CONTENTS

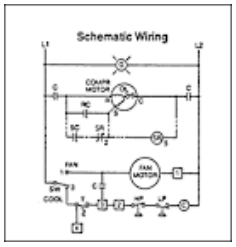
I have written a book “Electrical Plan Reading” which address’s symbols, abbrevations, floor plans, riser diagrams, etc.

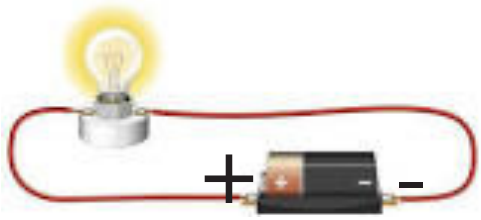
I have also written a book “Control Circuits”, a basic manual on controls for the electrician. Control is a broad term that means anything from a light switch to a complex system with relays, timers, etc.

Electrical diagrams are the plans and drawings you will use throughout your electrical career.

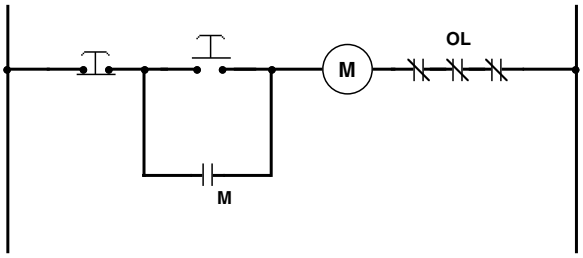
The plans are the roadmap of the work to be done. Persons unfamiliar with the symbols and specifications find the plans difficult to follow. An experienced electrician will actually make his own plans for certain jobs.

There are three types of diagrams the electrician must be able to read: (1) schematic diagrams, (2) pictorial diagrams, and (3) electrical blue prints.



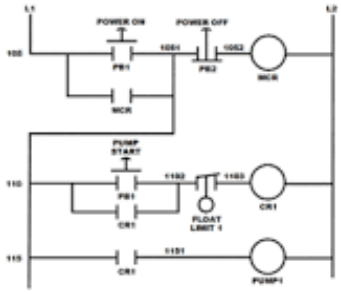


Schematic diagrams are useful for circuit operation or discussing theory, but they are not very useful in building construction. Schematic diagrams won't show the physical layout or location of the components required in construction.



Schematics are used in control circuits. They are read from left to right, from top to bottom.

A schematic (ladder diagram) gives you a roadmap for understanding how a system is designed and laid out — making the process of diagnosing a problem much easier.



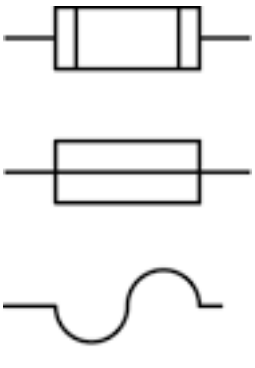
Think of a ladder's two rails as being an electrical supply (hot and ground) going into a system. The rungs of the ladder represent loads, such as motors, the compressor, switches, solenoids and other components that either interrupt or perform a function in the circuit.

Electrical schematics have an unfair reputation for being hard to understand. In fact, once you learn what each symbol in the schematics represents, you'll be able to easily read the manufacturer's diagrams, troubleshoot issues quickly and even create your own diagrams.

Schematics have two fundamental purposes. First, they communicate design intent. To someone skilled in the art of electrical design, schematics should clearly convey the intent of the design. And second, they exist to direct the layout.

Wiring diagrams, using lines and standardized symbols and abbreviations, are used in tracing circuits and trouble shooting.

Reading schematics isn't that hard when you know what all the symbols mean.



FUSE

Standardization of abbreviations and symbols is not universal. Some of the abbreviations and symbols vary in real-world documentation, depending upon the person making the drawing or designing the circuit.

You'll find that different manufacturers use different styles for their diagrams, but some features are consistent, such as:

• Symbols for switches are standardized

• Operating controls such as relays and thermostats are usually depicted in the open position

•Safety controls (overloads, high pressure/low pressure, limit switches) are usually depicted in the closed position

• Relay contacts are depicted as if the relay coil is de-energized.

BOM (Bill of Materials)

The other important output of a schematic is a bill of materials or BOM. The BOM output is a spreadsheet or database that matches every REFDES (Reference Designation) in the schematic with a physical component and a part number.

There are a variety of formats for the BOM output, depending on how sophisticated your schematic and parts database are, and what kind of output you want. At the simplest end of the spectrum, you may have a list of reference designators, each with a manufacturer's part number.

