

ELECTRONICS FOR GUITAR PEDALS

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Guitar effects pedals are electronic devices. They can be as simple as a one transistor amplifier circuit biased to create distortion to digital pedals that use powerful digital signal processors (DSPs) and complex software algorithms to create sophisticated distortions, delays and other effects. To be able to understand how they work, fault-find them, modify them and eventually how to design your own circuits you need at least a basic understanding of electronics. The learning resources listed below are all free to use and will provide you with a good understanding of electronic circuit design principles.

FREE ONLINE COURSES IN ELECTRONICS:

These courses are provided free of charge by the Open University to allow beginners to learn about electronics.

- **Introduction to Electronics:** <https://www.open.edu/openlearn/science-maths-technology/introduction-electronics/content-section-0?active-tab=description-tab>
- **Electronics Applications:** <https://www.open.edu/openlearn/science-maths-technology/electronic-applications/content-section-0?active-tab=description-tab>

FREE ELECTRONICS COURSES FROM ANALOG DEVICES:

Provided by a major manufacturer of analogue and digital electronics devices, these cover the physics and operation of semiconductor diodes, bipolar junction transistors, and field-effect transistors in simple analogue circuits. They cover amplifier biasing, small-signal analysis, and frequency response as well as elementary bipolar and MOSFET digital circuits, analogue-to-digital and digital-to-analogue conversion.

- **Electronics Course Wiki:** <https://wiki.analog.com/university/courses/electronics>

A USEFUL BOOK ON EVERYTHING ABOUT GUITAR RELATED ELECTRONICS

This is the translation of an excellent book originally written in German by a Physics Professor about the 'Physics of the electric guitar'. However it goes far beyond just the physics of guitars and discussions of acoustics as it includes detailed analyses of guitar amplifiers and effects circuits as well.

- **Gitec Forum:** <http://www.gitec-forum-eng.de/the-book/>

MORE ADVANCED ELECTRONICS TUTORIALS:

Aaron Lanterman is a Professor of Electrical and Computer Engineering at Georgia Tech who teaches about audio circuit design and music technology. Aaron is also a member of some Facebook guitar pedal groups and synthesiser groups. Aaron makes the contents of his excellent lectures freely available via his website as listed below.

- **Aaron Lanterman Tutorials:** <https://www.youtube.com/user/abovenyquist>

OTHER INFORMATION

Lots of university students choose to write their theses about guitar pedal circuits. Here is just one.

Distortion Circuits: <https://scholarworks.rit.edu/cgi/viewcontent.cgi?article=11227&context=theses>

CIRCUIT SIMULATION

Before building out a circuit prototype on a breadboard and using a ‘trial and error’ approach to selecting component values to give the desired operational performance it can save a lot of time and frustration to simulate the circuit using computer software. Virtually all the simulation software available today is derived from an early software implementation known as SPICE, developed at the University of California, Berkeley in the early 1970’s. Popular free simulators include LTspice from Linear Systems (now owned by Analog Devices) and TINA-TI from Texas Instruments (TI).

LTspice download page

Visit this page to download a copy of the LTspice free simulation software.

- <https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html>

Getting started with LTspice

These videos will give you a good starting place for using circuit simulation with LTspice.

- <https://www.youtube.com/watch?v=-VPjPx2A1-M>
- <https://www.youtube.com/watch?v=JRcyHuyb1V0>

LTspice tutorial

- http://www.simonbramble.co.uk/lt_spice/ltspice_lt_spice.htm

GUITAR PEDAL SCHEMATICS:

The following sites have a large number of schematics of guitar pedal circuits and other related circuits.

- **Effects Heaven:** <https://schematichaven.net/effects.html>
- **Experimentalists Anonymous:** <http://experimentalistsanonymous.com/>
- **Index of Schematics:** <http://schems.com/Schematics/>
- **Dirk Hendrik:** <http://www.dirk-hendrik.com/>

EXPLANATIONS AND ANALYSIS OF PEDAL CIRCUITS:

All of these sites have useful explanations of how the electronics used in guitar pedals work.

- **GeoFex:** <http://www.geofex.com>
- **All About Circuits:** <https://www.allaboutcircuits.com>
- **DIY Audio Circuits:** <http://www.diyaudiocircuits.com>
- **All Transistors:** <https://alltransistors.com>
- **ElectroSmash:** <https://www.electrosmash.com>
- **Jack Orman’s Muzique:** <http://www.muzique.com>
- **Runoffgroove:** <http://www.runoffgroove.com/articles.html>
- **Fetzer Valve Discussion and Calculator:** <http://www.runoffgroove.com/fetzervalue.html>
- **Gitec Forum:** <http://www.gitec-forum-eng.de/the-book/> (*A gold mine of info about guitars, amps and effects*)

GETTING STARTED WITH ELECTRONICS FOR GUITAR PEDALS:

