Electrical Components

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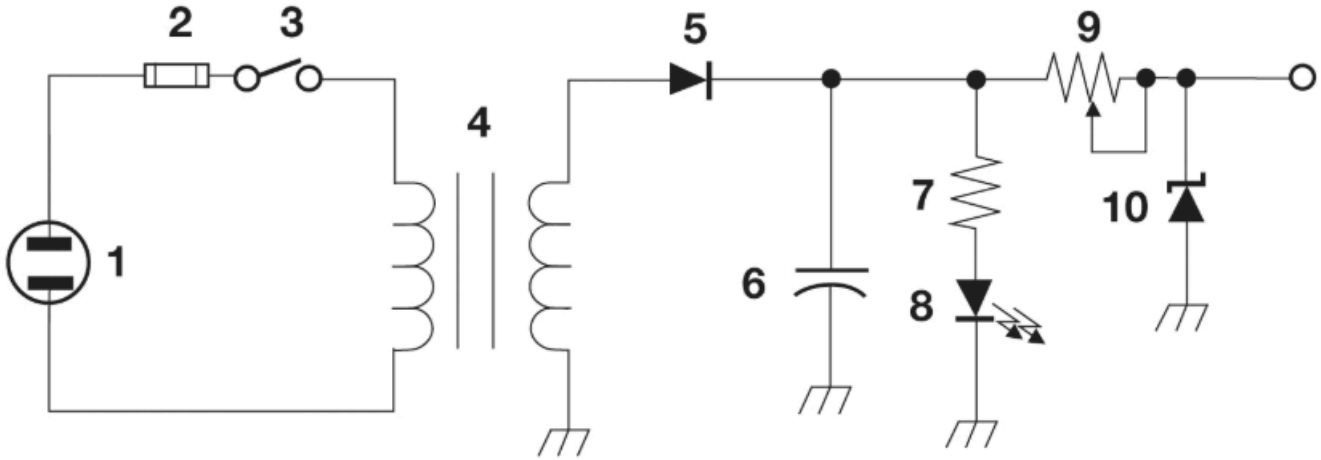
Schematic Diagrams

- A schematic is a wiring diagram that uses standard component symbols to show how various electrical components are connected
- A schematic does not show the size or physical appearance of the components nor does it show the wire lengths

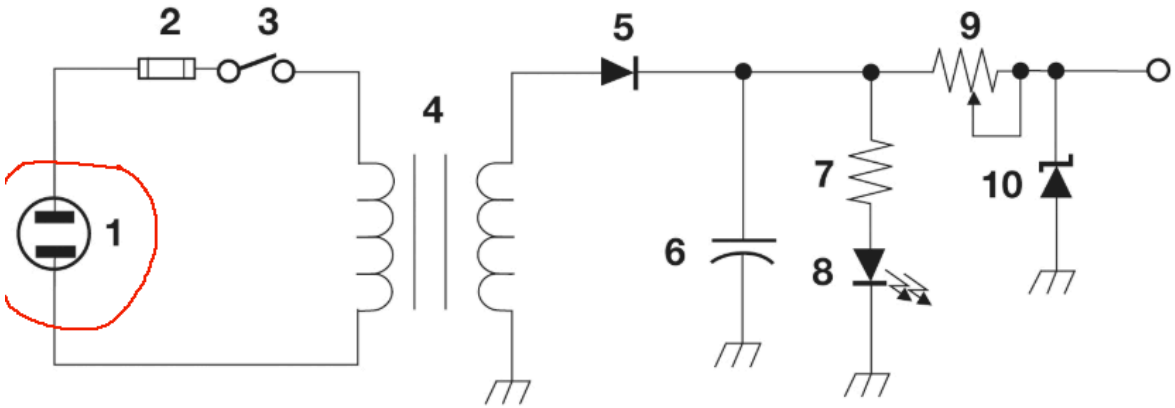
Schematic Diagrams



This is one of three possible schematic diagrams that may be on the test. The various components are numbered and the test question(s) will ask you to identify the component and about the component characteristics.