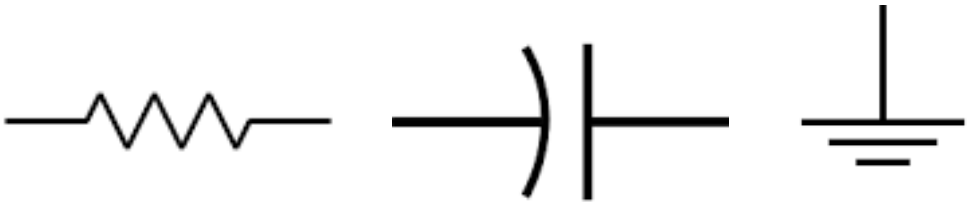
A good schematic will have a **legend** that shows pictures of the symbols used and details.

A legend simply put is a chart with all of the symbols used in an individual diagram.

The legend on a drawing should show any nonstandard symbols and their meanings.

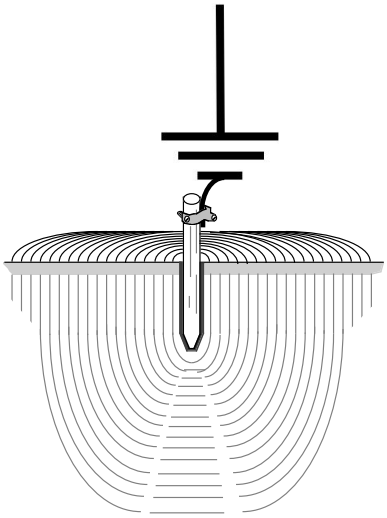
Electrical symbols are a graphical representation of basic electrical and electronic devices or components. These symbols are used in circuit and electrical diagrams to recognize a component. It is also called a schematic symbol. Each component has typical functionality according to its operational characteristics.

SYMBOLS

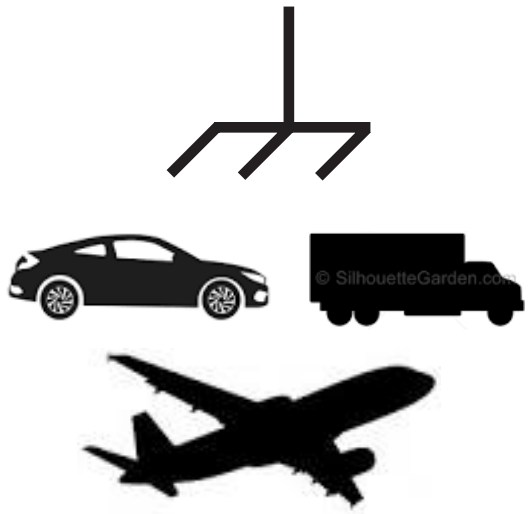


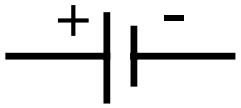
Resistor Capacitor Ground

GROUND TO EARTH



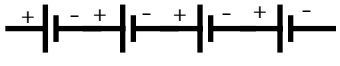
CHASSIS GROUND





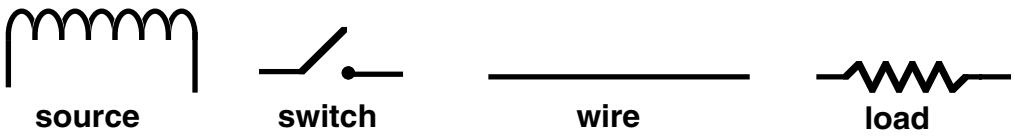
A battery cell produces approximately 1.5 volts DC.

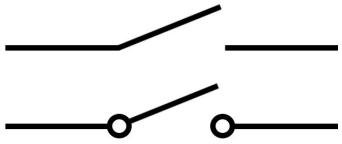
A self-contained multicell battery.



4 cells @ 1.5 volts each connected in series = 6 volt battery.

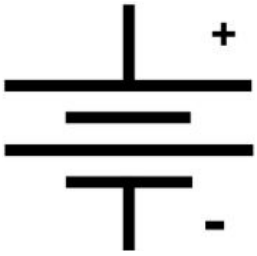
These are some standard symbols to represent the components in a circuit. This chapter gives some of the frequently used symbols.





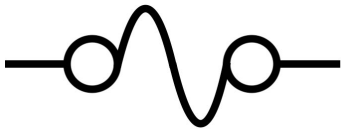
Switch symbols

Switches are usually shown with a schematic symbol that represents the type of switch and the number of poles/throws and pins.
Switches are identified in schematics with a reference designator starting with the letters “SW”.



