Make:

Companion to the Make: Getting Started with Arduino Deluxe Kit

BASIC Arduino Projects

26 Experiments with Microcontrollers and Electronics

Don Wilcher

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Make: Basic Arduino Projects

by Don Wilcher

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Preface

So, you've been playing around with Arduino, but are looking for some fun projects to try out with it. *Make: Basic Arduino Projects* is here to help you! It's got a wealth of cool devices and gadgets to build with Arduino and some common components. The projects in the book explain the world of electronics using a fun and hands-on approach.

The motivation behind writing this book is based on several conversations with Brian Jepson (Make: books' Publisher) and the need for a book that allows people to explore Arduino and the universe of electronic parts that go along with it. The Arduino is a very popular Maker platform that allows you to explore electronics with an interactive approach. As awesome as a box of parts is, it's difficult for people with little electronics experience to begin making things with it. This book solves that problem by letting you learn more about electronics while you make fun projects with the parts in this kit. *Basic Arduino Projects* is a practical guide that illustrates how a bunch of electronic parts, coupled with Arduino, can be transformed into awesome devices and gadgets for education and play.

In addition, being an electrical engineer and educator, I'm very sensitive to delivering good instructional content to my students (adults and teenagers). This book was written to attract young readers to the exciting world of electronics by building cool and creative projects using Arduino. This book is also intended for Makers and novices who have heard about the Arduino but never experienced the fun and excitement that comes from building cool electronic gadgets and devices with this open hardware platform.

By building and experimenting with the projects in this book, young readers, Makers, and electronic novices will learn how to:

- Read electronic circuit schematic and block diagrams.
- Assemble electronic circuits using the MakerShield prototyping board.

- Build basic logic circuits using the Arduino as a programmable computer brain.
- Use an LCD display for displaying text and special characters.
- Create simple electronic controllers for LEDs and servo motors.

Last, you will learn how to create gadgets and devices for education and play using imagination and some common electronic components. Enjoy the Maker adventure!

Conventions Used in This Book

The following typographical conventions are used in this book:

Italic
: Indicates new terms, URLs, email addresses, filenames, and file extensions.

`Constant width`
: Used for program listings, as well as within paragraphs to refer to program elements such as variable or function names, databases, data types, environment variables, statements, and keywords.

`Constant width bold`
: Shows commands or other text that should be typed literally by the user.

`Constant width italic`
: Shows text that should be replaced with user-supplied values or by values determined by context.

This icon signifies a tip, suggestion, or general note.

This icon indicates a warning or caution.

Using Code Examples

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We have a web page for this book, where we list errata, examples, and any additional information. You can access this page at *http://oreil.ly/basic-arduino*.

To comment or ask technical questions about this book, send email to *bookquestions@oreilly.com*.

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I would like to thank Brian Jepson (Publisher) for believing in the book concept and allowing me to explore Arduino in creative ways. Also, I would like to thank Patrick Di Justo (Editor) for pulling out the really cool projects from the original book proposal and coaching me to present them in fun and entertaining ways for young readers.

My final acknowledgment goes to my wife, Mattalene, who patiently worked with me on editing this book, keeping me on task with the writing/project builds, and reviewing the email revision messages from my editors. To my children, Tiana, D'Vonn, and D'Mar, thanks for being great kids while I worked on the book during family time.

1 The Trick Switch

Resistor-Capacitor Timing Basics

In electronics, sometimes we want to keep a device on for a certain amount of time even when an electrical switch is turned off. Ordinary pushbuttons used to turn electronic devices on and off can easily be operated by a timed delay switch. How awesome would it be to create such a device to delay turning off a simple LED? Such a gadget could be used to trick your friends, family, or even the local Makerspace when they see the LED staying on after the pushbutton has been released. With a few electronic components, you can make an LED (light-emitting diode) stay on for a few extra seconds when a pushbutton switch is turned off. Figure 1-1 shows an assembled Trick Switch. The electronic components required to build the Trick Switch are shown in the Parts List.

