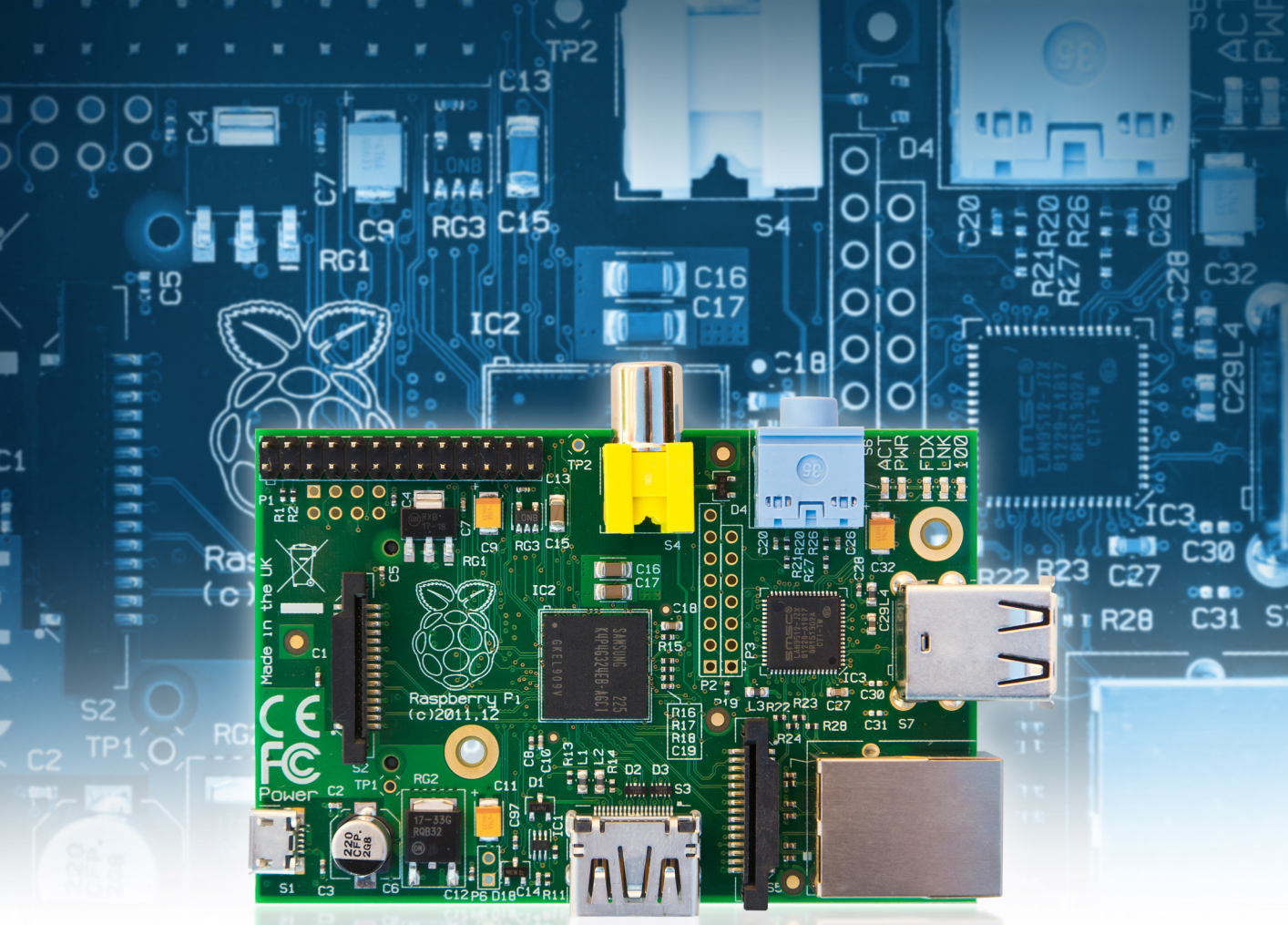


# Raspberry Pi®

## Hardware Projects

## Volume 1

Andrew Robinson
Mike Cook

WILEY

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# Introduction

**YOU'VE GOT A** Raspberry Pi – now what? This book has the answer; it's packed full of fun Raspberry Pi projects to inspire you. From getting your Pi generating comedy insults, testing your reactions and building a talking animatronic toy that tweets to building your own disco light show, prepare to be entertained and amazed by your credit card–sized computer.

One word of warning: After you start you might never stop! Electronics and coding can be addictive; who knows what you might go on to make with the skills you learn from this book.

Appendix A, "Getting Your Raspberry Pi Up and Running", is a beginner's guide to your first steps with the Raspberry Pi. If you've never coded before, Appendix B, "Introductory Software Project: The Insult Generator", will get you started programming in Python. Chapter 1, "Test Your Reactions", will get you wiring up simple computer-controlled circuits. Chapter 2, "The Twittering Toy", will show you how to make your code talk to Twitter and get you hacking household items. Chapter 3, "Disco Lights", shows you how to control LED strips and make them dance in time to the music. Along the way you will pick up the skills you need to develop your own ideas to make projects work exactly how you want them to.

Building and making is incredibly rewarding and satisfying. We want to get more people of the world to become producers of technology rather than consumers. The projects in this book are starting points – step by step, they're easy to follow so you can get results quickly. But then the real satisfaction can come, that which comes from making the project your own. At the end of each chapter there are ideas and suggestions to extend the project, together with background information to point you in the right direction. The real addictive fun begins when you see your own ideas become reality.

