

# Electrical Basics Clinic

September 15, 2012



Scott Russell

# Topics



- How to use a voltmeter (analog / digital), continuity testing →
- Primer on wire sizes →
- DC Wiring →
- Importance of Color Coding →
- Number of feeds / weakness of rail joints (and rail) as conductors →
- RRampMeter for DCC (method for checking DCC polarity) →
- Troubleshooting techniques →
- Turnouts make poor electrical switches →
- Powering Frogs →
- LED's: Care and feeding, simple balancing circuit for bicolor LEDs →
- Voltage regulators for bulbs →



# Volt / Ohmmeters - Photos



Analog



Digital



# Volt / Ohmmeters



- When checking for continuity or resistance, never connect to a powered circuit (or you will be replacing the fuse or buying a new meter)
- When measuring voltage, if meter is not auto-ranging, start at higher than expected setting and work your way down. If not sure it's DC, start with AC setting, it won't hurt the meter
- Current is usually a small value in most meters (less than 1 amp)



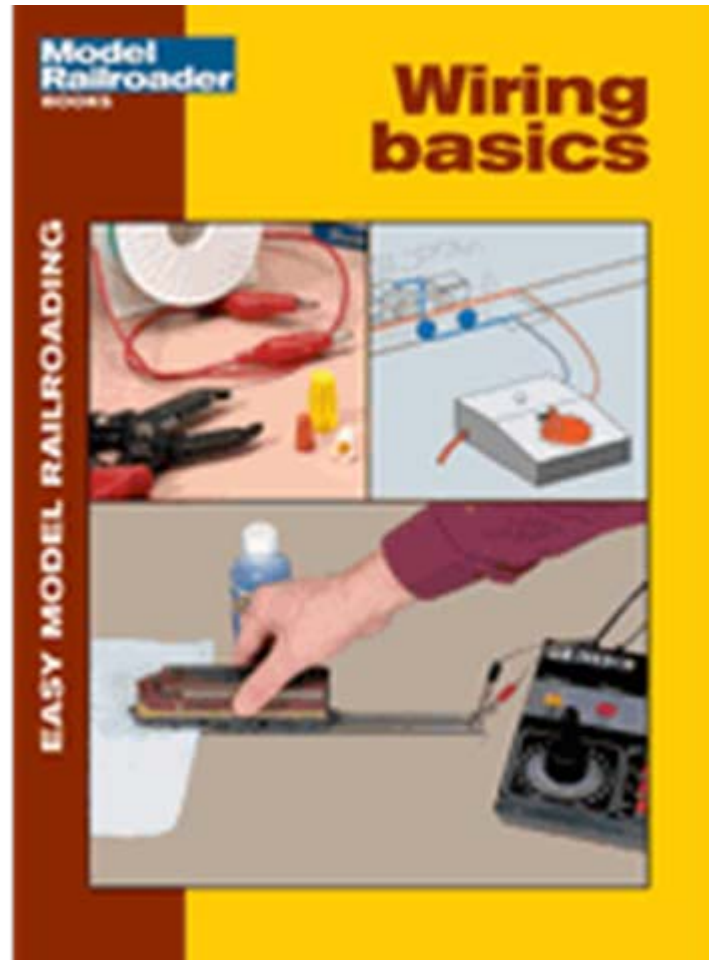
# Wire Sizes



- AWG – American Wire Gauge
- Increasing AWG number is decreasing gauge
- Common sizes/uses in model railroading
  - 12 (.0808” dia), 14 (.0641” dia) – Bus wire
  - 22 (.0253” dia), 24 (.0201” dia) – Feeder wires
  - 26 (.0159” dia), 28 (.0126” dia) and 30 (.0100” dia) – Decoder wire
- Stranded vs. solid
  - Nomenclature (i.e. 22 AWG 7/30)
  - Insulation



