Contents at a Glance

Introduction ............................................................................................................. 1

Part I: Getting Started in Electronics ................................................................. 7
Chapter 1: From Electrons to Electronics ............................................................ 9
Chapter 2: Keeping Humans and Gadgets Safe ..................................................... 29

Part II: Aisle 5, Component Shack: Stocking Up ............................................... 41
Chapter 3: Outfitting Your Electronics Bench ....................................................... 43
Chapter 4: Getting to Know You: The Most Common Electronic Components .... 63
Chapter 5: Filling Out Your Parts Bin ................................................................. 93

Part III: Putting It on Paper .................................................................................. 121
Chapter 6: Reading a Schematic ........................................................................ 123
Chapter 7: Understanding the Basics of Electronics Circuits ......................... 141

Part IV: Getting Your Hands Dirty ...................................................................... 159
Chapter 8: Everything You Need to Know about Soldering ......................... 161
Chapter 9: Making Friends with Your Multimeter ....... ....................................... 175
Chapter 10: Getting Down with Logic Probes and Oscilloscopes ................... 207

Part V: A Plethora of Projects ............................................................................. 231
Chapter 11: Creating Your Own Breadboard Circuit ...................................... 233
Chapter 12: Building Your Own Printed Circuit Boards ................................... 249
Chapter 13: The Exciting World of Microcontrollers ......................................... 281
Chapter 14: Great Projects You Can Build in 30 Minutes or Less ................. 299
Chapter 15: Cool Robot Projects to Amaze Your Friends and Family ............ 323

Part VI: The Part of Tens ..................................................................................... 359
Chapter 16: Ten (Or So) Cool Electronics Testing Tool Tips ....................... 361
Chapter 17: Ten Great Electronics Parts Sources ............................................. 369
Chapter 18: Ten Electronics Formulas You Should Know ............................. 375

Appendix: Internet Resources ............................................................................. 383

Glossary .................................................................................................................. 389

Index ..................................................................................................................... 399
# Table of Contents

**Introduction** ............................................. 1

- Why Buy This Book? ........................................ 1
- Why Electronics? ........................................... 1
- Foolish Assumptions ........................................ 2
- Safety Is Number 1 .......................................... 3
- How This Book Is Organized .................................. 3
  - Part I: Getting Started in Electronics ..................... 3
  - Part II: Aisle 5, Component Shack: Stocking Up ............. 4
  - Part III: Putting It on Paper ................................ 4
  - Part IV: Getting Your Hands Dirty ......................... 4
  - Part V: A Plethora of Projects ................................ 4
  - Part VI: The Part of Tens ................................... 5
- Icons Used in This Book ........................................ 5

**Part I: Getting Started in Electronics** .................. 7

**Chapter 1: From Electrons to Electronics** ............. 9

- Just What Is Electricity? ..................................... 9
  - First, you take an electron ................................ 10
  - Moving electrons around through conductors ............... 10
  - Voltage, the driving force ................................ 11
  - An important combo: Electrons, conductors, and voltage ... 12
- Where Do You Get Electricity? ................................ 12
  - They just keep on going: Batteries ......................... 13
  - Garden-variety electrical outlets .......................... 13
  - Solar cells .................................................. 15
- Where Do Electrical Components Fit In? .................... 15
  - Controlling electricity .................................... 16
  - Controlling electricity even better (ICs) .................. 16
  - Sensing with sensors ...................................... 17
  - Powering up ................................................ 18
- How Electricity Becomes Electronics ....................... 19
  - Creating a simple circuit ................................ 19
  - Deciding what to build .................................... 20
- Along the Way You Get to Play with Tools ................. 21
  - Tools to build things ..................................... 21
  - Tools to measure things .................................... 21
- The Wonderful World of Units ................................ 22
  - Measuring things in units ................................ 22
  - Getting to bigger or smaller units ........................ 22
  - Prefixes + units = ? ........................................ 23
Understanding Ohm's Law ........................................... 26
Taking Ohm's Law farther ........................................... 26
Dealing with numbers both big and small ......................... 27
The power of Ohm's Law ............................................. 27