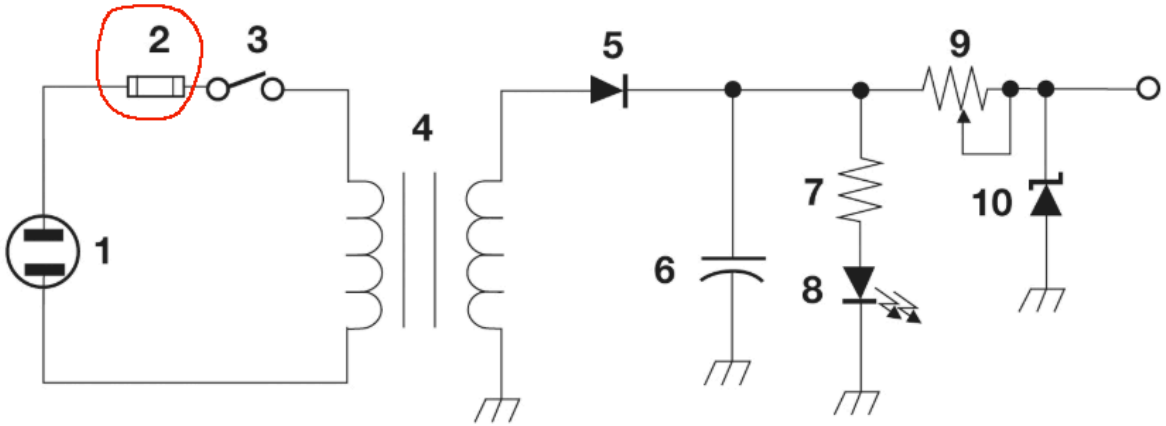
T6C01, T6C12, T6C13

Power Source



Either Alternating Current or Direct Current is used to provide voltage and current to an electronic device. In this particular diagram, the input is alternating current because it is feeding a transformer.

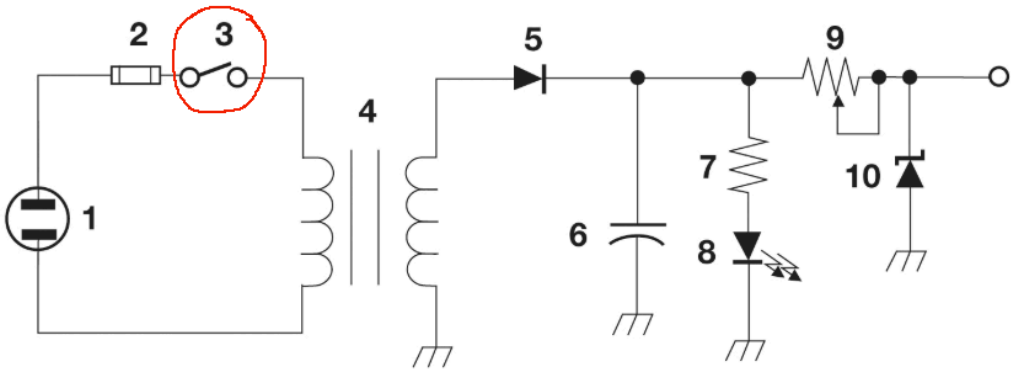
Fuse



A fuse is used to protect a circuit from drawing too much current. Fuses are rated by how many amperes of current can pass before the fuse opens the circuit. Fuses are made of a resistive material that gets hot and melts when the rated current draw is exceeded.

T6A09

Switch



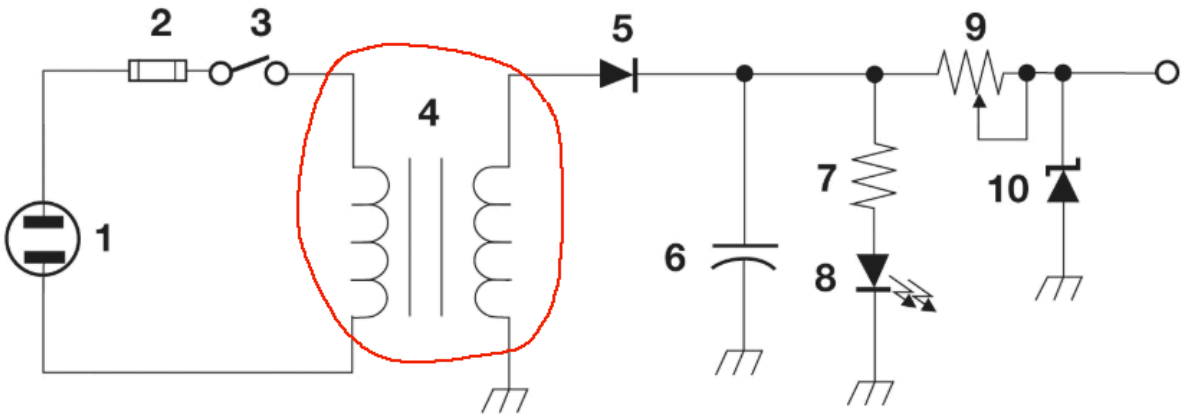
Switches come in a variety of configurations. The switch in this diagram is a “single pole, single throw” switch. It can be used to either complete or interrupt a single circuit.

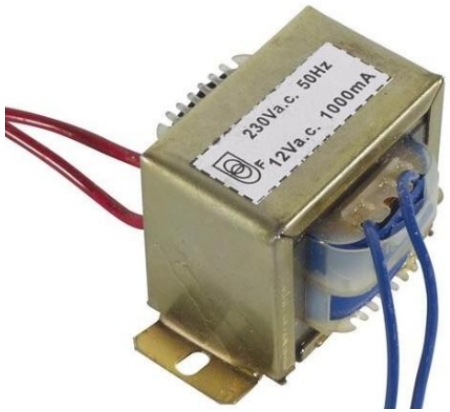
Other configurations of this switch type include “single pole, double throw”,“double pole, single throw”, “double pole, double throw” and more.

