



# A Geek Girl's Guide to **ELECTRONICS** and the Internet of Things

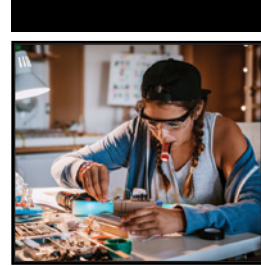
Audrey O'Shea

WILEY



# **A Geek Girl's Guide to Electronics and the Internet of Things**





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Audrey O'Shea

**WILEY**

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*To Jean White, my mom.*







## About the Author

**Audrey O’Shea** is a New York State licensed technical instructor teaching electronics and CompTIA certification courses at a technical high school. She also has taught college-level IT courses, holds numerous industry certifications, and has been a mentor to teachers who are new to the profession. Prior to beginning her teaching career, she served as CEO of a consulting company that provided computer training, along with custom software and network installation and support.

O’Shea has degrees in accounting and information technology as well as her teaching license, and she is a member of the Phi Kappa Phi honor society, a public speaker, and a proponent of encouraging women to set their sights on STEAM careers. She has written two books in the self-help genre and served as technical editor on another technology book. In her spare time she enjoys hiking and kayaking in the Adirondack Mountains of New York State, gaming, building and fixing things, and automating her home.





## About the Technical Editor

**Mike Hitsman** is a mechanical engineer working for a small construction company in Central New York. It affords him the luxury to pursue machining, welding, electrical diagnostics, and programming as needed day to day. He attributes his technical breadth to FIRST Robotics, where he started as a student and now mentors the local team. His knowledge of electronics is entirely self-taught, through lots of reading, lots of trial, and lots of errors.

Hitsman lives with Audrey O’Shea’s daughter at their country homestead, where he is slowly adding more and more automation to the old farmhouse. He’s as likely to be tweaking an IoT device as he is repairing something from 100 years ago.





# Acknowledgments

I would like to shower praise on the people who have helped me provide this book for your amusement and education. First, Kenyon Brown for giving me the opportunity. Next, Jan Lynn, my project editor, for pushing me to get it done. Also, a big thank-you to Michael Hitsman, my technical editor, for his polite and concise suggestions on how to make it better. I would be remiss if I failed to mention my friend and fellow author, Mike Meyers, who encouraged me to start writing in the first place, and I would not have made it this far without my mom, who always had my back when the world said, “You can’t,” and I said, “Yes, I can.” Finally, to my family and friends, thank you so much for understanding all the times I said, “I’m sorry, I can’t. I have a chapter due.” Thank you all.





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# Introduction

Welcome to the world of electronics! This is an exciting place to be, and I'm so glad that you've decided to join me in this journey. IoT and electronics are inseparable, as you'll soon see. We'll start with learning about electronic components and creating some useful circuits. In addition to traditional electronic circuits on breadboards, many chapters have circuits that use the programming power of an Arduino board. Finally we'll be connecting your circuits to the Internet so you can control them from anywhere. This book starts small and helps you grow in knowledge as it progresses and encourages you to reach even further. My true hope is that it will get you excited about working with electronics, regardless of whether it's a hobby or a new career, and that it will give you confidence to do whatever it is that makes your heart sing, no matter who or where you are in life.

I'm here to tell you that virtually everyone can do electronics, you included. Although this is a male-dominated field, I encourage you not to let that deter you from getting into the game. If you're female or any other non-traditional geek, follow your passion like I did. Like me, you may be the only woman in the room, but that's perfectly fine. It's an exciting and dynamic career field, and if you're different from the stereotypical electronics geek in some way, that's great! You bring a different perspective, which makes you that much more valuable.

## Who Will Benefit Most from This Book

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This book is intended for beginners, or those with some basic electronics knowledge who want to fill in those knowledge gaps with tidbits of information that can make all the difference. You'll start with the basics and progress to more

interesting (difficult) projects as you go along. This book contains more than 35 “Try This” projects where you can see how things work and solidify what you’re learning. Some of the projects include the following:

- Creating a super-bright camping light using LEDs
- Building a laser trip alarm
- Making paper and clay electronics for kids
- Creating light-activated circuits
- Constructing an Arduino wattmeter
- Connecting your projects to the Internet

You’ll learn some science behind how things work so the components and connections will make sense, and you’ll learn how to avoid some of the pitfalls of circuit building. For example, after studying the material in this book, you’ll know why you need a flyback diode for a motor (and understand what one is), instead of having to figure it out when the circuit fails and you’re on your third set of components. However, I expect there may be some of that in your future, too, as you take your own ideas and build them into new and interesting circuits. Mistakes are part of the learning process. That’s the fun of experimenting! You will create prototype circuits on breadboards, and if you’re happy with the result, you can solder them onto something more permanent because you’ll know how to do that, too.

## Sourcing Parts and Supplemental Materials

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I wouldn’t want to teach you to fly and then leave you on your own, so throughout the book I’ve included some of my favorite places to find information and components.

My website, [cliffjumpertek.com](http://cliffjumpertek.com), also has additional reference materials, tutorials, and videos of the book’s projects to help with your journey, should you need it.

## Special Features

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**TIP** Throughout the book, you’ll find tips that will provide you with supplemental information, usually to make something easier so you don’t have to learn from trial and error.

**WARNING** Included in this book are warnings—please take these seriously! Make sure you read all of these because they have information to protect you or others from injury and/or your project from damage.

**NOTE** Notes are supplemental material or interesting tidbits of information.

Time to turn the page and get started on your future in electronics! I'll see you there.

