

A decorative background pattern of light blue circuit board traces and nodes, resembling a PCB layout, is overlaid on a dark blue gradient background. The traces are most prominent on the left and right sides of the image.

YOUR BOAT'S ELECTRICAL SYSTEM

REGENT POINT YACHT CLUB


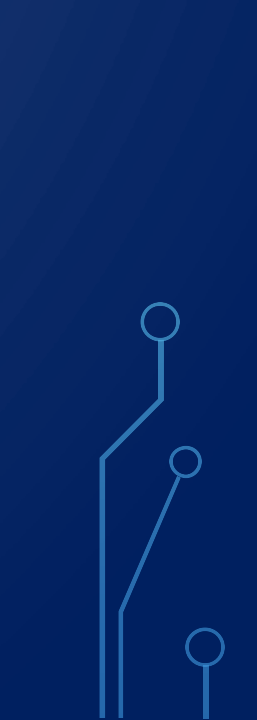
NOVEMBER 2, 2024

TODAY'S AGENDA

- Electricity 101
- Circuits & circuit diagrams
- How electricity flows into and around a boat (batteries, wires, distribution panels, etc.)
- Sources of AC & DC power on a boat
- Boat electrical survey
- Additional sources of electricity including generator, solar, wind, & water power
- Galvanic corrosion/Stray current corrosion
- Recommended tools/Resources
- ABYC



ELECTRICITY 101

- Electricity is a form of energy that can be carried by wires and is used for heating, lighting, and to provide power for machines.
- 
- 

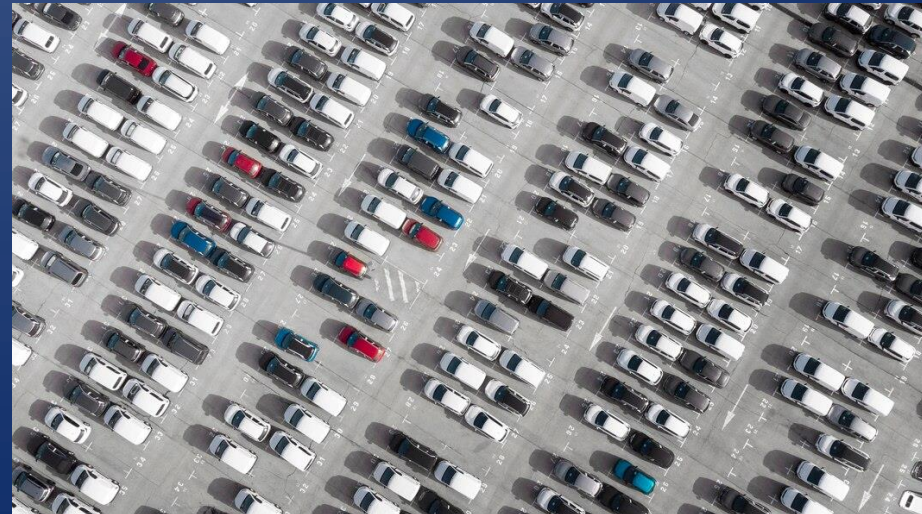
ELECTRICITY 101

- Amp - The unit of electricity used to measure electrical current (The number of electrons that pass a given point on a wire over a given period of time). Represented by the symbol (I).



ELECTRICITY 101

- Volt – The unit of electricity used to measure potential in electrical force. **(The number of amps that could flow over that wire)**. Represented by the symbol (V).



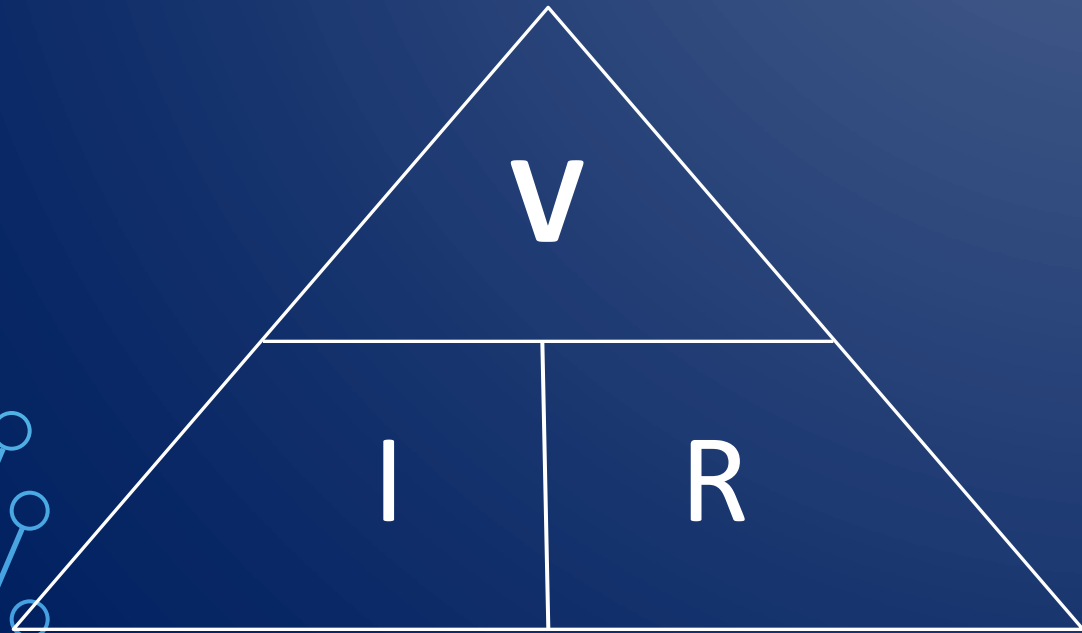
ELECTRICITY 101

- Ohm – The unit of electricity used to measure resistance. (The effects of size, length, type/condition of conductor & equipment on electricity flow). Represented by the symbol (R).



ELECTRICITY 101

- Ohm's Law: Amps (I) = Volts (V)/Resistance (R)



$$I = V / R$$

$$R = V / I$$

$$V = I \times R$$

ELECTRICITY 101



What is the resistance in this circuit?

Resistance (R) = Volts (V) / Amps (I)

Resistance = 12 Volts / 4.0 Amps

Resistance = 3.0 Ohms – (Ω)

ELECTRICITY 101

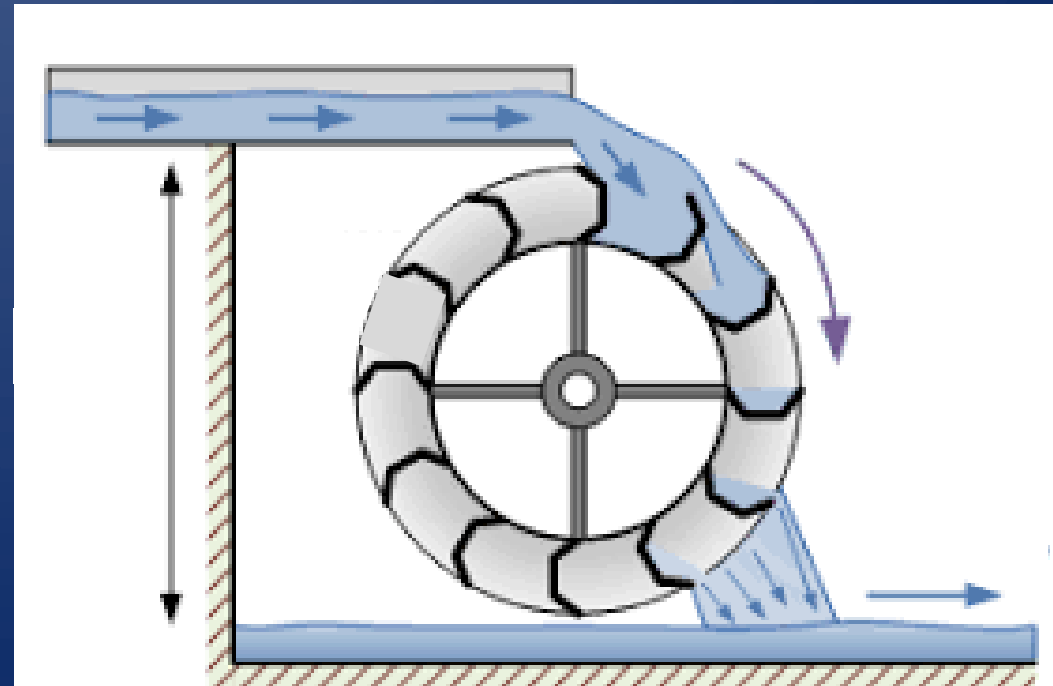
- Watt - The unit used to measure the useful work done by electricity. Represented by the symbol (P)

Water pressure = Volts

Water flow = Amps

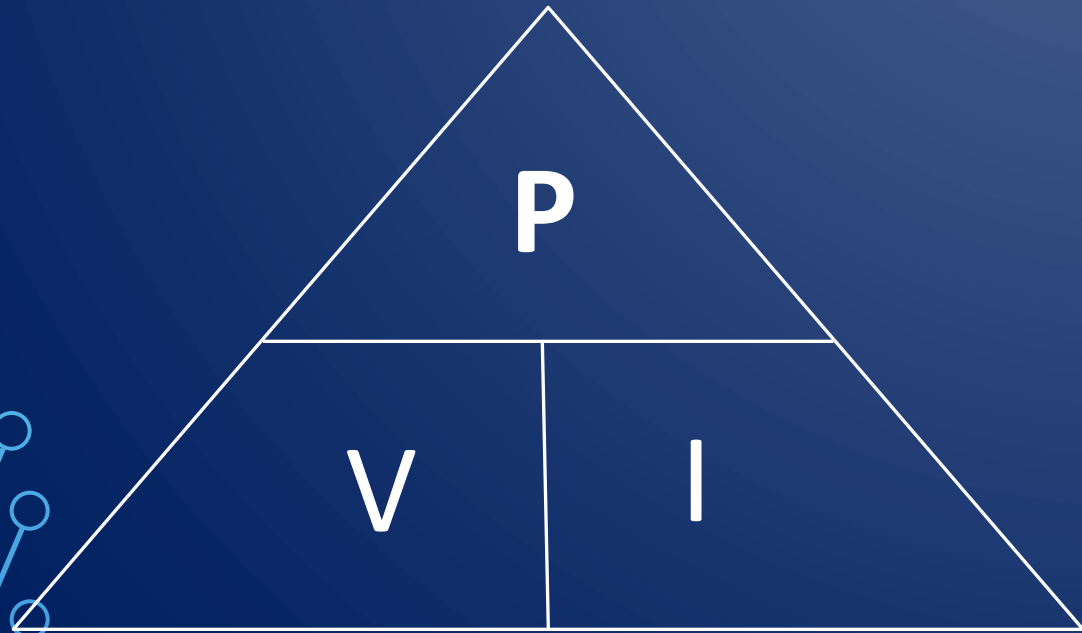
Pipe size = Resistance

Energy created = Watts



ELECTRICITY 101

- Watts (P), Volts (V), Amps (I)



$$P = V \times I$$

$$V = P / I$$

$$I = P / V$$

ELECTRICITY 101



- What is amp draw of this pump?
- Amps (I) = Watts (P)/Volts (V)
- Amps = 70 Watts/12 Volts
- Amps = 5.83*

*Amp draw per hour

ELECTRICITY 101

- Direct current (DC)(12 volts) - Electric current flows in one constant direction. (Navigation lights, electronics, etc.)



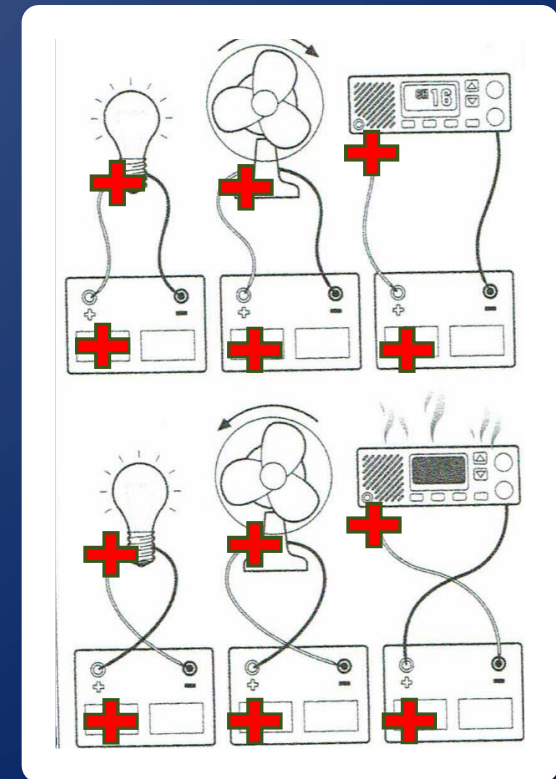
- Alternating current (AC) (120 volts 60 Hz) - Electric current periodically cycles and inverts its direction. (Microwave, TV, hair dryer, etc.)



***Europe = 220-240 volts 50 Hz**

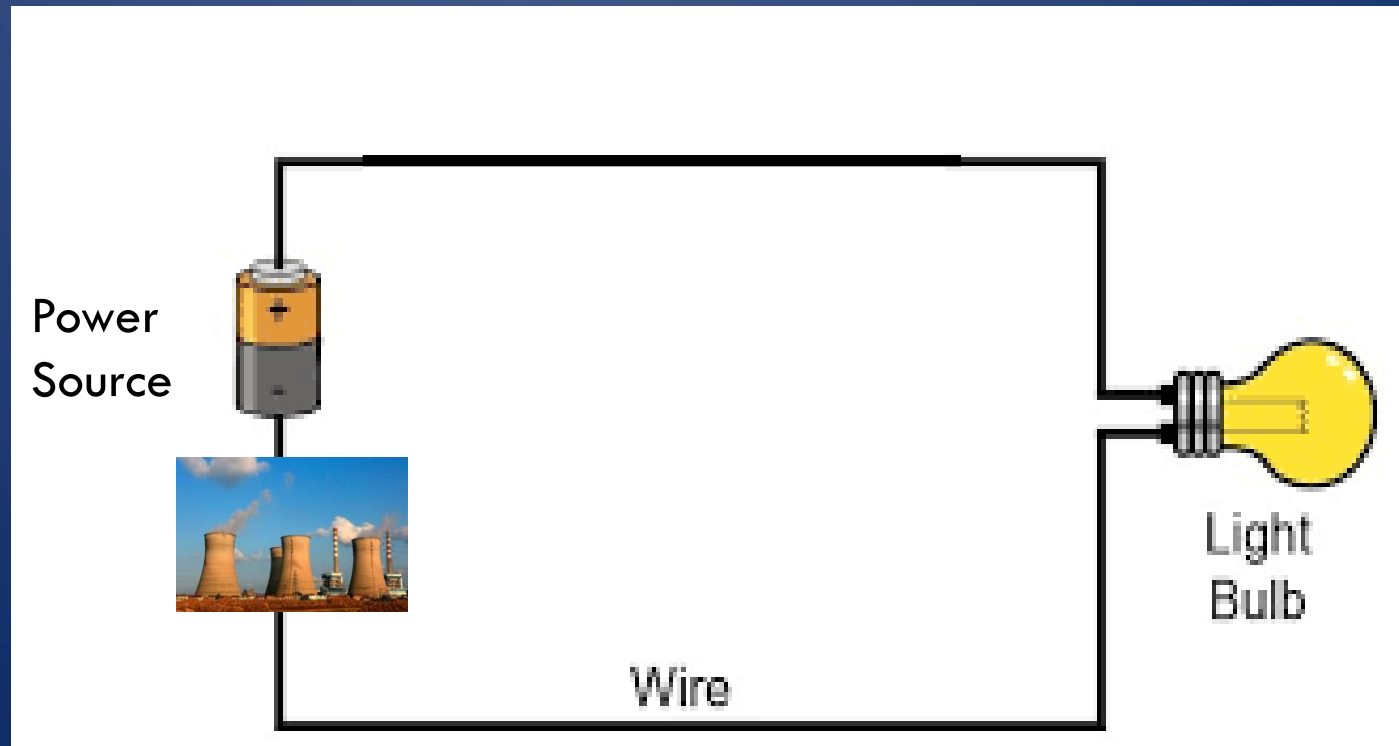
ELECTRICITY 101

- Polarity – Direction of current flow in an electrical circuit
- 12 volt components work properly when connected to positive side of circuit
- AC appliances may work properly but Reverse Polarity = **DANGER**



