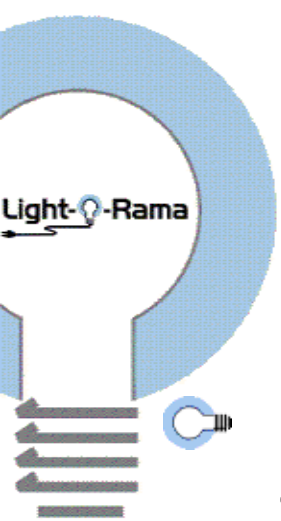







# **Welcome Hobbyists!**

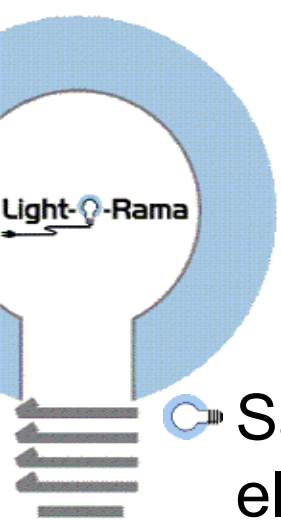
## **LOR-303**

### **Building Controllers**



# ***Objectives***

-  Have a good understanding of Electrical Safety.
-  Understand basic Electrical terminology.
-  Know the tools and materials required to build a light controller.
-  Understand the connections required to make a light controller work.
-  Successfully assemble a working Light Controller.

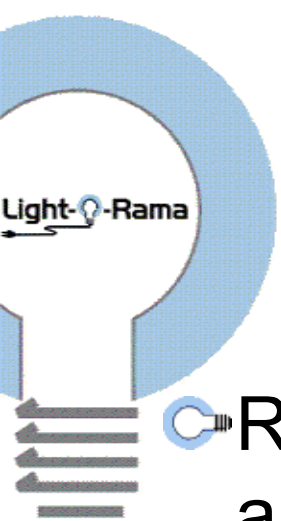


# ***Safety First !***

💡 Safety is of utmost importance when working with electricity. Develop safe work habits and stick to them. Be very careful with electricity. It may be invisible, but it can be dangerous if not understood and respected.

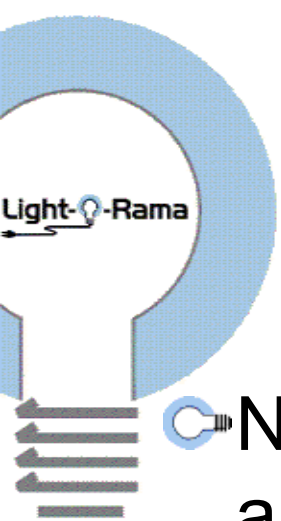
## 💡 Be Shock-Aware:

- ❖ Make sure controllers are unplugged or circuit breakers are off when servicing.
- ❖ Make sure work areas are dry.
- ❖ Keep enclosure covers on when they are not being serviced.
- ❖ Use insulated tools.



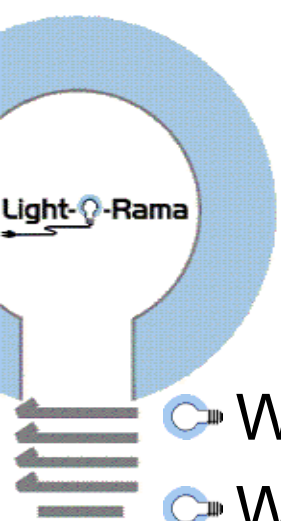
# ***Safety First !***

- ❏ Refrain from using a knife to strip wires – Use a wire stripper to protect fingers and to prevent nicks in wires.
- ❏ Safety glasses or goggles should be worn whenever power tools are used.
- ❏ Ensure that you are using proper gauge wire for the load.
- ❏ Replace wiring that shows signs of fraying or deterioration.



# ***Safety First !***

- ⚡ Never increase the size of a fuse or breaker in a circuit.
- ⚡ Use the proper protection, take precautions, and plan ahead.
- ⚡ Never by-pass safety to save money or to rush a project.



