:40.00
Location: 6.920792, 79.853160   Date/Time: 10/16/2015 10:25:41.00
Location: 6.920795, 79.853260   Date/Time: 10/16/2015 10:25:42.00
Location: 6.920799, 79.853160   Date/Time: 10/16/2015 10:25:43.00
Location: 6.920799, 79.853160   Date/Time: 10/16/2015 10:25:44.00
```

☑ Autoscroll   No line ending   57600 baud

In each entry, the current location is displayed with latitude, longitude, and date/time. Next, you will learn how to use these values to display the location on Google Maps.

Displaying the current location on Google Maps

Google Maps JavaScript API can be used to display the current location with a marker on Google Maps. We can simply pass the latitude and longitude to the Google JavaScript API library and display the current location as a simple marker.

The following steps will explain you how to display the Arduino GPS shield's current location on Google Maps:

1. Open a new Arduino IDE and paste the sample code `B04844_06_02.ino` from the `Chapter 6` code folder. Verify and upload the sketch to your Arduino Ethernet Shield or Arduino Ethernet board.
2. The code consists a mix of Arduino, HTML, and JavaScript. Let's look at some important points of the code.
    - The following JavaScript function creates a new Google map position with latitude and longitude:

      ```
      var myLatlng = new google.maps.LatLng(-
      25.363882,131.044922);
      ```

      The latitude and longitude values should be replaced with the real time returning values of the Arduino GPS shield as follows:

      ```
      var myLatlng = new
      google.maps.LatLng(gps.location.lat(),gps.location.lng());
      ```

    - The following JavaScript function will create a map and display a simple marker on Google Maps based on the location provided by the map options:

      ```
      var map = new google.maps.Map(document.getElementById('map-
      canvas'), mapOptions);
      ```

3. Open your web browser and type the IP address of the Arduino Ethernet Shield and navigate to the site. Read *Chapter 1, Internet-Controlled PowerSwitch*, for information on how to find the IP address of your Arduino Ethernet Shield. Example: `http://192.168.10.177`.
4. Your web browser will display your GPS shield's current location on the Google Map, as shown in the following screenshot:

Vauxhall St
Nawaloka Bus Stop
Nawaloka
Nawaloka Hospital
Stuart St

The current location of the Arduino GPS shield is displayed on the Google Map with a marker icon

In the next section, you will learn how to send the current GPS location by SMS to the client using Twilio and Temboo.

Getting started with Twilio

The Twilio platform provides API to programmatically send, receive, and track SMS messages worldwide, while also letting you test your SMS-enabled applications within a sandbox environment.

Creating a Twilio account

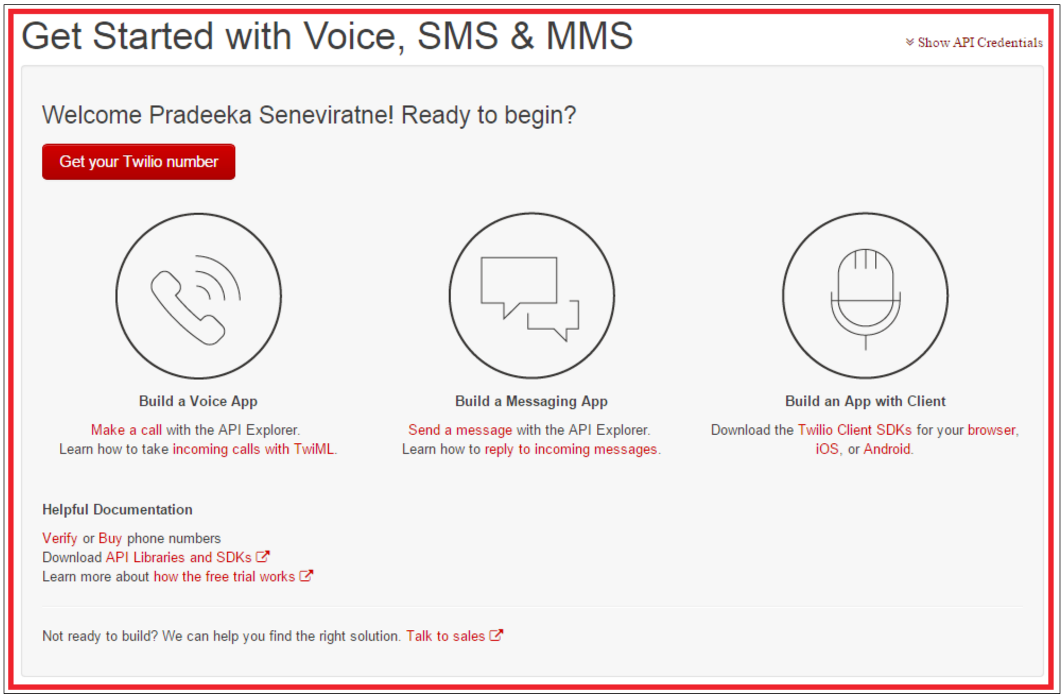
Using your Internet browser, visit `https://www.twilio.com/`. The Twilio landing page will be displayed with the sign up and log in options.

Click on the **SIGN UP** button. You will be navigated to the new user registration form.

Fill out the form with the relevant information and then click on the **Get Started** button. You will be navigated to the **Human Verification** page:

1. In this page, select your country from the drop-down list and type your phone number in the textbox.
2. Click on the **Text Me** button. You will be navigated to the **Enter Verification Page**. Meanwhile, your mobile phone will receive an SMS message containing a verification code.
3. In the **Enter Verification Page**, enter the verification code and click on the **Submit** button.

After successfully verifying your Twilio account, you will be navigated to the Twilio **Getting Started** page. This means that you have successfully created a Twilio account.



Get Started with Voice, SMS & MMS

Welcome Pradeeka Seneviratne! Ready to begin?

Build a Voice App

Make a call with the API Explorer.
Learn how to take incoming calls with TwiML.

Build a Messaging App

Send a message with the API Explorer.
Learn how to reply to incoming messages.

Build an App with Client

Download the Twilio Client SDKs for your browser, iOS, or Android.

Helpful Documentation

Verify or Buy phone numbers
Download API Libraries and SDKs
Learn more about how the free trial works

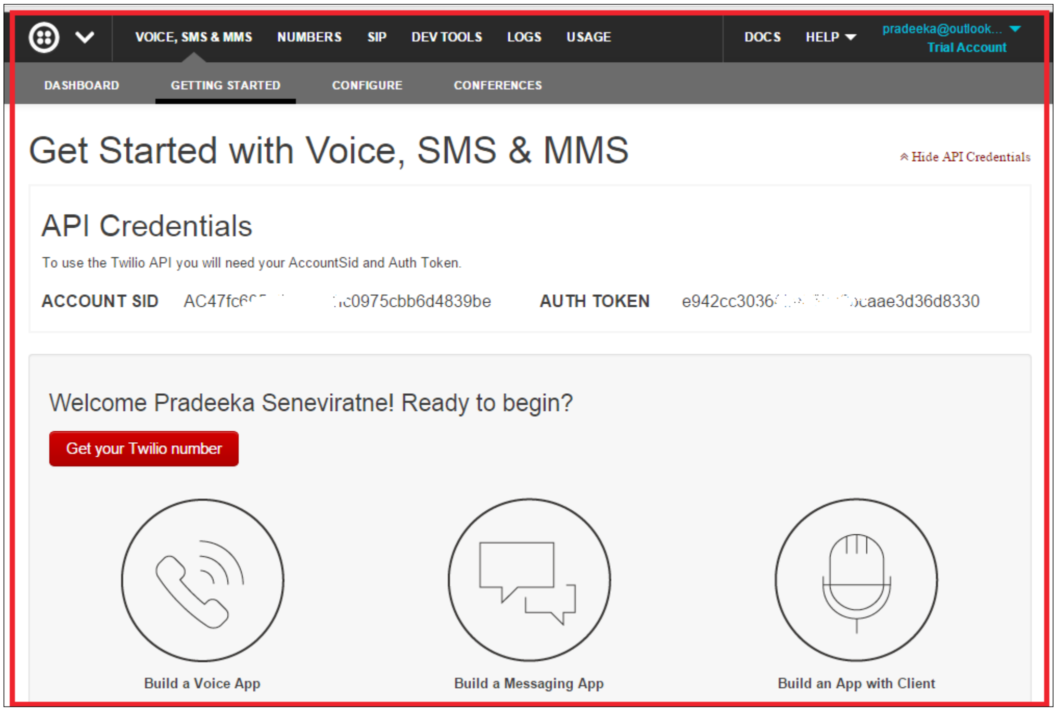
Not ready to build? We can help you find the right solution. Talk to sales

Twilio's getting started page

Finding Twilio LIVE API credentials

At the top of the Twilio getting started page, you will find the **Show API Credentials** link. Click on it, and the **API Credentials** panel will expand and display the following information:

- **ACCOUNT SID**
- **AUTH TOKEN**



Get Started with Voice, SMS & MMS

Hide API Credentials

API Credentials

To use the Twilio API you will need your AccountSid and Auth Token.

ACCOUNT SID AC47fc[redacted]c0975cbb6d4839be AUTH TOKEN e942cc3036[redacted]caae3d36d8330

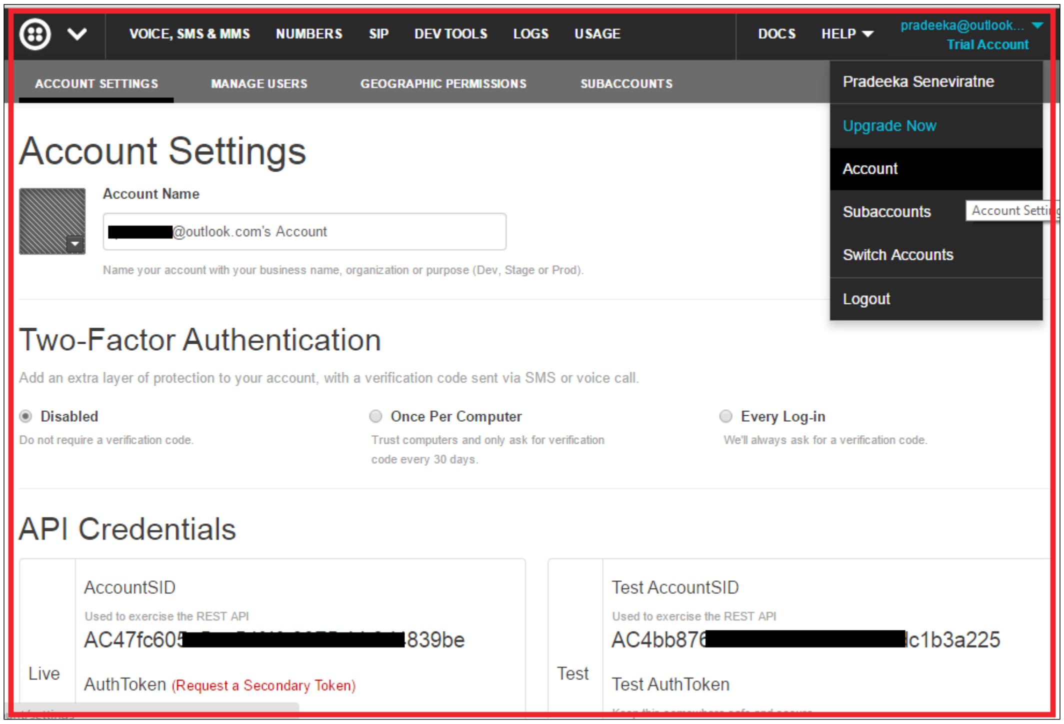
Welcome Pradeeka Seneviratne! Ready to begin?

Twilio API Credentials: Account SID and Auth Token

You will need the **ACCOUNT SID** and **AUTH TOKEN** in the next section when you connect your Twilio account with Temboo. However, the default account type is a trial account with limited API calls allocated. If you want to get the full benefit of Twilio, upgrade the account.

Finding Twilio test API credentials

At the top-right of the page, click on your account name, and from the drop-down menu, click on **Account**. The **Account Settings** page will appear, as shown here:



Account Settings

Account Name

[redacted]@outlook.com's Account

Name your account with your business name, organization or purpose (Dev, Stage or Prod).

Two-Factor Authentication

Add an extra layer of protection to your account, with a verification code sent via SMS or voice call.

● Disabled
Do not require a verification code.

○ Once Per Computer
Trust computers and only ask for verification code every 30 days.

○ Every Log-in
We'll always ask for a verification code.

API Credentials

Live

AccountSID
Used to exercise the REST API
AC47fc605[redacted]839be

AuthToken (Request a Secondary Token)

Test

Test AccountSID
Used to exercise the REST API
AC4bb876[redacted]c1b3a225

Test AuthToken

Twilio test API credentials: Test Account SID and Test Auth Token

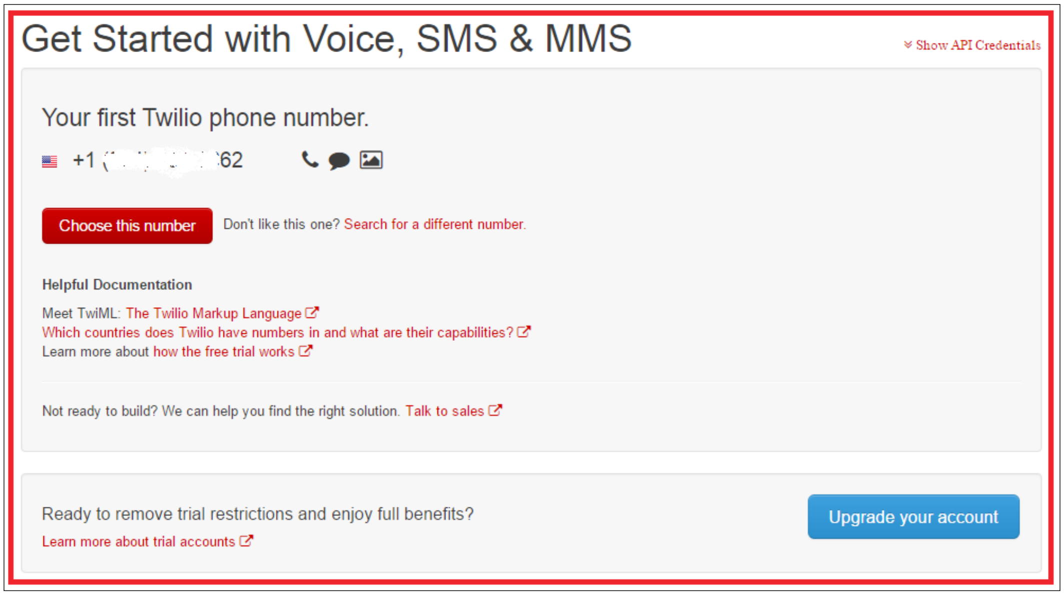
In this page, under **API Credentials,** you can find the **Test Account SID** and **Test Auth Token** to test your apps with Twilio.

Get your Twilio number

Your Twilio account provides phone numbers to use with Voice, SMS, and MMS. You can obtained one such number by following these instructions:

1. Click on the **Voice, SMS & MMS** menu item at the top of the page.
2. Click on **GETTING STARTED** in the submenu of **Voice, SMS & MMS**.
3. Click on the **Get your Twilio Number** button. Your first Twilio phone number will generate and you can choose the number by clicking on the **Choose this number** button. Also, you can search for a different number by clicking on Search, for a different number link.

   Some countries, such as Australia, do not have SMS capability for trial accounts. Use a United States number, which will enable you to send SMS internationally.



Get Started with Voice, SMS & MMS

Your first Twilio phone number.

+1 ([illegible]62

Don't like this one? Search for a different number.

Helpful Documentation

Meet TwiML: The Twilio Markup Language

Which countries does Twilio have numbers in and what are their capabilities?

Learn more about how the free trial works

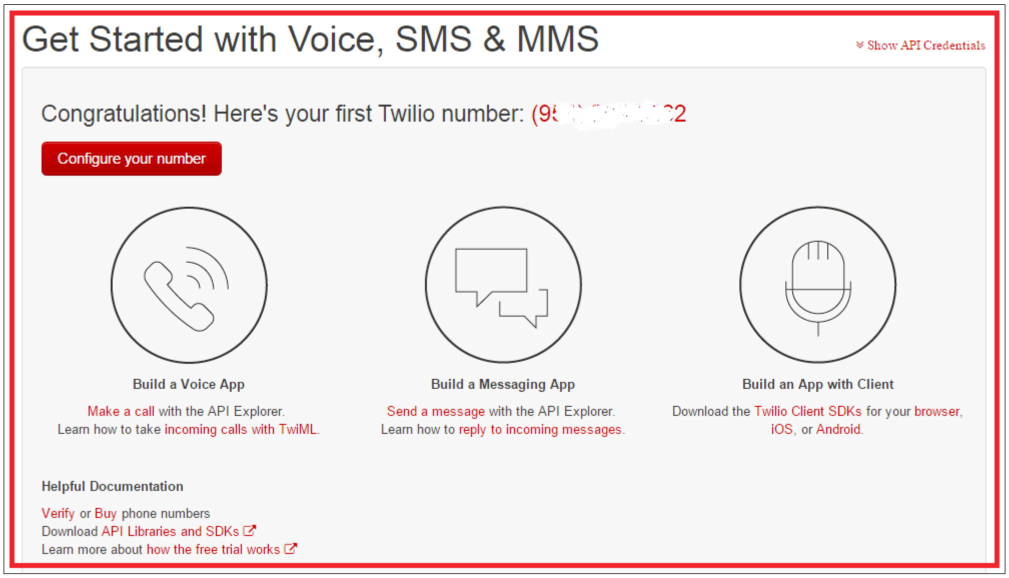
Not ready to build? We can help you find the right solution. Talk to sales

Ready to remove trial restrictions and enjoy full benefits?

Learn more about trial accounts

Twilio phone number

4. The following page will be displayed as a confirmation. You can further configure your Twilio phone number by clicking on the **Configure your number** button:



Get Started with Voice, SMS & MMS

Congratulations! Here's your first Twilio number: [redacted]

Build a Voice App

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Build a Messaging App

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Learn how to reply to incoming messages.

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Twilio Phone number configuration page

Creating Twilio Choreo with Temboo

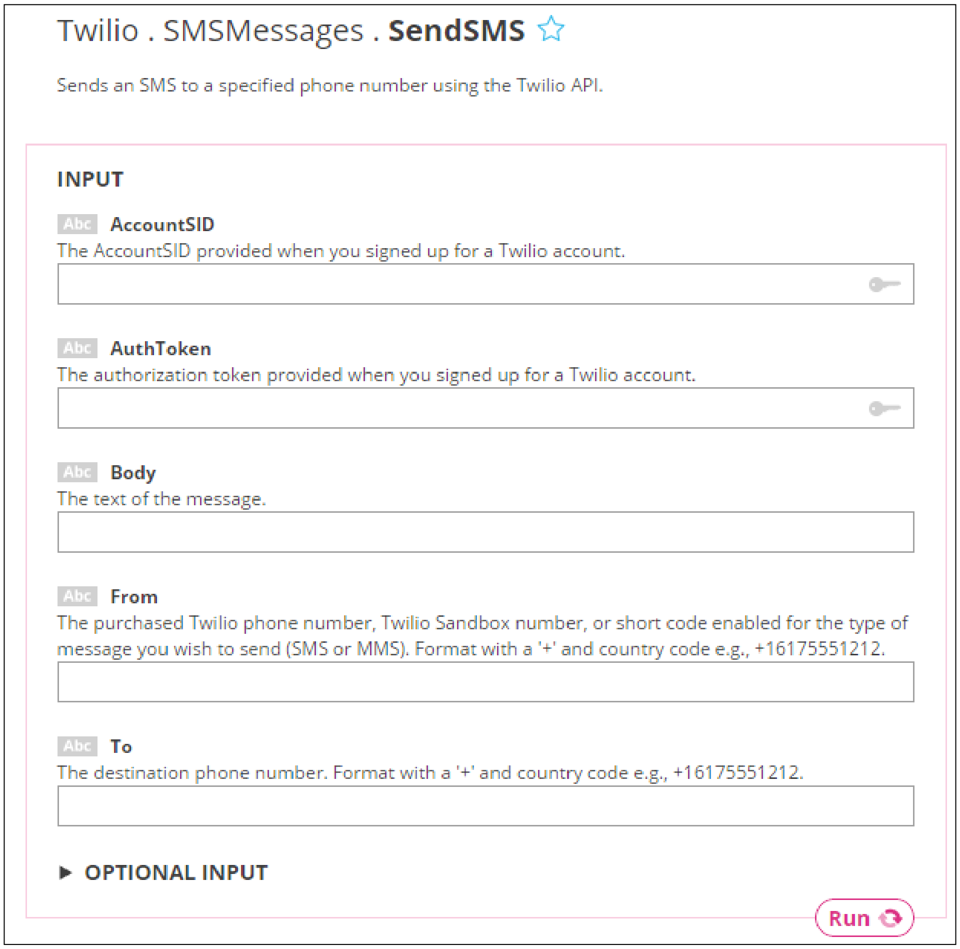
The Temboo provides us with a Choreo to send an SMS using the Twilio account. This Choreo uses Twilio API credentials to authenticate and send SMS to destination phone numbers. The advantage is that by using Temboo Choreos, you can write more complex functions using few lines of code.

Sending an SMS with Twilio API

To send an SMS with Twilio API, perform the following steps:

1. Sign in to your Temboo account. If you still don't have a Temboo account, create one as discussed in *Chapter 5*, *Solar Panel Voltage Logging with NearBus Cloud Connector and Xively*.
2. Under **CHOREOS**, expand **Twilio,** then expand **SMSMessages** and click on **SendSMS**.
3. The right-hand side of the page will load the Twilio SendSMS configuration form.

4. Turn **ON** the **IoT Mode**.



Twilio . SMSMessages . **SendSMS** ☆

Sends an SMS to a specified phone number using the Twilio API.

INPUT

Abc **AccountSID**
The AccountSID provided when you signed up for a Twilio account.

Abc **AuthToken**
The authorization token provided when you signed up for a Twilio account.

Abc **Body**
The text of the message.

Abc **From**
The purchased Twilio phone number, Twilio Sandbox number, or short code enabled for the type of message you wish to send (SMS or MMS). Format with a '+' and country code e.g., +16175551212.

Abc **To**
The destination phone number. Format with a '+' and country code e.g., +16175551212.

Twilio SendSMS form

5. Fill out the following textboxes with your Twilio API settings:
   - **AccountSID**: Type the Twilio Test Account SID
   - **AuthToken**: Type the Twilio Test AuthToken
   - **Body**: You can type any text message here in order to test
   - **From**: Type Twilio Sandbox number (use your Twilio phone number)
   - **To**: The destination phone number (use your phone number that associated with the Twilio account)

6. Click on the **Run** button to send the SMS to your phone.

Send a GPS location data using Temboo

To send a GPS location data using Temboo, perform the following steps:

1. Open a new Arduino IDE and copy and paste the sketch `B04844_06_03.ino` from the `Chapter 6` code folder.
2. Replace the `ToValue` and `FromValue` phone numbers, as shown here:

   ```
   String ToValue = "+16175XXX213";
   SendSMSChoreo.addInput("To", ToValue);
   String FromValue = "+16175XXX212";
   SendSMSChoreo.addInput("From", FromValue);
   ```

