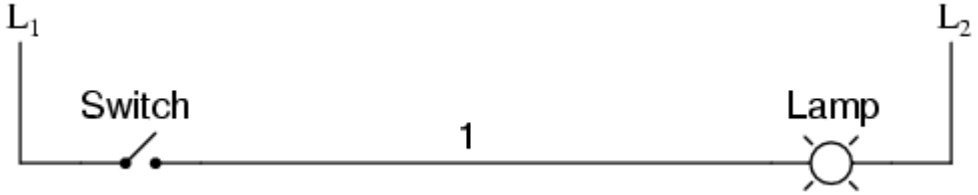
Electrical and Electronic Drawing

Ladder Diagrams

Prof. Yasser Mostafa Kadah

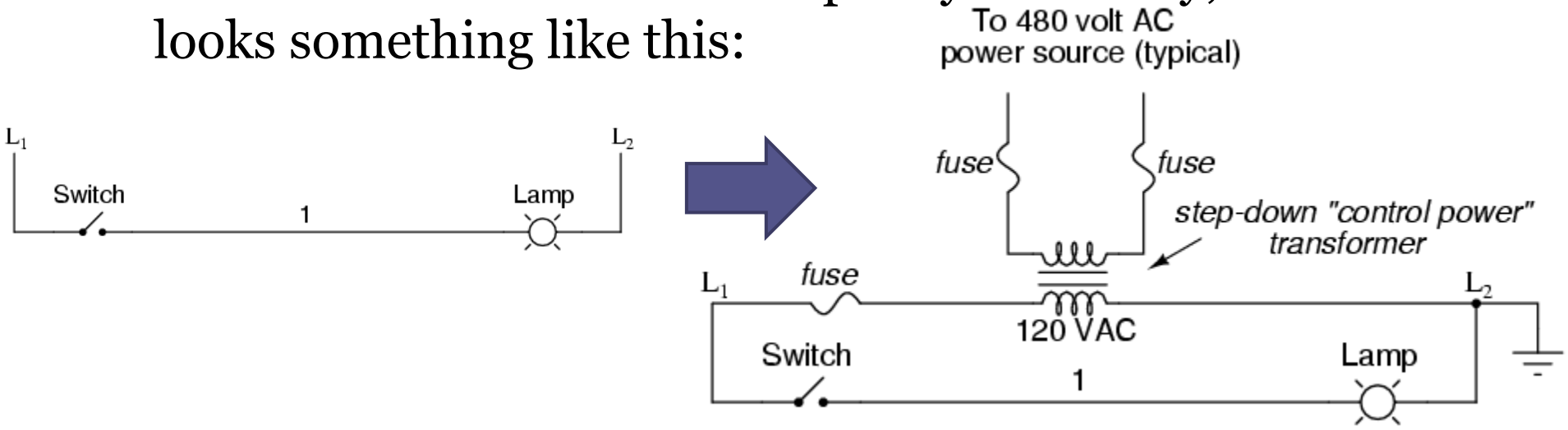
Ladder Diagram Basics

- Ladder diagrams are specialized schematics commonly used to document industrial control logic systems.
- They are called "ladder" diagrams because they resemble a ladder, with two vertical rails (supply power) and as many "rungs" (horizontal lines) as there are control circuits to represent.
- If we wanted to draw a simple ladder diagram showing a lamp that is controlled by a hand switch, it would look like this:



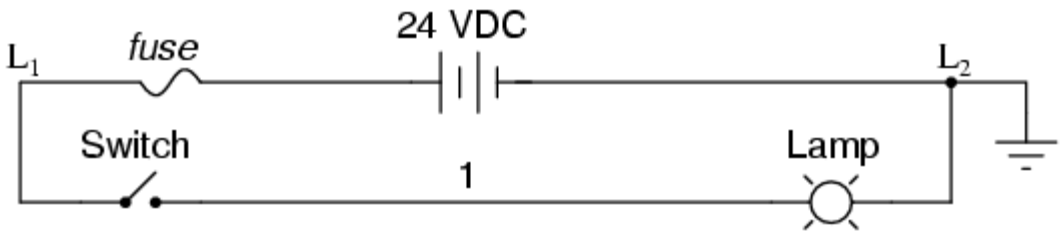
Ladder Diagram Basics

- The "L_1" and "L_2" designations refer to the two poles of a 120 VAC supply, unless otherwise noted. L_1 is the "hot" conductor, and L_2 is the grounded ("neutral") conductor.
  - These designations have nothing to do with inductors
- The actual transformer or generator supplying power to this circuit is omitted for simplicity. In reality, the circuit looks something like this:



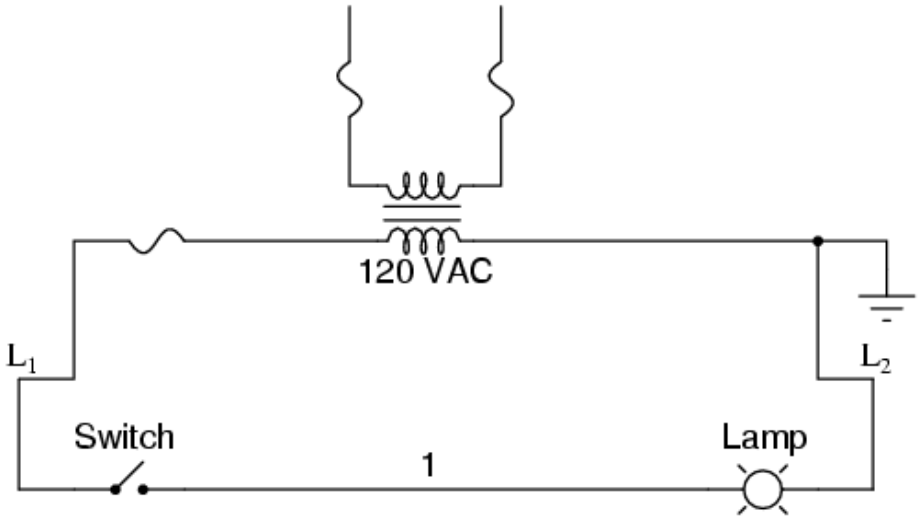
Ladder Diagram Basics

- Typically in industrial relay logic circuits, but not always, the operating voltage for the switch contacts and relay coils will be 120/240 volts AC.
- Lower voltage AC and even DC systems are sometimes built and still documented according to "ladder" diagrams as shown below.



Ladder Diagram Basics

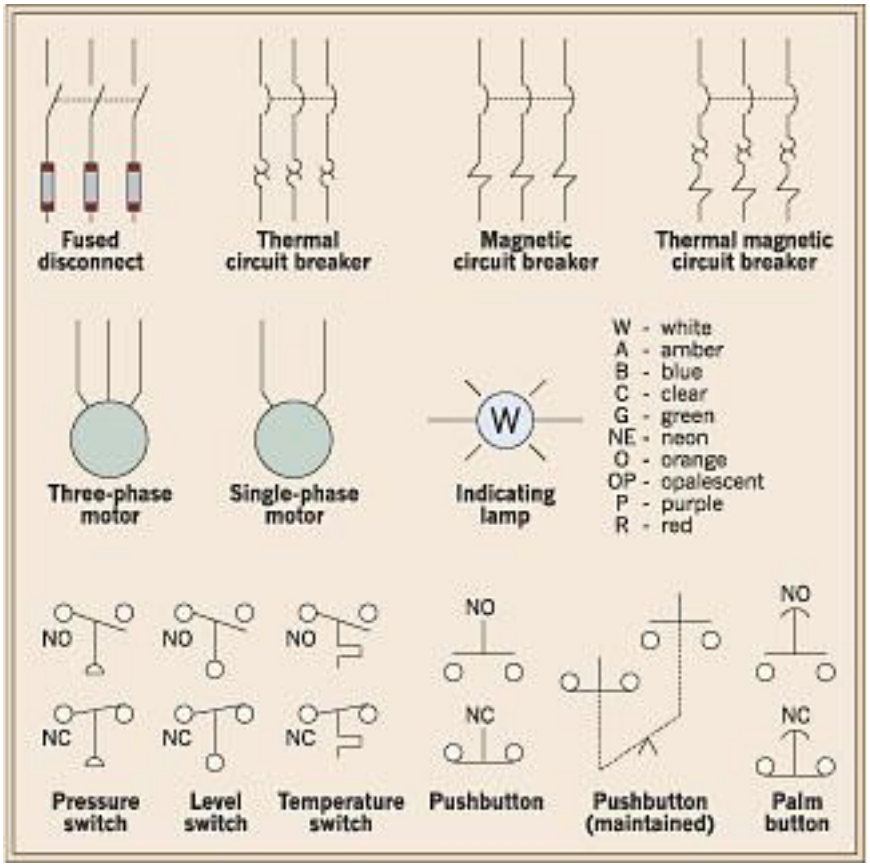
- In ladder diagrams, the load device (lamp, relay coil, solenoid coil, etc.) is almost always drawn at the right-hand side of the rung.
- While it doesn't matter electrically where the relay coil is located within the rung, it does matter which end of the ladder's power supply is grounded, for reliable operation.

