Technician License Class

1

Technician Class

Chapter 3

Electricity, Components and Circuits

2

Electricity

Current and Voltage.

- Electrons are negatively-charged atomic particles.
- Electric current is the flow of electrons through a material.

3

Electricity

Current and Voltage.

- The magnitude of a current is the number of electrons flowing past a given point in one second.
- Measured in amperes.
  - 1 Ampere = 1 coulomb/second.
    - 1 coulomb ≈ 6.24 billion billion (6.24×10^{18}) electrons.
  - Abbreviated to ”Amp” or “A”.
  - Use symbol “I” in formulas.
- Current is measured using an ammeter.

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Electricity

Current and Voltage.

- Voltage is the electrical force that causes electrons to flow.
  - a.k.a. – Electromotive force (EMF) or potential.
  - Measured in volts.
    - Abbreviated to “V”
    - Use symbol “E” in formulas
  - Voltage is measured using a voltmeter.

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Electricity

Current and Voltage.

- Voltage has polarity.
  - Positive voltage attracts electrons.
  - Negative voltage repels electrons.
- Voltage is **always** referenced between 2 points.
  - Surface of the earth is often used as a universal reference point.
    - Called earth ground, ground potential, or ground.

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Electricity

Current and Voltage.

- Direct and alternating current.
  - If the electrons always flow in the same direction it is called a direct current (DC).
  - If the direction the electrons are flowing reverses it is called an alternating current (AC).
  - A voltage that always has the same polarity is called a direct voltage (V_{DC}).
  - A voltage where the polarity changes is called an alternating voltage (V_{AC}).

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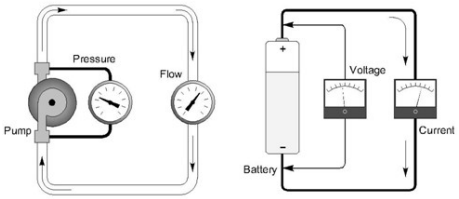
Electricity

Current and Voltage.

- Electrical pressure and flow.
  - The flow of water through a hose or pipe is a good analogy to understand the characteristics of electricity and how they are related.



8

T5A01 -- Electrical current is measured in which of the following units?

A. Volts
B. Watts
C. Ohms
D. Amperes

9

T5A03 -- What is the name for the flow of electrons in an electric circuit?

A. Voltage
B. Resistance
C. Capacitance
D. Current

10

T5A05 -- What is the electrical term for the force that causes electron flow?

A. Voltage
B. Ampere-hours
C. Capacitance
D. Inductance

11

T5A09 -- Which of the following describes alternating current?

A. Current that alternates between a positive direction and zero
B. Current that alternates between a negative direction and zero
C. Current that alternates between positive and negative directions
D. All these answers are correct

12

T7D01 -- Which instrument would you use to measure electric potential?

A. An ammeter
B. A voltmeter
C. A wavemeter
D. An ohmmeter

13

T7D04 -- Which instrument is used to measure electric current?

A. An ohmmeter
B. A wavemeter
C. A voltmeter
D. An ammeter

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Electricity

Circuits.

- A circuit is any path where current can flow.
- For current to flow, the circuit must be closed.
  - Current eventually ends up back where it started.
- If only one path, it is a series circuit.
  - Same current flows through all components.
- If multiple paths, it is a parallel circuit.
  - Same voltage is across all components.

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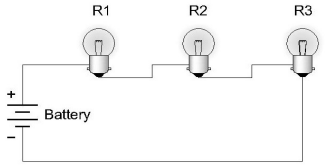
Electricity

Circuits.

- Series circuit.
  - The voltage across each component varies depending on the type and value of each component.
  - The sum of all voltages around the circuit is zero.
  - The same current flows through all components.



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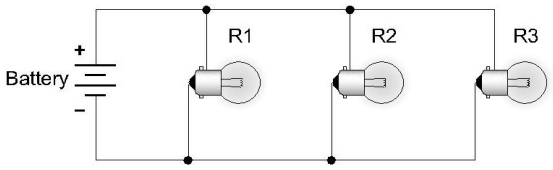
Electricity

Circuits.

- Parallel circuit.
  - The voltage across each component is the same.
  - The sum of all currents in each component equals the total current.
  - The current through each components varies depending on the type and value of the component.



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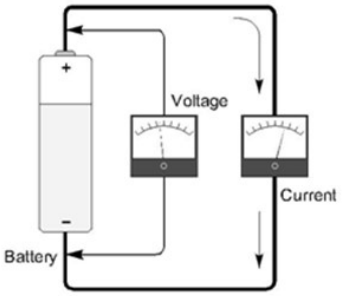
Electricity

Circuits.

- Measuring voltage and current.
  - Voltmeters are always placed in parallel with the circuit.
  - Ammeters are always placed in series with the circuit.



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T5D13 -- In which type of circuit is current the same through all components?

A. Series
B. Parallel
C. Resonant
D. Branch

19

T5D14 -- In which type of circuit is voltage the same across all components?

A. Series
B. Parallel
C. Resonant
D. Branch

20

T7D02 -- How is a voltmeter connected to a component to measure applied voltage?

A. In series
B. In parallel
C. In quadrature
D. In phase

21

T7D03 -- When configured to measure current, how is a multimeter connected to a component?