Parts List

- Arduino microcontroller
- SW1: mini pushbutton
- LED1: red LED
- C1: 100 uF electrolytic capacitor
- R1: 10K ohm resistor (brown, black, orange stripes)
- R2: 330 ohm resistor (orange, orange, brown stripes)
- Full-size clear breadboard

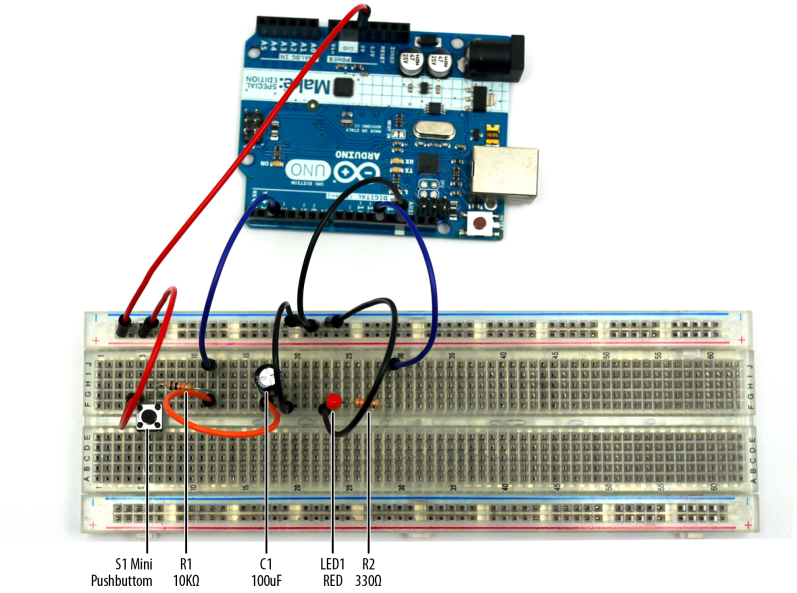

Figure 1-1. *Trick Switch circuit built on a full-size clear breadboard (both the 100 uF electrolytic capacitor and red LED negative pins are wired to ground)*

Tech Note

You can create your own electrical circuits and test them using diagrams with an online simulator called Circuit Lab.

Let's Build a Trick Switch

When you press the pushbutton switch on this device, the LED turns on. The capacitor will begin storing electrical energy from the +5VDC power supply circuit of the Arduino. Releasing the pushbutton switch cuts off the flow of electricity from the source, but the energy stored in the capacitor keeps the Arduino running for a few extra seconds. The Arduino keeps the LED lit until the capacitor's stored energy is empty. You can build the Trick Switch using the electronic components from the Parts List and the Fritzing wiring diagram shown in Figure 1-2. Here are the steps required to build the electronic device:

1. Place the required parts on your workbench or lab tabletop.
2. Wire the electronic parts using the Fritzing wiring diagram of Figure 1-2 or the actual Trick Switch device shown in Figure 1-1.
3. Type the Pushbutton sketch shown in Example 1-1 into the Arduino text editor.

4. Upload the Pushbutton sketch to the Arduino.
5. Press the mini pushbutton for a moment. The red LED turns on. After one to two minutes, the red LED will turn off.