# Basic Tools

- Wire cutters
- Wire Strippers (covered later)
- Screwdrivers
  - ❖ 1/8 inch tip for terminal blocks
- Nut drivers (wrenches)
- Needle nose pliers
- Electric drill (for mounting holes)
- Other tools depending on the specifics of the enclosure used



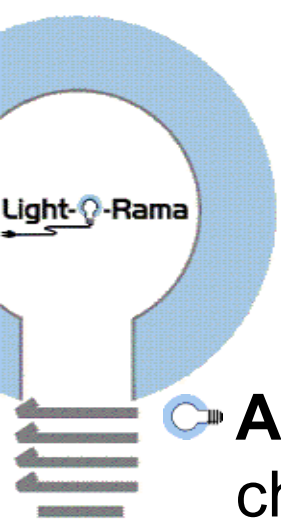
Wire Cutters



Nut drivers

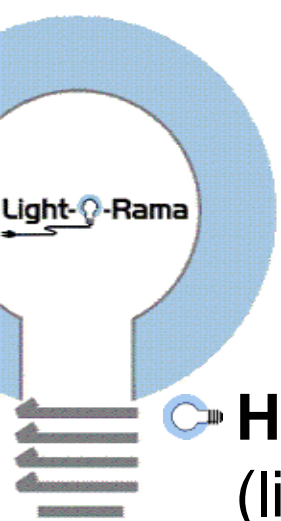


Needle Nose Pliers



# ***Basic Terminology***

- 💡 **Ampere** – a measure of the number of electrically charged particles that flow past a given point on a circuit in a given time.
- 💡 **Volt** - Measures the current pressure at receptacles and lights – Average household voltage is 120.
- 💡 **Watt** – The rate at which an electrical device (light bulb, appliance, etc.) consumes energy  $\text{Watts} = \text{volts} \times \text{amps}$ .
  - ❖ To convert watts to Amps:  $\text{Amps} = \text{watts} / \text{volts} \dots$ 
    - 💡 30 watt string of mini lights =  $30\text{watts} / 120\text{volts} = 0.25\text{amps}$ .




# ***Basic Terminology***

- **HOT** wire – The **HOT** wire delivers power to a device (like a light) and normally has **black** insulation – Cable with two **HOT** leads will have **red** and **black** leads.
- **Neutral** wire – Once the electricity has done it's work, it goes back to complete the circuit on the "**neutral**" wire, which is most often **white**.
- **Ground** wire - In addition to the neutral, the **green** (or bare copper) **ground** wire offers current another path should an electrical short happen.






# Basic Terminology

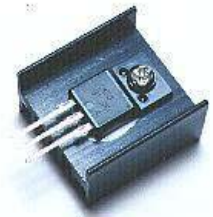
 **Terminal Block** – An insulating base with binding posts to make connections.




 **Standoff** – A metal or plastic spacer that is used when mounting a Printed Circuit Board (PCB).



 **Heatsink** – A piece of metal used to help cool electronic components.



 **Triac** – An electronic component that acts as a switch in an AC circuit (gets hot!).





# Basic Terminology

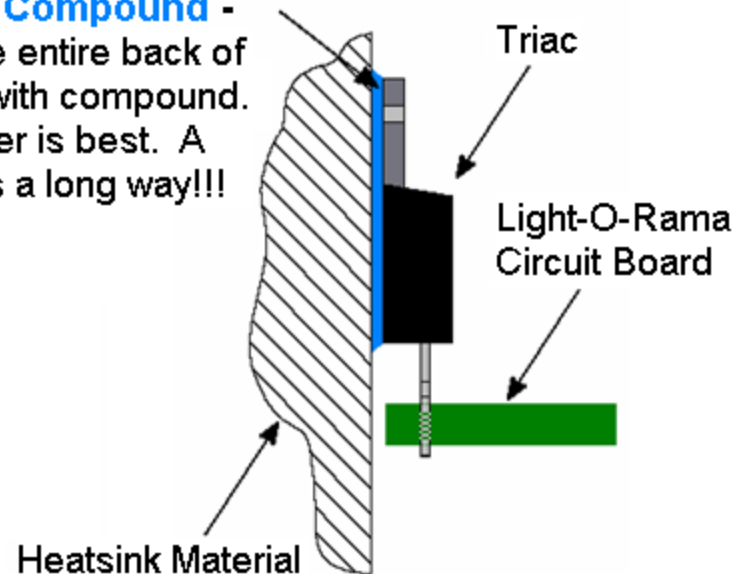
**Thermal Compound** – A paste used to help transfer heat to Heatsinks. Should always be used to install heatsinks. Is not a glue and will remain soft and messy forever.

