

# Amateur Radio Service Technician Class

Exam Preparation Class  
September — October 2018

Session 4

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These slides will be uploaded to my website  
<https://k7ojl.com/technician-class-materials/>  
just before class each week.  
Depending on how the class goes, they may get  
updated after the class.

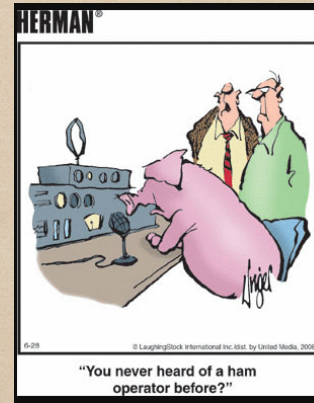
Questions from Session 1 or 2 or 3?  
Questions about Amateur Radio?





# Class Overview

- ◆ Questions?
- ◆ Decibels and Scientific Notation
- ◆ Ohms Law
- ◆ Safety First
- ◆ The Exam



# Decibels and Scientific Notation

## Decibel Table

dB	Power Change
3 dB	2x Power Change
6 dB	4x Power Change
9 dB	8x Power Change
10 dB	10x Power Change
20 dB	100x Power Change
30 dB	1000x Power Change
40 dB	10,000 x Power Change

Amount of change in dB of a power increase from 20 watts to 200 watts? 10 dB

Amount of change in dB of a power increase from 5 watts to 10 watts? 3 dB



## Going the Other Way

dB	Power Change
-3 dB	1/2 Power Change
-6 dB	1/4 Power Change
-9 dB	1/8 Power Change
-10 dB	1/10 Power Change
-20 dB	1/100 Power Change
-30 dB	1/1000 Power Change
-40 dB	1/10,000 Power Change

Amount of change in dB of a power decrease from 12 watts to 3 watts? -6 dB

Amount of change in dB of a power decrease from 1,500 watts to 150 watts? -10 dB

# Scientific Notation

Pfx	Symbol	Factor	Pfx	Symbol	Factor
gíga	G	1,000,000,000	milli	m	0.001
mega	M	1,000,000	micro		0.000001
kilo	k	1,000	nano	n	0.000000001
unit		1	píco	p	0.000000000001

Each step either adds or subtracts 3 decimal positions.



# Some Examples

- ♦ A frequency display of 2425 MHz would be 2.425 GHz
- ♦ A frequency of 28,400 kHz would be 28.4 MHz
- ♦ 500 milliwatts would be 0.5 watts
- ♦ 1.5 amperes is 1500 milliamperes
- ♦ One microvolt is one-millionth of a volt
- ♦ If an ammeter calibrated in amperes measures a 3000-milliampere current would show a reading of 3 amperes

# Random Definitions

Relay: an electrically controlled switch, usually using magnetism (inductance) to switch the relay

Integrated Circuit: a device that combines multiple transistors, capacitors, resistors, etc. into one package

LED's: commonly used as indicators (such as on/off)

Solder: comes in many types. Rosin Core solder is used for electrical circuits. A good solder connection will have a bright, silvery surface. A dull and grainy surface indicates a faulty, or "cold" connection

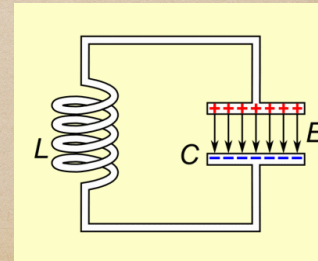
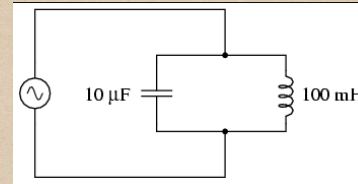
How to damage a meter? Measure voltages or currents beyond the instrument's rated capacity or measure volts in the resistance setting....

Schematic: An electrical circuit diagram showing electrical components as standard symbols & how the various components are connected. It does not show actual placement, sizes, or wire lengths.



