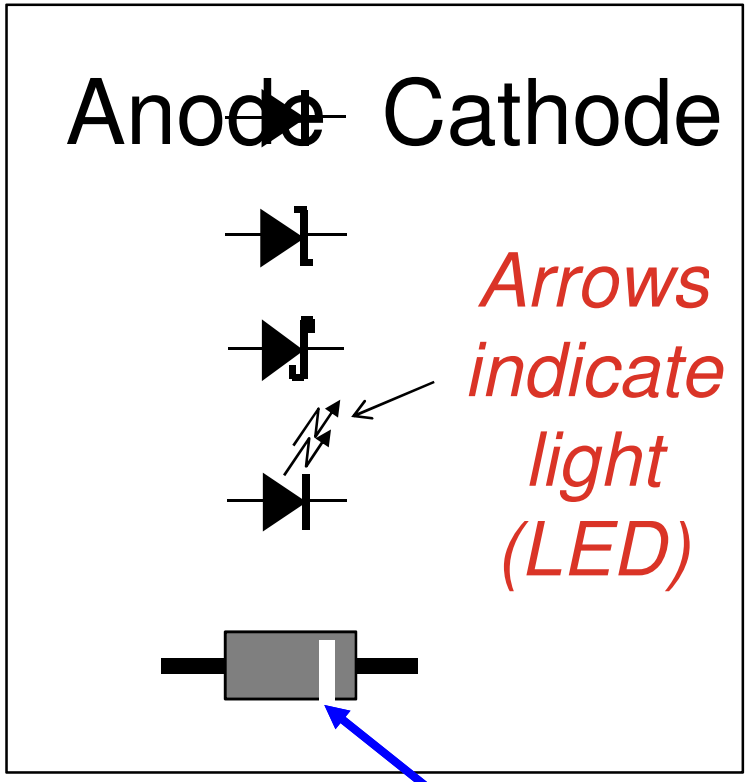
Diodes, Transistors and Integrated Circuits

(Semiconductors)

- Made of material like silicon that are “OK” conductors but not as good as metals
- Impurities added to semiconductors create material with more than usual electrons (*N-type*) and fewer than usual electrons (*P-type*)
- Structures of N and P material can control current flow through the semiconductor
- When N- and P-type material are placed in contact with each other, the result is a *PN junction* that conducts better in one direction than the other

Diodes

- Allows current to flow in only one direction
  - Two electrodes (Anode, Cathode)
  - AC current is changed to varying pulses of DC (called *rectification*)
  - Diodes used to change AC power to DC power are called *rectifiers* (heavy-duty diodes)
- Schematic
- Designator (D or CR)
- If AC voltage is applied to a diode, the result is a pulsing DC current because current is blocked when the voltage tries to push electrons in the wrong direction



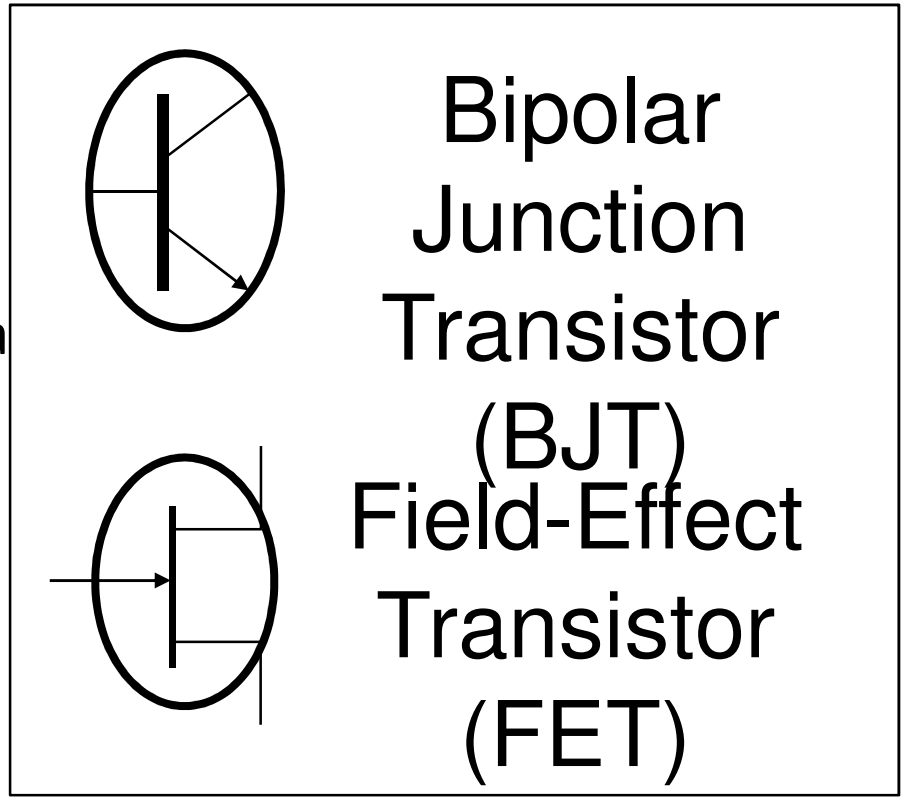
Stripe on diode indicates CATHODE

Diodes (cont.)

- When current flows through a diode, a small positive voltage develops from the anode to the cathode
  - Called *forward voltage drop*, usually less than 1 V
  - Voltage depends on the type of diode and the materials it's made from
- Light-emitting diode or *LED* gives off light when current flows through it in the forward direction from anode to cathode
  - Used as visual indicators (use less power than incandescent bulbs/lamps)
  - Material from which the LED is made determines the color of light emitted

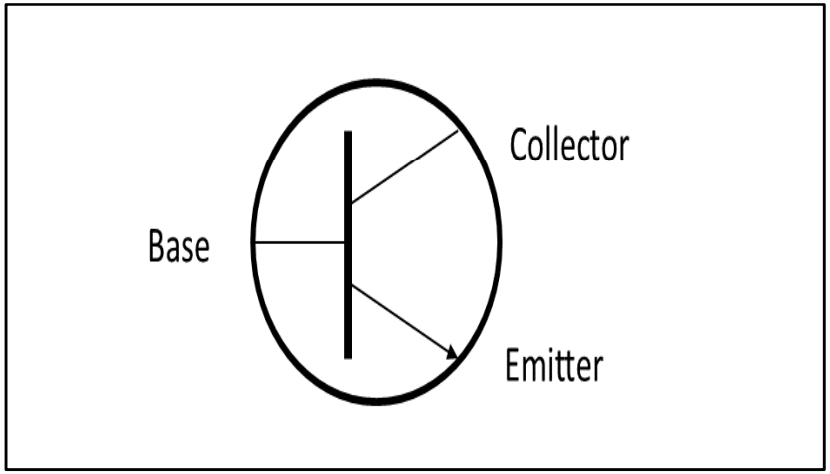
Transistors

- The function of a transistor is to *control* large signals with small ones
  - An “electronically controlled current valve”
  - When used as an amplifier, a transistor produces *gain*
  - Transistors can also be used as a *switch*
- Schematic
- Designator (Q)



Transistors (cont.)