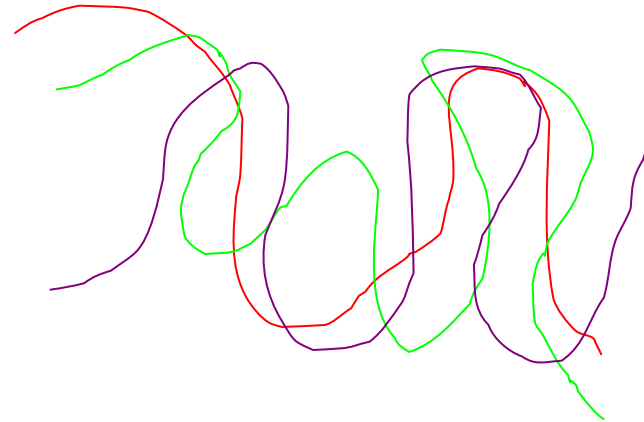
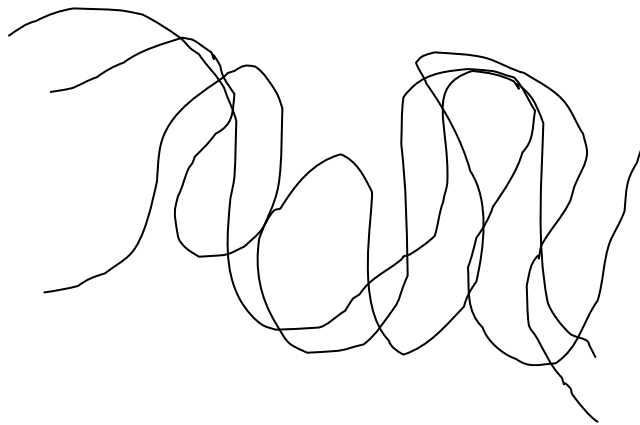
# DC Wiring



# Color Coding



- Colors used are not as important as being consistent
- Fight the temptation of using leftovers on a Sunday so you can get something done
- You won't remember



Enough said



# Rail as conductor, etc



- Nickel silver rail (which is copper, nickel and zinc, but no silver), has a resistance of  $.057\Omega/\text{ft}$
- Voltage drop @5A = 1.71v for 3 ft pc of flex track
- Copper wire has a resistance of  $2.525\Omega/1000\text{ ft}$  (14 AWG) and  $1.588\Omega/1000\text{ ft}$  (12 AWG)
- Voltage drop @5A =  $.025\text{v}/\text{ft}$  and  $.016\text{v}/\text{ft}$
- Feeders every 3 ft
- Don't rely on unsoldered joiners





# RRampMeter



- Accurately measures DCC voltage
  - Made to measure at 7100 Hz
  - Standard meter measures at 60 Hz
- Check for voltage drops
- Check for polarity
- Can be installed in line as an ampmeter
- Application notes at:  
[http://www.tonystrains.com/technews/rrampmeter\\_df-appnotes.htm](http://www.tonystrains.com/technews/rrampmeter_df-appnotes.htm)



# Troubleshooting



- If it worked before you did something, undo the last thing you did, and go backwards in order
- If something happened on its own (i.e. you weren't screwing with it), only change one thing at a time.
- Changing 2 things makes it 4 times harder, 3 things makes it 8 times harder, and so on
- In case you forgot, only change one thing at a time



# Turnouts make poor electrical switches



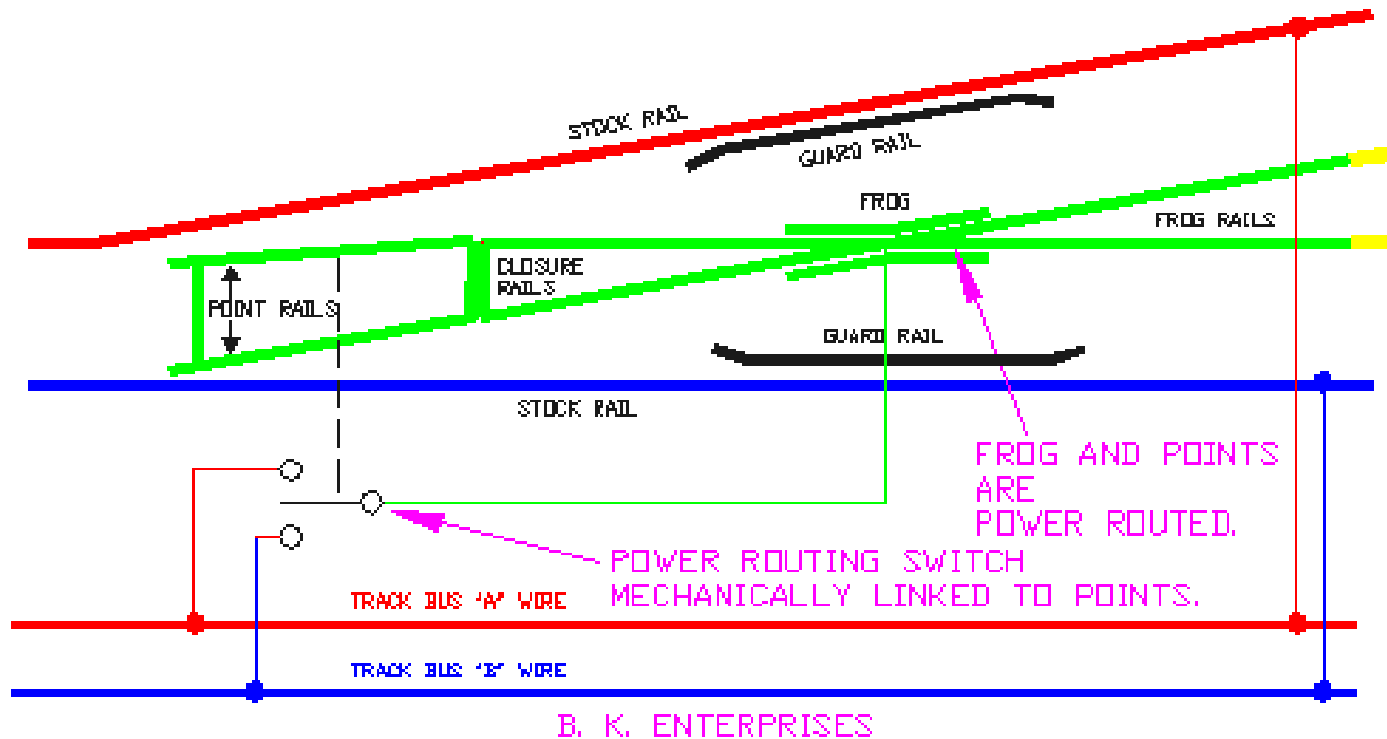
- What makes a good electrical switch
  - Silver or gold contacts
  - Positive snap or wiping action
  - Cross hatch contacts
- What does a turnout have
  - Mediocre snap
  - Sometimes wiping, but between copper and nickel silver, both inferior contact materials, with crud
- Use auxiliary contacts whenever possible and/or jumper the rails



