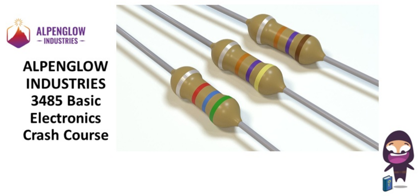
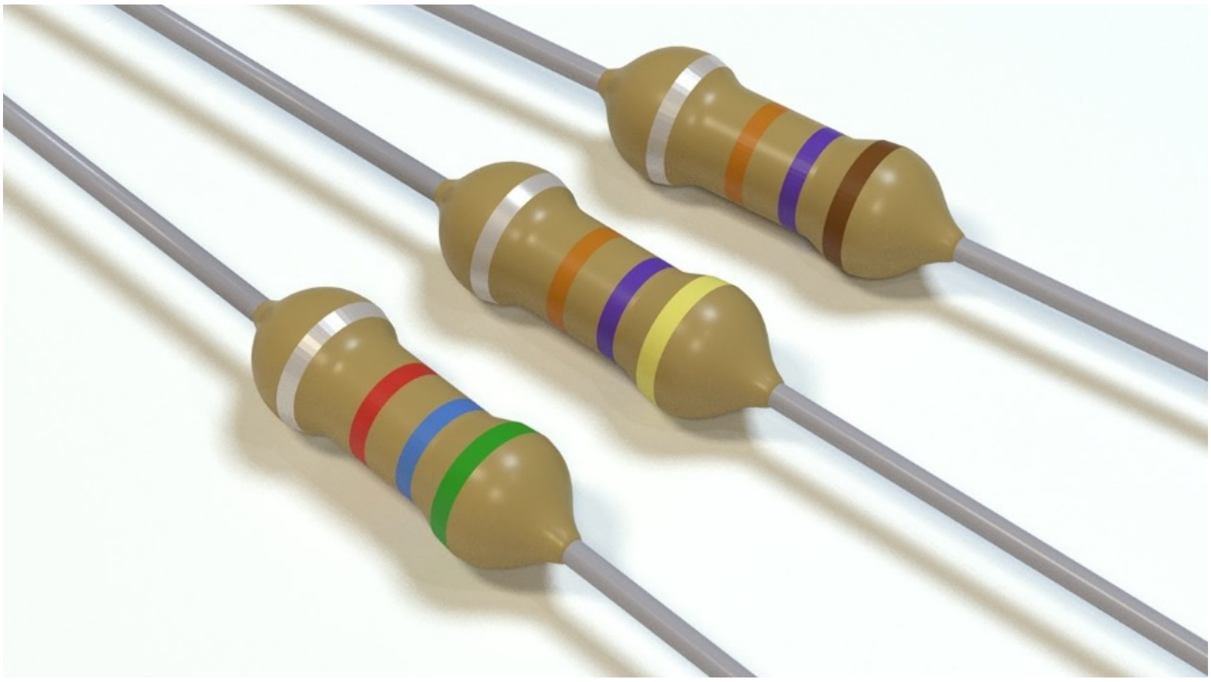


ALPENGLOW INDUSTRIES 3485 Basic Electronics Crash Course Instructions

Contents

ALPENGLOW INDUSTRIES

ALPENGLOW INDUSTRIES 3485 Basic Electronics Crash Course



Product Information

Specifications

- Manufacturer: Alpenglow Industries
- Product Name: Basic Electronics Crash Course
- Address: 3485 Sacramento Dr Ste F, San Luis Obispo, CA 93401
- Website: **www.alpenglowindustries.com**
- Instagram: **@alpenglowind**
- Mastodon: @alpenglow@mstdn.social

Product Usage Instructions

- **What is a Circuit?**
  A circuit is a loop of components through which current flows.
- **Current and Voltage**
  Current and Voltage are two basic and measurable properties of circuits.
- **Schematics**
  Schematics are symbolic drawings of circuits, arranged in a loop to visualize current flow and circuit operation for better understanding.
- **LEDs! (and Diodes)**
  LEDs are light-emitting diodes that can emit different colors based on the current levels. They can be analog or addressable LEDs
- **Using a Digital Multimeter (aka DMM)**
  DMMs allow you to measure voltage, current, resistance, and continuity, among other functions.
- **Parallel vs Series**
  Understand the difference between parallel and series connections in circuits.
- **Transistors**
  Learn about transistors and their role in electronic circuits.