A. In series
B. In parallel
C. In quadrature
D. In phase

22

Electricity

Economies of Scale -- The Multimeter

- The most basic piece of test equipment.
  - Everybody should have one.
- Three (or more) instruments in one:
  - Voltmeter
  - Ammeter
  - Ohmmeter
- Measures volts, amperes, and ohms in one package.

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Electricity

Economies of Scale -- The Multimeter.

- Digital multimeter (DVM)
  - Very inexpensive.
  - Often has extra features in addition to measuring volts, amps, & ohms.

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Electricity

Economies of Scale -- The Multimeter.

- Meters can only measure current.
  - A voltmeter measures voltage by:
    - Placing a known resistance in parallel with the voltage being measured.
    - Measuring the current through the known resistance.
    - Calculating the voltage using Ohm's law.
  - An ohmmeter measures resistance by:
    - Applying a known voltage to the circuit being measured.
    - Measuring the resulting current.
    - Calculating the resistance using Ohm's law.

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Electricity

The Multimeter.

- Measuring resistance.
  - **NEVER** attempt to measure resistance with power applied to the circuit.
    - You **WILL** damage your multimeter.
  - **NEVER** attempt to measure voltage with the resistance setting.
    - You **WILL** damage your multimeter.

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Electricity

The Multimeter.

- When measuring high voltages, make certain that the voltmeter and the test leads are rated for the voltage being measured.
- If a resistance reading is initially low but slowly increases to a higher value, it indicates the presence of a large capacitance in the circuit.

27

T7D06 -- Which of the following can damage a multimeter?

A. Attempting to measure resistance using the voltage setting
B. Failing to connect one of the probes to ground
C. Attempting to measure voltage when using the resistance setting
D. Not allowing it to warm up properly

28

T7D07 -- Which of the following measurements are made using a multimeter?

A. Signal strength and noise
B. Impedance and reactance
C. Voltage and resistance
D. All these choices are correct

29

T7D10 -- What reading indicates that an ohmmeter is connected across a large, discharged capacitor?

A. Increasing resistance with time
B. Decreasing resistance with time
C. Steady full-scale reading
D. Alternating between open and short circuit

30

T7D11 -- Which of the following precautions should be taken when measuring circuit resistance with an ohmmeter?

A. Ensure that the applied voltages are correct
B. Ensure that the circuit is not powered
C. Ensure that the circuit is grounded
D. Ensure that the circuit is operating at the correct frequency

31

T0A12 -- Which of the following precautions should be taken when measuring high voltages with a voltmeter?

A. Ensure that the voltmeter has very low impedance
B. Ensure that the voltmeter and leads are rated for use at the voltages to be measured
C. Ensure that the circuit is grounded through the voltmeter
D. Ensure that the voltmeter is set to the correct frequency

32

Electricity

Resistance and Ohm's Law.

- Resistance
  - The opposition to the flow of electrons.
  - Unit of measurement is the Ohm (Ω).
  - Measured with an ohmmeter.

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Electricity

Resistance and Ohm's Law.

- Resistance
  - All materials exhibit resistance.
    - Materials with a lot of free electrons (such as metals) have low resistance & are called conductors.
    - Materials with few free electrons (such as glass or rubber) have high resistance & are called insulators.

34

T5A04 -- What are the units of electrical resistance?

A. Siemens
B. Mhos
C. Ohms
D. Coulombs

35

T5A07 -- Why are metals generally good conductors of electricity?

A. They have relatively high density
B. They have many free electrons
C. They have many free protons
D. All these choices are correct

36

T5A08 -- Which of the following is a good electrical insulator?

A. Copper
B. Glass
C. Aluminum
D. Mercury

37

T5A11 -- What type of current flow is opposed by resistance?

A. Direct current
B. Alternating current
C. RF current
D. All these choices are correct

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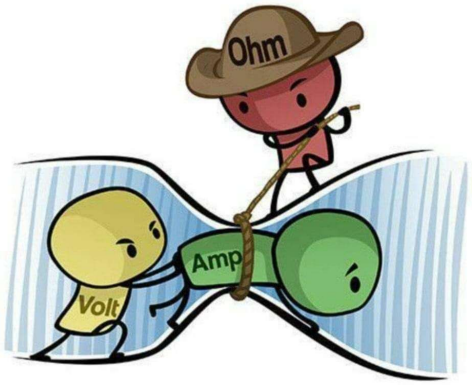
Electricity

Resistance and Ohm's Law.



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Electricity

Resistance and Ohm's Law.

- First published in 1827 by Georg Ohm in his book "*Die galvanische Kette, mathematisch bearbeitet*"
- Mathematically describes the relationship between voltage, current, and resistance.
- Most basic formula in electricity and electronics.

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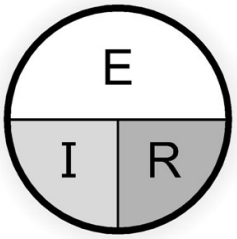
Electricity

Resistance and Ohm's Law.

- E = Electromotive Force
  - Force causing electrons to flow.
- I = Current Intensity
  - Number of electrons flowing past a point in a given period of time.
- R = Resistance
  - Opposition to flow of electrons.



E = I x R
I = E/R
R = E/I

41

T5D01 -- What formula is used to calculate current in a circuit?

A. I = E x R
B. I = E / R
C. I = E + R
D. I = E - R

42

T5D02 -- What formula is used to calculate voltage in a circuit?