3. Save the `B04844_06_03.ino` sketch in your local drive inside a new folder. Copy the code generated in the `HEADER FILE` section under the `Twilio SendSMS` section, and paste it into a new Notepad file. Save the file as `TembooAccount.h` in the same location.
4. Verify the sketch. If you get a compiler error indicating that the `TembooAccount.h` header file is missing, restart the Arduino IDE and open the `B04844_06_03.ino` sketch again and then verify. This will probably solve the issue.
5. Upload the sketch into your Arduino Ethernet board.
6. You will receive the first SMS including the GPS location data from your device. Wait for 30 minutes. You will receive the second SMS. You can change the delay between SMS messages by modifying the following code line as shown:

   ```
   delay(1800*1000); // wait 30 minutes between SendSMS calls
   ```

The value 1,800 seconds is equal to 30 minutes. To convert the 1,800 seconds into milliseconds, multiply it by 1,000.

Summary

In this chapter, you learned how to connect the Arduino GPS shield with Arduino Ethernet Shield while displaying the current location using Google maps with Google Maps JavaScript API. You also used Twilio and Temboo APIs to send SMS messages with GPS location data to the user.

In the next chapter, you will learn how to build a garage door light that can be controlled using Twitter tweets with the combination of Python and Python-Twitter (a Python wrapper around the Twitter API).

7

Tweet-a-Light – Twitter-Enabled Electric Light

In *Chapter 1*, *Internet-Controlled PowerSwitch*, we learned how to control a PowerSwitch Tail (or any relay) through the Internet by using the Arduino Ethernet library. Now, we will look into how Twitter tweets can be used to control the PowerSwitch Tail.

In this chapter, we will learn:

- How to install Python on Windows
- How to install some useful libraries on Python, including pySerial and Tweepy
- How to create a Twitter account and obtain Twitter API keys
- How to write a simple Python Script to read Twitter tweets and write data on serial port
- How to write a simple Arduino sketch to read incoming data from serial port

Hardware and software requirements

To complete this project, you will require the following hardware and software.

Hardware

- Arduino UNO Rev3 board (`https://store.arduino.cc/product/A000066`)
- A computer with Windows installed and Internet connected

- PowerSwitch Tail (120V or 240V depending on your voltage of mains electricity supply)—(`http://www.powerswitchtail.com/Pages/default.aspx`)
- A light bulb (120V or 240V depending on your voltage of mains electricity supply), holder, and wires rating with 120V/240V
- A USB A-to-B cable (`https://www.sparkfun.com/products/512`)
- Some hook-up wires

Software

The software needed for this project is mentioned under each topic so that it will be easier to download and organize without messing things up.

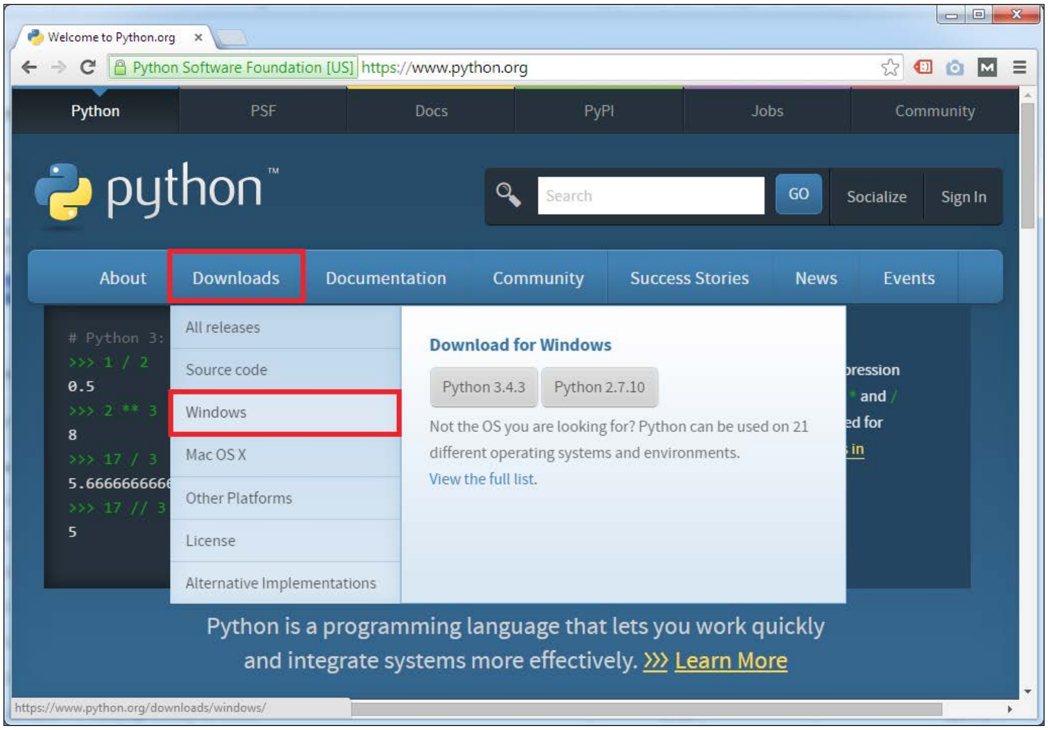
Getting started with Python

Python is an interpreted, object-oriented, and high-level computer programming language with very powerful features that's easy to learn because of its simple syntax. For this project, we can easily write an interface between Twitter and Arduino using the Python script.

Installing Python on Windows

The following steps will explain how to install Python on a Windows computer:

1. Visit `https://www.python.org/`.
2. Click on **Downloads** | **Windows**.



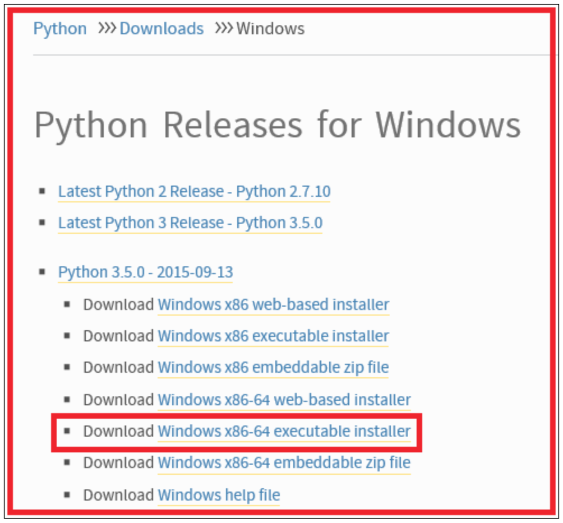
```
# Python 3:
>>> 1 / 2
0.5
>>> 2 ** 3
8
>>> 17 / 3
5.666666666
>>> 17 // 3
5
```

Not the OS you are looking for? Python can be used on 21 different operating systems and environments.

Python is a programming language that lets you work quickly and integrate systems more effectively. >>> Learn More

The Python home page

3. Then, you will navigate to the **Python Releases for Windows** web page:



Python >>> Downloads >>> Windows

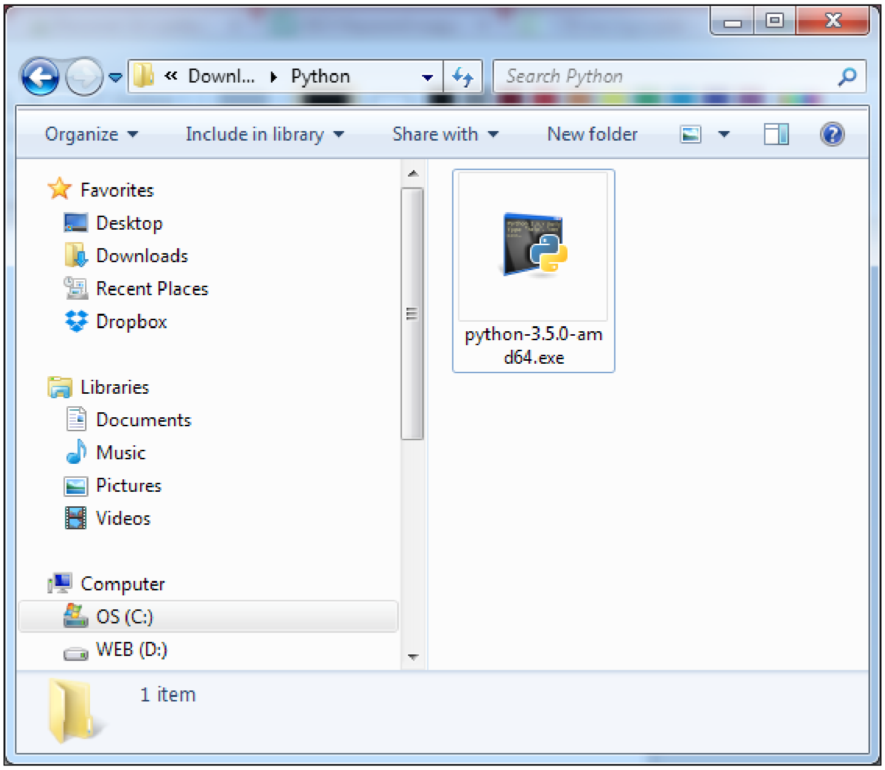
Python Releases for Windows

- Latest Python 2 Release - Python 2.7.10
- Latest Python 3 Release - Python 3.5.0

- Python 3.5.0 - 2015-09-13
  - Download Windows x86 web-based installer
  - Download Windows x86 executable installer
  - Download Windows x86 embeddable zip file
  - Download Windows x86-64 web-based installer
  - Download Windows x86-64 executable installer
  - Download Windows x86-64 embeddable zip file
  - Download Windows help file

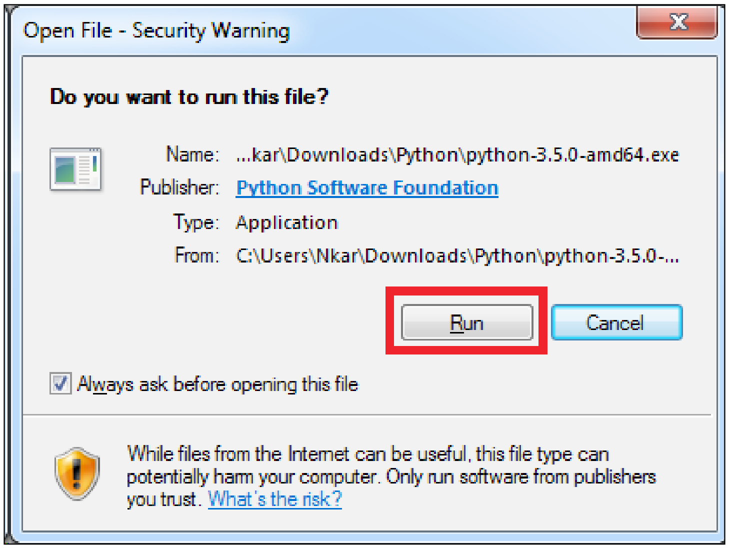
The Python download page

4. Python can be downloaded from two development branches: legacy and present. The legacy releases are labeled as 2.x.x, and present releases are labeled as 3.x.x. (For reference, the major difference of 2.7.x and 3.0 can be found at `http://learntocodewith.me/programming/python/python-2-vs-python-3/`). Click on the latest (see the date) Windows x86-64-executable installer to download the executable installer setup file to your local drive under Python 3.x.x.
5. Alternately, you can download a web-based installer or embedded ZIP file to install Python on your computer.
6. Browse the default `Downloads` folder in your computer and find the downloaded setup file. (My default downloads folder is `C:\Downloads`).
7. Double-click on the executable file to start the setup:



The Python setup

8. Click on the **Run** button if prompted as a security warning:



Open File - Security Warning

Do you want to run this file?

Name: ...kar\Downloads\Python\python-3.5.0-amd64.exe

Publisher: Python Software Foundation

Type: Application

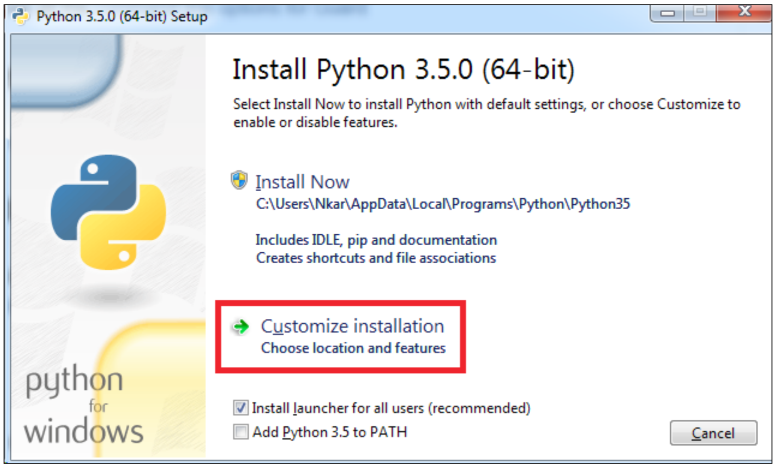
From: C:\Users\Nkar\Downloads\Python\python-3.5.0-...

☑ Always ask before opening this file

While files from the Internet can be useful, this file type can potentially harm your computer. Only run software from publishers you trust. What's the risk?

Security warning

9. The Python setup wizard starts:



Python 3.5.0 (64-bit) Setup

Install Python 3.5.0 (64-bit)

Select Install Now to install Python with default settings, or choose Customize to enable or disable features.

Install Now
C:\Users\Nkar\AppData\Local\Programs\Python\Python35

Includes IDLE, pip and documentation
Creates shortcuts and file associations

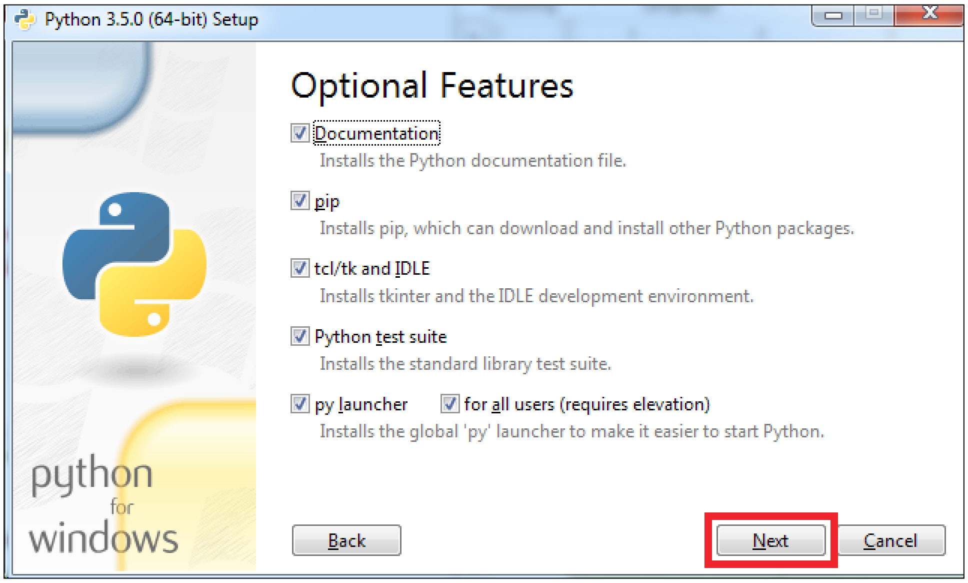
Customize installation
Choose location and features

☑ Install launcher for all users (recommended)

□ Add Python 3.5 to PATH

The Python setup wizard—start screen

10. Optionally, you can check **Add Python 3.5 to PATH**, or later, you can add it using Windows system properties. Click on the **Customize installation** section. The **Optional Features** dialog box will appear:



Python 3.5.0 (64-bit) Setup

Optional Features

☑ Documentation
Installs the Python documentation file.

☑ pip
Installs pip, which can download and install other Python packages.

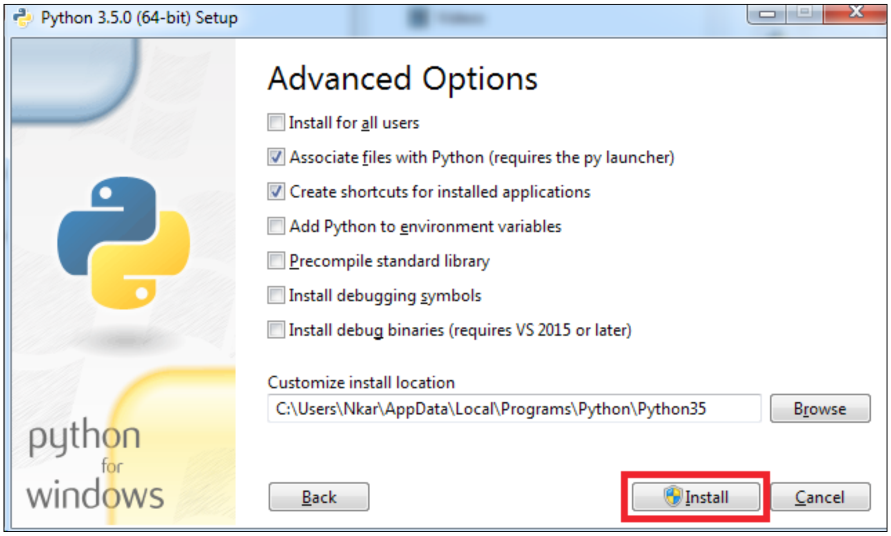
☑ tcl/tk and IDLE
Installs tkinter and the IDLE development environment.

☑ Python test suite
Installs the standard library test suite.

☑ py launcher ☑ for all users (requires elevation)
Installs the global 'py' launcher to make it easier to start Python.

The Python setup wizard – Optional Features

11. Click on the **Next** button to proceed. The **Advanced Options** dialog box will appear. Keep the selected options as default.



Python 3.5.0 (64-bit) Setup

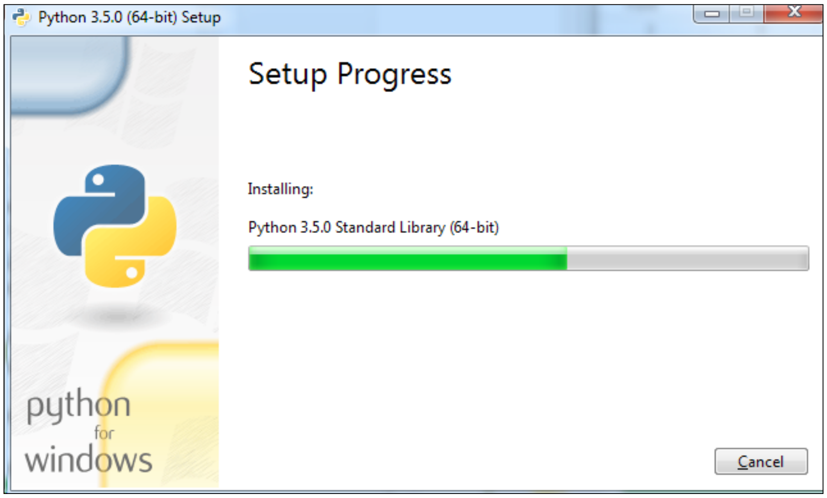
Advanced Options

□ Install for all users
☑ Associate files with Python (requires the py launcher)
☑ Create shortcuts for installed applications
□ Add Python to environment variables
□ Precompile standard library
□ Install debugging symbols
□ Install debug binaries (requires VS 2015 or later)

Customize install location
C:\Users\Nkar\AppData\Local\Programs\Python\Python35

The Python setup wizard – Advanced Options

12. The default installation path can be found under **Customize install location**. If you like, you can change the installation location by clicking on the **Browse** button and selecting a new location in your computer's local drive.
13. Finally, click on the **Install** button.
14. If prompted for User Access Control, click on **OK**. The **Setup Progress** screen will be displayed on the wizard:



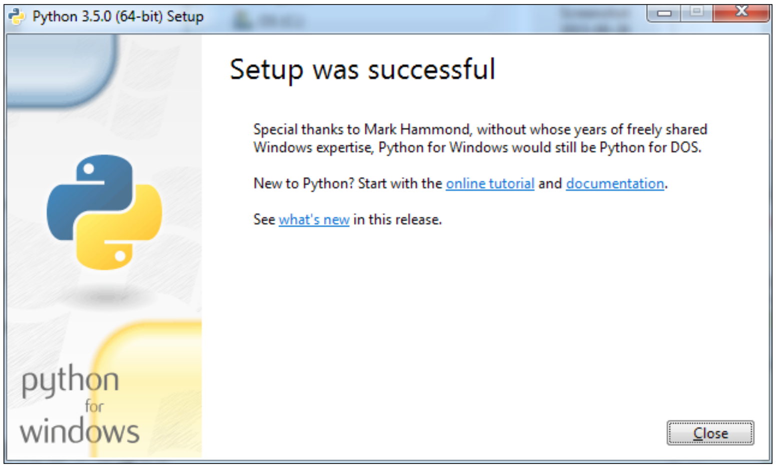
Setup Progress

Installing:

Python 3.5.0 Standard Library (64-bit)

Python setup installation progress

15. If the setup is successful, you will see the following dialog box. Click on the **Close** button to close the dialog box:



Setup was successful

Special thanks to Mark Hammond, without whose years of freely shared Windows expertise, Python for Windows would still be Python for DOS.

New to Python? Start with the online tutorial and documentation.

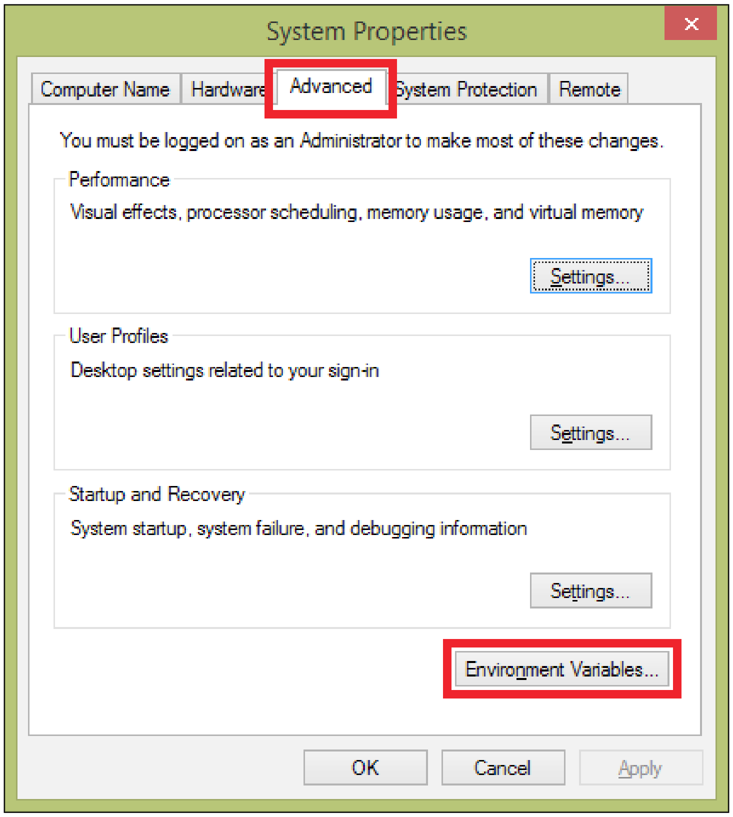
See what's new in this release.

The Python setup is successful

Setting environment variables for Python

If you have already set to **Add Python 3.5 to PATH** for writing the environment variables during the Python setup installation process, ignore this section. If not, then follow these steps to set environment variables for Python.

1. Open the Windows **Control Panel** and click on **System**. Then, click on **Advanced system settings**.
2. The **System Properties** dialog box will appear. Click on the **Advanced** tab. Then, click on the **Environment Variables…** button:



You must be logged on as an Administrator to make most of these changes.

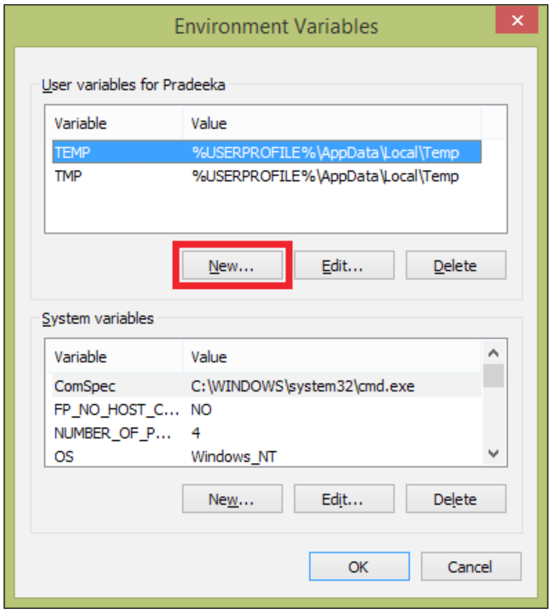
Visual effects, processor scheduling, memory usage, and virtual memory

Desktop settings related to your sign-in

System startup, system failure, and debugging information

The System Properties dialog box

3. The **Environment Variables** dialog box will appear. Click on the **New...** button under user variables:

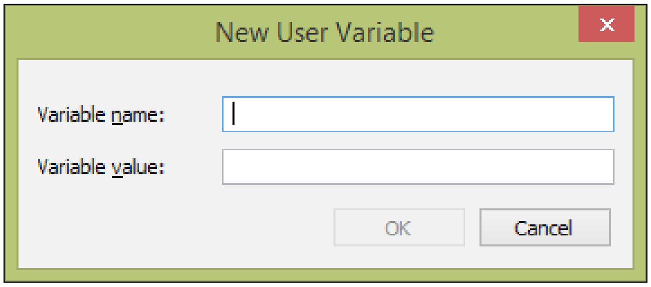


Variable	Value
TEMP	%USERPROFILE%\AppData\Local\Temp
TMP	%USERPROFILE%\AppData\Local\Temp

Variable	Value
ComSpec	C:\WINDOWS\system32\cmd.exe
FP_NO_HOST_C...	NO
NUMBER_OF_P...	4
OS	Windows_NT

The Environment Variables dialog box

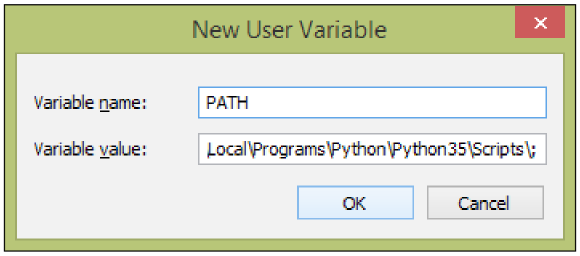
4. The **New User Variable** dialog box appears:



The New User Variable dialog box

5. Type the following for the respective textboxes:
   - **Variable name**: `PATH`
   - **Variable Value**: `C:\Users\Pradeeka\AppData\Local\Programs\Python\Python35;C:\Users\Pradeeka\AppData\Local\Programs\Python\Python35\Lib\site-packages\;C:\Users\Pradeeka\AppData\Local\Programs\Python\Python35\Scripts\;`

Modify the preceding paths according to your Python installation location:

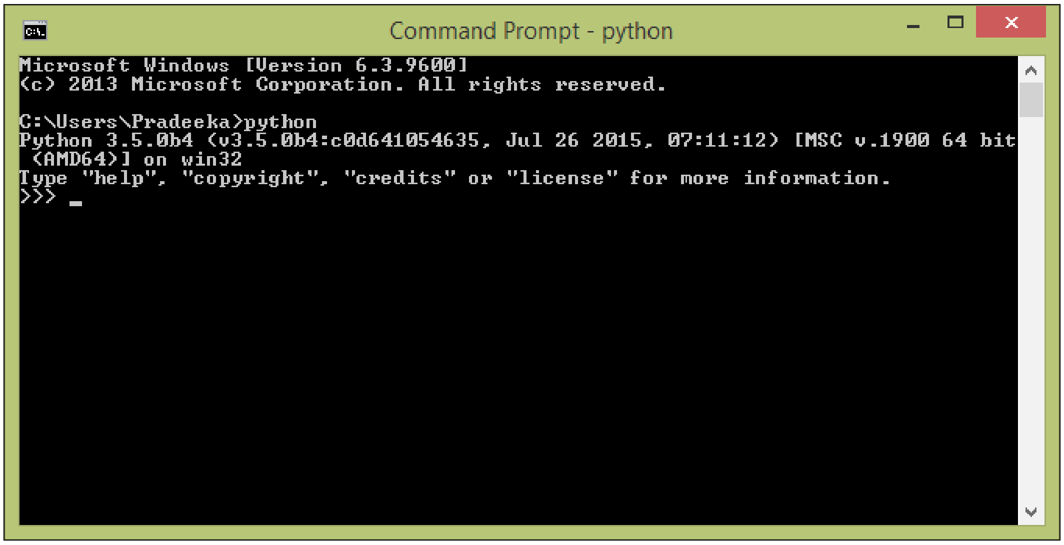


Variable name: PATH

Variable value: Local\Programs\Python\Python35\Scripts\;

The New User Variable dialog box

6. Click on the **OK** button three times to close all the dialog boxes.
7. Open Windows Command Prompt and type `python`, and then press the *Enter* key. The Python Command Prompt will start. The prompt begins with `>>>` (three greater than marks):