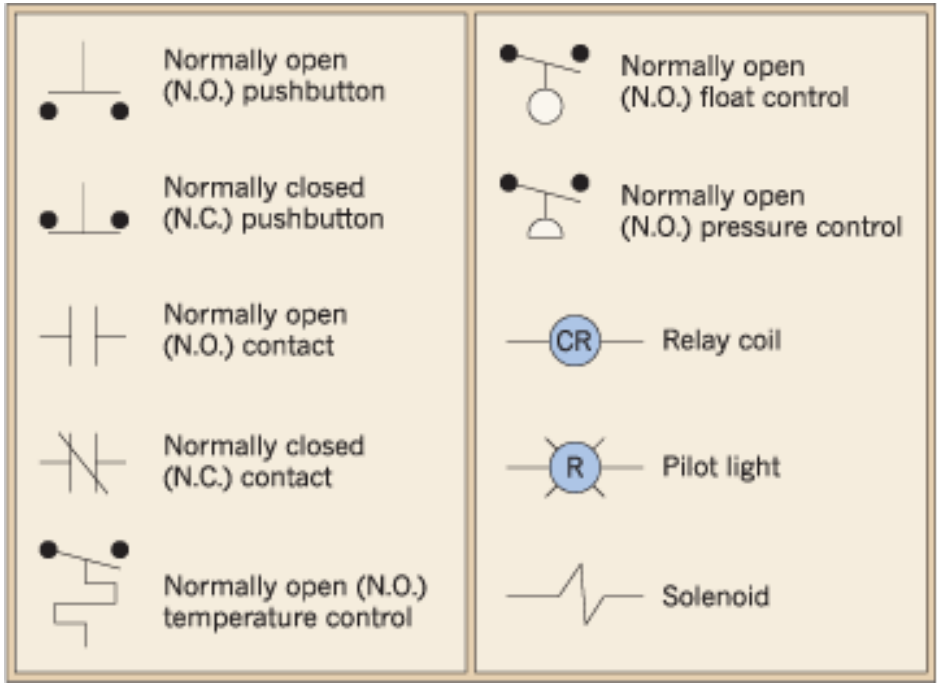


Ladder Diagram Components

- There are typically two distinct parts of a ladder drawing: power component and control component.
- Power portion consists of items such as the motor, motor starter contacts and overloads, disconnect(s), and protective devices (fuses and circuit breakers).
- Control part encompasses items that make the power components do their work.