A. E = I x R
B. E = I / R
C. E = I + R
D. E = I - R

43

T5D03 -- What formula is used to calculate resistance in a circuit?

A. R = E x I
B. R = E / I
C. R = E + I
D. R = E - I

44

T5D04 -- What is the resistance of a circuit in which a current of 3 amperes flows when connected to 90 volts?

A. 3 ohms
B. 30 ohms
C. 93 ohms
D. 270 ohms

45

T5D05 -- What is the resistance of a circuit for which the applied voltage is 12 volts and the current flow is 1.5 amperes?

A. 18 ohms
B. 0.125 ohms
C. 8 ohms
D. 13.5 ohms

46

T5D06 -- What is the resistance of a circuit that draws 4 amperes from a 12-volt source?

A. 3 ohms
B. 16 ohms
C. 48 ohms
D. 8 ohms

47

T5D07 -- What is the current in a circuit with an applied voltage of 120 volts and a resistance of 80 ohms?

A. 9600 amperes
B. 200 amperes
C. 0.667 amperes
D. 1.5 amperes

48

T5D08 -- What is the current through a 100-ohm resistor connected across 200 volts?

A. 20,000 amperes
B. 0.5 amperes
C. 2 amperes
D. 100 amperes

49

T5D09 -- What is the current through a 24-ohm resistor connected across 240 volts?

A. 24,000 amperes
B. 0.1 amperes
C. 10 amperes
D. 216 amperes

50

T5D10 -- What is the voltage across a 2-ohm resistor if a current of 0.5 amperes flows through it?

A. 1 volt
B. 0.25 volts
C. 2.5 volts
D. 1.5 volts

51

T5D11 -- What is the voltage across a 10-ohm resistor if a current of 1 ampere flows through it?

A. 1 volt
B. 10 volts
C. 11 volts
D. 9 volts

52

T5D12 -- What is the voltage across a 10-ohm resistor if a current of 2 amperes flows through it?

A. 8 volts
B. 0.2 volts
C. 12 volts
D. 20 volts

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Electricity

Power.

- The rate at which energy is consumed.
  - Any kind of energy – electrical, mechanical, etc.
- Power is measured in watts.
  - Abbreviated "W".
  - Use symbol "P" in formulas.
  - 1 hp ≈ 745 watts.
- Power is measured using a wattmeter.

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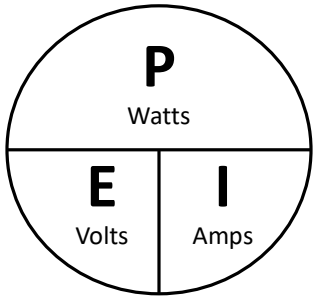
Electricity

Power.



$P = E \times I$

$E = P / I$

$I = P / E$

$P = E^2/R$

$P = I^2 \times R$

55

T5A02 -- Electrical power is measured in which of the following units?

A. Volts
B. Watts
C. Watt-hours
D. Amperes

56

T5A10 -- Which term describes the rate at which electrical energy is used?

A. Resistance
B. Current
C. Power
D. Voltage

57

T5C08 -- What is the formula used to calculate electrical power (P) in a DC circuit?

A. P = I x E
B. P = E / I
C. P = E – I
D. P = I + E

58

T5C09 -- How much power is delivered by a voltage of 13.8 volts DC and a current of 10 amperes?

A. 138 watts
B. 0.7 watts
C. 23.8 watts
D. 3.8 watts

59

T5C10 -- How much power is delivered by a voltage of 12 volts DC and a current of 2.5 amperes?

A. 4.8 watts
B. 30 watts
C. 14.5 watts
D. 0.208 watts

60

T5C11 -- How much current is required to deliver 120 watts at a voltage of 12 volts DC?

A. 0.1 amperes
B. 10 amperes
C. 12 amperes
D. 132 amperes

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Components and Units

Basic Components.

- 3 basic types of components:
  - Resistors.
  - Capacitors.
  - Inductors.

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Components and Units

Basic Components.

- Resistors.
  - A specific amount of a partially conductive material.
  - Oppose flow of electric current.
    - Resistance.
    - Convert electrical energy to heat energy.

63

Components and Units

Basic Components.

- Resistors.
  - Unit of measurement is the ohm (Ω).
  - Values expressed as:
    - Ohms (Ω).
    - Kilohms (1kΩ = 1,000 Ω).
    - Megohms (1MΩ = 1,000,000 Ω).
    - Values available from <1 Ω to >10 MΩ.
  - Maximum power rating in watts (W).
    - 1/8W to several hundred watts.

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Components and Units

Basic Components.

- Capacitors.
  - Two conductive surfaces separated by an insulator.
  - Temporarily store electrical energy.
  - Stores energy in an electric field.
    - Capacitance.
    - Like a very temporary storage battery.

65

Components and Units

Basic Components.

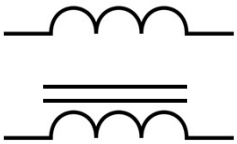
- Capacitors.
  - Unit of measurement is the farad (F).
  - Values expressed as:
    - Farads (F).
    - Microfards (1 µF = 10^{-6} F).
    - Picofarads (1 pF = 10^{-12} F).
      - Values available from 1 pF to >1 F.
  - Maximum voltage rating in volts (V), or kilovolts (kV).
    - Values from a few volts to several kilovolts.

