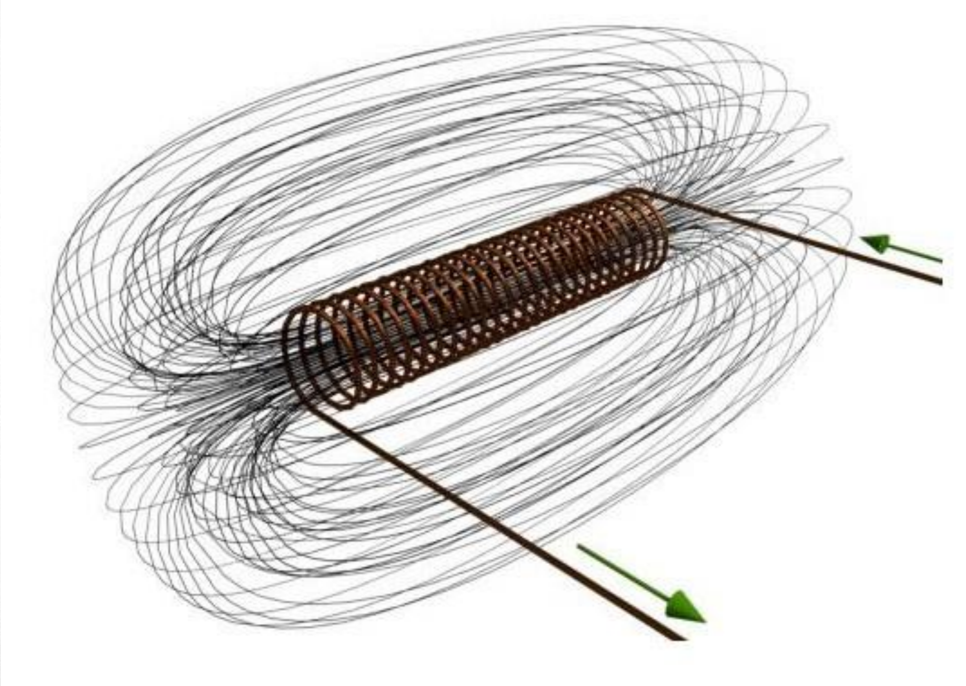
General License Course Chapter 4.1 - Electrical Review

ARRL The national association for AMATEUR RADIO

Show and Tell: *Toys…*

Demos: Inductor, electromagnet/compass, transformer

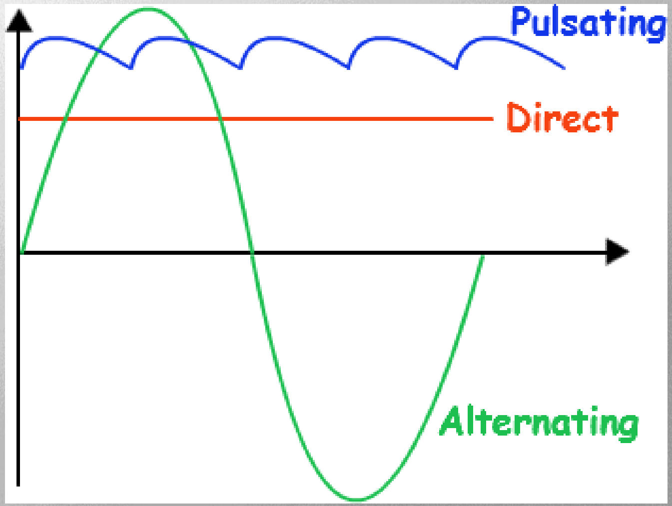


ARRL The national association for AMATEUR RADIO

Direct vs. Alternating Current

- Alternating current (AC) - the flow of electric current periodically reverses direction *(alternates)*
- Direct current (DC) - the flow of electric current is only in one direction
- One AC cycle is shown below, in green. 60 Hz (cycles per second) is the frequency of AC power transmission in the U.S.

Vertical axis = voltage
Horizontal axis = time



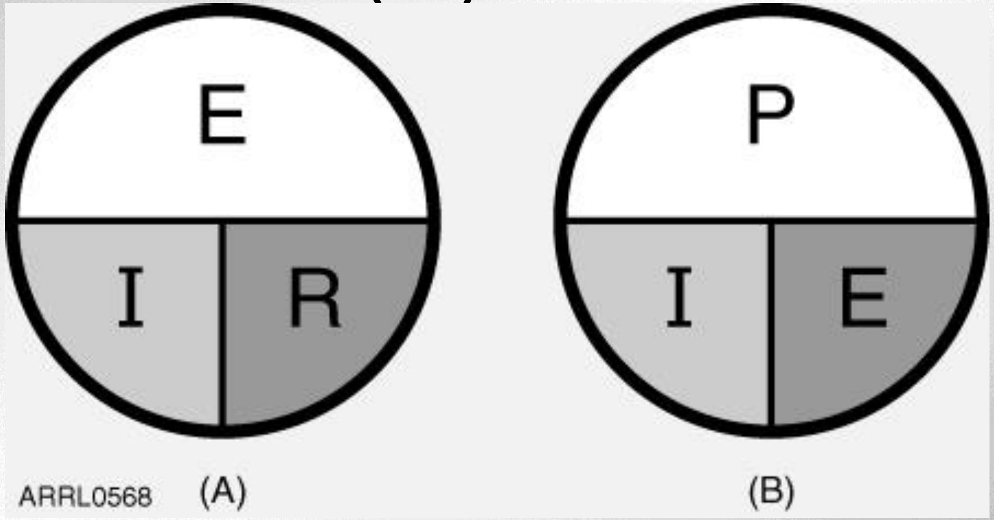
Current, Voltage, and Power

- *Current* = I, the flow of electrons, measured in Amperes (A or Amps) with an ammeter
- *Voltage* = E, electro-motive force that makes electrons move, measured in volts (V) with a voltmeter
- *Power* (P) is measured in watts (W) with a wattmeter,

$$P = E \times I$$

Resistance & Ohms Law

- Resistance (R) is the opposition to current flow measured in Ohms (Ω) with an ohmmeter.



R=E/I, I=E/R, E=I x R, P=I x E, $P=I^2 \times R$, $P=E^2 / R$

Pay attention to UNITS of measurement!

Doing the Math

- How many watts of electrical power are used if 400 V dc is supplied to an 800 ohm resistor (load)?

$$P=E^2/R$$

$$P= (400 \times 400) / 800 = 160{,}000 / 800$$

160,000 / 800 = **<u>200 watts</u>**

ARRL The national association for AMATEUR RADIO

Doing the Math

- How many watts of electrical power are used by a 12V dc light bulb that draws 0.2 A?
  - P = E x I
- P = 12V x 0.2A = **2.4 watts**

ARRL The national association for AMATEUR RADIO

Doing the Math

- How many watts are being dissipated when a current of 7.0 mA flows through a 1250 ohm resistance?
    - $P = I^2 \times R$ *(I in <u>Amps</u>, R in <u>OHMS</u>!)*
    - P = (.007 x .007) X 1250 = 0.06125 W
    - 0.06125 W = ~**<u>61 mW</u>** (milliwatts)

ARRL The national association for AMATEUR RADIO

The **decibel (dB)**

- The **decibel (dB)** is a logarithmic unit used to express the ratio of two values of a physical quantity. One of these values is a standard reference value, in which case the decibel is used to express the level of the other value relative to this reference.
- The following examples yield <u>unitless</u> answers in dB because they are relative ratios expressed in **decibels**

dBs to Remember

If $\text{dB} = 10 \log_{10} \frac{P_1}{P_2}$

then what power ratio is 20 dB?

$$20 = 10 \log_{10} \frac{P_1}{P_2}$$

$$\frac{20}{10} = \log_{10} \frac{P_1}{P_2}$$

$$2 = \log_{10} \frac{P_1}{P_2}$$

Remember: logarithm of a number is the exponent to which the base must be raised to get the number.

$$\therefore 10^2 = \frac{P_1}{P_2}$$

$$100 = \frac{P_1}{P_2}$$

Or $P_1 = 100\ P_2$

20 dB means P_1 is 100 times P_2

dB	$\frac{P_1}{P_2}$
3	2
6	4
10	10
20	100
30	1000
40	10000
50	10^5
60	10^6

- AND a 1 dB loss represents a 20.6% reduction of power.
- (a 1dB gain would be a 25.8% increase – see handout)

ARRL The national association for AMATEUR RADIO

Doing the Math - Decibels

- **What percentage of power loss would result from a transmission line loss of 1 dB?**
- First, calculate how much power is reaching the antenna:
- Percentage Power = 100% x $\log^{-1}$ (dB/10)
- 100% x $\log^{-1}$ (-1/10) = 100% x $\log^{-1}$ (.1) = ~**79.4%**
- Therefore, **a 1 dB loss represents a 20.6% loss of power** (in the form of heat)

3 dB Rule

- Remember that to double power or reduce power by half is a 3 dB change
- A 2 times increase in power is ___ dB?
- $dB = 10 \log_{10} (P_M / P_{Ref})$
- $dB = 10 \log_{10} (2 / 1) = 3dB$
- Keystrokes: 2 / 1 = 2 [log] x 10 = 3.010299
- (round answer to 3 dB)

Deci-bels	Loss-Power Ratio	Gain-Power Ratio
1	0.794	1.26
2	0.631	1.58
3	0.501	2.00
4	0.398	2.51
5	0.316	3.16
6	0.251	3.98
7	0.200	5.01
8	0.158	6.31
9	0.126	7.94
10	0.100	10.00
20	0.010	100.00
30	0.001	1,000.00
40	0.0001	10,000.00
50	0.00001	100,000.00

Take Quiz 1

G5B01 - What dB change represents a factor of two increase or decrease in power?