FAQ

- **What are the basic functions of a multimeter?**
  A multimeter can measure voltage, current, resistance, continuity, and some models can detect live high voltage without contact, measure capacitance, and frequency.
- **What is the difference between analog and digital signals?**
  Analog signals are continuous and vary in a smooth manner, while digital signals are discrete and have specific values at specific intervals.
- **How do LEDs create different colors?**
  LEDs create different colors by varying the current levels to the individual red, green, and blue pins. Addressable LEDs have a processor inside that receives signals to change colors.

3485 Sacramento Dr Ste F
San Luis Obispo, CA 93401
www.alpenglowindustries.com
instagram: @alpenglowind
mastodon: @alpenglow@mstdn.social

Basic Electronics Crash Course

What is a Circuit?
A circuit is a loop of components, around which current flows

- Electricity flows from positive to negative in engineering-land because some dude said so
- An open circuit has a break in the middle – no current flows
- A closed circuit is complete – current flows in a circle
- A short circuit is when current is re-routed around a component – usually this is an unintended mistake and causes some magic smoke to be let out. But it can be a purposeful part of a circuit's design – for example, a switch creates a short between two wires and turns a circuit on.

Current and Voltage
Two basic and measurable properties of circuits

- Current – the amount of "juice" flowing, represented as I, measured in Amps
- Voltage – the level of the "juice", represented as V, measured in volts
- The power a circuit consumes is current * voltage!
- ? = ??
- Power is represented as P, measured in watts

Resistors
Resistors resist electrical power – they help control the amount of current flowing, and cause a voltage drop between each end. This power loss is radiated as heat! Resistors are little heaters!

- Resistance is represented as R, measured in ohms
- The voltage dropped across a resistor is current * resistance
- ? = ??
- which can be re-written as:

- ? =?/ ?
- Everything has resistance – human bodies have high resistance. Wires and batteries have low resistance.
- Resistors can also be used to "tie" signals high or low in digital circuits – they can be used to set a voltage level rather than control current.
- Many materials will change resistance in response to something – temperature, light, pressure. Many things we can "sensors" are really resistors that respond to these changes, which enable us to sense things and gather information about the world around us.

Schematics
Schematics are symbolic drawings of circuits, generally arranged in a loop so you can visualize the current flowing, and other things that are happening. It's supposed to make the circuit easier to understand.

- Each component has a symbol, a reference designator, and a number. This helps you correlate it to a physical component and put the right thing in the right spot.
- Signals can be named for clarity (GND, 5V)
- Assume that any signal with the same name is wired (or "tied") together – all GND symbols will be connected in the physical circuit, all 5V symbols will be connected. Lines connecting them can be omitted from the schematic for clarity. Other signals with the same name will also be connected on more complex schematics.

LEDs! (and Diodes)
LEDs are light-emitting diodes.

- Diodes allow current to flow in one direction, but block current from flowing in the opposite direction.
- This makes LEDs (and all single diodes) directional! They will create a closed circuit if placed in one direction, and an open circuit if placed in the other direction.
- Diodes have a forward voltage drop (Vf), but unlike a resistor, the voltage drop is mostly the same no matter how much current goes through them.
- The Vf of an LED is different for each color
- LED brightness is proportional to current – the more current they're driven with, the brighter they are!
- Too much current will cause your LED to pop. Most LEDs are nicely bright and happy with somewhere between 1mA and 10mA of current. Over 30mA and things start to get dicey.
- All colors of light can be made by mixing red, green, and blue (RGB). Multicolor LEDs have 3 tiny LEDs inside of them, and by driving the individual R, G, and B and different current levels, they create any color.
  - Multicolor LEDs can be a simple analog component, an LED with one pin each for red, green, and blue. The amount of current given to each pin determines the color. These just need 3 resistors and a power source to work.
  - Multicolor LEDs can also be a smart digital component where there's a tiny processor inside of them and they take a communications signal telling them what color to be. These are called "addressable LEDs" and you need a microprocessor to get them to work. They are extremely common these days, anything you've seen where the LEDs have color-changing patterns are typically made with addressable LEDs.
- LEDs of any sort are the very best electronics component ever. The inductors are pretty cool too.

Using a Digital Multimeter (aka DMM)
Multimeters allow you to measure voltage, current, resistance, and continuity. Some also help you determine the directionality of a diode or LED, some can detect live high voltage without making contact, some can also measure

capacitance and frequency.