There are also rotary switches, momentary switches, and gang switches.

T6A08, T6D03

Transformer





A transformer is a static electrical device that transfers electrical energy between two or more circuits through electromagnetic induction.

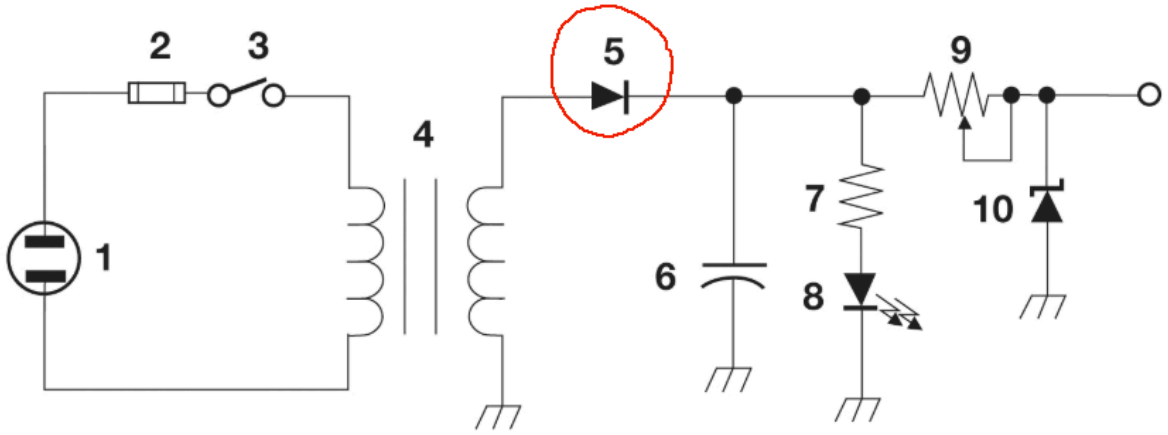
They are used to isolate one circuit from another and/or to increase or decrease the voltage from one side to the other.

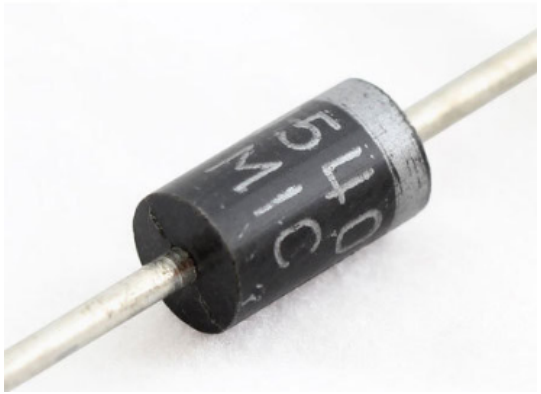
The amount of increase (or decrease) depends on the ratio of the number of turns in the coil on each side of the transformer.

The transformer in this circuit has a iron core, signified by the two parallel lines in the middle of the transformer.

T6C09, T6D06

Diode





A diode is a two-terminal electronic component that conducts current primarily in one direction; it has low (ideally zero) resistance in one direction, and high (ideally infinite) resistance in the other.

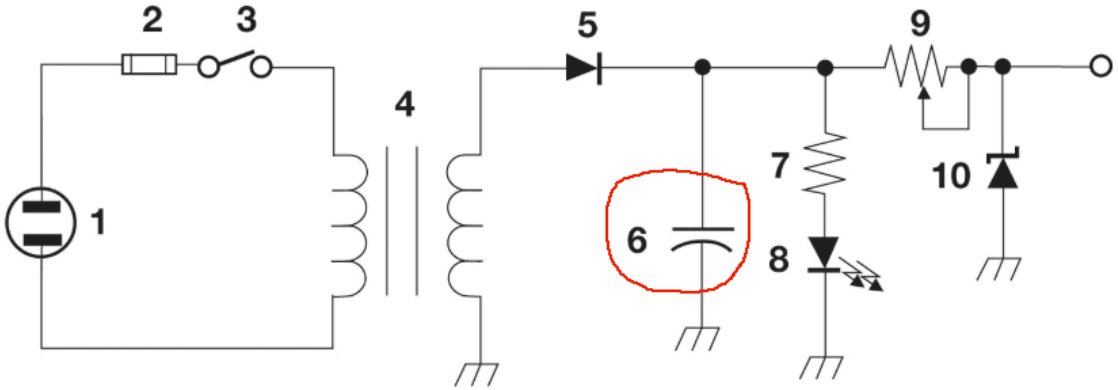
The two electrodes are the anode and cathode. The cathode side is marked with a stripe.