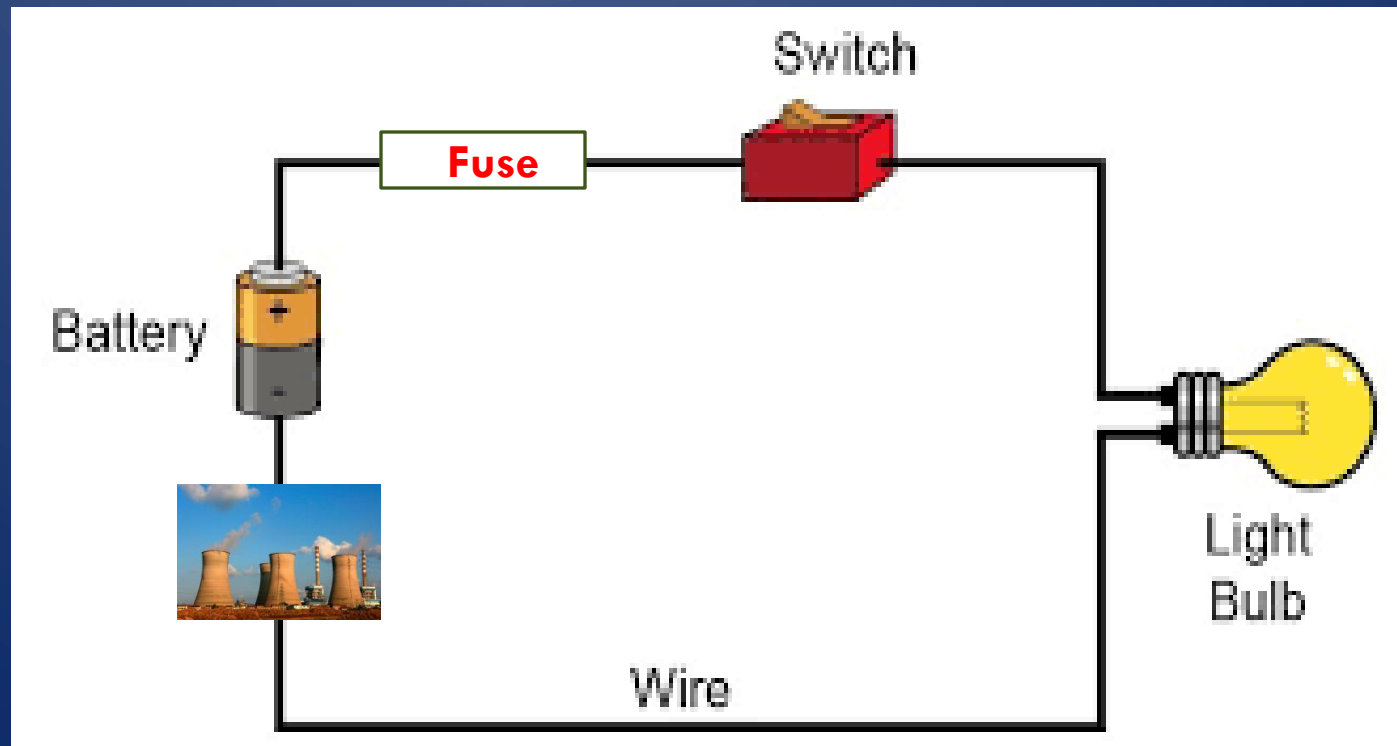
CIRCUITS

- Basic AC/DC circuit



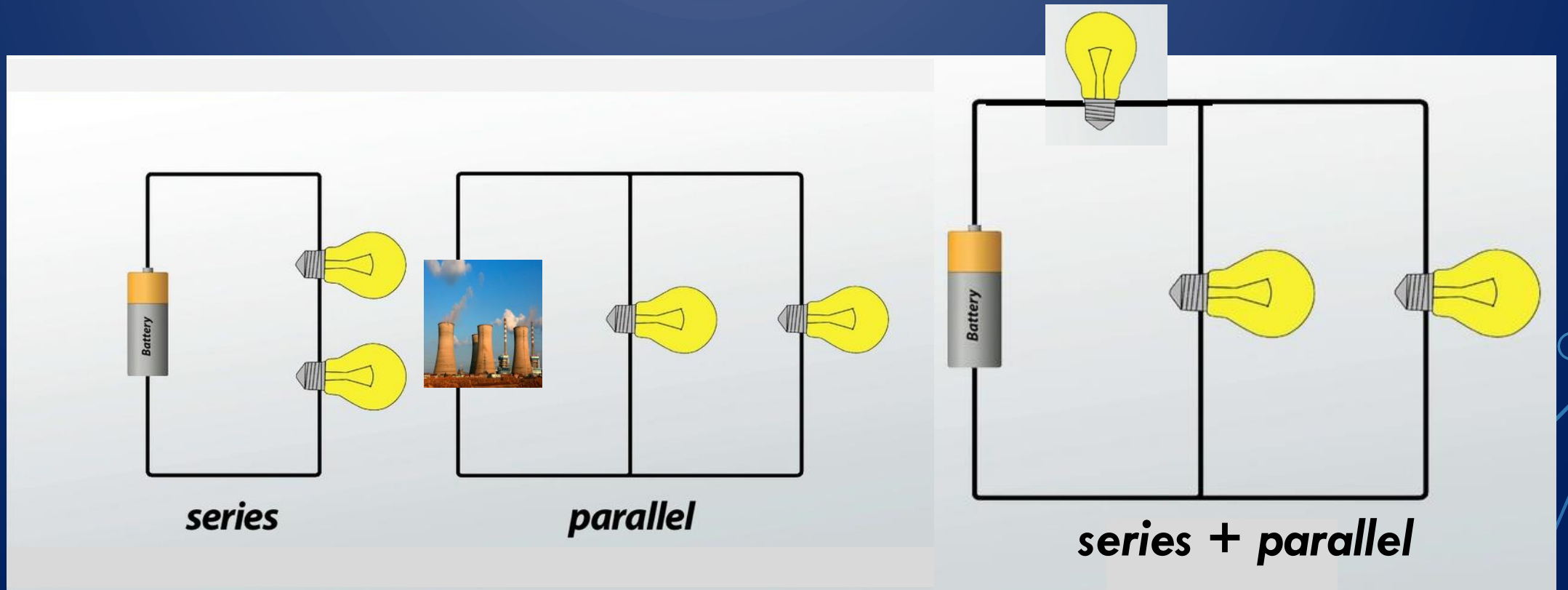
CIRCUITS

- More common AC/DC circuit on boat



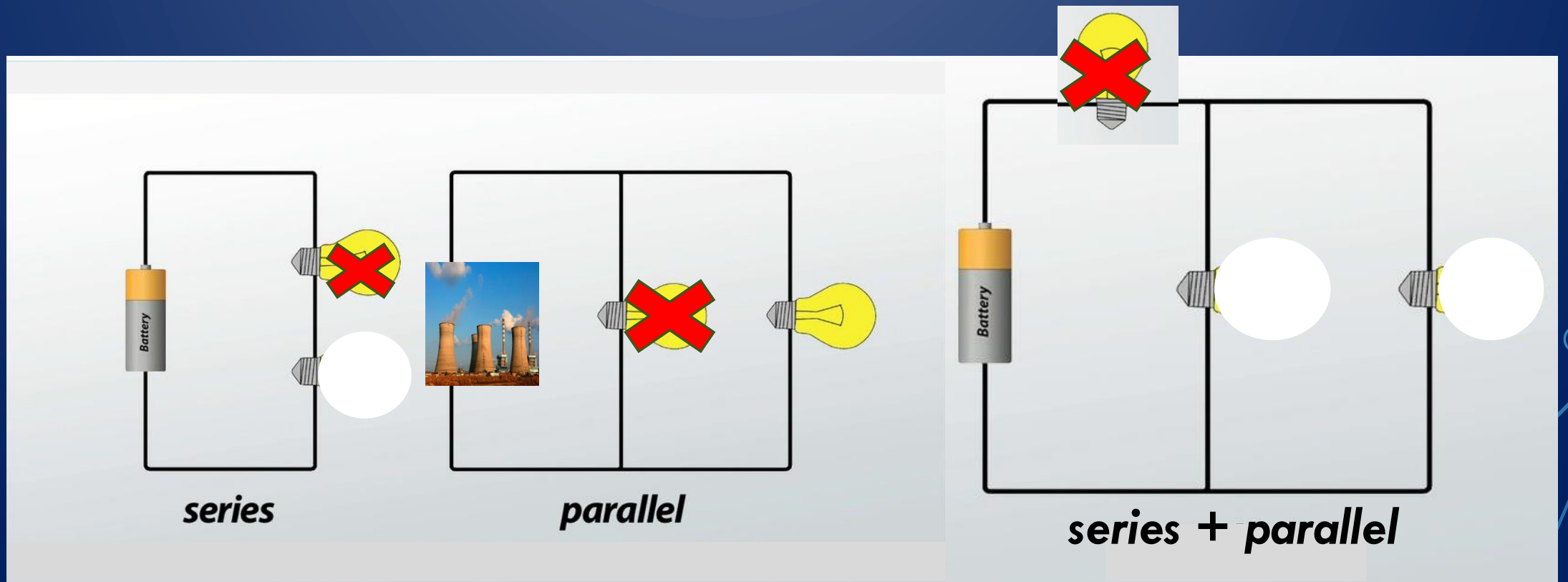
CIRCUITS

- Series/Parallel/Series plus Parallel Circuits



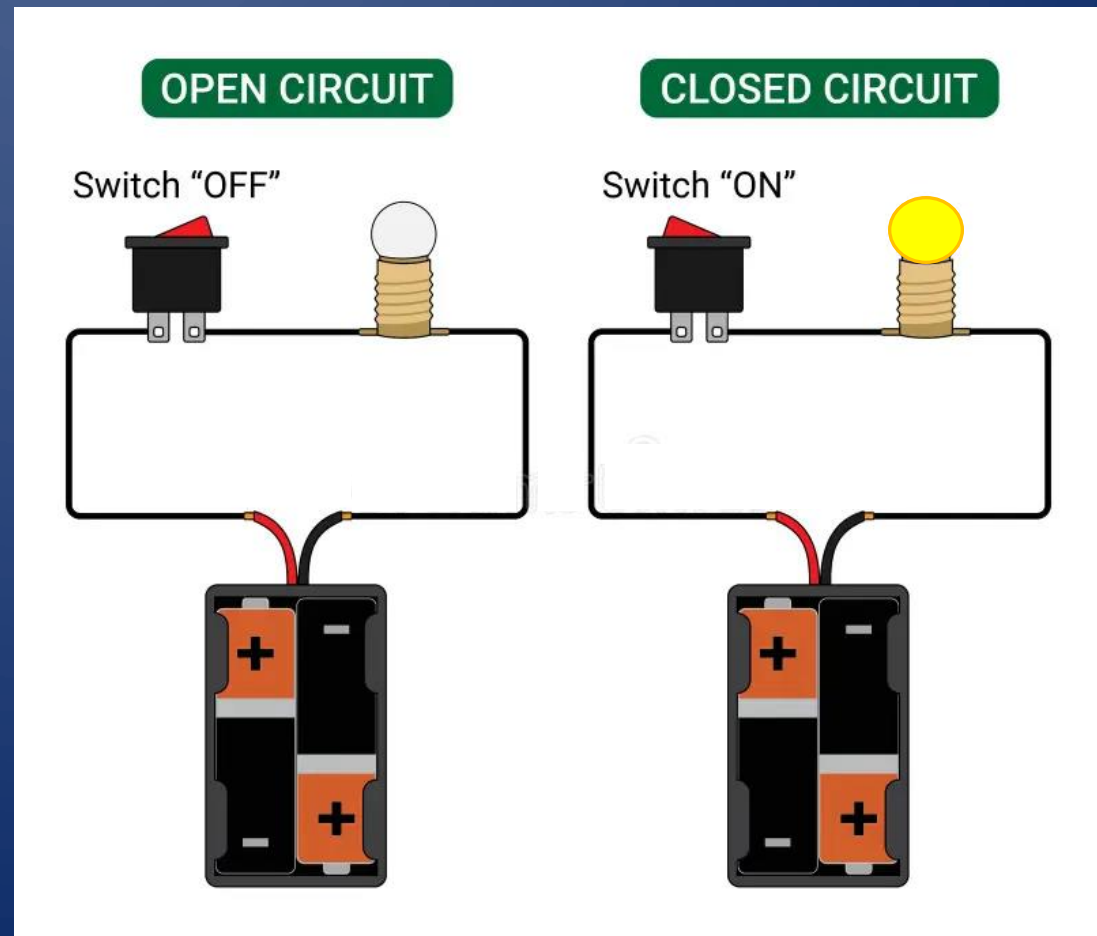
CIRCUITS

- Series/Parallel/Series plus Parallel Circuits – Pros & Cons



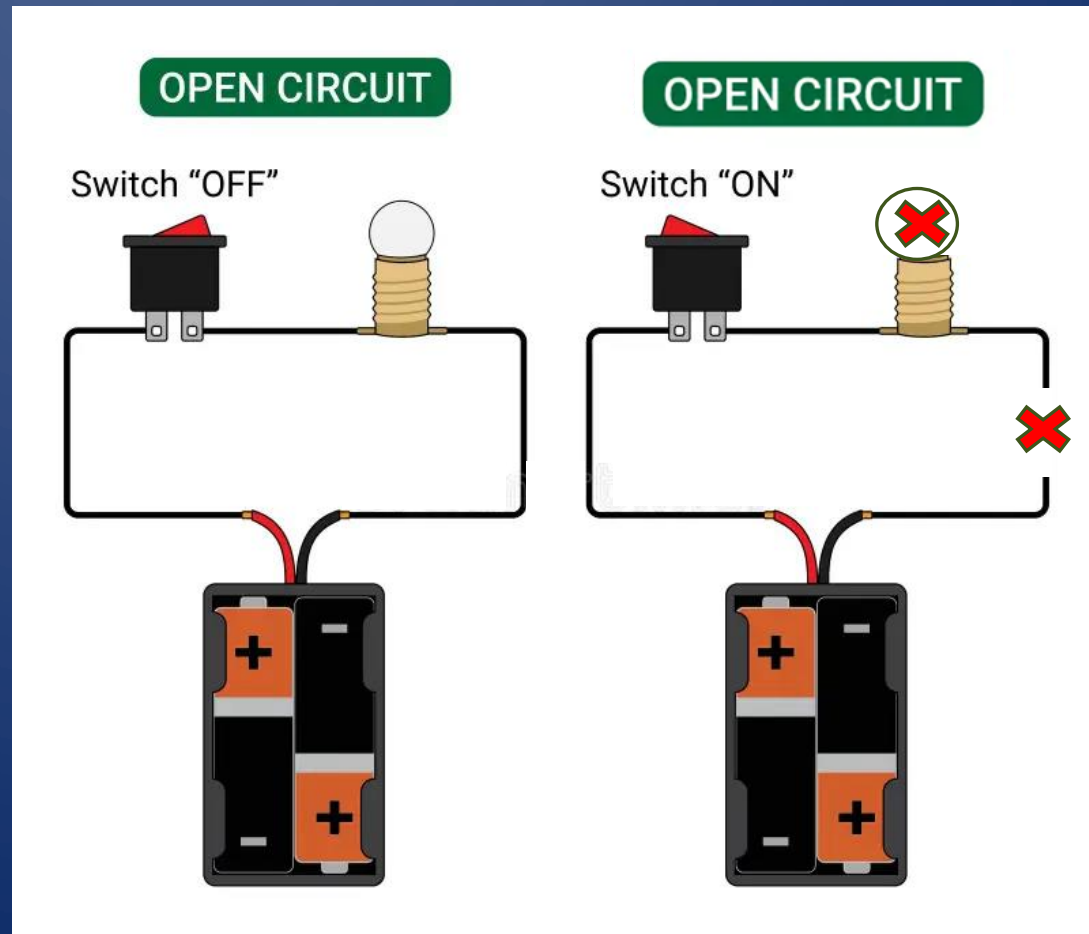
CIRCUITS

- Open/Closed Circuit



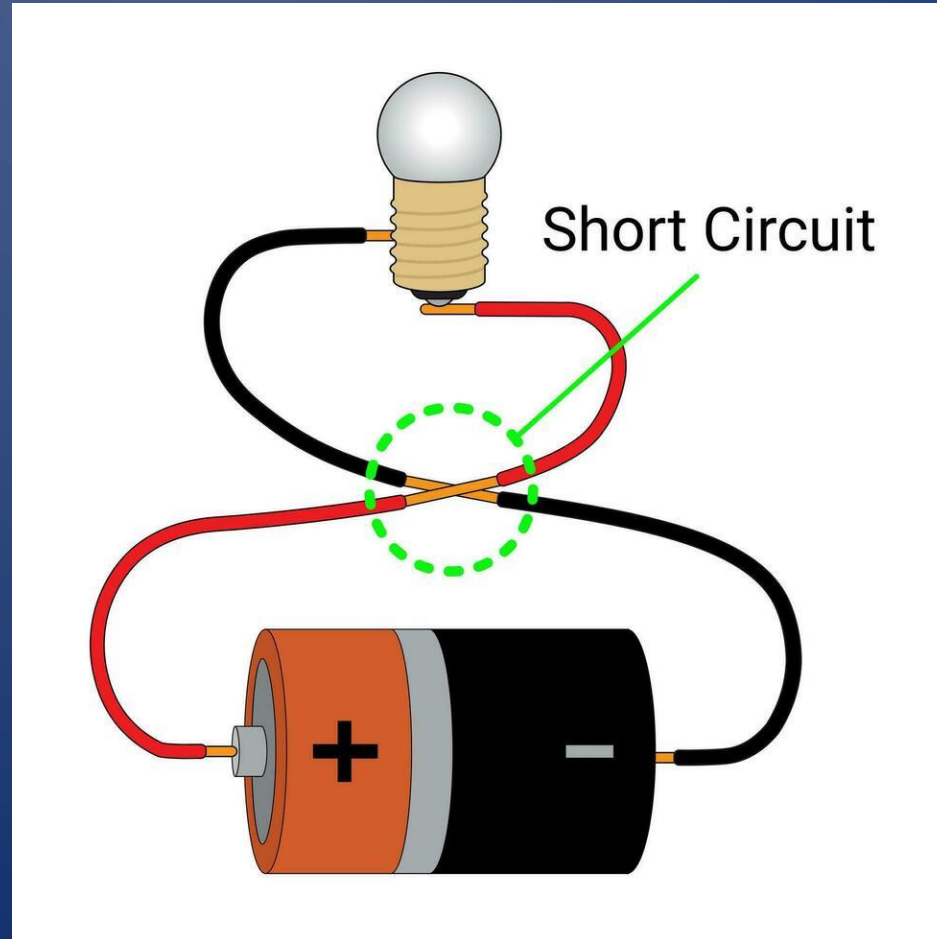
CIRCUITS

- Open Circuit



CIRCUITS

- Short Circuit

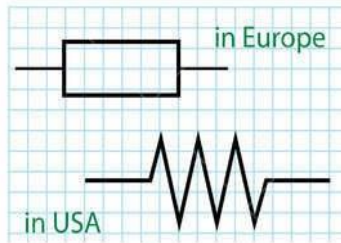


CIRCUITS

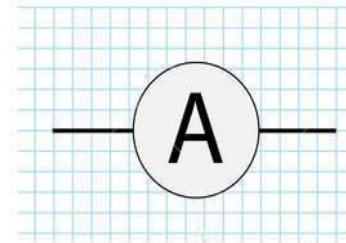
- Electrical circuit diagram symbols

ELECTRICAL CIRCUIT SYMBOLS

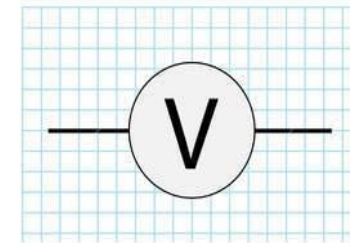
Resistor



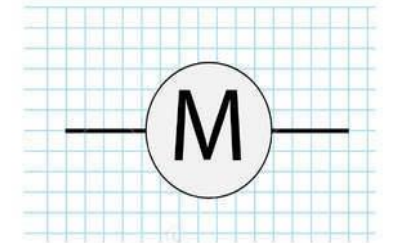
Ammeter



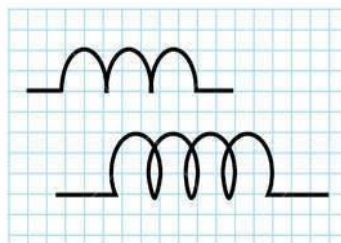
Voltmeter



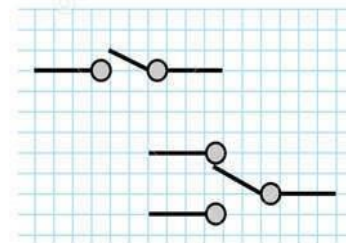
Motor



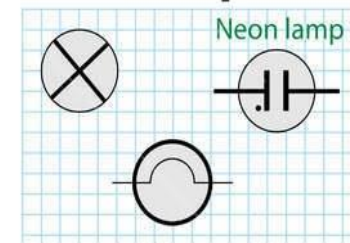
Inductor