A. Approximately 2 dB

B. Approximately 3 dB

C. Approximately 6 dB

D. Approximately 9 dB

G5B01 - What dB change represents a factor of two increase or decrease in power?

A. Approximately 2 dB

B. Approximately 3 dB

C. Approximately 6 dB

D. Approximately 9 dB

G5B03 - How many watts of electrical power are consumed if 400 VDC is supplied to an 800-ohm load?

A. 0.5 watts

B. 200 watts

C. 400 watts

D. 3200 watts

G5B03 - How many watts of electrical power are consumed if 400 VDC is supplied to an 800-ohm load?

A. 0.5 watts

B. 200 watts

C. 400 watts

D. 3200 watts

G5B04 - How many watts of electrical power are consumed by a 12 VDC light bulb that draws 0.2 amperes?

A. 2.4 watts

B. 24 watts

C. 6 watts

D. 60 watts

G5B04 - How many watts of electrical power are consumed by a 12 VDC light bulb that draws 0.2 amperes?

A. 2.4 watts

B. 24 watts

C. 6 watts

D. 60 watts

G5B05 - How many watts are consumed when a current of 7.0 milliamperes flows through a 1,250-ohm resistance?

A. Approximately 61 milliwatts

B. Approximately 61 watts

C. Approximately 11 milliwatts

D. Approximately 11 watts

G5B05 - How many watts are consumed when a current of 7.0 milliamperes flows through a 1,250-ohm resistance?

A. Approximately 61 milliwatts

B. Approximately 61 watts

C. Approximately 11 milliwatts

D. Approximately 11 watts

G5B10 - What percentage of power loss is equivalent to a loss of 1 dB?

A. 10.9 percent

B. 12.2 percent

C. 20.6 percent

D. 25.9 percent

G5B10 - What percentage of power loss is equivalent to a loss of 1 dB?

A. 10.9 percent

B. 12.2 percent

C. 20.6 percent

D. 25.9 percent

General License Course
Chapter 4.2 - AC Power

ARRL The national association for AMATEUR RADIO

AC Power

- Definition and Measurement
- Root Mean Square (V_{RMS})
- The RMS value for an ac voltage is equivalent to the value of a dc voltage that results in the same power dissipation in a resistor

Definition & Measurement

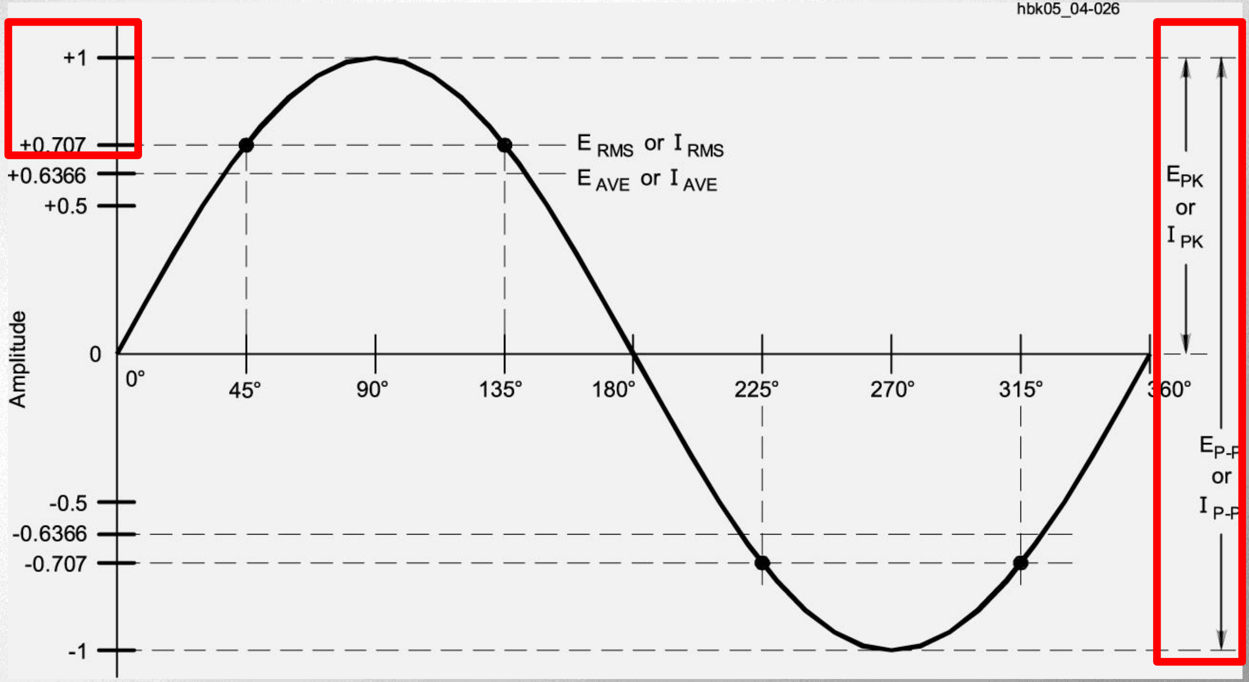
- RMS value is 0.707 times the ac waveform peak voltage (V_{PK})
- $V_{RMS} = 0.707 \times V_{PK} = 0.707 \times (V_{P\text{-}P} / 2)$
- $V_{PK} = 1.414 \times V_{RMS}$
- $V_{P\text{-}P} = 2 \times 1.414 \times V_{RMS} = 2.828 \times V_{RMS}$

(next slide....)

Measurements

- Relationships between RMS, average, peak-to-peak (p-p) values

120v AC RMS =
~170v peak =
~340 p-p



Components must be able to withstand PEAK voltages!

Doing the RMS Math

- A sine wave with a *peak* voltage of 17 V has an RMS value of?
- V_{RMS} = 0.707 x 17 V = **12 V**

ARRL The national association for AMATEUR RADIO

PEP Definition & Measurement

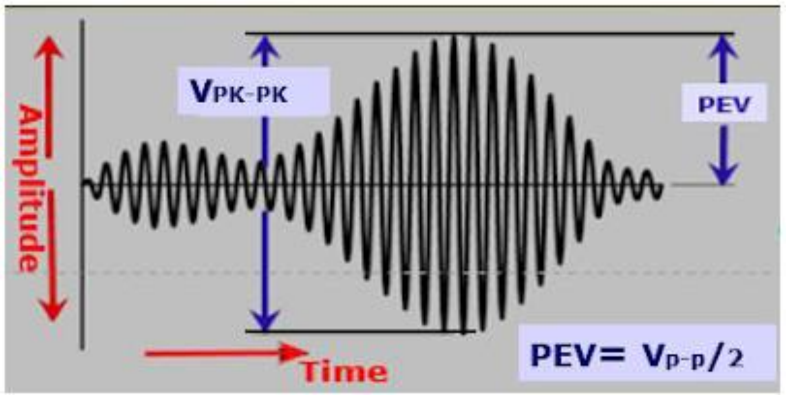
- PEP (Peak Envelope Power) is the average power of one complete RF cycle at the peak of the signal’s envelope
- PEP is an easy way to measure or specify the maximum power of an amplitude modulated signal
- 1500 W PEP is the full amateur power limit