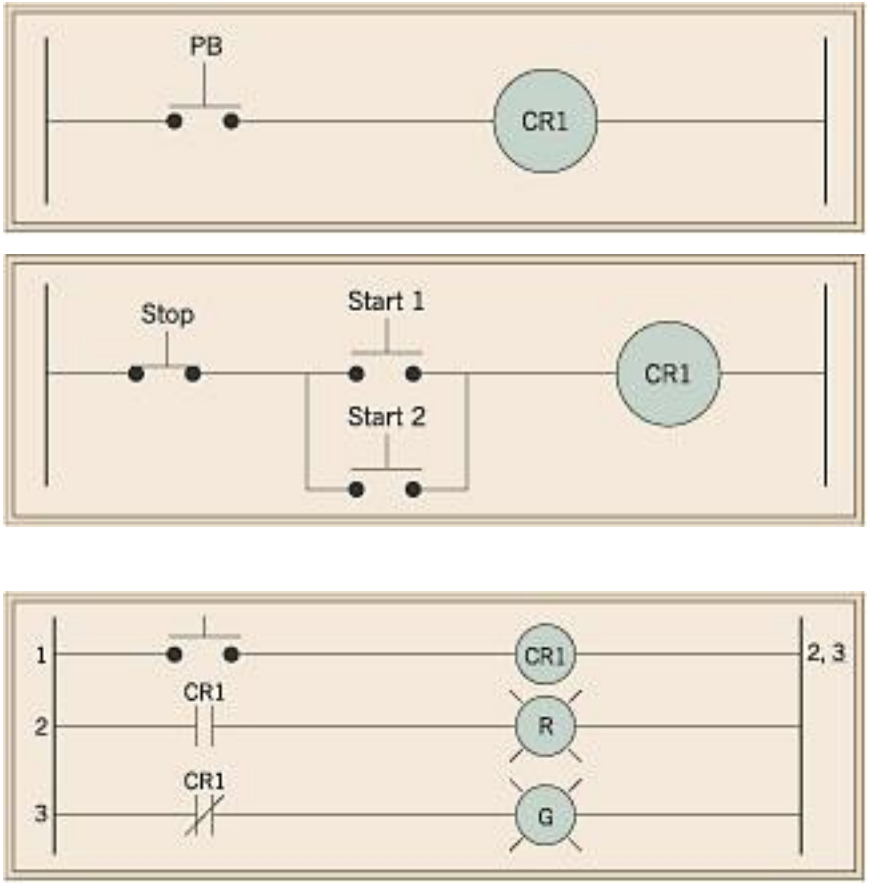
Ladder Diagram Symbols





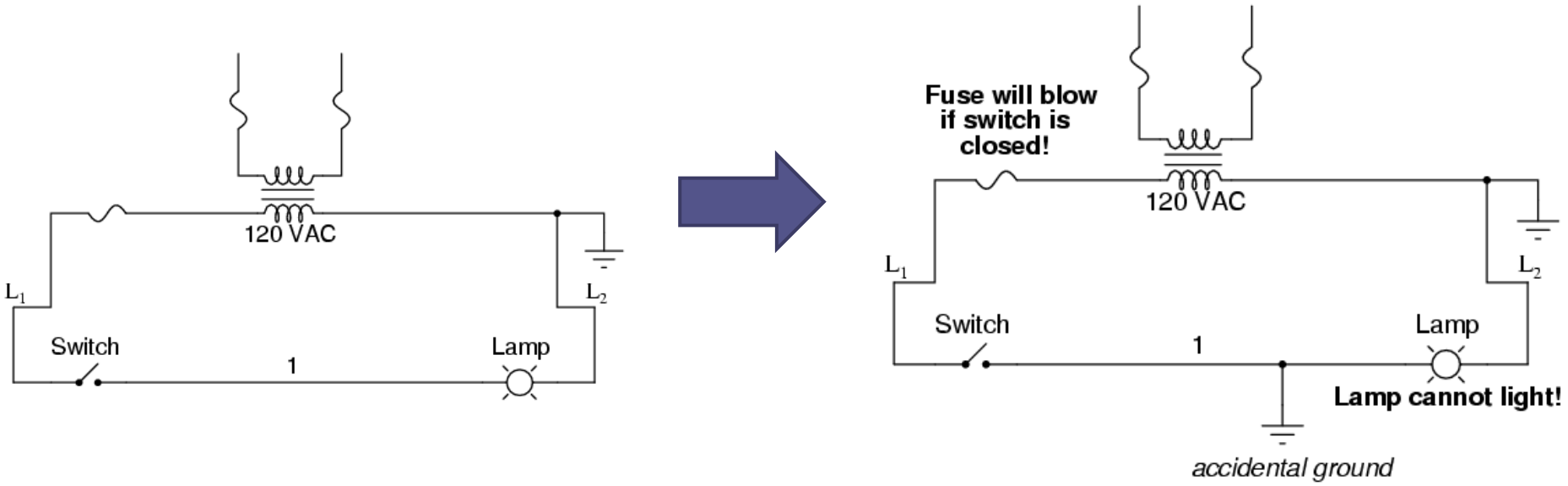
Ladder Diagram Examples

- Rungs are usually numbered on the left side of the rail
- Number on the right side of the rail references the contacts associated with the coil