Welcome to the world of digital making.

# Chapter 1
# Test Your Reactions

## In This Chapter

- Getting started interfacing hardware with the Raspberry Pi
- Working with basic electronic circuits
- An introduction to electronic components, including transistors and resistors
- How to wire up a switch and an LED

**THINK YOU'VE GOT** fast fingers? Find out in this chapter as you take your first steps in hardware interfacing to build a reaction timer. You'll program the Raspberry Pi to wait a random time before turning on a light and starting a timer. The timer will stop when you press a button.

## Welcome to the Embedded World!

For some people the idea that computers aren't always big black or beige boxes on desks is a surprise, but in reality the majority of computers in the world are embedded in devices. Think about your washing machine – to wash your clothes it needs to coordinate turning the water on, keeping it heated to the right temperature, agitating your clothes by periodically spinning the drum, and emptying the water. It might repeat some of these steps multiple times during a wash, and has different cycles for different types of fabric. You might not have realised it's a computer program. It takes inputs from switches to select the wash and sensors that measure water temperature, and has outputs that heat the water and lock the door shut, and motors to turn the drum and open and close valves to let water in and out.

**YOUR TURN!** Take a moment to consider the number of appliances and gadgets that need to measure inputs, do some processing to reach a decision and then control an output in response.

A modern kitchen is crammed with computers that watch over and automate our appliances to save us effort. Computers aren't just embedded in practical products either; they're in electronic toys and entertainment devices. After working through this chapter and the other examples in this book you'll be on your way to designing your own embedded systems to make your life easier, or entertain you.

Before you get too carried away connecting things up it's worth considering a couple of warnings that will protect you and your electronic components.

## Good Practice

Electricity can be dangerous, so it is important to use it safely. The muscles in your body are controlled by tiny electrical signals, and these can be affected if electricity flows through your body. Your heart is a muscle that can be stopped by an electric shock.

The flow of electricity can cause heating, which will either cause burns to your body (sometimes deep within tissue) or can cause a fire.

**WARNING**

Electricity can kill! Only experiment with low voltages and currents, and never work with mains. If you are ever in doubt then you should check with someone suitably qualified.

Hardware is less forgiving than software; if you make a mistake with code, you might get an error, the program might crash, or in rare cases you might cause your Raspberry to reset. If you make a mistake in hardware then you can cause permanent damage. As such, hardware engineers tend to check and double check their work before applying the power!

When experimenting you should beware of short-circuiting your projects. Make sure that nothing conductive touches your circuit. Tools, metal watchstraps and jewellery, unused wires, spare components and tin foil have all been known to damage circuits. Keep your working area clear of anything you don't need and make sure that nothing metallic can touch your Raspberry Pi or circuit.

### Static Discharge

You may have felt a small electric shock due to static sometimes. This occurs when a charge builds up and then discharges to a conductor, which you feel as a small shock. If you are holding a component when this happens, that large voltage will flow through the component and damage it. Other objects such as plastic can become charged too and then discharge through a component. As such, you should take care to avoid this static discharge through components or circuits. In industry, conductive work surfaces and wrist straps are earthed to prevent static buildup. This may be an extreme solution for a hobby; you can discharge yourself by touching something earthed like a water tap, and avoid working on surfaces that are prone to picking up static charge like plastics – for example, avoid working on nylon carpets or plastic bags.

**TIP**

You may have noticed components are supplied in antistatic bags, or static-dissipative bags or static-barrier bags. These bags are made from special plastic designed to protect the contents from being zapped by static discharges and conduct any charge away. Beware that some of these bags can be slightly conductive and so may interact with your powered-up circuit.

## Obtaining Components

Another difference with hardware is that you can't download everything you need from the Internet! However, you can do the next best thing and order parts online. There are a number of online electronics retailers that supply parts, including the two worldwide distributors of the Raspberry Pi, element14/Premier Farnell/Newark and RS Components. Pimoroni, SparkFun, SK Pang, Cool Components, Adafruit and other web stores have a smaller range but cater well to electronic hobbyists.

Maplin Electronics and Radio Shack have shops on the high street with a smaller selection of parts.

### An Interface Board

Although the Raspberry Pi has a general purpose input/output (GPIO) connector that you can connect to directly, as a beginner, it is easier to use an add-on board. An interface board can offer some protection to your Pi against burning out if you get your wires crossed!

### PiFace Digital

This chapter uses the PiFace Digital interface because it is very easy to use. PiFace Digital has eight LEDs on it so that you can start controlling hardware without any electronics knowledge. Later in this chapter you'll connect your own LEDs and switches to PiFace Digital with the screw terminals. Hopefully you'll go on to use more advanced boards, and eventually you may want to design an interface board of your own!

**TIP** In computing, *digital* refers to things that can either be on or off – there's no in between. In contrast, *analogue* devices have many points between their maximum and minimum values. A button is digital in that it is either on or off. A temperature is an example of something that is analogue.

## Setting up PiFace Digital

PiFace Digital communicates using *Serial Peripheral Interface* (SPI) bus. It's a standard means of connecting peripheral devices to microprocessors. Before you use PiFace Digital with the Raspberry Pi you need to install some software.