Extracted from:

Essential 555 IC

Design, Configure, and Create Clever Circuits

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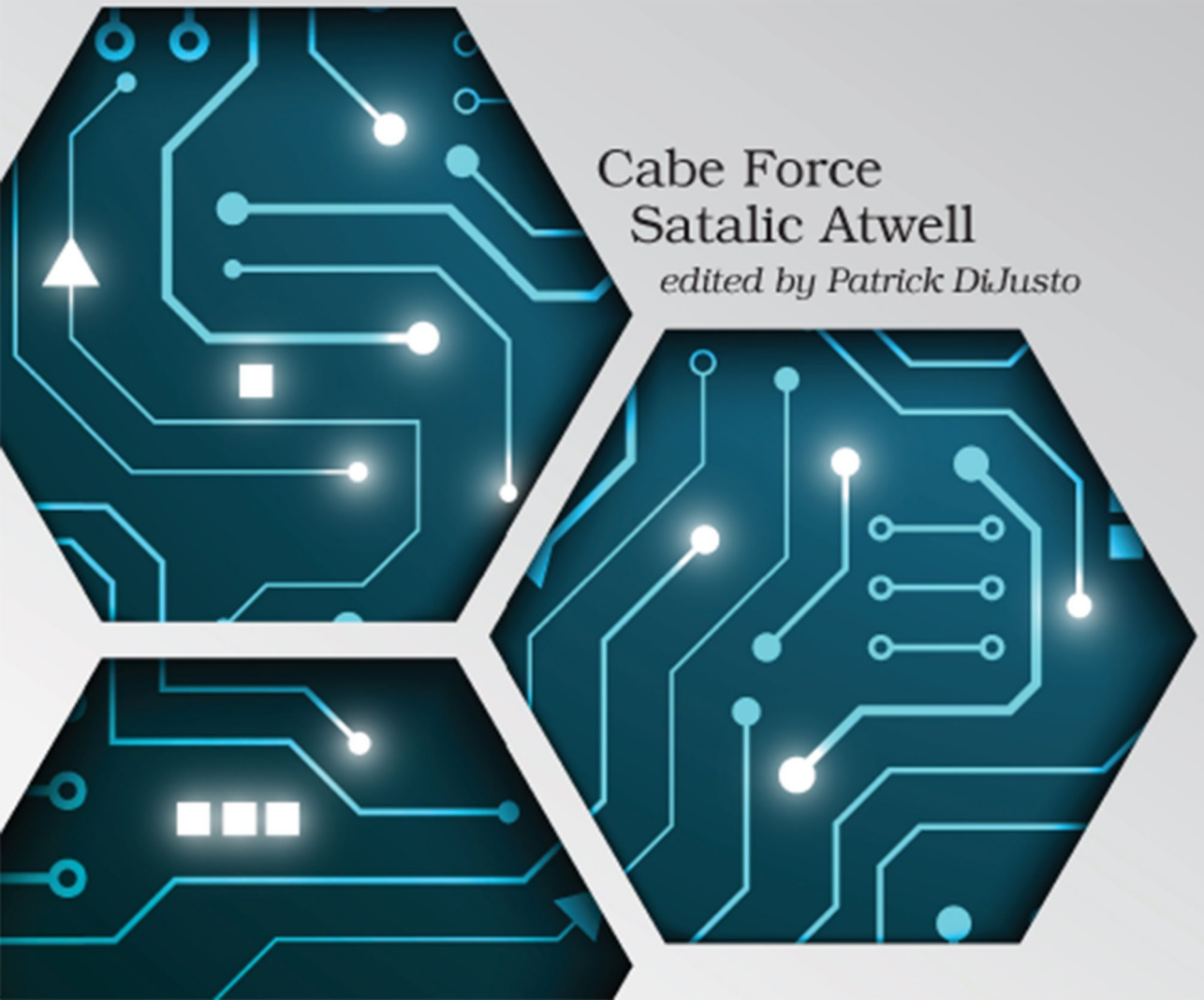

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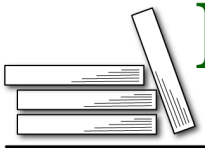