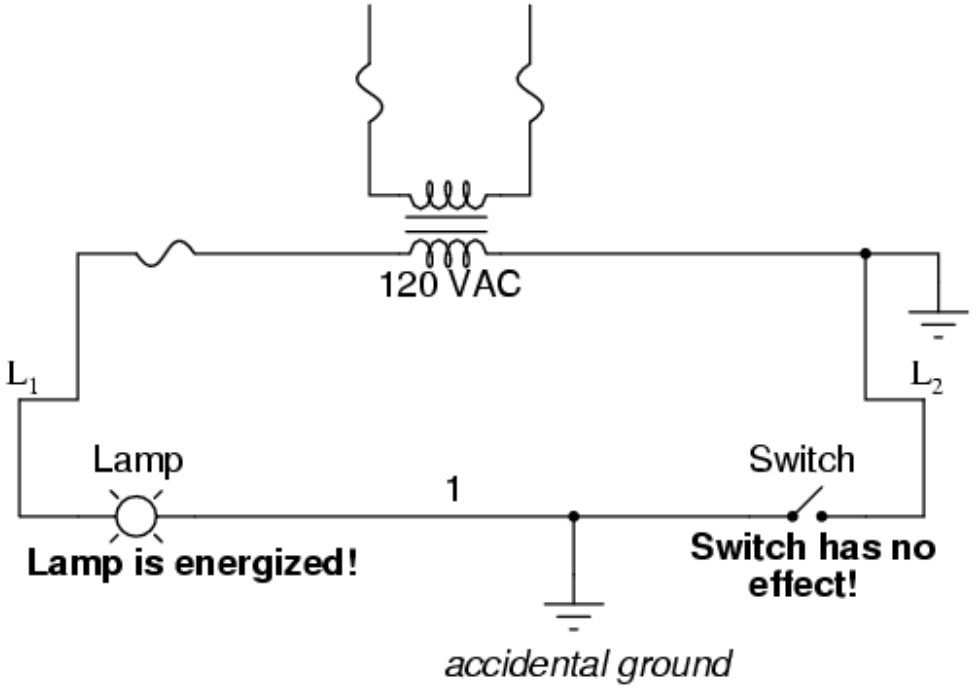
Ladder Diagram Fault Diagnosis

- Suppose that wire #1 were to accidently come in contact with ground, the insulation of that wire having been rubbed off so that the bare conductor came in contact with grounded, metal conduit.
- Our circuit would now function like this:

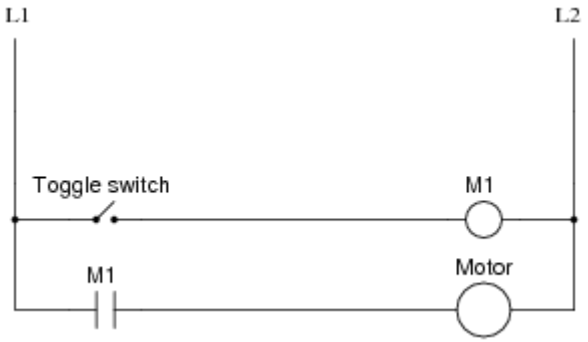


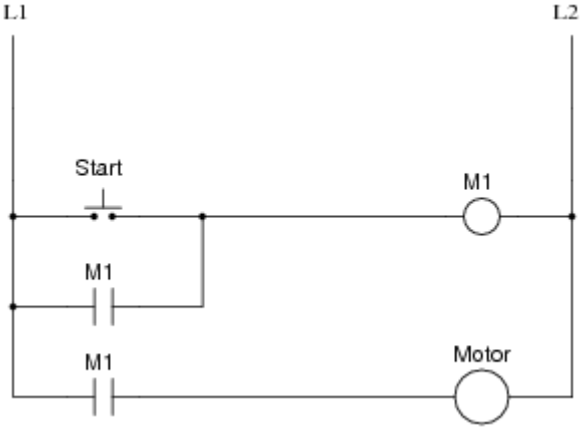
Ladder Diagram Fault Diagnosis

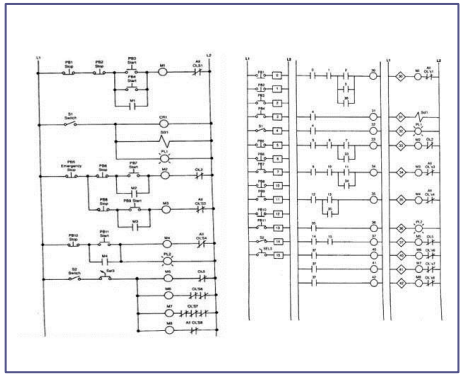
- Consider what would happen to the circuit with the same fault (wire #1 coming in contact with ground), except this time swap the positions of switch and fuse (L_2 is still grounded):
  - Load(s) must always be located nearest grounded power conductor in the ladder diagram.