```
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\Pradeeka>python
Python 3.5.0b4 (v3.5.0b4:c0d641054635, Jul 26 2015, 07:11:12) [MSC v.1900 64 bit
 (AMD64)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>> _
```

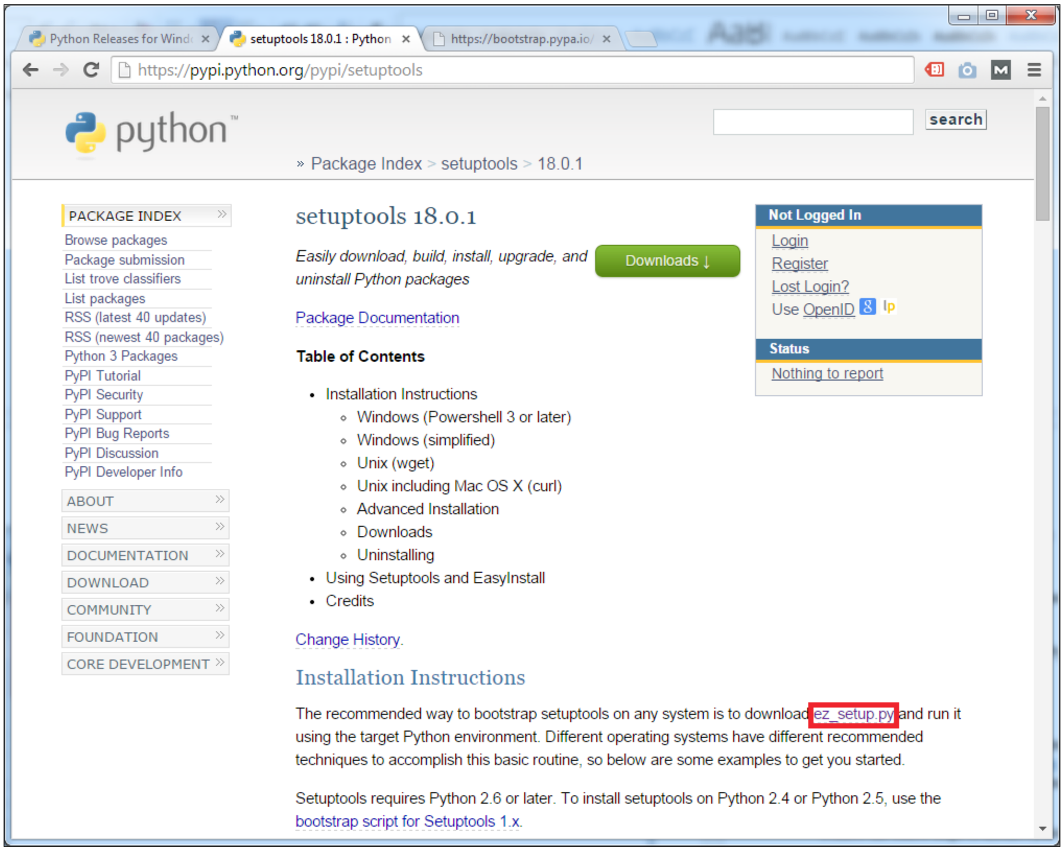
Python Command Prompt

This ensures that the Python environment variables are successfully added to Windows. From now, you can execute Python commands from the Windows command prompt. Press *Ctrl* + *C* to return the default (Windows) command prompt.

Installing the setuptools utility on Python

The `setuptools` utility lets you download, build, install, upgrade, and uninstall Python packages easily. To add the `setuptools` utility to your Python environment, follow the next steps. At the time of writing this book, the `setuptools` utility was in version 18.0.1.

1. Visit the `setuptools` download page at `https://pypi.python.org/pypi/setuptools`.
2. Download the `ez_setup.py` script by clicking on the link (`https://bootstrap.pypa.io/ez_setup.py`):



setuptools 18.0.1

Easily download, build, install, upgrade, and uninstall Python packages

Package Documentation

Table of Contents

- Installation Instructions
  - Windows (Powershell 3 or later)
  - Windows (simplified)
  - Unix (wget)
  - Unix including Mac OS X (curl)
  - Advanced Installation
  - Downloads
  - Uninstalling
- Using Setuptools and EasyInstall
- Credits

Change History

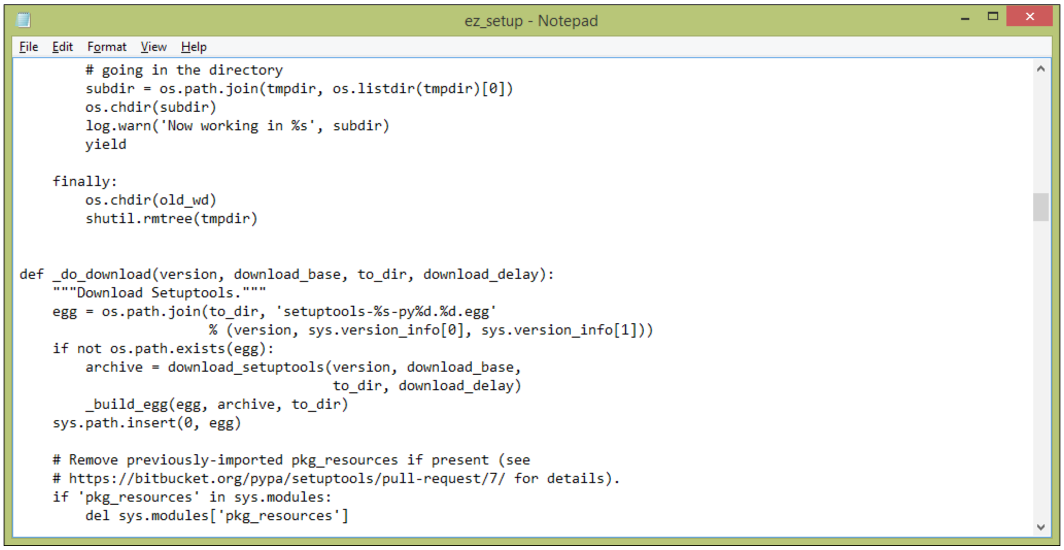
Installation Instructions

The recommended way to bootstrap setuptools on any system is to download ez_setup.py and run it using the target Python environment. Different operating systems have different recommended techniques to accomplish this basic routine, so below are some examples to get you started.

Setuptools requires Python 2.6 or later. To install setuptools on Python 2.4 or Python 2.5, use the bootstrap script for Setuptools 1.x.

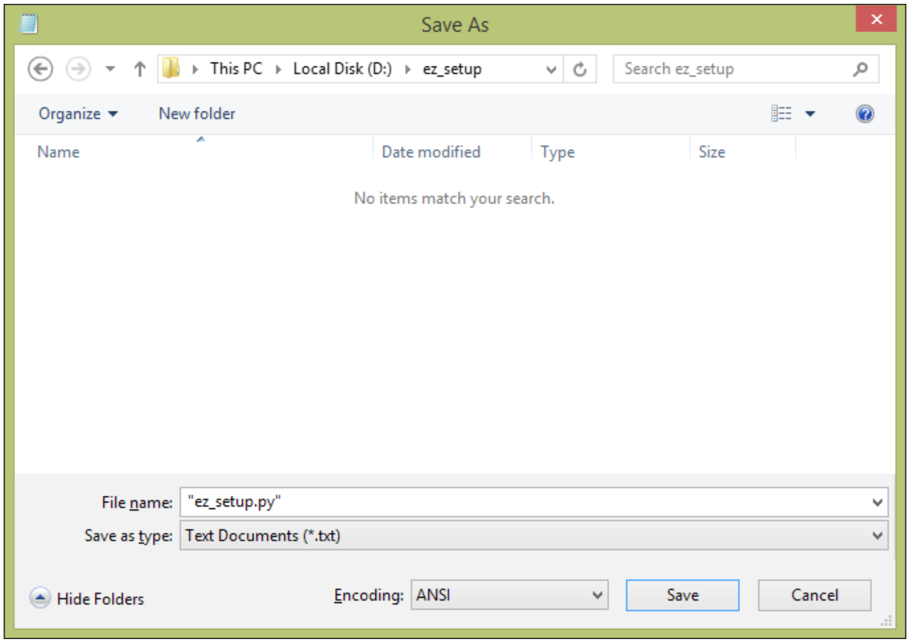
The setuptools download page

3. The script opens in the browser's window itself, rather than downloading as a file. Therefore, press *Ctrl* + *A* to select all the code and paste it on a new Notepad file:



```
        # going in the directory
        subdir = os.path.join(tmpdir, os.listdir(tmpdir)[0])
        os.chdir(subdir)
        log.warn('Now working in %s', subdir)
        yield

    finally:
        os.chdir(old_wd)
        shutil.rmtree(tmpdir)


def _do_download(version, download_base, to_dir, download_delay):
    """Download Setuptools."""
    egg = os.path.join(to_dir, 'setuptools-%s-py%d.%d.egg'
                       % (version, sys.version_info[0], sys.version_info[1]))
    if not os.path.exists(egg):
        archive = download_setuptools(version, download_base,
                                      to_dir, download_delay)
        _build_egg(egg, archive, to_dir)
    sys.path.insert(0, egg)

    # Remove previously-imported pkg_resources if present (see
    # https://bitbucket.org/pypa/setuptools/pull-request/7/ for details).
    if 'pkg_resources' in sys.modules:
        del sys.modules['pkg_resources']
```

4. Next, save the file as `ez_setup.py` in your local drive.



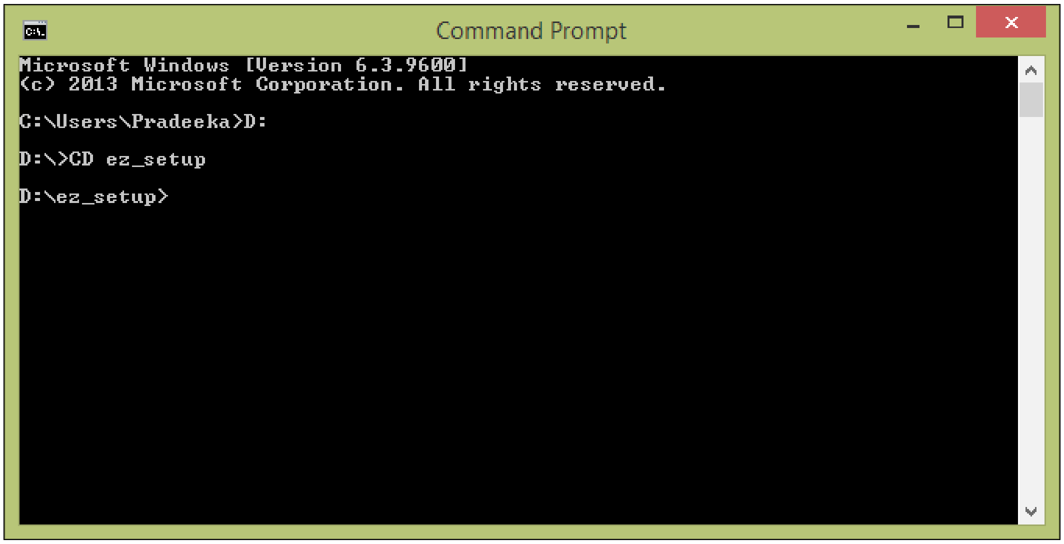
File name: "ez_setup.py"

Save as type: Text Documents (*.txt)

Encoding: ANSI

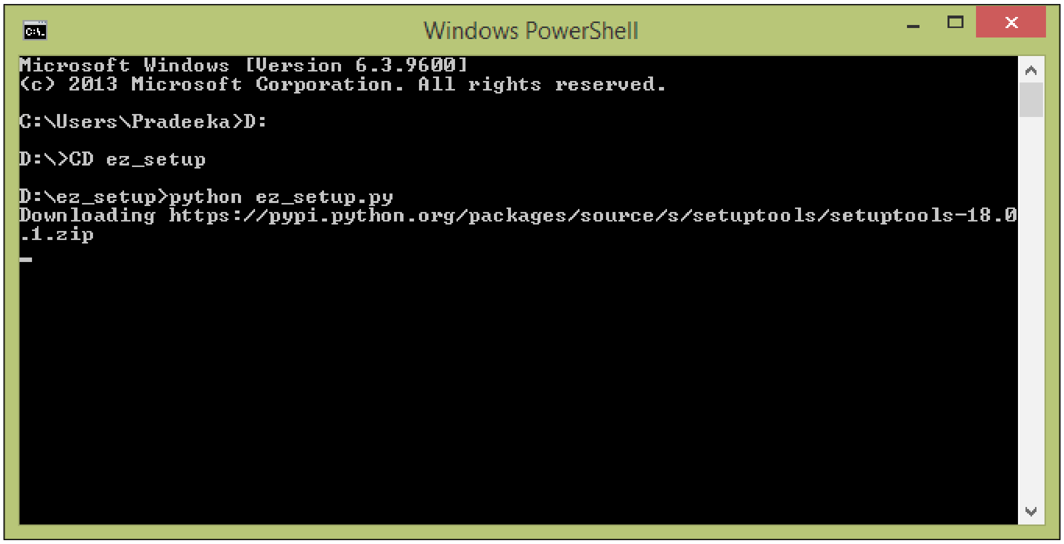
5. Open Windows Command Prompt and navigate to the location of the `ez_setup.py` file using the `cd` command. We assume that the drive is labeled as the letter `D:`, and the folder name is `ez_setup`:

   ```
   C:\>D:
   D:\>CD ez_setup
   ```



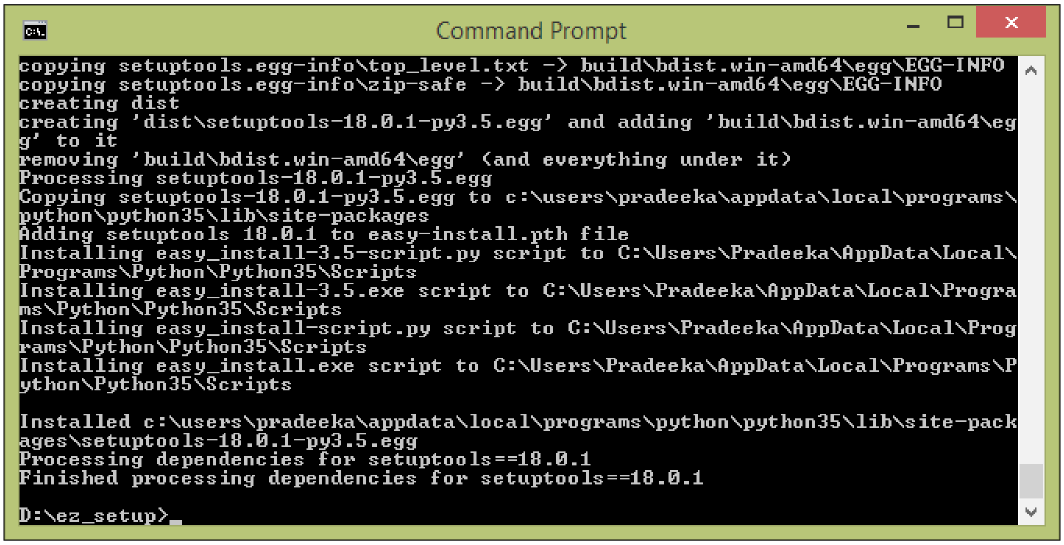
```
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\Pradeeka>D:

D:\>CD ez_setup

D:\ez_setup>
```

6. Type `python ez_setup.py` and press the *Enter* key to run the Python script:



```
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\Pradeeka>D:

D:\>CD ez_setup

D:\ez_setup>python ez_setup.py
Downloading https://pypi.python.org/packages/source/s/setuptools/setuptools-18.0
.1.zip
_
```

This installs the `easysetup` utility package on your Python environment:



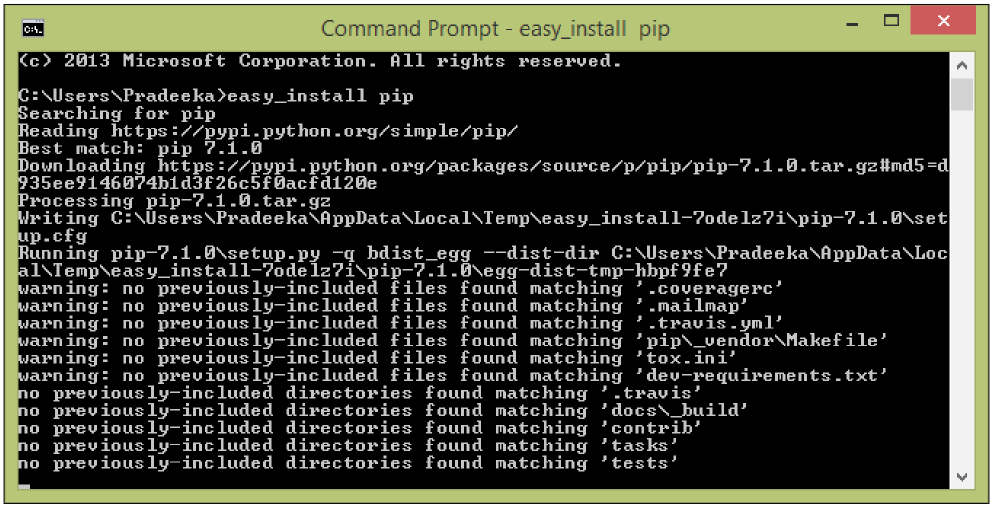
```
copying setuptools.egg-info\top_level.txt -> build\bdist.win-amd64\egg\EGG-INFO
copying setuptools.egg-info\zip-safe -> build\bdist.win-amd64\egg\EGG-INFO
creating dist
creating 'dist\setuptools-18.0.1-py3.5.egg' and adding 'build\bdist.win-amd64\eg
g' to it
removing 'build\bdist.win-amd64\egg' (and everything under it)
Processing setuptools-18.0.1-py3.5.egg
Copying setuptools-18.0.1-py3.5.egg to c:\users\pradeeka\appdata\local\programs\
python\python35\lib\site-packages
Adding setuptools 18.0.1 to easy-install.pth file
Installing easy_install-3.5-script.py script to C:\Users\Pradeeka\AppData\Local\
Programs\Python\Python35\Scripts
Installing easy_install-3.5.exe script to C:\Users\Pradeeka\AppData\Local\Progra
ms\Python\Python35\Scripts
Installing easy_install-script.py script to C:\Users\Pradeeka\AppData\Local\Prog
rams\Python\Python35\Scripts
Installing easy_install.exe script to C:\Users\Pradeeka\AppData\Local\Programs\P
ython\Python35\Scripts

Installed c:\users\pradeeka\appdata\local\programs\python\python35\lib\site-pack
ages\setuptools-18.0.1-py3.5.egg
Processing dependencies for setuptools==18.0.1
Finished processing dependencies for setuptools==18.0.1

D:\ez_setup>_
```

Installing the pip utility on Python

The `pip` utility package can be used to improve the functionality of `setuptools`. The `pip` utility package can be downloaded from `https://pypi.python.org/pypi/pip`. You can now directly install the `pip` utility package by typing the following command into Windows Command Prompt:

```
C:\> easy_install pip
```

However, you can ignore this section if you have selected pip, under **Optional Features**, during the Python installation.