# Capacitors & Inductors

- ♦ Capacitors and Inductors operate opposite each other
- ♦ If a pulsing / alternating current is introduced, oscillation will occur
- ♦ Often a crystal or a rapidly switching current source is used to drive the circuit
- ♦ The value of the capacitor and the inductor are selected based on the desired oscillation frequency
- ♦ A capacitor and inductor, either in parallel or series, forms a resonant or tuned circuit



One last thought about a circuit that includes a capacitor: when measuring the resistance with an ohmmeter, the circuit will first show little or no resistance after which the resistance will climb sharply as the capacitor charges and reaches capacity



Ohms Law

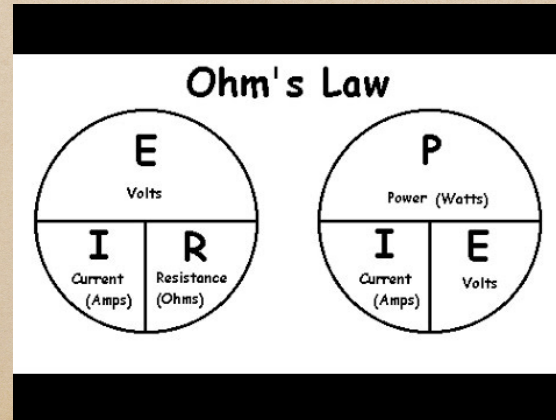
# Ohms Law Defined

- ◆ Ohms Law defines the relationship among Electromotive Force (measured in Volts and depicted as 'E'), Resistance (measured in ohms and depicted as 'R') and Current (measured in amperes and depicted as 'I')
- ◆ It further defines the relationship among Power (measured in Watts and depicted as 'P'), Resistance (measured in ohms and depicted as 'R') and Current (measured in amperes and depicted as 'I')

## The Magic Circles

$$E \text{ (volts)} = I \text{ (amperes)} * R \text{ (ohms)}$$

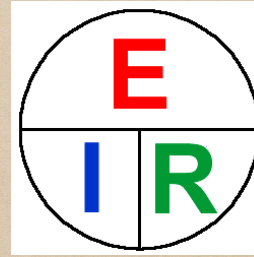
$$P \text{ (watts)} = I \text{ (amperes)} * E \text{ (volts)}$$



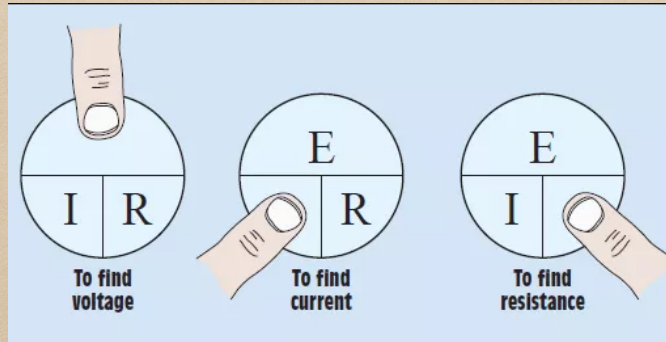


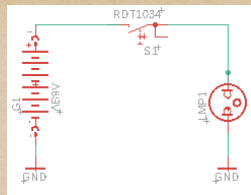
# How To Use the Magic Circle for Volts, Ohms, Amperes

- ♦ There are three elements in the equation, volts, amps, ohms
  - ♦ Two are known, one is the unknown
- ♦ Cover the unknown and then solve the equation



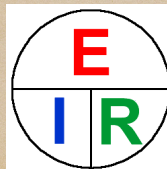
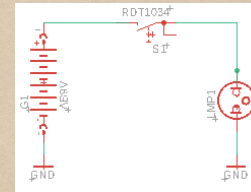
For Example





What is the voltage in this circuit where the current is 0.5 amperes and the resistance is 2 ohms?

What is the resistance in this circuit where the voltage is 2 volts and the current is 4 amperes?