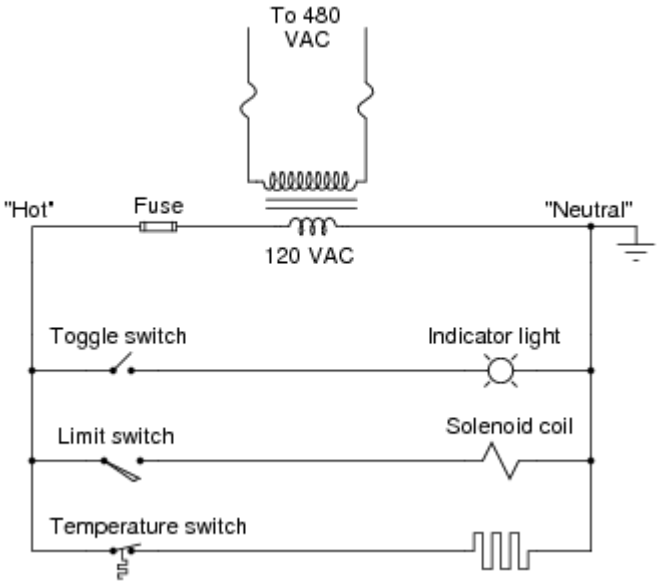


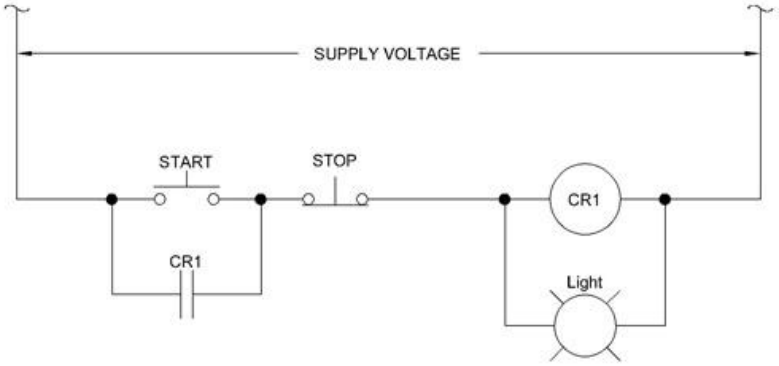
Ladder Diagram More Examples











Ladder Diagrams - Summary

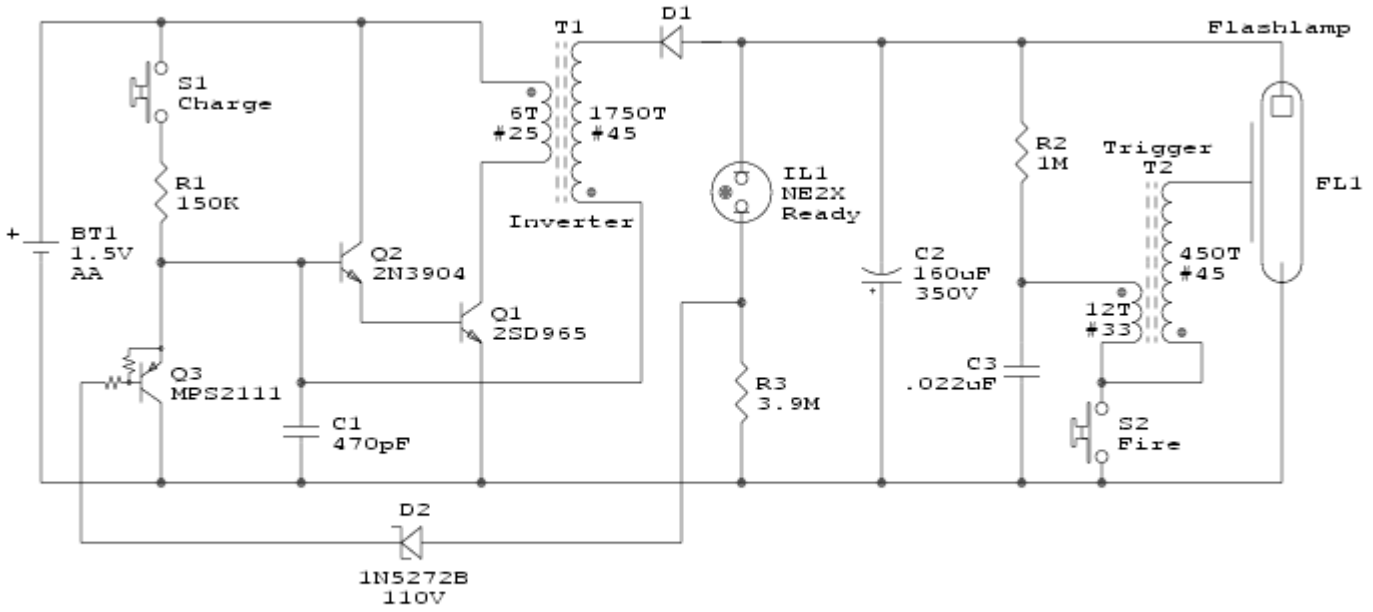
- Ladder diagrams (sometimes called "ladder logic") are a type of electrical notation and symbology frequently used to illustrate how electromechanical switches and relays are interconnected.
- The two vertical lines are called "rails" and attach to opposite poles of a power supply, usually 120/240 volts AC. L1 designates the "hot" AC wire and L2 the "neutral" (grounded) conductor.
- Horizontal lines in a ladder diagram are called "rungs," each one representing a unique parallel circuit branch between the poles of the power supply.
- Typically, wires in control systems are marked with numbers and/or letters for identification. The rule is, all permanently connected (electrically common) points must bear the same label.