```
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\Pradeeka>easy_install pip
Searching for pip
Reading https://pypi.python.org/simple/pip/
Best match: pip 7.1.0
Downloading https://pypi.python.org/packages/source/p/pip/pip-7.1.0.tar.gz#md5=d
935ee9146074b1d3f26c5f0acfd120e
Processing pip-7.1.0.tar.gz
Writing C:\Users\Pradeeka\AppData\Local\Temp\easy_install-7odelz7i\pip-7.1.0\set
up.cfg
Running pip-7.1.0\setup.py -q bdist_egg --dist-dir C:\Users\Pradeeka\AppData\Loc
al\Temp\easy_install-7odelz7i\pip-7.1.0\egg-dist-tmp-hbpf9fe7
warning: no previously-included files found matching '.coveragerc'
warning: no previously-included files found matching '.mailmap'
warning: no previously-included files found matching '.travis.yml'
warning: no previously-included files found matching 'pip\_vendor\Makefile'
warning: no previously-included files found matching 'tox.ini'
warning: no previously-included files found matching 'dev-requirements.txt'
no previously-included directories found matching '.travis'
no previously-included directories found matching 'docs\_build'
no previously-included directories found matching 'contrib'
no previously-included directories found matching 'tasks'
no previously-included directories found matching 'tests'
```

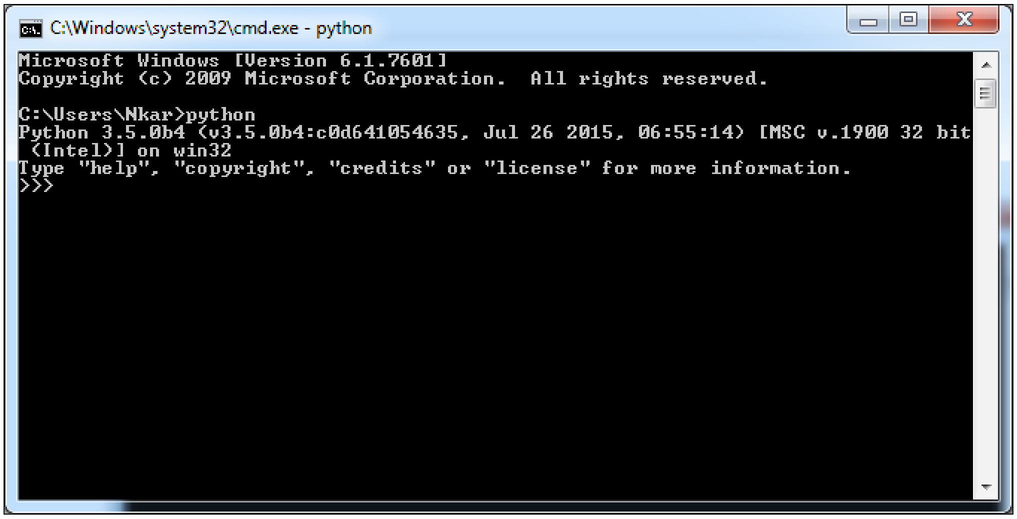
Opening the Python interpreter

Follow these steps to open the Python interpreter:

1. Open Command Prompt and type the following:

   ```
   C:\> Python
   ```

2. This command will load the Python interpreter:



```
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Users\Nkar>python
Python 3.5.0b4 (v3.5.0b4:c0d641054635, Jul 26 2015, 06:55:14) [MSC v.1900 32 bit
 (Intel)] on win32
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

To exit from the Python Interpreter, simply type `exit()` and hit the *Enter* key.

Installing the Tweepy library

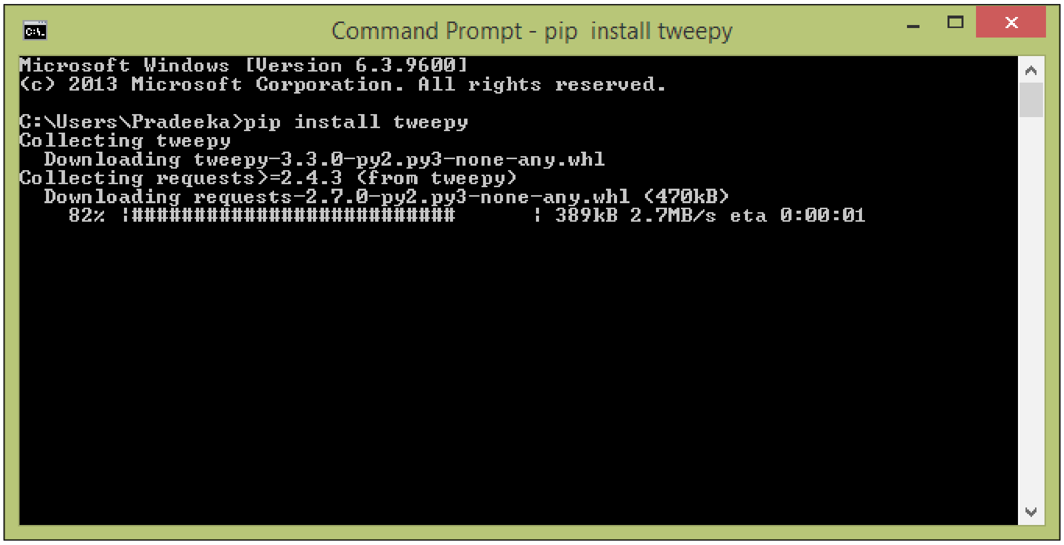
The Tweepy library provides an interface for the Twitter API. The source code can be found at `https://github.com/tweepy/tweepy`. You do not have to download the Tweepy library to your computer. The `pip install` command will automatically download the library and install it on your computer.

Follow these steps to install the Python-Twitter library on your Python installation:

1. Open the Windows command prompt and type:

   ```
   C:\>pip install tweepy
   ```

2. This begins the installation of the Tweepy library on Python:



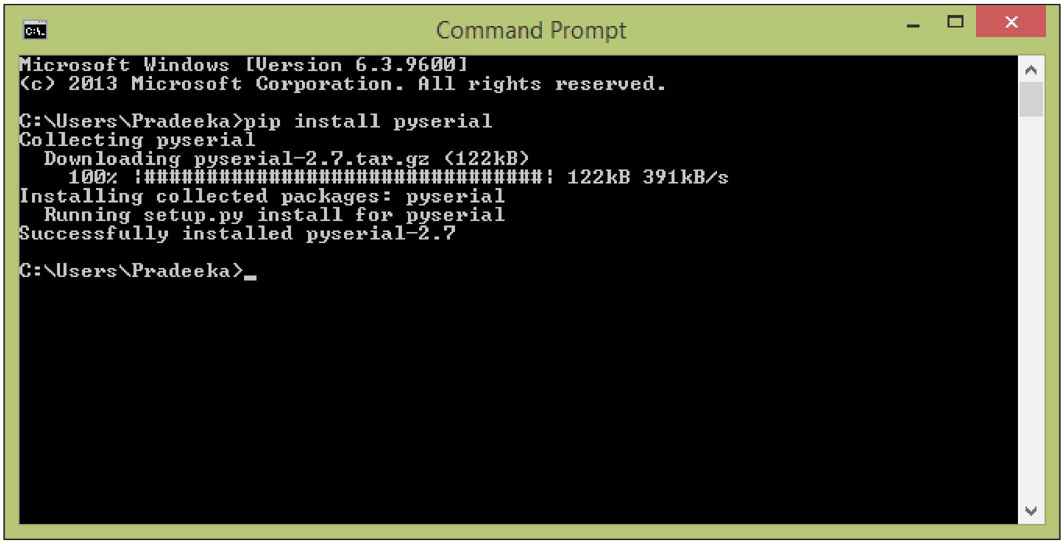
```
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\Pradeeka>pip install tweepy
Collecting tweepy
  Downloading tweepy-3.3.0-py2.py3-none-any.whl
Collecting requests>=2.4.3 (from tweepy)
  Downloading requests-2.7.0-py2.py3-none-any.whl (470kB)
    82% |##########################      | 389kB 2.7MB/s eta 0:00:01
```

Installing pySerial

To access the serial port in the Python environment, we have to first install the pySerial library on Python:

1. Open the Windows Command Prompt and type the following:

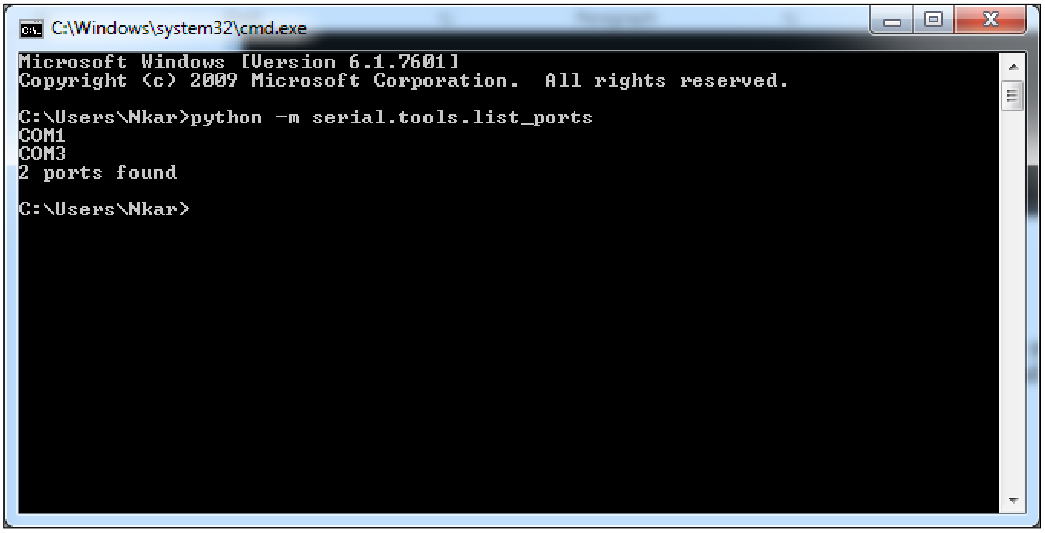
   ```
   C:\>pip install pyserial
   ```



```
Microsoft Windows [Version 6.3.9600]
(c) 2013 Microsoft Corporation. All rights reserved.

C:\Users\Pradeeka>pip install pyserial
Collecting pyserial
  Downloading pyserial-2.7.tar.gz (122kB)
    100% |################################| 122kB 391kB/s
Installing collected packages: pyserial
  Running setup.py install for pyserial
Successfully installed pyserial-2.7

C:\Users\Pradeeka>_
```

2. After installing the pySerial library, type the following command to list the available COM ports in your computer:

   ```
   C:/> python -m serial.tools.list_ports
   ```

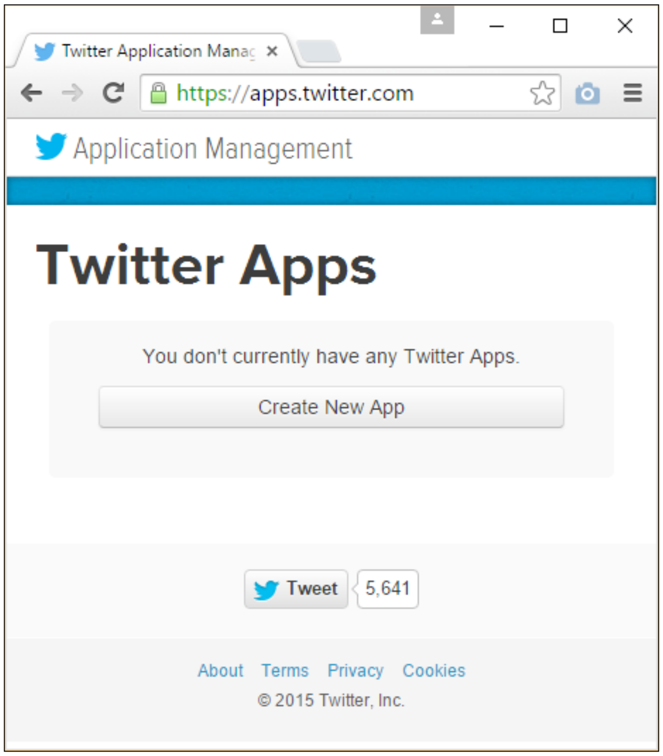


```
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation.  All rights reserved.

C:\Users\Nkar>python -m serial.tools.list_ports
COM1
COM3
2 ports found

C:\Users\Nkar>
```

Creating a Twitter app and obtaining API keys

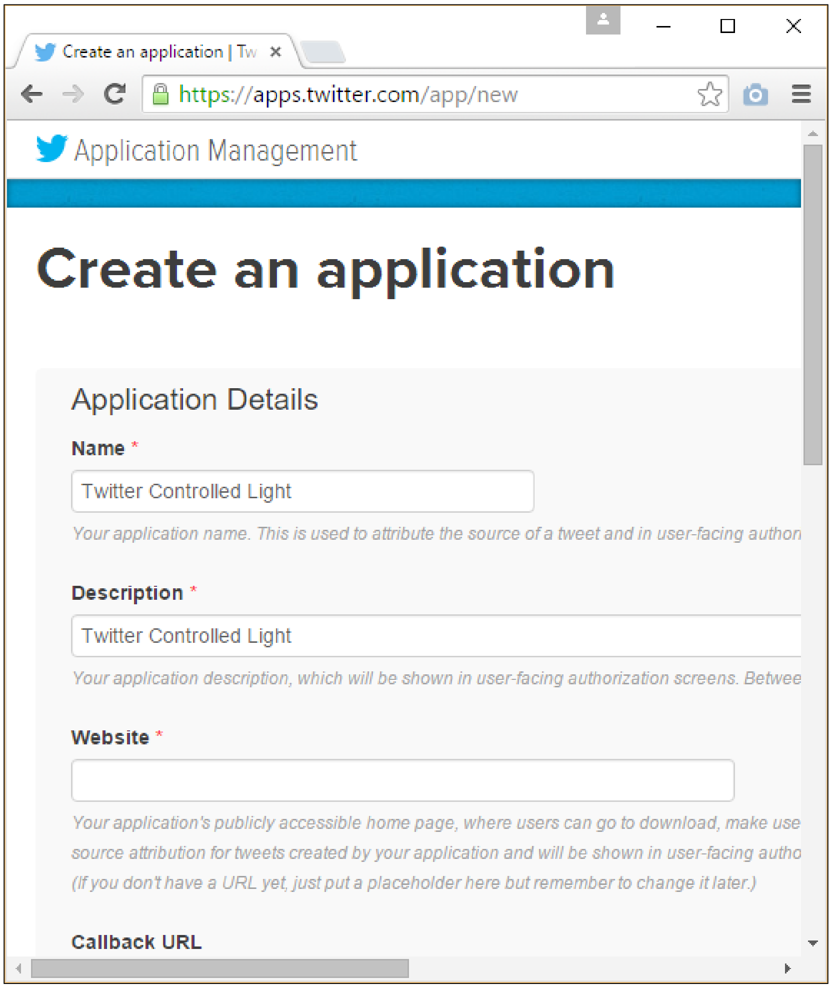
To proceed with our project, use the following steps to create a Twitter App and obtain the API keys.

