

# Marine Electrical Simplified

## Batteries & Beyond

## Learning the A, B, C's\*



\*Amps, Batteries, Current, (More)

# A Bit About Me

- Lifetime boater
- ABYC/NMEA Certified Electrical Tech
- Active with NMEA/NMMA/ABRA/ABYC
- Cruising Editor of Waterway Guide™
- Past President of SSCA
- Owner of CHARDONNAY BOATWORKS
- USCG Licensed Deck & Engine Room

# So Much To Learn

- Direct & Alternating Current
- Amps, Volts, & Watts
- Shore Power and Ship's Power
- Positive & Negative
- Hot/Neutral/??
- Ungrounded, Grounded, & Grounding
- Single, Split, & Three Phase
- Batteries, Generators, and More

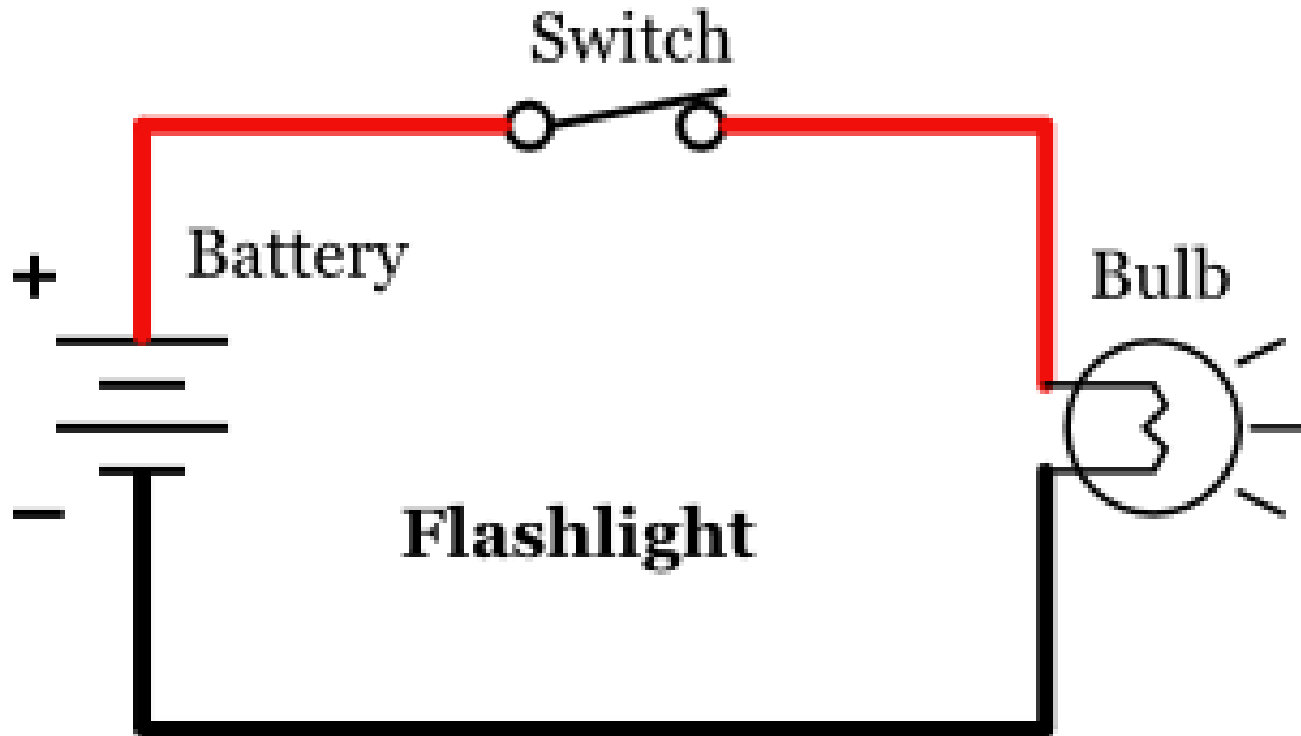
# Troubleshooting

- Mostly consists of ruling things out
- It's important to know what 'normal' is
- Most problems are diagnosed by how they vary from published or known values
- So: Do you know your usual voltages and currents on your boat?