T6B02, T6B06, T6B09

More on Diodes

- Current flows from the anode to the cathode (A->C). Diodes have a threshold voltage value and current will flow when the threshold voltage is exceeded.
- While they will normally only allow current to flow in one direction, a very high voltage applied to the cathode can cause the diode to break down and allow current to flow in the reverse direction.

Capacitor



A capacitor consists of two or more conductive surfaces separated by an insulator. The insulator can be air, a vacuum, or other solid material such as plastic or paper.

Applying voltage higher than the rated value can cause the capacitor to short circuit.

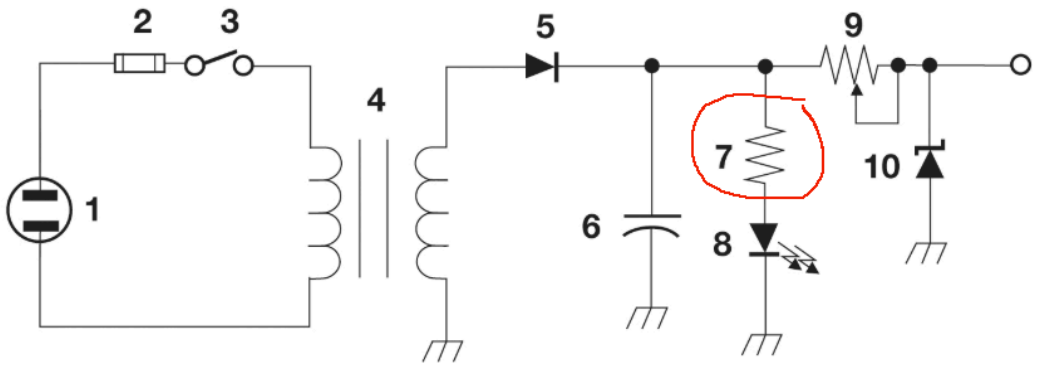
Capacitance is measured in **Farads**

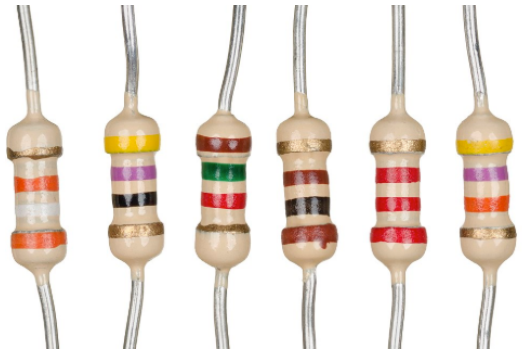
T5C01, T5C02, T6A04, T6A05, T6C06, T7D10

More on Capacitors

- One Farad is a rather large amount of power stored in a capacitor. Capacitors capable of being charged to one or more farads are massive and found in places like the large Hadron collider in Cern, Switzerland.
- The capacitors used in most electrical circuits have fractions of a Farad capacity, usually measured in microfarads (1/1,000 of a Farad), nanofarad (1/1,000,000 of a Farad), and picofarads (1/1,000,000,000 of a Farad).
- A capacitor stores energy in an electrical field.
- When measuring resistance with a ohmmeter which shows increasing resistance over time, there is a capacitor in the circuit being measured

Resistor





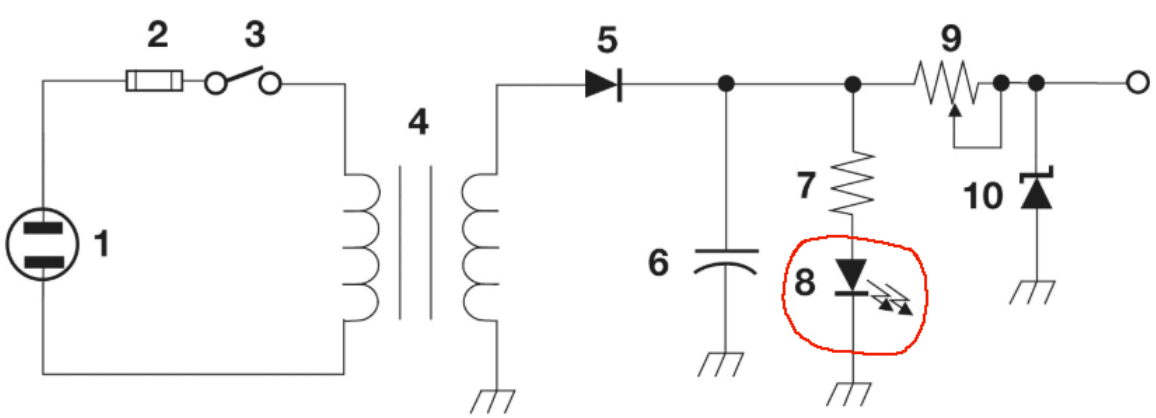
A resistor restricts, but doesn't inhibit, current flow in a circuit. Some of the current is converted into heat, the rest flows through the resistor.