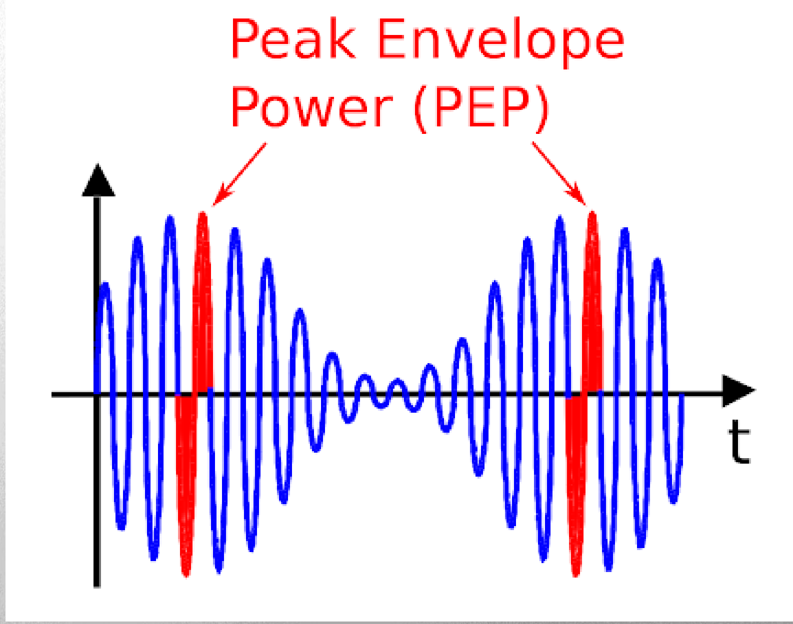
ARRL The national association for AMATEUR RADIO

These are illustrations of <u>modulated</u> AM signals. (Unmodulated carriers will be discussed in a moment)

To determine PEP, measure the amplitude of the peak of the modulation envelope, in volts. That is Peak Envelope Voltage (PEV) in the top figure.

From this, the RMS voltage and PEP can be calculated





PEP Doing the Math

Example 11: If a 50-Ω load is dissipating 1200 W PEP, the RMS voltage is

$$V_{RMS} = \sqrt{PEP \times R} = \sqrt{1200 \times 50} = 245 \text{ V} \quad [G5B12]$$

$$E = \sqrt{P \text{ x } R}$$

Keystrokes:

1200 x 50 = 60,000 [square root symbol] = 244.9489

Round answer to <u>245 V</u>

PEP Doing the Math

Example 13: If an oscilloscope measures 200 $V_{P\text{-}P}$ across a 50-Ω load, the PEP power is

$$PEP = \frac{\left[\frac{0.707 \times 200}{2}\right]^2}{50} = \frac{4999}{50} = 100\ \text{W}\ \ [\text{G5B06}]$$

$P = E^2/R$ and *PEV = Peak to Peak ÷ 2*

- 0.707 x (200 ÷ 2) = 70.7 [x^2] / 50 = 99.97
- Round answer to <u>100 W</u>

ARRL The national association for AMATEUR RADIO

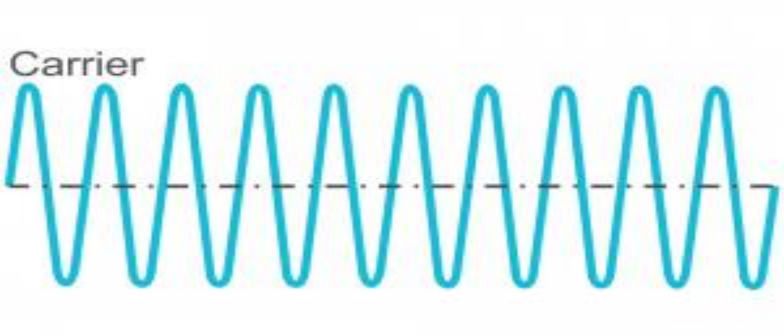
PEP Doing the Math

- What is the output PEP from a transmitter if an oscilloscope measures 500 volts *peak-to-peak* across a 50 Ω resistor connected to the transmitter output?
- $P = E^2/R$ and *PEV = Peak to Peak ÷ 2*
- Keystrokes:
- $0.707 \times 500 = 353.5 / 2 = 176.75^2 / 50 = 624.81125$
- Round answer to <u>625 W</u>

ARRL The national association for AMATEUR RADIO

PEP & Average Readings

- PEP is equal to average power if an AM carrier is not modulated
  - An unmodulated AM signal, a key down CW signal, and a FM signal are all constant power modes for which PEP = Average Power ("Ratio" = 1.00)
  - *Single sideband PEP is <u>not</u> equal to average power*
- If your CW transmitter generates 1060 W average output power, the PEP is also 1060 W



ARRL The national association for AMATEUR RADIO

Take Quiz 2

G5B06 - What is the PEP produced by 200 volts peak-to-peak across a 50-ohm dummy load?

A. 1.4 watts

B. 100 watts

C. 353.5 watts

D. 400 watts

G5B06 - What is the PEP produced by 200 volts peak-to-peak across a 50-ohm dummy load?

A. 1.4 watts

B. 100 watts

C. 353.5 watts

D. 400 watts

G5B07 - What value of an AC signal produces the same power dissipation in a resistor as a DC voltage of the same value?

A. The peak-to-peak value

B. The peak value

C. The RMS value

D. The reciprocal of the RMS value

G5B07 - What value of an AC signal produces the same power dissipation in a resistor as a DC voltage of the same value?

A. The peak-to-peak value

B. The peak value

C. The RMS value

D. The reciprocal of the RMS value

G5B08 - What is the peak-to-peak voltage of a sine wave with an RMS voltage of 120 volts?

A. 84.8 volts

B. 169.7 volts

C. 240.0 volts

D. 339.4 volts

G5B08 - What is the peak-to-peak voltage of a sine wave with an RMS voltage of 120 volts?

A. 84.8 volts

B. 169.7 volts

C. 240.0 volts

D. 339.4 volts

G5B09 - What is the RMS voltage of a sine wave with a value of 17 volts peak?

A. 8.5 volts

B. 12 volts

C. 24 volts

D. 34 volts

G5B09 - What is the RMS voltage of a sine wave with a value of 17 volts peak?

A. 8.5 volts

B. 12 volts

C. 24 volts

D. 34 volts

G5B11 - What is the ratio of PEP to average power for an unmodulated carrier?

A. 0.707

B. 1.00

C. 1.414

D. 2.00

G5B11 - What is the ratio of PEP to average power for an unmodulated carrier?

A. 0.707

B. 1.00

C. 1.414

D. 2.00

G5B12 - What is the RMS voltage across a 50-ohm dummy load dissipating 1200 watts?

A. 173 volts

B. 245 volts

C. 346 volts

D. 692 volts

ARRL The national association for AMATEUR RADIO

G5B12 - What is the RMS voltage across a 50-ohm dummy load dissipating 1200 watts?

A. 173 volts

B. 245 volts

C. 346 volts

D. 692 volts

ARRL The national association for AMATEUR RADIO

G5B13 - What is the output PEP of an unmodulated carrier if the average power is 1060 watts?

A. 530 watts

B. 1060 watts

C. 1500 watts

D. 2120 watts

G5B13 - What is the output PEP of an unmodulated carrier if the average power is 1060 watts?

A. 530 watts

B. 1060 watts

C. 1500 watts

D. 2120 watts

G5B14 - What is the output PEP of 500 volts peak-to-peak across a 50-ohm load?

A. 8.75 watts

B. 625 watts

C. 2500 watts

D. 5000 watts

G5B14 - What is the output PEP of 500 volts peak-to-peak across a 50-ohm load?

A. 8.75 watts

B. 625 watts

C. 2500 watts

D. 5000 watts

General License Course Chapter 4.3 – Basic Components

ARRL The national association for AMATEUR RADIO

Review - Prefixes

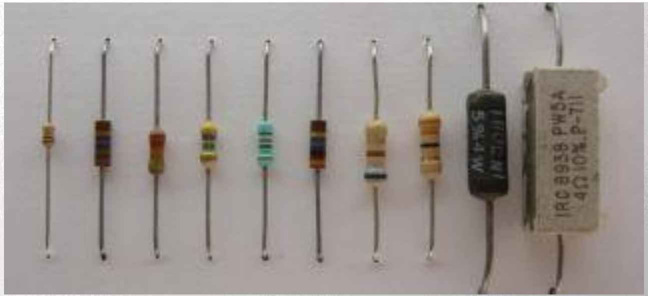
- pico (AKA micro micro) = 1 trillionth = .000 000 000 001 = 10^{-12}
- nano = 1 billionth = .000 000 001 = 10^{-9}
- micro = 1 millionth = .000 001 = 10^{-6}
- milli = 1 thousandth = .001 = 10^{-3}
- 1 = 1
- kilo = x1,000 = 1000 = 10^{3}
- mega = x1,000,000 = 1,000,000 = 10^{6}
- giga = x1,000,000,000 = 1,000,000,000 = 10^{9}

Resistors & Resistance

- Resistors may have the same nominal value but vary in other characteristics

Table 4.1
Characteristics of Resistor Types

Resistor Type	*Power Ratings*	*Applications*
Carbon composition	⅛ – 2 W	General use, wire leads
Carbon film	⅒ – ½ W	General use, wire leads and SMT package
Metal film	⅒ – ½ W	Low-noise, wire leads and SMT package
Wirewound	1 W – 100 W or more	Power circuits
Metal oxide	½ – 10 W	Noninductive for RF applications