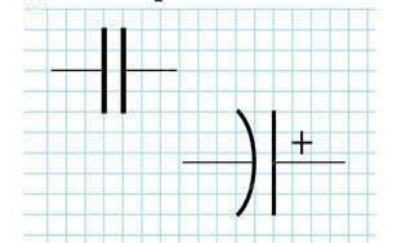
Switch



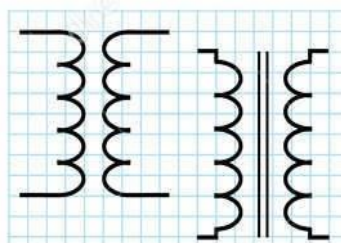
Lamp



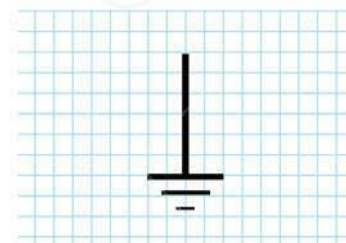
Capacitor



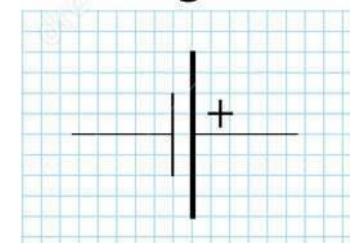
Transformer



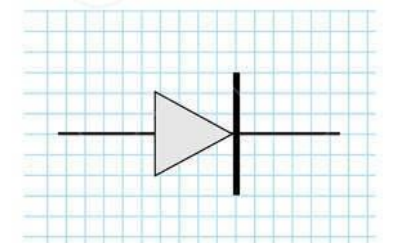
Ground



DC voltage source



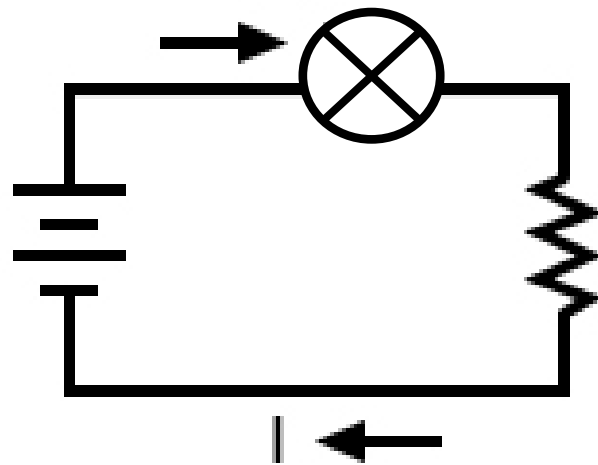
Diode



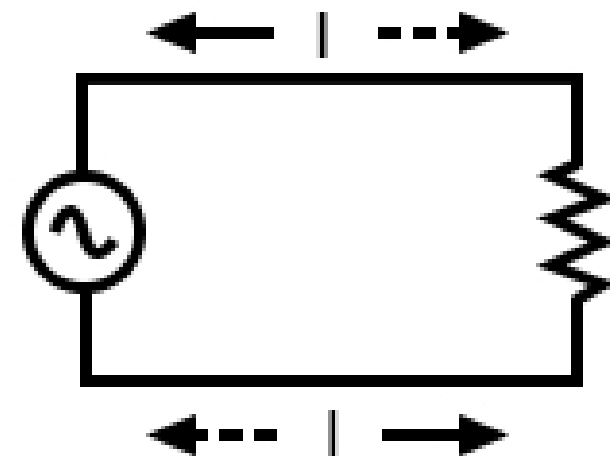
CIRCUITS

Basic AC/DC circuit diagram

**DIRECT CURRENT
(DC)**

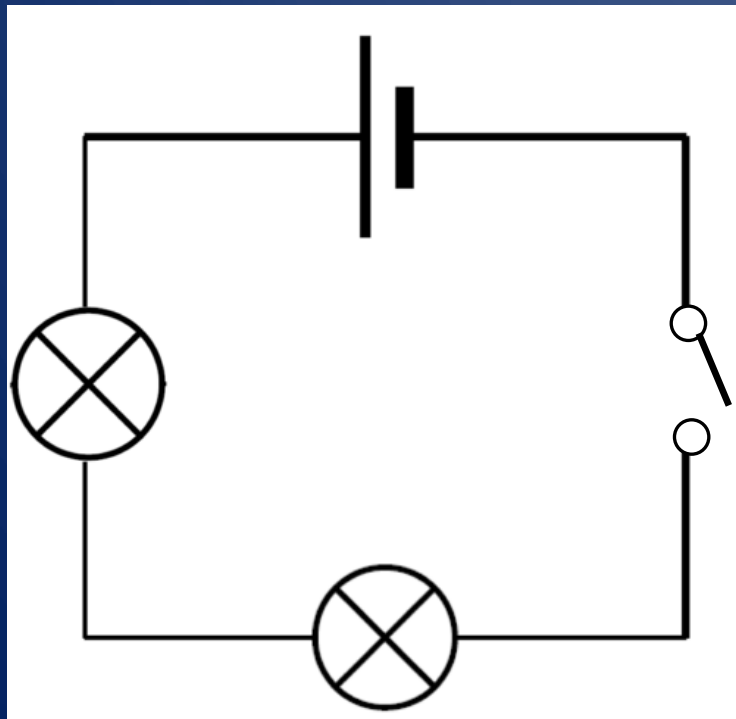


**ALTERNATING CURRENT
(AC)**

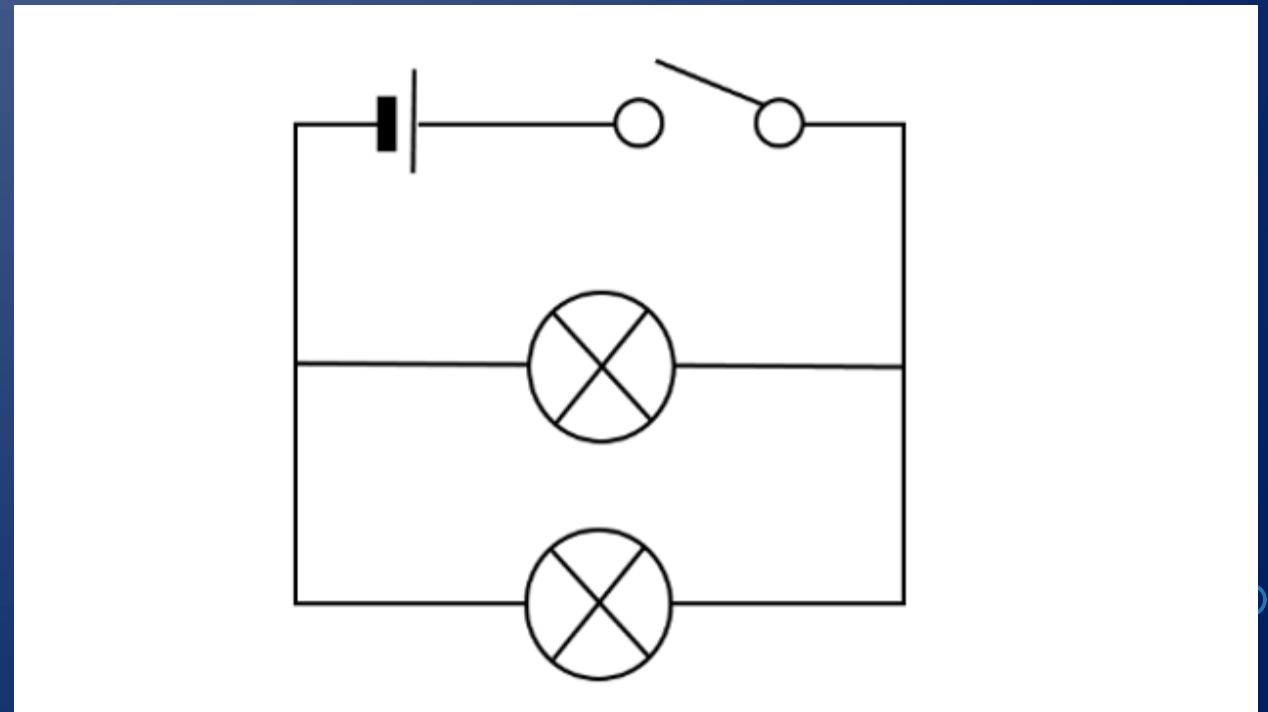


CIRCUITS

DC circuit diagrams



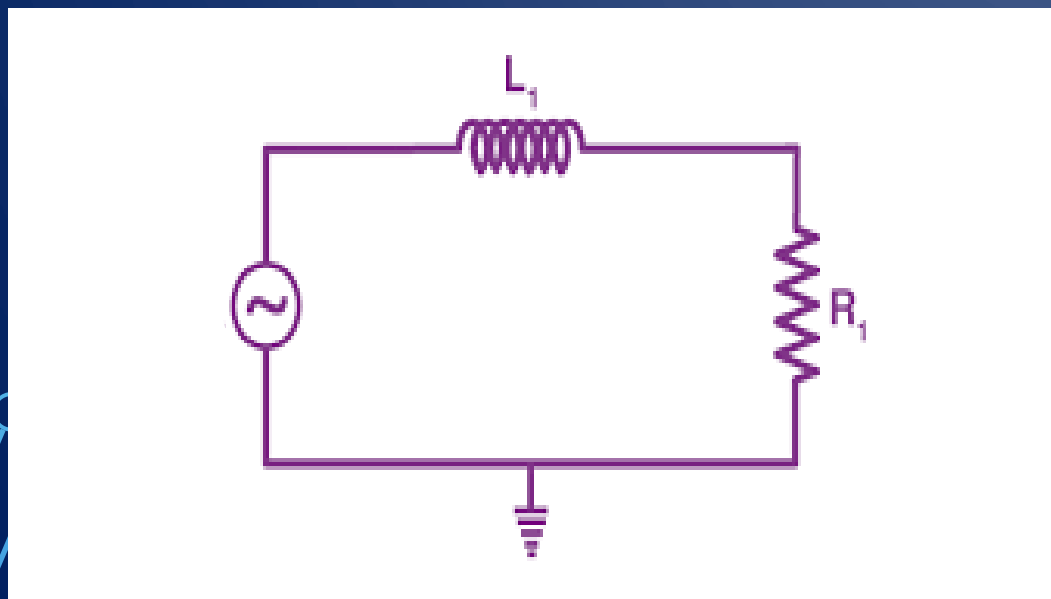
Series



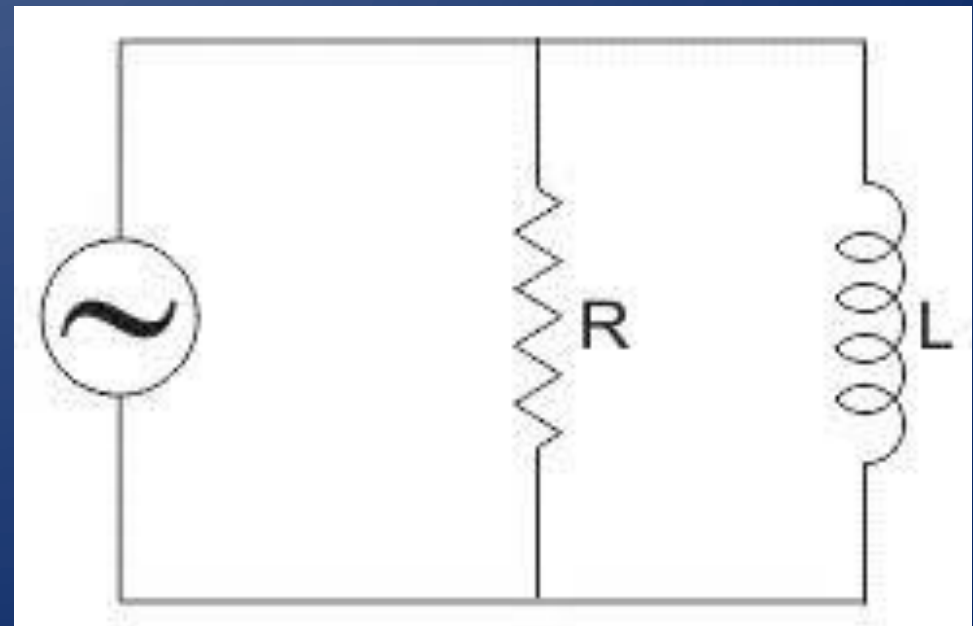
Parallel

CIRCUITS

AC circuit diagrams

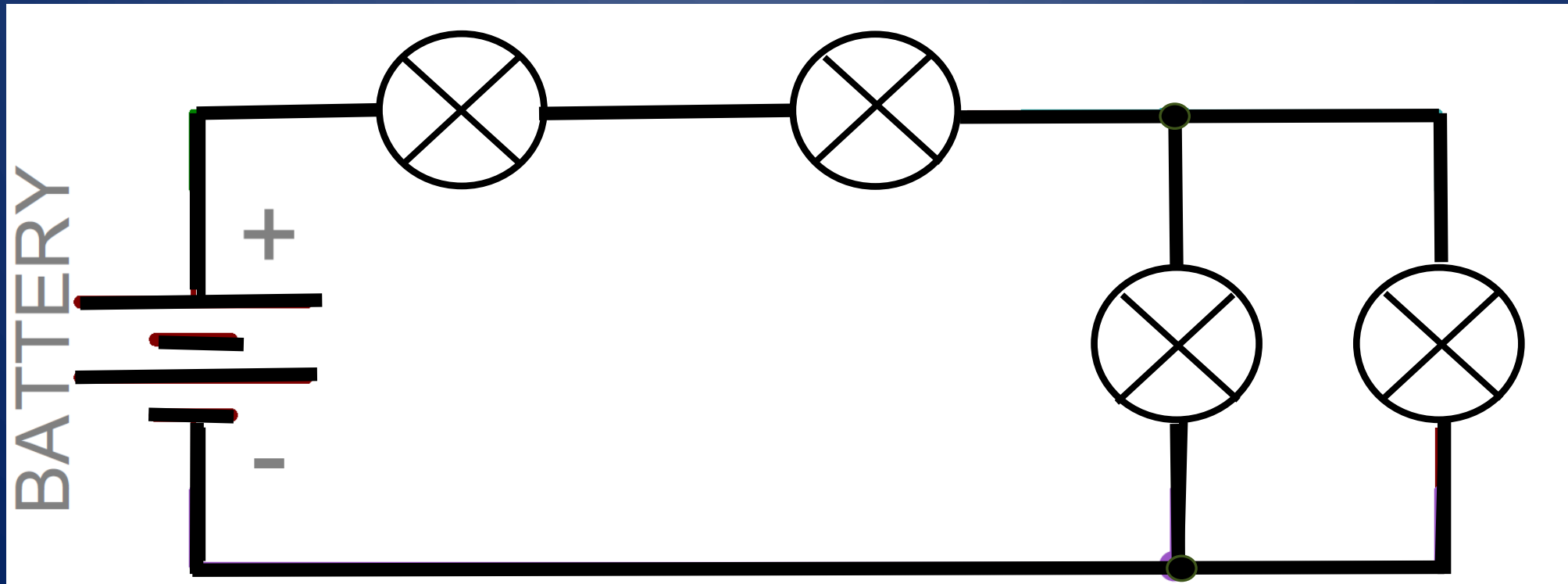


Series



Parallel

CIRCUITS



Series + Parallel

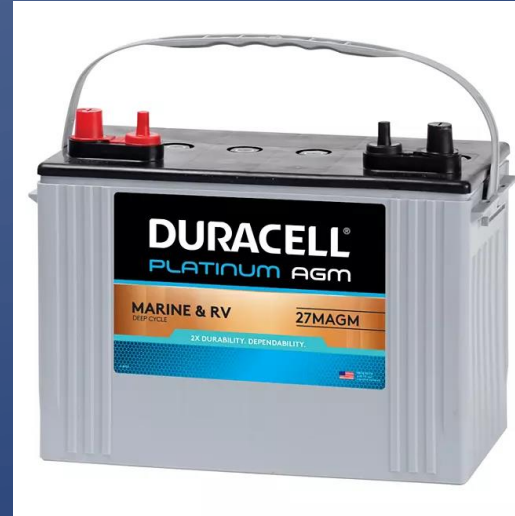
BATTERIES



Flooded Lead Acid



Gel



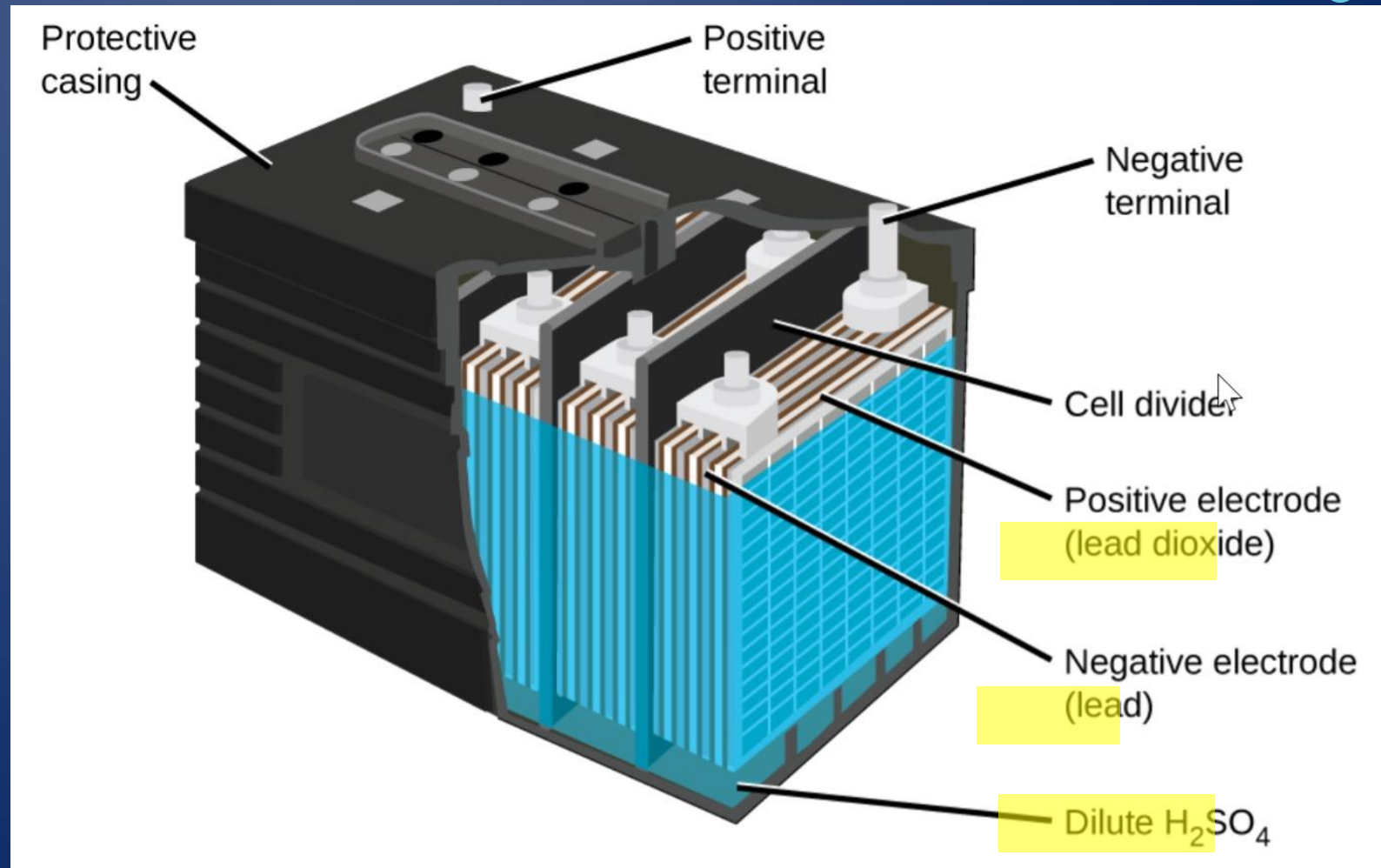
AGM
(Absorbent Glass Mat)



Lithium Iron Phosphate
(LFP or LiFePO4)