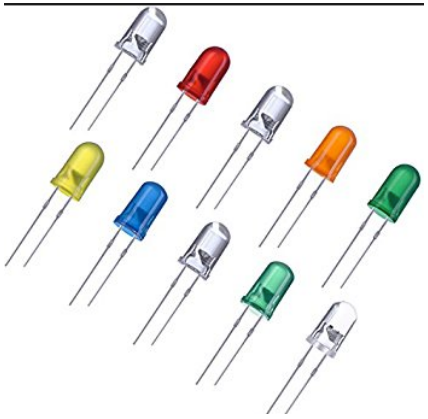
Resistors come in various compositions and power ratings (the amount of current and voltage the resistor can accommodate).

Resistance is measured in Ohms (Ω)

T6C02, T7D11, T7D12

Light-Emitting Diode





LED's are a special type of diode. They allow current to flow in one direction, but convert some of the energy into light.

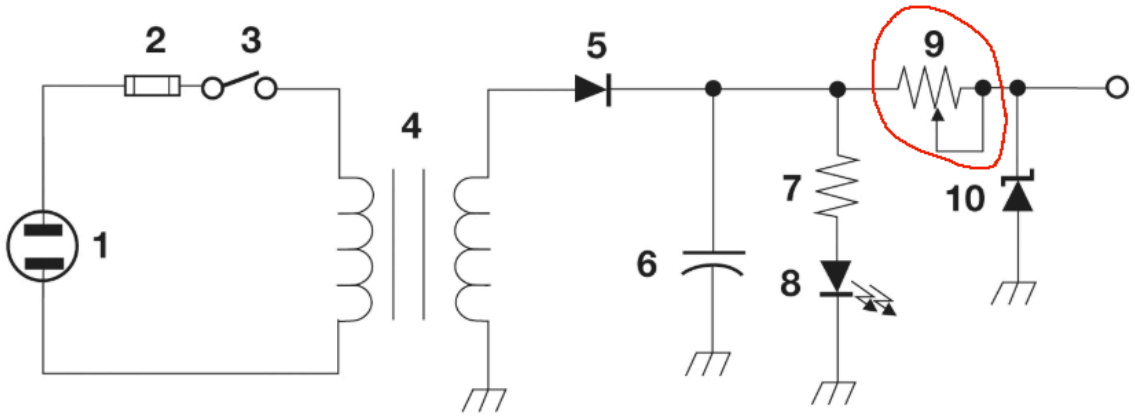
The positive (anode) lead will be the longer lead and have a flat edge on the outer casing.

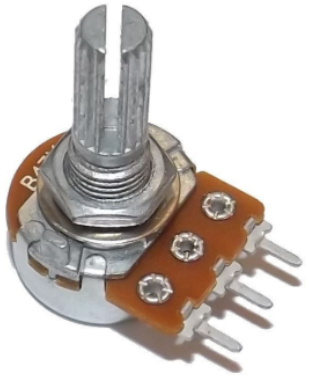
Diodes have very low resistance and will short a circuit if not coupled with a resistor to limit the current flow through the LED.

LED's are often used as a visual indictor.

T6B07, T6C07, T6D02

Variable Resistor



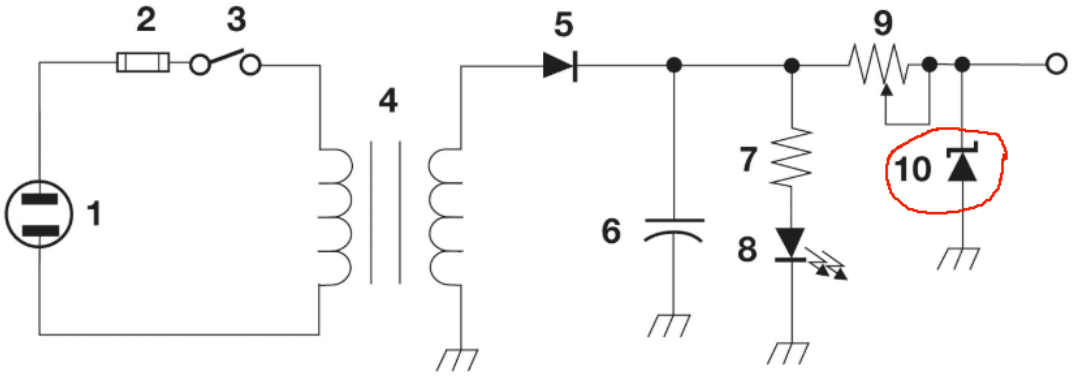


A variable resistor, (aka potentiometer), is often used as a voltage divider (when all three pins are used) or as a variable resistor when two pins are used (as in this example).