Resistors & Resistance

- Resistance nominal values
- 1 Ω to more than 1 MΩ (value or color codes printed on them)
- Standard values (no 500Ω - choose 470Ω or 510Ω)
- Resistor Tolerance (accuracy)
- Precision (1% or less), general purpose (5 or 10%)
- Temperature Coefficients are resistance change characteristics (positive or negative)
  - Positive - resistance increases as temperature goes up
  - Negative - resistance decreases as temperature goes up
  - Thermistors - precise resistance changes in response to temperature

Resistors & Resistance

- Parasitic Inductance: (inductance is the next topic)
  - Parasitic – unwanted characteristic resulting from the components physical construction (wire-wound resistor on a ceramic form)
  - Placing a wire-wound resistor in an RF circuit can disrupt operation or tuning (they are fine for DC or low frequency)
  - RF circuits normally use carbon composition, carbon film, or metal oxide resistors which have very low inductance

Inductors & Inductance

- Inductors - sometimes also referred to as “chokes”
- Inductance is the ability to store electromagnetic energy (measured in henries, H)
- Increasing the core permeability will increase the ability to store magnetic energy and thus the inductance
- The magnetic properties of the core (the “mix”) may be optimized for a specific range of frequencies

Inductors & Inductance

- *Variable inductors* – used in low-power receiving and transmitting applications
  - *Low-power* - adjusted by moving a magnetic core in and out of the inductor
  - *High-Power* - adjusted by moving a sliding contact along the inductor, like a roller inductor in an antenna matching network

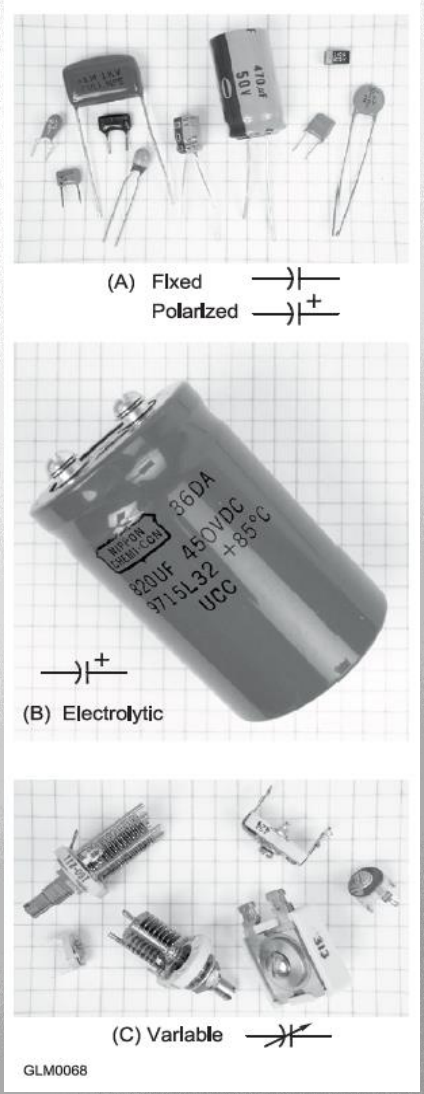
Inductors & Inductance

- Toroidal inductors (with a magnetic core) keep nearly all of their magnetic energy in the core so that external coupling is minimized. Also, large values of inductance are attainable and the magnetic properties ("mix") of the core can be optimized for a specific range of frequencies. ALL THREE!

ARRL The national association for AMATEUR RADIO

Capacitors & Capacitance

- Capacitors ("caps") have two conducting surfaces (electrodes) separated by a dielectric
- Capacitance is the ability to store electrostatic energy, measured in farads, F
- Blocks dc current flow



Capacitors & Capacitance

- The simplest capacitor is a pair of metal plates separated by air
- Capacitor types:
  - Ceramic – RF filtering, bypassing at high frequencies, **low cost**
  - Plastic film – audio circuits & lower radio frequencies
  - Silvered-mica – highly stable, low loss, use in RF circuits
  - Electrolytic and tantalum – power supply filter circuits
  - Air and vacuum dielectric – transmitting and RF circuits

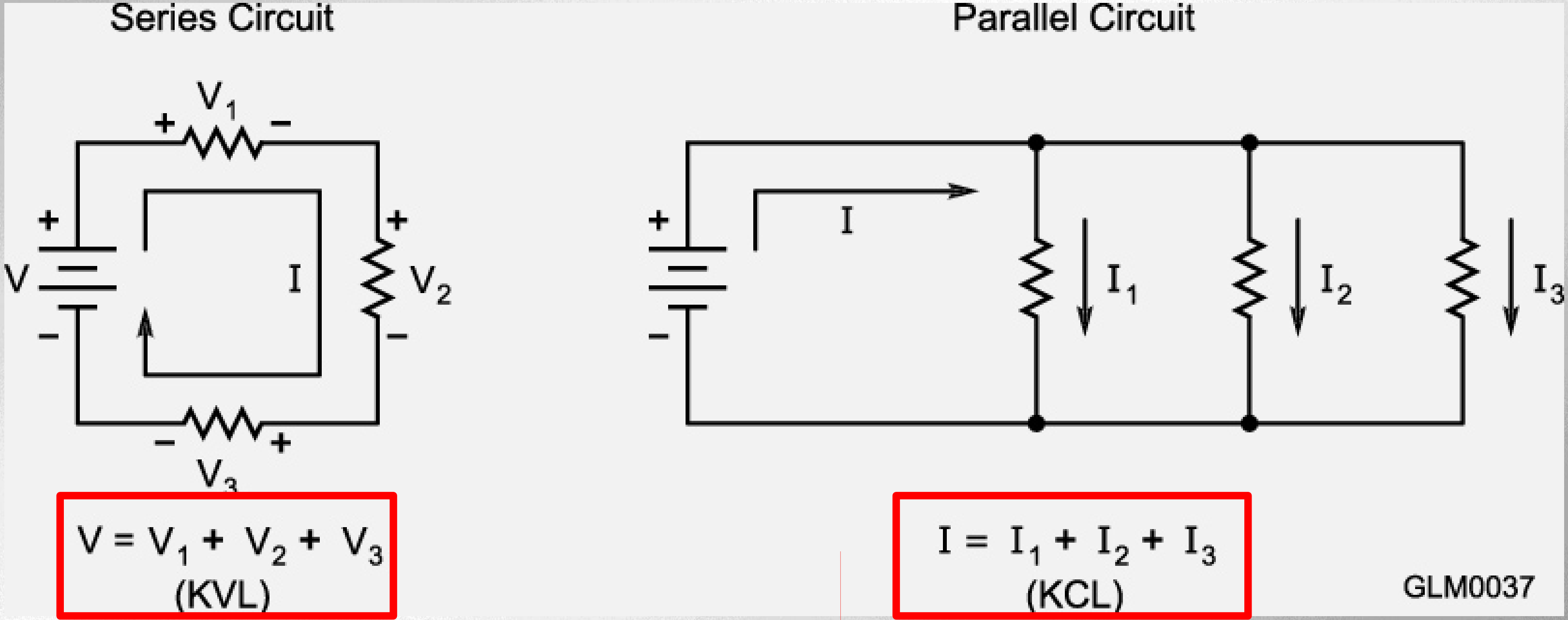
Capacitors & Capacitance

- Aluminum and tantalum ***electrolytic*** capacitors
- Dielectric is a thin film
- Voltage **must** be applied with the correct polarity; failure to do so can cause <u>destruction of the dielectric layer</u> leading to a <u>short circuit</u> and possible <u>overheating/explosion</u> ***(all three...)***
- Benefit – Create large capacitances in comparatively small volumes