66

Components and Units

Basic Components.

- Inductors.
  - A coil of wire, possible wound on a magnetic core.
  - Temporarily store electrical energy.
    - Stores energy in a magnetic field.
    - Inductance.



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Components and Units

Basic Components.

- Inductors.
  - Unit of measurement is the henry (H).
  - Values expressed as:
    - Henries (H).
    - Millihenries (1 mH = 10^{-3} H).
    - Microhenries (1 µH = 10^{-6} F).
      - Values available from 1 µH to several Henries.
  - Maximum current rating in milliamps (mA) or amps (A).
    - Values from a few milliamps to several amps.

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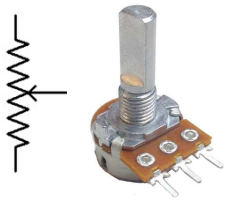
Components and Units

Basic Components.

- All 3 types of components can be made adjustable.
  - Commonly referred to as “variable”.
- A variable resistor with 3 terminals is often called a “potentiometer”.
  - Commonly shortened to “pot”.
  - Used to adjust voltage or signal level.
    - e.g. – Volume control.



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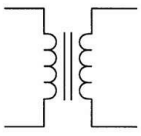
Components and Units

Basic Components.

- Transformers.
  - Two or more inductors arranged so that they share their stored magnetic energy.
  - Used to change AC voltage levels.
    - e.g. - Change 120 V_{AC} household voltage to a lower value for use in electronic equipment.



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Components and Units

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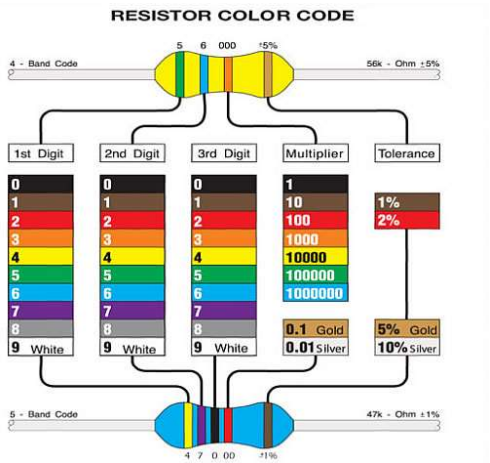

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T5C01 -- What describes the ability to store energy in an electric field?

A. Inductance
B. Resistance
C. Tolerance
D. Capacitance

72

T5C02 -- What is the unit of capacitance?

A. The farad
B. The ohm
C. The volt
D. The henry

73

T5C03 -- What describes the ability to store energy in a magnetic field?

A. Admittance
B. Capacitance
C. Resistance
D. Inductance

74

T5C04 -- What is the unit of inductance?

A. The coulomb
B. The farad
C. The henry
D. The ohm

75

T6A01 -- What electrical component opposes the flow of current in a DC circuit?

A. Inductor
B. Resistor
C. Voltmeter
D. Transformer

76

T6A02 -- What type of component is often used as an adjustable volume control?

A. Fixed resistor
B. Power resistor
C. Potentiometer
D. Transformer

77

T6A03 -- What electrical parameter is controlled by a potentiometer?

A. Inductance
B. Resistance
C. Capacitance
D. Field strength

78

T6A04 -- What electrical component stores energy in an electric field?

A. Varistor
B. Capacitor
C. Inductor
D. Diode

79

T6A05 -- What type of electrical component consists of conductive surfaces separated by an insulator?

A. Resistor
B. Potentiometer
C. Oscillator
D. Capacitor

80

T6A06 -- What type of electrical component stores energy in a magnetic field?

A. Varistor
B. Capacitor
C. Inductor
D. Diode

81

T6A07 -- What electrical component is typically constructed as a coil of wire?

A. Switch
B. Capacitor
C. Diode
D. Inductor

82

T6D06 -- What component changes 120 V AC power to a lower AC voltage for other uses?

A. Variable capacitor
B. Transformer
C. Transistor
D. Diode

83

Components and Units

Reactance and Impedance.

- In circuits containing only resistors, the voltage & current are always “in phase”.
  - Current flow changes at the same time and in the same direction as the voltage change.

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Components and Units

Reactance and Impedance.

- In circuits containing capacitors or inductors, voltage & current are “out of phase”.
  - Current flow changes before the voltage changes in a capacitor.
    - Current “leads” voltage.
  - Current flow changes after the voltage changes in an inductor.
    - Current “lags” voltage.

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Components and Units

Reactance and Impedance.

ELI the **ICE** man

86

Components and Units

Reactance and Impedance.

- The opposition to AC current flow in capacitors or inductors is called reactance (X).
  - Reactance (X) is measured in Ohms (Ω).
    - Capacitive reactance (X_C) is measured in Ohms (Ω).
    - Inductive reactance (X_L) is measured in Ohms (Ω).
- The combination of resistance and reactance is called impedance (Z).
  - Impedance (Z) is measured in Ohms (Ω).

87

T5C12 -- What is impedance?

A. The opposition to AC current flow
B. The inverse of resistance
C. The Q or Quality Factor of a component
D. The power handling capability of a component

88

T5C05 -- What is the unit of impedance?

A. The volt
B. The ampere
C. The coulomb
D. The ohm

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Components and Units

Resonance.

