Adhesives, Illumination and Electronics

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ADHESIVES

Characteristics of Popular Types

Polyvinyl Acetates (PVA)
Cyanoacrylates (CA)
Epoxies and Epoxy Hybrids
Polyurethanes (PU)
Methyl-Methacrylates (MMA)
UV Resins
Anaerobics

Preparation

- As with all adhesives, proper preparation of the surfaces is key to strong bonds
- Glossy or shiny surfaces should dulled or roughed up
- Non-porous hardwoods joints should be sanded to provide “tooth”
- Metal joints should be roughed up and free of oils, oxidation or other contaminants

Polyvinyl Acetates (PVAs)

Type I

- Aka Aliphatic Resins
- Brands: Elmer's Carpenter, Titebond I
- Porous surfaces and most woods
- Water clean-up
- Not water resistant after cure
- Moderate strength
- All PVAs require clamping

PVA Type II

- Brands: Titebond II, Elmer's Carpenter Ext.
- Water clean-up
- Water resistant after cure
- Limited work time, fast setting
- Stronger than Type I PVA

PVA Type III

- Brands: Titebond III, Elmer's Carpenter Max
- Completely waterproof after cure
- Exceptional strength, stronger than Type II
- Longer work time allows better alignment
  - Much longer cure time than type I or II
- Good for most woods
- Good for some metal to wood bonds
- Sandable and stainable (water based)

Cyanoacrylates (CA)

- One part, air cure with humidity
- Good for hard to bond materials
- Not for polyethylene, polypropylene
- Excellent bonds to most porous surfaces
- Available in several grades of thickness
- Cure time can be accelerated with “kicker”
- Bonds are not flexible
- Clean up with acetone

Epoxies

- 2 parts: resin and hardener
  - 1:1 and 2:1 ratios – see mfgrs' data
- Longer cure times mean stronger bonds
- Some are flexible, others more rigid
- Loctite E-20NS good for metal and wood
  - Metal to metal, wood to wood, metal to wood
  - 20 minute cure to handle, max strength 24 hrs.
  - Good all around epoxy

Epoxies (cont.)

- Hobby store epoxies tend to be more flexible
  - 30 minute cure good strength for most wood bonds
  - 5 minute cure good for quick repair where high strength is not an issue
- Loctite E-120HP has longer cure but exceptional strength
  - Alcohol or acetone cleanup and thinning
  - Moderate heat can speed cure time

Epoxy Hybrids

- Brand: Loctite HY 4090
- New development, more will follow
- Blends advantages of epoxy and CA
- Two part 1:1 base + accelerator
  (vs epoxy resin + hardener)
- Pros: fast curing, strong bonds, same compatibility as epoxy
- Con: currently expensive ($25 for 25 ml x2)

Polyurethane (PU)

- Brand: Gorilla Glue
- Single part cures with water
  - Best adhesion when parts are water wetted
  - Once opened, shelf life declines
- Foams when curing, clamping required
- Keep off skin!-very difficult to remove
- Not water clean-up
- Final bond takes hours but is exceptionally strong

Methyl-Methacrylates (MMA)

- Brands: Devcon Plastic Weld, Plast-Aid
- 2 part mixes and cures FAST (10 minutes)
- Generates heat and fumes – flammable
- This is nasty stuff to work with – use gloves
- Exceptionally strong chemical weld on plastics
- Also bonds glass, metal, wood
- Can be cut, drilled and machined
- VERY EXPENSIVE, short work time

UV Curing Resins

- Brands: CRL Clear V740, Loctite 352
- One part liquid
- Cures with application of strong UV light
  - Quick, clear cure (minutes)
- Bonds: plastics, glass, metal, wood, ceramics
- Strong bond with proper curing with UV lamp

Anaerobics

- Brands: all Loctite Thread Lockers
- One part liquid cures only when in presence of metal ions
  - Not an air cure
- Also good for most metal to metal bonds
- Several types are available depending on:
  - Strength desired, permanent or removable
  - Application before or after assembly