ARRL The national association for AMATEUR RADIO

Components in Series & Parallel Circuits

- Kirchhoff's Voltage Law - Kirchhoff's Current Law



Total current = the sum of the currents in each branch

Adding Components in Series and Parallel

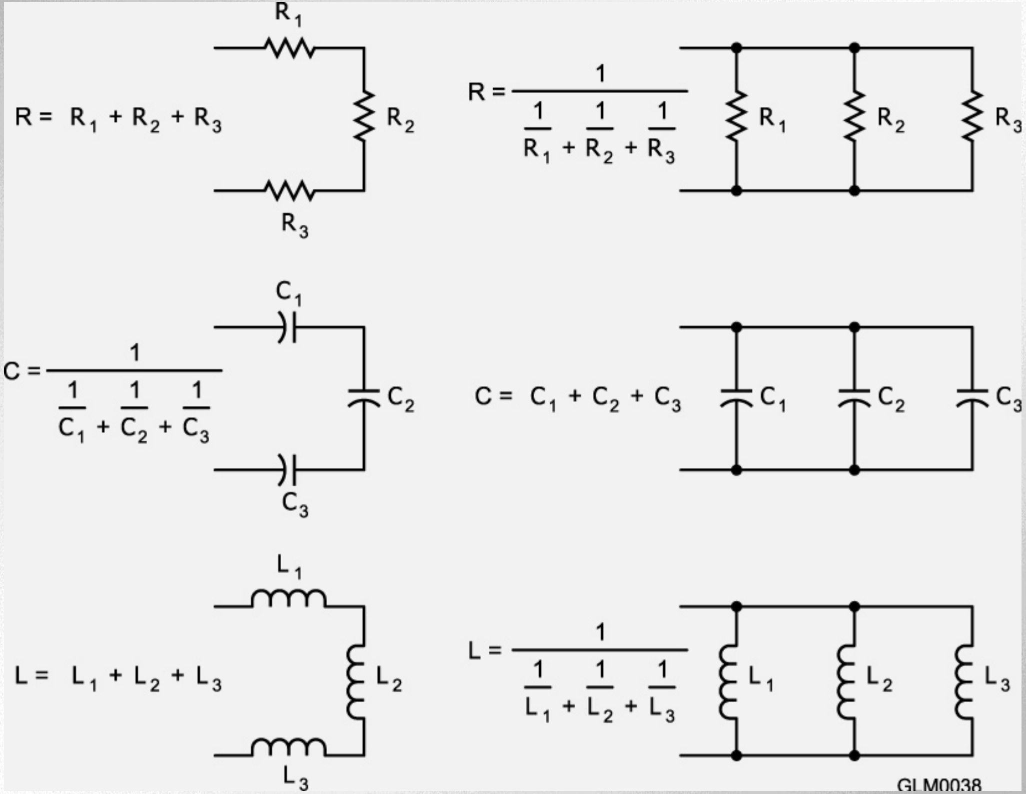
Table 4.3

Effect on Total Value of Adding Components in Series and Parallel

Component	*Adding In Series*	*Adding In Parallel*
Resistor	Increase	Decrease
Inductor	Increase	Decrease
Capacitor	Decrease	Increase

ARRL The national association for AMATEUR RADIO

Doing the Math



ARRL The national association for AMATEUR RADIO

...and learning some schematic symbols...

Doing the Math

- Make your calculator do the hard work
- Some calculators require a 2nd function key to get to a 2nd set of commands, like using the shift key on your computer keyboard
- Example: A 100 and a 200 Ω resistor connected in parallel?

Keystrokes: 100 [function 1/x] + 200 [function 1/x] = 0.015 [function 1/x] = 66.666 Ω (round to 67 Ω)

- *Reciprocal of reciprocals...*

ARRL The national association for AMATEUR RADIO

Doing the Math

- Three 100 μF capacitors in series?
  - Keystrokes: 100 [function 1/x] + 100 [function 1/x] + 100 [function 1/x] = 0.03 [function 1/x] = 33.33333 μF
- Three 10 mH inductors in parallel?
  - Keystrokes: 10 [2nd function 1/x] + 10 [function 1/x] + 10 [function 1/x] = 0.3 [function 1/x] = 3.33333 mH
- A 20 mH and 50 mH inductor in series?
  - Keystrokes: 20 + 50 = 70 mH (simple addition)

Doing the Math

- A 20 μF and 50 μF capacitor in series?
  - Keystrokes: 20 [function 1/x] + 50 [function 1/x] = 0.07 [function 1/x] = 14.2857 μF (round to 14.3 μF)
- A 10 Ω, 20 Ω, and 50 Ω resistor in parallel?
  - Keystrokes: 10 [function 1/x] + 20 [function 1/x] + 50 [function 1/x] = 0.17 [function 1/x] = 5.88235 Ω (round to 5.9 Ω)

Doing the Math

Units conversion practice: ($\mu F = 10^{-6}$, $nF = 10^{-9}$, $pF = 10^{-12}$)

22,000 pF = 22 nF 4700 nF = 4.7 µF

What is the total capacitance of two 5 nF and one 750 pF in parallel?

(*First convert 750 pF to nF = 750/1000 = 0.750 nF*)

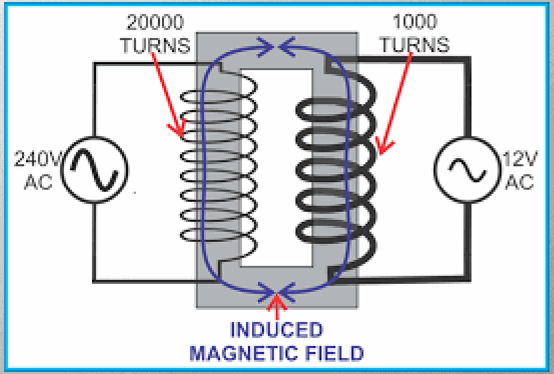
5 + 5 + 0.750 = 10.75 nF

What three equal value resistors wired in series will equal 450 Ω?

R x 3 = 450 Ω, divide both sides by 3 to put the R by itself. R = 450/3 = 150 Ω

Transformers

- Primary Winding – power is applied
- Secondary winding – power is extracted
- When AC voltage is applied to the primary winding (E_P), mutual inductance causes AC voltage (E_S) to appear across the secondary winding (works in both directions)
- The *turns ratio* of the secondary (N_S) to the primary (N_P) windings determines how the current and voltage are changed
- $E_S = E_P \times (N_S / N_P)$ and $I_S = I_P \times (N_P / N_S)$



ARRL The national association for AMATEUR RADIO

Transformers

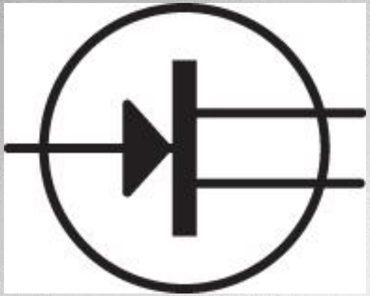
- A significant change between primary and secondary voltage usually requires a change in the size of wire between windings
- In a step-up transformer, the primary winding carries higher current and is wound with larger-diameter wire than the secondary
- Mindful of the above, if you reverse the primary and secondary windings of a 4:1 step down transformer, it becomes a 4:1 step UP transformer.

Doing the Transformer Math

- Example: What is the voltage across a 1500 turn secondary when 120 VAC is applied to a 500 turn primary?
- $E_S = (N_S/N_P) \times E_P$
- Keystrokes:
- E_S = 1500/500 = 3 x 120 = 360 V

Schematic Symbols

Symbol 1 in figure G7-1 represents a field effect transistor



Maybe write these in on your handouts?

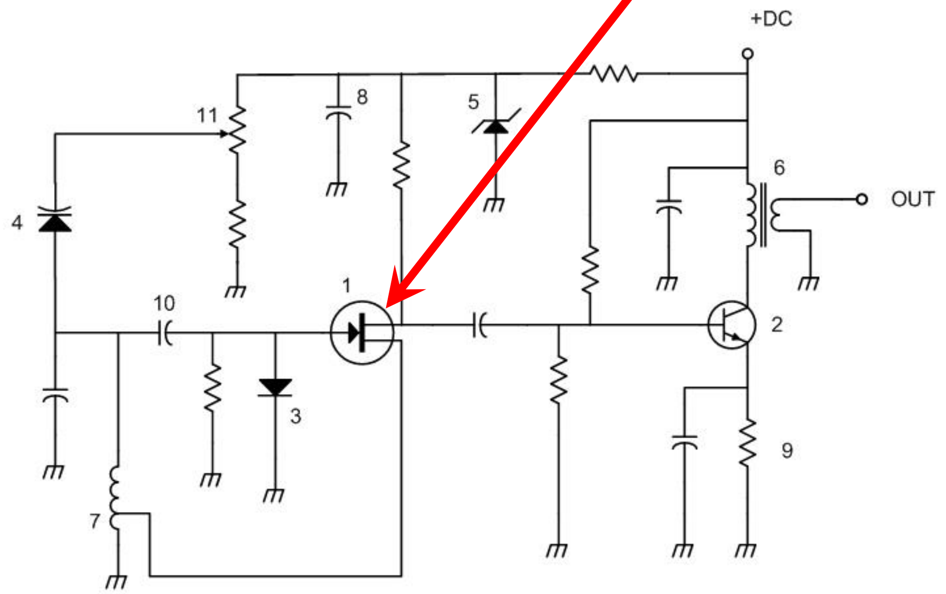
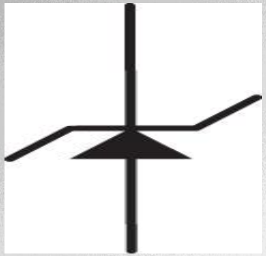