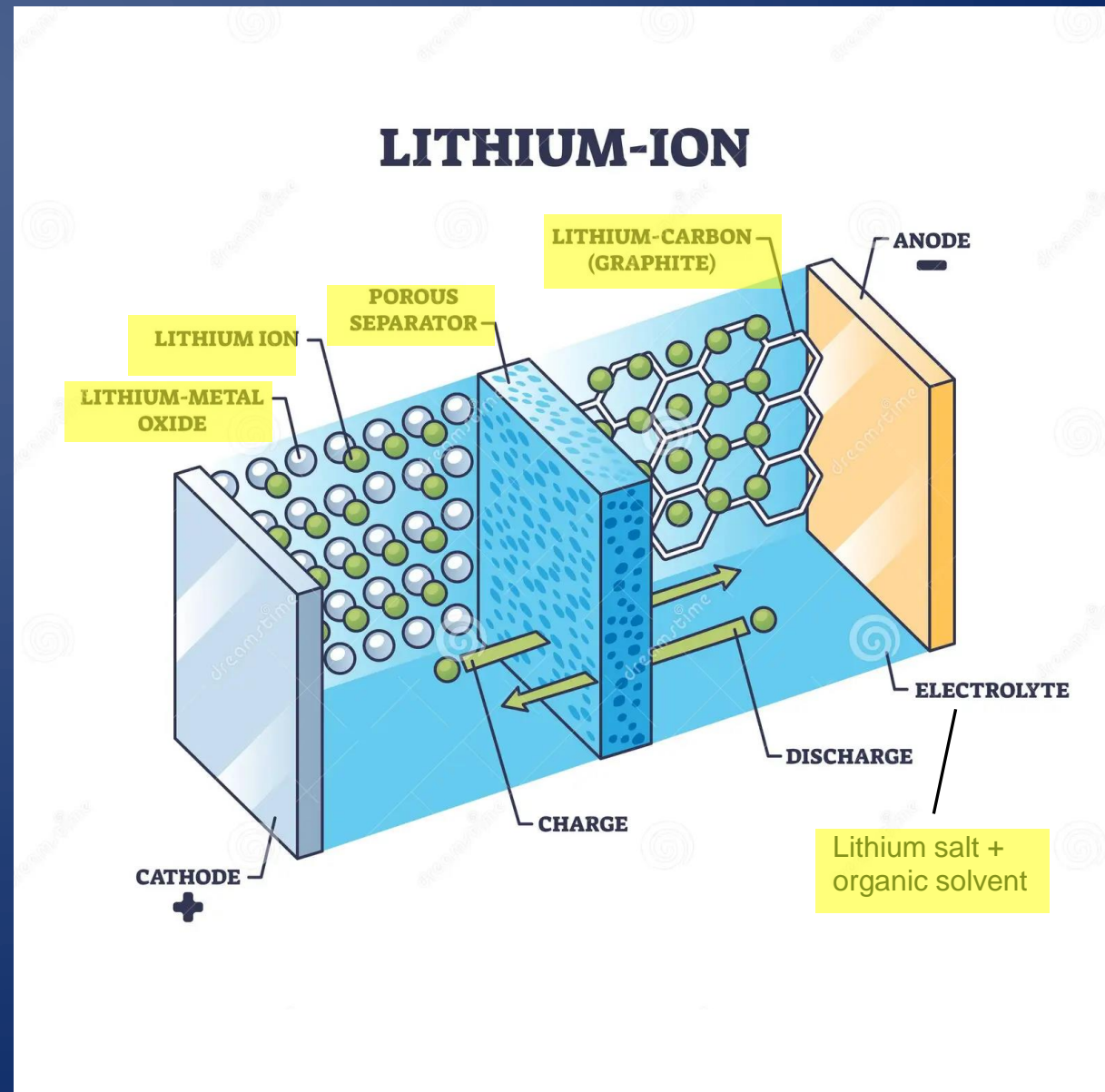
BATTERIES

- Flooded Lead Acid, Gel & AGM



BATTERIES

• Lithium-Ion



BATTERIES

- Sizes and weights

BCI Group #	Length (in)	Width (in)	Height (in)
24	10.25	6.81	8.88
24F	10.75	6.81	9.00
24H	10.25	6.81	9.38
24R	10.25	6.81	9.00
24T	10.25	6.81	9.75
27	12.06	6.81	8.88
27F	12.50	6.81	8.94
27H	11.75	6.81	9.25
31	13.00	6.72	9.44
8D	20.75	11.13	9.88



BATTERIES



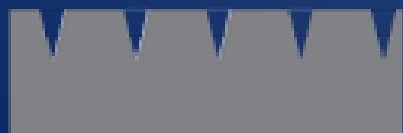
- Starting vs. Deep Cycle

STARTER BATTERY

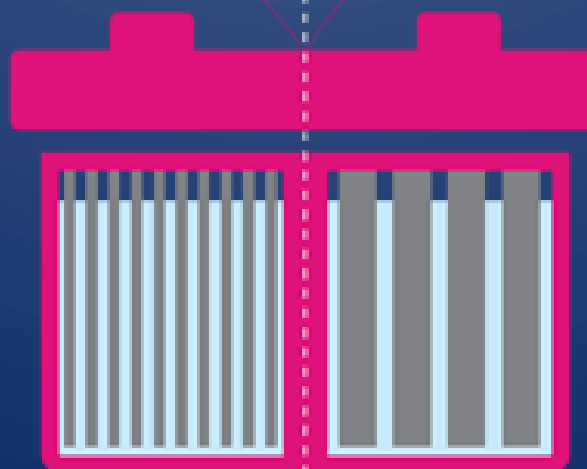
DEEP CYCLE BATTERY

Engine Starting

Continuous Power



Depth of Discharge



Depth of Discharge

BATTERIES

- Starting Battery Terminology

- Cold Cranking Amps - # of amps a battery can deliver for 30 seconds at 0° F, while maintaining voltage of 7.2 volts. (400, 500, 650 CCA etc.)
- Marine Cranking Amps - # of amps a battery can deliver for 30 seconds at 32° F, while maintaining voltage of 7.2 volts (Usually higher because batteries work better when it is warmer)



BATTERIES

- Deep Cycle Battery Terminology
- Amp – hours (Ah) - Total amount of energy a battery can deliver for 20 hours at a constant rate of discharge before voltage drops to 10.5 volts. (100 amp-hour battery can run a 5A load for 20 hours)* (60Ah, 80Ah, 100Ah etc.)
- Reserve Minutes- The number of minutes a battery can run a 25A load until dropping to 10.5 volts. (Battery with a 180 reserve rating, will run a 25A load for three hours.



BATTERIES

- Deep Cycle -Number of Amp-Hours (Ah)

BCI Group #	Voltage	Type	Part #	Amp Hours	Continuous (A)	Peak (A)
24	12V	Deep Cycle	RB60	60	60	140
24	12V	Deep Cycle	RB75	75	75	150
24	24V	Deep Cycle	RB24V10	10	10	70
27	12V	Deep Cycle	RB80	80	80	160
31	12V	Deep Cycle	RB100	100	100	200
31	24v	Deep Cycle	rb24v52	52	50	100
31	12V	Dual Purpose	RB100-HP	100	100	800
8D	12V	Deep Cycle	RB200	200	100	200
8D	12V	Deep Cycle	RB300	300	100	200
8D	12V	Dual Purpose	RB300-HP	300	100	800

*Max 50%
Discharge

BATTERIES

- 6 volt vs. 12 volt

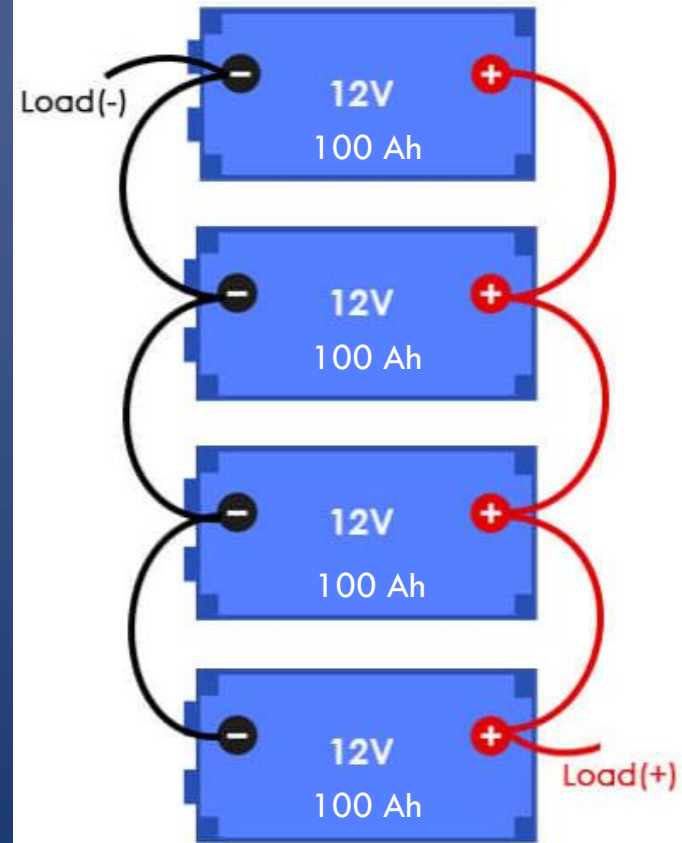


BATTERIES

- 12 volt bank



Connections in parallel



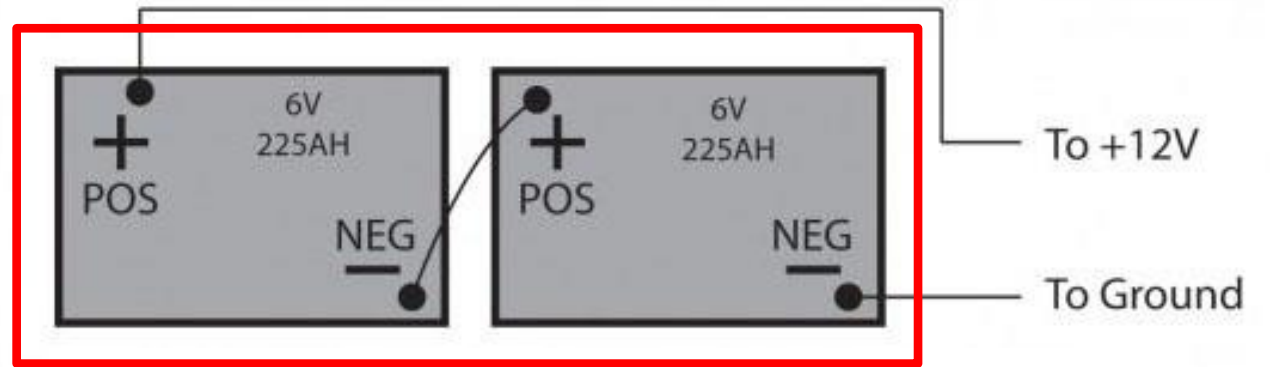
12 volt 400 Ah

BATTERIES

- 6 volt bank



6 volt batteries in series



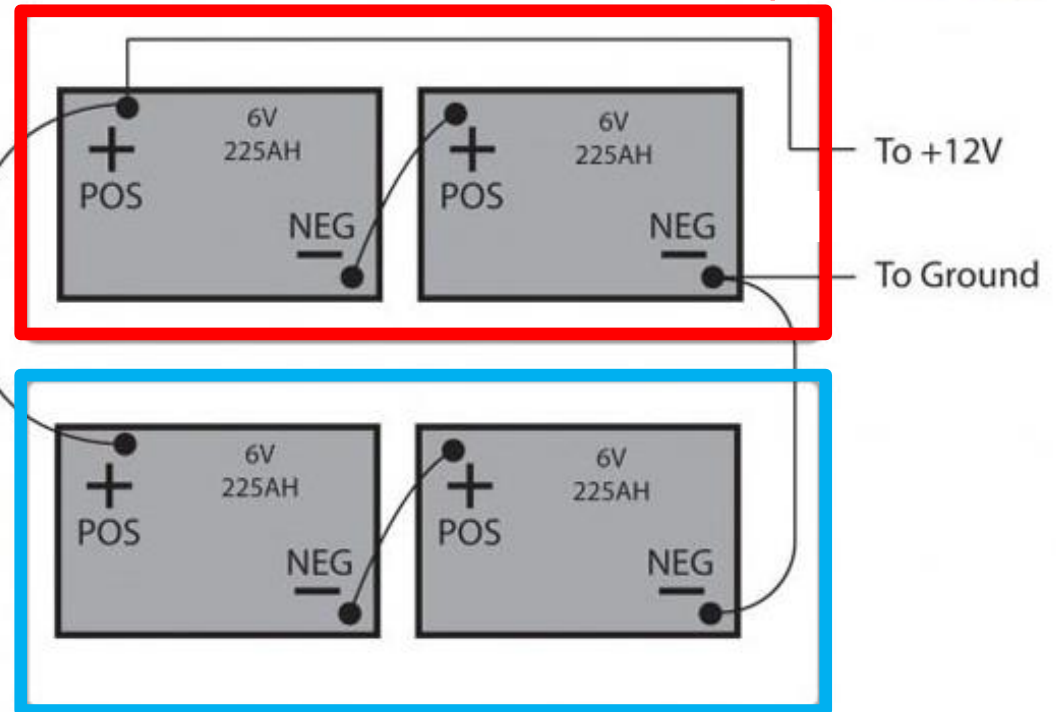
$$6 \text{ volt @ } 225 \text{ Ah} \times 2 = 12 \text{ Volt @ } 225 \text{ Ah}$$

BATTERIES

- 6 volt bank



6 volt batteries in series/parallel



12 volt @ 225 Ah x 2 = 12 volt @ 450 Ah

BATTERIES

- Relative Benefits/Downsides*



Flooded Lead Acid

- Tolerates overcharging
- Requires maintenance
- High self-discharge rate
- Hates vibration
- Heavy
- \$

BATTERIES

- Relative Benefits/Downsides*



Gel

- Sensitive to overcharging
- Maintenance free, spill & leak proof
- Low self-discharge rate
- Handles extreme temps
- Long life span
- Heavy
- \$\$

BATTERIES

- Relative Benefits/Downsides*



- Sensitive to overcharging
- Maintenance free, spill & leak proof
- Low self-discharge rate
- Handles extreme temps
- Long life-span
- Heavy
- \$\$

AGM

(Absorbent Glass Mat)

BATTERIES

• Relative Benefits/Downsides*



Lithium Ion
(LFP or LiFePO₄)

- Sensitive to overcharging
- Maintenance free & spill and leak-proof
- Low self-discharge rate
- Higher discharge capacity - *80% vs. 50%
- Longer life-span
- Lighter than others
- Can overheat & cause fires
- \$\$\$

BATTERIES

- Do's and Don'ts
- Don't mix types – AGM with Flooded Lead Acid, etc.
- Don't mix old and new
- Keep batteries clean and dry – remove corrosion – use dielectric grease on connections
- Check cables and terminal connections frequently to insure they haven't come loose

BATTERIES












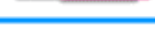
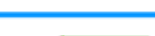


- Add distilled water as needed for flooded lead acid batteries
- Use smart charge controller (multi-stage charging (Bulk, Absorption & Float) and use controller to desulfate battery cells - (Do not overcharge)
- Orient batteries per manufacturer's recommendation
- Use proper wiring
- Install appropriate fuses/circuit breakers

WIRE

- Color & Type



"ABYC" CABLE & WIRE COLOR CODES FOR MARINE/BOAT WIRING

WIRE / CABLE COLOR CODE	COLOR NAME	ITEM USED FOR	USAGE / APPLICATIONS
	RED	DC +Ve Conductor "L+"	Positive Mains "+"
 	BLACK or YELLOW	DC -Ve Conductor "L-"	Negative Mains "-"
	YELLOW w/Red Stripe	Starting Circuit	Starting Switch to Solenoid
	BROWN	Generator Armature, Pumps, Alternator Charge Light	Generator Armature to Regulator, Fuse or Switch to Pumps or Lights, Generator - Terminal - Alternator or Light to Regulator
	BROWN w/ Yellow Stripe	Bilge Blowers	Fuse or Switch to Blower
	DARK BLUE	Cabin & Instrument Lights	Fuse or Switch to Lights
	LIGHT BLUE	Oil Pressure	Oil Pressure Sender to Gauge
	TAN	Water Temperature	Water Temperature Sender to Gauge
	ORANGE	Common Feed & Accessory Feed	Distribution Panel to Accessory Switch, Ammeter to Alternator or Generator Output & Accessory Fuses or Switches.
	PURPLE	Ignition & Instrument Feed	Ignition Switch to Coil & Electrical Instruments, Distribution Panel to Electrical Instruments
	PINK	Fuel Gauge	Fuel Gauge Sender to Gauge.
	GRAY	Tachometer & Navigation Lights	Tachometer Sender to Gauge, Fuse or Switches to Lights or Bonding Wires (if insulated)
 	GREEN or GREEN w/ Yellow Stripe	Protective Ground "PG" DC Grounding Conductor	Bonding System, Bonding Wires if Insulated

*Tinned & stranded

WIRE

- Size – AWG - (American Wire Gauge)

More Amps/Distance

AWG WIRE SIZE CHART



Wire in engine room

WIRE

- Size

*Critical Circuits

- Bilge pumps
- Bilge blowers
- Electronics
- Navigation lights

*Non-Critical Circuits

- Everything else

CIRCUIT TYPE		CURRENT FLOW IN AMPS															
Non-Critical 10% VOLTAGE DROP	Critical 3% VOLTAGE DROP	5A	10A	15A	20A	25A	30A	40A	50A	60A	70A	80A	90A	100A	120A	150A	200A
0 to 20 ft	0 to 6 ft		16 AWG	14 AWG	14 AWG	12 AWG	10 AWG	8 AWG	6 AWG	6 AWG	6 AWG	4 AWG	4 AWG	4 AWG	2 AWG	1 AWG	2 0 AWG
30 ft	10 ft	16 AWG	14 AWG	12 AWG	12 AWG	10 AWG	10 AWG	8 AWG	6 AWG	6 AWG	6 AWG	4 AWG	4 AWG	4 AWG	2 AWG	1 AWG	2 0 AWG
50 ft	15 ft		12 AWG	10 AWG	10 AWG	8 AWG	8 AWG	6 AWG		4 AWG	4 AWG			2 AWG	2 AWG		
65 ft	20 ft	14 AWG		10 AWG	8 AWG		6 AWG	6 AWG	4 AWG	4 AWG	2 AWG	2 AWG	2 AWG	2 AWG	1 AWG	0 AWG	
80 ft	25 ft	12 AWG	10 AWG	8 AWG		6 AWG		4 AWG	2 AWG	2 AWG	2 AWG	2 AWG	1 AWG	1 AWG	0 AWG	2 0 AWG	3 0 AWG
100 ft	30 ft				6 AWG		4 AWG	4 AWG	2 AWG	2 AWG	1 AWG	1 AWG	0 AWG	0 AWG	2 0 AWG	3 0 AWG	4 0 AWG
130 ft	40 ft		8 AWG			4 AWG	4 AWG	2 AWG	2 AWG	1 AWG	0 AWG	0 AWG	2 0 AWG	2 0 AWG	3 0 AWG	4 0 AWG	
165 ft	50 ft	10 AWG		6 AWG	4 AWG		2 AWG	2 AWG	1 AWG	0 AWG	2 0 AWG	3 0 AWG	3 0 AWG	3 0 AWG	4 0 AWG		
200 ft	60 ft		6 AWG		4 AWG		2 AWG	1 AWG	0 AWG	2 0 AWG	3 0 AWG	3 0 AWG	4 0 AWG	4 0 AWG	4 0 AWG		
	70 ft			4 AWG		2 AWG	1 AWG	0 AWG	2 0 AWG	3 0 AWG		4 0 AWG					
	80 ft	8 AWG			2 AWG		1 AWG	0 AWG	2 0 AWG	3 0 AWG	4 0 AWG						
	90 ft				2 AWG		1 AWG	0 AWG	2 0 AWG	3 0 AWG							
	100 ft		4 AWG	2 AWG		1 AWG	0 AWG	2 0 AWG	3 0 AWG	4 0 AWG							
	110 ft						0 AWG										
	120 ft	6 AWG		2 AWG	1 AWG	0 AWG		3 0 AWG	4 0 AWG								
	130 ft		2 AWG				2 0 AWG										

*Length of wire = distance to and from load

WIRE

• Size &
Type
Calculator

The screenshot shows a web browser window with the URL <http://circuitwizard.blueseasystems.com/#>. The page features the Blue Sea Systems logo and navigation links for iOS and Android. The main content is divided into two sections: "Find the Correct DC Wire" and "Find the Correct Circuit Protection".

Find the Correct DC Wire

Information required to meet ABYC Standards:

- Circuit Voltage (V DC):
- Load Current (amps):
- Length of Conductor (feet):

Modify these default values if necessary:

- Allowable Voltage Drop (%):
- Type of Load:
- Wire Insulation Temperature Rating (°C):
- In Engine Room?