- **Schematic Symbols:** <https://www.electronics-tutorials.ws/resources/basic-schematic-symbols.html>
- **Build Your First Effect:** <https://www.coda-effects.com/2018/06/how-to-build-your-first-diy-guitar.html>
- **Building Prototypes:** <https://www.coda-effects.com/2019/05/tutorial-how-to-prototype-with.html>
- **All About Capacitors:** <https://www.coda-effects.com/2020/01/all-you-need-to-know-about-capacitors.html>
- **Pedal Effect Circuit Design:** <https://www.edn.com/pedal-effect-circuit-design-getting-started/>
- **Build Your Own Effect:** <https://humbuckersoup.com/build-your-own-effects/build-your-own-effects/>
- **Distortion Pedal Analysis:** https://www.neatcircuits.com/doctor_pedal.htm
- **KOT Analysis:** <https://ccrma.stanford.edu/~kaichieh/KingOfTone.pdf>
- **Design Your Distortion:** <http://www.generalguitargadgets.com/how-to-build-it/technical-help/articles/design-distortion/>

YOUTUBE VIDEOS ON GETTING STARTED WITH PEDAL BUILDING:

- **Simple Explanation of Components:** <https://www.youtube.com/watch?v=6Maq5IyHSuc>
- **Identifying Electronic Symbols and Reading a Schematic Diagram:**
 - https://www.youtube.com/watch?v=_HZ-EQ8Hc8E
 - https://www.youtube.com/watch?v=9cps7Q_IrX0
 - <https://www.youtube.com/watch?v=pmApobc3W1U>
 - <https://www.youtube.com/watch?v=-dzHDgJVJh4>
 - <https://www.youtube.com/watch?v=D11gFBNa0Ik>
- **How to Solder:** <https://www.youtube.com/watch?v=Qps9woUGkvI>
- **More about soldering:** <https://www.youtube.com/watch?v=Tf2vxwm52fU>
- **Where to Start:** <https://www.youtube.com/watch?v=gD7Mmzz2vNs>
- **Pedal Hardware:** <https://www.youtube.com/watch?v=qW9no1LK9-8>
- **Build a Guitar Pedal in 10 Minutes:** https://www.youtube.com/watch?v=Rv5iQ_aenX8
- **Building Tips:** https://www.youtube.com/watch?v=vkecebK_410
- **How to Start Building Guitar Pedals:** https://www.youtube.com/watch?v=k08eUFK_gNM
- **Choosing What Components to Use:** <https://www.youtube.com/watch?v=hzXTNTqSzaQ>
- **All About Resistors:** <https://www.youtube.com/watch?v=n1hj4GRPn24>
- **What Value Resistors and Capacitors to Stock Up On:**
https://www.youtube.com/watch?v=45yMyHe_7p0
- **What Capacitors and Diodes to Stock Up On:**
https://www.youtube.com/watch?v=VEumC_MHQx8
- **Capacitor Physical Sizes:** <https://www.youtube.com/watch?v=CQBtLax7aM0>
- **Capacitor Ratings in Guitar Pedals:** <https://www.youtube.com/watch?v=qoZuj1LTmk0>
- **How Tone Control Circuits in Pedals Work:** <https://www.youtube.com/watch?v=1klj0AimKys>
- **Inductors Explained:** <https://www.youtube.com/watch?v=KSylo01n5FY>
- **Capacitors Explained:** <https://www.youtube.com/watch?v=X4EUwTwZ110>
- **How Transistors Work:** <https://www.youtube.com/watch?v=7ukDKVHnac4>
- **What Capacitors to Use:** <https://www.youtube.com/watch?v=67M7fsbLUIU>
- **Designing an Overdrive Pedal:** <https://www.youtube.com/watch?v=F-WHBgIowmU>
- **Playlist of Guitar Pedal Tutorials:**
<https://www.youtube.com/playlist?list=PLA9F39CBD2060BBF2>

ELECTRONICS TUTORIALS VIDEOS:

These are a few useful tutorials for beginners

- **DC Analysis:** <https://www.youtube.com/watch?v=sqxzQkAdJm0>
- **Operational Amplifiers:** <https://www.youtube.com/watch?v=gzb5Bw3Wusc>
- **Using an Oscilloscope:** <https://www.youtube.com/watch?v=u4zyptPLIJI>

The common emitter configuration is the most common type of solid state circuit used for amplification and creating distortion in guitar pedals. The following tutorials describe how it works and how to bias the transistors.

- **Common Emitter Transistor Amplifier Circuits and Biasing:**
<https://www.youtube.com/watch?v=IkabRft5Sdk>
<https://www.youtube.com/watch?v=c6cmkm3UPUI>
<https://www.youtube.com/watch?v=VWY2WQcKJgk>

Field effect transistors such as JFETs are used in a lot of guitar pedals as buffers and to produce amplification with tube like second harmonic distortion. Although they are quite common, they differ from bipolar transistors (BJTs) in many different ways and require a lot more knowledge to use correctly. This tutorial should help explain the basics of using them.

- **FET Tutorial:** <https://www.youtube.com/watch?v=oambDFa0Pr8>