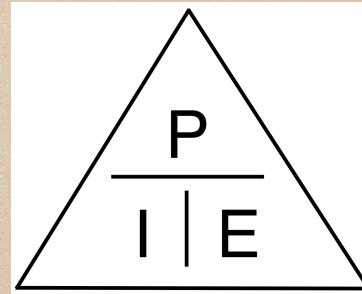
1st Example: Volts = Amperes \* Ohms =  $0.5 * 2 = 1$  Volt

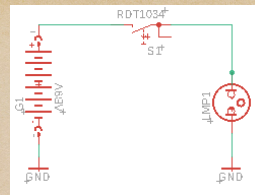
2nd Example: Resistance = Volts / Amperes =  $2 / 4 = 0.5$  ohms



# Calculating Power (Watts)

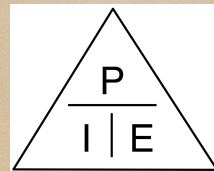
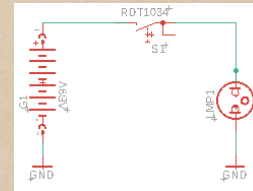
- ♦ Power is the rate at which electrical energy is used
- ♦ Power is measured in Watts and is often described in watt-hours
- ♦ The magic triangle works the same way as the ohms law circle





If the voltage in this circuit is 13.8 volts DC and the current is 10 amperes, how much power is being consumed?

If the voltage in this circuit is 12 volts DC and the load is 120 watts, how many amperes are flowing?



1st Example: Watts = 10 amperes x 13.8 volts = 138 watts

2nd Example: Amperes = 120 watts / 12 volts = 10 amperes

# The Four Equations

Converting between Wavelength in Meters and Frequency in MHz:

Wavelength in meters =  $300 / \text{frequency MHz}$

Frequency MHz =  $300 / \text{Wavelength in meters}$

Calculating the length of a dipole in feet:

Length in Feet =  $468 / \text{Frequency in MHz}$

Ohms Law:

$E = I \times R$  (where E=volts, I=amperes, and R=ohms). Draw the circle

Ohms Power Law:

$P = I \times E$  (where P=watts, I=amperes, and E=volts). Draw the circle



# Kirchoff's Laws

- ♦ Voltage Law: the sum of the voltages in a series circuit adds up to zero
  - ♦ Sources add voltages, components use (subtract) voltages
- ♦ Current Law: the sum of currents entering a node must equal the sum of the currents leaving a node
  - ♦ In a series circuit the current is the same across all components
  - ♦ In a parallel circuit, the current divides proportionately at each junction
  - ♦ In all cases, the amount of current injected must equal the amount of current returned to the injection point

What happens to current at the junction of two components in series? It is the same in both components (or, in other words, a series loop has only one path, so the same current goes through each component)

In a parallel circuit, the current will divide at the junction point depending on the value of the components in each leg of the circuit

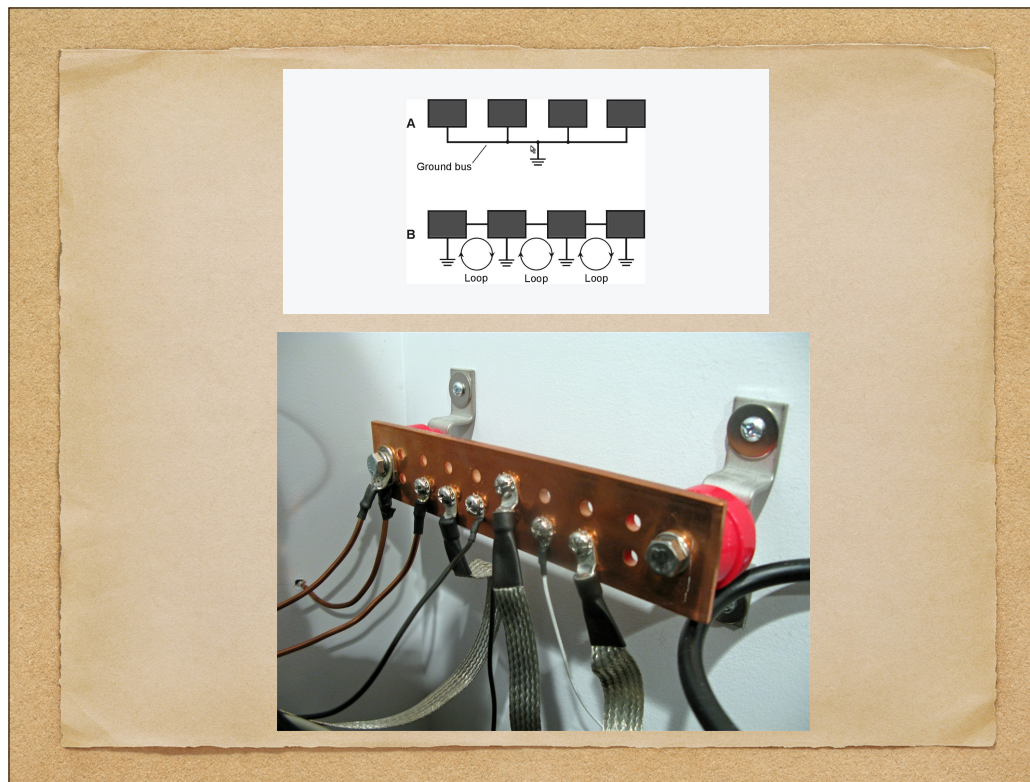
Safety First!!