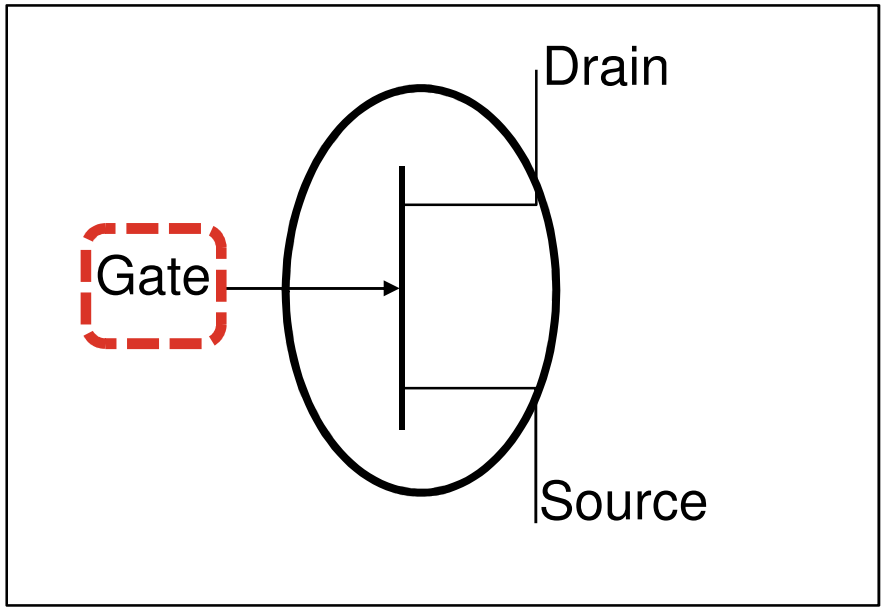
- Two common types of transistors: *bipolar junction transistors* (BJT) and *field effect transistors* (FET)
- The Bipolar Junction Transistor (BJT) has three layers of N or P material connected to electrodes
- Depending on the arrangement of layers, a BJT is either an NPN or PNP transistor
- The three electrodes of an FET are the *gate*, *drain*, and *source*
- RF power transistors are used as the primary gain-producing component in RF power amplifiers



Bipolar Junction Transistor Schematic (showing the 3 electrodes)

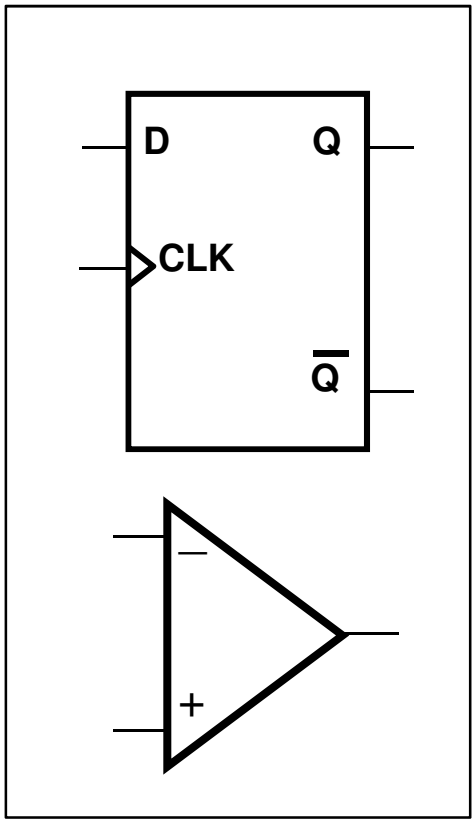
Transistors (cont.)

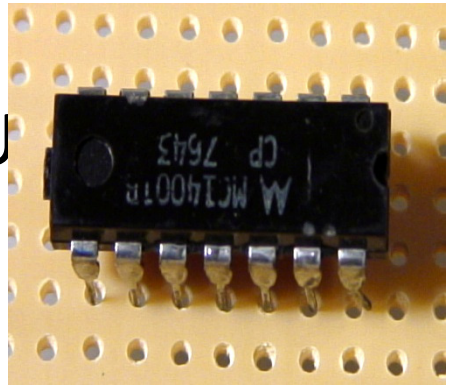
- The Field-Effect Transistor (FET) has a conducting path or channel of N and P material connected to the drain and source electrodes
- Voltage applied to the gate electrode controls current through the channel



Integrated Circuits

- An integrated circuit (IC or chip) is made of many components connected together as a useful circuit and packaged as a single component
- Schematic symbol
- Designator (IC or U





PRACTICE QUESTIONS

Which is true about forward voltage drop in a diode?

A. It is lower in some diode types than in others
B. It is proportional to peak inverse voltage
C. It indicates that the diode is defective
D. It has no impact on the voltage delivered to the load

T6B01 A 3-10

What electronic component allows current to flow in only one direction?

A. Resistor
B. Fuse
C. Diode
D. Driven element

T6B02 C 3-10

Which of these components can be used as an electronic switch?

A. Varistor
B. Potentiometer
C. Transistor
D. Thermistor

T6B03 C 3-10

Which of the following components can consist of three regions of semiconductor material?

A. Alternator
B. Transistor
C. Triode
D. Pentagrid converter

T6B04 B 3-10

What type of transistor has a gate, drain, and source?

A. Varistor
B. Field-effect
C. Tesla-effect
D. Bipolar junction

T6B05 B 3-10

How is the cathode lead of a semiconductor diode often marked on the package?

A. With the word “cathode”
B. With a stripe
C. With the letter C
D. With the letter K

T6B06 B 3-10

What causes a light-emitting diode (LED) to emit light?

A. Forward current
B. Reverse current
C. Capacitively-coupled RF signal
D. Inductively-coupled RF signal

T6B07 A 3-10

What does the abbreviation FET stand for?

A. Frequency Emission Transmitter
B. Fast Electron Transistor
C. Free Electron Transmitter
D. Field Effect Transistor

T6B08 D 3-10

What are the names for the electrodes of a diode?

A. Plus and minus
B. Source and drain
C. Anode and cathode
D. Gate and base

T6B09 C 3-10

Which of the following can provide power gain?

A. Transformer
B. Transistor
C. Reactor
D. Resistor

T6B10 B 3-11

What is the term that describes a device's ability to amplify a signal?

A. Gain
B. Forward resistance
C. Forward voltage drop
D. On resistance

T6B11 A 3-11

What are the names of the electrodes of a bipolar junction transistor?

A. Signal, bias, power
B. Emitter, base, collector
C. Input, output, supply
D. Pole one, pole two, output

T6B12 B 3-11

Which of the following devices or circuits changes an alternating current into a varying direct current signal?

A. Transformer
B. Rectifier
C. Amplifier
D. Reflector

T6D01 B 3-11

Which of the following is commonly used as a visual indicator?

A. LED
B. FET
C. Zener diode
D. Bipolar transistor

T6D07 A 3-11

What is the name of a device that combines several semiconductors and other components into one package?

A. Transducer
B. Multi-pole relay
C. Integrated circuit
D. Transformer

T6D09 C 3-11

What is the function of component 2 in figure T-1?

A. Give off light when current flows through it

B. Supply electrical energy

C. Control the flow of current

D. Convert electrical energy into radio

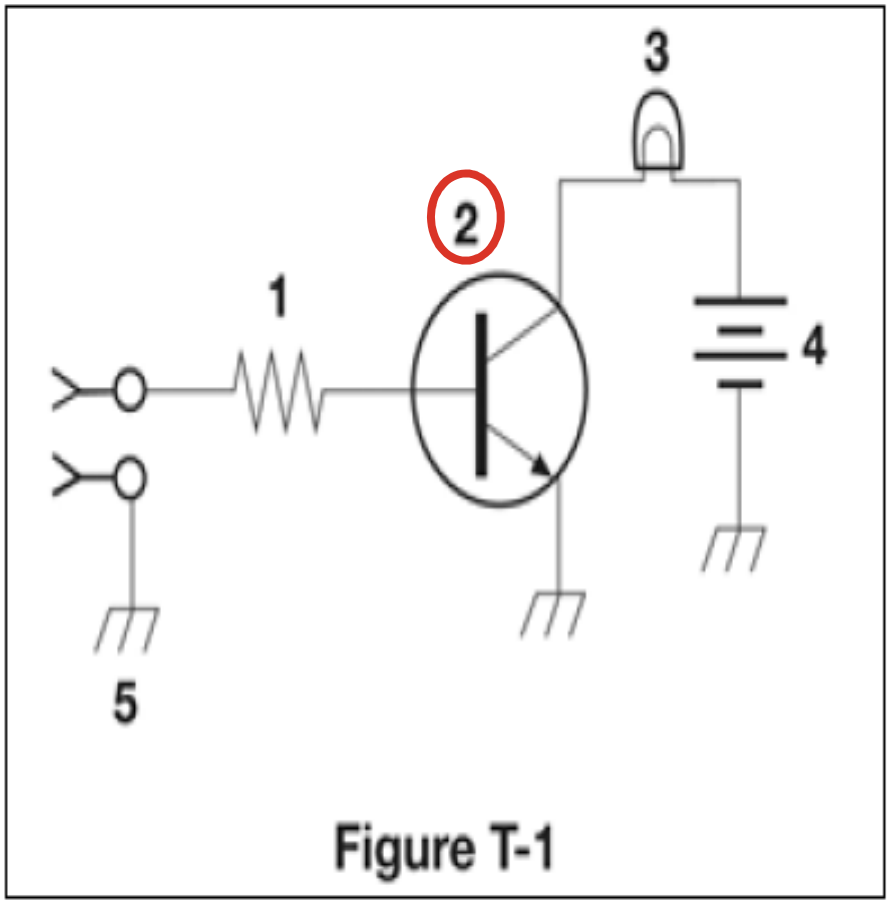
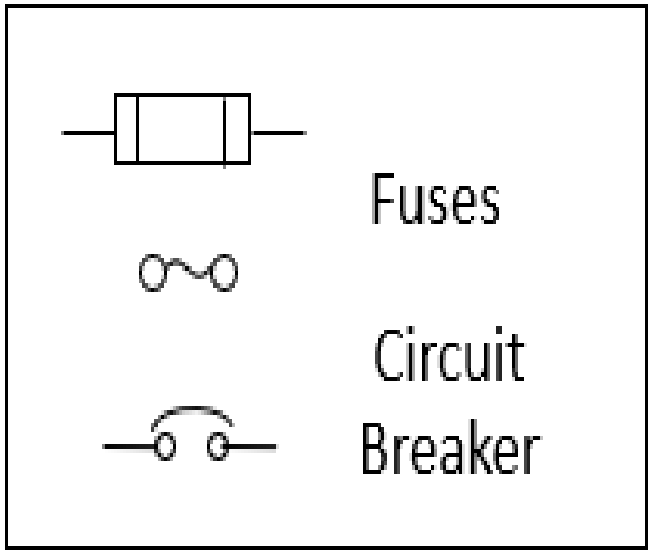