Additional Derating Factors (if applicable):

- Duration (minutes):
- Terminated on Fuse?
- In Conduit or Sheath?
- Extra Thermal Insulation?

Buttons: Calculate, Reset, Change my entries

Find the Correct Circuit Protection

- Battery CCA:
- Main or Branch:

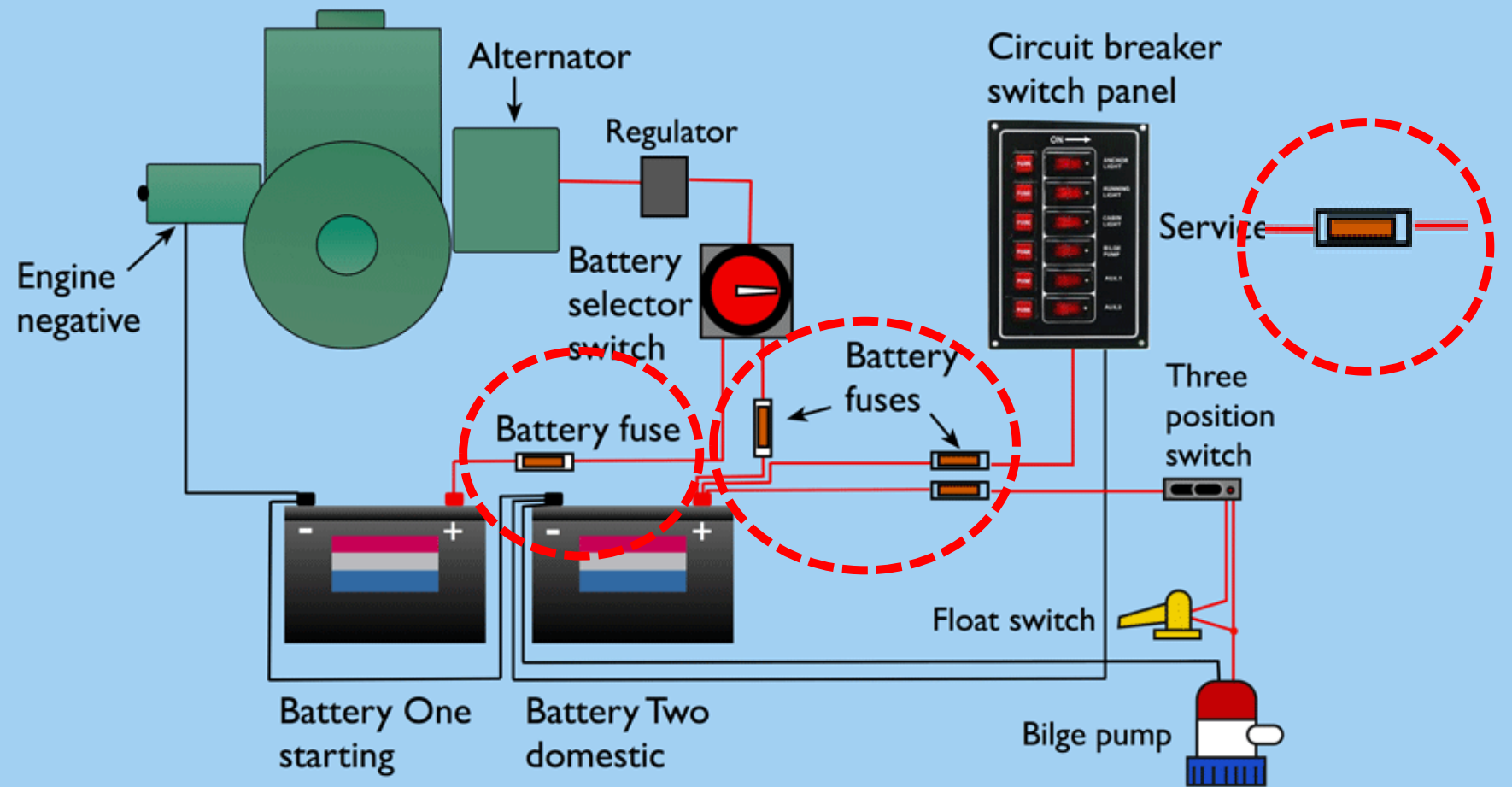
<http://circuitwizard.blueseasystems.com/#>

FUSES

Uses

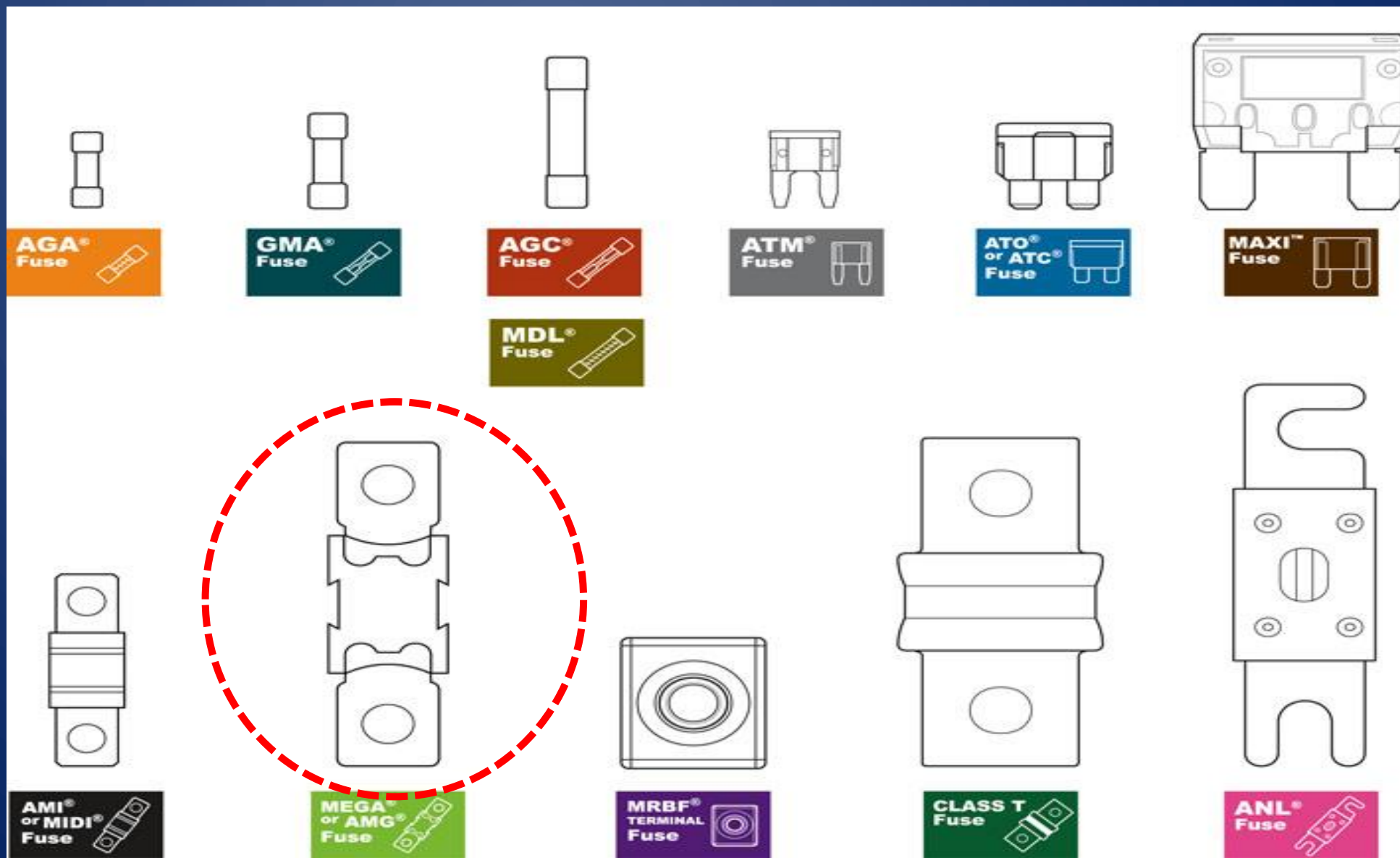
*Protect wire
and appliance

Basic 12 volt DC wiring diagram



FUSES

Types



FUSE SELECTION CHART

Calculations are based on 105°C wire.
For lower temperature rated wire, consult the Circuit Wizard at www.circuitwizard.blueseasystems.com

FUSES

Sizes & Types

*Size of smallest wire in circuit and amps is important

LEGEND		AGC® MDL®		ATO® or ATC® Fuse		MAXI™ Fuse		AMI® or MIDI® Fuse		MRBF TERMINAL Fuse		MEGA® or AMG® Fuse		CLASS T Fuse		ANL® Fuse								
Outside Engine Room		.25A to 30A		1A to 30A		30A to 80A		30A to 200A		30A to 300A		100A to 300A		225A to 400A		35A to 400A								
Inside Engine Room		SINGLE WIRE		BUNDLED WIRES		SINGLE WIRE		BUNDLED WIRES		SINGLE WIRE		BUNDLED WIRES		SINGLE WIRE		BUNDLED WIRES								
AWG WIRE SIZE	16 AWG	25A	20A	20A	15A	25A	20A	20A	15A															
	14 AWG	30A	25A	20A		30A	25A	20A		30A	30A													
	12 AWG		30A	25A		30A	25A	50A	40A	30A		50A	40A	30A			35A							
	10 AWG					60A	50A	40A	40A	60A	50A	40A	40A				50A	40A	40A	35A				
	8 AWG					80A	70A	60A	50A	80A	70A	60A	50A				80A	60A	50A	40A				
	6 AWG						80A	70A	125A	100A	80A	70A	125A	100A	80A	70A	125A	100A	130A	100A	70A	60A		
	4 AWG								150A	125A	125A	100A	150A	125A	125A	100A	150A	125A	125A	100A	150A	130A	100A	80A
	2 AWG								200A	175A	150A	125A	200A	175A	150A	125A	200A	175A	150A	125A	200A	175A	150A	130A
	1 AWG								200A	175A	150A	250A	200A	175A	150A	250A	200A	175A	150A	250A	200A	175A	150A	150A
	0 AWG								200A	175A	300A	250A	200A	175A	300A	250A	200A	175A	300A	250A	200A	175A	150A	130A
	2 0 AWG										300A	225A	200A	300A	225A	200A	350A	300A	225A	350A	300A	225A	200A	150A
	3 0 AWG											250A	225A	250A	225A	400A	350A	250A	225A	400A	350A	250A	225A	150A
4 0 AWG											300A	250A	300A	250A	400A	400A	300A	250A	400A	400A	300A	250A	150A	

Additional replacement fuses available from Blue Sea Systems:



1A to 10A



20A



























5A to 30A

FUSE HOLDERS

- Types

FUSE HOLDER SELECTION CHART

MDL® AGC®	ATO® or ATC® Fuse	MAXI® Fuse	AMI® or MIDI® Fuse	MRBF TERMINAL Fuse	MEGA® or AMG® Fuse	CLASS T Fuse	ANL® Fuse
Crimpable In-Line Fuse Holder  5060	ATO® or ATC® In-Line Fuse Holders 5064  5065	MAXI® In-Line Fuse Holder  5068	AMI® or MIDI® Safety Fuse Block  7720	Terminal MRBF Fuse Blocks  5191*	MEGA® or AMG® Fuse Block  5001	CLASS T Fuse Block  5502	ANL® Fuse Blocks  5005
Waterproof In-Line Fuse Holders  5061	ST Blade Fuse Blocks Battery Terminal Mount 5023	MAXI® Fuse Block  5006100	SafetyHub Fuse Block  7748	 2151*	MEGA® or AMG® Safety Fuse Block  7721	 5007100 110A-200A	 5503
 5062	Compact Fuse Block 5045 5046		 7725	 5194*		 5502100 225A-400A	
Heavy Duty In-Line Fuse Holder  5063	Split Bus 5032			 5196*			
ST Glass Fuse Blocks  5015 5018	Common Sourced 5025 5026 5028 5029			*Ignition Protected when using Blue Sea Systems MRBF Fuses.			
	Independent Sourced 5035						
	SafetyHub Fuse Block  7748						
	 7725						

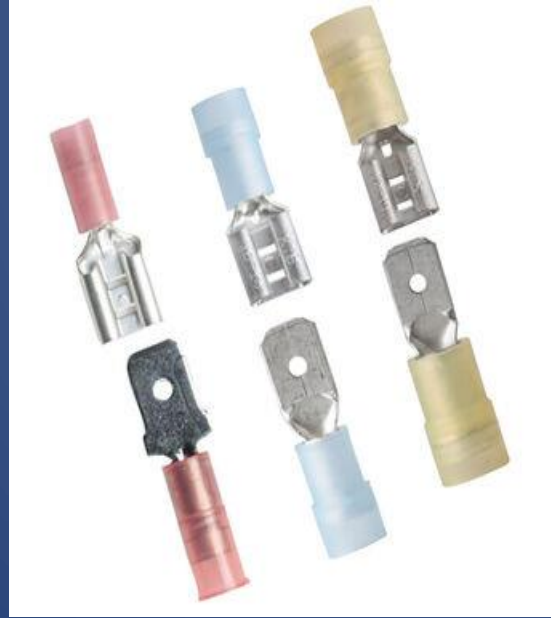
LEGEND
 Ingress protection
 Ignition protection

Although this process uses information from ABYC E-11 to recommend wire size and circuit protection, it may not cover all of the unique characteristics that may exist on a boat. If you have specific questions about your installation please consult an ABYC certified installer.

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CONNECTORS

- Sizes & Types



*Tinned

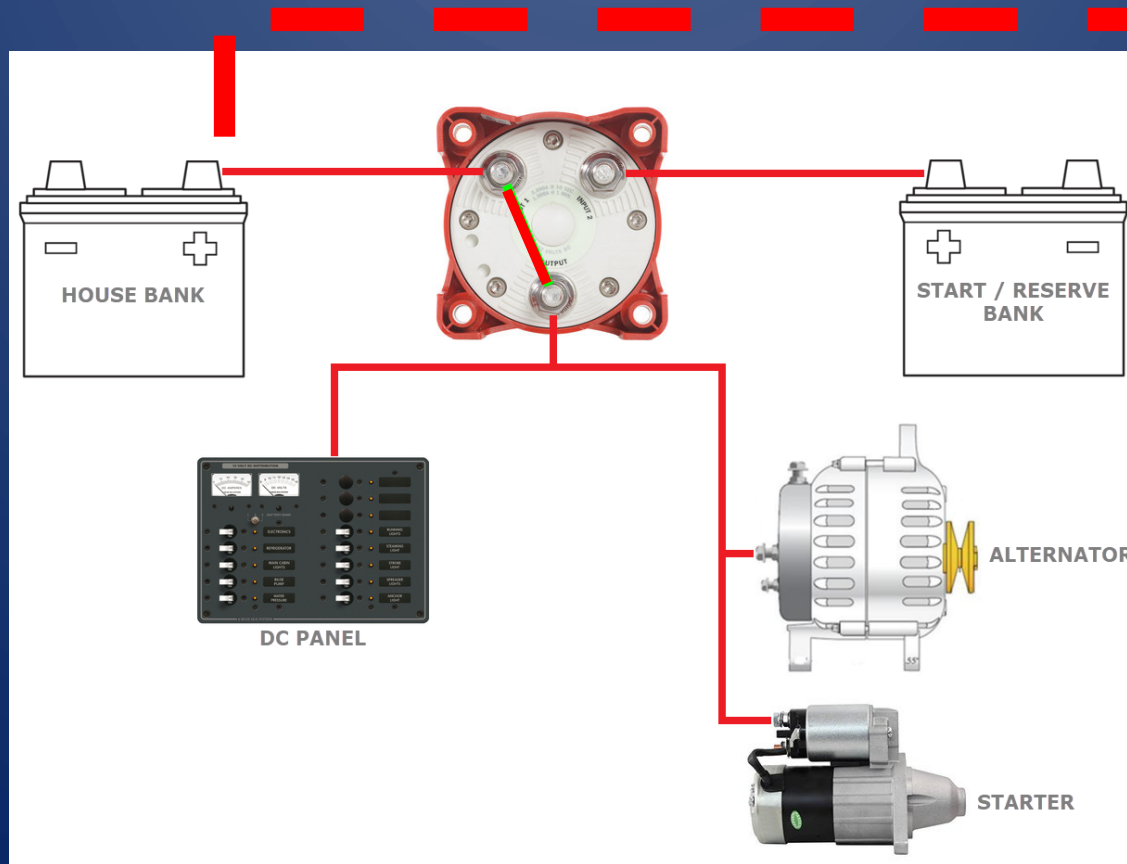
BATTERY SELECTOR SWITCHES

- On, Off vs. 1, 2, 1+2, Off



BATTERY SELECTOR SWITCH(ES)

- Determines route of electricity **to and from** battery



BATTERY SELECTOR SWITCHES



NO

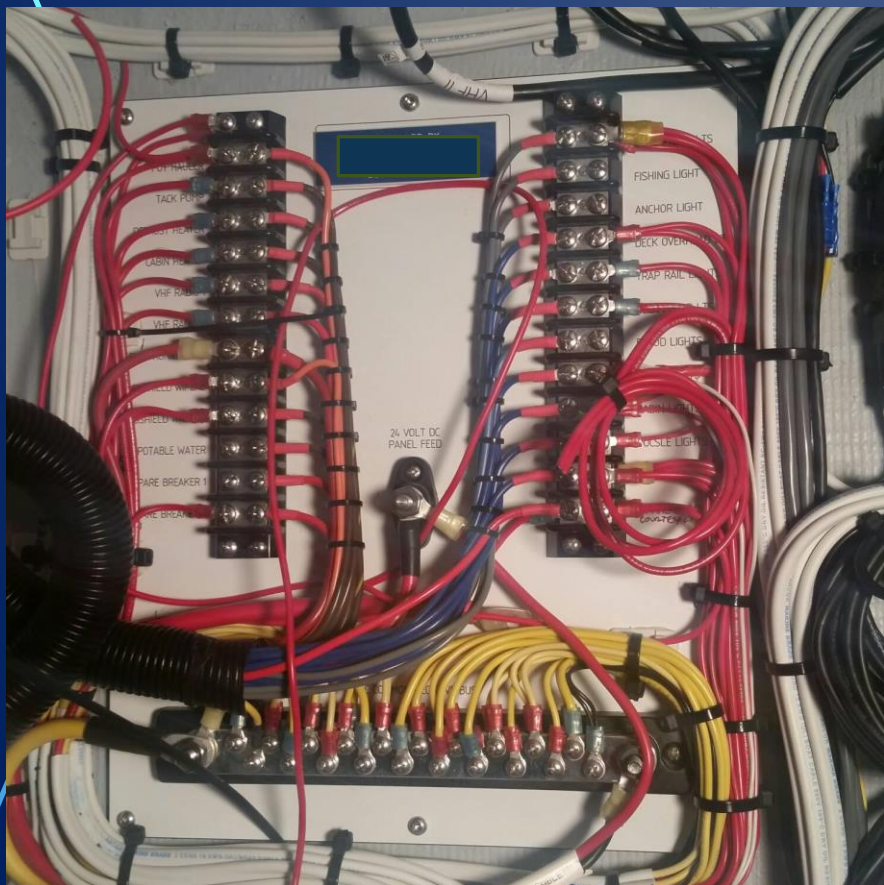


YES

DISTRIBUTION PANEL(S)