Chapter 2: Keeping Humans and Gadgets Safe ................. 29
The Sixth Sense of Electronics .................................... 29
The Dangers of Electrical Shock ................................. 30
Electricity = voltage + current .................................... 30
Is it AC or DC? .......................................................... 30
Trying to not get electrocuted ...................................... 31
Getting a first aid chart ............................................ 32
Zaps, Shocks, and Static Discharge .............................. 33
That guy from the $100 bill again ................................. 34
How static can turn components to lumps of coal .............. 34
Tips for reducing static electricity ............................... 35
Grounding your tools ................................................. 37
Working with AC Current ........................................... 37
The Heat Is On: Safe Soldering ..................................... 39
Wearing Body Armor .................................................. 40

Part II: Aisle 5, Component Shack: Stocking Up ............ 41

Chapter 3: Outfitting Your Electronics Bench ................. 43
Oh, the Hand Tools You Will Use ................................. 43
Screwdrivers (the tool, not the cocktail) ......................... 44
Take it off: Wire cutters and strippers ........................... 46
Getting a grip with needle-nosed pliers ......................... 47
Magnifiers: The better to see you with ......................... 48
A place for everything, and everything in its place ............. 49
Filling out the toolbox ................................................. 50
Where to Park Your Tools ......................................... 51
Tools You Don't Absolutely Need (But May Find Handy) .... 52
Getting 'hole-istic' with a drill press ............................. 52
Cutting things to size with a table saw or circular saw ....... 53
Getting intricate with a motorized hobby tool ................ 53
Keeping Things Clean and Well-Oiled .......................... 54
Spic-and-span electronics .......................................... 54
Oil and grease to keep parts slippery ............................ 55
Yet more cleaning and construction supplies ................ 56
Sticky Stuff to Keep Things Together ........................... 57
Setting Up Your Electronics Lab ................................. 58
The top ingredients for a great lab ................................ 58
Picking a perfect place to practice electronics ................. 59
Triple threat: Heat, cold, and humidity ......................... 60
Workbench basics ..................................................... 61
# Table of Contents

## Chapter 4: Getting to Know You: The Most Common Electronic Components

- Viva la Resistors ......................................................... 64
  - Ohming in on resistor values ........................................ 65
  - Color me red, green, and blue ..................................... 66
  - Understanding resistor tolerance .................................. 67
  - Let there be heat ................................................... 68
  - Dialing with potentiometers ........................................ 69
- Capacitors: Reservoirs for Electricity ................................. 70
  - A quick look inside a capacitor .................................... 70
  - Farads big and small .................................................. 71
  - Keeping an eye on the working voltage ............................ 71
  - Dielectric this, dielectric that ..................................... 71
  - How much capacity does my capacitor have? ..................... 73
  - When a microfarad isn’t quite a microfarad ....................... 75
  - Tolerating hot and cold ............................................. 76
  - Being positive about capacitor polarity .......................... 77
  - Changing capacitance .............................................. 78
- Diode Mania .................................................................. 78
  - Important ratings for diodes: Peak voltage and current ......... 80
  - Which way is up? ..................................................... 81
  - Fun, fun, fun with light-emitting diodes ......................... 81
  - Resistors, meet LEDs ................................................ 82
- The Transistor: A Modern Marvel .................................... 83
  - Slogging through transistor ratings ................................ 84
  - On the case of transistor cases ..................................... 85
  - Making connections .................................................. 86
  - Transistor types ..................................................... 87
- Packing Parts Together on Integrated Circuits ...................... 88
  - Linear, digital, or combination plate? ............................. 88
  - IC part numbers ..................................................... 90
  - Understanding IC pinouts .......................................... 90
  - Exploring ICs on your own ......................................... 91

## Chapter 5: Filling Out Your Parts Bin ................................. 93

- Making the Connection ............................................. 93
- Wire ........................................................................... 94
  - Making connections with connectors ............................... 97
- Powering Up ............................................................. 98
  - Turning the juice on with batteries .................................. 98
  - Turning on power with solar cells ................................ 102
- Turning Electricity On and Off ....................................... 103
  - Turning current on and off with switches ....................... 103
  - Let a relay flip the switch ......................................... 105
- Making Decisions with Logic Gates ................................. 106
  - Using logic in electronics ................................ .......... 107
  - Common logic gates .............................................. 107
Controlling Frequency with Inductors and Crystals .................109
  Storing energy in inductors ..................................109
  Making frequencies crystal clear ................................111
Making Sense of Things .............................................111
  Can you see the light? .........................................111
  Sensing the action with motion detectors ........................112
  You’re getting warmer: Temperature sensors ......................113
Good Vibrations with DC Motors ..................................115
So You Want to Make Some Noise? ..................................116
  Speaking of speakers ..........................................117
  Buzzers ..........................................................118