- Black lead goes into COM
- Red lead typically goes into the hole marked "V" for any measurement other than current. Usually the symbol for each measurement is above this hole, but not always.
- NO POWER should be applied to your circuit when you measure:
    - Continuity
    - Resistance
    - Capacitance
    - Diode direction
- Resistance and capacitance are best measured out-of-circuit – if measured in the circuit, other resistors, capacitors, and components connected to the same points can change the perceived value.
- Power should be applied to your circuit to measure:
    - Voltage
    - Current
    - Frequency
- To measure current, your multimeter becomes part of the circuit, so that all current passes through it. This means you need a break in your circuit so that you can insert your multimeter into it. Change the red lead to the one marked "A" and be sure the current you want to measure is under the current rating of your multimeter! Most multimeters have fuses, but it's a pain to blow one and have to stop and change it out. And find that spare that you're sure you put somewhere. Always immediately change the red lead back to V when you are done measuring current. If you forget, when you go back to measuring voltage, you'll short out your circuit!
- Be sure you are on the DC voltage or current setting to measure DC circuits, and the AC voltage or current setting to measure AC circuits! More on AC and DC below.

Parallel vs Series

- Components in series with each other have the same current passing through them
- For components in parallel, the current is split between them. How much goes to each component depends on its resistance, it won't be an equal split unless the resistance is equal.
- Batteries in series add voltage to each other, but the capacity is the same as the capacity of a single cell.
- Batteries in parallel add capacity, but the voltage is the same as a single cell.
- Battery capacity is measured in Amp-hours. 1Ah means the battery can source 1A of current for 1 hour. Or 0.5A of current for 2 hours. Or 100 mA of current for 10 hours.

Inductors
Inductors bridge the gap between a stationary circuit and the physical world – they make things move!

- Inductance is measured in henries (H).
- Electricity flowing in a coiled loop creates a magnetic field
- This electromagnet can be turned on and off by opening and closing your circuit (current flowing, current not flowing)
- Magnetic material reacts to magnets, causing things to move
- Solenoids – move a shaft up and down inside a coil. Short, quick movements like car door locks, credit knocker

on a pinball machine

- Relays – a magnetically-actuated switch that can open and close. Used to switch a high voltage with a low voltage signal, like a wall outlet you control with a timer or phone app.
- Electric Motors – make a shaft spin by creating a rotating magnetic field. Lots of different types of motors – “brushed DC” motors take a constant voltage and create an electromagnet on the inside of the motor (the spinning shaft part) with fixed magnets on the outside (stationary part) of the motor. AC synchronous motors take a varying voltage and create an electromagnet with varying field on the outside (stationary part) with fixed magnets on the inside (spinning shaft part). Brushless DC motors are basically AC motors, they just have extra electronics that convert the steady DC voltage to an AC voltage.
- Inductors do other things not involving motion too, but it all comes back to creating that magnetic field.

DC and AC
It’s confusing – it stands for either Direct Current or Alternating Current, but we mostly use it to describe voltage (which also is either direct and at a steady/constant level, or alternating in a sine wave between + and -).

- DC, direct current – The voltage and current supplied are constant.
- AC, alternating current – the voltage continuously varies between + and – and the current switches direction. WTF why? Because the electricity was generated by an alternator, which is just a backwards motor. The magnets rotate, causing an electric field to be induced in the coiled wires. This is why all wall power is AC – it’s always generated by a spinning shaft. Think of turbines in dams, the shaft in a windmill, even with nuclear power plants the output is a spinning shaft. Solar power is different – it generates a DC voltage across the solar cell.

Analog vs Digital
More than just old skool vs new skool or who’s the OG hipster (analog!). It describes what signals look like.

- Analog signals can be at any level between 2 points. So a 5V analog signal can be at 2.43V, 3.72V, 0V, 5V, or 0.82V. A sine wave is an analog signal.
- Digital signals can be at either point, but not in between. A 5V digital signal can be either at 5V or 0V. A square wave is a digital signal.
- Digital signals are used in wired communications – like USB or HDMI, or whatever the hell Lightning is.
- Analog signals are used in audio and radio communications – like the AM/FM radio in a car, music, our voices.

Transistors

- Can act as amplifiers – a small bit of current into or out of one pin allows a bigger current to pass between two other pins. The output current is proportional to the input, the more you “pull” on the input, the more is “pushed” through the output.
- Can act as switches – a small voltage on one pin connects the two other pins together. They are either on or off, connected or disconnected.
- No moving parts! It’s all atomic-level electron attraction and repulsion, the gist is that they don’t wear out, and they can be turned on and off super fast.
- BJTs – bipolar junction transistors – are generally used as amplifiers in analog applications. There are 2 types called NPN and PNP which either source or sink current to turn on, and are generally used on either the negative side (NPN) or positive side (PNP) of a circuit. Lots of audio amplifiers, filters, and effects pedals use

BJT transistors.