1. Go to `https://apps.twitter.com/` and sign in with your Twitter login credentials (create a new Twitter account if you don't have one). The following page will display on the browser:



apps.twitter.com, the Application Management start page

2. Click on the **Create New App** button. The **Create an application** page will display:



Create an application

Application Details

Name *

Twitter Controlled Light

Your application name. This is used to attribute the source of a tweet and in user-facing authori

Description *

Twitter Controlled Light

Your application description, which will be shown in user-facing authorization screens. Betwee

Website *

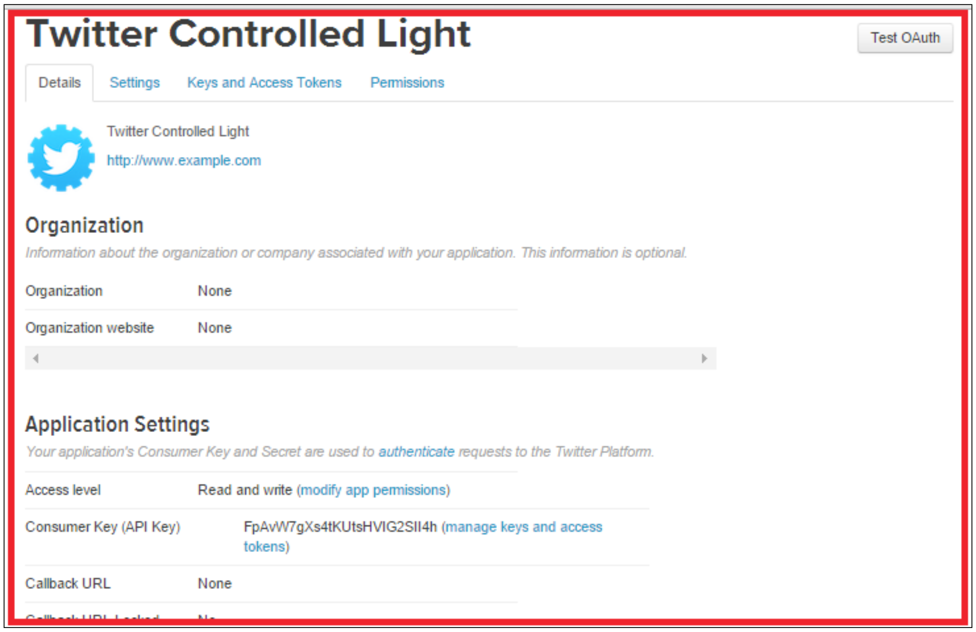
Your application's publicly accessible home page, where users can go to download, make use
source attribution for tweets created by your application and will be shown in user-facing autho
(If you don't have a URL yet, just put a placeholder here but remember to change it later.)

Callback URL

Twitter's Create an application page

3. Fill in the required fields (for the website textbox, just type `http://www.example.com` as a placeholder), accept the **Developer Agreement** by clicking on the **Yes, I agree** checkbox.
4. After this, click on the **Create your Twitter application** button.

5. You will be navigated to the following page:



Twitter Controlled Light

Twitter Controlled Light
http://www.example.com

Organization

Information about the organization or company associated with your application. This information is optional.

Organization None

Organization website None

Application Settings

Your application's Consumer Key and Secret are used to authenticate requests to the Twitter Platform.

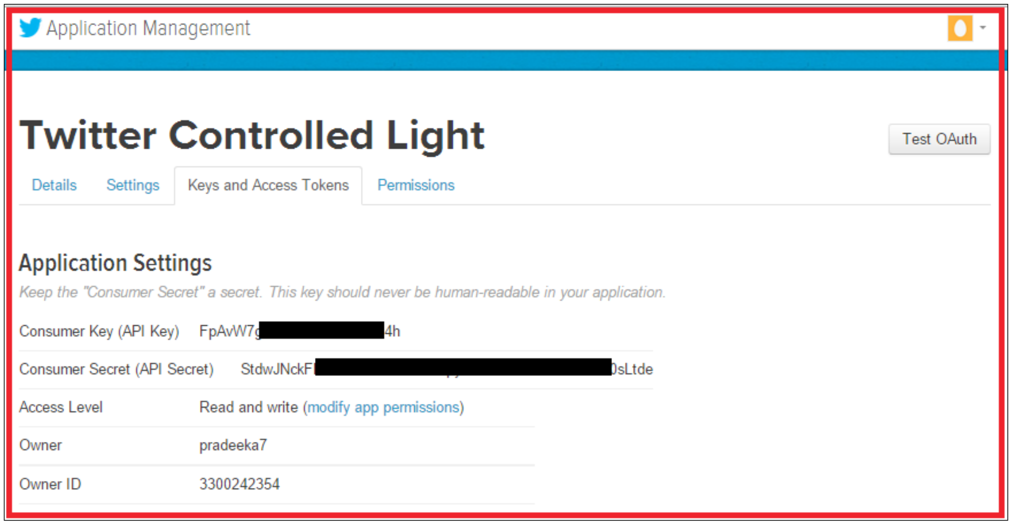
Access level Read and write (modify app permissions)

Consumer Key (API Key) FpAvW7gXs4tKUtsHVIG2SIl4h (manage keys and access tokens)

Callback URL None

The Twitter application settings page

6. Click on the **Keys and Access Tokens** tab. Under this tab, you will find **Consumer Key (API Key)** and **Consumer Secret (API Secret)**. Copy these two keys and paste them in a Notepad file, because you will require them in the next section:



Twitter Controlled Light

Application Settings

Keep the "Consumer Secret" a secret. This key should never be human-readable in your application.

Consumer Key (API Key) FpAvW7g[redacted]4h

Consumer Secret (API Secret) StdwJNckF[redacted]0sLtde

Access Level Read and write (modify app permissions)

Owner pradeeka7

Owner ID 3300242354

Writing a Python script to read Twitter tweets

The Tweepy library provides a set of easy functions to interface with the Twitter API. Our Python script provides the following operations and services:

- Read tweets from the specified twitter screen name. For example, `@PacktPub`, every 30 seconds (if you want, you can change the delay period)
- Always read the latest tweet
- If the tweet includes the text, `#switchon`, then print the tweet on the console and write `1` on the serial port
- If the tweet includes the text, `#switchoff`, then print the tweet on the console and write `0` on the serial port
- Otherwise, maintain the last state

The following Python script will provide an interface between Twitter and the serial port of your computer. The sample script, `twitter_test.py`, can be found inside the `Chapter 7` codes folder. Copy the file to your local drive and open it using Notepad or NotePad++:

```
import tweepy
import time
import serial
import struct

auth = tweepy.OAuthHandler('SZ3jdFXXXXXXXXXXPJaL9w4wm',
'jQ9MBuy7SL6wgRK1XXXXXXXXXXGGGGIAFevITkNEAMglUNebgK')
auth.set_access_token('3300242354-
sJB78WNygLXXXXXXXXXXGxkTKWBck6vYIL79jjE',
'ZGfOgnPBhUD10XXXXXXXXXXt3KsxKxwqlcAbc0HEk21RH')

api = tweepy.API(auth)
ser = serial.Serial('COM3', 9600, timeout=1)
last_tweet="#switchoff"
public_tweets = api.user_timeline(screen_name='@PacktPub',count=1)
while True: # This constructs an infinite loop
  for tweet in public_tweets:
    if '#switchon' in tweet.text: #check if the tweet contains the
    text #switchon
      print (tweet.text)  #print the tweet
      if last_tweet == "#switchoff":
        if not ser.isOpen(): #if serial port is not open
          ser.open();  #open the serial port
          ser.write('1') # write 1 on serial port
```

```
            print('Write 1 on serial port')  #print message on console
            last_tweet="#switchon"
        elif "#switchoff" in tweet.text: #check if the tweet contains
        the text #switchoff
          print (tweet.text)  #print the tweet
          if last_tweet == "#switchon":
            if not ser.isOpen(): #if serial port is not open
              ser.open();  #open the serial port
              ser.open();  #open the serial port
              ser.write("0") # write 0 on serial port
            print('Write 0 on serial port')  #print message on console
            last_tweet="#switchoff"
        else:
          ser.close()  #close the serial port
        time.sleep(30)  #wait for 30 seconds
```

Now, replace the following code snippet with your Twitter Consumer Key and Consumer Secret:

```
auth = tweepy.OAuthHandler('SZ3jdFXXXXXXXXXXXXPJaL9w4wm',
'jQ9MBuy7SL6wgRK1XXXXXXXXXXXXGGGGIAFevITkNEAMglUNebgK')
auth = tweepy.OAuthHandler(' Consumer Key (API Key)', ' Consumer
Secret (API Secret)')
```

Also, replace the following code snippet with Access Token and Access Token Secret:

```
auth.set_access_token('3300242354-
sJB78WNygLXXXXXXXXXXXXGxkTKWBck6vYIL79jjE',
'ZGfOgnPBhUD10XXXXXXXXXXXXt3KsxKxwqlcAbc0HEk21RH')
auth.set_access_token(' Access Token, ' Access Token Secret ')
```

Next, replace the COM port number with which you wish to attach the Arduino UNO board. Also, use the same baud rate (in this case, 9,600) in Python script and Arduino sketch (you will write in the final step of this chapter):

```
ser = serial.Serial('Your Arduino Connected COM Port', 9600,
timeout=1)
```

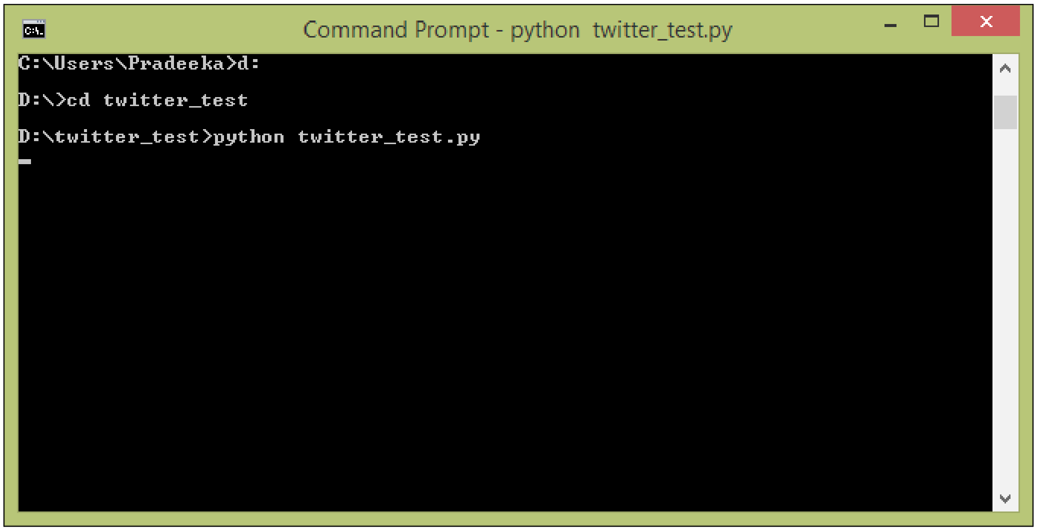
Finally, replace the Twitter screen name with your Twitter account's screen name:

```
public_tweets = api.user_timeline(screen_name='@PacktPub',count=1)
public_tweets =
api.user_timeline(screen_name='@your_twitter_screen_name',count=1)
```

Now, save the file and navigate to the file location using Windows Command Prompt. Then, type the following command and press *Enter*:

```
>python your_python_script.py
```

Replace `your_python_script` with the filename. The script will continuously monitor any incoming new Twitter tweets and write data on the serial port according to the command that has been sent:



```
C:\Users\Pradeeka>d:

D:\>cd twitter_test

D:\twitter_test>python twitter_test.py
_
```

Windows Command Prompt will display any incoming Tweets and actions against them.

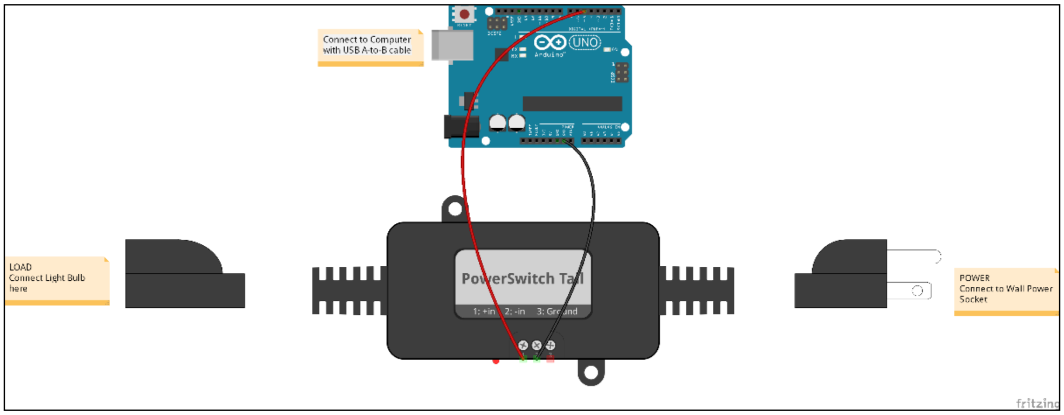
Reading the serial data using Arduino

You can read incoming data from the serial port where we wrote data using the Python script in the previous section using Arduino. The following Arduino sketch will read the incoming data from the serial port and turn on the PowerSwitch Tail if it finds `1`, and turn off the PowerSwich Tail if it finds `0`.

The sample code, `B04844_07_01.ino`, can be found in the `Chapter 7` codes folder, so you can copy and paste it on a new Arduino IDE and upload it to your Arduino UNO board.

Connecting the PowerSwitch Tail with Arduino

Connect the PowerSwitch Tail to your Arduino UNO board, as shown in the following Fritzing diagram. For this project, we will use a 240V AC PowerSwitch Tail:



1. Using a hook-up wire, connect the Arduino digital pin **5** with the PowerSwitch Tail positive (+ in) connecter.
2. Using another hook-up wire, connect the Arduino ground pin with the PowerSwitch Tail negative (- in) connector.
3. Connect a 240V AC light bulb to the **LOAD** end of the PowerSwitch Tail.
4. Connect the **LINE** end of the PowerSwitch Tail to the wall power socket and make sure that the main's electricity is available to the PowerSwitch Tail.
5. Using a USB A-to-B cable, connect the Arduino UNO board to the computer or laptop on which you wish to run the Python script. Make sure that you attach the USB cable to the correct USB port that is mentioned in the Python script.
6. Connect your computer to the Internet using Ethernet or Wi-Fi.
7. Now, run the Python script using Windows Command Prompt.
8. Log in to your Twitter account and create a new tweet including the text, `#switchon`. In a few seconds, the light bulb will turn on. Now, create a new tweet that includes the text, `#switchoff`. In a few seconds, the light bulb will turn off.

The drawback to this system is that you can't send the same Tweet more than once, because of the Twitter restrictions. Each time, make sure you create different combinations of text to make your tweet, and include your control word (`#switchon`, `#switchoff`) with it.

Summary

In this chapter, you learned how to use Twitter, a social media platform, to interact with our Arduino UNO board and control its functionalities.

In the next chapter, you will learn how to control devices using Infrared, the Internet, and Arduino.

8

Controlling Infrared Devices Using IR Remote

Most consumer electronic devices come with a handheld remote control that allows you to wirelessly control the device from a short distance. Remote controls produce digitally encoded IR pulse streams for button-presses, such as Power, Volume, Channel, Temperature, and so on. However, can we extend the control distance between the device and the remote control? Yes we can; by using Arduino IoT in conjunction with a few electronic components. This chapter explains how you can incrementally build an Internet-controlled infrared remote control with Arduino.

In this chapter, we will cover the following topics:

- How to build a simple infrared receiver and decode values for each remote control key
- The infrared raw data format
- How to build an infrared sender to send the captured raw data to the target device
- How to control the infrared sender to interact with the target device through the Internet

Building an Arduino infrared recorder and remote

With Arduino and some basic electronic components, we can easily build an infrared recorder and remote control. This allows you to record any infrared command (code) sent by an infrared remote control. Also, it allows you to resend the recorded infrared command to a target device and the device will treat the command the same as the remote control's command. Therefore, you can playback any recorded infrared command and control your respective infrared device.

The typical uses of applications are:

- Switching on/off your air conditioner
- Adjusting the temperature of your air conditioner before you arrive home
- Anything you control with the traditional remote control

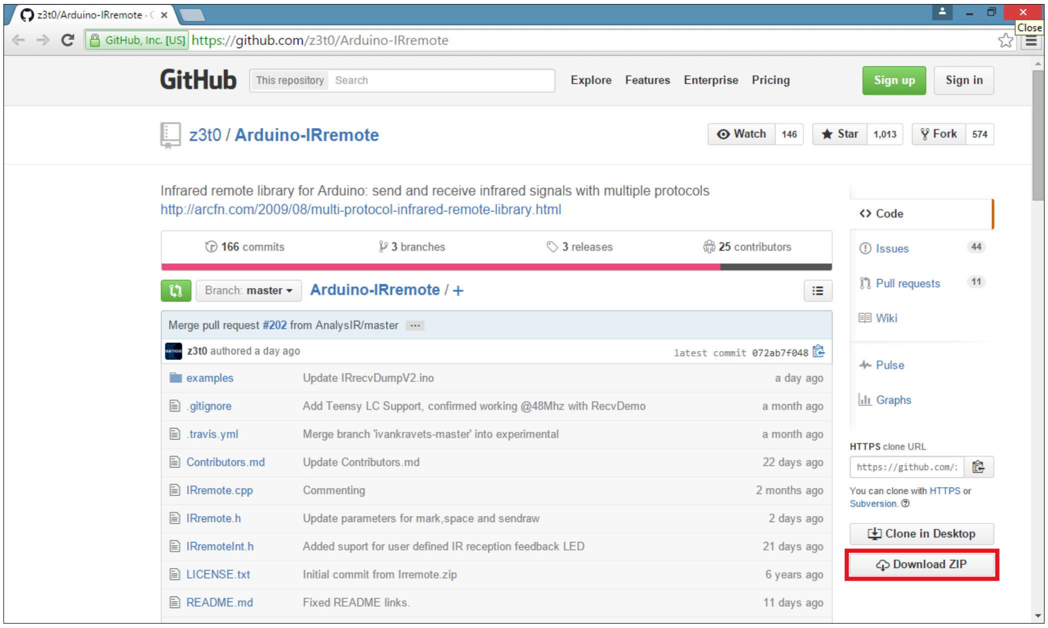
The following hardware and software components are needed to build a basic IR remote.