Part III: Putting It on Paper ........................................121

Chapter 6: Reading a Schematic ......................................123
  What’s a Schematic, and Why Should I Care? ......................123
  Getting a Grip on Schematic Symbols .............................124
    Getting the scoop on basic schematic symbols ...................125
    Symbols for electronic components .............................129
    Logic gate symbols ...........................................133
    Miscellaneous symbols .......................................134
  Getting Component Polarity Right ................................136
  One Size Fits All: Adjustable Components .........................138
  Photo-Sensitive Components Help You See the Light ...............139
  Alternative Schematic Drawing Styles ............................139

Chapter 7: Understanding the Basics of Electronics Circuits ....141
  What the Heck Is a Circuit? .......................................142
  A Very Basic Circuit .............................................142
    Powering a light bulb .........................................142
    Controlling the current with a resistor .........................143
  Parallel (or Series) Parking Your Light Bulbs ....................144
    Circuits: The series .........................................144
    Parallel circuits .............................................145
  Exploring a Voltage Divider Circuit ................................146
  Measuring Current with Voltage ..................................148
  What a Team: Capacitors and Resistors ............................149
    How the dynamic duo of resistors and capacitors works .........149
    Turning things on and off ....................................150
  Talking of Transistors ...........................................151
    Using a transistor as a switch ................................151
    When is a transistor an amplifier? .............................152
    What else can you do with transistors? .........................154
  An Operational Amplifier .......................................155
  Simplifying a Project with an Integrated Circuit ................156
Part IV: Getting Your Hands Dirty .......................... 159

Chapter 8: Everything You Need to Know about Soldering ............ 161
To Solder or Not to Solder ........................................... 161
Things You Absolutely, Positively Need for Soldering ..................... 163
Choosing just the right soldering pencil ................................ 166
Selecting a soldering tip ............................................. 166
Preparing Your Soldering Pencil ..................................... 167
Successful Soldering ................................................. 167
Avoiding Cold Solder Joints like the Plague ............................. 169
Avoiding Static Discharge While Soldering ................................ 170
Thwarting discharge before it begins ................................... 170
Stocking up on anti-static supplies ................................... 171
Unsoldering and Resoldering ......................................... 172
Putting a spring-loaded plunger desolder pump to work ................. 172
This bulb desolder pump definitely sucks ............................... 173
Soldering Tips and Techniques ...................................... 174

Chapter 9: Making Friends with Your Multimeter ....................... 175
The Basics of Multimeters ........................................... 175
Remember: Safety First! ............................................. 177
Which to choose: Digital or analog? ................................... 177
Taking a Close-Up Look at Multimeters ................................ 179
Basic features of every meter ....................................... 179
Making sense of all the inputs and dials ................................ 181
Accuracy, resolution, and sensitivity ................................... 183
The well-stocked multimeter ......................................... 183
Maximum range: Just how much is enough? ............................ 185
Home on the automatic range ...................................... 186
Extra nice-to-have functions ....................................... 188
Setting Up the Meter .................................................. 189
Five Basic Tests That You Can Make with Your Multimeter ............ 191
Testing voltage ....................................................... 191
Testing current ....................................................... 193
Testing wires and cables for continuity ................................ 194
Testing switches ..................................................... 196
Testing fuses ......................................................... 199
Testing Resistors, Capacitors, and Other Electronic Components .... 200
Gee, it looks all burned out! ........................................ 200
Testing resistors ..................................................... 201
Testing potentiometers ............................................... 202
Testing diodes ......................................................... 202
Testing capacitors ................................................... 204
Testing transistors ................................................... 205
Chapter 10: Getting Down with Logic Probes and Oscilloscopes

The Search for Spock: Using a Logic Probe

Sound, lights, action!

Signals that are too fast (even for Superman)

Know thy circuit

Putting the Logic Probe to Work

Observe the usual safety precautions, please

Connecting the probe to the circuit

What if the indicator doesn’t indicate?

Scoping Out the Oscilloscope

So, exactly what does it do?