Assignments

- Draw the ladder diagram of a practical electrical installation or device of your choice. Examples include wiring at your house, wiring of an air-conditioning device, etc.

Exercise Problems

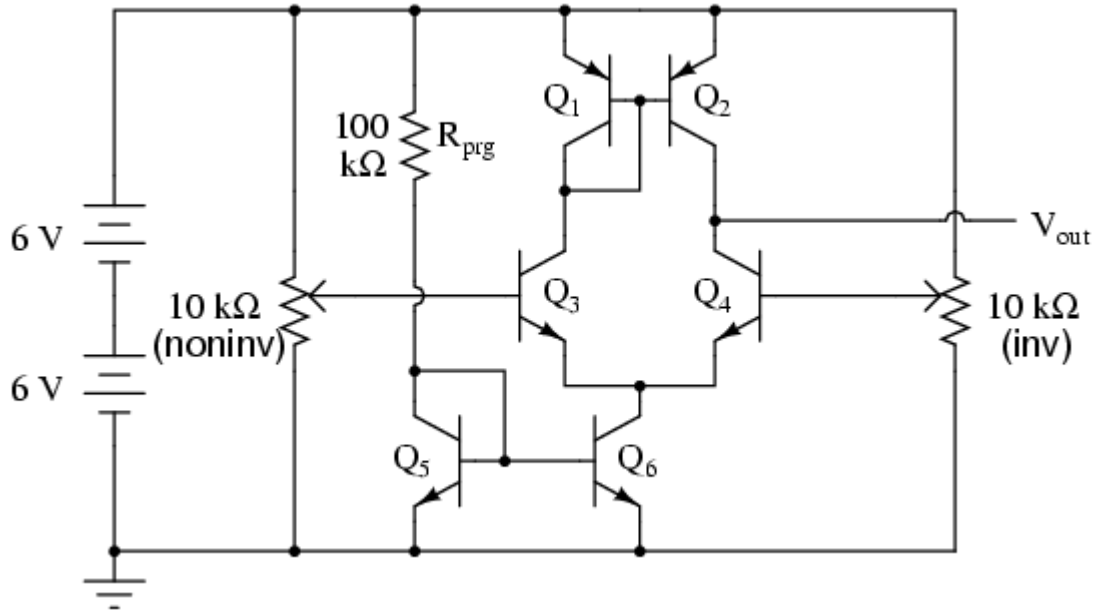
- Draw the following circuit and identify its components in the form of a bill of material (BOM)



Kodak MAX Flash Unit

Exercise Problems

- Draw the following circuit and identify its components in the form of a bill of material (BOM)



Exercise Problems

- Draw the following circuit and identify its components in the form of a bill of material (BOM)