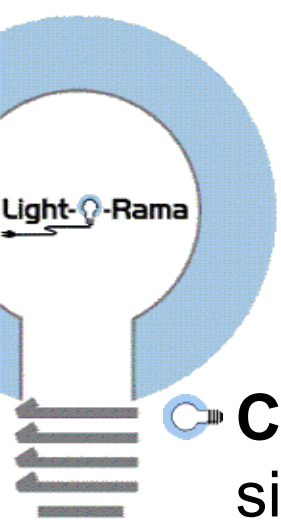
Thermal Compound comes in a variety of packages. 1 gram is enough to mount 8 triacs.



Sometimes called:  
Thermal Grease  
Heat Sink Grease  
Heat Sink Compound

**Thermal Compound** -  
Cover the entire back of the triac with compound. A thin layer is best. A little goes a long way!!!





# ***LOR Terminology***

- 🔌 **Communications** – The means of sending control signals to LOR controllers – LOR uses RS-485 (EIA-485) running on CAT-5 or Phone cable.
- 🔌 **Daisy Chain** -- How LOR controllers are connected in the network. One cable connects A to B .. another cable connect B to C .. another connect C to D .....
- 🔌 **Unit** – A Light-O-Rama light controller – This is what the lights are connected to (often called “Controller”).
- 🔌 **Unit ID** – Each LOR controller has a unique ID assigned to filter out its own commands.



# Enclosures

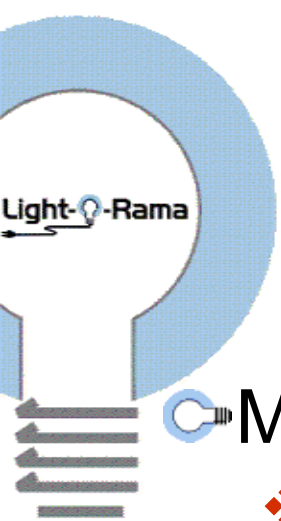
- ❏ LOR cards **MUST** be mounted in enclosures. There are exposed line voltage connectors that pose a serious shock threat if they are not properly enclosed.
- ❏ Enclosures protect the controller board from the environment and they protect you from the shock hazard of the card.
- ❏ Obviously if the enclosure is intended for outside use it must be water resistant – LESS obvious is that you should not attempt to make your enclosure completely air tight. Doing so can lead to condensation within the enclosure.
- ❏ Plastic and metal are customary materials used to construct enclosures. Both work well.



Standard Planet Christmas member's Computerized Light Control Enclosure



Well maybe these are a more typical representation of enclosures being used.



# Enclosures

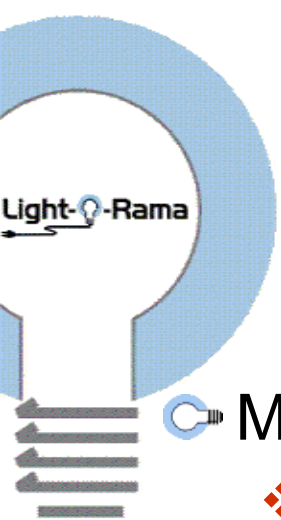
## Metal Enclosures

### ❖ Metal Enclosures **MUST** be grounded!

- 💡 Connect ground of supply wire directly to the enclosure.
- 💡 **Do not** use two conductor power supply wires.
- 💡 Heat sinks are insulated and can optionally be grounded.

### ❖ Connector Knockouts (be cautious)

- 💡 Metal enclosures use knockouts to make holes for connectors.
- 💡 **DO NOT** remove knockouts after mounting controller cards in the enclosure (Too easy to slip and damage the card).
- 💡 Prepare all connectors and additional mounting holes required for the enclosure prior to mounting the card.