Sticking to common oscilloscope features

Bench, handheld, or PC-based?

Understanding oscilloscope bandwidth and resolution

The ins and outs of using an oscilloscope

What all the wiggly lines mean

So, When Do I Use an Oscilloscope?

Putting the Oscilloscope to Work: Testing, 1-2-3!

Basic setup and initial testing

Does your battery have any juice?

Dissecting your radio to display an audio waveform

Testing the frequency of an AC circuit

Part V: A Plethora of Projects

Chapter 11: Creating Your Own Breadboard Circuit

Taking a Look at Solderless Breadboards

Solderless breadboards, inside and out

All sizes, big and small

Creating a Circuit with Your Solderless Breadboard

Why you gotta get pre-stripped wires

Breadboarding techniques

Neatness counts

Making the Move from Your Circuit to a Solder Breadboard

Prototyping with Pre-Drilled Perf Boards

Getting Wrapped Up in Wire Wrapping

Chapter 12: Building Your Own Printed Circuit Boards

Anatomy of a Circuit Board

How the Copper Gets onto the Circuit

Ready, Set: Preparing to Build Your Board

Choosing the right copper clad

Cutting and cleaning

Creating a PCB Photographically

Making the mask
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positively or negatively sensitized</td>
<td>256</td>
</tr>
<tr>
<td>Mirror, mirror on the PCB</td>
<td>257</td>
</tr>
<tr>
<td>Preparing the PCB for etching</td>
<td>257</td>
</tr>
<tr>
<td>Let there be light: Exposing and developing the board</td>
<td>259</td>
</tr>
<tr>
<td>Creating a PCB by Using the Transfer Film Method</td>
<td>260</td>
</tr>
<tr>
<td>Flip-flop, flop-flop</td>
<td>261</td>
</tr>
<tr>
<td>Getting a good image</td>
<td>261</td>
</tr>
<tr>
<td>Transferring the layout to copper clad</td>
<td>262</td>
</tr>
<tr>
<td>Be sure to QC (Quality Control) your work!</td>
<td>263</td>
</tr>
<tr>
<td>Choosing a Method for Making Your Own Circuit Layouts</td>
<td>264</td>
</tr>
<tr>
<td>Showing You My Etchings: Etching the Circuit Board</td>
<td>265</td>
</tr>
<tr>
<td>First step: Inspecting the board</td>
<td>265</td>
</tr>
<tr>
<td>Cleaning the board — carefully, please!</td>
<td>266</td>
</tr>
<tr>
<td>Kvetching about etching</td>
<td>266</td>
</tr>
<tr>
<td>Mixing the etchant</td>
<td>267</td>
</tr>
<tr>
<td>Now that you’re itching to etch</td>
<td>269</td>
</tr>
<tr>
<td>Final Prep and Drilling</td>
<td>270</td>
</tr>
<tr>
<td>PCBs R Us: Using a PCB Service</td>
<td>272</td>
</tr>
<tr>
<td>Now you’re a board designer</td>
<td>272</td>
</tr>
<tr>
<td>PCBs: Everybody’s doing it (But will they do it for you?)</td>
<td>273</td>
</tr>
<tr>
<td>Using CAD to Make Artwork</td>
<td>274</td>
</tr>
<tr>
<td>What you can do with Eagle Light CAD</td>
<td>274</td>
</tr>
<tr>
<td>Getting to work designing a board</td>
<td>274</td>
</tr>
<tr>
<td>Chapter 13: The Exciting World of Microcontrollers</td>
<td>281</td>
</tr>
<tr>
<td>So, How Does It Work?</td>
<td>281</td>
</tr>
<tr>
<td>What’s Inside a Microcontroller?</td>
<td>282</td>
</tr>
<tr>
<td>Discovering Microcontrollers for Hobbyists</td>
<td>284</td>
</tr>
<tr>
<td>How much is that microcontroller in the window?</td>
<td>285</td>
</tr>
<tr>
<td>PC calling microcontroller: Come in, please!</td>
<td>286</td>
</tr>
<tr>
<td>Microcontrollers That Stand Out from the Rest</td>
<td>287</td>
</tr>