Figure G7-1

Schematic Symbols

Symbol 5 in figure G7-1 represents a Zener diode



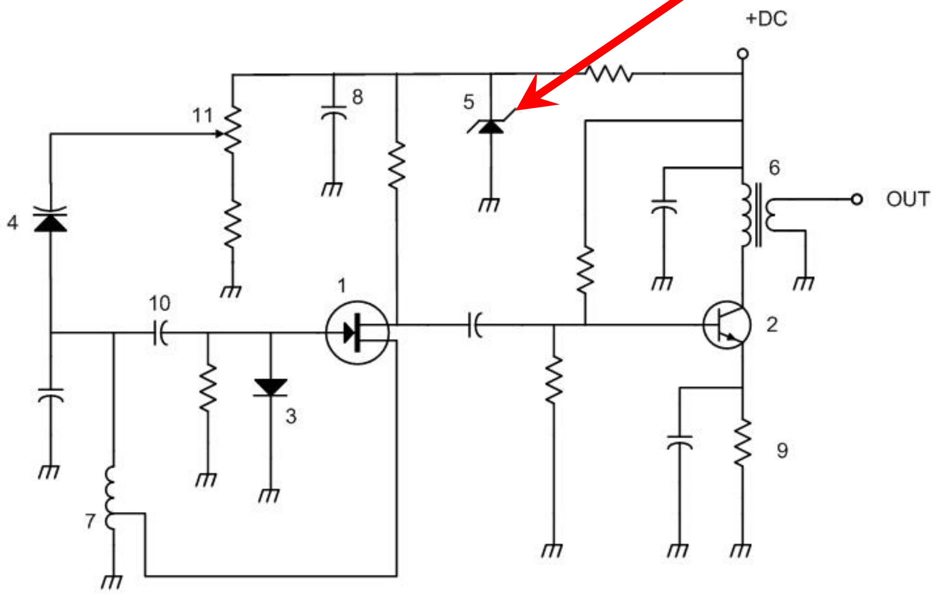


Figure G7-1

Schematic Symbols

Symbol 2 in figure G7-1 represents an NPN junction transistor

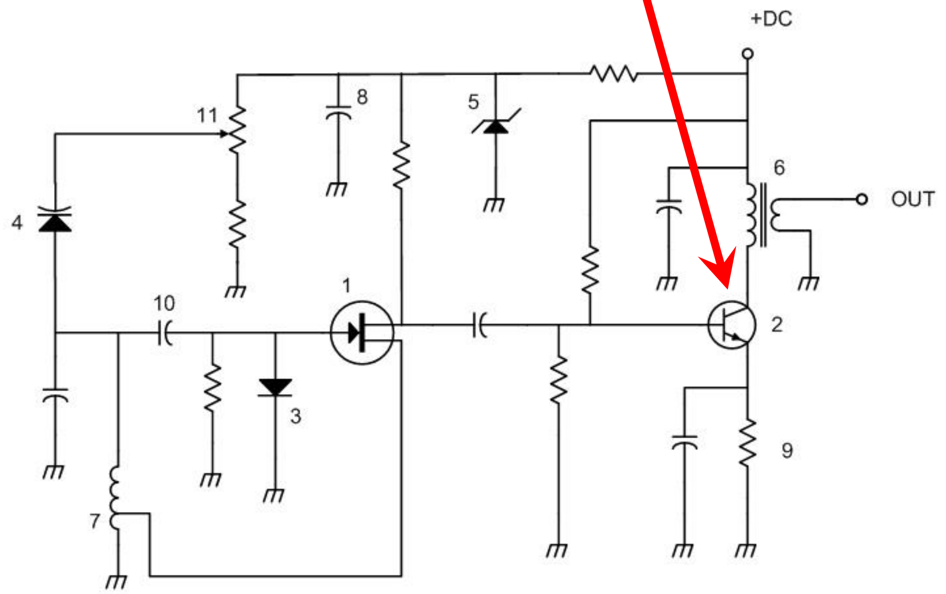
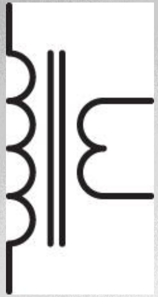


Figure G7-1

ARRL The national association for AMATEUR RADIO

Schematic Symbols

Symbol 6 in Figure G7-1 represents a solid core transformer



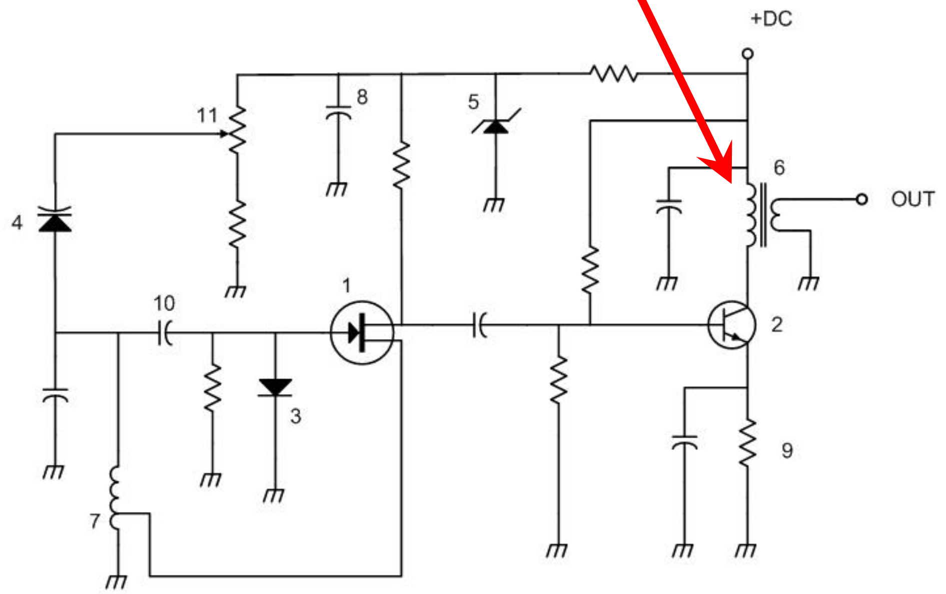
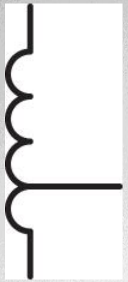


Figure G7-1

ARRL The national association for AMATEUR RADIO

Schematic Symbols

Symbol 7 in Figure G7-1 represents a tapped inductor



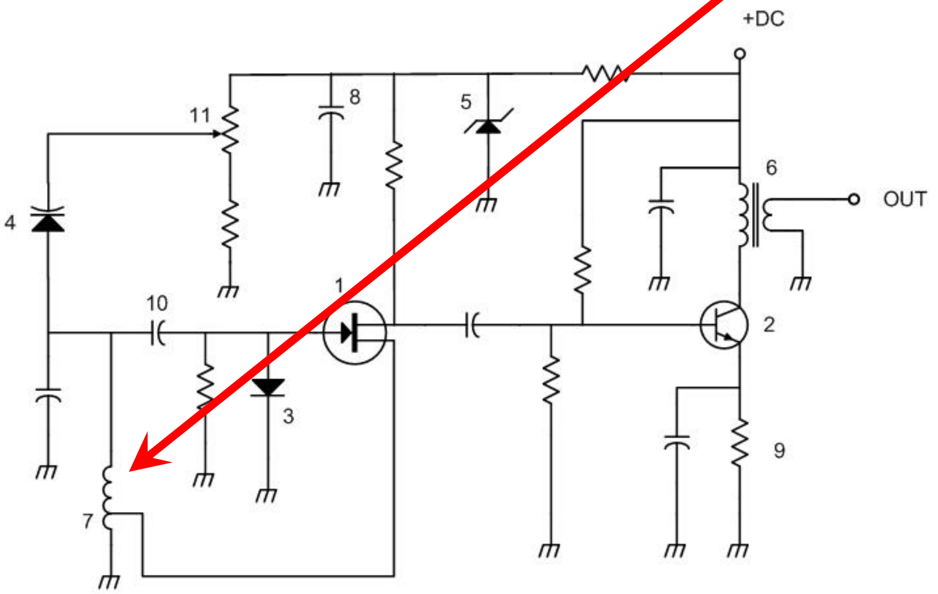


Figure G7-1

Take Quiz 3

G7A09 - Which symbol in figure G7-1 represents a field effect transistor?

A. Symbol 2

B. Symbol 5

C. Symbol 1

D. Symbol 4

ARRL The national association for AMATEUR RADIO

G7A09 - Which symbol in figure G7-1 represents a field effect transistor?