Hardware

- The Arduino Uno: R3 board
- The Arduino Ethernet Shield or Arduino Ethernet board
- An LED light: Infrared 950 nm
- An IR receiver diode: TSOP38238
- A 330 Ohm 1/6 Watt resistor
- A mini pushbutton switch
- An IR socket that can be found at `http://www.ebay.com/itm/IR-Infrared-Power-Adapter-Remote-Control-AC-Power-Socket-Outlet-Switch-Plug-/311335598809`, or a similar one.

Software

Download the IR Arduino library from `https://github.com/z3t0/Arduino-IRremote`. Click on the **Download ZIP** button. Extract the downloaded ZIP file and place it in your computer's local drive. You will get the `Arduino-IRremote-master` folder; the folder name may be different. Inside this folder, there is another folder named `Arduino-IRremote-master`. This folder name may also be different. Now, copy and paste this folder on the Arduino libraries folder:



Infrared remote library for Arduino: send and receive infrared signals with multiple protocols
http://arcfn.com/2009/08/multi-protocol-infrared-remote-library.html

Merge pull request #202 from AnalysIR/master …
z3t0 authored a day ago latest commit 072ab7f048

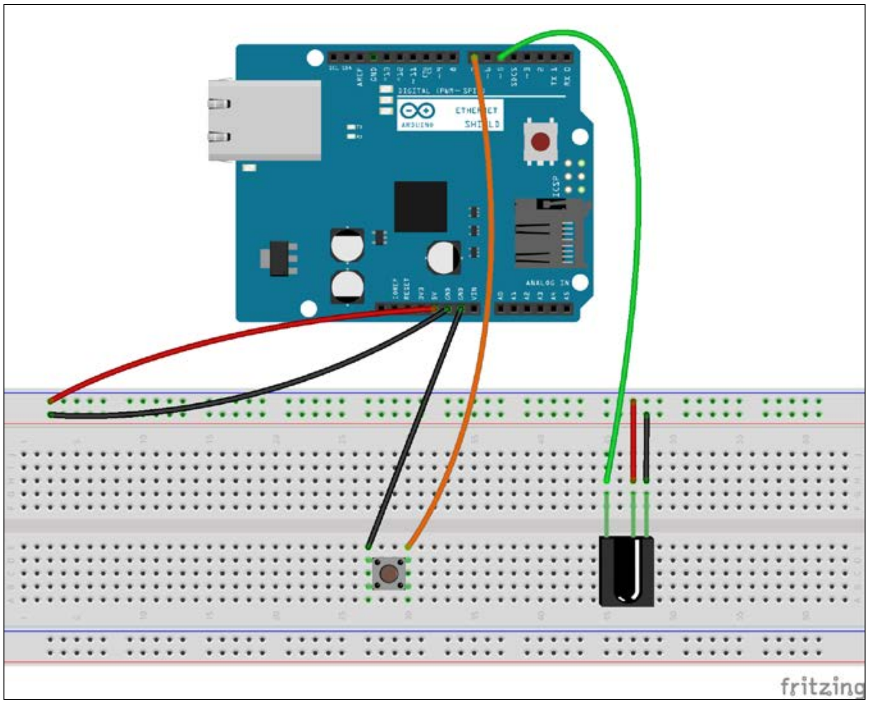
examples	Update IRrecvDumpV2.ino	a day ago
.gitignore	Add Teensy LC Support, confirmed working @48Mhz with RecvDemo	a month ago
.travis.yml	Merge branch 'ivankravets-master' into experimental	a month ago
Contributors.md	Update Contributors.md	22 days ago
IRremote.cpp	Commenting	2 months ago
IRremote.h	Update parameters for mark,space and sendraw	2 days ago
IRremoteInt.h	Added suport for user defined IR reception feedback LED	21 days ago
LICENSE.txt	Initial commit from Irremote.zip	6 years ago
README.md	Fixed README links.	11 days ago

You can clone with HTTPS or Subversion.

The Arduino-IRremote library on GitHub

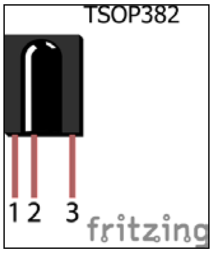
Building the IR receiver module

The following Fritzing schematic representation shows you how to wire each component together with the Arduino board to build the IR Receiver module. It shows the connection between each electronic component:



The IR receiver: The TSOP382 IR receiver is attached to the Arduino+ Ethernet Shield - Fritzing representation

1. Use the stack Arduino Ethernet Shield with the Arduino UNO board using wire wrap headers, or the Arduino Ethernet board instead.
2. The TSOP382 IR receiver diode has three pins, as shown in the following image:



The TSOP382 IR receiver diode from Vishay (`http://www.vishay.com/`)

These three pins are:

- OUT: Signal
- GND: Ground
- Vs: Supply voltage

3. Connect the GND pin to Arduino Ground (GND), and then connect the Vs pin to Arduino 5V. Finally, connect the OUT pin to the Arduino digital pin 5.
4. Connect the mini push button switch between the Arduino ground (GND) and the Arduino digital pin 7.

Capturing IR commands in hexadecimal

You can capture the IR commands sent from the remote control in a hexadecimal notation:

1. Open a new Arduino IDE and paste the code, `B04844_08_01.ino`, from the `Chapter 8` code folder. Alternately, you can open the same file from **File | Examples | IRremote | IRrecvDemo**.
2. We have included the header file, `IRremote.h`, at the beginning of the sketch:

```
#include <IRremote.h>
```

3. Next, declare a digital pin to receive IR commands. This is the data pin of the TSOP382 IR receiver diode that is connected with the Arduino. Change the pin number according to your hardware setup:

```
int RECV_PIN = 5;
```

4. Create an object, `irrecv`, using the `IRrecv` class, and use the `RECV_PIN` variable that was declared in the preceding line as the parameter:

```
IRrecv irrecv(RECV_PIN);
```

5. Finally, declare variable `results` has a type of `decode_results`:

```
decode_results results;
```

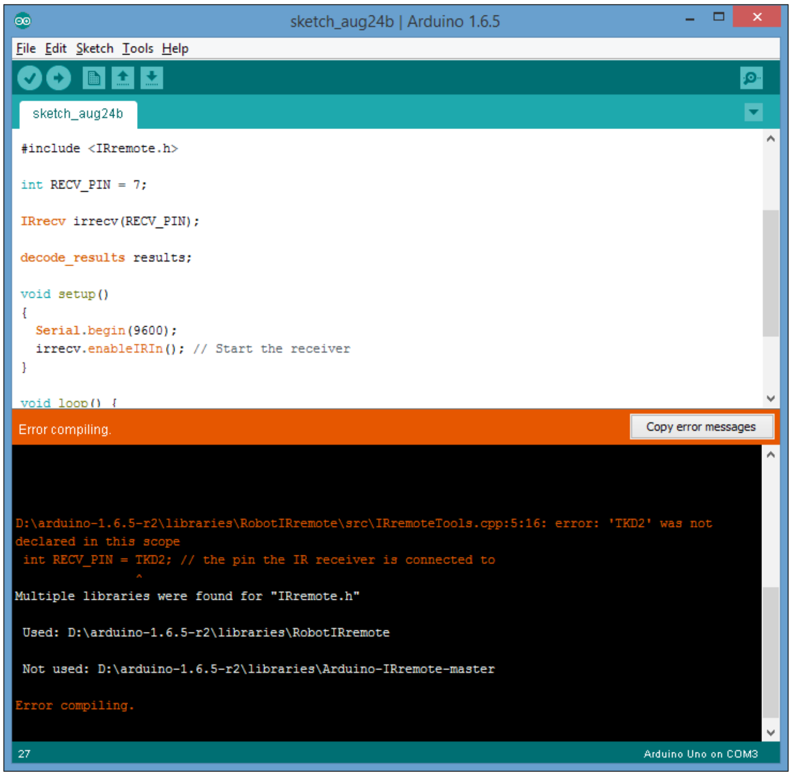
6. Inside the `setup()` function, start the serial communication with 9,600 bps and start the IR receiver using the `enableIRIn()` function:

```
void setup()
{
  Serial.begin(9600);
  irrecv.enableIRIn(); // Start the receiver
}
```

7. Inside the `loop()` function, we continuously check any incoming IR commands (signals) and then decode and print them on the Arduino Serial Monitor as hexadecimal values:

```
void loop() {
  if (irrecv.decode(&results)) {
    Serial.println(results.value, HEX);
    irrecv.resume(); // Receive the next value
  }
  delay(100);
}
```

8. Verify and upload the sketch on your Arduino board or Arduino Ethernet board. If you get compiler errors as follows, it is definitely because of the confliction of two or more IRremote libraries. To resolve this, navigate to the Arduino libraries folder and delete the `RobotIRremote` folder, or rename the folder, `Arduino-IRremote-master`, to `IRremote`. Now, close and open the Arduino IDE with the sketch file and try to verify the sketch again. This will fix the compiler error:



```
#include <IRremote.h>

int RECV_PIN = 7;

IRrecv irrecv(RECV_PIN);

decode_results results;

void setup()
{
  Serial.begin(9600);
  irrecv.enableIRIn(); // Start the receiver
}

void loop() {
```

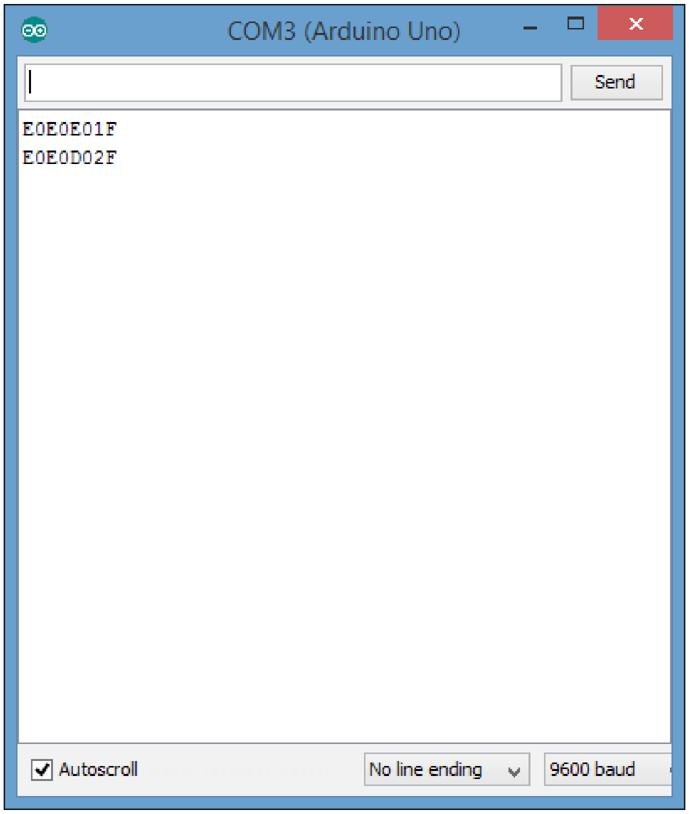
Error compiling.

```
D:\arduino-1.6.5-r2\libraries\RobotIRremote\src\IRremoteTools.cpp:5:16: error: 'TKD2' was not
declared in this scope
 int RECV_PIN = TKD2; // the pin the IR receiver is connected to
                ^
Multiple libraries were found for "IRremote.h"

 Used: D:\arduino-1.6.5-r2\libraries\RobotIRremote

 Not used: D:\arduino-1.6.5-r2\libraries\Arduino-IRremote-master

Error compiling.
```

The compiler error because of the conflicting libraries

9. Once uploaded, open the Arduino Serial Monitor.
10. Get your TV remote control and point it toward the TSOP382 IR sensor. Press any key on your TV remote control. You will see a hexadecimal number displayed on the serial monitor for each key press. Each key on your TV remote has a unique hexadecimal value. The values you captured here will be required in the next step of our project.

For testing purposes, we used a Samsung television (model number: UA24H4100) remote control to capture IR command values for the volume up and volume down buttons. the following image shows the captured output:



```
E0E0E01F
E0E0D02F
```

Hexadecimal values for SAMSUNG UA24H4100 TV volume up and volume down remote control buttons

The command values for volume up and volume down in a hexadecimal format are as follows:

```
VOLUME UP: E0E0E01F
VOLUME DOWN: E0E0D02F
```

Capturing IR commands in the raw format

Capturing IR commands in the raw format is very useful when you send them back to the target device later. The following steps will guide you in capturing the IR commands sent by a remote control in the raw format:

1. Open a new Arduino IDE and paste the sketch, `B04844_08_02.ino`, from the `Chapter 8` sample code folder. Alternately, you can open the sketch by clicking on **File** | **Examples** | **IRremote** | **IRrecvDumpV2**.
2. Change the pin number of the following line if you have attached the IR receiver diode to a different Arduino pin:

   ```
   int recvPin = 5;
   ```

3. Verify and upload the sketch on your Arduino board, and then, open the Arduino Serial Monitor.
4. Point your remote control to the IR receiver diode and press the volume up button, and then the volume down button. You will see outputs on the Arduino Serial Monitor similar to the following:

   ```
   Encoding  : SAMSUNG
   Code      : E0E0E01F (32 bits)
   Timing[68]:
        -47536
        +4700, -4250     + 750, -1500     + 700, -1500     + 700,
        -1550
        + 700, - 400     + 700, - 400     + 700, - 400     + 700,
        - 450
        + 650, - 450     + 650, -1600     + 600, -1600     + 650,
        -1600
        + 600, - 500     + 600, - 500     + 600, - 550     + 600,
        - 500
        + 600, - 500     + 600, -1650     + 550, -1650     + 600,
        -1650
        + 550, - 550     + 550, - 600     + 500, - 600     + 500,
        - 600
        + 550, - 550     + 550, - 600     + 500, - 600     + 500,
        - 600
        + 500, -1750     + 500, -1700     + 500, -1750     + 500,
        -1700
        + 500, -1750     + 500,
   ```

```
unsigned int  rawData[69] = {47536, 4700,4250, 750,1500,
700,1500, 700,1550, 700,400, 700,400, 700,400, 700,450,
650,450, 650,1600, 600,1600, 650,1600, 600,500, 600,500,
600,550, 600,500, 600,500, 600,1650, 550,1650, 600,1650,
550,550, 550,600, 500,600, 500,600, 550,550, 550,600, 500,600,
500,600, 500,1750, 500,1700, 500,1750, 500,1700, 500,1750,
500,0};  // SAMSUNG E0E0E01F
unsigned int  data = 0xE0E0E01F;


Encoding  : SAMSUNG
Code      : E0E0D02F (32 bits)
Timing[68]:
     -29834
     +4650, -4300     + 700, -1550     + 700, -1500     + 700,
     -1500
     + 700, - 450     + 700, - 400     + 650, - 500     + 600,
     - 500
     + 600, - 500     + 600, -1650     + 600, -1600     + 600,
     -1650
     + 600, - 500     + 600, - 500     + 600, - 550     + 550,
     - 550
     + 550, - 550     + 550, -1700     + 500, -1700     + 550,
     - 600
     + 500, -1700     + 550, - 550     + 550, - 600     + 500,
     - 600
     + 500, - 600     + 550, - 550     + 550, - 600     + 500,
     -1700
     + 550, - 550     + 550, -1700     + 500, -1700     + 550,
     -1700
     + 500, -1700     + 550,
unsigned int  rawData[69] = {29834, 4650,4300, 700,1550,
700,1500, 700,1500, 700,450, 700,400, 650,500, 600,500,
600,500, 600,1650, 600,1600, 600,1650, 600,500, 600,500, 600,550,
550,550, 550,550, 550,1700, 500,1700, 550,600,
500,1700, 550,550, 550,600, 500,600, 500,600, 550,550,
550,600, 500,1700, 550,550, 550,1700, 500,1700, 550,1700,
500,1700, 550,0};  // SAMSUNG E0E0D02F
unsigned int  data = 0xE0E0D02F;
```

Raw data for the Samsung UA24H4100 TV's volume up and volume down IR remote control buttons, Arduino Serial Monitor output text extract.