<tr>
<td>Introducing the BASIC Stamp</td>
<td>287</td>
</tr>
<tr>
<td>Introducing the OOPic</td>
<td>290</td>
</tr>
<tr>
<td>Getting to Know the BASIC Stamp 2</td>
<td>292</td>
</tr>
<tr>
<td>Step 1: Making the circuit</td>
<td>292</td>
</tr>
<tr>
<td>Step 2: Programming the darned thing</td>
<td>292</td>
</tr>
<tr>
<td>Step 3: Let 'er rip!</td>
<td>295</td>
</tr>
<tr>
<td>Making changes made easy</td>
<td>296</td>
</tr>
<tr>
<td>Adding a switch to the mix</td>
<td>296</td>
</tr>
<tr>
<td>Where to Go from Here</td>
<td>298</td>
</tr>
<tr>
<td>Chapter 14: Great Projects You Can Build in 30 Minutes or Less</td>
<td>299</td>
</tr>
<tr>
<td>Getting What You Need Right Off the Bat</td>
<td>300</td>
</tr>
<tr>
<td>Creating Cool, Crazy, Blinky Lights</td>
<td>300</td>
</tr>
<tr>
<td>Taking a closer look at the 555 flasher</td>
<td>301</td>
</tr>
<tr>
<td>Running down the LED flasher parts</td>
<td>304</td>
</tr>
</tbody>
</table>
Putting the Squeeze on with Piezoelectricity ........................................... 305
Piezo — what? ......................................................................................... 305
Experimenting with piezoelectricity ....................................................... 305
Gathering parts for the piezoelectricity circuit ....................................... 307
Building the Amazing See-in-the-Dark Infrared Detector ....................... 308
Chasing down infrared light ................................................................. 308
Detecting parts for the infrared detector ............................................... 310
Cheese It! It's the Cops!! ................................................................. 310
How your warbler works ........................................................................ 310
Scoping out the 555 siren parts list ....................................................... 311
Get Lost . . . or Found, with the Electronic Compass ............................... 312
Peeking under the compass hood ......................................................... 312
Checking your electronic compass parts ................................................. 314
When There's Light, You Hear This Noise ... ....................................... 314
Making your alarm work for you ......................................................... 314
Assembling a light alarm parts list ...................................................... 315
‘Lil Amp, Big Sound .............................................................................. 316
The ins and outs of ‘Lil Amp .............................................................. 316
Sounding the roll call for little amplifier’s parts ..................................... 317
Building the Handy-Dandy Water Tester .............................................. 317
How the water tester works ................................................................. 317
Gathering water tester parts ............................................................... 318
Creating a Very Cool Lighting Effects Generator ................................. 319
Arranging the LEDs ............................................................................ 319
Going to the store for light chaser parts .............................................. 321

