

Practical Electronic Circuits

**A Strong Foundation for
Creating Electronic Projects**

By

A. B. Lawal

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ISBN: 9781671485518

Published in the United States

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Preface

This book “Practical Electronic Circuits: A Strong Foundation for Creating Electronic Projects” is designed to provide skills and a hands-on practical experience for students of electronic engineering and computer science. It also provides a good foundation for anyone interested in learning how to create electronic projects.

Electronics curricula are densely packed in many engineering and computer science colleges. This book therefore is a great help because it treats each topic thoroughly. It is also a great companion.

The book will be of great help for your electronics education because it is filled with simple and moderately complex practical projects. Links to stores where you can get very cheap electronic parts to work with are also included.

You will also learn how to be safe in your workspace, and how to develop the courage you need to carry out any electronic project. A step by step approach is used to explain the process of carrying out an electronic project.

This book is also a great value for every electronics students undergoing technical training. It encourages them through providing useful technical advice needed in a highly practical environment, with a clearly defined problem so they do not get stuck while building even complex projects.

About the Author

A. B. Lawal is a control and instrumentation Engineer. He also has a master’s degree in computer science. He worked for a couple telecommunication companies for over 10 years before becoming a lecturer in a prestigious engineering college in the United States. He is currently involved in evaluation, revision, redesign, and expansion of electronic systems and technically related computer programs.

1. Fundamentals of Electronic Circuits

1.1 Power Supplies & Electronic Signals

In this chapter, I lay some important groundwork that you need to make sense of the rest of the book. I examine the bits and pieces that make up the most common types of electronic devices, and that make electronic circuits in general to work.

All electronic and electrical devices, from the simplest flashlight to a giant and complex control systems on a modern aircraft, all need one thing in common: **power supply**.

1.1.1 Power Supply

A power supply is a source of electricity, or more precisely, a source of electrons. Without power supply, an electronic device is all just a pile of inactive plastic, metal or silicon (among other things).

A few examples of power supplies are batteries, power adaptors for charging your mobile phones and laptop computers and so on. **Fig. 1.1.1** shows a power supply built by assembling a few batteries.

However, a power supply itself can be built with electronic devices, such as shown in **Fig. 1.1.2** and **Fig. 1.1.3**.



Fig. 1.1.1: 12V DC Battery Power Supply: Image Source: Superbrightleds.com



Fig. 1.1.2: A Laptop Charger. Image Source: waveform.com



Fig. 1.1.3: Power supply of a desktop computer. Image Source: avnet.com

Next, I take a look at the basic concept underlying all electronic circuits: **signals**.

I'm not going to bore you with any complicated or tedious or physics concepts, but I want to warn you from the start.

In order to learn how electronic circuits work and get to a level where you can design and build your own electronic devices, you need to have at least a basic idea of what a signal is. So put on your thinking cap and come with me.

Fig. 1.1.4 shows various symbols used for representing DC and AC power sources in electronic circuits. The positive terminal of a DC power supply is usually represented by “+” while the negative terminal is represented by “-”.

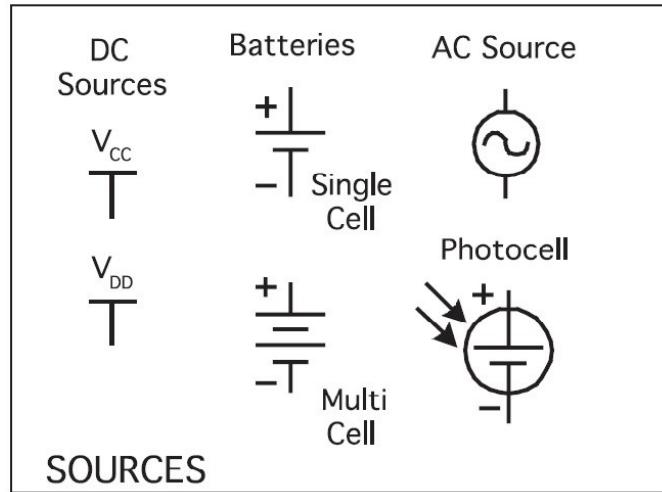


Fig. 1.1.4. various symbols for circuit power supplies

As shown in Fig. 1.1.4, the + terminal of bi-polar junction **transistor** circuits is often represented by V_{CC} , while the + terminal of **FET** and **MOSFET** circuits is often represented by V_{DD} . We will look at FET (field effect transistor) and MOSFET (metal-oxide-semiconductor transistor) circuits later.

1.1.2 Electronic Signal

In the field of electronics, a signal is an electric current or [electromagnetic field](#) used to transmit data from one place to another.

DC (Direct Current) is the simplest form of signal because it travels in only one direction so it can be switched on or off. It is the principle behind the working of the early [telegraph](#).

AC (Alternating Current) on the other hand is a type of current that pulsates or changes direction periodically. Electronic devices process AC signals very often. Such signals are electromagnetic carriers of one or more data streams. **Fig. 1.1.5** shows graphical representations of DC and AC signals.

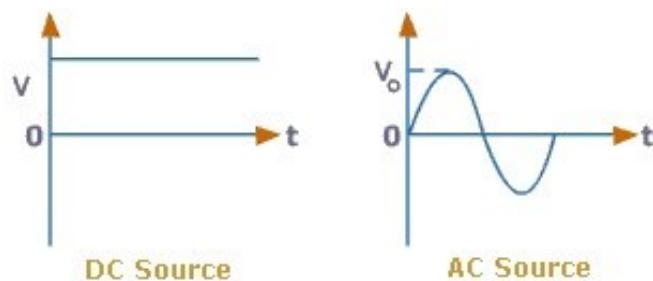


Fig. 1.1.5: DC signal (left) and AC signal (right).