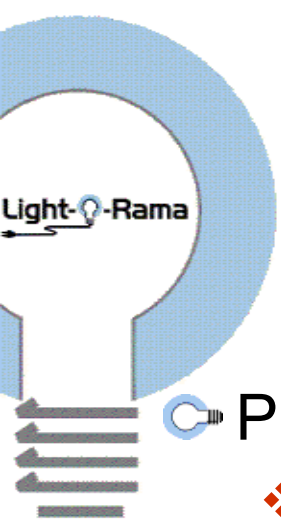
# Enclosures

## Metal Enclosures (cont'd)

### ❖ Mounting cards

- 💡 Cards **with** LOR heatsinks should be installed using the 4 holes in the heatsinks for mounting.
- 💡 Cards **without** LOR heatsinks should be installed using standoffs (minimum of 0.5 inches in length).
- 💡 If your enclosure has a back panel then mount the card to the back panel then install the back panel in the enclosure.
- 💡 If your enclosure does not have a back panel then mount the card to the back of the box.

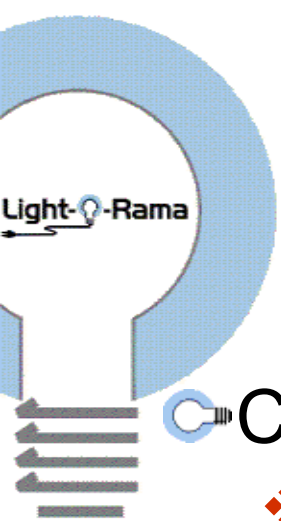
 Never mount the card directly to an enclosure without a LOR heatsink or standoffs installed.



# Enclosures

## Plastic Enclosures

- ❖ Cards **with** LOR heatsinks should be installed using the 4 holes in the heatsinks for mounting.
- ❖ Cards **without** LOR heatsinks should be installed using standoffs (minimum of 0.5 inches in length).
- ❖ If your enclosure has a back panel then mount the card to the back panel then install the back panel in the enclosure.
- ❖ If your enclosure does not have a back panel then mount the card to the back of the box. If there is a LOR heatsink installed, use short standoffs to keep the heatsink off the back of the box.



# **WIRE** *(What size to use?)*

Choose the correct **wire** for the job.

❖ The size of the supply wire should match the size fuse you install in the controller

- 💡 10 amp fuse – 16awg wire
- 💡 15 amp fuse – 14awg wire
- 💡 20 amp fuse – 12awg wire



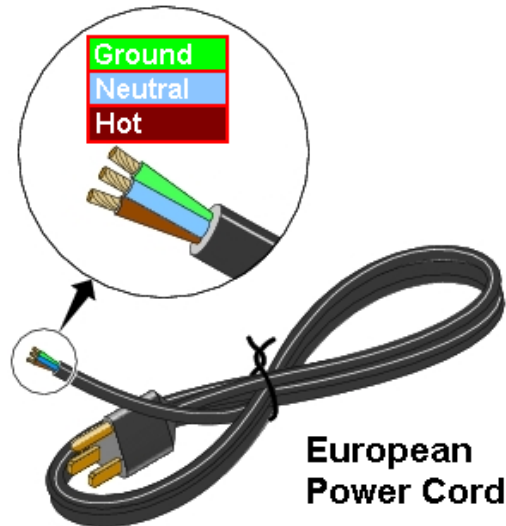
- ❖ The size of your output wire should be a minimum of 18awg – LOR Showtime products use 16awg.
- ❖ If you use a metal enclosure you must use a 3 wire supply and ground the enclosure.