# Important Grounding Info

- ◆ Grounding protects against electrical shock!!
  - ◆ Use 3-way cords and plugs on all AC powered equipment
  - ◆ Use a circuit protected by a ground-fault interrupter
  - ◆ Connect all AC powered station equipment to a common safety ground
    - ◆ Prevents different equipment from having "floating grounds"
- ◆ The GREEN WIRE in a 3-wire AC plug is always connected to the equipment ground





Connect all grounds to a common point. No “daisy chains”! Will cause ground loops instead of having all equipment at the same ground

Ground bus bars are a good choice. One side is connected to the house ground (where the green wire is attached) and the other side goes to a good earth ground (wire as short as possible)

# Fuses

- ♦ A fuse of the proper value will protect you and your equipment in case of an overload
- ♦ A fuse should always be included in home-built equipment
- ♦ Never replace a blown fuse with one of a higher amperage value
- ♦ Electrical current flowing through the human body may
  - ♦ Cause injury by heating tissue
  - ♦ Disrupt electrical function of cells
  - ♦ Cause involuntary muscle contractions



# Battery Safety

- ♦ If a lead-acid battery is discharged too quickly (as in a short circuit) the battery could overheat, discharge flammable hydrogen gas, or explode
- ♦ Touching both terminals with hands or other conductive material can cause serious electrical shock and a short circuit





# Tower Safety

- ♦ Keep towers a safe distance from a power line!!!!
  - ♦ Far enough so that if the tower falls, no part of it can come closer than 10 feet to the power lines
- ♦ Never attach to a utility pole (they carry high-voltage power lines)
- ♦ When climbing, always use a climbing harness (fall arrester) and safety glasses
- ♦ Never, ever climb without a helper or observer
- ♦ Everyone around the tower should wear a hard hat
- ♦ Crank-up towers should not be climbed unless safety-locking devices are installed



## More on Towers

- ♦ A “gin pole” is used to lift tower sections or antennas safely
- ♦ Use safety wires on turnbuckles to prevent them from loosening from vibration
- ♦ Local electrical codes govern tower grounding requirements
  - ♦ Generally separate eight-foot long ground rods for each tower leg, bonded to the tower and each other
  - ♦ Use copper strap (lowest impedance to RF) for bonding
  - ♦ Keep connections short and direct (no sharp corners)

So, What Is A Gin Pole (You Might Ask)





# RF Exposure

- ♦ The amount of RF energy the human body will absorb varies with the frequency
  - ♦ The body is most susceptible at 50 MHz (6 meters)
  - ♦ This is the frequency with the lowest “maximum permissible exposure”
- ♦ RF Exposure Evaluation is required when the maximum power output is 50 watts or more
  - ♦ The evaluation is done based on the FCC OET Bulletin 65 using computer models and actual field measurements



- ♦ Relocate antennas if necessary to avoid excessive RF exposure (particularly mobile antennas)
- ♦ Whenever station equipment changes you must re-evaluate for RF exposure limits


Touching an antenna while transmitting can cause a serious RF burn!