A. Symbol 2

B. Symbol 5

C. Symbol 1

D. Symbol 4

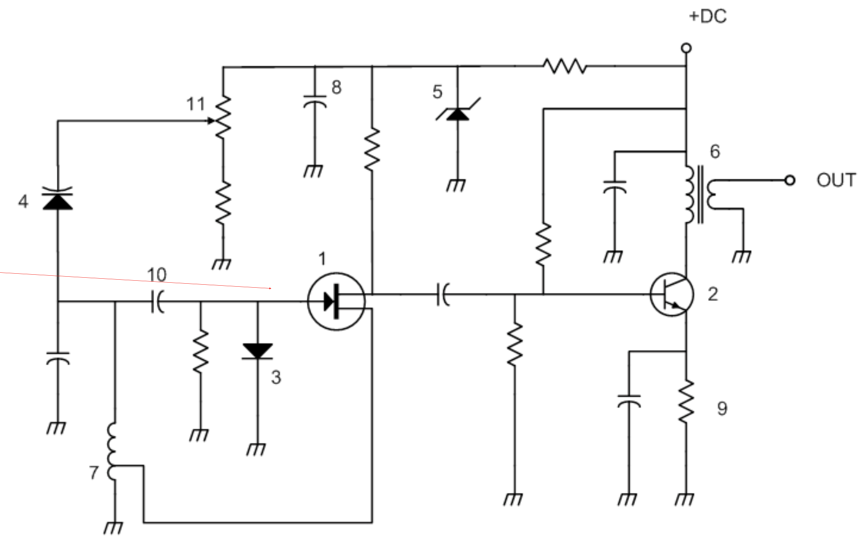


Figure G7-1

ARRL The national association for AMATEUR RADIO

G7A10 - Which symbol in figure G7-1 represents a Zener diode?

A. Symbol 4

B. Symbol 1

C. Symbol 11

D. Symbol 5

G7A10 - Which symbol in figure G7-1 represents a Zener diode?

A. Symbol 4

B. Symbol 1

C. Symbol 11

D. Symbol 5

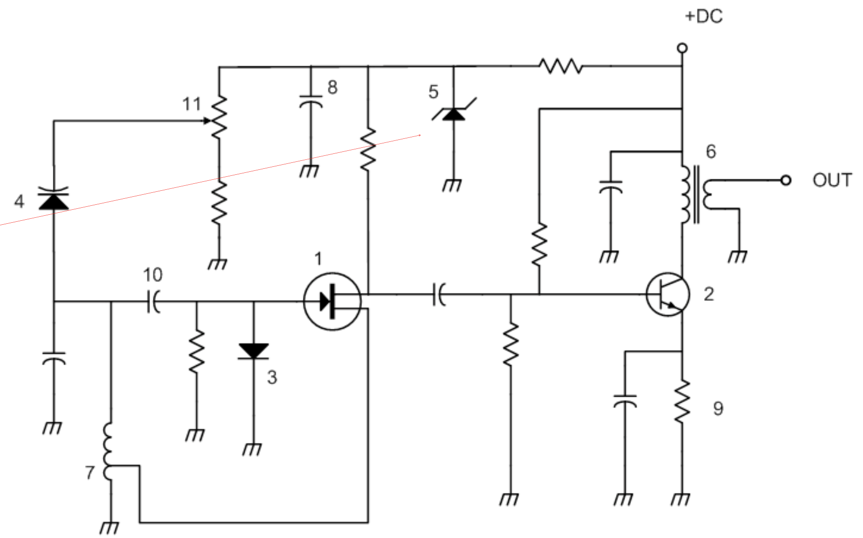


Figure G7-1

ARRL The national association for AMATEUR RADIO

G7A11 - Which symbol in figure G7-1 represents an NPN junction transistor?

A. Symbol 1

B. Symbol 2

C. Symbol 7

D. Symbol 11

G7A11 - Which symbol in figure G7-1 represents an NPN junction transistor?

A. Symbol 1

B. Symbol 2

C. Symbol 7

D. Symbol 11

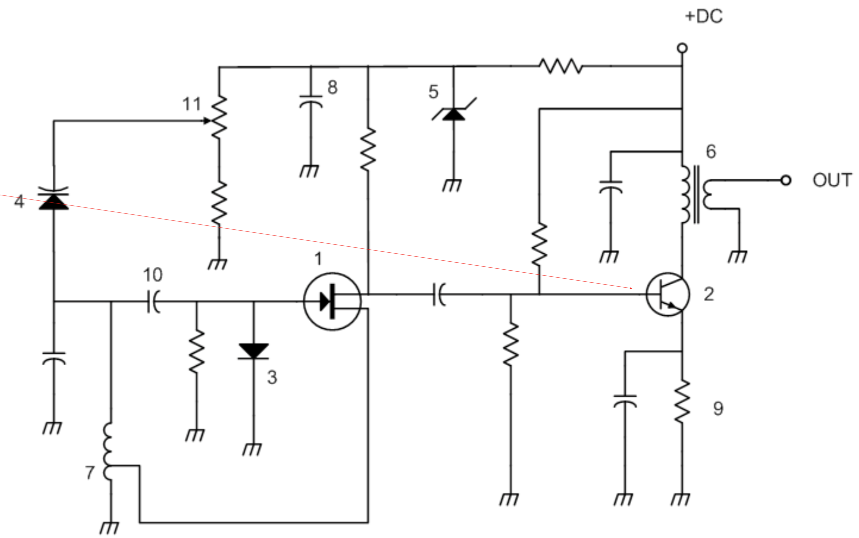


Figure G7-1

G7A12 - Which symbol in Figure G7-1 represents a solid core transformer?

A. Symbol 4

B. Symbol 7

C. Symbol 6

D. Symbol 1

G7A12 - Which symbol in Figure G7-1 represents a solid core transformer?

A. Symbol 4

B. Symbol 7

C. Symbol 6

D. Symbol 1

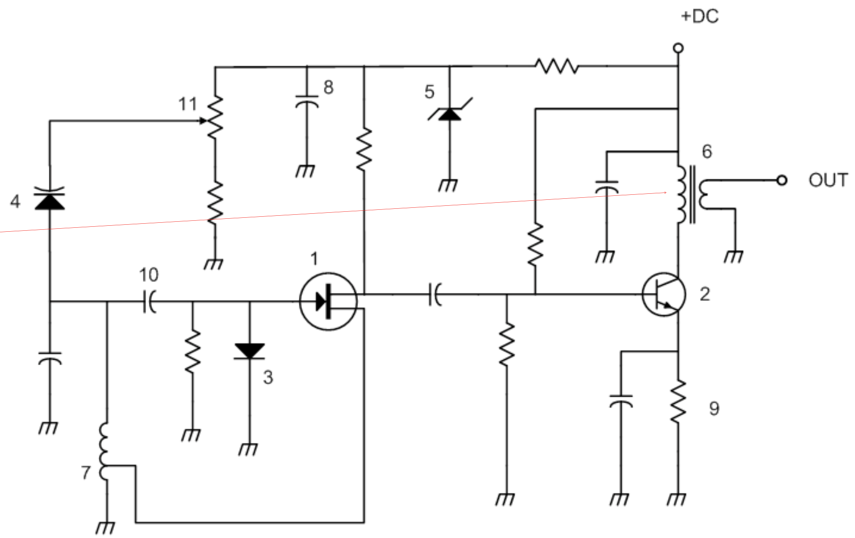


Figure G7-1

G7A13 - Which symbol in Figure G7-1 represents a tapped inductor?

A. Symbol 7

B. Symbol 11

C. Symbol 6

D. Symbol 1

G7A13 - Which symbol in Figure G7-1 represents a tapped inductor?

A. Symbol 7

B. Symbol 11

C. Symbol 6

D. Symbol 1

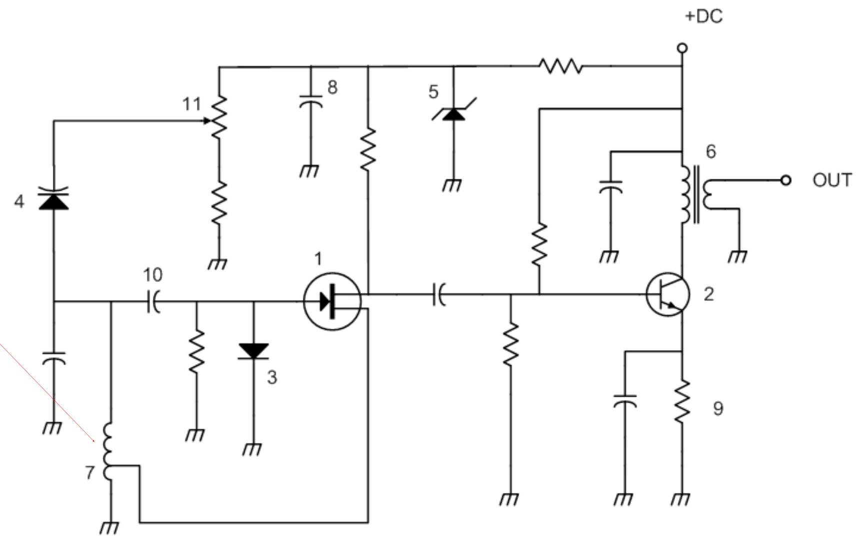


Figure G7-1

ARRL The national association for AMATEUR RADIO

G6B01 - What determines the performance of a ferrite core at different frequencies?