Figure T-1

T6D10 C 3-11

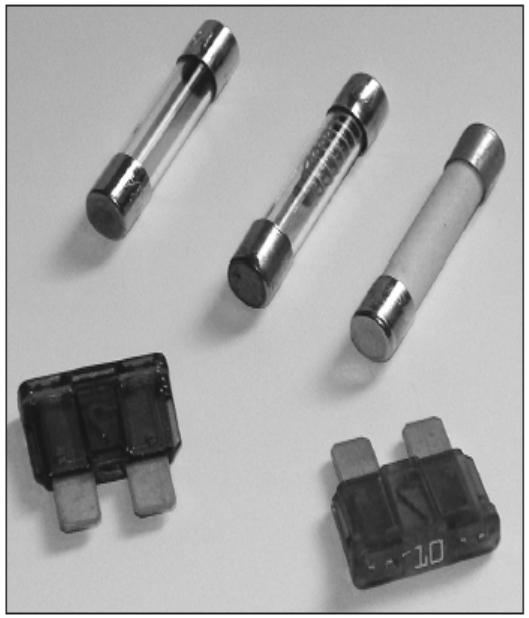
Protective Components

- Protective components (such as *fuses* and *circuit breakers*) are used to prevent equipment damage or safety hazards such as fire or electrical shock
- Designed to remove power in case of a circuit *overload*
  - Fuses blow – one time protection
  - Circuit breakers trip – can be reset and reused
- Fuses interrupt current overloads by melting a short length of metal – when the metal melts, the current path is broken and power is removed from circuits
- Replacing a fuse or circuit breaker with one with



Schematics

Circuit Breaker



Fuses

Ground Fault Circuit Interrupter (GFCI) circuit breaker

PRACTICE QUESTIONS

What electrical component is used to protect other circuit components from current overloads?

A. Fuse
B. Thyratron
C. Varactor
D. All these choices are correct

T6A09 A 3-12

What is the purpose of a fuse in an electrical circuit?

A. To prevent power supply ripple from damaging a component
B. To remove power in case of overload
C. To limit current to prevent shocks
D. All these choices are correct

T0A04 B 3-12

Why should a 5-ampere fuse never be replaced with a 20-ampere fuse?

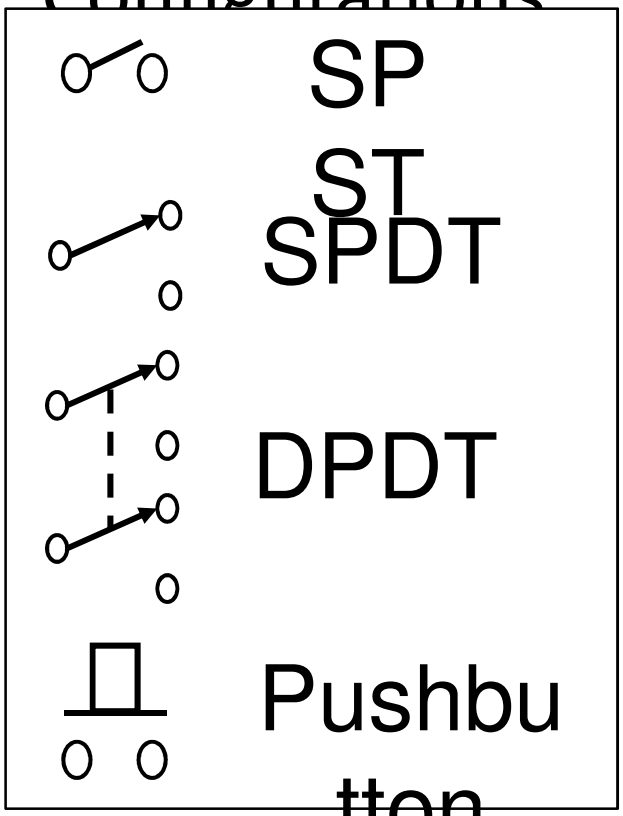
A. The larger fuse would be likely to blow because it is rated for higher current
B. The power supply ripple would greatly increase
C. Excessive current could cause a fire
D. All these choices are correct

T0A05 C 3-12

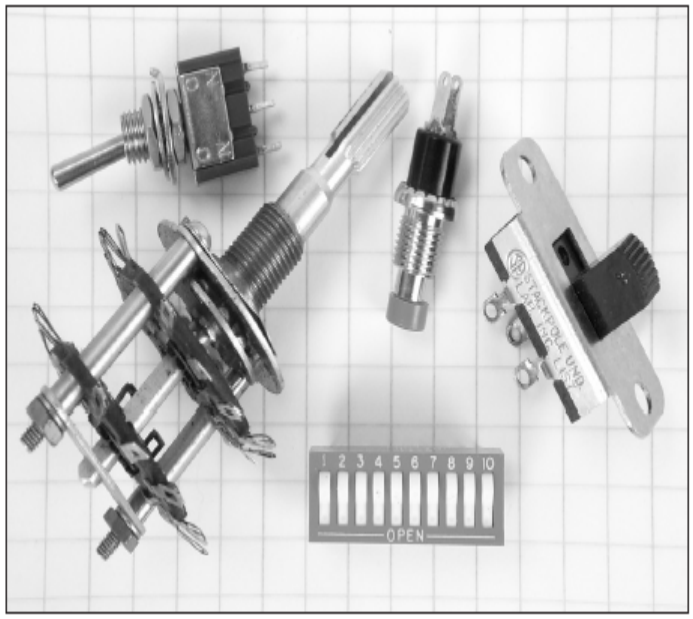
Circuit Gatekeepers … Switches & Relays

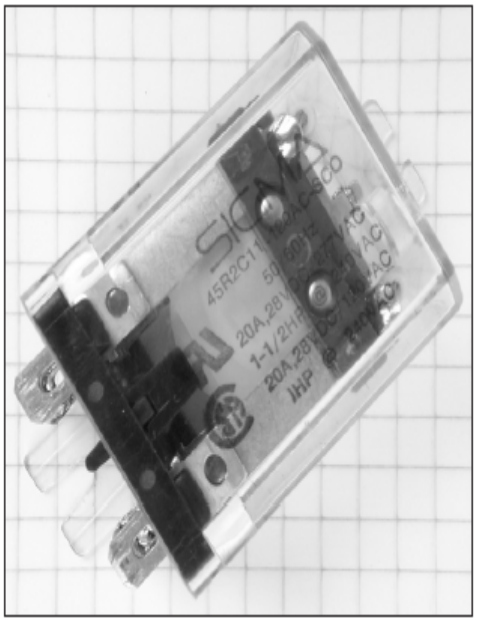
- *Switches* and *relays* control current through a circuit by connecting and disconnecting paths for current to follow
- Switches and relays are described by their number of poles and the number of throws
  - The combination of poles and throws describes the switch
  - Each circuit controlled by the switch is a *pole*
  - Each position is called a *throw*
- A switch is operated manually while a relay is

Switch Configurations



Switch es





Relay

Indicator, Meters and Displays

- Indicators and displays are important components for radio equipment
  - An *indicator* is either ON or OFF
- A *meter* provides information as a value in the form of numbers or on a numeric scale
- A *display* combines indicators, numbers, and labels
  - A *liquid crystal display* or **LCD** is used on the front panel of many radios and test instruments

PRACTICE QUESTIONS

What is the function of an SPDT switch?

