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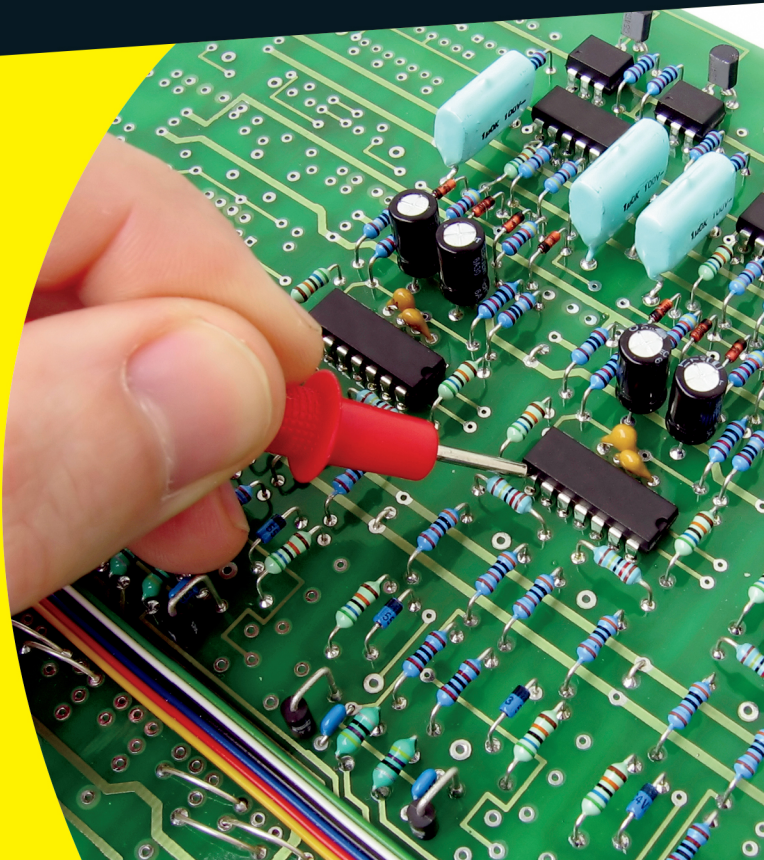
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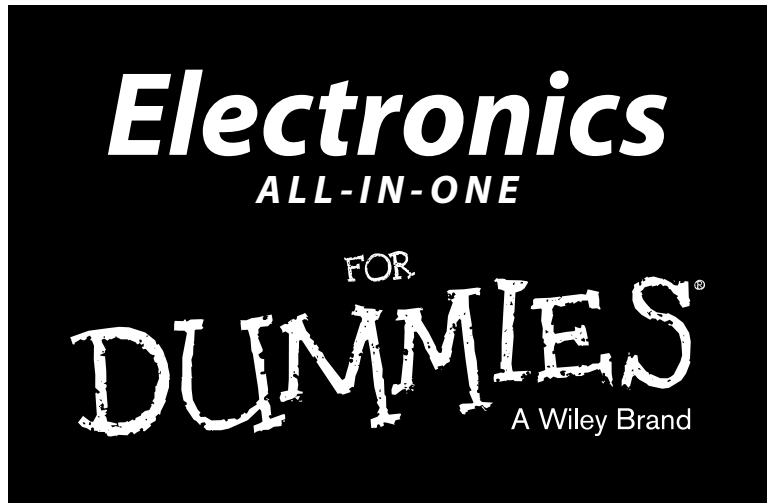
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by Doug Lowe and Dickon Ross



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Introduction

Electronics changed the world during the 20th century, from radios, telephones and cinema to modern computing and the so-called Information Age. This revolution may turn out to be as important as the Industrial Revolution. The Internet was recently voted the greatest invention of all time – and yet it’s not even 25 years old. Each new electronic gadget is adopted quicker than the last (you may be reading this book on an e-reader or tablet computer) and mobile phones now outnumber people on the planet.

Yet despite using electronics every day, many people have virtually no understanding of what’s going on under their thumbs and behind those screens; the process may just as well be magic to them. Fortunately, you don’t have to understand completely the inner workings of every component, even if you want to design an amazing new electronic gizmo.

This book is for people who’ve always been fascinated by electronics but didn’t make a career out of it. In these pages, you find clear and concise explanations of the most important concepts that form the basis of all electronic devices, such as the nature of electricity (if you think you know what it is, you’re kidding yourself); the difference between voltage, amperage and wattage; how basic components such as resistors, capacitors, diodes and transistors work; and how you can use some super-complex components such as integrated circuits to realise your own dream project.