A common use of a potentiometer is a volume control in a radio.

T6A02, T6A03, T6A08

Schottky Diode



A Schottky diode was the first semiconductor invented. It is a very fast diode compared to a “normal” diode. The amount of voltage needed to cause current to flow is very low, meaning the diode can switch on or off quickly.

The Schottky Diode is distinguished from “normal” diodes by the “curly” cathode indicator. Note that in a Schottky Diode, the current flows from the cathode to the anode whereas in normal diodes, current flows from the anode to the cathode (compare #5 to #10)

Schematic 2

1. A Resistor
2. A Transistor
3. A lamp
4. A battery
5. Common or Ground

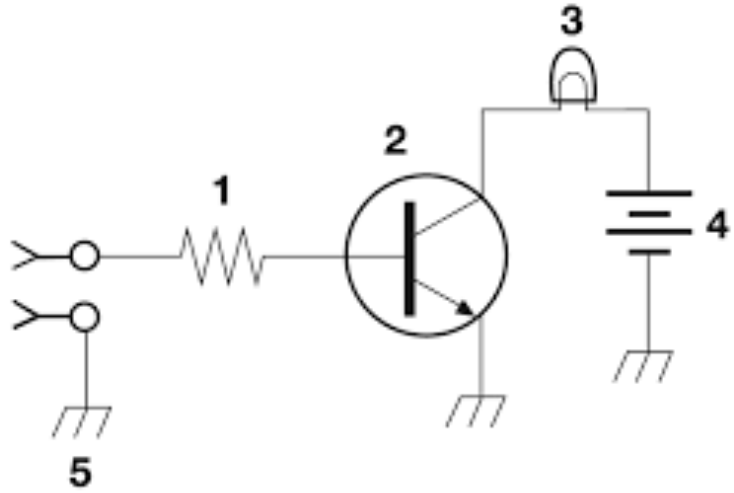


Figure T-1

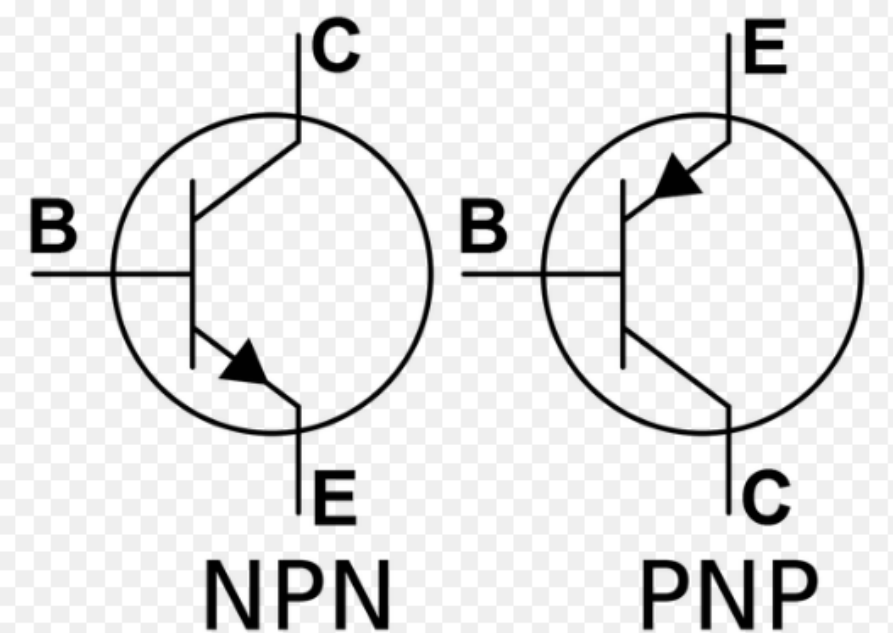
Common or ground is the return path for the current flowing in the circuit.

The only thing this circuit does is turn on a lamp if some other part of the circuit which isn't shown) draws current. The transistor in the circuit acts as a the switch to control the flow of current.

T6C03, T6C04, T6C05, T6D10

Transistors

- Transistors are used to switch or modulate current
- B: Base, C: Collector, E: Emitter
- Two flavors, distinguished by the emitter arrow
- Transistors are excellent amplifiers
  - A small modulated signal on one pair of pins will modulate a larger carrier on the other pair
- They are also excellent switches
  - Current won't flow on one pair if a signal is present on the other pair