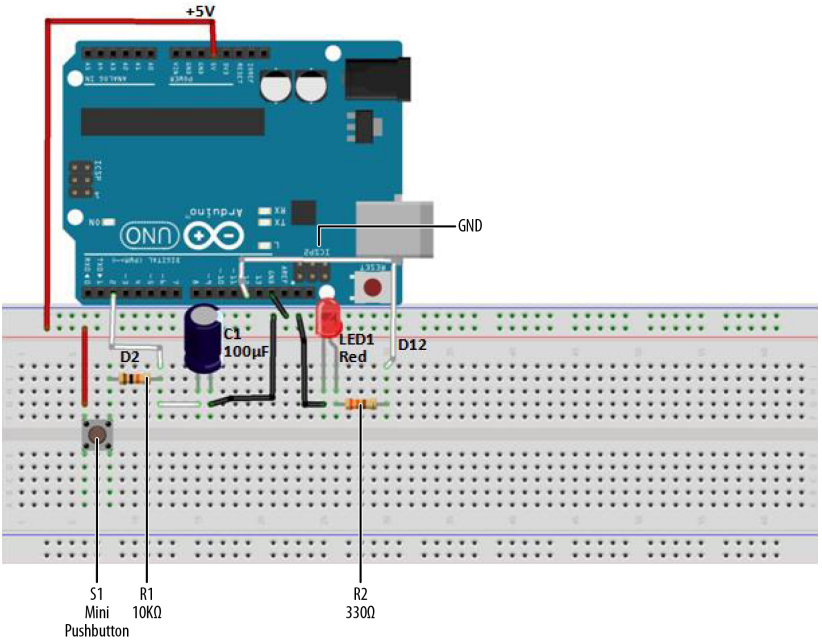

Figure 1-2. *Trick Switch Fritzing diagram*

Troubleshooting Tip

If the Trick Switch device doesn't work, check for incorrect resistor values, incorrect wiring, sketch typos, and improper orientation of polarized electronic components (the LED and capacitor).

Example 1-1. *Pushbutton sketch*

```
/*
  Pushbutton Sketch

Reads the capacitor voltage at digital pin 2 and turns on and off a light-
emitting diode (LED) connected to digital pin 12.


 17 Nov 2012
 by Don Wilcher
```

```
 */

// constants won't change; they're used here to
// set pin numbers:
const int buttonPin = 2;     // the number of the pushbutton pin
const int ledPin =  12;      // the number of the LED pin

// variables will change:
int buttonStatus = 0;        // variable for reading the pushbutton status

void setup() {
  // initialize the LED pin as an output:
  pinMode(ledPin, OUTPUT);
  // initialize the pushbutton pin as an input:
  pinMode(buttonPin, INPUT);
}

void loop(){
  // read the status of the pushbutton value:
  buttonStatus = digitalRead(buttonPin);

  // check if the pushbutton is pressed
  // if it is, the buttonEvent is HIGH:
  if (buttonStatus == HIGH) {
    // turn LED on:
    digitalWrite(ledPin, HIGH);
  }
  else {
    // turn LED off:
    digitalWrite(ledPin, LOW);
  }
}
```

Tech Note

The `ledPin` value can be changed to 13 to operate the onboard LED.

Trick Switch with On/Off Indicators

In developing new products, electronics designers are always improving designs by adding features and functions that excite the customer. The Trick Switch device you built can be improved by adding an LED indicator. This LED indicates when the Trick Switch timing cycle is done. Figure 1-3 shows you where to add a green LED to the Trick Switch on the full-size clear breadboard.

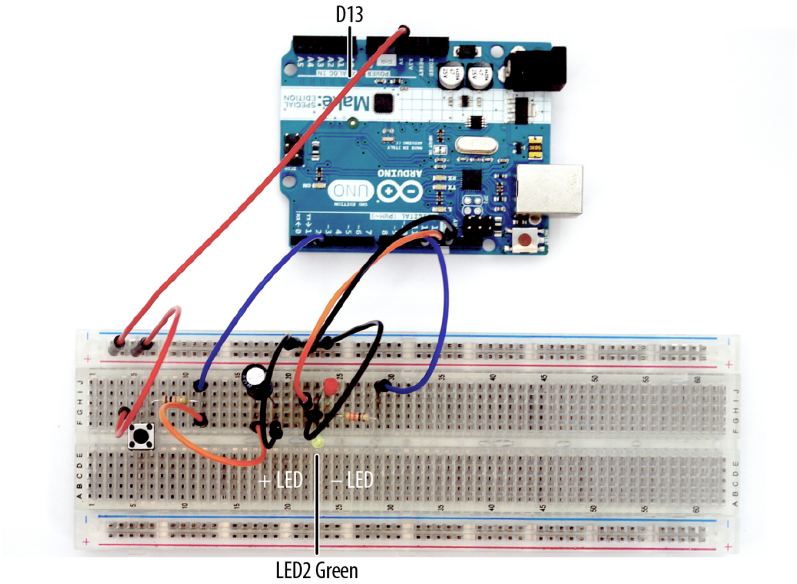

Figure 1-3. *Adding a green LED indicator to the Trick Switch circuit built on a full-size clear breadboard*

To complete the new product design, you need to make a few changes to the Push-button sketch. Modify the sketch using the code changes shown in Example 1-2.