Adhesives Selection Chart

adhesive class>>	Methyl-Meth acrylate MMAs	Epoxies and Hybrids	Anaerobics	CAs	UV curing	Hot Melts	Poly Urethane PUs	Poly Vinyl Acetate PVA-I	Poly Vinyl Acetate PVA-II	Poly Vinyl Acetate PVA-III
retail names>	Devcon Plastic Welder Plast-Aid	various see mfgr notes	Loctite Thread Lockers	various see mfgr notes	Loctite 352 CRL UV 740	various	Gorilla Glue see appl. directions	Titebond I Elmers Wood white glues	Titebond II	Titebond III
Substrates↓↓										
Dense Woods	√	1		1		√	√	1	1	√
Porous Woods		√		√		√	√	√	√	√
Metals		2	√	√	√	√	√			
Plastics	√	3		4	√					
PVC	√	3		√	√					
ABS	√	3		√						
Composites		1		√		√	√			
Glass		√		√	√					
Ceramics		√		3	√					
Fiberglass	√	1		√						
Rubber	√	√		√						√
Paper		√		√		√	√	√	√	√
Cardboard		√		√		√	√	√	√	√

Notes:

1-special prep. Roughen surfaces
2-Loctite E-20NS good for metal to metal and metal to wood
3-see mfgr data for specifics
4-not for poyethylene or polyppropylene

Illumination and Electronics

As it relates to illumination of model boats

Common Illumination Lamps

- Incandescent
  - Can draw significant current (50+ ma each)
  - Can run on AC or DC
  - Lamps generate heat
  - Subject to eventual burnout and replacement
- LEDs
  - Low voltage and current (10-20 ma typical)
  - DC only
  - Little to no heat
  - Extremely long life

LEDs (cont.)

- Available in many colors and configurations
- Common diameters
  - 1 mm = .04 in or 3/64
  - 1.8 mm = .07 in or 5/64
  - 3 mm (or T1) = .12 in or 1/8
  - 5 mm (or T 1 ¾) = .20 in or 7/32
  - 10mm = .39 in or 13/32
- Long lead is + (pos)
- DO NOT EXCEED volt or ma current ratings
  - Use conservatively lower voltage for longer life

LED characteristics

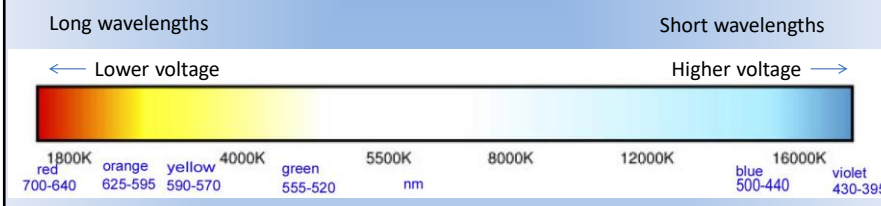
- LEDs operate at low voltages (1.8 to 4.5)
- Need minimum voltage to fire
  - Each size and color will vary
- Max volt and current levels must be followed
  - Excessive current will lead to thermal runaway
  - Current-limiting is essential (resistor or voltage control)
- Difference in brightness between rated voltage and 80% is very small
  - Run conservatively low
- Colored LEDs produce light at specific wavelengths-not broad spectrum like incandescents

LEDs (cont.)

- Selection criteria
  - Diameter, mounting options
  - Color
    - Lens color and native LED color
    - Diffuse lens or water clear
  - Brightness (mcd)
  - Voltage and current limits
    - Red end of spectrum lower voltages, blue end higher
  - Resistor included or not
  - Flashing or not
  - Viewing angle (think flood or spot) (2Θ)

Visible Color Spectrum

Kelvin and nm wavelength



LEDs can be specified in either K or nm wavelength

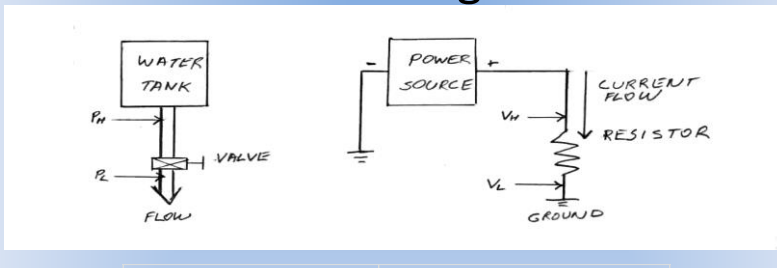
Things to Consider

- Color of interior space will affect the apparent color of the light
  - Red colors will warm the color of light
  - Blue colors will cool the color
- Projection distance
  - Dispersion angle, LED spacing
- Use of fiber optic cable
- Single or multiple switches
- External power connection location