A. A single circuit is opened or closed
B. Two circuits are opened or closed
C. A single circuit is switched between one of two other circuits
D. Two circuits are each switched between one of two other circuits

T6A08 C 3-13

What type of switch is represented by component 3 in figure T-2?

A. Single-pole single-throw

B. Single-pole double-throw

C. Double-pole single-throw

D. Double-pole double-throw

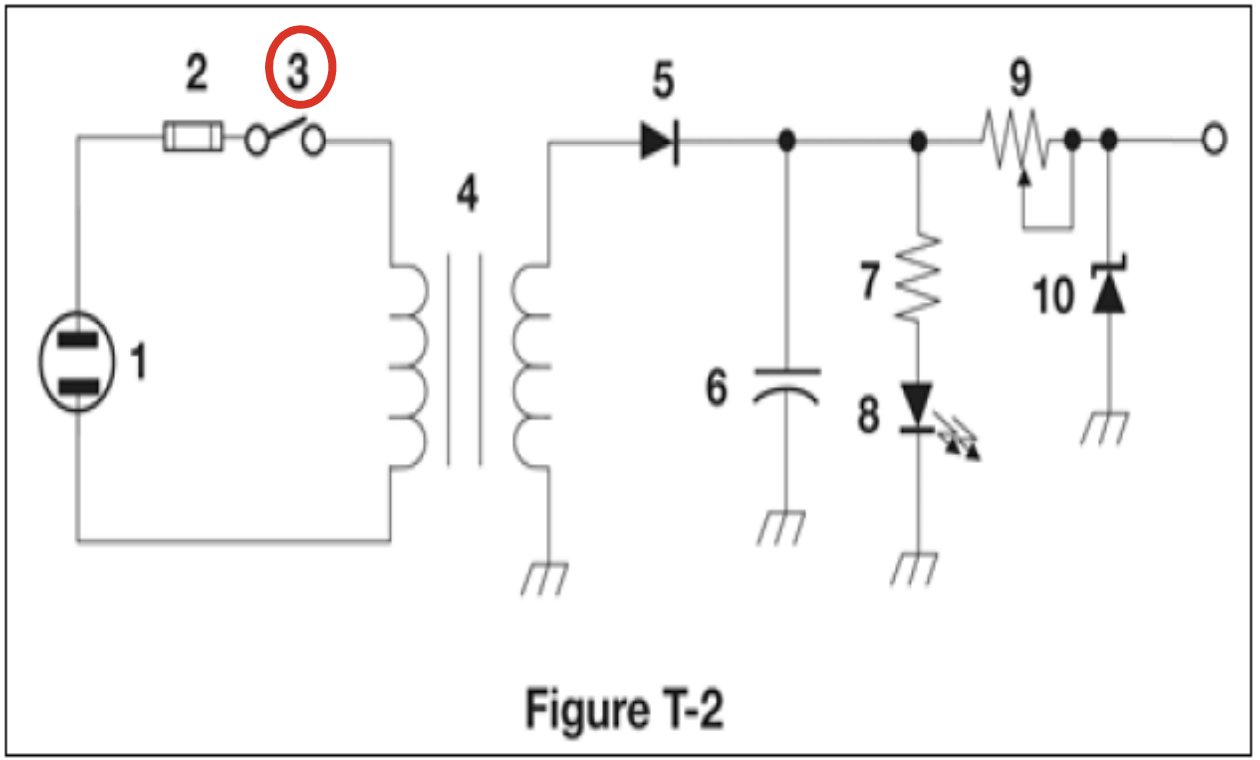


Figure T-2

T6A12 A 3-13

What is a relay?

A. An electrically-controlled switch
B. A current controlled amplifier
C. An inverting amplifier
D. A pass transistor

T6D02 A 3-13

Which of the following displays an electrical quantity as a numeric value?

A. Potentiometer
B. Transistor
C. Meter
D. Relay

T6D04 C 3-14

Fig 3.15 – Schematic Symbols (see text)