Example 1-2. *Pushbutton sketch modified to include LED indicators*

```
// constants won't change; they're used here to
// set pin numbers:
const int buttonPin = 2;      // the number of the pushbutton pin
const int ledPin = 12;        // the number of the LED pin
const int ledPin13 = 13;      // onboard LED

void setup() {
  // initialize the LED pins as outputs:
  pinMode(ledPin, OUTPUT);
  pinMode(ledPin13, OUTPUT);
  // initialize the pushbutton pin as an input:
  pinMode(buttonPin, INPUT);
}

void loop(){
  // read the state of the pushbutton value:
  int buttonStatus;
  buttonStatus = digitalRead(buttonPin);

  // check if the pushbutton is pressed
  // if it is, the buttonStatus is HIGH:
  if (buttonStatus == HIGH) {
```

```
    // turn LED on:
    digitalWrite(ledPin, HIGH);
    // turn off onboard LED:
    digitalWrite(ledPin13,LOW);
  }
  else {
    // turn LED off:
    digitalWrite(ledPin, LOW);
    // turn on onboard LED:
    digitalWrite(ledPin13, HIGH);
  }
}
```

After you've saved the sketch changes and uploaded them to the Arduino, the green LED will turn on. When you press the mini pushbutton, the green LED will turn off, and the red LED will turn on. Pretty awesome stuff. Enjoy!

The block diagram in Figure 1-4 shows the electronic component blocks and the electrical signal flow for the Trick Switch. A Fritzing electronic circuit schematic diagram of the switch is shown in Figure 1-5. Electronic circuit schematic diagrams are used by electrical/electronic engineers to design and build cool electronic products for society.

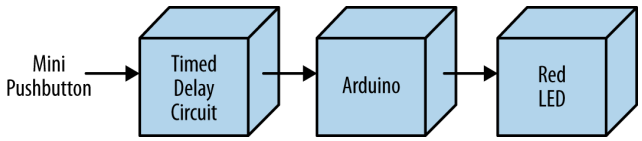

Figure 1-4. *Trick Switch block diagram*

Something to Think About

Try different resistor and capacitor values and see what happens. Can you detect any patterns? How can a small piezo buzzer be used with the Trick Switch?

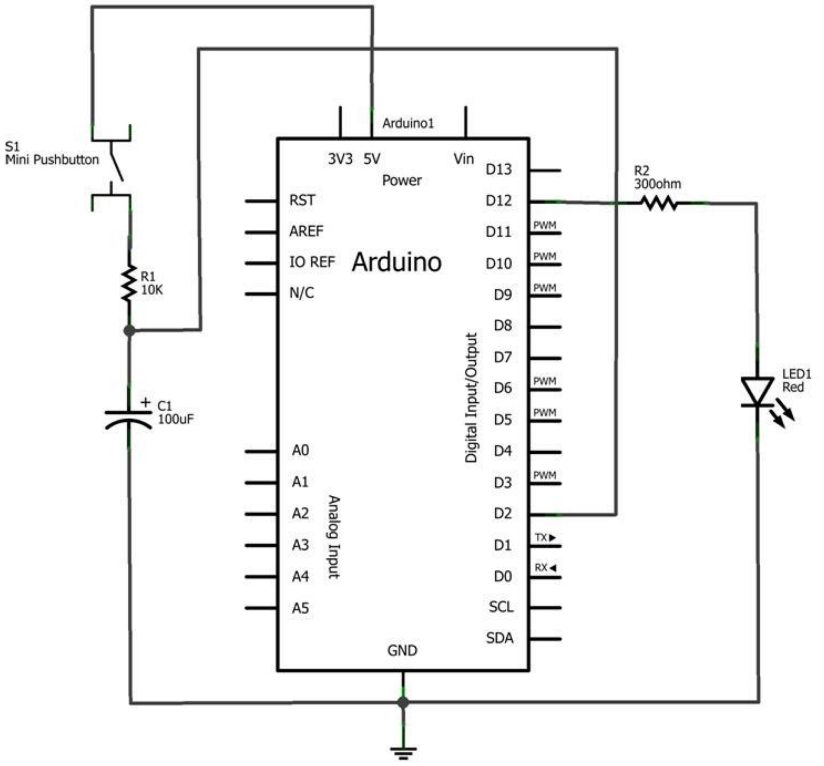

Figure 1-5. *Trick Switch circuit schematic diagram*