Basic Knowledge of Electricity

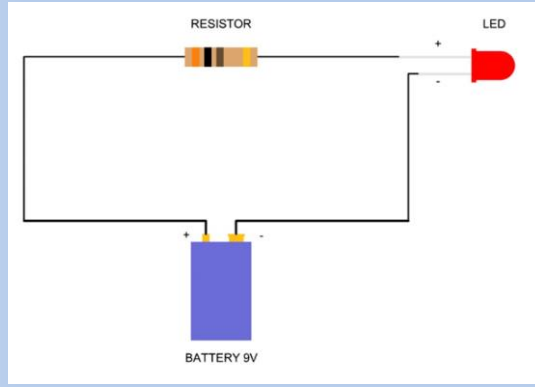
- Proper selection and connection requires understanding of some fundamentals
- Electronic theory is not required
- Think of electricity being similar to water

Electronics is Analogous to Water



WATER	ELECTRONICS
Pressure	Voltage
Valve	Resistor
Flow Rate	Current
Pressure Drop	Voltage Drop

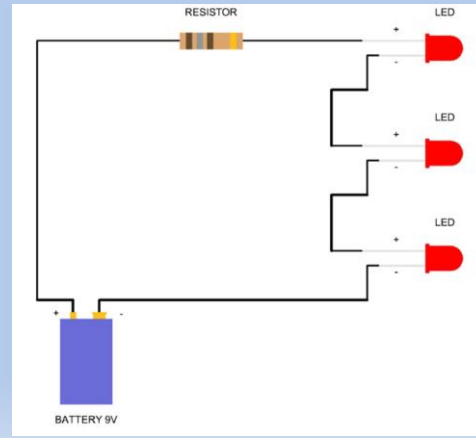
Single LED and resistor



$R = (V_{bat} - V_{led})/I_{led}$

If voltage of LED is 2.0 and current is 20ma, R=(9-2)/.020=350 ohms

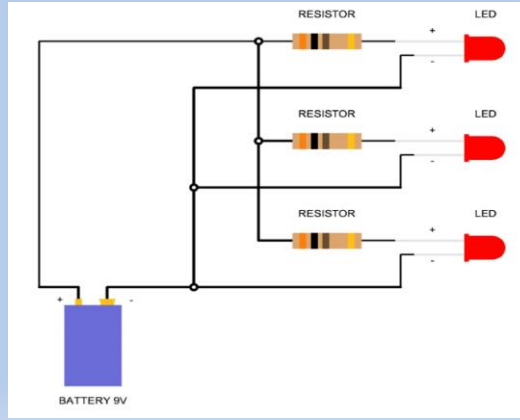
LEDs in series have same current



R = (V_{bat} – 3xV_{led})/I_{led}, same current through each LED
R=(9-6)/.020=150 ohms

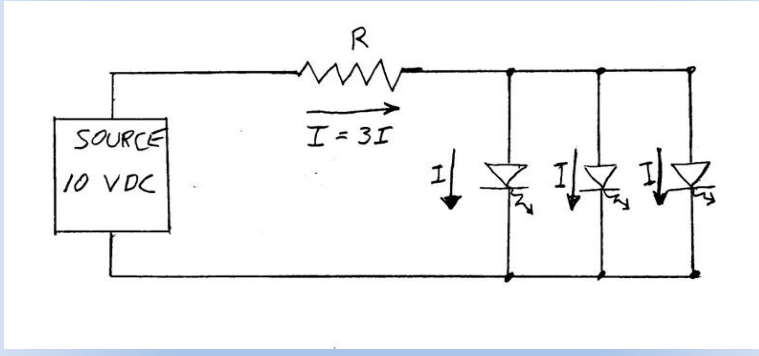
Three LEDs in Parallel

Same voltage for all LEDs with resistor in parallel



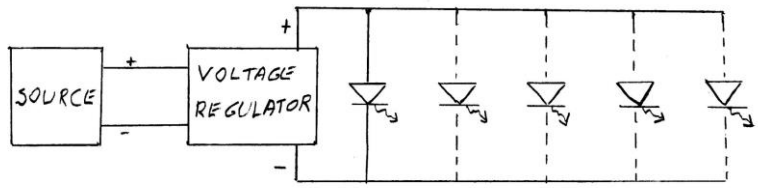
R = same as for one LED, I will be 3x for one LED
LEDs need not be the same-compute R for each

LEDs in Parallel have same voltage



I=20ma per led voltage for each led = 2.5
Total current=60 ma Voltage dropped by R=7.5 (10.0-2.5)
R=(Vbat-Vled)/Iled=(10-2.5)/.060=125 ohms
All LEDs in parallel have same voltage

The Simple Way



Source is any DC supply 5 to 12 volts
Output is adjustable and fixed regardless of number of leds or lamps added
All leds or lamps in parallel must be of the same voltage but not necessarily the same current
Regulator automatically adjusts output to meet preset voltage