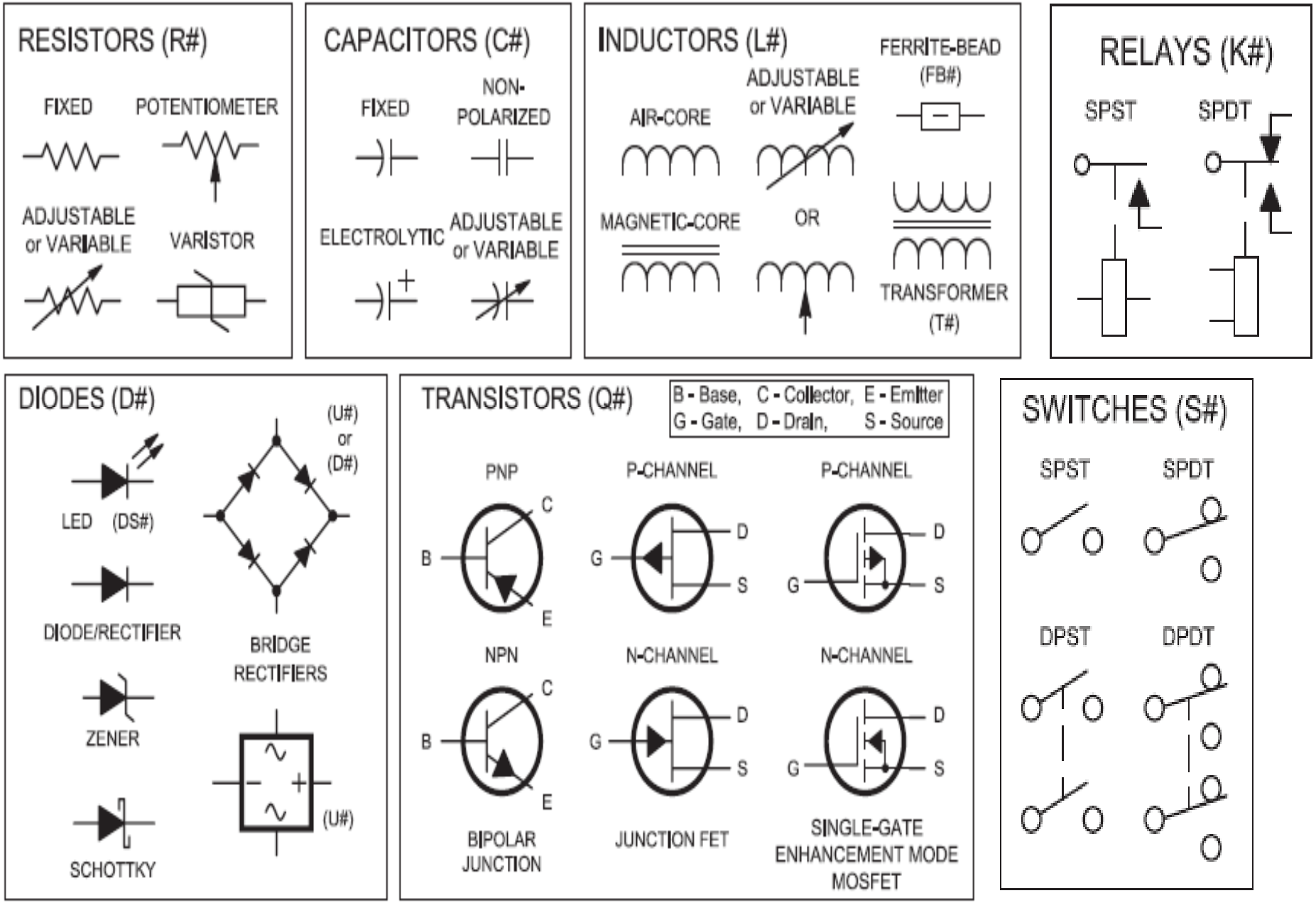
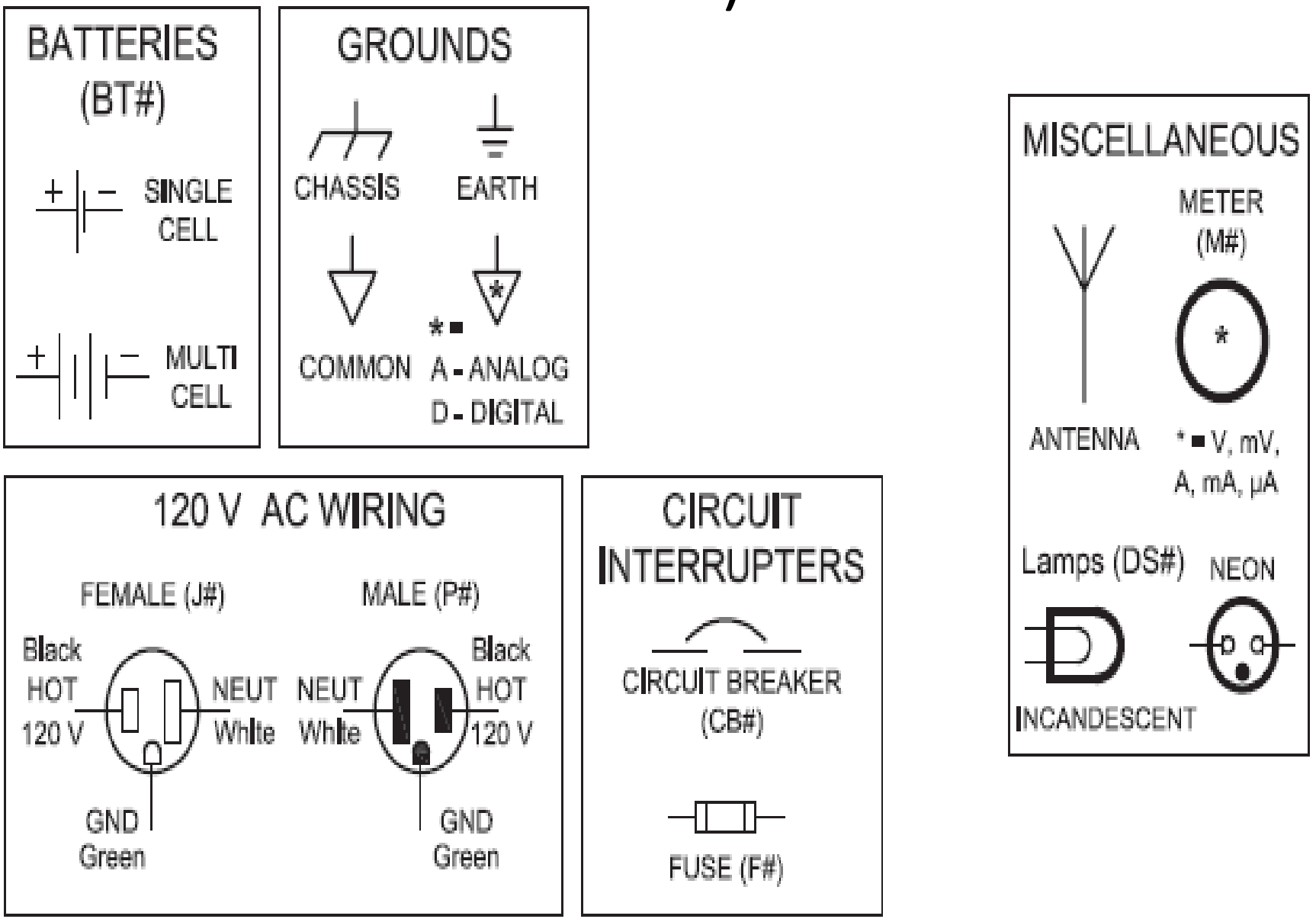


Fig 3.15 – Schematic Symbols (cont., see text)



Schematic Diagrams and Symbols

- *Symbols* are used when drawing a circuit because there are so many types of components
- *Schematic diagrams* are a visual description of a circuit and its components that uses standardized drawings called *circuit symbols*
  - Shows how the components are connected electrically

PRACTICE QUESTIONS

What is the name of an electrical wiring diagram that uses standard component symbols?

A. Bill of materials
B. Connector pinout
C. Schematic
D. Flow chart

T6C01 C 3-14

What is component 1 in figure T-1?

A. Resistor
B. Transistor
C. Battery
D. Connector

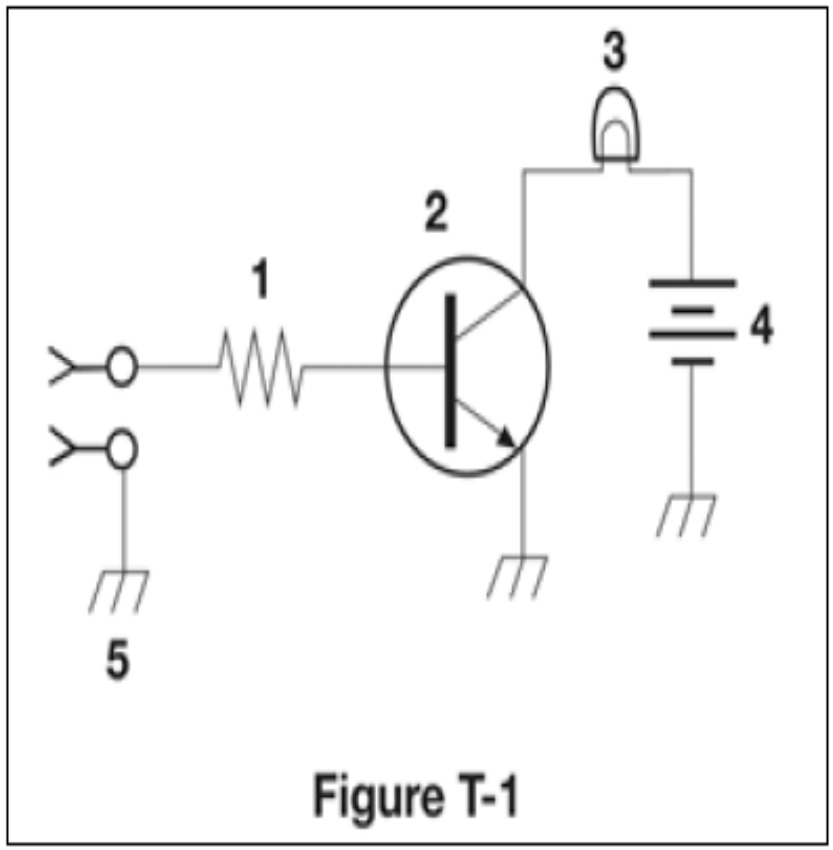


Figure T-1

T6C02 A 3-14

What is component 2 in figure T-1?