5. Open a new Notepad file and paste the output to it because we will need some part of this output in the next section.

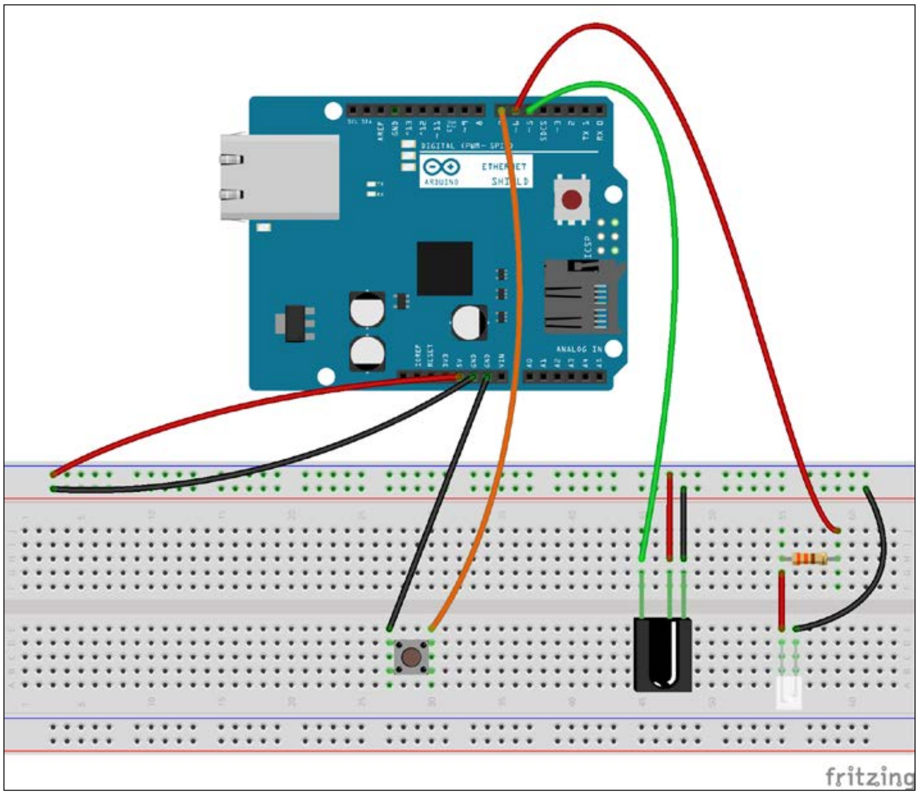
Building the IR sender module

You can send any hardcoded IR command in the raw format using an Arduino sketch. In the previous section, we captured the IR raw data for the volume up and volume down buttons. In this example, we will learn how to send the hard coded IR command for volume up to the television. First, we have to build a simple IR sender module by adding an Infrared LED light and a 330 Ohm resistor.

The following Fritzing schematic shows how to wire each component together with the Arduino to build the IR Receiver module. It also shows the connection between each electronic component.

The following are additional wiring instructions for the circuit that you have previously built to capture the IR commands:

1. Connect the infrared LED cathode (-) to the Arduino ground.
2. Connect the infrared LED anode (+) to the Arduino digital pin 6 through a 330 Ohm resistor:



The IR sender: the infrared LED is attached to the Arduino Ethernet Shield—Fritzing representation

3. Now, open a new Arduino IDE and copy the sample Arduino sketch, `B04844_08_03.ino`, located in the `Chapter 8` code folder. Verify and upload the sketch on your Arduino board.
4. To send the IR command for the volume up button, we need to identify the raw data array for the volume up command:

```
Encoding  : SAMSUNG
Code      : E0E0E01F (32 bits)
Timing[68]:
     -47536
     +4700, -4250     + 750, -1500     + 700, -1500     + 700,
     -1550
     + 700, - 400     + 700, - 400     + 700, - 400     + 700,
     - 450
     + 650, - 450     + 650, -1600     + 600, -1600     + 650,
     -1600
     + 600, - 500     + 600, - 500     + 600, - 550     + 600,
     - 500
     + 600, - 500     + 600, -1650     + 550, -1650     + 600,
     -1650
     + 550, - 550     + 550, - 600     + 500, - 600     + 500,
     - 600
     + 550, - 550     + 550, - 600     + 500, - 600     + 500,
     - 600
     + 500, -1750     + 500, -1700     + 500, -1750     + 500,
     -1700
     + 500, -1750     + 500,
unsigned int  rawData[69] = {47536, 4700,4250, 750,1500,
700,1500, 700,1550, 700,400, 700,400, 700,400, 700,450,
650,450, 650,1600, 600,1600, 650,1600, 600,500, 600,500,
600,550, 600,500, 600,500, 600,1650, 550,1650, 600,1650,
550,550, 550,600, 500,600, 500,600, 550,550, 550,600, 500,600,
500,600, 500,1750, 500,1700, 500,1750, 500,1700, 500,1750,
500,0};  // SAMSUNG E0E0E01F
unsigned int  data = 0xE0E0E01F;
```

The highlighted `unsigned int` array consists of `69` values separated by commas, and it can be used to increase the Samsung television's volume by 1. The array size differs depending on the device and remote control manufacturer.

Also, you need to know the size of the command in bytes. For this, it is 32 bits:

```
Code      : E0E0E01F (32 bits)
```

The command will be sent to the target device when you press the mini push button attached to the Arduino. We have used the `sendRaw()` function to send the raw IR data:

```
for (int i = 0; i < 3; i++) {
    irsend.sendRaw(rawData,69,32)
    delay(40);
  }
```

The following is the parameter description for the `sendRaw()` function:

```
irsend.sendRaw(name_of_the_raw_array, size_of_the_raw_array,
command_size_in_bits);
```

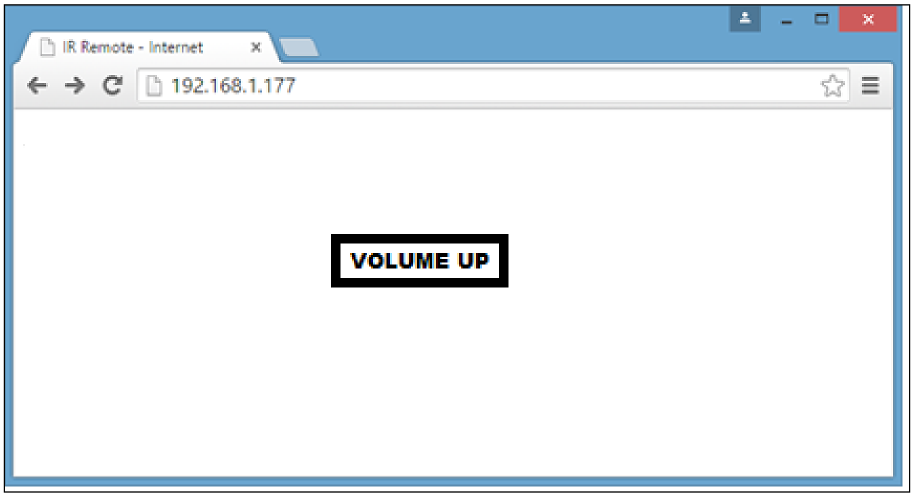
1. Point the IR remote to your television and press the mini push button. The volume of the television will increase by one unit.
2. Press the mini push button many times to send the hardcoded IR command to the television that you want to control.

Controlling through the LAN

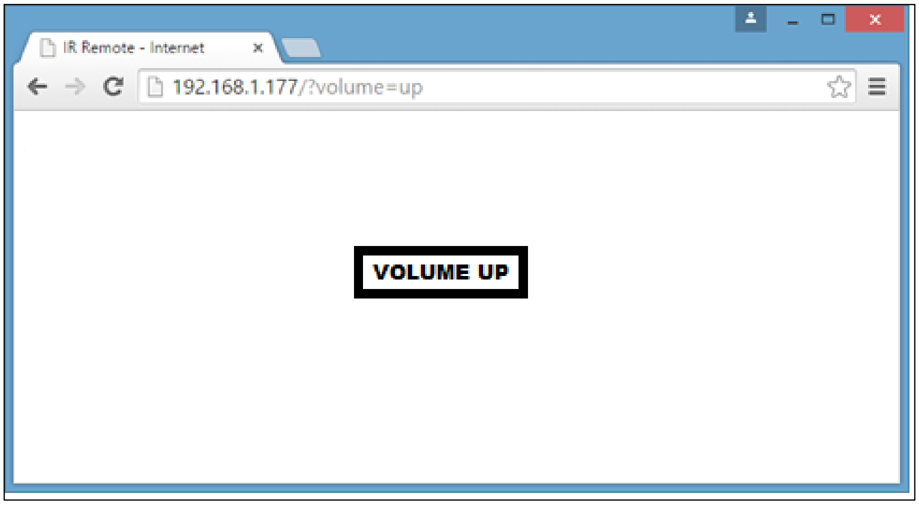
In *Chapter 1*, *Internet-Controlled PowerSwitch*, we learned how to control a PowerSwitch Tail through the internet by sending a command to the server using the GET method. The same mechanism can be applied here to communicate with the Arduino IR remote and activate the IR LED. To do this, perform the following steps:

1. Open a new Arduino IDE and copy the sample code, `B04844_08_04.ino`, into the `Chapter 8` code folder.
2. Change the IP address and MAC address of the Arduino Ethernet Shield according to your network setup.
3. Connect the Ethernet shield to the router, or switch via a Cat 6 Ethernet cable.
4. Verify and upload the code on the Arduino board.
5. Point the IR LED to the Television.
6. Open a new web browser (or new tab), type the IP address of the Arduino Ethernet Shield, `http://192.168.1.177/` and then hit *Enter*. If you want to control the device through the Internet, you should set up port forwarding on your router.

7. You will see the following web page with a simple button named **VOLUME UP**:



8. Now, click on the button. The volume of the television will increase by 1 unit. Click on the **VOLUME UP** button several times to increase the volume. Also, note that the address bar of the browser is similar to `http://192.168.1.177/?volume=up`:



Likewise, you can add the `VOLUME DOWN` function to the Arduino sketch and control the volume of your television. Apply this to an air conditioner and try to control the power and temperature through the Internet.

Adding an IR socket to non-IR enabled devices

Think, what if you want to control a device that hasn't any built-in infrared receiving functionality. Fortunately, you can do this by using an infrared socket. An infrared socket is a pluggable device that can be plugged into a electrical wall socket. Then, you can plug your electrical device into it. In addition, the IR Socket has a simple IR receiving unit, and you can attach it to a place where the IR signal can be received properly.

The following image shows the frontal view of the IR socket:

The infrared socket—front view

The following image shows the side view of the IR socket:

The IR socket side view

A generic type of IR socket comes with a basic remote control with a single key for power on and off:

The IR remote control for The IR socket

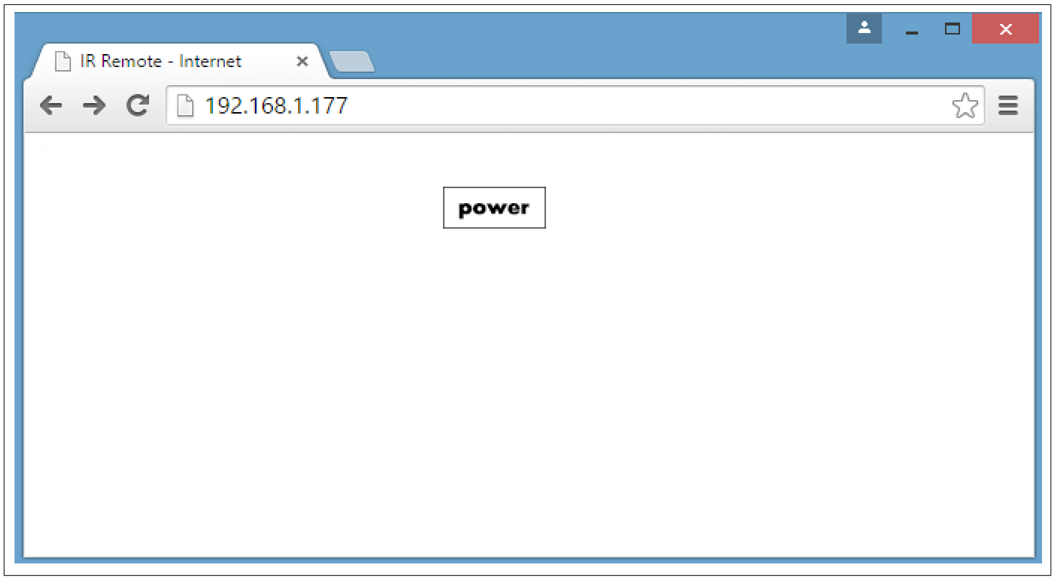
1. Before you proceed with this project, trace the IR raw code for the power button of your remote control.
2. Copy the Arduino sketch, `B04844_08_05.ino`, from the sample code folder of `Chapter 8`, and paste it to a new Arduino IDE. Then, modify the following line with the IR raw code for the power button:

```
unsigned int  rawData[69] = {47536, 4700,4250, 750,1500,
700,1500, 700,1550, 700,400, 700,400, 700,400, 700,450,
650,450, 650,1600, 600,1600, 650,1600, 600,500, 600,500,
600,550, 600,500, 600,500, 600,1650, 550,1650, 600,1650,
550,550, 550,600, 500,600, 500,600, 550,550, 550,600,
500,600, 500,600, 500,1750, 500,1700, 500,1750, 500,1700,
500,1750, 500,0};  // POWER BUTTON
```

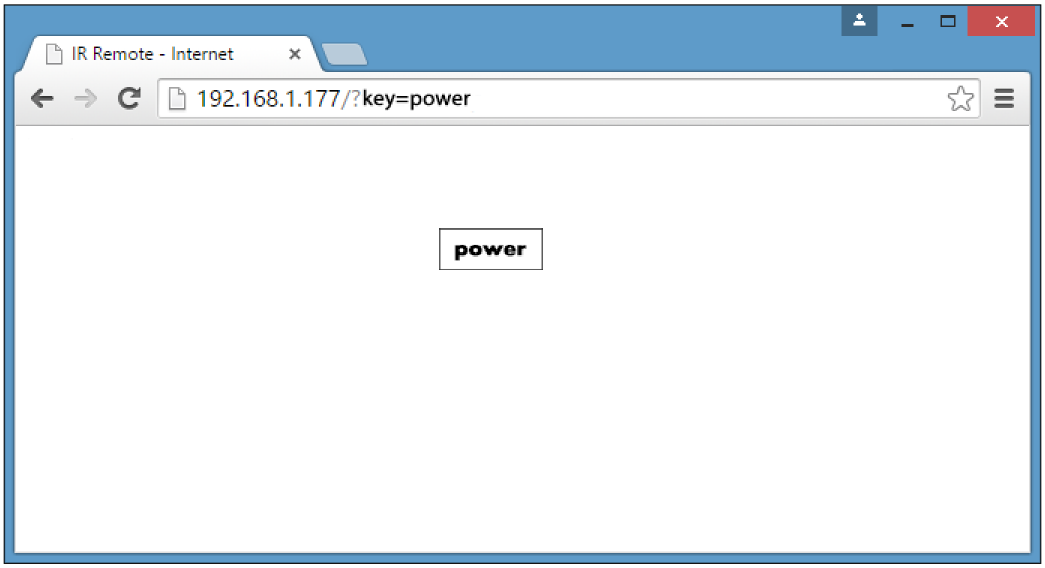
3. Also, modify the following line with the correct parameters:

   ```
   irsend.sendRaw(rawData,69,32)
   ```

4. Verify and upload the sketch on the Arduino board.
5. Plug the IR socket into a wall power outlet and turn on the switch.
6. Point the IR LED attached with the Arduino to the IR socket.
7. Plug any electrical device (for this project, we used an electric fan for testing) into the IR socket and make sure that the power is available. Then, turn the power switch of the fan to the ON position.
8. Open a new web browser (or new tab), type the IP address of the Arduino Ethernet shield, `http://192.168.1.177/` and then press *Enter*.
9. You will see the following web page with a simple button named **Power**:



10. Now, click on the **Power** button. The electric fan will turn on. Click on the **Power** button again to turn off the fan. Also, note that the address bar of the browser is changed to `http://192.168.1.177/?key=power`.



Summary

In this chapter, you have learned how to recode and send infrared commands using the Arduino IR library with the raw data format. Further, you have learned how to activate the IR LED via the internet and send the IR command to the target device.

Throughout this book, you have learned how to integrate Arduino with shields, sensors, and actuators that can be controlled and sensed through the Internet. Further, you gained knowledge about Arduino cloud computing with platforms and technologies such as Temboo, Twilio, and NearBus.

You can adopt, fully or partially, the projects that were discussed in this book for your Arduino IoT projects, and also, you can hack them for further improvements or alternations. In addition, the project blueprints can be used for your hobby, school, or university projects, as well as for home automation and industry automation projects.

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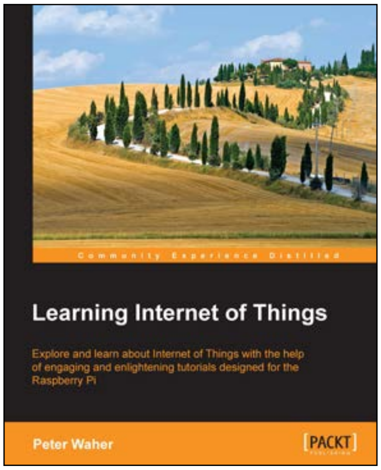
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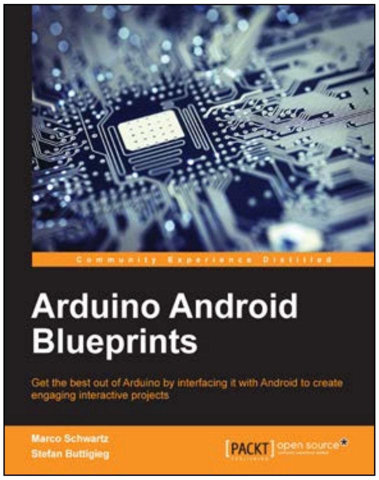
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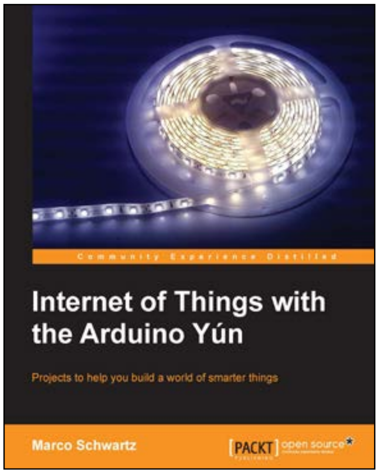
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