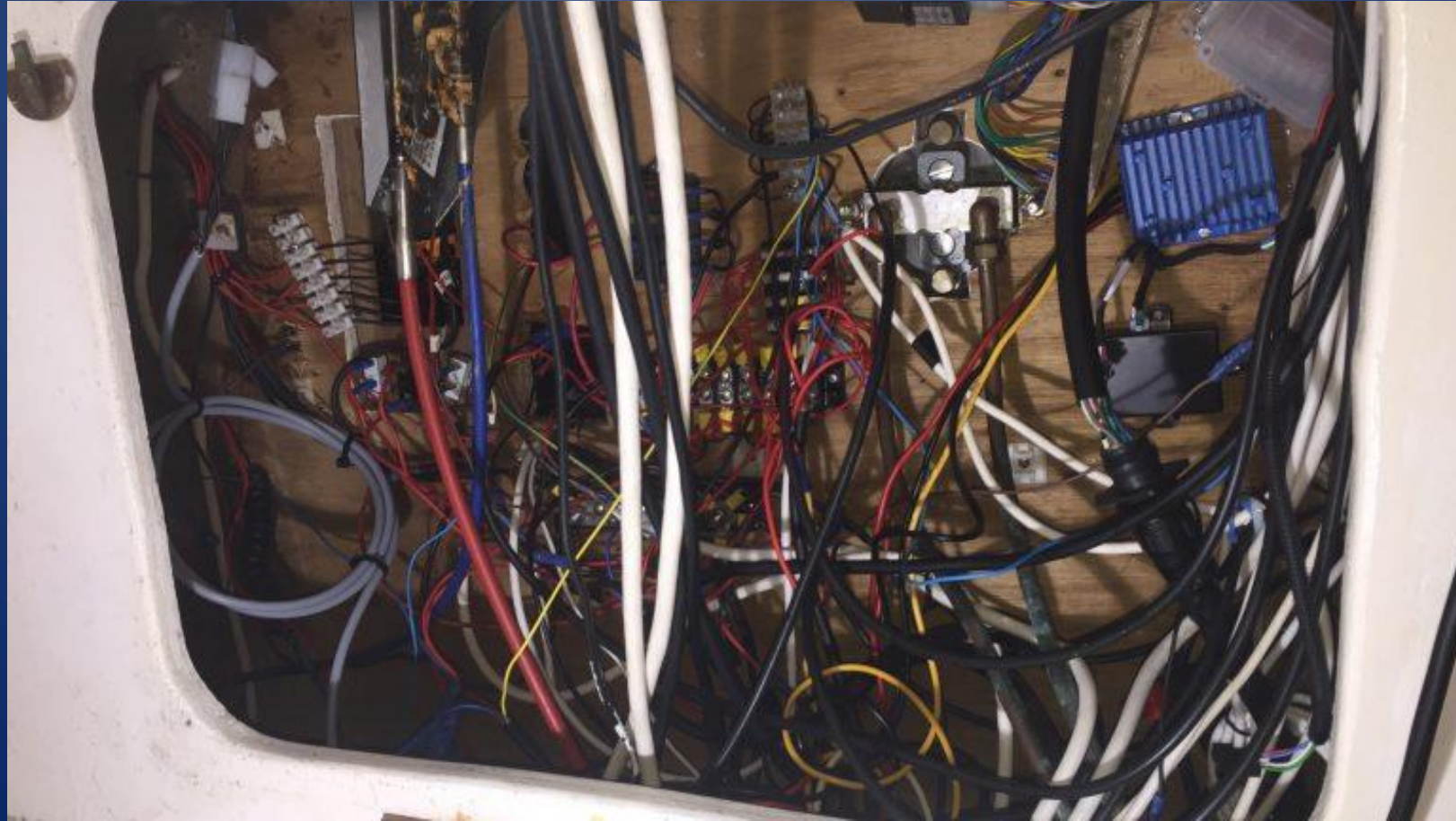


DISTRIBUTION PANELS



“Good”

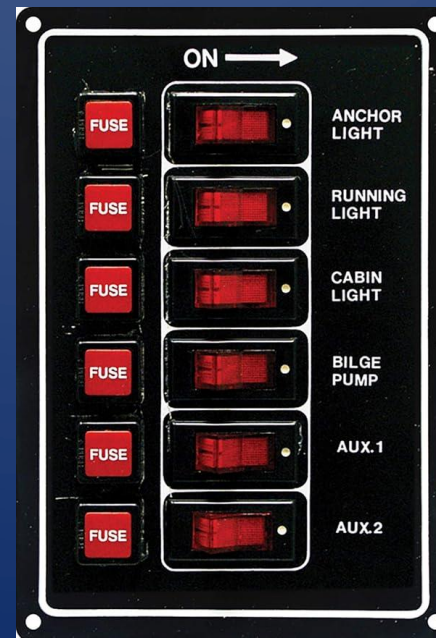
DISTRIBUTION PANELS



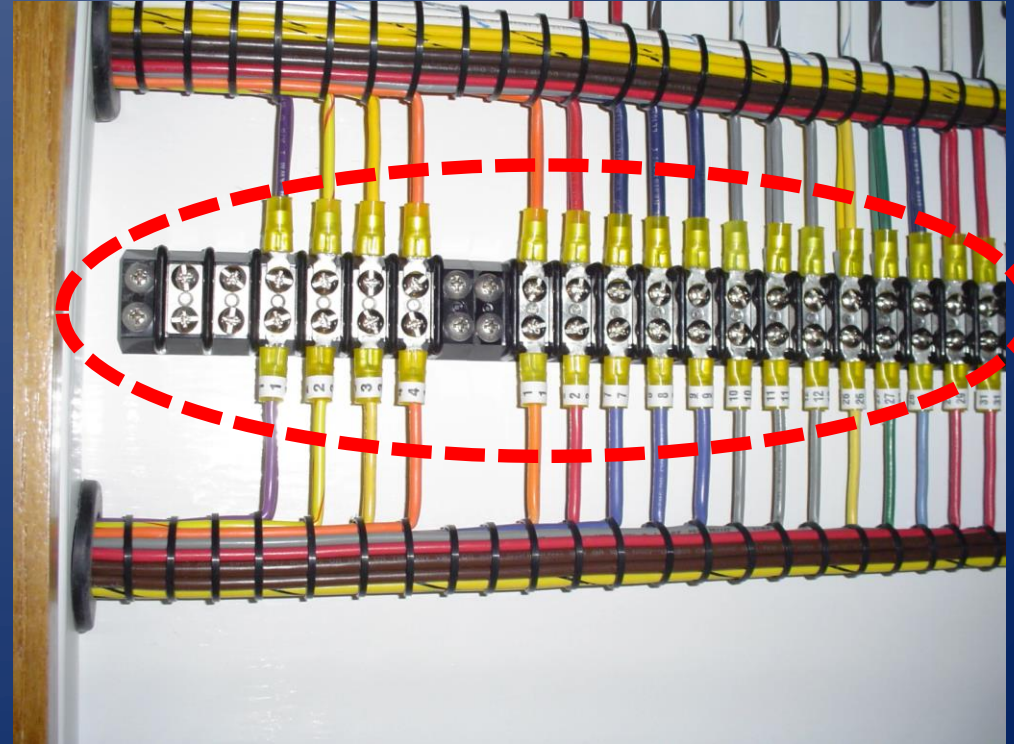
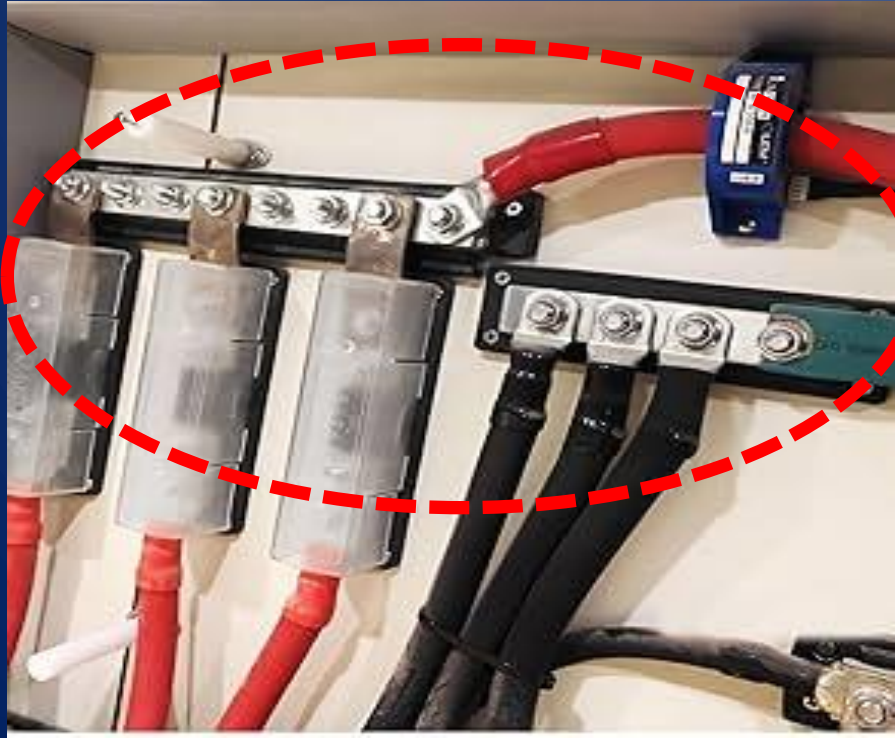
“Bad”

CIRCUIT BREAKERS

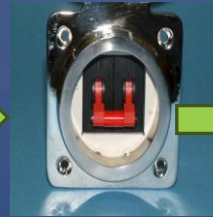
- Types



BUS BARS AND TERMINAL BLOCKS



SOURCES OF AC ELECTRICITY ON BOAT (DOCKSIDE)



SOURCES OF AC POWER ON BOAT (DOCKSIDE)



Amperage/Voltage	Female Connector	Male Plug
15A or 20A 125V Straight Blade		
20A 125V Locking		
30A 125V Locking		
50A 125V Locking		
50A 125/250V Locking		

SOURCES OF AC ELECTRICITY ON BOAT (DOCKSIDE)

- Care of power cables - What to look for:
 - Burning/blackening/melted cable plug/connector
 - Corrosion on blades on the connector/plug
 - Exposed wires



SOURCES OF AC ELECTRICITY ON BOAT (DOCKSIDE)



Smart Plug

SOURCES OF AC ELECTRICITY ON BOAT (AT ANCHOR)



*Energy conversion penalty



SOURCES OF AC ELECTRICITY ON BOAT (AT ANCHOR)

*Cost/
output/
noise/smell
& fuel



SOURCES OF AC ELECTRICITY ON BOAT (AT ANCHOR)



How many amps can these generators produce?

(I) Amps = (P) Watts / (V) Volts

$I = 1800 \text{ Watts} / \text{Voltage at } 120 \text{ AC}$

$I = 15 \text{ Amps per hour}$



(I) Amps = (P) Watts / (V) Volts

$I = (5 \text{kw}) = 5,000 \text{ Watts} / \text{Voltage at } 120 \text{ AC}$

$I = 41 \text{ Amps per hour}$

SOURCES OF AC ELECTRICITY ON BOAT (AT ANCHOR)



SOURCES OF DC ELECTRICITY ON BOAT (AT ANCHOR)



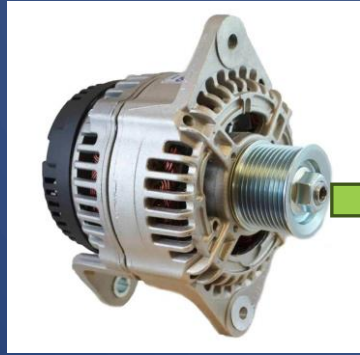
House



Start



SOURCES OF DC ELECTRICITY ON BOAT (AT ANCHOR)

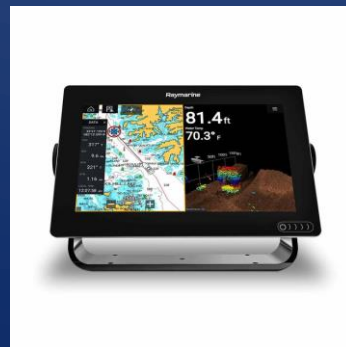


House



Start

*Output/noise/smell/fuel/wear and tear



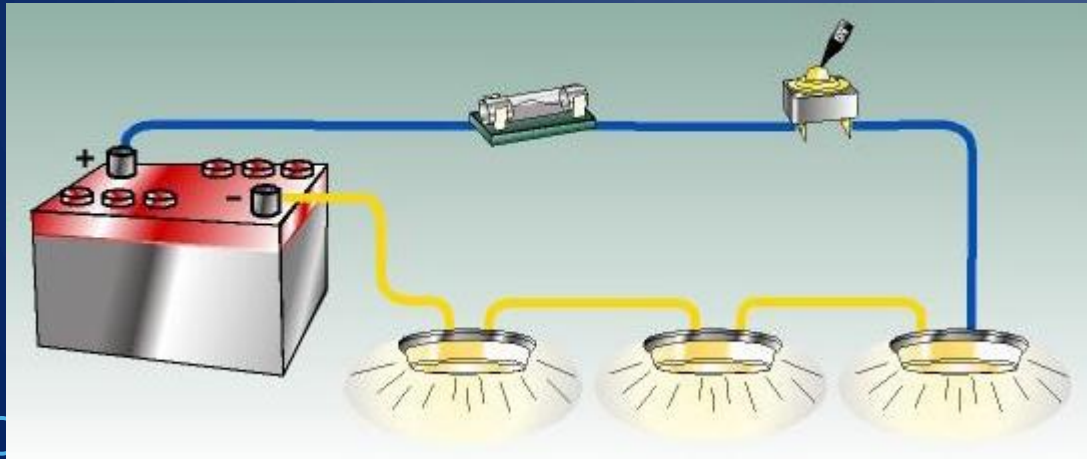
DO I NEED MORE ELECTRICITY, IF SO HOW MUCH?

Boat electrical survey

*Don't ignore inputs from engine, generator, solar, wind, etc.

Energy Budget			
Budget 1 Item	Passage Making Amps	Hours	AH/day
Living areas			
Refrigeration			0
Potable water pump	5	0.1	0.5
Sump pump		0	0
cabin lights	5	5	25
Water maker		0	0
CD/radio	4	0.5	2
TV/DVD	2	3.5	7
Laptops/personal electronics	1	5	5
Gas solenoid	1.2	24	28.8
Heating	1	0	0
Other	3	10	30
Instruments			
VHF	0.2	24	4.8
GPS	0.2	24	4.8
Radar			0
Autopilot	0.3	24	7.2
Running Systems			
Windlass	30	0	0
Running lights	3	10	30
Anchor light	1	0	0
Engine Starting	50	0.005	0.25
Total			145.35
Charging			
	Amps	Hours	AH/day
Engine	2	5	10
Solar (watts nameplate)	220	5	92
Wind			
Total			92
	Number	AH	AH, usable
Batteries	3	140	147
Days reserve if 20% generation	1.2		
Days reserve if full generation	2.7		
Days to recharge from 50% TO 85% battery capacity	1.6		

DO I NEED MORE ELECTRICITY, IF SO HOW MUCH



15
Watts

15
Watts

15
Watts

- What is amp draw of these lights?

- Amps (I) = Watts (P)/Volts (V)

- Amps = 15 Watts + 15Watts + 15Watts/
12 Volts

- (I) = 3.75 Amps per hour

DO I NEED MORE ELECTRICITY, IF SO HOW MUCH?



ADDITIONAL SOURCES OF DC ELECTRICITY



*Cost/savings



2 - 4
Amps
per hour



.2 - .5
Amps per
hour



ADDITIONAL SOURCES OF DC ELECTRICITY

*Cost/output/
engine
compatibility



60 amp

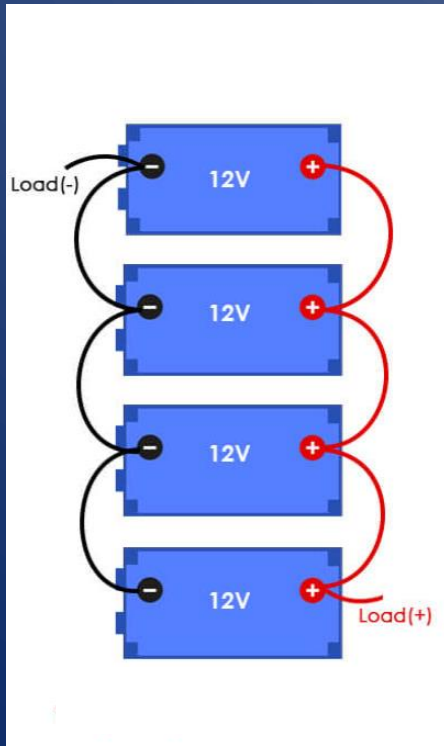


100 -150 amp

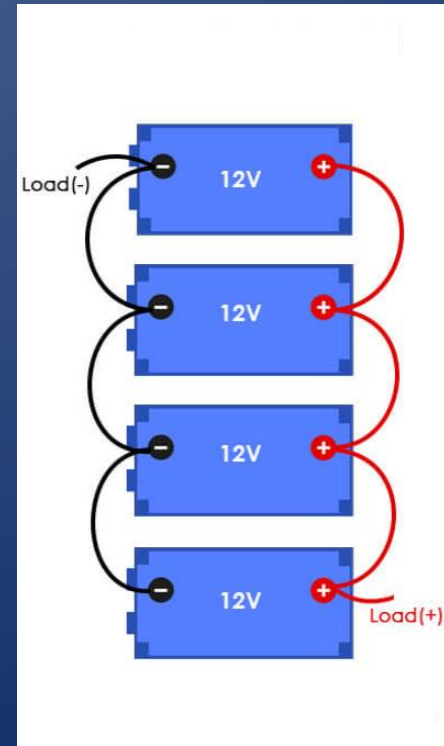
*Alternator \geq 25% - 40% of battery bank.

ADDITIONAL SOURCES OF DC ELECTRICITY

*Cost/output/
room



200 Ah



200 Ah

* Don't Mix
& Match

* Lithium Ion
50% vs.
80%
discharge

ADDITIONAL SOURCES OF DC ELECTRICITY

*Cost/output/
location/
exposure



• **Monocrystalline:** High efficiency and durability.

• **Polycrystalline:** Balanced between cost and efficiency.



• **Thin-film:** Most flexible and lightweight, but less efficient.



HQST
HIGH QUALITY SOLAR TECHNOLOGY

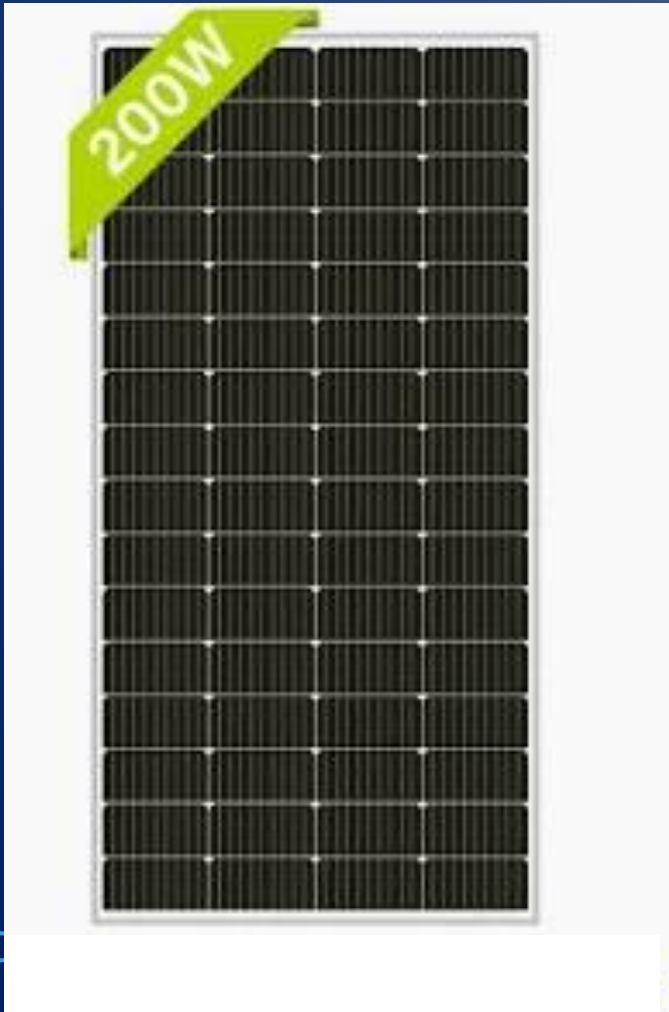
Email: sales@myhq solar.com
Web: www.hqsolarpower.com

Module Type:	HSP100D-L
Max Power at STC (P_{max})	100W
Open Circuit Voltage (V_{oc})	21.6V
Short Circuit Current (I_{sc})	6.5A
Optimum Operating Voltage (V_{mp})	18.0V
Optimum Operating Current (I_{mp})	5.56A
Operating Temperature:	-40°F to 176°F (-40°C to +80°C)
Dimensions:	32.5x 26.4 x 1.18in
Weight:	12.1 lbs
Solar Cells:	64 Cells
Cables:	14 AWG 24IN
Junction Box:	IP65
Connectors:	MC4 Connectors
Cell Efficiency:	0.181
Maximum System Voltage:	600VDC UL
Maximum Series Fuse Rating:	15A

WARNING: This module produces electricity when exposed to light. Please follow all applicable electrical safety precautions. Only qualified personnel should install or perform maintenance work on these modules. Beware of dangerously high DC voltages when connecting modules. Do not damage or scratch the rear surface of the module. Follow your battery manufacturer's recommendation.