A. Resistor
B. Transistor
C. Indicator lamp
D. Connector

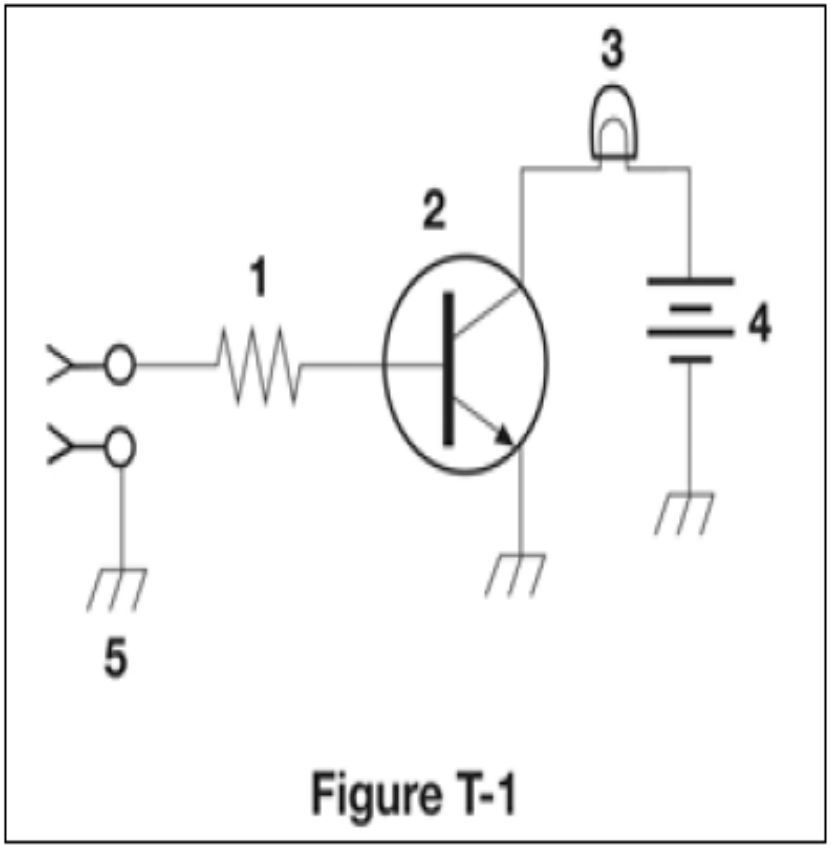


Figure T-1

T6C03 B 3-14

What is component 3 in figure T-1?

A. Resistor
B. Transistor
C. Lamp
D. Ground symbol

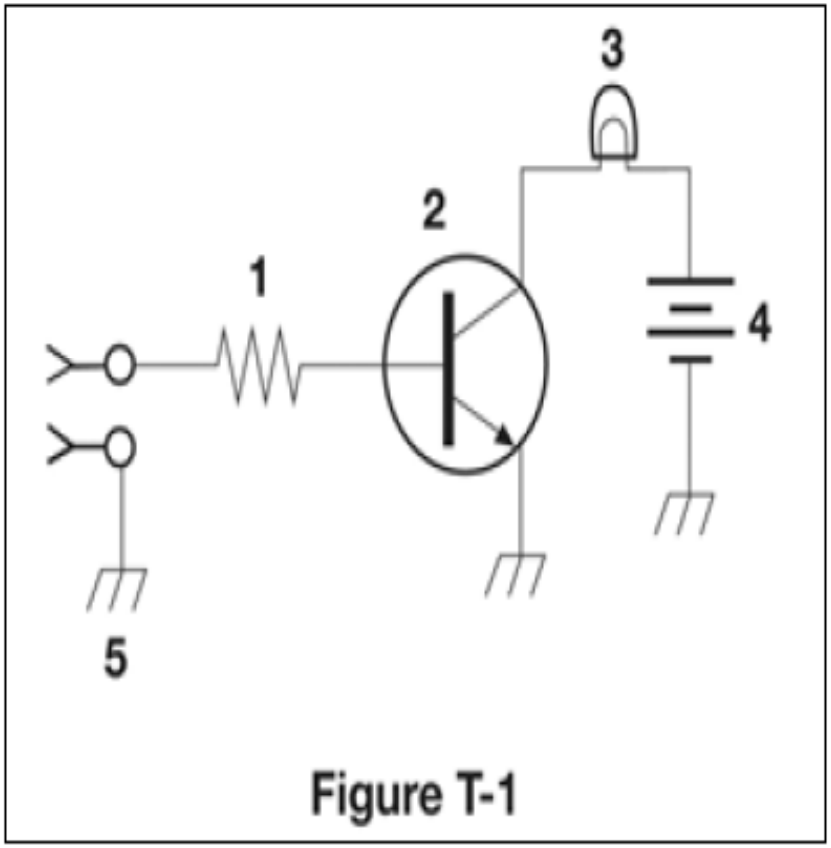


Figure T-1

T6C04 C 3-14

What is component 4 in figure T-1?

A. Resistor
B. Transistor
C. Ground symbol
D. Battery

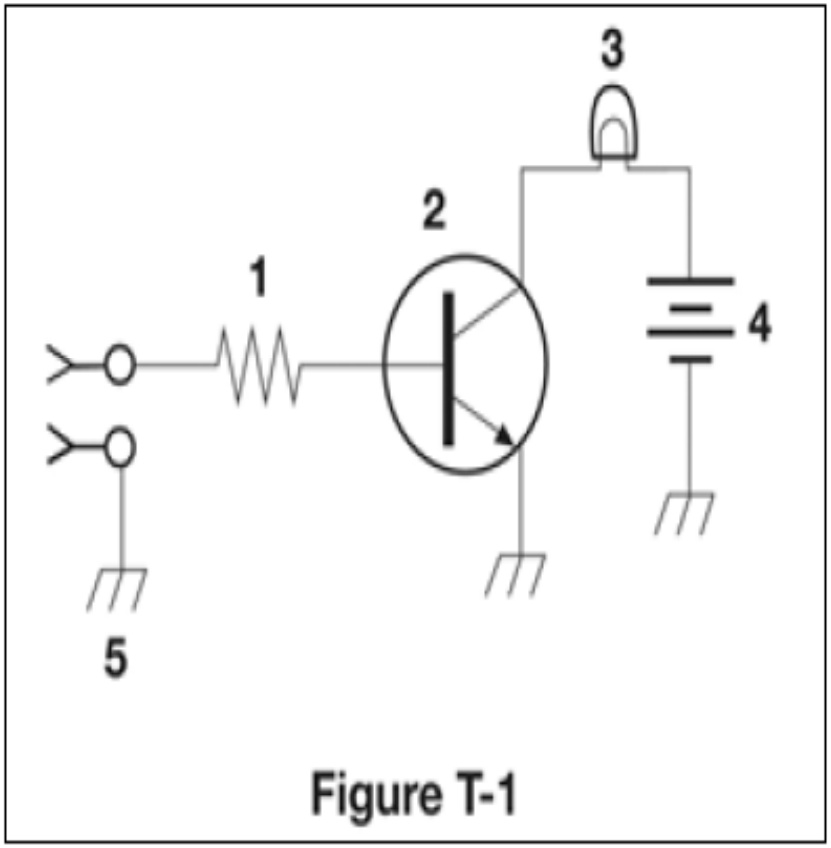


Figure T-1

T6C05 D 3-14

What is component 6 in figure T-2?

A. Resistor
B. Capacitor
C. Regulator IC
D. Transistor

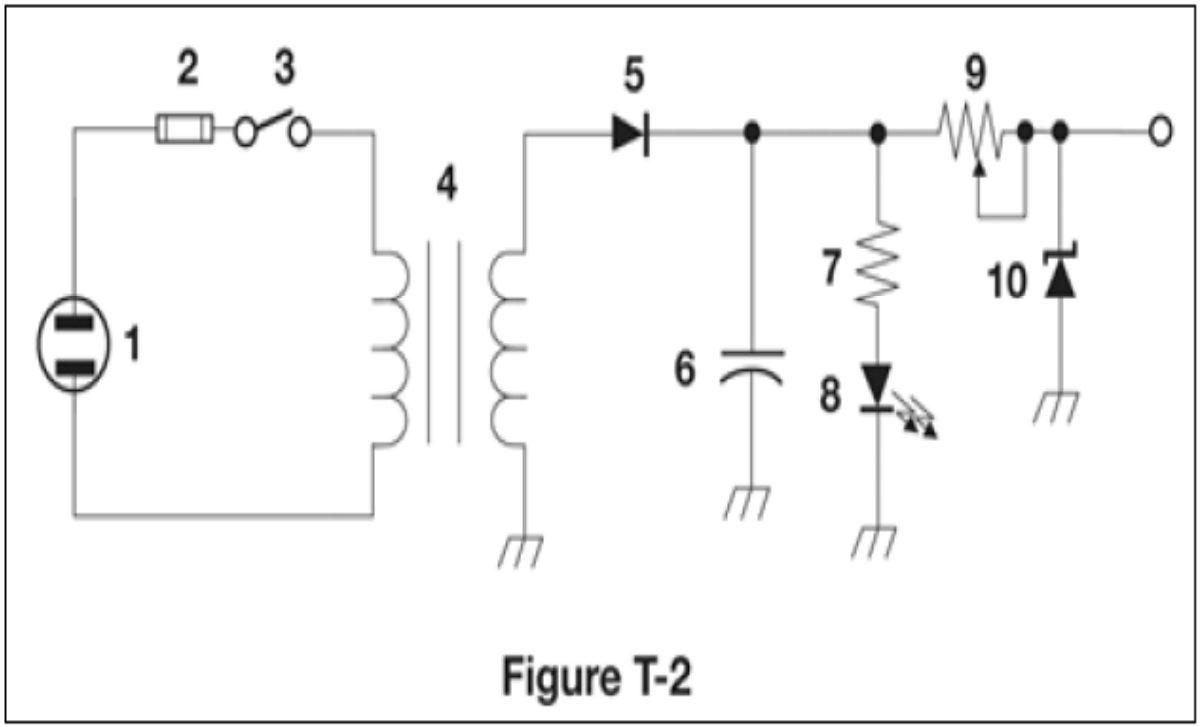


Figure T-2

T6C06 B 3-14

What is component 8 in figure T-2?