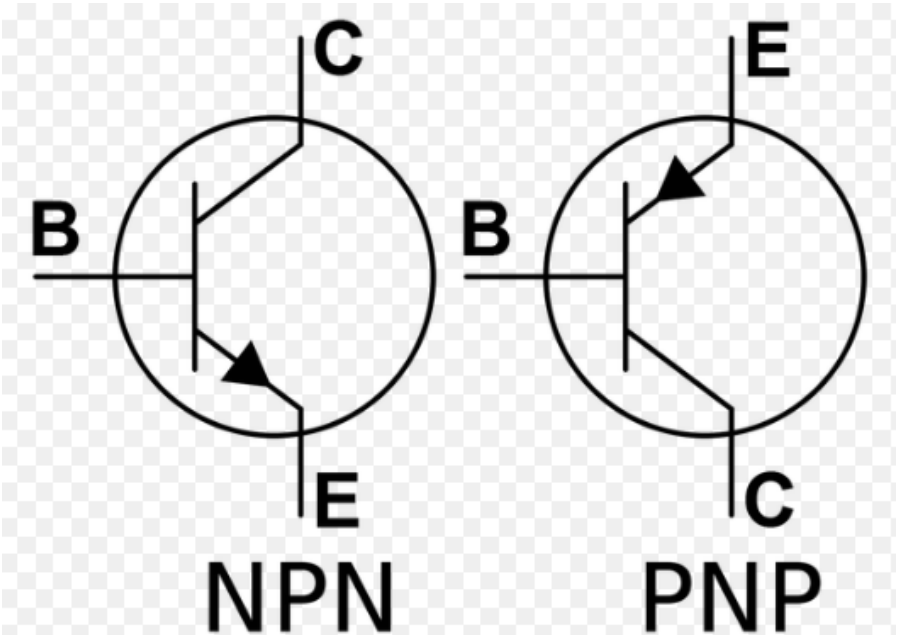


A **Field Effect Transistor** (FET) is a transistor that amplifies or switches voltage. The 3 pins are called the Source, Gate, and Drain

T6B01, T6B03, T6B04, T6B05, T6B08, T6B10, T6B11, T4A10, T4A11, T4B05, T4B12

More on Transistors

- When input voltage applied to Base/Emitter, it changes the resistance between the Collector and Emitter. That then affects how much current can flow between the Collector and Emitter
- Amplification is called “gain” and is measured in “dBm”
- The final amplifier in a transmitter or RF power amplifiers are generally (expensive) transistors.



The 3rd Schematic

1. A connector to/from some other part of the schematic
2. A variable capacitor
3. A variable inductor
4. An antenna

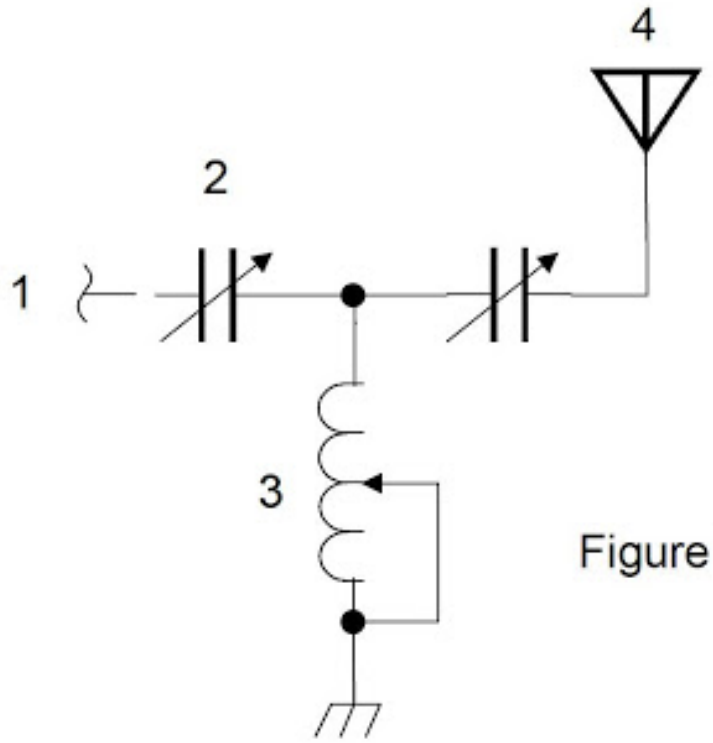


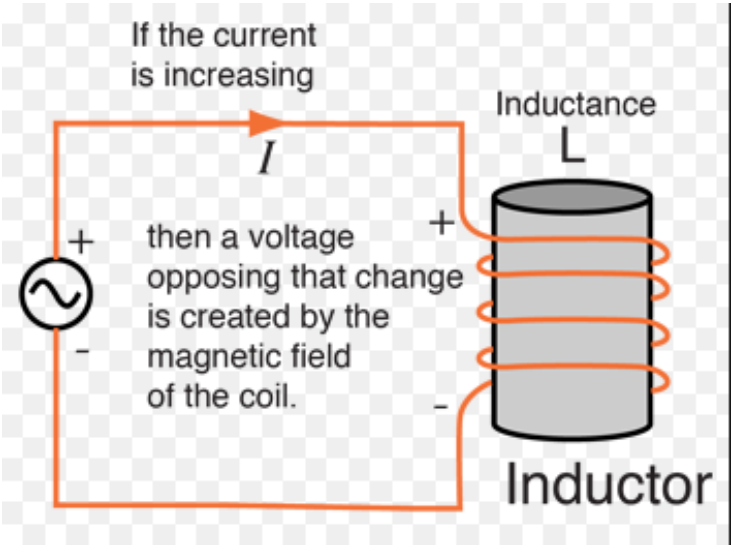
Figure T3

This circuit actually works, whereas the other two circuits are pretty much nonsense. This circuit is a transmatch to make the transmitter think it's seeing a 50 ohm impedance.