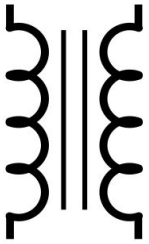
Battery symbol

Batteries are shown with a schematic symbol that has a long line and a short line, together representing one battery cell. In practice, most battery schematic symbols are drawn as two cells regardless of how many cells the battery actually contains. Batteries are identified in schematics with a reference designator starting with the letter “B”.



Fuse symbol

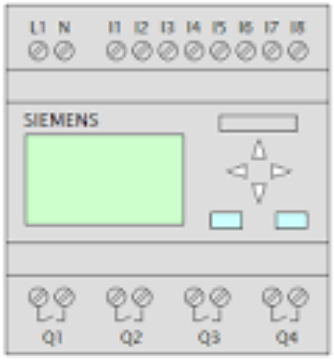
Fuses or PTCs (positive temperature coefficient devices) are circuit protection devices that “blow” (burn out) or increase resistance dramatically in the case of too much current flowing through them. Fuses are usually shown in schematics with a symbol that looks like a sideways letter “S”. Fuses are identified in schematics with a reference designator starting with the letter “F”.



Transformer symbol

Transformers are usually shown with a schematic symbol that symbolically represents how a transformer works. It looks like two parallel inductor coils with something in between them, usually a line or two. Transformers are identified in schematics with a reference designator starting with the letter “T”.

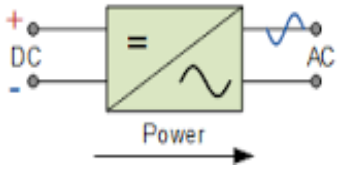
Electrical symbols are a graphical representation of basic electrical and electronic devices or components. These symbols are used in circuit and electrical diagrams to recognize a component. An electronic circuit or schematic drawing uses a wired path between electronic components to complete the circuit.



PROGRAMMABLE LOGIC CONTROLLER (PLC)

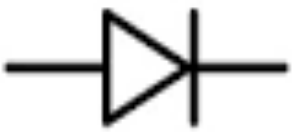
A programmable logic controller or programmable controller is an industrial computer that has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, machines, robotic devices, etc.

PLCs are complex and powerful computers. But, we can describe the function of a PLC in simple terms. The PLC takes inputs, performs logic on the inputs in the CPU and then turns on or off outputs based on that logic. The CPU monitors the status of the inputs.



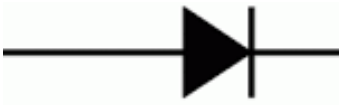
Inverter symbol

A power inverter, or inverter, is a power electronic device or circuitry that changes direct current to alternating current. The resulting AC frequency obtained depends on the particular device employed.



Rectifier symbol

A rectifier is a special type of diode that converts alternating current (AC) into direct current (DC). This is an important process, as alternating current is able to reverse direction periodically, while direct current consistently flows in a single direction, making it simple to control.



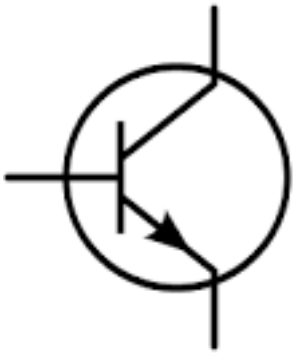
Diode

A diode is a switching device, while a rectifier is generally used for the conversion of AC voltage to DC voltage. A diode allows the flow of current only when it is forward biased. The diode blocks the reverse flow of current.

No matter what type you're dealing with or what it's used for, a diode and a rectifier are the same thing.

Dynamic braking

Dynamic braking is the use of an electric traction motor as a generator when slowing a vehicle such as an electric or diesel-electric locomotive.With dynamic braking, an IGBT (transistor) allows power to flow to a resistor, where it's dissipated as heat. Regenerative braking takes the energy generated by the motor and feeds it back to the AC power source or to a common bus, where it can be used again.



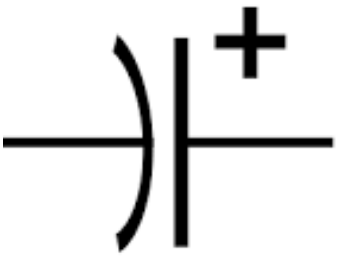
Transistor

Dynamic braking resistors are used on AC variable frequency drives (VFD's) to dissipate energy that is produced in the motor as the drive provides braking torque to stop the motor. The dynamic braking resistor is connected to the DC bus and will see voltages as high as 800 volts during braking conditions.

This transistor or DBU controls the DC link voltage by connecting the brake resistor.