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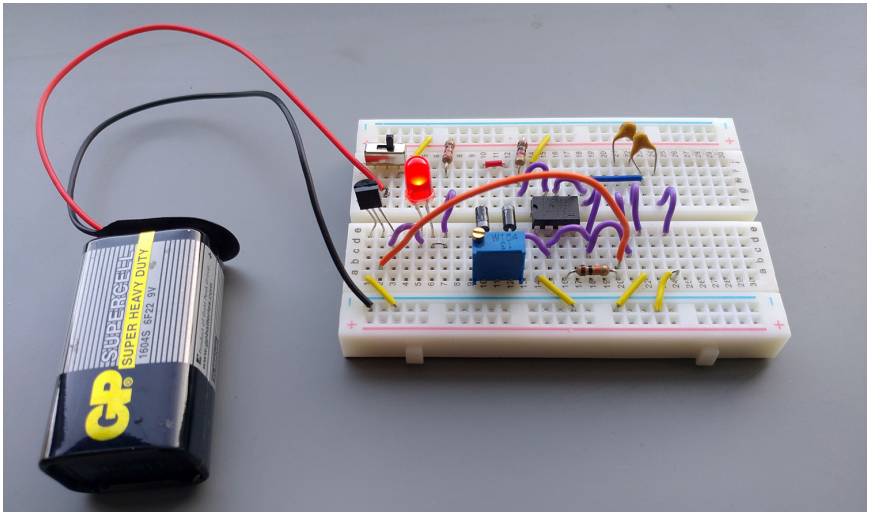
ISBN-13: 978-1-68050-783-6
Encoded using the finest acid-free high-entropy binary digits.
Book version: P1.0—April 2021

CHAPTER 6

LED Brightness Dimmer



Learning how to dim an LED is as important as learning how to turn one on.

You might be wondering: "Are LEDs dimmable? Can I just use a potentiometer?" Sure you can, but with one caveat to that solution: when you lower the amount of electricity going to the LED using a resistor or potentiometer (variable resistor), all the excess energy gets converted to heat. Let's say you have a 9 volt battery in the setup, and you want to dim a 2.1 volt LED. That means the potentiometer must dissipate nearly 7 volts of energy. Unless that potentiometer is huge, there's a good chance it's going to get really, really hot.

Deliberately designing a circuit that you know is going to heat up is dangerous for many reasons, so let's defeat the heat. What you need is a way to reduce the amount of energy going to an LED without building up waste heat. The solution is something called *pulse width modulation*, also known as PWM.

In electronics, a *pulse* is a discrete burst of energy with a beginning, middle, and an end. When the pulse ramps up to peak voltage, the signal is said to be *high*. When the pulse reduces to zero, the signal is said to be *low*. The middle portion of the pulse, also known as the *width*, can last any amount of time: a fraction of a second, a few seconds, a minute, or an hour or more. The distance from one pulse to the next pulse is called a *duty cycle*. If the signal is at a peak voltage 100% of the time, it's called 100% duty cycle. Peak voltage only half the time is a 50% duty cycle, and so on.

To dim an LED, we *modulate*, or change the signal so that it's at peak voltage for only half the time and absolutely off for the other half of the time—a 50% duty cycle. This accomplishes our goal of reducing the amount of energy going to the LED, except that instead of reducing the voltage by half, we're reducing the time the LED is lit by half. Either way, the end result is that the LED appears only half as bright as it should.

Persistence of Vision

Obviously, if the LED's duty cycle is too long, you won't see a dimming effect, just a light blinking on and off. But because of the way the human eyes and nervous system work, an LED blinking at hundreds or thousands of times per second will be perceived as a dim LED. It's almost as if the brain averages an image of a fully lit LED and a fully dark LED into a mental image of a 50% lit LED.

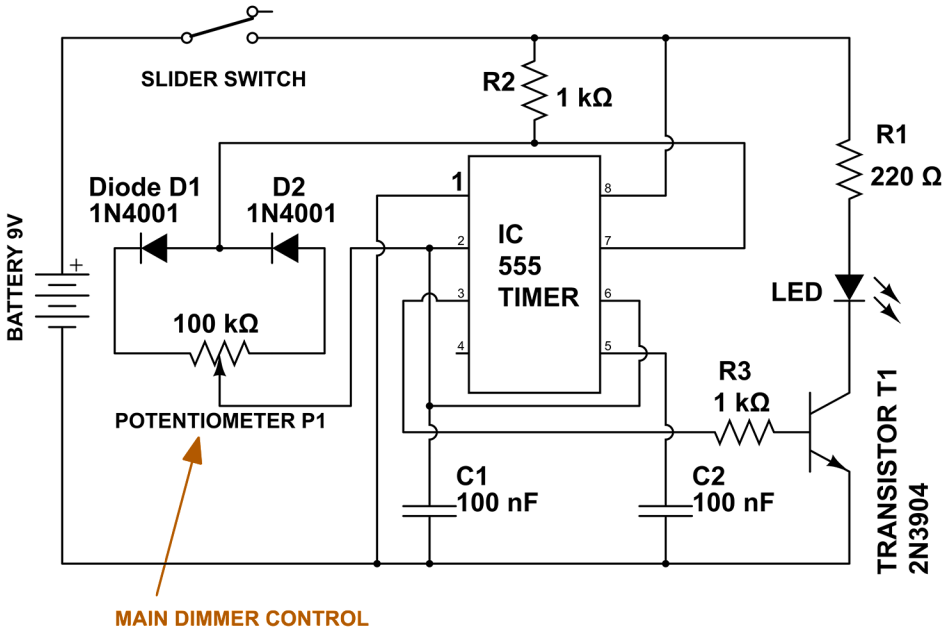
By using pulse width modulation to dim an LED, no electrical power is wasted as heat, as it would be if we used a potentiometer.