- Because current leads voltage in a capacitor & lags voltage in an inductor, a combination of capacitance & inductance exists where the lead time & lag time cancel, resulting in the current & voltage being in phase.
- This condition is called resonance.

90

Components and Units

Resonance.

- Resonant circuit.
  - a.k.a. - Tuned circuit.
  - Acts as filter.
  - Used to adjust frequency of receiver or transmitter.
- The capacitive reactance (X_C) and inductive reactance (X_L) in a resonant circuit are equal.
- Impedance (Z) of a resonant circuit is purely resistive.
  - Reactance = 0Ω.

91

T6D08 -- Which of the following is combined with an inductor to make a resonant circuit?

A. Resistor
B. Zener diode
C. Potentiometer
D. Capacitor

92

T6D11 -- Which of the following is a resonant or tuned circuit?

A. An inductor and a capacitor in series or parallel
B. A linear voltage regulator
C. A resistor circuit used for reducing standing wave ratio
D. A circuit designed to provide high-fidelity audio

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Break

94

Components and Units

Diodes, Transistors, and Integrated Circuits.

- Resistors, capacitors, and inductors are linear devices.
  - Response is **ALWAYS** proportional to the stimulus.

95

Components and Units

Diodes, Transistors, and Integrated Circuits.

- Diodes and transistors are non-linear devices.
  - Response is **NOT** always proportional to the stimulus.

96

Components and Units

Diodes, Transistors, and Integrated Circuits.

- Semi-conductors.
  - Some materials are not good conductors, but are not good insulators either.
    - Silicon, Germanium, etc.

97

Components and Units

Diodes, Transistors, and Integrated Circuits.

- Doping.
  - Adding impurities to certain semi-conductor materials changes their ability to control the flow of current.
    - P-type material.
    - N-type material.

98

Components and Units

Diodes, Transistors, and Integrated Circuits.

- Junctions.
  - When P-type & N-type materials are placed in contact with each other, a “junction” is created.
  - Current will flow easily in one direction through a junction but not in the other direction.

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Components and Units

Diodes, Transistors, and Integrated Circuits.

- Diodes.
  - The function of the diode is to allow the flow of current in only one direction.
    - Connections named anode & cathode.
      - Cathode is normally identified with a stripe.
    - An analogy is a check valve in a water pipe.

100

Components and Units

Diodes, Transistors, and Integrated Circuits.

- Diodes.

101

Components and Units

Diodes, Transistors, and Integrated Circuits.

- Diodes.
  - High voltage and/or high current diodes designed for use in power supplies are sometimes called “rectifiers”.
    - Convert AC voltage to a varying DC voltage.

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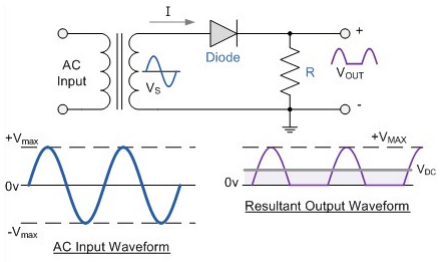
Components and Units

Diodes, Transistors, and Integrated Circuits.

- Diodes.



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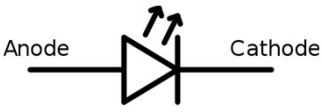
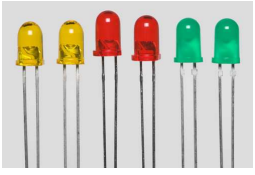
Components and Units

Diodes, Transistors, and Integrated Circuits.

- Light-Emitting Diodes (LEDs).
  - Special types of diodes that emit light from the junction when current flows.
    - Color of the light determined by the type of semi-conductor material used.
    - Commonly used as visual indicators.





104

Components and Units

Diodes, Transistors, and Integrated Circuits.

- Forward Voltage Drop.
  - When current is flowing through a junction in the forward direction, there is a voltage drop across the junction.
  - This voltage drop is not affected by the amount of current flowing.

105

Components and Units

Diodes, Transistors, and Integrated Circuits.

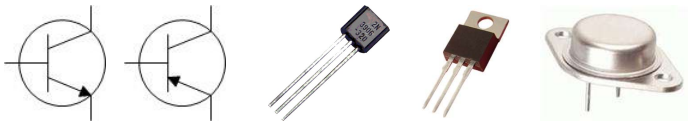
- Forward Voltage Drop.
  - The voltage drop is different for different types of materials.
    - Germanium = ~0.3 volts.
    - Silicon = ~0.7 volts.
    - LEDs = ~1.2 to 1.5 volts.

106

Components and Units

Diodes, Transistors, and Integrated Circuits.

- Transistors.
  - Have 3 layers of material & 2 junctions.
    - N-P-N.
    - P-N-P.



107

Components and Units

Diodes, Transistors, and Integrated Circuits.

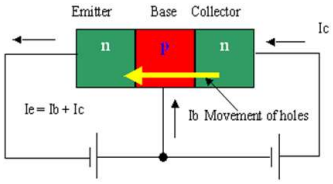
- Transistors.
  - Bipolar Transistors.
    - Connections named Emitter, Base, & Collector.
    - Small change in base current results in large change in emitter current.
    - Low input impedance.
    - Low output impedance.