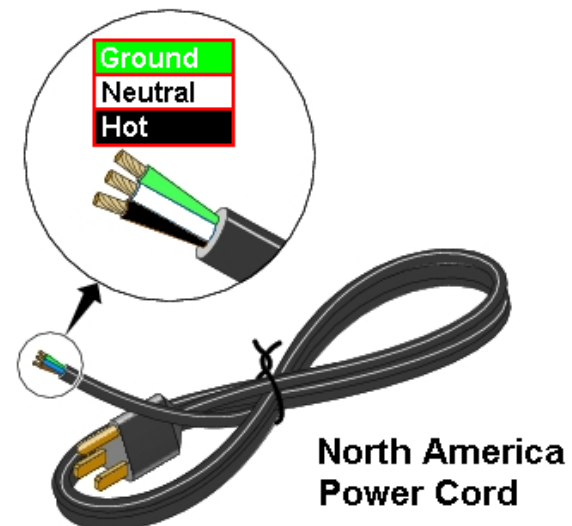


# **Wire (Determine Hot Neu Gnd)**

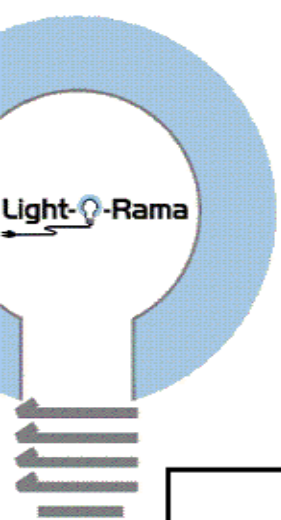
120 Volt	Ground	Hot	Neutral
<b>USA Wire</b>	Green	Black	White
<b>European Wire</b>	Green/White Green/Yellow	Brown	Blue
<b>US Plugs</b>	Round	Small Flat prong	Large Flat prong



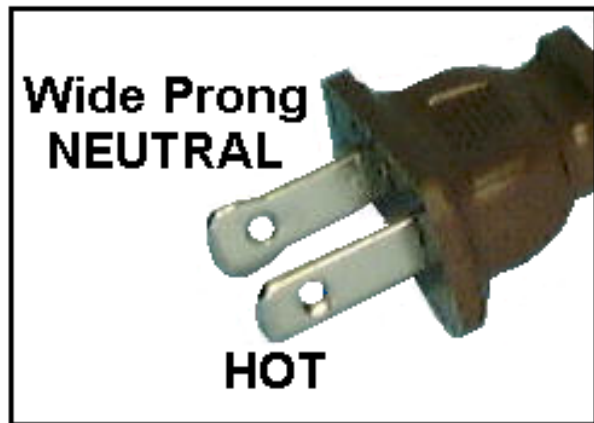
European  
Power Cord



North America  
Power Cord

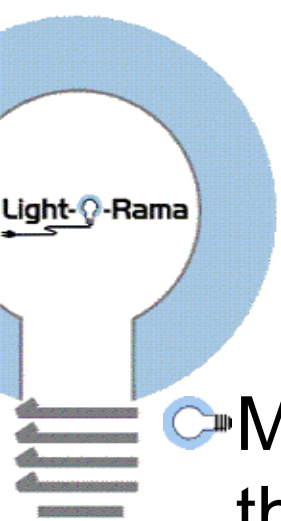


# **Wire** *(Determine Hot Neu Gnd)*



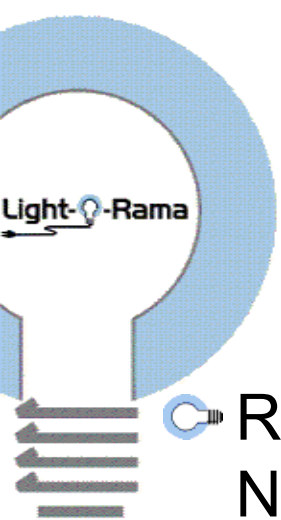
**LAMP / ZIP  
CORD  
POLARITY**





## ***Wire (Removing insulation)***

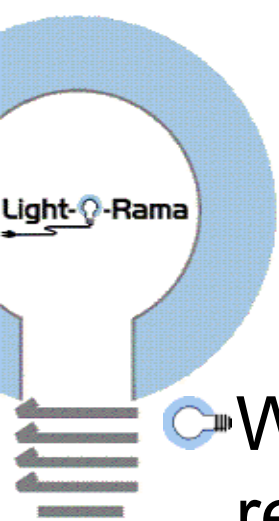
- Most LOR connectors have terminal blocks that will accept bare conductors without crimped terminals installed.
- Wires must be carefully stripped so the conductor is exposed the proper length.
- Usually stranded wire (as apposed to solid wire) is used when building LOR controllers. When stripping stranded wire take care not to cut away any of the strands.