Chapter 15: Cool Robot Projects to Amaze Your Friends and Family ...... 323
Robots: The Big Picture ........................................................................ 324
Rover the Robot parts list ...................................................................... 325
The bits and pieces of a ‘bot ............................................................... 326
Introducing Rover the Robot ............................................................... 326
Preparing to Build the ‘Bot .................................................................. 327
First, get yourself a template .................................................................. 327
Gathering your materials ...................................................................... 328
Getting to know the pieces .................................................................... 328
Building the Body of the ‘Bot ............................................................... 330
Cutting and drilling the pieces of a robot body ...................................... 330
Assembling and mounting the motors ................................................ 332
Doing a wheelie ................................................................................... 333
Mounting the caster ............................................................................. 334
Adding the second deck ....................................................................... 335
Control switches .................................................................................. 336
Driving Miss Rover ............................................................................. 338
Giving Rover Some Smarts ................................................................... 340
Mulling over microcontrollers ............................................................... 340
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC motors out, R/C servo motors in</td>
<td>341</td>
</tr>
<tr>
<td>Going inside a servo motor</td>
<td>342</td>
</tr>
<tr>
<td>Going shopping for servos</td>
<td>342</td>
</tr>
<tr>
<td>Making servos serviceable</td>
<td>343</td>
</tr>
<tr>
<td>Modifying the R/C servo motors</td>
<td>343</td>
</tr>
<tr>
<td>Mounting the servos to the Rover</td>
<td>347</td>
</tr>
<tr>
<td>Putting Your Servos on a Roll with Wheels</td>
<td>350</td>
</tr>
<tr>
<td>Sensing Things with a Bumper Car Switch</td>
<td>351</td>
</tr>
<tr>
<td>Connecting Up to the Board of Education</td>
<td>352</td>
</tr>
<tr>
<td>Making Switch and Power Connections</td>
<td>354</td>
</tr>
<tr>
<td>Making the Smart Rover Smart</td>
<td>355</td>
</tr>
<tr>
<td>Putting the program in place</td>
<td>355</td>
</tr>
<tr>
<td>Looking at the program up-close</td>
<td>356</td>
</tr>
<tr>
<td>Where Can I Go from Here?</td>
<td>358</td>
</tr>
<tr>
<td><strong>Part VI: The Part of Tens</strong></td>
<td>359</td>
</tr>
<tr>
<td>Chapter 16: Ten (Or So) Cool Electronics Testing Tool Tips</td>
<td>361</td>
</tr>
<tr>
<td>Put a Pulse Here, Put a Pulse There</td>
<td>362</td>
</tr>
<tr>
<td>Counting Up Those Megahertz</td>
<td>363</td>
</tr>
<tr>
<td>A Power Supply with a Changeable Personality</td>
<td>364</td>
</tr>
<tr>
<td>Making All Kinds of Signals</td>
<td>365</td>
</tr>
<tr>
<td>Calling All Alien Worlds</td>
<td>365</td>
</tr>
<tr>
<td>Analyze This</td>
<td>366</td>
</tr>
<tr>
<td>A Trio of Testing Toys</td>
<td>366</td>
</tr>
<tr>
<td>Where to Get Testing Tool Deals</td>
<td>367</td>
</tr>
<tr>
<td>Chapter 17: Ten Great Electronics Parts Sources</td>
<td>369</td>
</tr>
<tr>
<td>North America</td>
<td>369</td>
</tr>
<tr>
<td>All Electronics</td>
<td>369</td>
</tr>
<tr>
<td>Allied Electronics</td>
<td>370</td>
</tr>
<tr>
<td>B.G. Micro</td>
<td>370</td>
</tr>
<tr>
<td>Digikey</td>
<td>370</td>
</tr>
<tr>
<td>Electronic Goldmine</td>
<td>370</td>
</tr>
<tr>
<td>Fry’s Electronics</td>
<td>371</td>
</tr>
<tr>
<td>Jameco Electronics</td>
<td>371</td>
</tr>
<tr>
<td>Mouser Electronics</td>
<td>371</td>
</tr>
<tr>
<td>RadioShack</td>
<td>371</td>
</tr>
<tr>
<td>Outside North America</td>
<td>372</td>
</tr>
<tr>
<td>Dick Smith Electronics (Australia)</td>
<td>372</td>
</tr>
<tr>
<td>Farnell (UK)</td>
<td>372</td>
</tr>
<tr>
<td>Maplin (UK)</td>
<td>372</td>
</tr>
<tr>
<td>Advice for Shopping Mail Order</td>
<td>372</td>
</tr>
<tr>
<td>Do</td>
<td>373</td>
</tr>
<tr>
<td>Don’t</td>
<td>373</td>
</tr>
<tr>
<td>New or Surplus?</td>
<td>374</td>
</tr>
</tbody>
</table>
Chapter 18: Ten Electronics Formulas You Should Know ...............................................375
Calculating Relationships with Ohm's Law .................................................................375
Calculating Resistance .................................................................................................377
Calculating resistors in series ......................................................................................378
Calculating two resistors in parallel .............................................................................378
Calculating Capacitance ...............................................................................................379
Calculating capacitors in parallel .................................................................................379
Calculating two capacitors in series .............................................................................379
Calculating three or more capacitors in series ............................................................379
Calculating Units of Energy ..........................................................................................380
Calculating RC Time Constants ..................................................................................380
Calculating Frequency and Wavelength ......................................................................381
Calculating frequency of a signal ...............................................................................382
Calculating wavelength of a signal ..............................................................................382

Appendix: Internet Resources ......................................................................................383
Figuring Things Out with Calculators .........................................................................383
Gabbing about Electronics in Discussion Forums .......................................................384
Surfing for Robot Parts .................................................................................................384
Getting Up to Speed with Tutorials and General Information .....................................385
Trolling for Printed Circuit Board Chemicals and Supplies .........................................386
Getting Things Surplus .................................................................................................387
Surfing for Circuits ......................................................................................................387

Glossary .........................................................................................................................389

Index ..............................................................................................................................399