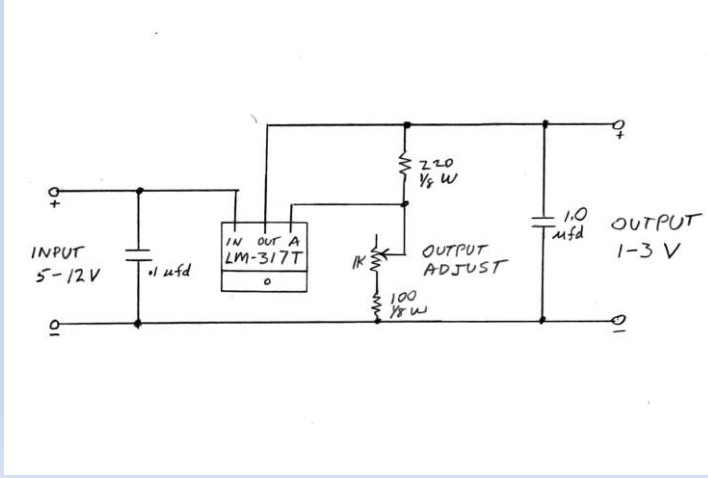
Advantages of Voltage Regulator

- No math required!
- Eliminates resistors
- Precise voltage and current adjustment
- Can use broad range of supply
- More flexibility in LED selection
- Very small size
- Affordable ($10)

For those who are interested in trying their hand at building a simple electronic project the following is the circuit schematic for a voltage regulator.

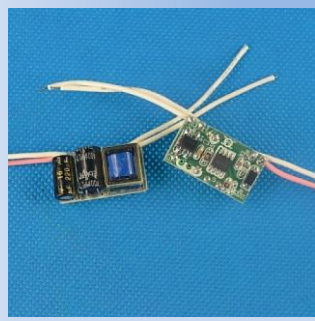
I would be happy to assist or build one for anyone.

Variable Voltage Regulator



Commercial Regulators

On Ebay ...less than $10

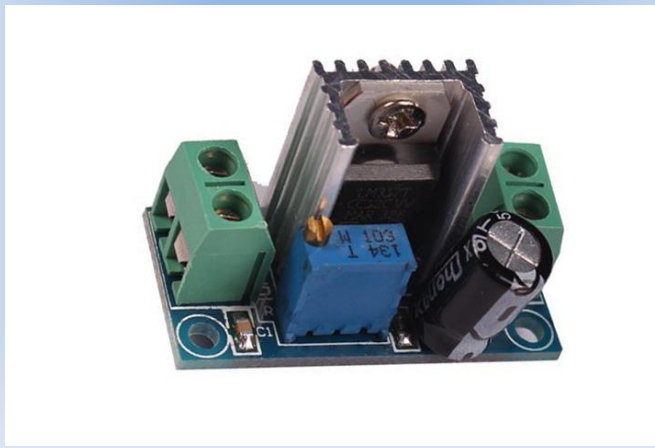


120 vac input voltage regulator

DC to DC voltage regulator

Commercial regulators

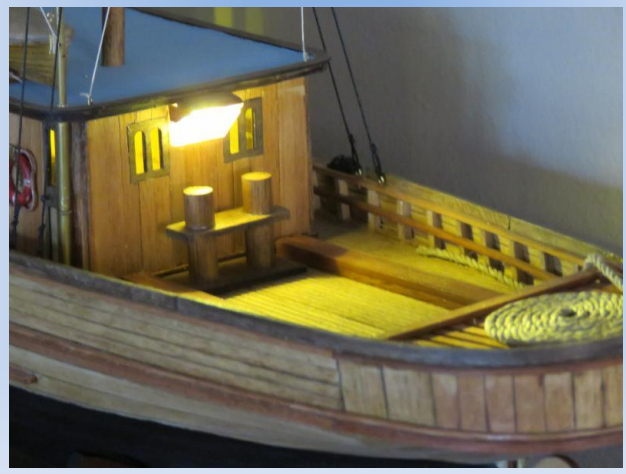
Amazon – less than $5.00



Question:
What does all of this have to do with lighting my boat??

Answer:
Quite a lot, actually. Illumination can involve multiple lights and colors with different power requirements. Power supplies rarely match light voltage.

Direct Lighting



Indirect Lighting (interior)

Direct Lighting

Direct Lighting

Lighting a new build

- Plan desired effects before building
  - Direct or indirect light, color
  - Placement of lights, mounting method
- Search appropriate sites
  - Scale, style, color and output
  - Voltage and current requirements
- Decide on types of connections
  - Parallel, series, or a combination
  - Plan for differing voltages

New Builds (cont.)