## ***Wire (Removing insulation)***

- ❏ Refrain from use a knife to strip wire. Nicks in the wire can lead to wire failure, hot spots and fires.
- ❏ The yellow handled stripper/cutter is a good tool for both cutting and stripping wire.
- ❏ If you are going to strip lots of wires an automatic stripper such as the one with the red handle works great. Try to get one with a depth gauge.

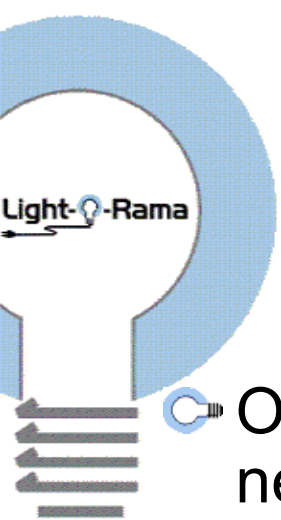




## ***Wire (Removing insulation)***

Wire should have  $\frac{1}{4}$  inch of insulation removed. Twist the wire tightly once stripped.





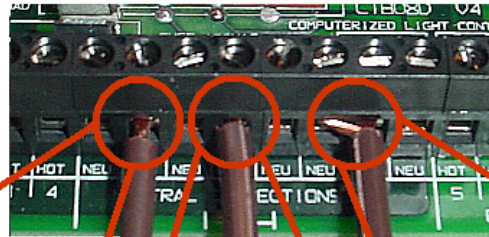
# Connecting Wires to the Terminal Block

- Once the wire has been stripped to the proper length it needs to be connected to the terminal block.
- The terminal block has a screw that holds the wire in place.
- The screw should be tightened very snugly to ensure that there is a good electrical and mechanical connection.
- Once you have completed making all connections go back and **RE-TIGHTEN** everything. (**later do it again!**)
- A loose connection can cause overheating and controller failure.

# Connecting Wires to the Terminal Block



Ensure wires are inserted completely into connectors and that the ends are not frayed.



Too much of the conductor exposed

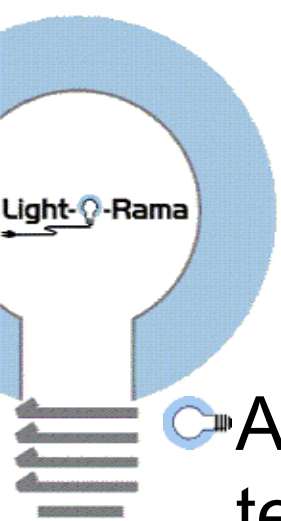


Looks good



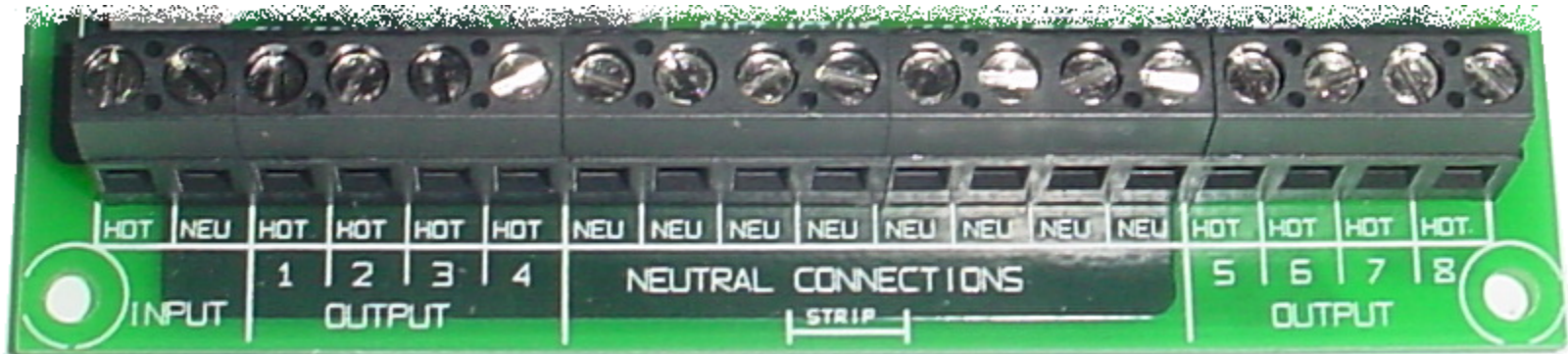
Frayed wire - some of the strands are not in the connector