A. Resistor
B. Inductor
C. Regulator IC
D. Light emitting

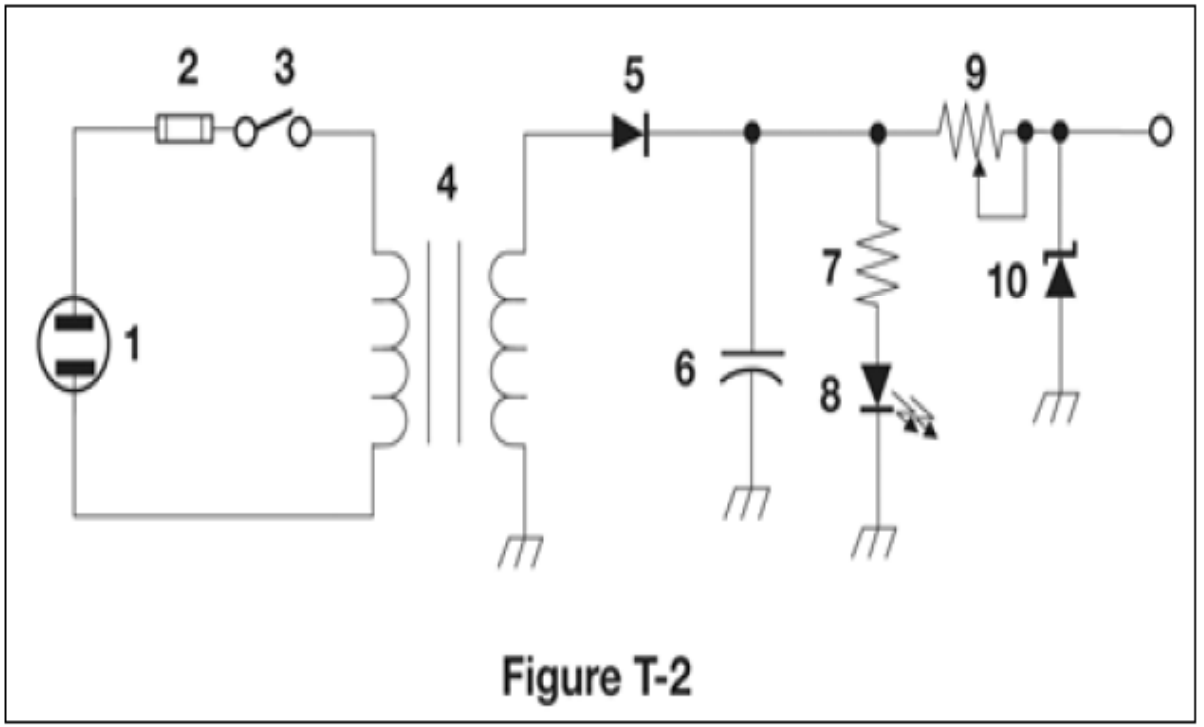


Figure T-2

T6C07 D 3-14

What is component 9 in figure T-2?

A. Variable capa
B. Variable indu
C. Variable resis
D. Variable trans

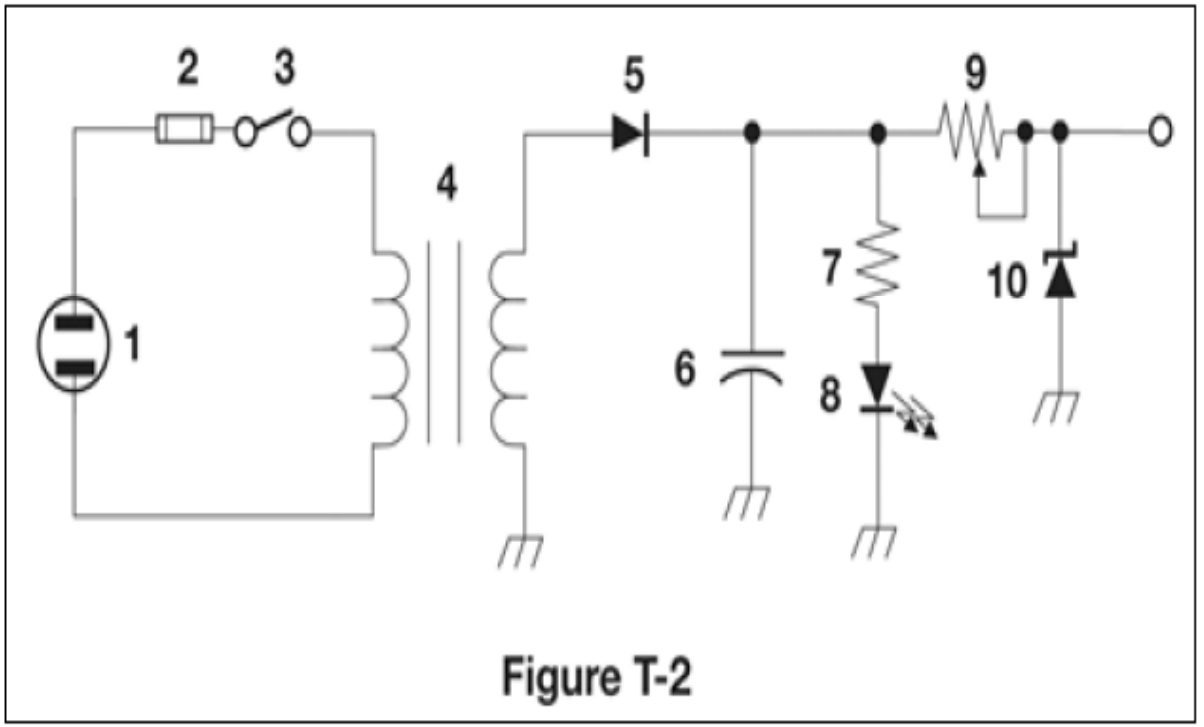


Figure T-2

T6C08 C 3-14

What is component 4 in figure T-2?