- Plan power supply
  - Source, voltage, current capacity
    - Battery or AC-DC adapter
  - Voltage control for unequal requirements
    - Resistors
    - Regulators
    - Multiple sources
  - Plan wire routing through model
  - Keep source and regulator outside the hull

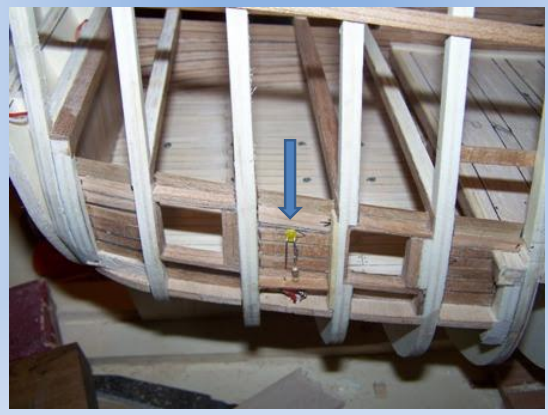
New Builds (cont.)

- Lighting complications
  - Incandescent lamps 3 or 6 volt at 30-60 ma
  - LEDs 1.8 to 4.5 volt at 5-30 ma
  - Coin batteries (lithium) are 3 volts, short life
  - AAA, AA, C and D cells are 1.5, 3.0, 4.5, 6.0, 7.5
  - 9v cells have moderate life
  - AC to DC adapters commonly 3.5v, 5.0v, 6.0v, 9.0v, 11.0v, 12.0v.
  - Ii is likely you will have to deal with voltage mismatch at some point

New Builds (cont.)

- Safety factors
  - All bulbs will run longer if operated at slightly lower voltages than advertised
  - LEDs are more voltage-critical and should be run at about 80% voltage (“typical” not “max”)
  - Incandescent lamps (grain of wheat, rice) should operate at 90% voltage
  - This becomes very important when installing in areas that will become inaccessible.

Mounting LEDs inside planking



Only the tip of the lens needs to protrude

Lighting new builds (cont.)

- Pre-paint interiors to be lighted
- Bench test all lights
  - Proper voltages for each, safety margins
    - Voltage regulators, resistors or batteries
    - Observe polarity of supply and lights
  - Desired light output and color
- Install all lights and test again before closing
- For incandescent lights, consider possible future bulb replacement access

Lighting an existing boat

- Severely limits interior lighting options
- Mostly the same as for new build
- Plan access points for interior lights
  - Work on the back side of the boat
    Try to minimize the damage!

Existing Boats (cont.)

- Plan wire routing out of sight
  - Conductive copper tape (rocketfin.com)
  - Thin magnet wire can be easily hidden
  - 30 gauge is fine for limited number LEDs
  - 26 or 24 is better for groups
  - Incandescents will require 24-26 minimum

Halogen Deck Lamps

Search Lights

Navigation Lights / Boards

Misc. Lights

Cabin lights

Bullet lights

Marker lights

Hollow lights for LED inclusion

Lighting Component Sources

- Mack Marine (mackproductsrc.com)
  - Nautical lights, incandescent
- Shipsnthings.com
  - Nautical lights, incandescent and LED
- FiberOpticProducts.com
  - LED drivers (voltage regulators)
  - LED lights
  - Fiber optic cables

Sources (cont.)

- Rocketfin.com
  - 1.8, 3, 5, 10 mm LED bulbs with wires
  - Flashing and non-flashing LEDs
  - Conductive copper tape
- Modeltrainsoftware.com
  - 1.8, 3, 5, 10 mm LEDs, as well as nano, pico sizes
  - Battery holders and switches
- Shopled.com
  - LEDs only, all sizes, colors

Sources (cont.)

- Allied Electronics (alliedelec.com)
- Jameco Electronics (jameco.com)
  - Wide assortment of LEDs
  - Wide range of resistors
  - AC to DC adapters
  - Switches of all types
  - Battery holders for all batteries
  - Components for voltage regulators

Sources (cont.)

- Cornwall Boats (cornwallmodelboats.co.uk)
  - Accurate nautical incandescent lights
- Alwayshobbies.com
  - Model boat lighting and fittings
- Microlumina.com
  - Micro LED lights for models
- Harbormodels.com
  - Good selection of nautical lights and sizes
  - AC-DC adapters

Sources (cont.)

- Hobby stores specializing in trains often have lighting adaptable to boats
- Build your own
  - Candles
  - Deck lights
  - Interior lights (indirect, not seen)
  - Strip lights