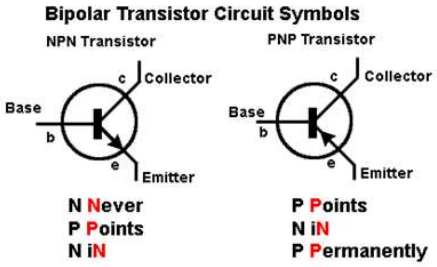
108

Components and Units

Diodes, Transistors, and Integrated Circuits.

- Transistors.
  - Bipolar Transistors.





109

Components and Units

Diodes, Transistors, and Integrated Circuits.

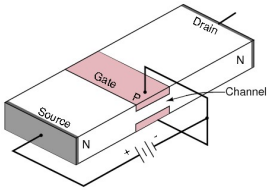
- Transistors.
  - Field-Effect Transistors (FETs).
    - Connections named Source, Drain, & Gate.
    - Change in gate voltage results in change in drain current.
    - High input impedance.
    - Low output impedance.

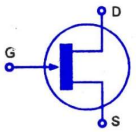
110

Components and Units

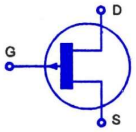
Diodes, Transistors, and Integrated Circuits.

- Transistors.
  - Field-Effect Transistors (FETs).





N-Channel JFET



P-Channel JFET

111

Components and Units

Diodes, Transistors, and Integrated Circuits.

- Transistors.
  - Both bipolar transistors and FETs can be used to amplify signals.
    - Gain.
  - Both bipolar transistors and FETs can be used to turn signals on or off.
    - Electronic switch.

112

Components and Units

Diodes, Transistors, and Integrated Circuits.

- Integrated circuits.
  - A collection of components contained in one device that accomplishes a specific task.
    - Acts like a “black-box”.

113

T6B01 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

114

T6B02 -- What electronic component allows current to flow in only one direction?

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

115

T6B03 -- Which of these components can be used as an electronic switch?

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

116

T6B04 -- Which of the following components can consist of three regions of semiconductor material?

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

117

T6B05 -- What type of transistor has a gate, drain, and source?

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

118

T6B06 -- 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

119

T6B07 -- 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

120

T6B08 -- What does the abbreviation FET stand for?

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

121

T6B09 -- 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

122

T6B10 -- Which of the following can provide power gain?

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

123

T6B11 -- 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

124

T6B12 -- 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

125

T6D01 -- 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

126

T6D07 -- Which of the following is commonly used as a visual indicator?

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

127

T6D09 -- 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

128

T6D10 -- 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 waves

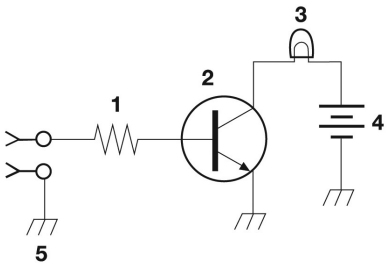


Figure T-1

129

Components and Units

Protective Components.

- Used to prevent or limit damage and safety hazards.
  - Fuse.
  - Circuit breaker.
  - Ground fault circuit interrupter (GFCI).
  - Surge protectors.
  - Lightning arrestors.

130

Components and Units

Protective Components.

- Fuses blow.
  - One-time protection.
  - A piece of metal melts when the maximum current is exceeded.




131

Components and Units

Protective Components.

- Circuit breakers trip.
  - Use a bi-metallic strip or an electromagnet to open circuit when the maximum current is exceeded.
  - Can be reset & reused.

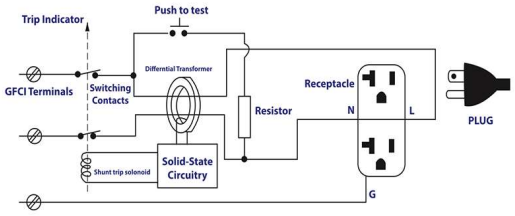


132

Components and Units

Protective Components.

- Ground fault circuit interrupter (GFCI).
  - Opens the circuit if the current flowing into a device is not equal to the current flowing out of the device.
  - Can be reset & reused.



133

Components and Units

Protective Components.

- Surge protectors.
  - Limit transient voltage spikes.
  - AC power lines (outlet strips).
  - Telephone wiring.
- Lightning arrestors.
  - Limit transient voltage spikes.
  - Antenna feed lines.

134

T6A09 -- 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

135

T0A04 -- 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

136

T0A05 -- 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 of these choices are correct

137

Components and Units

Circuit gatekeepers.

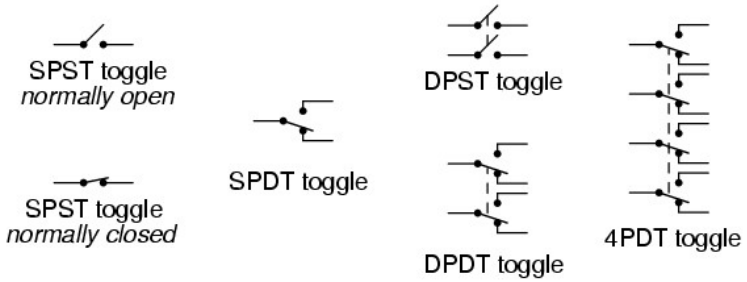
- Switches and relays are used to control the flow of current through a circuit.
  - Turn current flow off
    - a.k.a. – Opening the circuit.
  - Turn current flow on
    - a.k.a. – Closing the circuit.
  - Make the current take a different path.