# Using Auxiliary Contacts



Courtesy of Wiring for DCC by Allan Gartner



# Powering Turnout Frogs



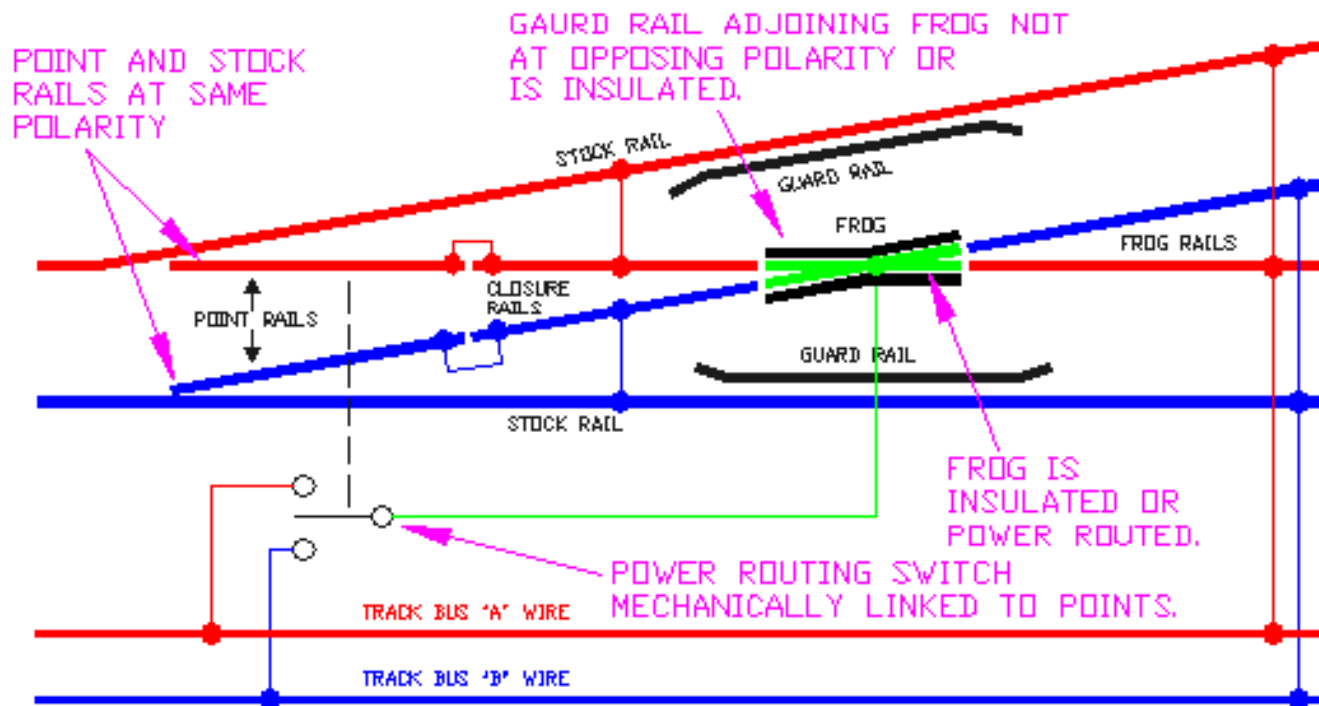
- Why power your frogs
  - It is a long (1" plus) dead spot in your track
  - Would you leave a 1" dead spot in your mainline?
- How to power your frogs
  - Auxiliary switch contacts
  - Added contacts for hand throws
  - Hex Frog Juicer™ for DCC