Parts

555 Timer IC	Newark part number 58K8943	Jameco part number 27423
NPN Transistor, 2N3904	Newark part number 83C3116	Jameco part number 178597
LEDs of your choice. I suggest red.	Newark part number 52K5254	Jameco part number 206519
2x Diode, 1N4148	Newark part number 95W3791	Jameco part number 36038
220 Ω Resistor	Newark part number 38K0351	Jameco part number 690700
2x 1 kΩ Resistor	Newark part number 38K0327	Jameco part number 690865

100 kΩ Potentiometer	Digikey part number CF14JT100KCT-ND	Jameco part number 853599
0.01 μF (10 nF) Ceramic Capacitor	Newark part number 46P6665	Jameco part number 15229
0.1 μF (100 nF) Ceramic Capacitor	Newark part number 46P6667	Jameco part number 25523
9 V Battery Holder/Strap	Newark part number 31C0662 or 59K0356	Jameco part number 101470
9 V Battery	Newark part number 81F157	Jameco part number 27423
Slider Switch SPDT	Newark part number 10X9279	Jameco part number 2192384
Half-size Breadboard	Newark part number 99W1759	Jameco part number 2157693

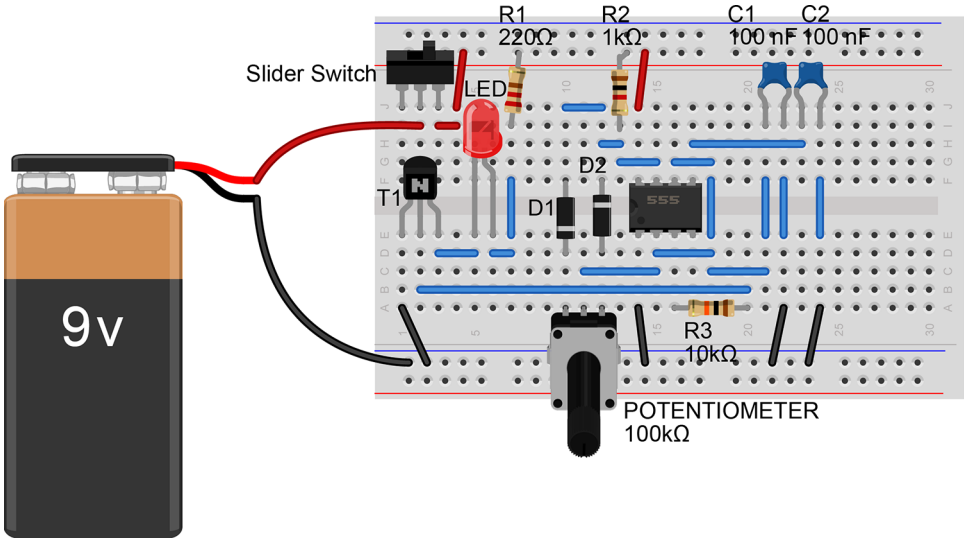
The Official Schematic.



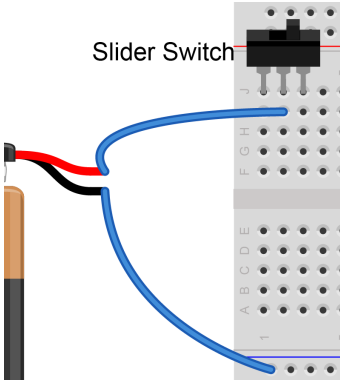
Pay special attention to how to orient the diodes in the circuit. This is an elaborate circuit, so we're going to use a full breadboard.

This circuit can be used as an accessory in many of the other projects. You could use it to control the speed of a small motor like the kind you find inside old broken toys: just hook up the motor where the LED and resistor sit above the transistor.

Breadboard View



This is the breadboard view. Again, pay close attention to the orientation of the diodes.



Place switch on the breadboard and connect positive lead on the battery to the middle pin on switch (common node).