138

Components and Units

Circuit gatekeepers.

- Switches.
  - Manually operated.

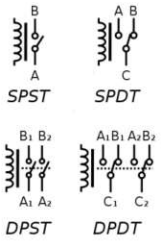


139

Components and Units

Circuit gatekeepers.

- Relays.
  - An electrically-controlled switch.
  - A set of switch contacts connected to an electromagnet.



140

T6A08 -- 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

141

T6A12 -- 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

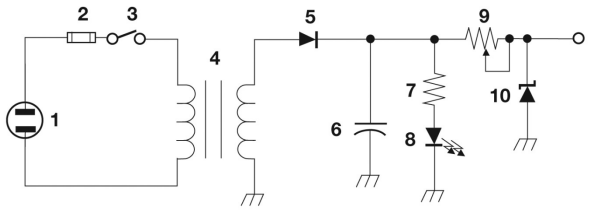


Figure T-2

142

T6D02 -- What is a relay?

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

143

Components and Units

Indicators, Meters, and Displays.

- An indicator displays on/off status.
- A meter shows a value on a numeric scale.
- A display consists of several indicators and/or meters.

144

T6D04 -- Which of the following displays an electrical quantity as a numeric value?

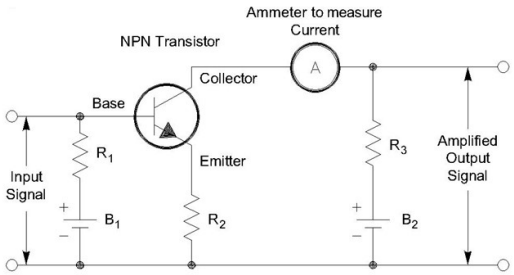
A. Potentiometer
B. Transistor
C. Meter
D. Relay

145

Components and Units

Schematics and Component Symbols.

- A schematic diagram portrays how components are connected together to form a circuit.



146

Components and Units

Schematics and Component Symbols.

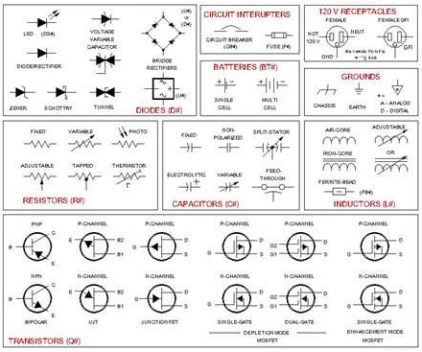
- Schematic diagrams:
  - **DO** use a set of standard symbols for each component in a circuit.
  - **DO** represent the way components are interconnected.
  - **DO NOT** represent the physical layout of the components.
  - **DO NOT** represent the length of the conductors used for the interconnections.

147

Components and Units

Schematics and Component Symbols.

- Component symbols.



148

T6C01 -- 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

149

T6C02 -- What is component 1 in figure T-1?

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

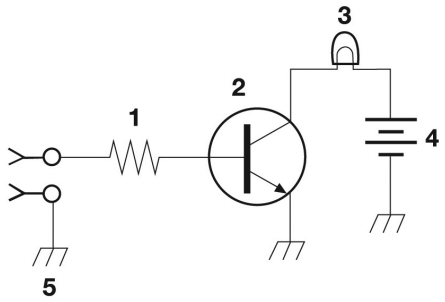


Figure T-1

150

T6C03 -- What is component 2 in figure T-1?

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

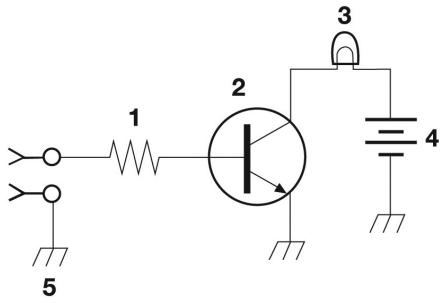


Figure T-1

151

T6C04 -- What is component 3 in figure T-1?

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

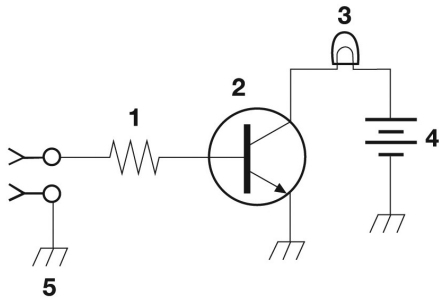


Figure T-1

152

T6C05 -- What is component 4 in figure T-1?

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

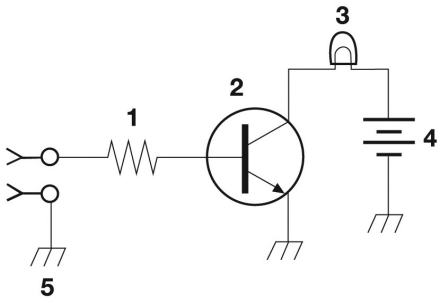


Figure T-1

153

T6C06 -- What is component 6 in figure T-2?

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

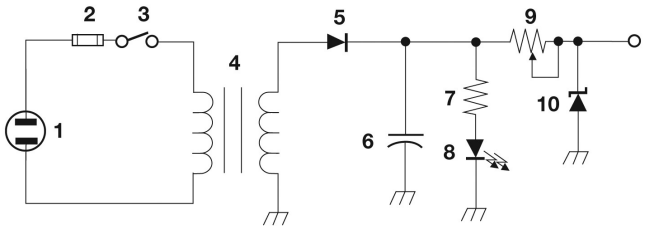


Figure T-2

154

T6C07 -- What is component 8 in figure T-2?