When antennas are where people may accidentally touch them (such as at a shelter or an outdoor activity), they need to be guarded and well marked

# Managing RF Exposure

- ♦ The “Duty Cycle” of the RF emitter is an important component of RF exposure
  - ♦ Duty Cycle is the percentage of the time that the transmitter is transmitting vs the time it is not
- ♦ “Power Density” is the average amount of RF power exposure over a period of time
  - ♦ Duty Cycle directly affects power density
  - ♦ 3 minutes on and 3 minutes off vs 6 minutes on would double the power density allowed over a 6 minute period





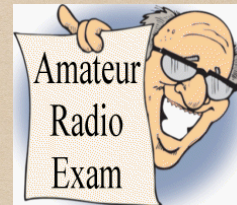
BE SAFE!



# The Exam

# The Exam Session

- ◆ Please bring:
  - ◆ Your FRN (FCC Registration Number)
  - ◆ 2 forms of ID, one of which must have your picture
  - ◆ A calculator (not a smart phone!)
  - ◆ \$15 in cash or check. No credit cards can be accepted
- ◆ The first action will be to fill out a form 605





# Form 605 Paperwork

- ♦ Applicant fills out the top section down to the signature
- ♦ Upon completion of the exam, the exam coordinator will fill out the bottom section
- ♦ If you have ever been convicted of a felony, a written statement as to why you should be granted a license must be submitted

NCVEC QUICK-FORM 605 APPLICATION  
AMATEUR OPERATOR/PRIMARY STATION LICENSE

**SECTION 1 - TO BE COMPLETED BY APPLICANT**

First Last Name: \_\_\_\_\_呼号: \_\_\_\_\_呼号: \_\_\_\_\_  
 Address: \_\_\_\_\_  
 City: \_\_\_\_\_ State: \_\_\_\_\_ Zip: \_\_\_\_\_  
 Email: \_\_\_\_\_

**Basic Qualification Question**  
 Have the Applicant or any party to this application, or any party directly or indirectly controlling the Applicant, ever been convicted of a felony by any state or federal court? ☐ YES ☐ NO  
 If "YES", see "FCC BASIC QUALIFICATION QUESTION INSTRUCTIONS AND PROCEDURES" on the back of this form.

**HOW DO YOU WANT TO APPLY FOR (Mark an X in the appropriate box(es)):**

☐ EXAMINATION for a new license grant ☐ CHANGE my address to my new address  
☐ EXAMINATION for upgrade of my license class ☐ CHANGE my station call sign systematically  
☐ CHANGE my name on my license to my new name ☐ RENEWAL of my license grant  
 Former Name: \_\_\_\_\_呼号: \_\_\_\_\_呼号: \_\_\_\_\_  
 Exp. Date: \_\_\_\_\_

Do you have another license application on file with the FCC which has not been acted upon? ☐ YES ☐ NO

**Identify Self:**

1. I hereby certify that the use of my amateur frequency privileges of power, frequency, and class of license is for the purpose of providing information and services to the public and is not for financial gain or other commercial purpose.  
 2. I hereby certify that I am not a person who has been convicted of a felony by any state or federal court.  
 3. I hereby certify that I am not a person who has been convicted of a felony by any state or federal court.  
 4. I hereby certify that I am not a person who has been convicted of a felony by any state or federal court.

**Signature of Applicant:**  
 X \_\_\_\_\_ Date Signed: \_\_\_\_\_

**SECTION 2 - TO BE COMPLETED BY ALL ADMINISTERING VES**

Applicant is qualified for operator license class:

☐ NO NEW LICENSE OR UPGRADE WAS EARNED  
☐ TECHNICIAN Element 2  
☐ GENERAL Elements 2 and 3  
☐ AMATEUR EXTRA Elements 2, 3 and 4

**DATE OF EXAMINATION SESSION**  
**EXAMINATION SESSION LOCATION**  
**VEE ORGANIZATION**  
**VEE REQUEST DATE**

**I CERTIFY THAT I HAVE COMPLIED WITH THE ADMINISTERING VE REQUIREMENTS IN PART 97 OF THE COMMISSIONER'S RULES AND WITH THE INSTRUCTIONS PROVIDED BY THE COORDINATING VEC AND THE FCC.**