# Turnout – DCC Friendly



Courtesy of Wiring for DCC by Allan Gartner



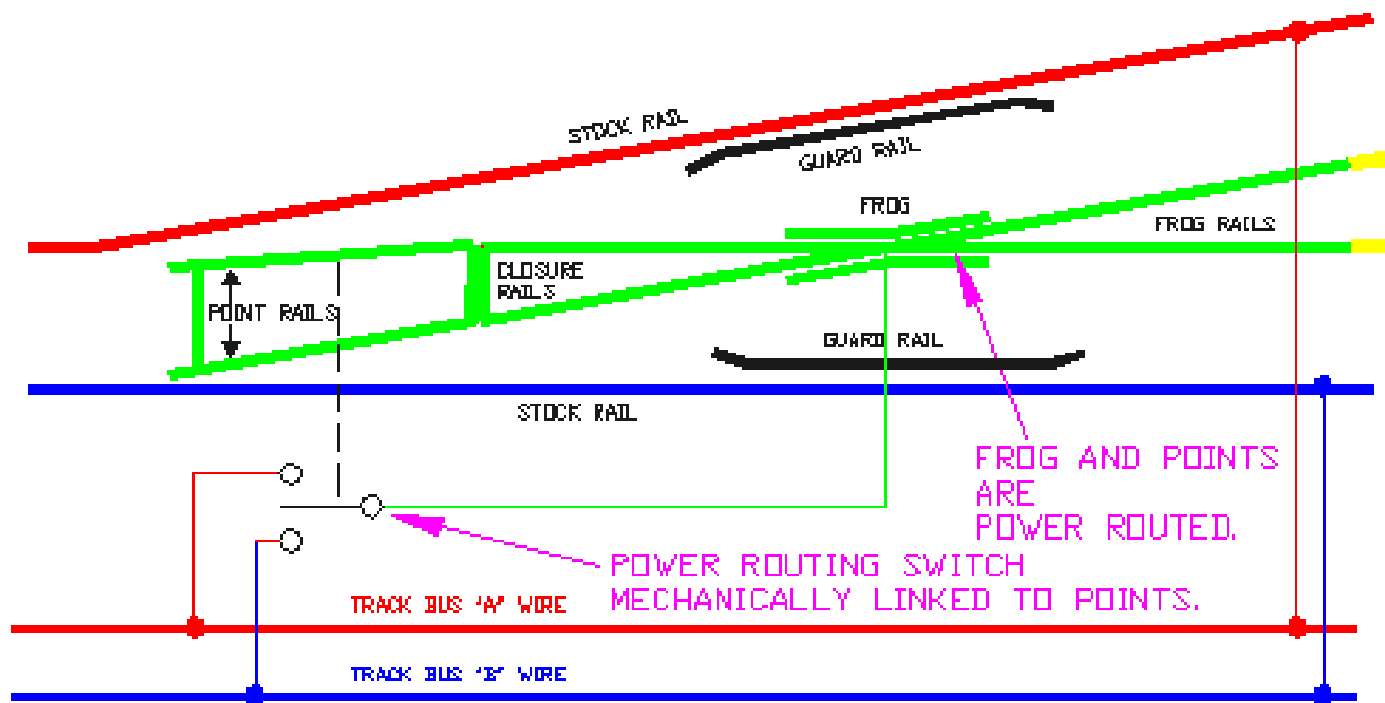
DCC Friendly



# Turnout – Not DCC Friendly



Courtesy of Wiring for DCC by Allan Gartner



B. K. ENTERPRISES

Not DCC Friendly



# LED's/IRED's



- IRED invented in 1961 by Bob Baird and Gary Pittman at Texas Instruments
- LED (red) invented in 1962 by Nick Holonyak, Jr. at GE
- Typical life is 25,000 to 100,00 hours
- LED's are “current” devices not “voltage” devices
- Ohm's law:  $V = IR$  (don't be frightened or run screaming, it's actually pretty easy) →
- Bicolor LED's – 2 leaded, 3 leaded →
- White LED's
- Sizes →
- Simple (and not so simple) circuits →