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

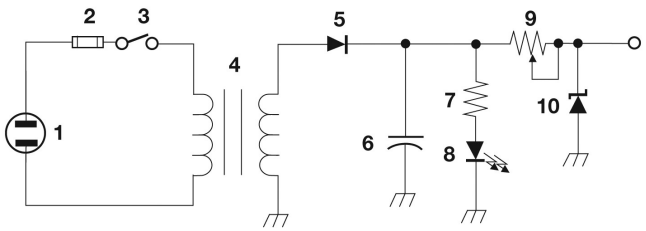


Figure T-2

155

T6C08 -- What is component 9 in figure T2?

A. Variable capacitor
B. Variable inductor
C. Variable resistor
D. Variable transformer

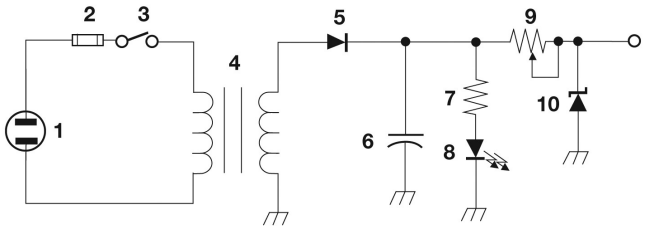


Figure T-2

156

T6C09 -- What is component 4 in figure T2?

A. Variable inductor
B. Double-pole switch
C. Potentiometer
D. Transformer

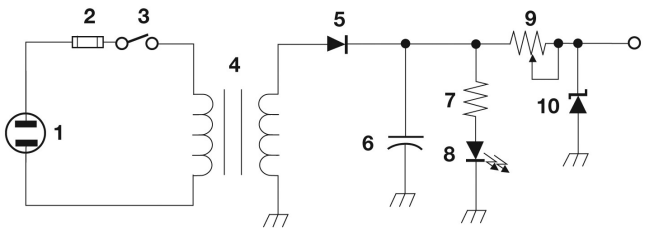


Figure T-2

157

T6C10 -- What is component 3 in figure T-3?

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

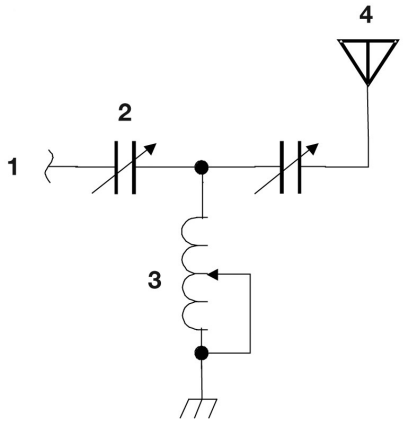


Figure T-3

158

T6C11 -- What is component 4 in figure T-3?

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

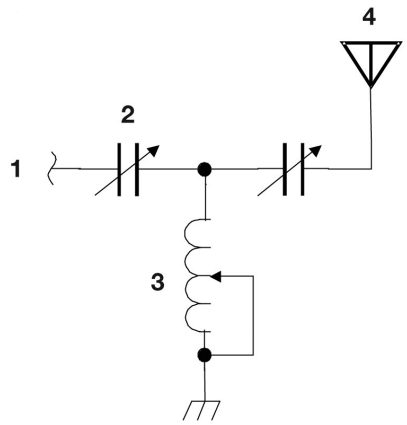


Figure T-3

159

T6C12 -- 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

160

Radio Circuits

Oscillators and Amplifiers.

- Oscillators produce a low-power signal at a specific frequency.
  - Used in both receivers & transmitters to determine operating frequency.
  - Crystal-controlled oscillator.
  - Variable-frequency oscillator (VFO).

161

Radio Circuits

Oscillators and Amplifiers.

- Amplifiers increase the strength of a signal.
  - Increase voltage, current, or power.
  - Amount of increase is called “gain”.
    - Numeric value – For example, a gain of 10 means the output signal is 10 times bigger than input signal.
    - dB – For example, a power gain of 3 dB means the output signal has twice the power than the input signal.

162

T7A05 -- What is the name of a circuit that generates a signal at a specific frequency?

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

163

Radio Circuits

Modulators.

- The process of combining information (voice, data, etc.) signals with an RF signal (carrier) is called “modulation”.
  - Can be as simple as an on-off switch.
    - Telegraph key.
  - Can be very complex.
- The circuit that does the modulation is called a “modulator”.

164

T7A08 -- Which of the following describes combining speech with an RF carrier signal?

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

165

Radio Circuits

Mixers.

- Mixers combine 2 different frequency signals together to produce 4 output frequencies.
  - f_1 x f_2 → f_1, f_2, f_1-f_2, & f_1+f_2.
  - Usually only one output frequency wanted, so filters remove the other 3 frequencies.
  - Used in both transmitters & receivers.
- Used to shift a signal or group of signals to another frequency.

166

T7A03 -- Which of the following is used to convert a radio signal from one frequency to another?

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

167

Questions?

168

Technician Class

Next Week

Chapter 4

Propagation, Antennas and Feed Lines

169