T6C10, T6C11

Inductance

- An inductor is a coil of wire and may have an air core or some type of a metal core
- Inductors store electrical energy in a magnetic field
- Inductors oppose rising current until the magnetic field is full and then passes the current.
- As the incoming current falls, the inductor releases the magnetic field



Inductance is measured in “henries”

One henry is a very large amount of power. Most of the inductors in today’s electrical circuits are measured in milli henries and micro henries.

T5C03, T5C04, T6A06, T6A07

Inductance vs Capacitance

Inductors

- Stores energy in the form of a magnetic field
- A current can pass through an inductor but will create a magnetic field as it does so
- As a property of the magnetic field, when the current suddenly increases or decreases, the current within the magnetic field will change in the opposite direction. This resists, or impedes, the change in current across the circuit. The inductor inhibits the current from changing instantly.

Capacitors

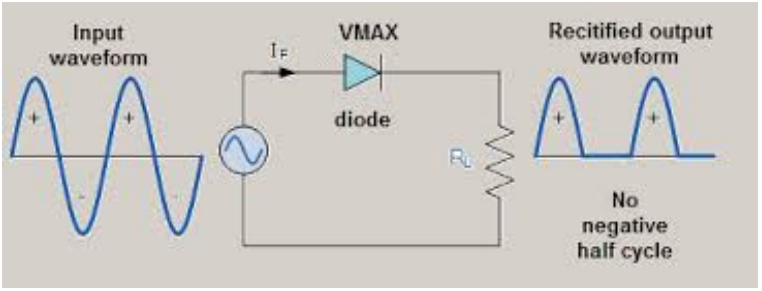
- Stores energy in the form of an electrical field
- As a current is applied to the circuit, charges accumulate on the plates of the capacitor. Therefore, voltage cannot change instantly across a capacitor
- When the current decreases the capacitor will release the charge

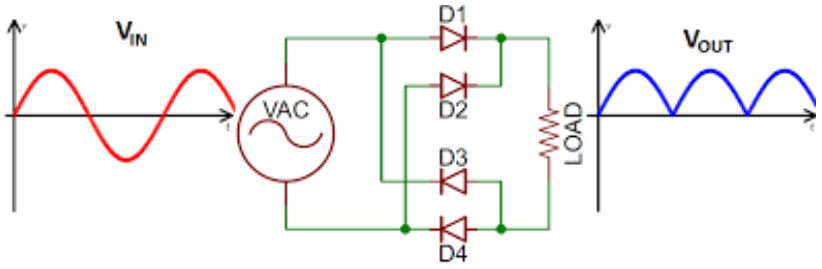
T6A05, T6A06, T6D08, T6D11

A Rectifier for example…

A Rectifier is used to convert alternating current to direct current. A rectifier is a component of a Power Supply. A Regulator governs the amount voltage from a power supply.

The capacitors in a power supply will retain a charge for considerable time and are usually quite large. Before working on a power supply, ensure that the capacitors are fully discharged.





T6D01, T6D05, T0A11

Good Things to Know

- Some battery types are rechargeable. Carbon-zinc batteries are not
  - If a battery is rechargeable, it will say so
  - Rechargeable batteries include Nickel-metal Hydride, Lithium Ion, Lead Acid
- Copper, gold, aluminum are a good conductors of electricity. Wood, glass, and rubber are good insulators
- Copper wire has some resistance, meaning that the voltage will drop as the length of the wire increases. Heavier wire has less resistance. Shorter lengths have less loss
- Opposition to the flow of AC current is called impedance and is also measured in ohms

T5A07, T5A08, T5C12, T5C13, T6A10, T6A11

How Much Power Does a Transceiver Need?

- Modern transceivers require at least 12 volts of power
  - Most power supplies, as well as the automotive charging system, deliver 13.7 volts which will drop to about 12.5 volts when transmitting
- The amount of current needed is determined by:
  - The efficiency of the transmitter at full power
  - The receiver and control circuit requirements
  - The efficiency (regulation) of the power supply
  - The amount of heat dissipation
- A 100 watt transmitter will required about 20-25 watts on transmit and 1-5 watts on receive

T4A01, T4A03, T5A06

Jot down any questions you may have to ask during the online meeting