# AC/DC is more than a Band

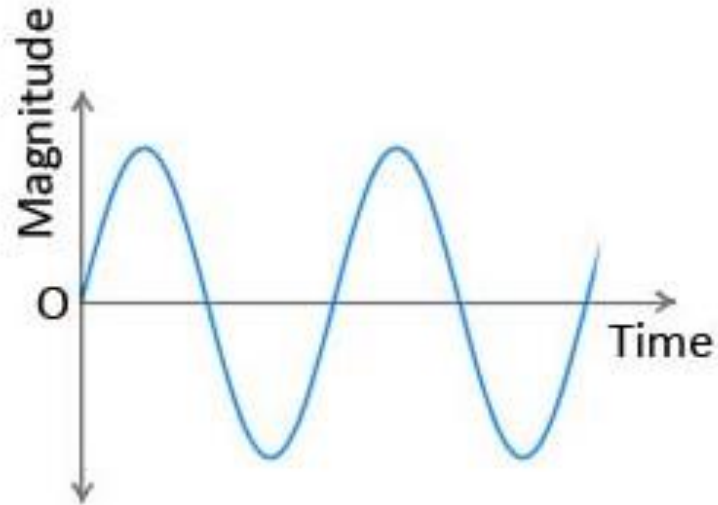
- Edison vs Tesla or General Electric vs Westinghouse!
- For now think Batteries vs Shore Power
- All the formulas apply to both
- Both power your boat or chill your beer
- Both can cause a fire
- Both can be safe or dangerous...

# Direct Current

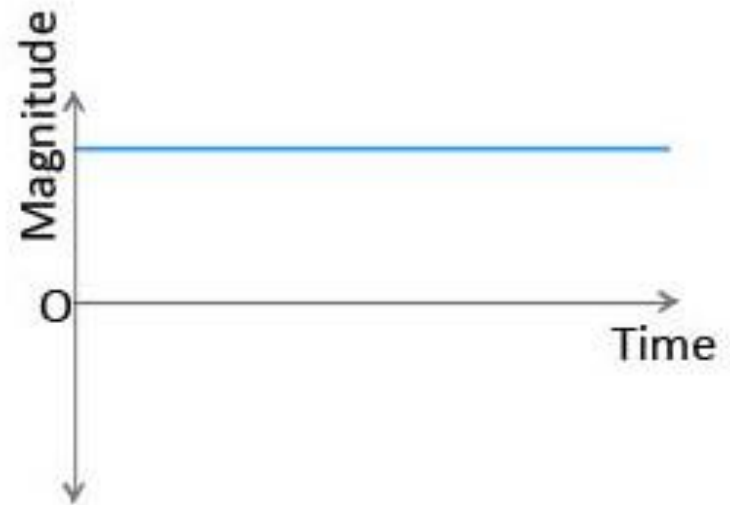


Power Flows from Negative (Anode) to Positive (Cathode)

# Alternating Current



Alternating Current



Direct Current

A/C switches from Pos (+) to Neg (-) between 50 and 60 time per second (in most cases) while DC is a steady from from Neg to Pos

# First thing to Memorize: Amps, Volts, & Watts

- Electrical Current (volume of flow) is measured in AMPS (shown as “i”)
- Electromotive Force (pressure of flow) is measured in VOLTS (shown as “e”)
- Resistance to Electrical Flow, is measured in OHMS (shown as “r”)
- Power, a combination of FLOW and PRESSURE, is measure in WATTS (“w”)



# Stick with me Here!

- We measure POWER in WATTS, so a Water Heater might say it is rated at 1500 Watts and your small refrigerator might be rated at 60 Watts
- Watts are a combination of VOLTS (pressure) and AMPS (volume)  
$$\text{'E' (volts)} \times \text{'I' (amps)} = \text{'W' (watts)}$$
- So 12 volts x 100 amps = 1200 Watts
- And 120 volts x 10 amps = 1200 Watts

# Almost there...

POWER Formula:

**Watts = Volts X Amps**

**Amps = Watts / Volts**

**Volts = Watts / Amps**

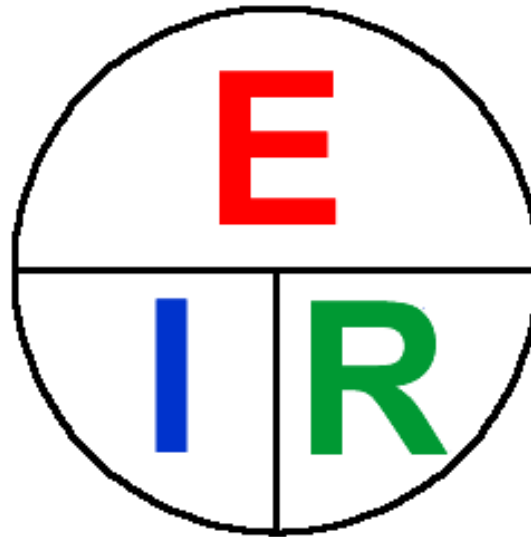
# Whew!

## OHMS LAW:

$$I = E/R$$

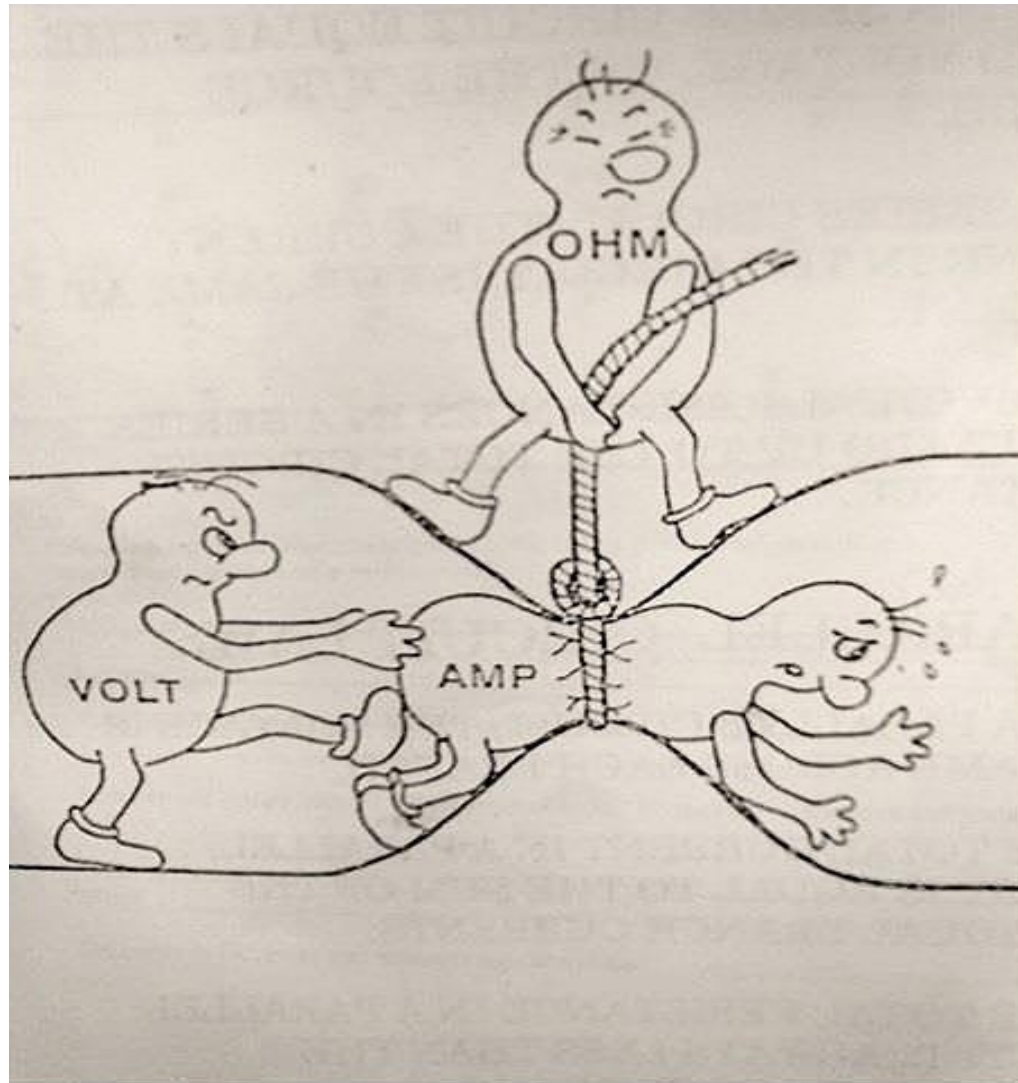
$$R = E/I$$

$$E = IR$$





Or, Viewed Another Way:

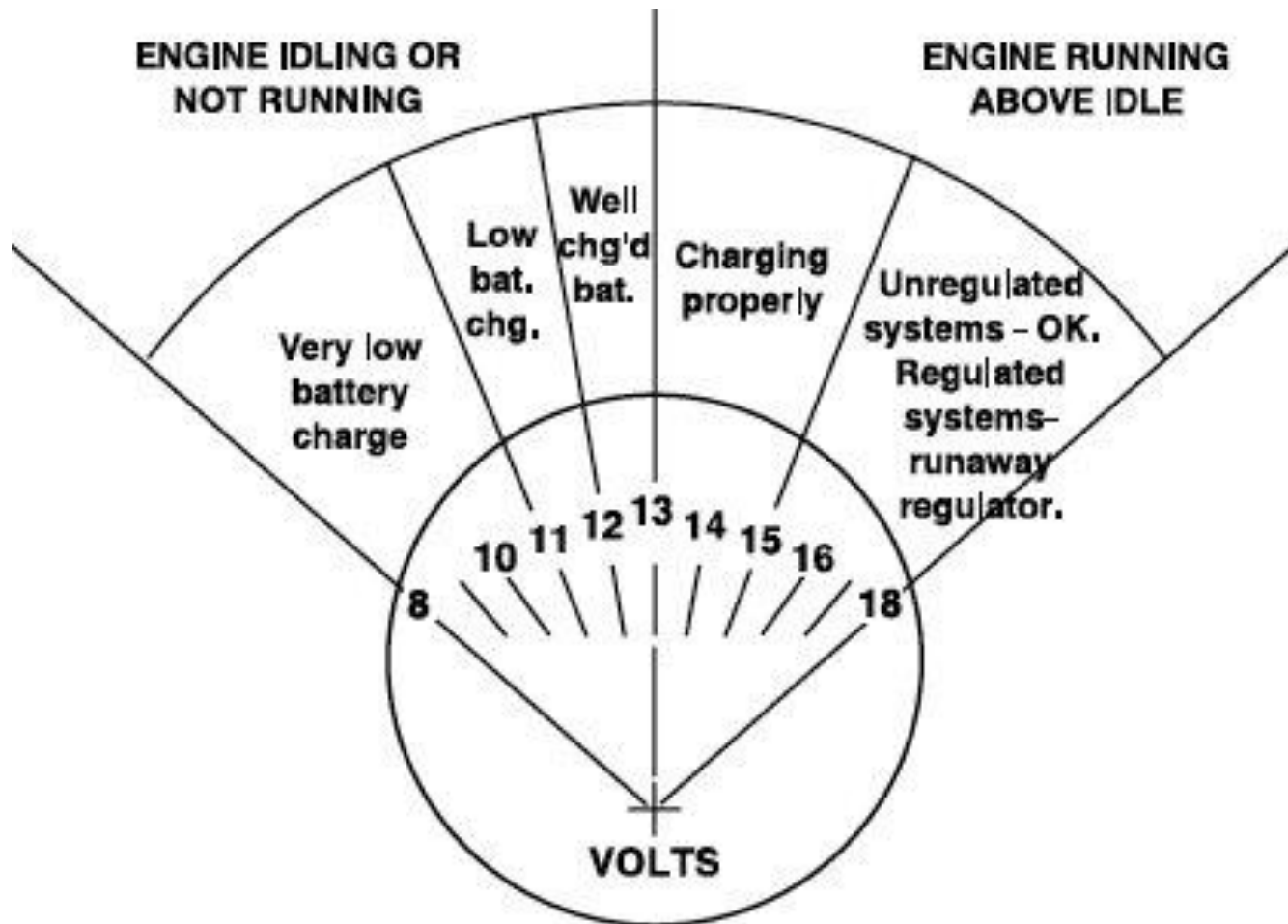


# Amps, Hours, Amp/Hours

- 1 amp for 1 hour is 1 amp/hour (a/h)
- Many Cruising Boats monitor AH used from a House Battery using an Amp Hour Meter that reads all power in and out of the battery bank.