CE □ ⚠ ISO 9001 Quality Control Verified

ADDITIONAL SOURCES OF DC ELECTRICITY



How many amps can this solar panel produce?

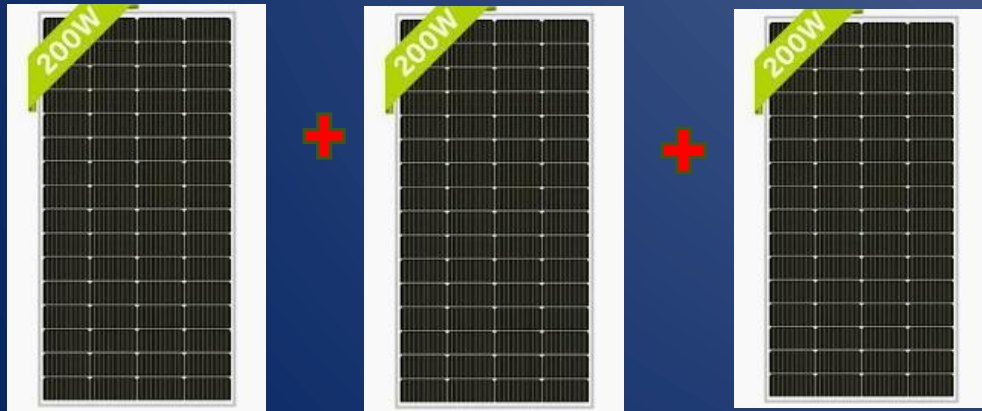
$$\text{Amps (I)} = \text{Watts (P)} / \text{Volts (V)}$$

$$(I) = 200\text{Watts} / \text{Voltage (at } P_{\text{max}} 18.6\text{v)}$$

$$(I) = 10.75 \text{ Amps per hour}^*$$

***Not all the time**

ADDITIONAL SOURCES OF DC ELECTRICITY

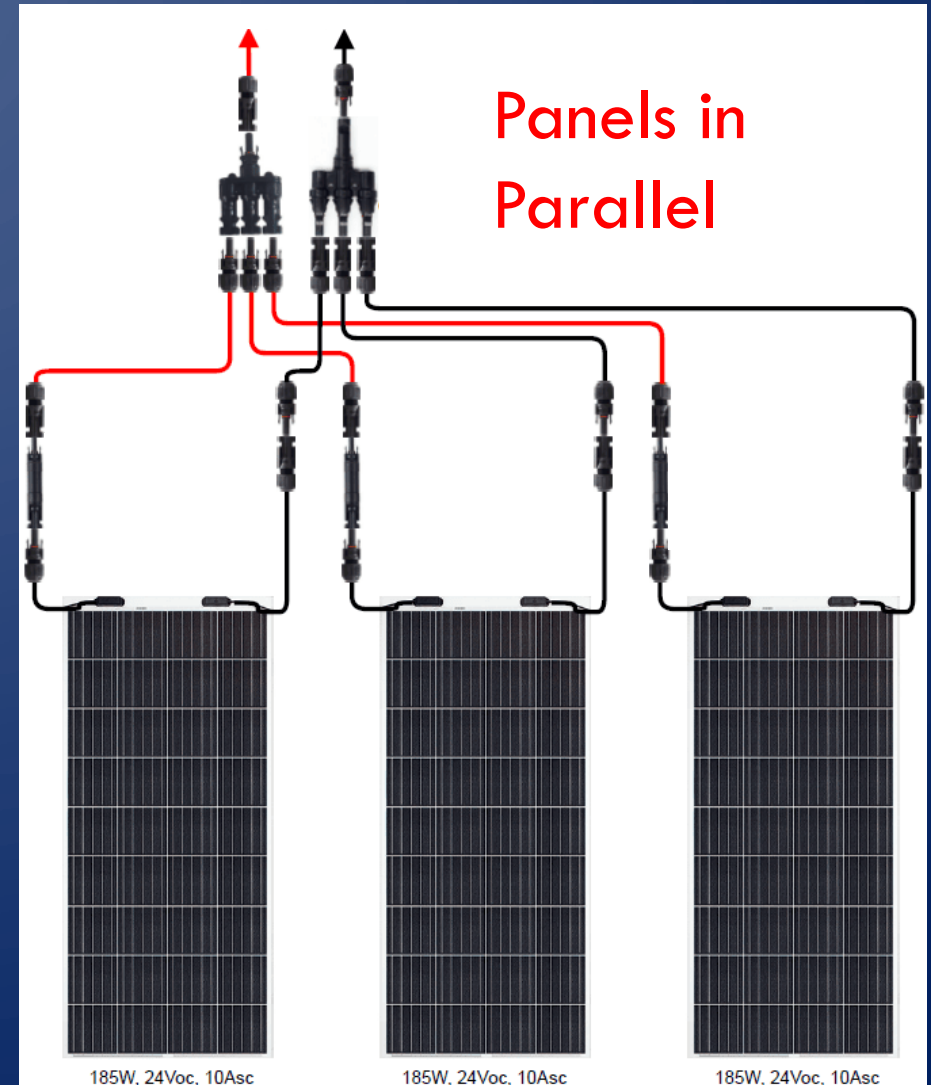


10.75 Amps

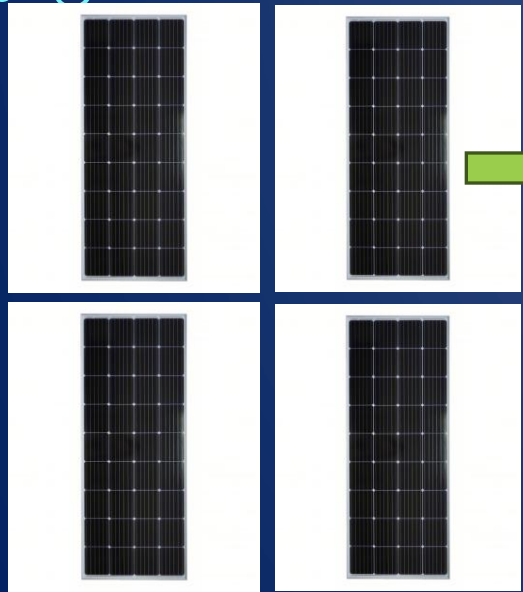
10.75 Amps

10.75 Amps

= 32.25 Amps x 4-5hrs/day = 128 Amps – 162 Amps per day



ADDITIONAL SOURCES OF DC ELECTRICITY



House

Start



*MPPT vs. PWM

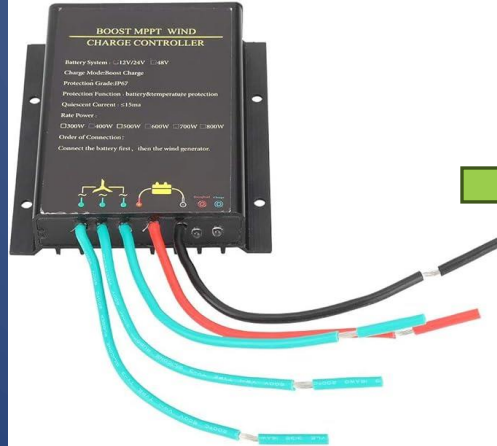


ADDITIONAL SOURCES OF DC ELECTRICITY



*Cost/output/
min-max
windspeed/
noise/location/
danger

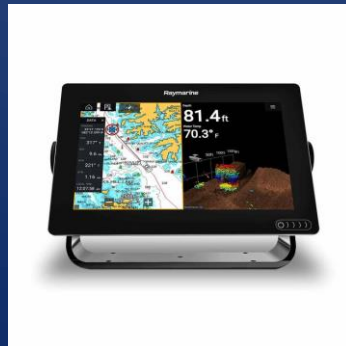
ADDITIONAL SOURCES OF DC ELECTRICITY



House



Start



ADDITIONAL SOURCES OF DC ON BOAT



***Cost/output/
support/drag/fish
strikes?**

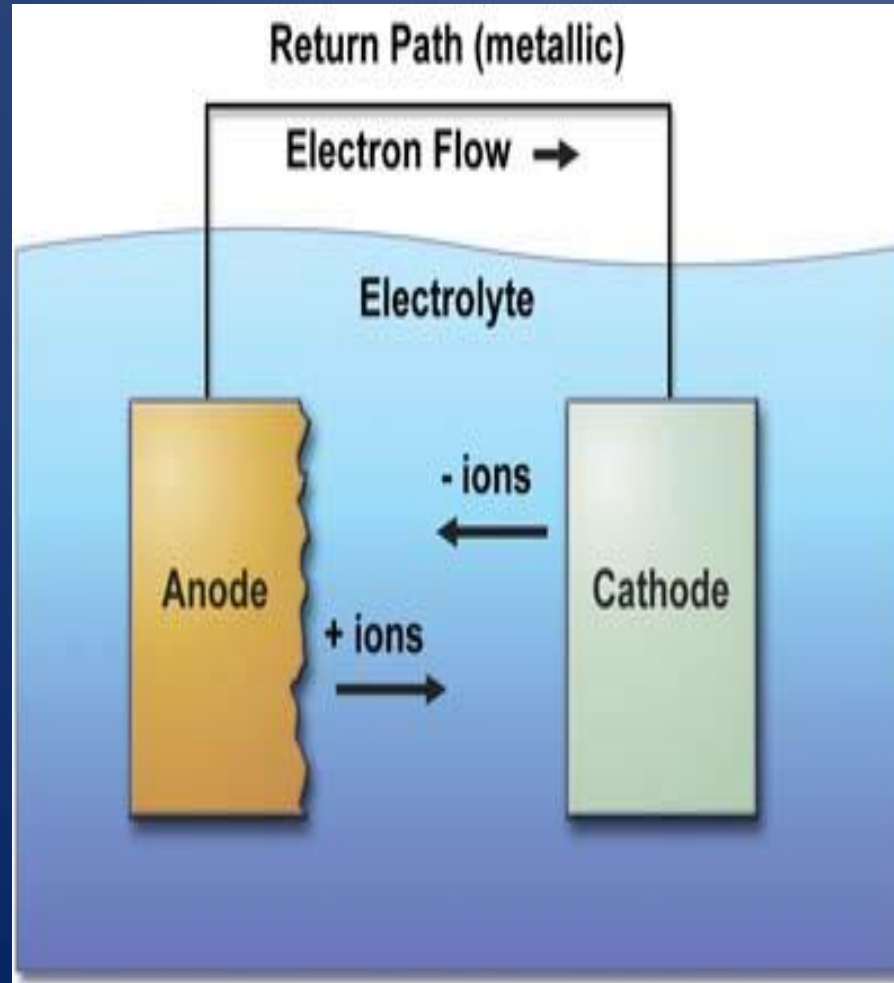
ADDITIONAL SOURCES OF DC POWER ON BOAT



House



GALVANIC CORROSION



Simple galvanic corrosive table

The farther apart on the chart, the more dissimilar the metals are, and the higher the level of corrosion of the anode.

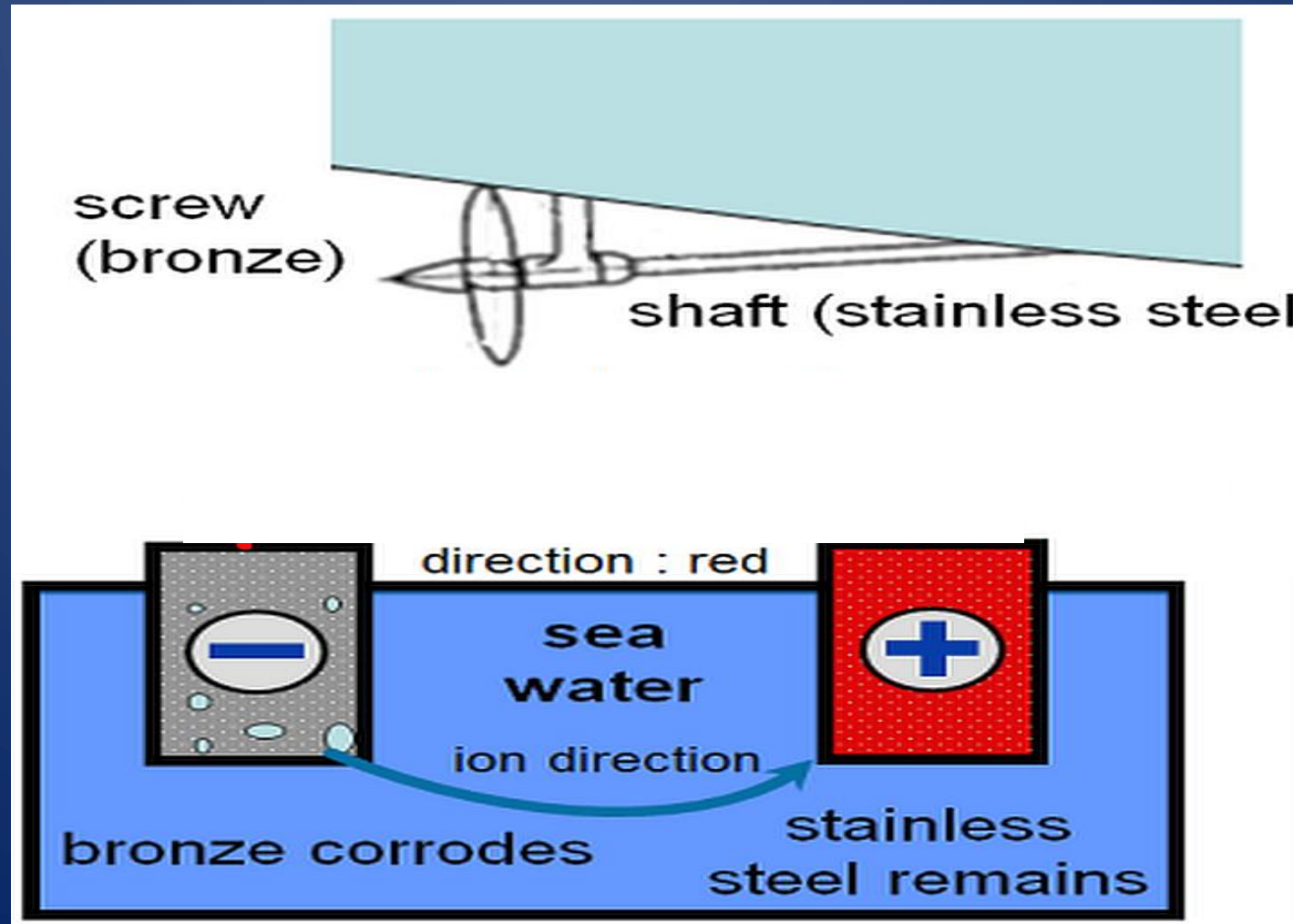
Magnesium
Zinc
Aluminum
Steel or Iron
Nickel
Brass
Copper
Bronze
Stainless Steel (304)
Silver
Graphite
Titanium
Gold

Active (Anode)



Noble (Cathode)