For VEC NAME (Print Name, NE, Last, Initials) ☐ YES ☐ NO **VEE REQUEST DATE** ☐ YES ☐ NO **DATE EARNED**  
 For VEC NAME (Print Name, NE, Last, Initials) ☐ YES ☐ NO **VEE REQUEST DATE** ☐ YES ☐ NO **DATE EARNED**  
 For VEC NAME (Print Name, NE, Last, Initials) ☐ YES ☐ NO **VEE REQUEST DATE** ☐ YES ☐ NO **DATE EARNED**

DO NOT SEND THIS FORM TO FCC - THIS IS NOT AN FCC FORM.  
 IF THIS FORM IS SENT TO FCC, FCC WILL RETURN IT TO YOU WITHOUT ACTION.

NCVEC FORM 605 - September 2017  
 FOR VEC USE ONLY - Page 1

If you've been convicted of a felony, see me after the class for explanation of what the statement must include and how to submit the statement.

Note that a felony conviction does not disqualify an applicant. Further, the VE team has no involvement in the statement submission or review process.



# Taking the Exam

- ♦ You'll be given an exam booklet with the 55 questions you are to answer along with an answer sheet
- ♦ You'll also be given two blank pieces of paper to use as scratch paper. You must turn in the two sheets of paper, even if they weren't used when you turn in the answer sheet
- ♦ If you don't have a pen or pencil, one will be provided
- ♦ Make no marks on the exam books. They are reusable
- ♦ Mark your answers on the answer sheet. Double / triple check
- ♦ There is no time limit
- ♦ Your test will be different than your neighbors
- ♦ Three VE's will supervise the test session and each will independently grade your exam



# Upon Successful Completion

- You will be issued a form indicating successful completion
- The white (top) copy of the form is given to the successful applicant, the yellow is kept in our local files, and the pink is sent to W5YI-VEC as part of your application for a license
- Keep the form at least until your license appears in the FCC database

WSYI-VEC  
National Volunteer Examiner Coordinator  
This certifies that:

DATE OF ISSUE: \_\_\_\_\_ NAME: \_\_\_\_\_ STATION CALL SIGN: \_\_\_\_\_  
CITY / STATE (Session Site): \_\_\_\_\_ NUMBER AND STREET: \_\_\_\_\_

I have SUCCESSFULLY PASSED the following elements:

☐ Element 1: Technician Class ☐ Element 2: General Class ☐ Element 3: Amateur Extra Class

I have SUCCESSFULLY PASSED all elements for the following operator license class:

☐ Technician Class Operator ☐ General Class Operator ☐ Amateur Extra Class Operator

IF you achieve a test as Technician operator radio license, this reflects evidence necessary (pending) operating with the right and privilege of your new operator class of the certificate (See Section 97.503). When operating on an extra class in the certificate's date is longer 30 days, you must appear your call sign with all elements of the certificate (See Section 97.503). When operating on an extra class, the date is longer 30 days, you must appear your call sign with all elements of the certificate (See Section 97.503). When operating on an extra class, the date is longer 30 days, you must appear your call sign with all elements of the certificate (See Section 97.503).

THIS CERTIFICATE IS NOT A LICENSE PERMIT OR ANY OTHER KIND OF OPERATING AUTHORITY

VOLUNTEER EXAMINERS

SIGNATURE: \_\_\_\_\_ STATION CALL SIGN: \_\_\_\_\_

WSYI-VEC  
P.O. Box 200000 • Arlington, TX 76000-0000  
800-488-8384

White Original - Applicant Yellow - VE Team Records Pink - VEC Office

- Your call sign will appear in the FCC call sign database 10-12 days after the test session
- <http://wireless2.fcc.gov/UlsApp/UlsSearch/searchAmateur.jsp>

No login is required as call signs are part of the public record



GET ON THE AIR!



Check into the WDARC net on Thursday evening 7pm