A. Variable induc
B. Double-pole s
C. Potentiomete
D. Transformer

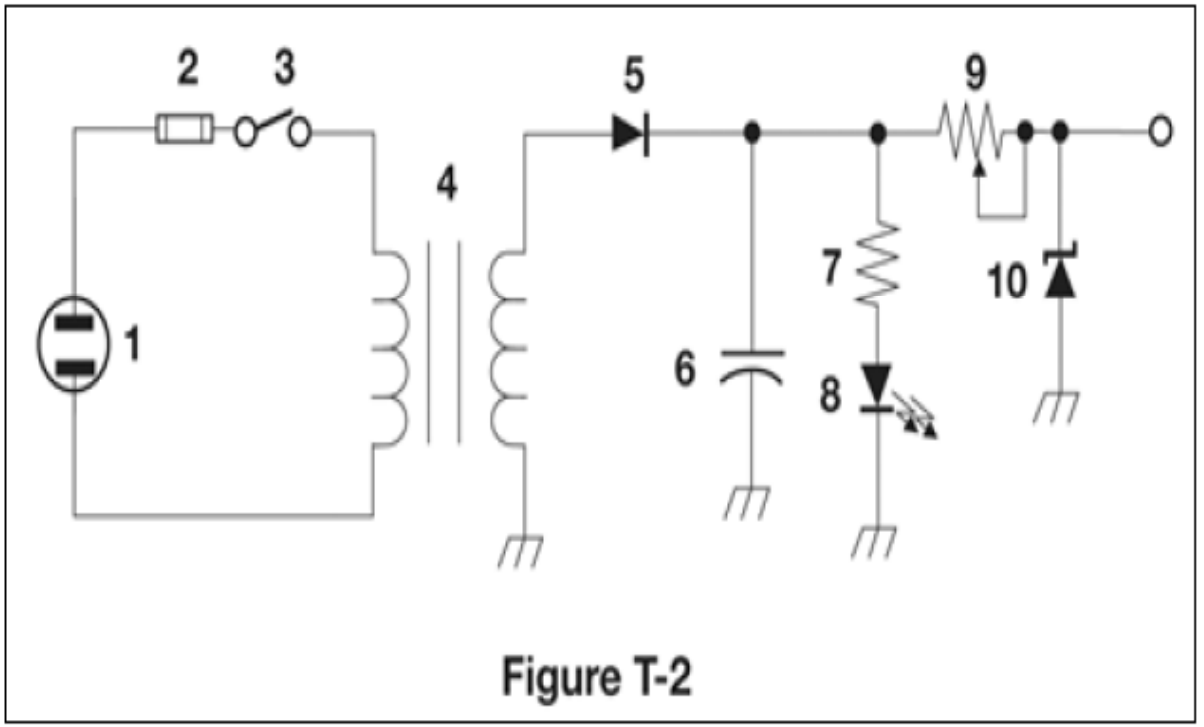


Figure T-2

T6C09 D 3-14

What is component 3 in figure T-3?

A. Connector
B. Meter
C. Variable capacitor
D. Variable inductor

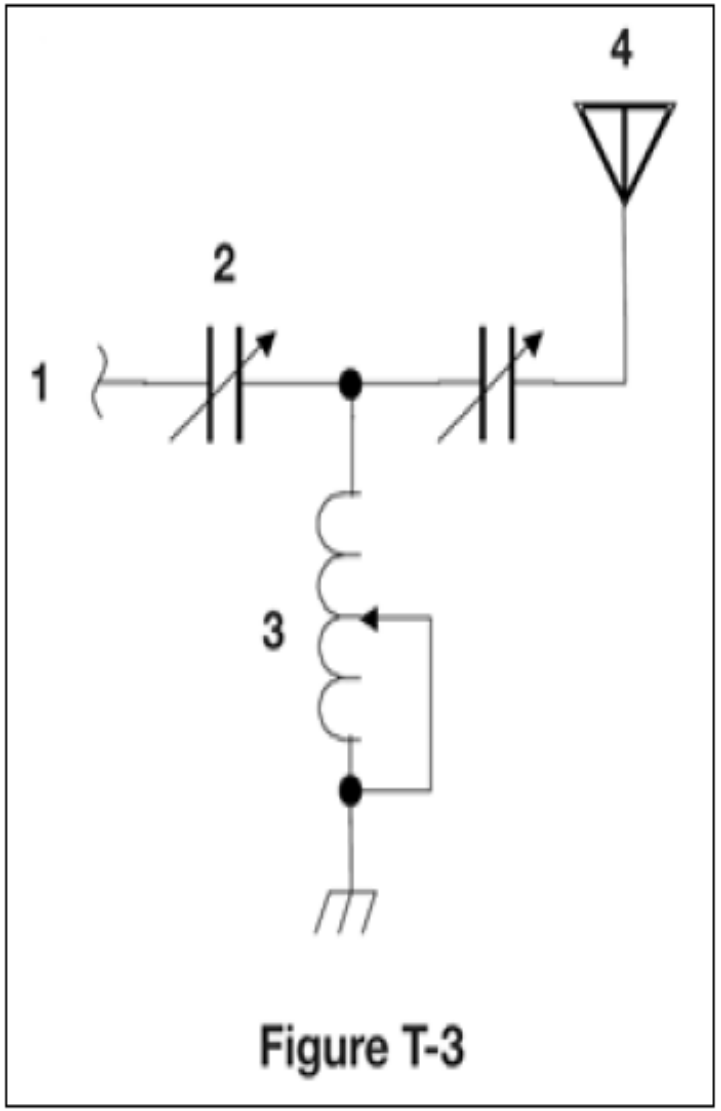


Figure T-3

T6C10 D 3-14

What is component 4 in figure T-3?

A. Antenna
B. Transmitter
C. Dummy load
D. Ground

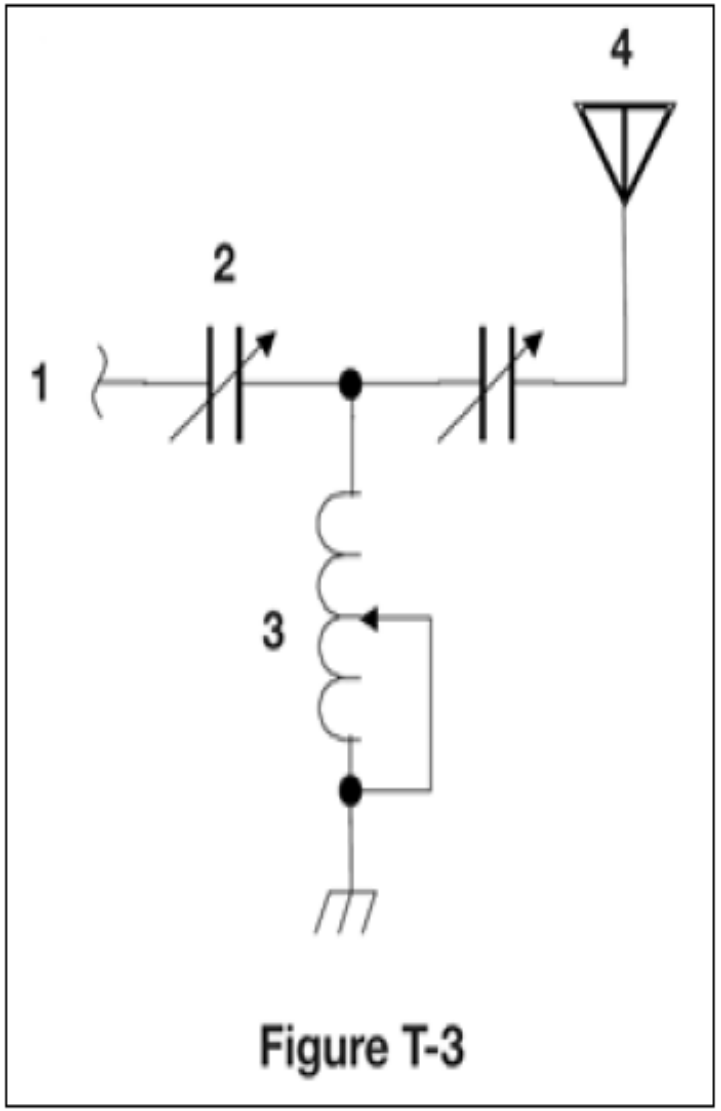


Figure T-3

T6C11 A 3-14

Which of the following is accurately represented in electrical schematics?

A. Wire lengths
B. Physical appearance of components
C. Component connections
D. All these choices are correct

T6C12 C 3-14

Radio Circuits

- An *oscillator* produces a steady signal at one frequency
  - Used in both receivers and transmitters to determine the operating frequency
- The process of combining data or voice signals with an RF signal is *modulation*
- Modulators add the data or voice signal to an RF signal or carrier
  - A *demodulator* circuit extracts the information from a modulated signal

PRACTICE QUESTIONS

What is the name of a circuit that generates a signal at a specific frequency?

A. Reactance modulator
B. Phase modulator
C. Low-pass filter
D. Oscillator

T7A05 D 3-17

Which of the following describes combining speech with an RF carrier signal?

A. Impedance matching
B. Oscillation
C. Modulation
D. Low-pass filtering

T7A08 C 3-17

Which of the following is used to convert a signal from one frequency to another?

A. Phase splitter
B. Mixer
C. Inverter
D. Amplifier

T7A03 B 3-18

END OF MODULE 3

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