- FETs – field effect transistors – are generally used like switches in digital applications. There are two types – N channel switches negative voltages (or GND), P channel switches positive voltages. They can be used to switch power on and off to different components, or change the direction of spin of motors by electrically switching the positive and negative terminals.

Chips or Integrated Circuits (ICs)

- A collection of a bunch of microscopic components, usually transistors, resistors, and capacitors that are in one body and configured for a specific purpose.
- Have a power and a GND pin and at least one output signal
- Can be programmable or not
- Can be analog or digital
- Can be big or small
- Can require external components to work
- Can have 3 legs/leads or hundreds.
- May have communications pins to talk to other chips
- Examples: the UM66T music chip, the processor in your computer, a voltage converter, an addressable LED, a humidity sensor, the microprocessor in an Arduino, a USB communications IC, a camera IC.

Microprocessors

Programmable chips that make stuff happen!

- Tiny brains
- You program them to do a specific thing – in other words, they follow a specific set of instructions that you write for them.
- They have digital inputs and outputs – can sense whether something is high or low on a pin (input), and then create a high or low on a different pin (output).
- Most have analog inputs – can tell what voltage the pin is at. They aren't truly analog – they will round to the nearest bit. How much voltage that is depends on their operating voltage and the number of bit in their analog – to – digital converter (ADC).
- Most have communications pins that are specially configured for particular protocols. Ex: USB, serial, SPI, I2C. They communicate with other chips (or with your computer) using these protocols.
- You can measure stuff, turn things on or off, sense when something else is on or off, tell another chip to do a thing, and lots of other stuff. Your imagination is what turns all of those possibilities into a specific tool, machine, product, or piece of art!

Capacitors
Capacitors are like tiny batteries.

- Capacitance is measured in farads (F).
- Often abbreviated to "cap".
- Many types of materials used to make capacitors and some have polarity! Electrolytic and tantalum capacitors

can explode, catch on fire, or otherwise be damaged when opposite voltage is applied. Ceramic capacitors are great general-purpose capacitors that do not have polarity.

- Capacitors can provide a super short burst of current – used to quiet down “noisy” power supplies, used near power pins on ICs which tend to demand quick bursts of current that can otherwise bog down a battery (the internal resistance of the battery causes the voltage to briefly drop when current is suddenly demanded, this introduces “noise”).
- They take a short time to charge, can be used to cause a delay
- Charging and discharging capability can be used to create a signal that oscillates
- Used inside of microprocessors to measure analog voltages (like a mini voltmeter!)
- Will block DC voltages but pass AC ones – used inline to “decouple” and pass audio signals in and out of circuits that are running at different voltages

Oscilloscopes

Cool name for a great tool that makes you feel like a mad scientist. Oscilloscopes allow you to see your electronic signals, or what’s happening inside your circuit.

- Often abbreviated to “scope”
- Graph voltage (vertical axis) over time (horizontal axis)
- Can zoom way into super tiny and fast timescales – nanoseconds!
- Can zoom way into super tiny voltages – millivolts!
- Lots of knobs for twiddling – each oscilloscope manufacturer has a different style and layout, people generally tend to settle on one they like and stick to it.
- Mostly useful for digital communication signals, audio, looking at noise on a power line, and other things that change rapidly in 1 second or less. To just measure voltage, a multimeter is usually fine and easier.

Metric Prefixes and Suffixes

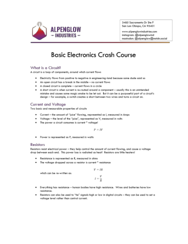
001						
Mega	001					
M	kilo	001.				
X106	k		001			
	X103		milli	001		
			m	micro	001	
			X10-3	µ or u	nano	001
				X10-6	n	pico
		Base Units			X10-9	p
		Ex: g, m, V				X10-12

Ex:
0.1V = 100 mV
35 uF = 0.000035 F 2.37 kohm = 2370 ohms 30 mW = 0.03 W

Oddities

- A capacitor in the picofarad range is shortened to “puff”. Ex: 100 pF = 100 “puff”
- The nano range is often skipped over in capacitance in the US. For whatever reason, a 47 nF capacitor will more often be referred to as 0.047 uF or 47,000 pF.
- The “ohms” part is often left off of resistance when talking about it. A “10k” resistor is 10k ohms. Similarly, Megaohms is often shortened to “Meg” or “Megs”.

Documents / Resources

 Basic Electronics Crash Course	**ALPENGLOW INDUSTRIES 3485 Basic Electronics Crash Course** [pdf] Instructions 3485 Basic Electronics Crash Course, 3485, Basic Electronics Crash Course, Electronics Crash Course, Crash Course, Course

References

- Alpenglow Industries
- User Manual