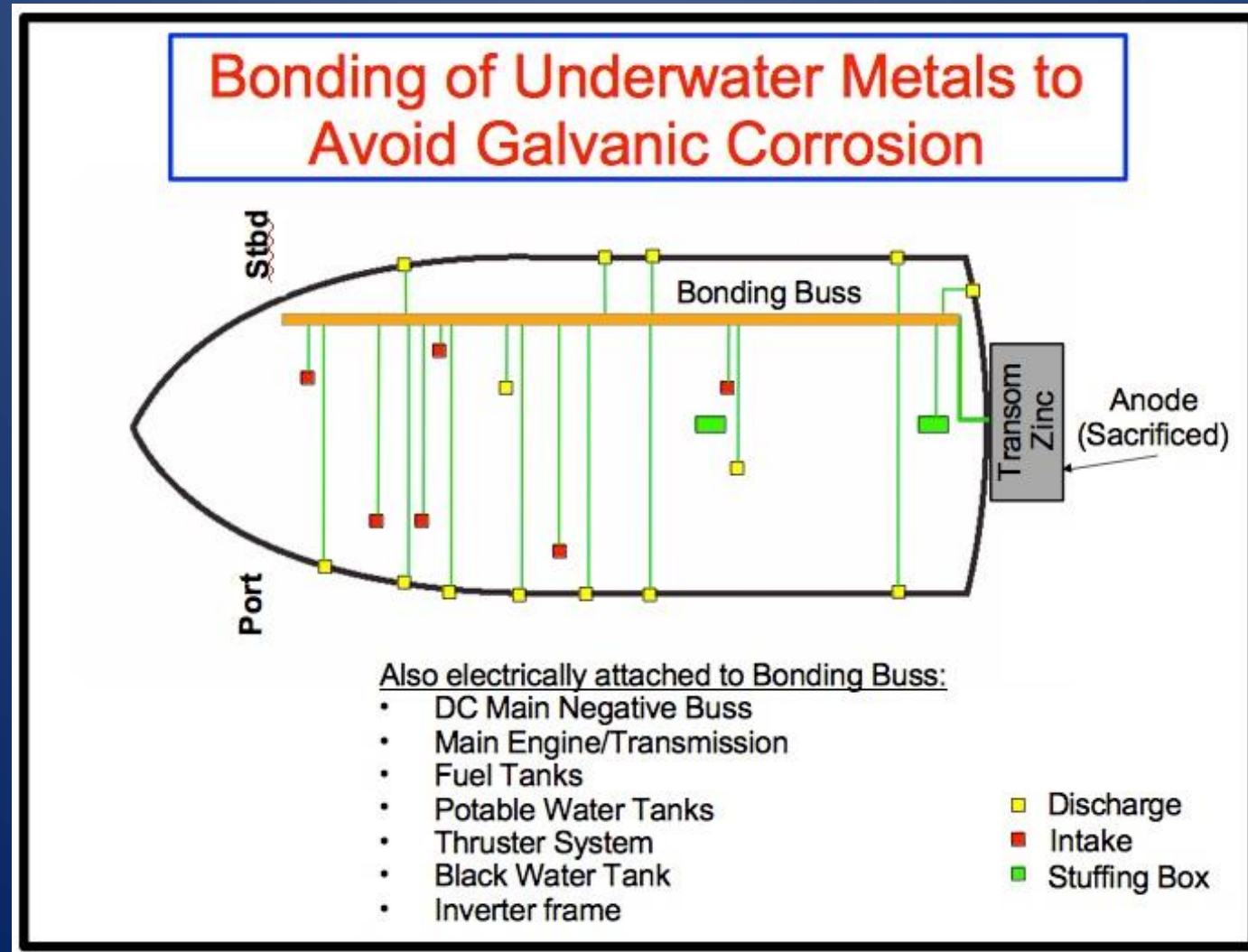
GALVANIC CORROSION



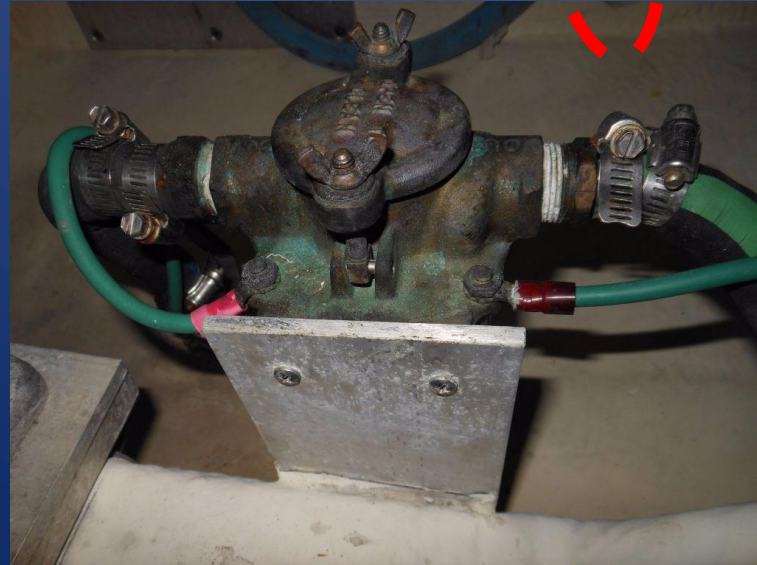
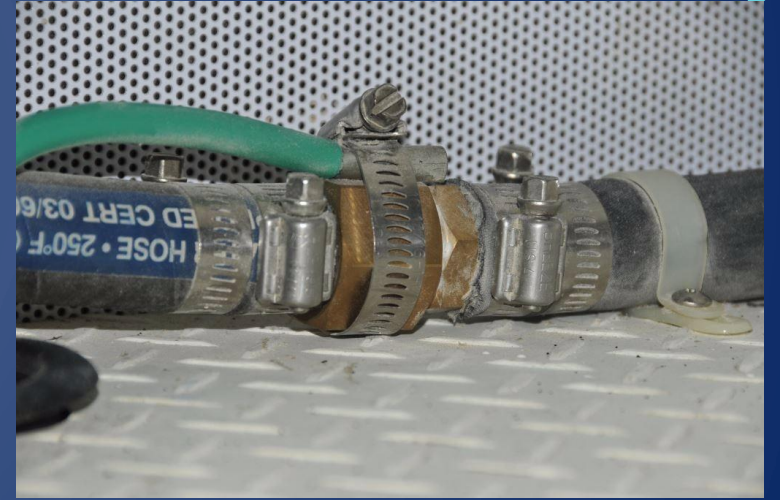
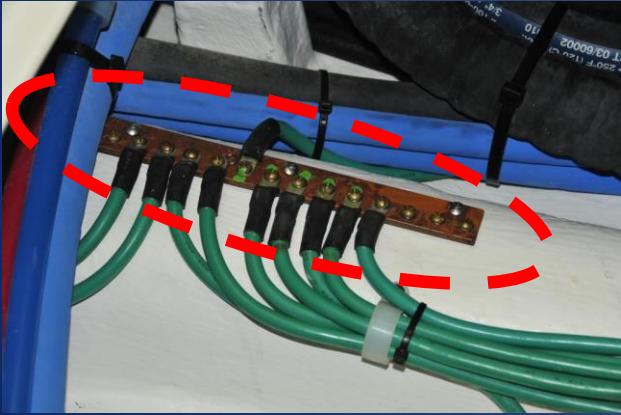
GALVANIC CORROSION



GALVANIC CORROSION



GALVANIC CORROSION



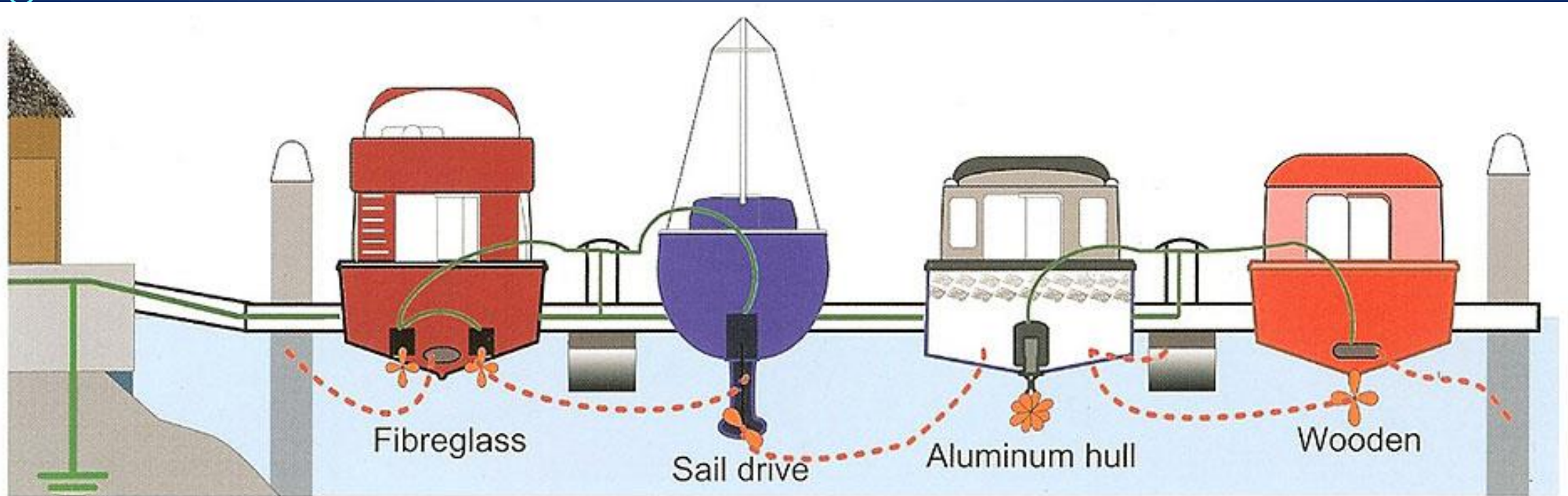
GALVANIC CORROSION



GALVANIC CORROSION

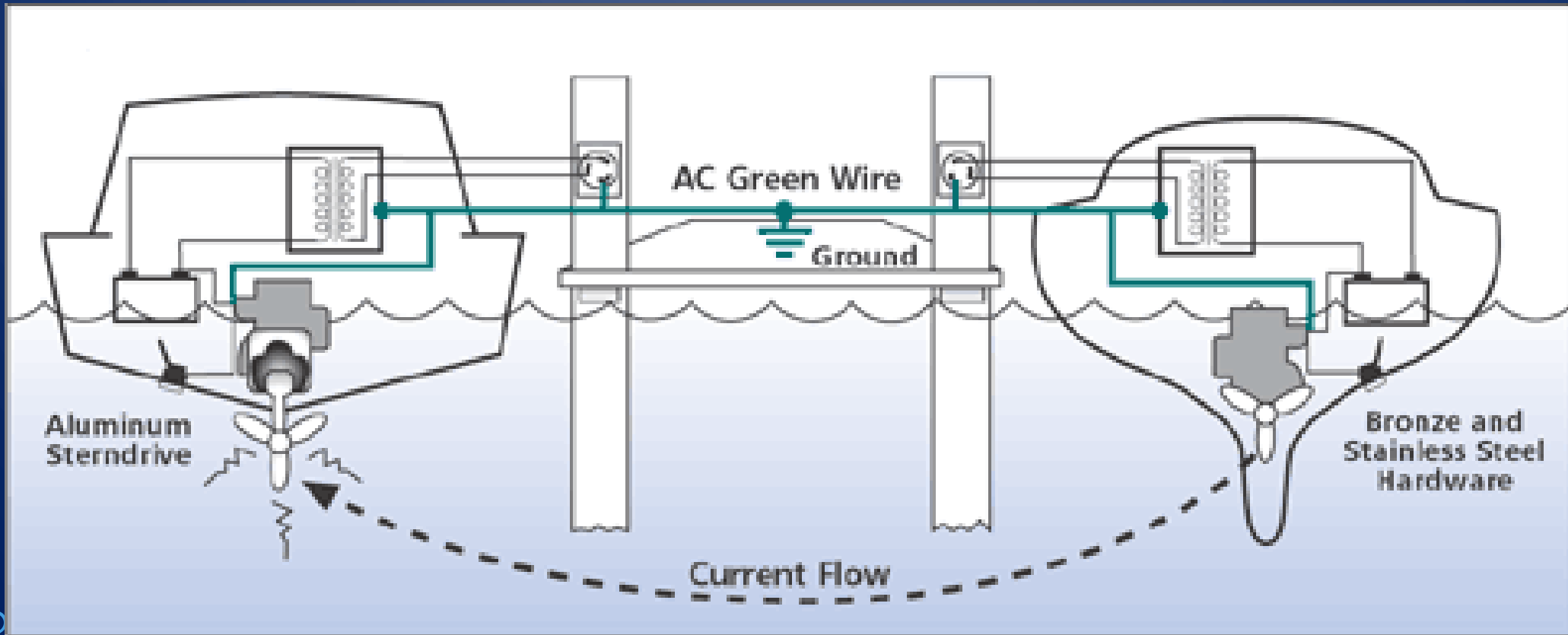


STRAY CURRENT CORROSION



- Green = shore power
- - Red = daisy chain of electrolysis

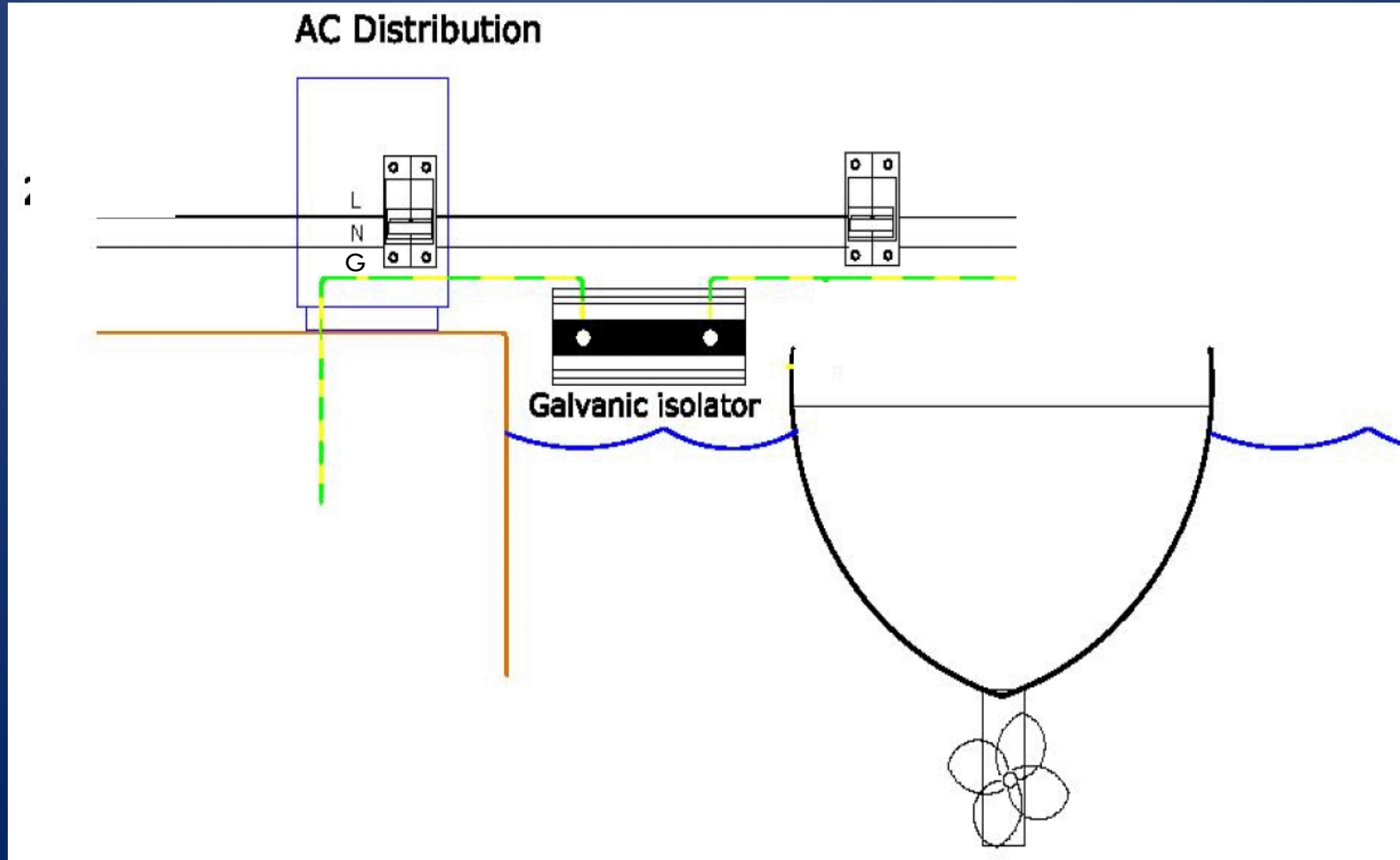
STRAY CURRENT CORROSION



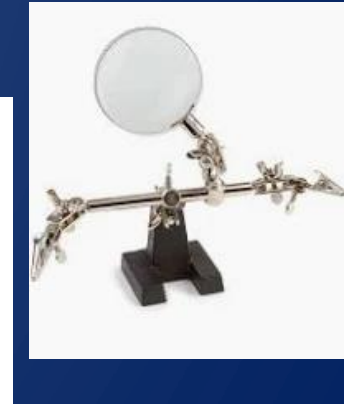
STRAY CURRENT CORROSION



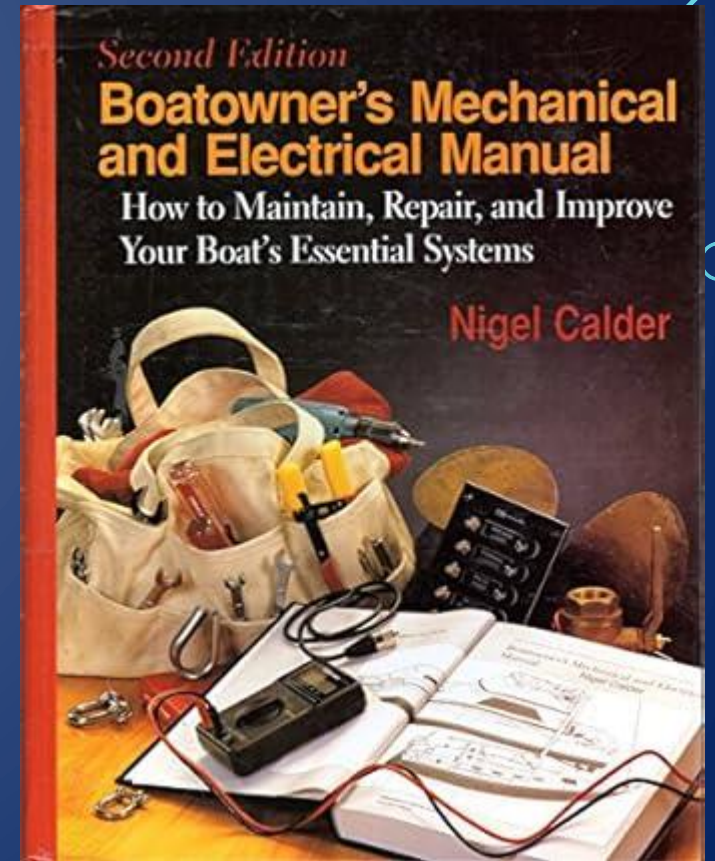
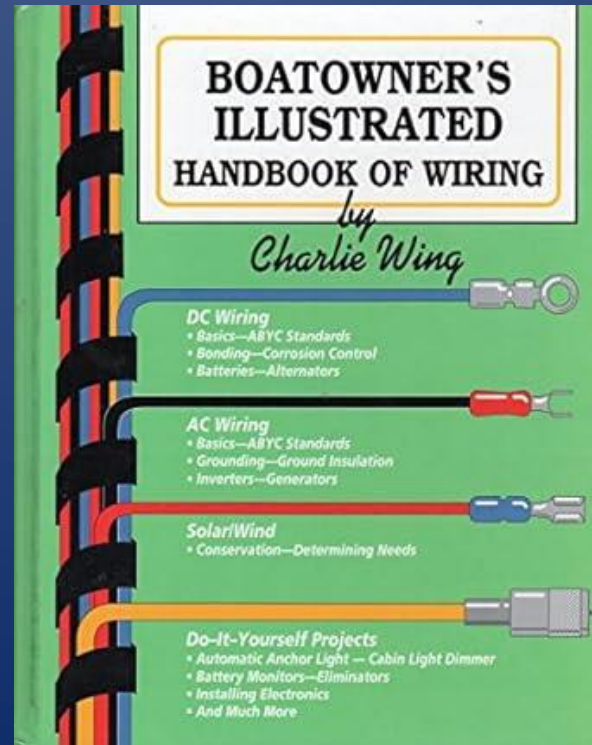
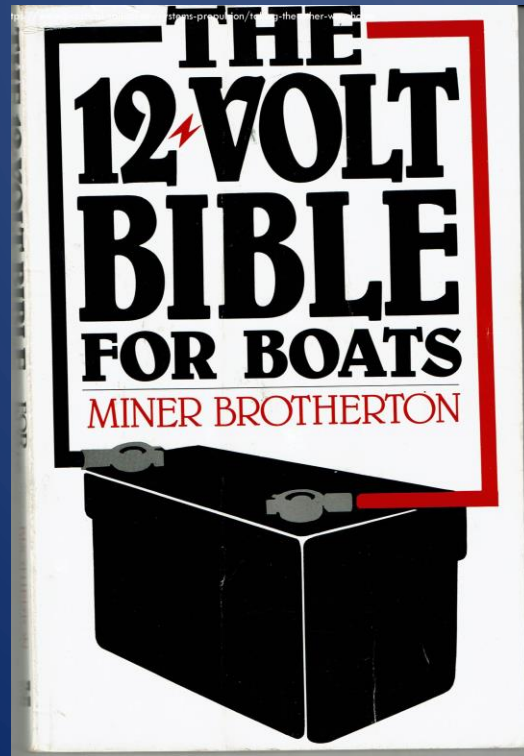
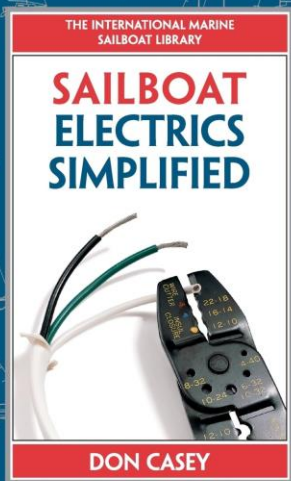
STRAY CURRENT CORROSION



RECOMMENDED TOOLS



RECOMMENDED BOOKS



ABYC – AMERICAN BOAT & YACHT COUNCIL



- Sets voluntary standards for design, construction, maintenance and repair of recreational boats
- Mix of industry, surveyors and independent volunteers
- Concerned primarily with safety of systems

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