A. Its conductivity

B. Its thickness

C. The composition, or "mix," of materials used

D. The ratio of outer diameter to inner diameter

G6B01 - What determines the performance of a ferrite core at different frequencies?

A. Its conductivity

B. Its thickness

C. The composition, or "mix," of materials used

D. The ratio of outer diameter to inner diameter

G6B05 - What is an advantage of using a ferrite core toroidal inductor?

A. Large values of inductance may be obtained

B. The magnetic properties of the core may be optimized for a specific range of frequencies

C. Most of the magnetic field is contained in the core

D. All these choices are correct

G6B05 - What is an advantage of using a ferrite core toroidal inductor?

A. Large values of inductance may be obtained

B. The magnetic properties of the core may be optimized for a specific range of frequencies

C. Most of the magnetic field is contained in the core

D. All these choices are correct

G6A04 - Which of the following is characteristic of an electrolytic capacitor?

A. Tight tolerance

B. Much less leakage than any other type

C. High capacitance for a given volume

D. Inexpensive RF capacitor

G6A04 - Which of the following is characteristic of an electrolytic capacitor?

A. Tight tolerance

B. Much less leakage than any other type

C. High capacitance for a given volume

D. Inexpensive RF capacitor

G6A08 - Which of the following is characteristic of low voltage ceramic capacitors?

A. Tight tolerance

B. High stability

C. High capacitance for given volume

D. Comparatively low cost

G6A08 - Which of the following is characteristic of low voltage ceramic capacitors?

A. Tight tolerance

B. High stability

C. High capacitance for given volume

D. Comparatively low cost

G5C01 - What causes a voltage to appear across the secondary winding of a transformer when an AC voltage source is connected across its primary winding?

A. Capacitive coupling

B. Displacement current coupling

C. Mutual inductance

D. Mutual capacitance

G5C01 - What causes a voltage to appear across the secondary winding of a transformer when an AC voltage source is connected across its primary winding?

A. Capacitive coupling

B. Displacement current coupling

C. Mutual inductance

D. Mutual capacitance

G5C02 - What is the output voltage if an input signal is applied to the secondary winding of a 4:1 voltage step-down transformer instead of the primary winding?

A. The input voltage is multiplied by 4

B. The input voltage is divided by 4

C. Additional resistance must be added in series with the primary to prevent overload

D. Additional resistance must be added in parallel with the secondary to prevent overload

G5C02 - What is the output voltage if an input signal is applied to the secondary winding of a 4:1 voltage step-down transformer instead of the primary winding?

A. The input voltage is multiplied by 4

B. The input voltage is divided by 4

C. Additional resistance must be added in series with the primary to prevent overload

D. Additional resistance must be added in parallel with the secondary to prevent overload

G5C05 - Why is the primary winding wire of a voltage step-up transformer usually a larger size than that of the secondary winding?

A. To improve the coupling between the primary and secondary

B. To accommodate the higher current of the primary

C. To prevent parasitic oscillations due to resistive losses in the primary

D. To ensure that the volume of the primary winding is equal to the volume of the secondary winding

G5C05 - Why is the primary winding wire of a voltage step-up transformer usually a larger size than that of the secondary winding?

A. To improve the coupling between the primary and secondary

B. To accommodate the higher current of the primary

C. To prevent parasitic oscillations due to resistive losses in the primary

D. To ensure that the volume of the primary winding is equal to the volume of the secondary winding

G5C06 - What is the voltage output of a transformer with a 500-turn primary and a 1500-turn secondary when 120 VAC is applied to the primary?

A. 360 volts

B. 120 volts

C. 40 volts

D. 25.5 volts

G5C06 - What is the voltage output of a transformer with a 500-turn primary and a 1500-turn secondary when 120 VAC is applied to the primary?

A. 360 volts

B. 120 volts

C. 40 volts

D. 25.5 volts

G5B02 - How does the total current relate to the individual currents in a circuit of parallel resistors?

A. It equals the average of the branch currents

B. It decreases as more parallel branches are added to the circuit

C. It equals the sum of the currents through each branch

D. It is the sum of the reciprocal of each individual voltage drop

G5B02 - How does the total current relate to the individual currents in a circuit of parallel resistors?

A. It equals the average of the branch currents

B. It decreases as more parallel branches are added to the circuit

C. It equals the sum of the currents through each branch

D. It is the sum of the reciprocal of each individual voltage drop

G5C03 - What is the total resistance of a 10-, a 20-, and a 50-ohm resistor connected in parallel?

A. 5.9 ohms

B. 0.17 ohms

C. 17 ohms

D. 80 ohms

G5C03 - What is the total resistance of a 10-, a 20-, and a 50-ohm resistor connected in parallel?

A. 5.9 ohms

B. 0.17 ohms

C. 17 ohms

D. 80 ohms

G5C04 - What is the approximate total resistance of a 100- and a 200-ohm resistor in parallel?

A. 300 ohms

B. 150 ohms

C. 75 ohms

D. 67 ohms

ARRL The national association for AMATEUR RADIO

G5C04 - What is the approximate total resistance of a 100- and a 200-ohm resistor in parallel?

A. 300 ohms

B. 150 ohms

C. 75 ohms

D. 67 ohms

G5C08 - What is the equivalent capacitance of two 5.0-nanofarad capacitors and one 750-picofarad capacitor connected in parallel?

A. 576.9 nanofarads

B. 1,733 picofarads

C. 3,583 picofarads

D. 10.750 nanofarads

G5C08 - What is the equivalent capacitance of two 5.0-nanofarad capacitors and one 750-picofarad capacitor connected in parallel?

A. 576.9 nanofarads

B. 1,733 picofarads

C. 3,583 picofarads

D. 10.750 nanofarads

G5C09 - What is the capacitance of three 100-microfarad capacitors connected in series?

A. 0.33 microfarads

B. 3.0 microfarads

C. 33.3 microfarads

D. 300 microfarads

G5C09 - What is the capacitance of three 100-microfarad capacitors connected in series?

A. 0.33 microfarads

B. 3.0 microfarads

C. 33.3 microfarads

D. 300 microfarads

G5C10 - What is the inductance of three 10-millihenry inductors connected in parallel?

A. 0.30 henries

B. 3.3 henries

C. 3.3 millihenries

D. 30 millihenries

ARRL The national association for AMATEUR RADIO

G5C10 - What is the inductance of three 10-millihenry inductors connected in parallel?

A. 0.30 henries

B. 3.3 henries

C. 3.3 millihenries

D. 30 millihenries

G5C11 - What is the inductance of a circuit with a 20-millihenry inductor connected in series with a 50-millihenry inductor?

A. 7 millihenries

B. 14.3 millihenries

C. 70 millihenries

D. 1,000 millihenries

G5C11 - What is the inductance of a circuit with a 20-millihenry inductor connected in series with a 50-millihenry inductor?

A. 7 millihenries

B. 14.3 millihenries

C. 70 millihenries

D. 1,000 millihenries

G5C12 - What is the capacitance of a 20-microfarad capacitor connected in series with a 50-microfarad capacitor?

A. 0.07 microfarads

B. 14.3 microfarads

C. 70 microfarads

D. 1,000 microfarads

G5C12 - What is the capacitance of a 20-microfarad capacitor connected in series with a 50-microfarad capacitor?

A. 0.07 microfarads

B. 14.3 microfarads

C. 70 microfarads

D. 1,000 microfarads

ARRL The national association for AMATEUR RADIO

G5C13 - Which of the following components should be added to a capacitor to increase the capacitance?

A. An inductor in series

B. An inductor in parallel

C. A capacitor in parallel

D. A capacitor in series

G5C13 - Which of the following components should be added to a capacitor to increase the capacitance?

A. An inductor in series

B. An inductor in parallel

C. A capacitor in parallel

D. A capacitor in series

G5C14 - Which of the following components should be added to an inductor to increase the inductance?

A. A capacitor in series

B. A capacitor in parallel

C. An inductor in parallel

D. An inductor in series

G5C14 - Which of the following components should be added to an inductor to increase the inductance?

A. A capacitor in series

B. A capacitor in parallel

C. An inductor in parallel

D. An inductor in series

Next Week
Chapters 4.4 and 8