# OHM's Law



## LED Example

Red LED, Typical  $V_F = 1.7$  Volts @  $I_F = 20$  mA

Voltage = Supply voltage –  $V_F$

Assume 12 Volt supply

$$12 - 1.7 = 10.3$$

$$10.3 = .020 * R$$

$$R = 10.3/.020 = 515\Omega$$

Closest standard resistor is 510 or 560 $\Omega$

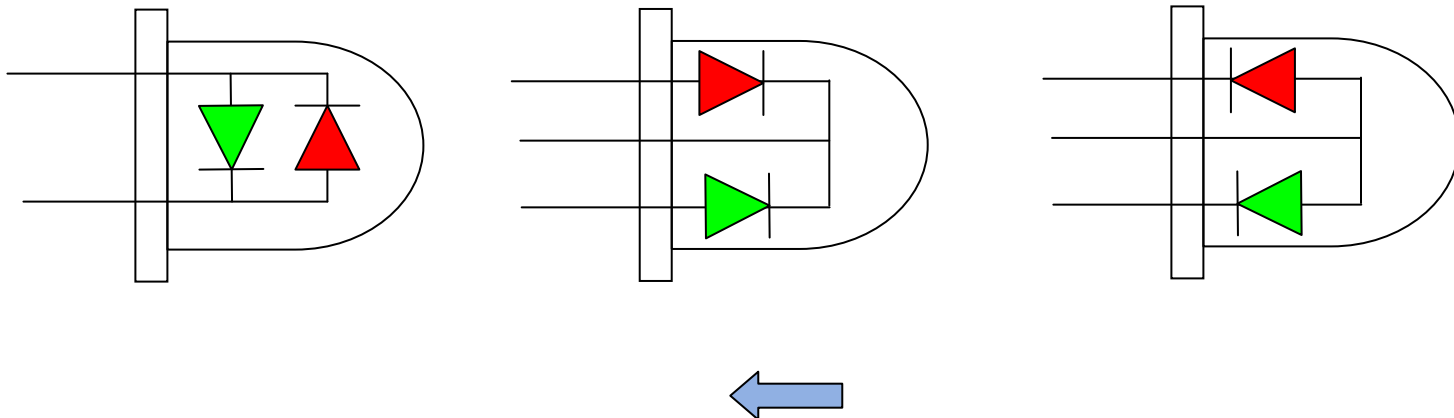
Closest common resistor is 470 or 680 $\Omega$