# What Voltage Tells Us



# Shore Power and Ship's Power

- In the US we have 120 and 240 volt single phase power at 60 cycles per second (Hz)
- In Europe we (mostly) have 230 volt single phase power at 50 Hz
- Larger boats will often use 480 volt three phase power
- Generators create AC to match the shore power while cruising (in most cases)



# Simple Shore Power Tests

- Voltage (120 / 240 / 230)
- Frequency (50 / 60 hz)
- 30 or 50 amp (US)
- 16 or 32 amp (most of Europe)
- ELCI's and Ground Faults

# Tools you'll Need

- DMM (Digital Multi-Meter)
- Clamp On Ammeter (AC & DC)
- Test Light (AC and DC)
- Wrenches and Screwdrivers
- Jumper Wires
- A Good Head Lamp;
- Close up Glasses (for seeing and eye protection)

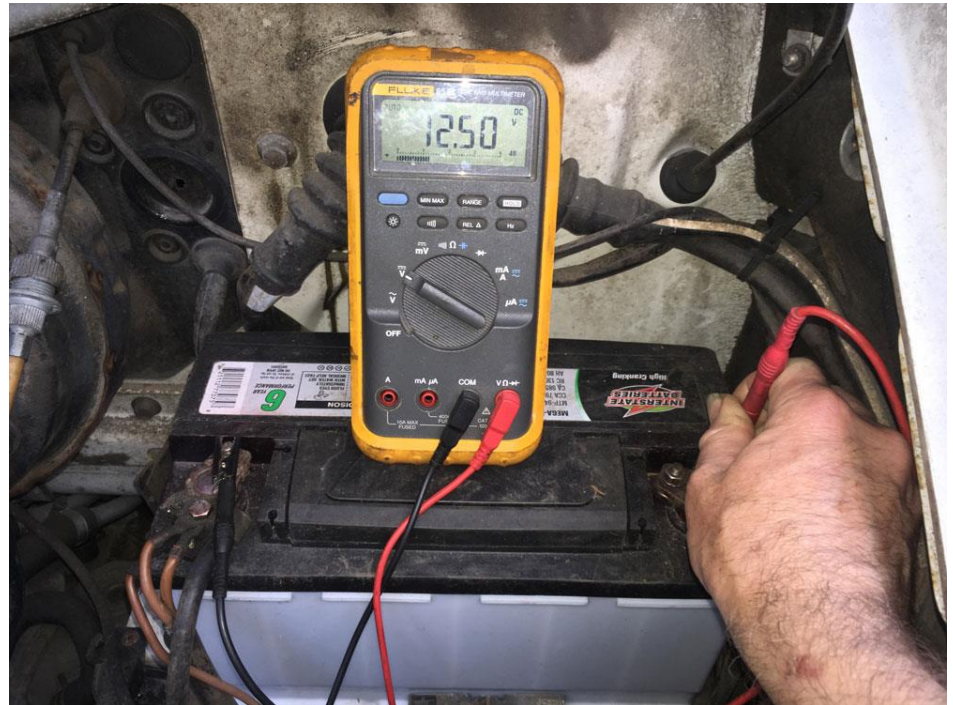
# Introducing the DMM

- Not a place to penny pinch but values are available -- like the Prova below
- Pros like Fluke, the #87 is the Gold Standard for most
- Probes and Clamps



# DMM Measures

- AC and DC Voltage
- AC and DC Amperage
- Resistance
- Continuity
- Capacitance



Checking Battery Voltage– Parallel to Circuit

# What to Take Home

- A Respect for Electricity on a Boat
- Confidence that “You can Do This!”
- A Sense of Skepticism of “New and Improved”
- A GOOD Digital Multi-meter with Clamp
- And a Commitment to learning more