## What Does This Book Cover?

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This book is designed to provide you with a foundation of knowledge in electronics, IoT, and the Arduino environment. Its multitude of projects are the springboard to a deeper understanding and ever more challenging projects.

**Chapter 1: IoT and Electronics** The book starts with an explanation of how electronic circuit boards fit into the world of IoT. The components of an IoT system are explained, showing how IoT starts with electronic sensors and then interfaces with computers and communication systems. It also notes some of the challenges in developing and using IoT systems, as well as where IoT may be headed in the future.

**Chapter 2: Electricity: Its Good and Bad Behavior** Understanding how electricity behaves will help you to determine why circuits are or are not working. This chapter delves into the science behind electricity. It also explains electricity's characteristics and the relationship between those electrical characteristics. You'll learn how to build a simple circuit and then how to create a circuit on a breadboard, which is the foundation for most of the circuits created in the rest of the book.

**Chapter 3: Symbols and Diagrams** The field of electronics uses symbols to represent components when communicating information. This chapter teaches the basic symbology used and how to create a breadboard circuit using a schematic as a guide.

**Chapter 4: Introduction to the Arduino Uno** The Arduino is a popular platform for creating IoT implementations. In this chapter, you'll learn the form and function of the Arduino Uno and its programming platform. You'll also learn about analog and digital signals and the role of binary, all while building projects.

**Chapter 5: Dim the Lights** This chapter gets its name from one of the eight labs included in it; however, it's more about measuring electricity. You'll learn to use a multimeter and create a voltmeter, ohmmeter, and ammeter using an Arduino board. There's also a great project for creating a camp lamp, and it finishes with a lesson on soldering, perfboards, and shrink tubing, so you'll know how to put those projects together on a more permanent basis.

**Chapter 6: Feel the Power** Power is another characteristic of an electrical circuit and is explained in this chapter. You'll learn the relationship between Ohm's law and Watt's law as well as power from batteries, power ratings of resistors, and ways to measure circuit power. You'll also learn how to use an LCD screen with an Arduino board.

**Chapter 7: Series and Parallel Circuits** Electricity behaves differently depending on the path that it takes through a circuit. This chapter explains the implications of letting it take those different paths. You'll also learn about the effect of wire size and composition. In the spirit of full disclosure, this chapter involves math.

**Chapter 8: Diodes: The One-Way Street Sign** This is the first of several chapters about specific electronic components. You'll learn about diode construction and why diodes behave as they do, along with some common uses for diodes. The projects show you how to work with seven-segment LEDs and bar LEDs.

**Chapter 9: Transistors** You may know that transistors are the foundation of our modern computer processors, but they can do so much more. This chapter explains different types of transistors and their uses while giving you some practice working with them.

**Chapter 10: Capacitors** Another powerhouse when it comes to computer circuits is the lowly capacitor. They're found everywhere and sometimes taken for granted. This chapter teaches you the characteristics of capacitors and gives you some experience putting them to work.

**Chapter 11: The Magic of Magnetism** Magnetism and electricity are like two sides of a coin. This chapter examines that relationship and how magnetism is put to serious work. You'll also learn about relays, which are a component of many industrial electronic circuits.

**Chapter 12: Electricity's Changing Forms** Working with electricity is even more fun when you can change it into light and heat and sound, or vice versa. This chapter shows you several ways to do just that, along with the science behind the changes.

- Chapter 13: Integrated Circuits and Digital Logic** Integrated circuits make our work easier by having an entire circuit on a chip the size of your thumbnail, or even smaller, while digital logic chips can be the decision-makers on our circuits. This chapter explores both and introduces the oscilloscope, which lets you see in real time what is happening electrically in a circuit.
- Chapter 14: Pulse Width Modulation** Pulse width modulation (PWM) enables a digital signal to control an analog device, such as a motor. In this chapter, you'll build a PWM circuit on a breadboard and then learn how to accomplish the same magic using an Arduino board.
- Chapter 15: Sources of Electricity** Sources of electricity are touched upon in other chapters, but this one brings all the pieces together in one place. Here you can practice making some electrical current of your own and build an Arduino circuit to monitor the output of a photovoltaic cell.
- Chapter 16: Transformers and Power Distribution** Transformers are used to change the electrical properties of a circuit and play a big role in power supplies and power distribution. This chapter examines the types and roles of transformers. It also explains how they accomplish changing electrical properties and gives you some experience working with one.
- Chapter 17: Inverters and Rectifiers** Many times a circuit needs to be converted from DC to AC or AC to DC. The devices that perform that task are called inverters and rectifiers, respectively. In this chapter, you'll learn how both work and how to filter circuits for a more desirable and consistent output. You'll even build a small variable power supply.
- Chapter 18: Radio Waves and Tuned Circuits** Radio waves are the communication vehicles of our cell phone networks, local area networks, and free music stations. Their use grows every day, so knowing how they work is important whether you're working with computers or IoT devices. This chapter explains AM and FM and introduces working with an Arduino shield to create a radio.
- Chapter 19: Connecting Your Circuits to the Cloud** Being able to control devices remotely is an important aspect of many IoT implementations. This chapter teaches you how to do just that using a Wi-Fi enabled Arduino board and the Arduino IoT cloud.
- Chapter 20: Just for Fun** While working with electronics is always fun, most of the time electronic circuits are created for serious work. This chapter explores some of the not-so-serious uses of electricity. If you're the least bit creative, and I'm sure you are, then this chapter is for you!