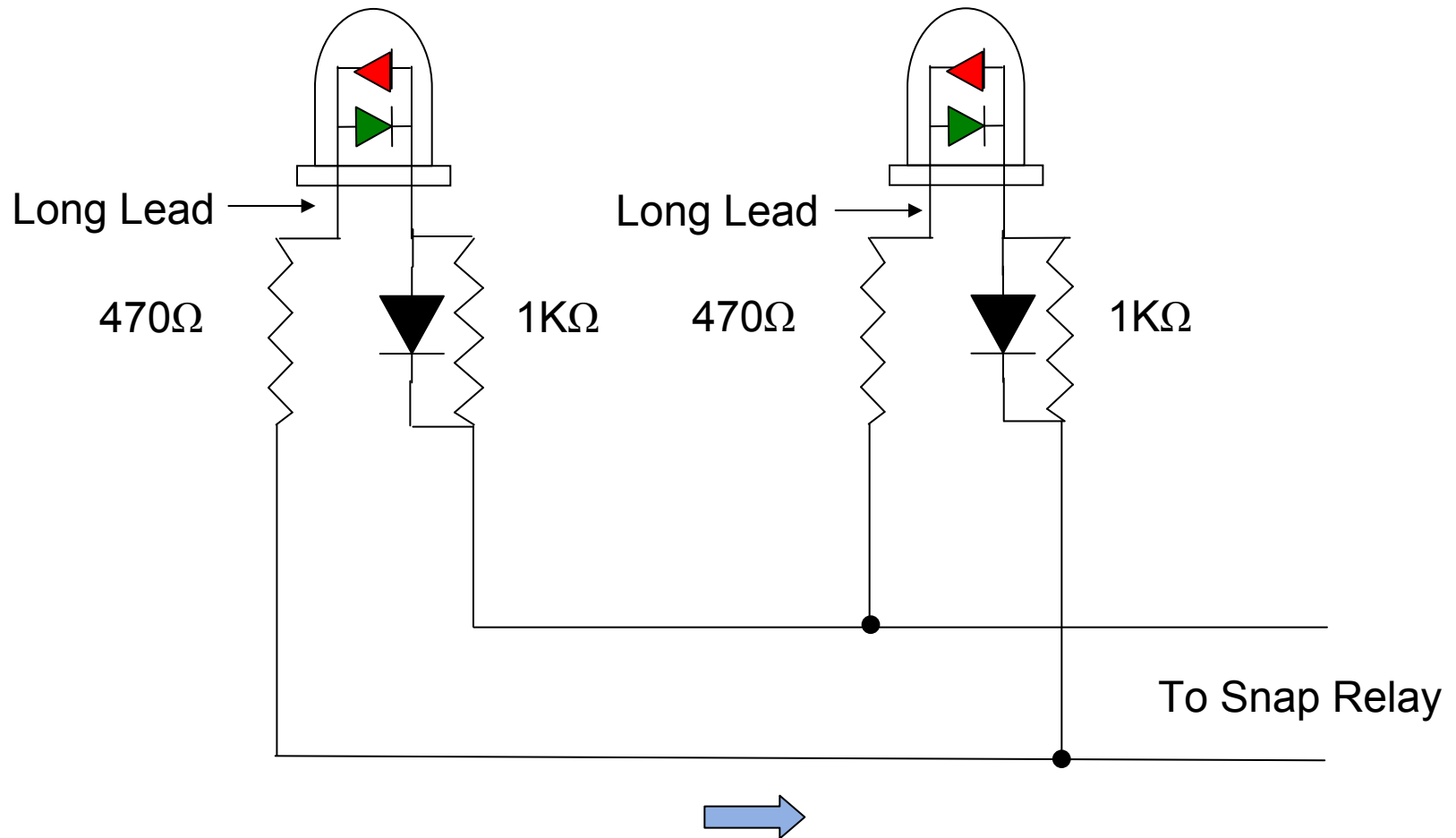
# Bi-Color LED's



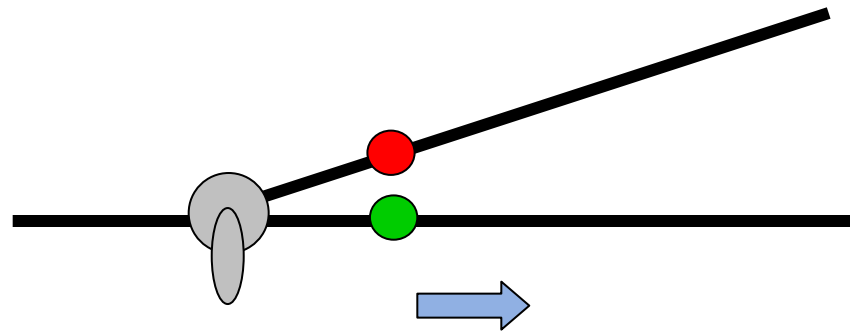
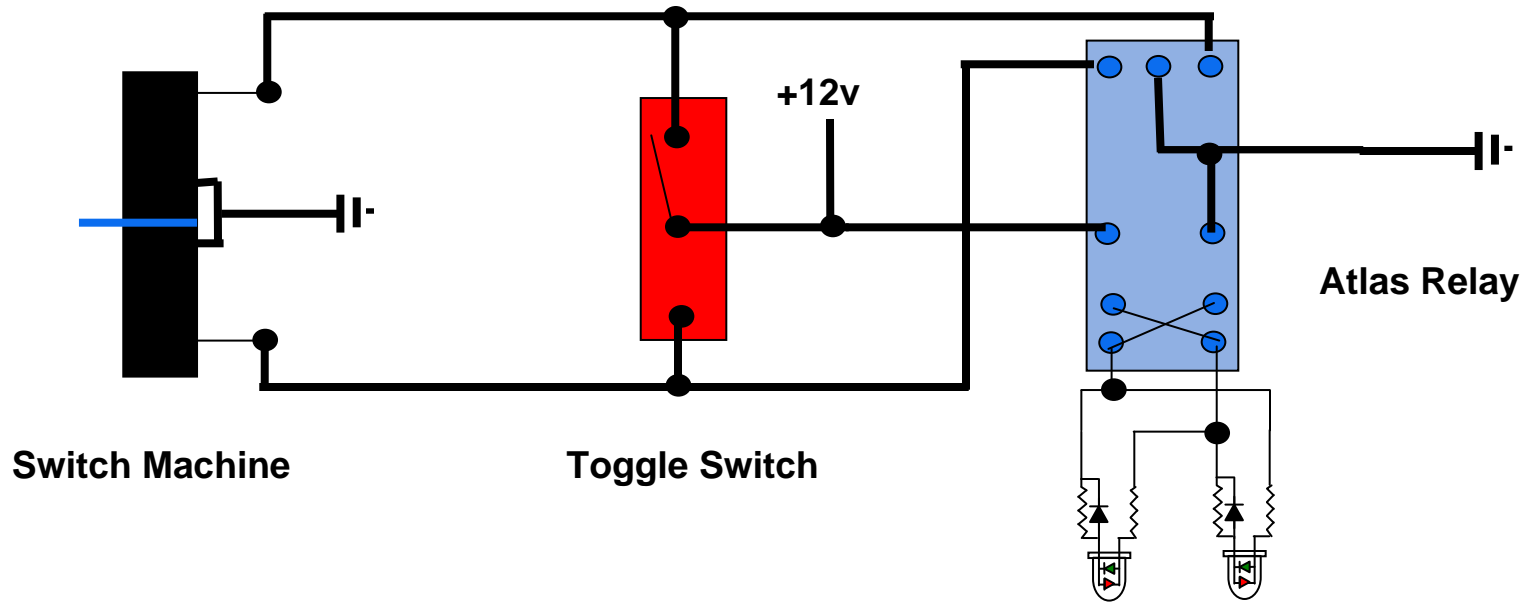
- Red / Green commonly used for Model RR use
- 2 lead: Red and Green chips are in reverse parallel
- 3 lead: Red and Green chips are either cathode to cathode (common -) or anode to anode (common +)