You not only gain an appreciation of the electronic devices that are part of everyday life, but also discover how to build simple circuits that impress your friends, are great fun and may even be the prototype for the invention that makes your fortune!

About This Book

Electronics All-in-One For Dummies is a practical reference containing the most important topics you need to know when you dabble in building your own electronic circuits. It’s a big book made up of eight smaller ones, which we call *minibooks*. Each of these minibooks covers the basics of one key topic for working with electronics, such as circuit-building techniques, how electronic components work or using integrated circuits.

Throughout these minibooks, we include dozens of simple, practical projects which you can build to demonstrate the operation of typical circuits. For example, in the chapter on transistors (Book II, Chapter 6), you find several simple projects that demonstrate common uses for transistors, such as driving an LED, inverting an input and creating an oscillator.

Reading about electronics circuits is one thing, but to understand how a circuit works, you need to build it and see it in operation. Most of the projects are simple enough that you can build them in 20–30 minutes, assuming you have the parts on hand.

This book doesn't pretend to be a comprehensive reference for every detail on every possible topic related to electronics. Instead, it shows you how to get up and running quickly so that you have more time to do the things you really want to do. Designed using the easy-to-follow *For Dummies* format, this book helps you get the information you need without labouring to find it.

To make its use as easy as possible, we design this book with multiple access points to help you find what you want. At the beginning of the book is a detailed table of contents that covers the entire book. Plus, each minibook begins with a minitable of contents that shows you at a mini-glance what chapters are included in that minibook. Useful running heads appear at the top of each page to point out the topic we discuss on that page, and handy thumb-tabs run down the side of the pages to help you find each minibook quickly. At the back, a comprehensive index lets you find information anywhere in the entire book.

This book isn't the kind you pick up and read from start to finish, as if it were a novel. If we see you reading it like this at the beach, we'll kick sand in your face. Beaches are for reading romance novels or murder mysteries, not electronics books. Although you can read this book straight through from start to finish, it's designed for you to pick up, open to just about any page and start reading.

You don't have to memorise anything in this book. It's a 'need-to-know' book: you pick it up when you need to know something. Want a reminder on how to calculate the correct load resistor for an LED circuit? Pick up the book. Can't remember the pinouts for a 555 timer IC? Pick up the book. After you find what you need, put the book down and get on with your life.

Foolish Assumptions

This book assumes that you're curious about electronics, but you really don't know much, if anything, about its inner workings. You chose this book, rather

than a book consisting exclusively of recipes for electronic circuits, and therefore we assume that you want to discover more about how parts such as resistors, capacitors and transistors actually work.

You don't need to be well-versed in physics or mathematics to benefit from reading this book, although a little bit of school algebra is helpful (but we do our best to refresh that possibly painful memory).

We assume you may want to jump around this book a bit, diving deep into a topic or two that holds special interest for you, and possibly skimming through other topics. For this reason, we provide loads of chapter cross-references to point you to information that can fill in any gaps or refresh your memory on a topic.

Staying Safe

Most of the electronic circuits we describe in this book are perfectly safe: they run from common AAA or 9 V batteries and therefore don't work with voltages large enough to hurt you.

Occasionally, however, you come across circuits that work with higher voltages, which can be dangerous. You need to consider any project involving mains voltage (that you plug into an electrical outlet) as potentially dangerous and handle it with the utmost care. In addition, even battery-powered circuits that use large capacitors can build up charges that can deliver a potentially painful shock.

When you work with electronics, you also encounter dangers other than those posed by electricity. Soldering irons are hot and can burn you. Wire cutters are sharp and can cut you. Plus, plenty of the small parts you use can fall on the floor and find themselves in the mouths of children or pets.

Safety is such an important topic that we devote a whole chapter to it. We strongly urge you to read Book I, Chapter 4 *before* you build anything.

Icons Used in This Book

Like all *For Dummies* books, this one is chock-full of helpful icons that draw your attention to items of particular importance. You find the following icons throughout this book.



Pay special attention to this icon; it lets you know that a particularly useful fact is at hand.



We can't recall what we use this icon for, sorry. Oh, yes, important things to note and bear in mind!