A very common source of alternating current is the *mains*, which is usually obtained from the electric sockets on the walls of your room or office. Mains is usually supplied by the electric power authority in your locality. **Fig. 1.1.6.**



Fig. 1.1.6: Mains sockets. Image source: [Rapidonline.com](https://www.rapidonline.com)

Before I move on to the next section I must mention that the oscilloscope is a very good example of both DC and AC signal sources often used in electronics labs. See **Fig. 1.1.7.** You will learn how to use the oscilloscope later.



Fig. 1.1.7: A 70MHz 2-Channel analogue oscilloscope. Image Source: [Amazon.com](https://www.amazon.com)

1.2 Electricity: Charges & Current

Even though we don't know exactly what electricity is, we do know a lot about what it does and how it behaves.

You will find it easier to understand electricity if you avoid using the term *electricity* itself to describe it. The reason is very simple: The word **electricity** is not very precise. Scientists and engineers use the word electricity to refer to a few different but related things.

The most common ones are rather precise names like *electric charge*, *electric current*, *electric field*, and *electric energy*. All these are what are commonly called electricity.

1.2.1 Electric Charge

Electric charge, electrical charge, electrostatic charge, or simply charge, is the characteristic of a unit of matter that expresses the extent to which it has more or fewer electrons than protons.

In an atom, it is the *electron* that carries a negative elementary or unit charge and the proton carries a positive charge. The two types of charge are equal and opposite.

For practical purposes, the most important thing you should know about electric charge is that **opposite charges attract** and **similar charges repel**. In other words,

- negative charges attract positive charges
- positive charges attract negative charges
- negative charges repel negative charges
- positive charges repel positive charges

Therefore an electron and a proton attract each other, but an electron repels another electron and a proton repels another proton. The unit of electric charge is **coulomb** (symbol is **C**).

1.2.2 Electric Current

An electric current is defined as the rate of flow of **electric charge** past a given point or region. We say an **electric current** exists when there is a net flow of electric charge through a given point or region. In electric circuits this charge is often carried by electrons moving through a wire.

In other words, electric current is the total charge that passes through a given cross-sectional area A per unit time. This cross-sectional area is frequently represented by a slice through a solid material, such as a conductor (for example, a copper wire).

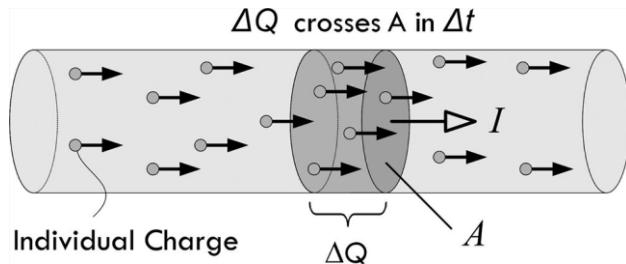


Fig. 1.2.1: ΔQ Charge crosses a conductor of cross-sectional area A in Δt time.

Supposing ΔQ represents the amount of charge that passes through an area in a given time interval Δt as shown in **Fig. 1.2.1.**, then the *average current* I_{ave} is defined as:

$$I_{ave} = \frac{\Delta Q}{\Delta t}$$

The SI unit (international system of units) of current is therefore coulombs per second or C/s, but the **ampere (A)** is often preferred.

So $1 \text{ A} = 1 \text{ C/s}$.

The ampere is a rather too large a unit for practical uses in electronic circuits, so you will find it more convenient to express current in *millamps (mA)*, *microamps (μA)* or *nanoamps (nA)*.

$$1 \text{ mA} = 1 \times 10^{-3} \text{ A},$$

$$1 \text{ } \mu\text{A} = 1 \times 10^{-6} \text{ A},$$

$$1 \text{ nA} = 1 \times 10^{-9} \text{ A}.$$

1.2.3 Current Drawn By Common Electronic Devices

When tinkering with circuits in general, it is good to have idea of how much current common electronic and electrical devices (commonly called **loads**) draw from their power supplies. Below are some examples:

A 100-watt lightbulb (electrical device): about 1 A;

A laptop computer (electronic gadget): between 2 to 3 A;

A microwave oven (electrical device): about 10 A;

A fluorescent light: 1 to 2 A;

A radio or stereo set: (electronic): 0.5 to 3 A;

A typical LED (a small electronic indicator light): 20 mA;

An microchip (electronic): a few μA or even perhaps several pA

A current sufficient to induce a cardiac or respiratory arrest: about 100 mA to 1 A.

A mobile (smart) phone: around 200 mA

An electric fan (electrical device): about 1 A;

A TV set (electronic gadget): 1 to 3 A;

A toaster (electrical gadget): 7 to 10 A;

An automobile starter: around 200 A;

A lightning strike: about 1000 A.

Electric current can be measured by a **ammeter** but a digital **multimeter** is often used in electronics because it has higher precision and can measure various ranges of current. We will look at the multimeter and how to use it in chapter 7.

In electronic circuits, an ammeter is represented by

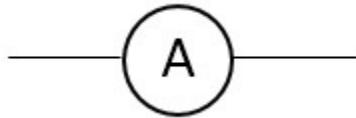


Fig. 1.2.2 shows an analogue DC ammeter and **Fig. 1.2.3** shows a digital DC ammeter.



Fig. 1.2.2: An analogue DC ammeter, range 0 to 3A. Image Source: [School Specialty Canada](#)



Fig. 1.2.3: An digital DC ammeter, range 0 to 10A. Image Source: [Arbor Scientific](#)