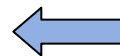
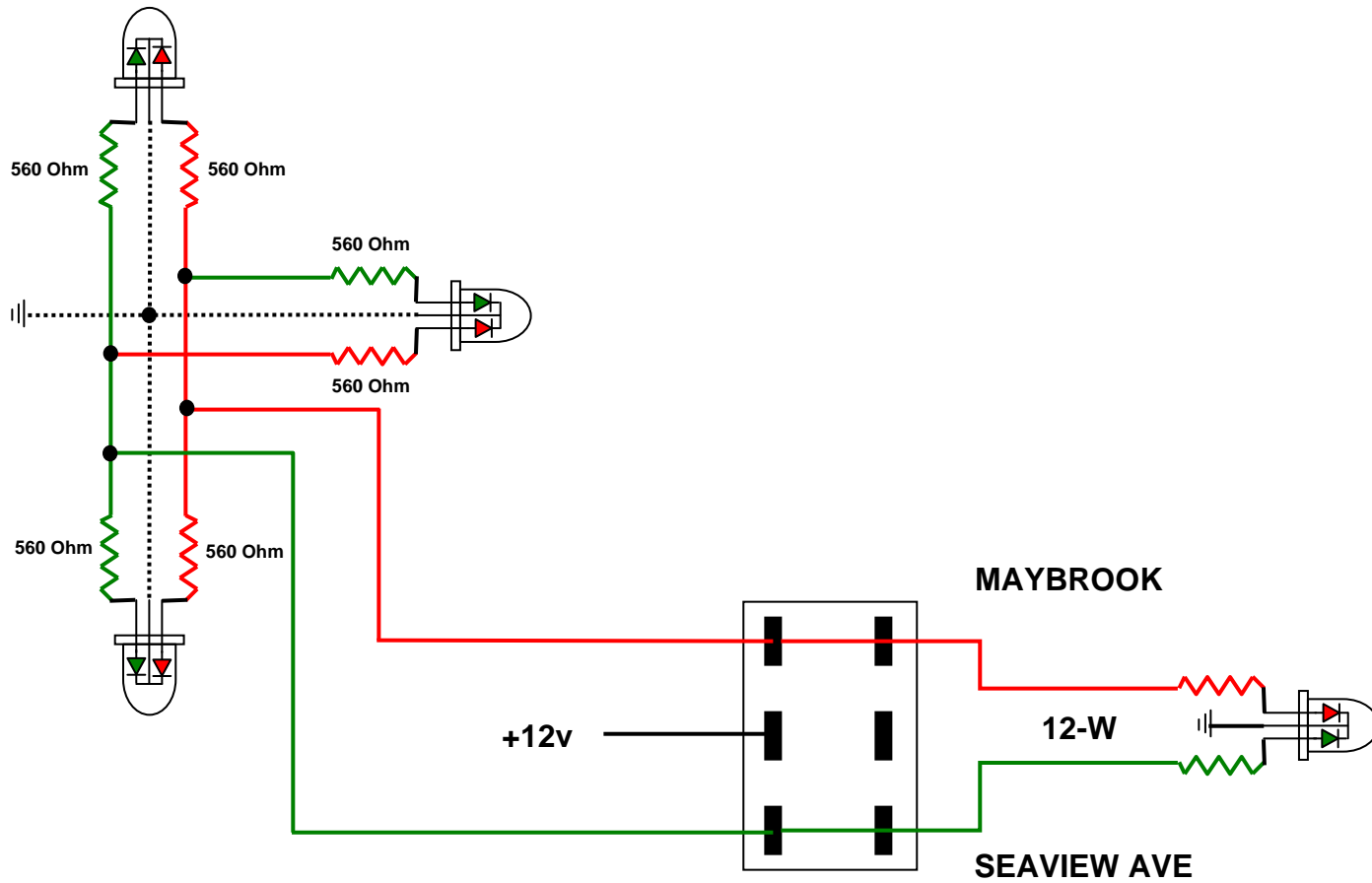
# Bi-Color LED Balancing Circuit