Hold it – overly technical material is just around the corner. We use this icon for those paragraphs that go into greater depth, down into explaining how something works under the bonnet. Although enlightening, if these paragraphs go deeper than you want to know, just move on. You can also see this icon as a reminder not to get bogged down in details and instead focus on the larger point.



Danger, danger! This icon highlights information that may help you avert damage to your circuits or even personal disaster. Definitely pay attention to these warning icons, because they let you know about potential safety hazards.

Beyond the Book

As you walk your journey of discovery into the world of electronics, you can augment what you read here by checking out some of the access-anywhere extra goodies that we've hosted for you online.

You can find the book's e-cheat sheet online, at www.dummies.com/cheatsheet/electronicσαιouk. The at-a-glance, essential info that we serve up in this cheat sheet can be very handy sources of reference when printed out and pinned up near your workspace.

Additionally, you can also find a variety of great bonus content online, at www.dummies.com/extras/electronicσαιouk.

Where to Go from Here

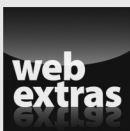
This book works like a reference source. To discover the basics of electronics, peruse Book I. If you have a topic in mind that you want to find out about, look for it in the table of contents (which is detailed enough to find most topics) or turn to the index, where you can find even more detail.

The book is loaded with information and you can stay swimming in the shallow end or dive as deep as you desire. If you want to take a brief dip into a topic, you're more than welcome. If you want to know the big picture on digital electronics, for instance, read Book VI, Chapter 1. If you want to learn about logic gates, read Chapter 2 in Book VI. Or if you want to focus in on XOR gates, use the index to find the specific section in Book VI, Chapter 2.

Whatever your needs, with this book in hand you're ready to immerse yourself in the exciting hobby of electronics. Browse through the table of contents and decide where you want to start. Be bold! Be courageous! Be adventurous! Be careful! But above all, have fun!

Book I

Getting Started with Electronics



For Dummies can help you get started with lots of subjects. Visit www.dummies.com to learn more and do more with *For Dummies*.

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Chapter 1

Entering the Exciting World of Electronics

In This Chapter

- ▶ Understanding electricity
 - ▶ Distinguishing between electrical and electronic devices
 - ▶ Outlining the most common uses for electronics
 - ▶ Looking at a typical electronic circuit board
-

Electronic devices are everywhere: for example (and incredibly), the number of mobile phones on the planet exceeds the number of people. Plus, no one uses film to take photos anymore because cameras have become electronic devices, and at any given moment young people in particular are engrossed in sending text messages while simultaneously listening to music on their smartphones.

Without electronics, life today would be extremely different.

If you've ever wondered what makes these electronic devices tick, this chapter's for you. Here we lay some important groundwork that helps the rest of this book to make sense. We examine the bits and pieces that make up the most common types of electronic devices, and take a look at the basic concept that underlies all electronics: electricity.

Having a bright idea

In January 1880, Thomas Edison filed a patent for a new type of device that created light by passing an electric current through a carbon-coated filament contained in a sealed glass tube. Historians say that Edison didn't really invent the light bulb, just improved on previous ideas, but that's another story.

Edison's light bulb patent was approved, but he still had a lot of work to do before manufacturing a commercially viable light bulb. The biggest problem with his design was that the bulbs dimmed the more they were used; when the carbon-coated filament inside the bulb became hot, it shed little particles of carbon that stuck to the inside of the glass. These particles resulted in a black coating on the inside of the bulb, which obstructed the light.

But one day, someone on Edison's team noticed that the black carbon came off only one end of the filament. The team thought that maybe some type of electric charge was coming out of the filament. To test this theory, they introduced a third wire into the bulb to see whether it would catch some of this electric charge.

It did. The team soon discovered that an electric current flowed from the heated filament to this third wire, and that the hotter the filament became the more electric current flowed. This discovery, today called *the Edison Effect*, marks the beginning of the technology known as *electronics*.

What Is Electricity?

We promise not to bore you with loads of tedious or complicated physics concepts, but in order to discover how electronics works at a level that lets you design and build your own electronic devices, you need to have a basic idea of what electricity is. After all, the whole purpose of electronics is to get electricity to do useful and interesting things.

Introducing electricity: Common knowledge

The concept of electricity is an odd one, familiar and mysterious. Here are a few of the familiar facts about electricity, based on practical experience:

- ✔ Electricity comes from power plants that burn coal, catch the wind or harness nuclear reactions. It travels from the power plants to people's houses in big cables hung high in the air or buried in the ground. At your home, it flows through wires in the walls (like water flows through