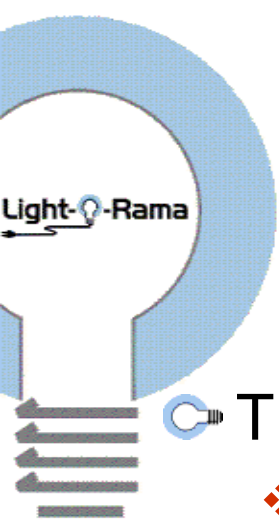


# Connecting Wires (General)

- A LOR controller's PCB has markings near the terminals detailing the required connections.
- Different controllers have different layouts – Below is a representative example.







# Connect Wires (Power In)

The power cord connects to the **INPUT** terminals.

- ❖ If you have a three wire power cord: The **GREEN** wire is not connected to the card. We will cover the ground wires later.



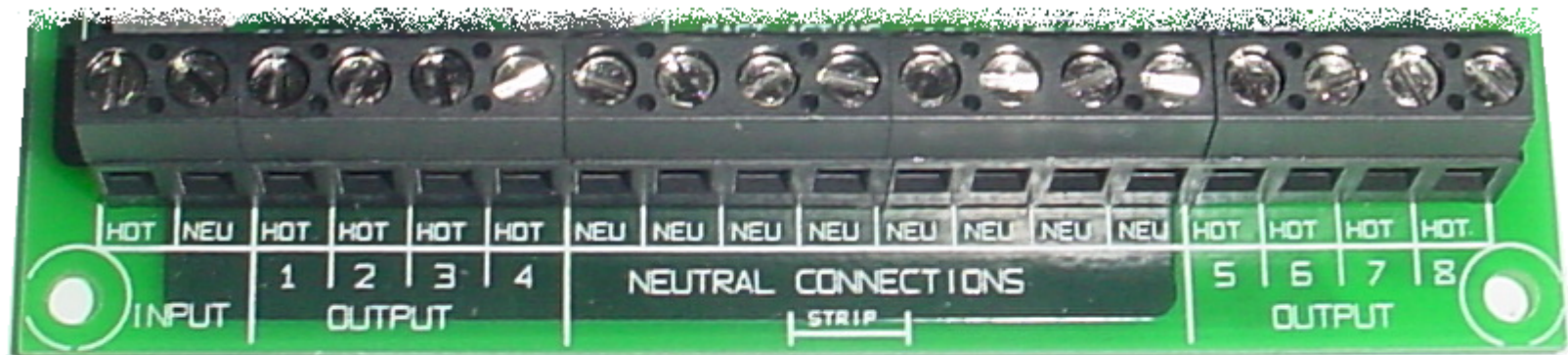
Connect the supply cord  
to the terminal marked  
**INPUT**

Make sure to connect  
the Hot and Neutral  
wires to correct terminal



# Connecting Wires (Power Out)

The receptacles that control the lights are connected to terminals marked **OUTPUT**.