Potentiometer

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat.The potentiometer is a device that limits the passage of electrical current, causing a voltage fall.



Electrolytic capacitor

They are commonly used as filtering devices in various power supplies to reduce the voltage ripple. When used in switching power supplies, they are often the critical component limiting the usable life of the power supply, so high quality capacitors are used in this application.

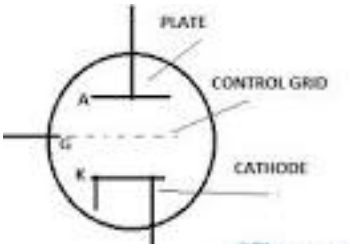
The conductivity of the electrolyte drops at low temperatures, which increases equivalent series resistance.

Thermistor

The thermistor is a solid state temperature sensing device which acts a bit like an electrical resistor but is temperature sensitive. Thermistors can be used to produce an analogue output voltage with variations in ambient temperature and as such can be referred to as a transducer.

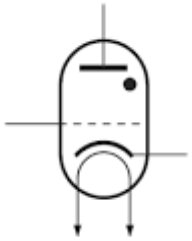
Transducer

An electrical transducer can be defined as, a transducer which gives electrical energy as an output. These transducers convert one form of energy into an electrical signal. Here one form of energy may be heat, light, or sound and the electrical signal can be frequency, current or voltage.



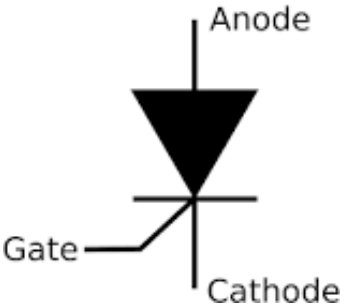
Thyratron tube

A thyratron is a type of gas-filled tube used as a high-power electrical switch and controlled rectifier. Thyratrons can handle much greater currents than similar hard-vacuum tubes. Electron multiplication occurs when the gas becomes ionized, producing a phenomenon known as Townsend discharge.



Thyratron gas

The main difference between thyristor and thyratron is that the thyristor is current controlled device while a thyratron is a voltage controlled device. The thyratron is a large tube filled with gases such as mercury, xenon, hydrogen etc. and the conduction increases due to ionization of these gases.

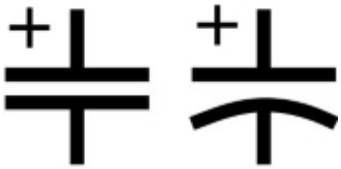


Thyristor

Thyristor are current operated devices, a small Gate current controls a larger Anode current. The thyristor acts like a rectifying diode once it is triggered “ON”. Anode current must be greater than holding current to maintain conduction. Blocks current flow when reverse biased, no matter if Gate current is applied. The primary function of a thyristor is to control electric power and current by acting as a switch. For such a small and lightweight component, it offers adequate protection to circuits with large voltages and currents (up to 6000 V, 4500 A).

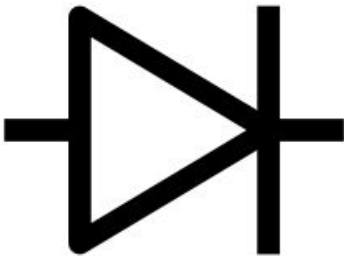
Resistors are extremely common electrical components. They are usually shown as a zigzag line.

Capacitors are also very common. They are shown as two lines separated by a gap, conveying their fundamental construction of two charged plates separated by a dielectric. The two primary capacitor symbols are non-polarized and polarized.

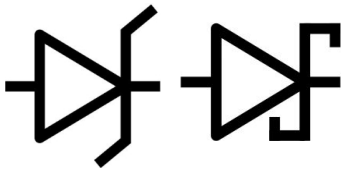


Polarized capacitors are denoted by a curved line (to indicate a negative terminal) and/or a plus sign (to indicate a positive terminal). Capacitor symbols. Shown are a non-polarized capacitor on the top left and three versions of a polarized capacitor.

Inductors, like resistors and capacitors, are fundamental passive components used in electric circuits. Inductors are shown as a series of curves representing their basic construction. Inductors are most simply constructed with a coil of wire around some core material.



Diodes are electrical components that only permit current to flow in one direction. There are a variety of diode types. Zener diodes, for example, don't allow reverse current until the diode's reverse voltage reaches a certain, defined level.



Zener diode symbol

Schottky diode symbol

Diodes are identified in schematics with a reference designator starting with the letter "D" or "Z" (for Zeners). "LED" is sometimes used for light-emitting diodes.