# Balancing Circuit Application



# Signal Circuit



# LED Sizes



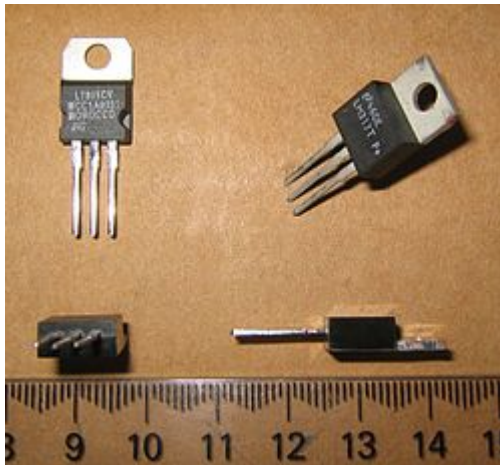
- T 1  $\frac{3}{4}$  = 5mm (leaded)
- T1 = 3mm (leaded)
- 0603 = .06" x .03" = 1.5mm x .75mm (SMT)
- 0402 = .04" x .02" = 1mm x 0.5mm (SMT)



# Adjustable Voltage Regulators



- More consistent bulb brightness than resistors
- Less chance of burning out bulb with voltage spikes or layout to layout voltage differences
- Available in several package sizes (LM317xx)

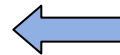
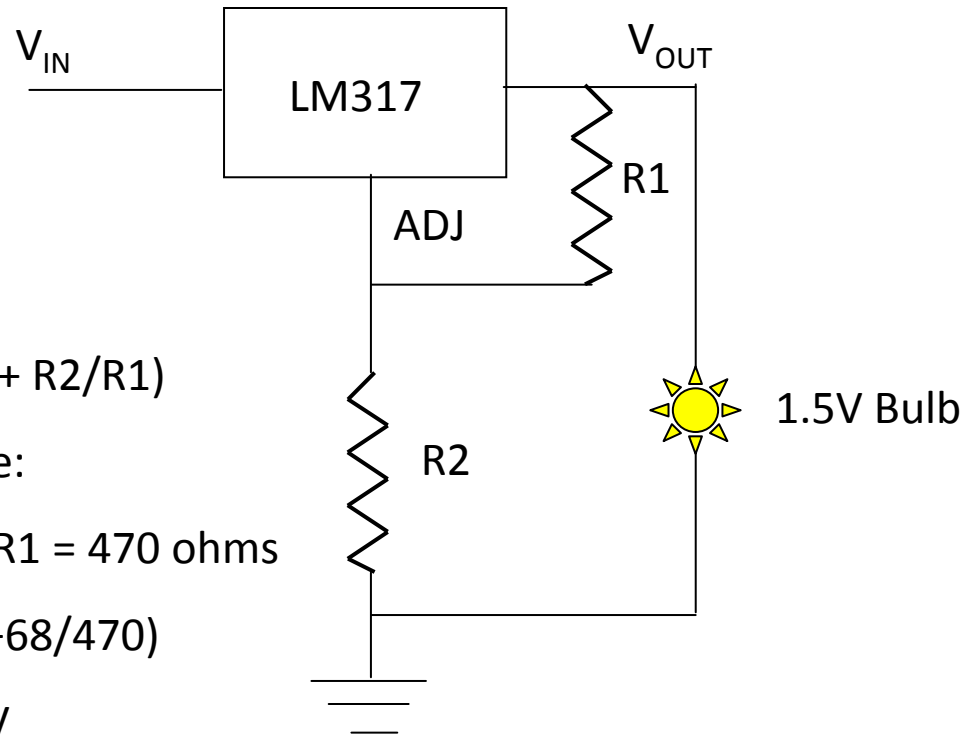


TO-220 (1.5A)



TO-92 (1.0A)

# Simple VR Circuit





The End



# Questions?

Applause