Hot connection  
for circuit 1

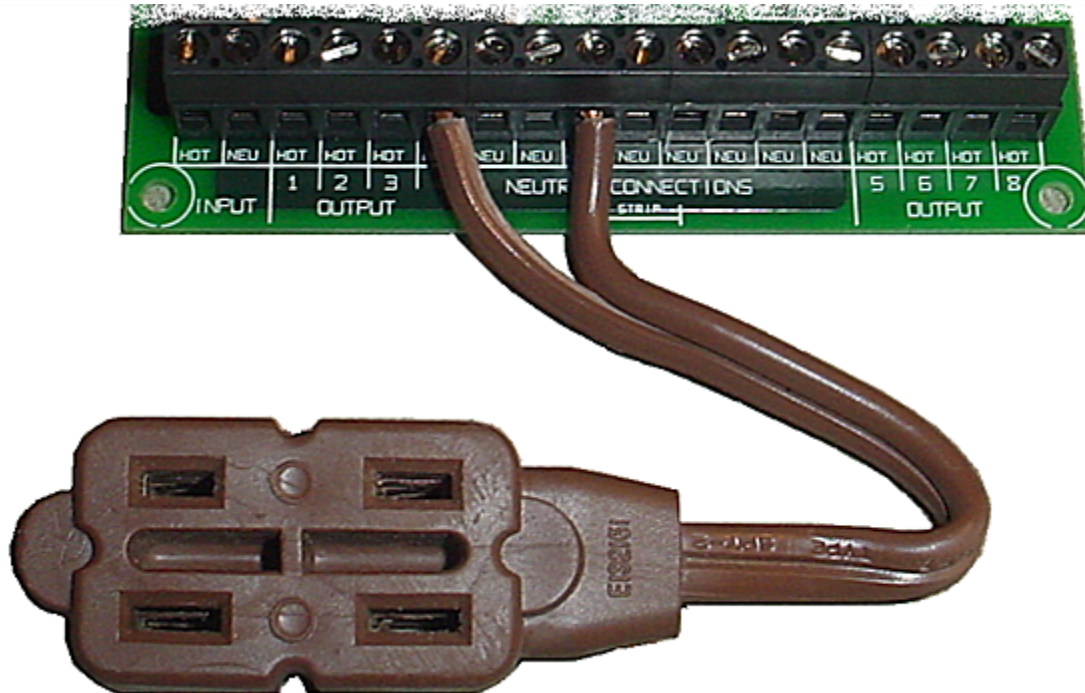
All neutrals are the  
same any circuit can  
be connected to any  
neutral

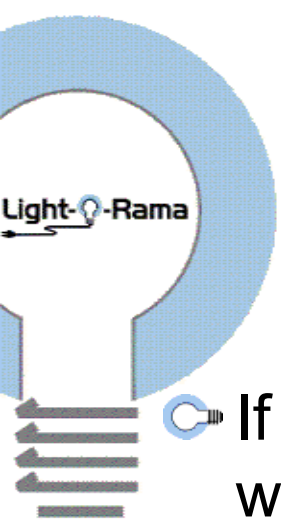
Hot connection  
for circuit 5



# Connecting Wires (Power Out)

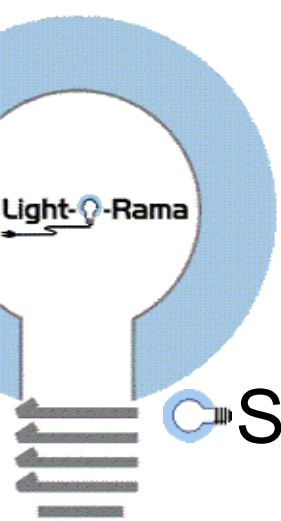
- Receptacle connected to **OUTPUT** circuit 4.
- ❖ It does not matter which NEU is used.










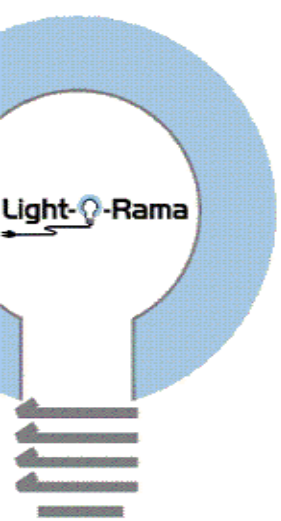
# Connecting Wires (The ground)

- If you use a metal enclosure you **must** have a three wire supply. Connect the green ground wire of the supply cord directly to the enclosure.
- If you have three wire receptacles you should connect the green wires from the receptacles to the green wire from the supply cord.
- Generally lights have a two prong plug and there is a temptation to skip the ground when three wire receptacles are used. However if your receptacle accepts a three prong plug it should be properly wired with a working ground.



# ***Classroom Workshop***

-  STEP 1 – Prepare wires ends.
-  STEP 2 – Connect Power Supply cable.
-  STEP 3 – Connect Power Receptacles.
-  STEP 4 – Double Check all connections.
-  STEP 5 – Test Units.



# ***The End***