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LED Spotlights

Introduction

In our 2005 haunt providing 120V AC power to the various lights and props requiring it became a fairly large problem. Extension cords and wire suitable for 120 volts is fairly expansive. Providing enough circuits to prevent overload was always a major concern. And, of course, there is always the danger associated with working with 120V AC.

We had a few LED lights operating quite successfully in 2005 and made the decision that for 2006 we would move, to the greatest extent possible, to all low voltage LED lighting. The plan is to use one large modified computer power supply (salvaged from a dead Compaq Proliant 4500 server) to power all the LED lights. 12V DC will be run to a central distribution point in each room of the haunt (fused and switched) and from there to the lights. But first we needed to figure out what to use for the various lights we need. Which include spotlights (white and colored), wide spread low ambient lights, simulated candle and torch flame and UV lighting.

We decided to tackle the LED spotlights first because it seemed the simplest and there is some information and how-tos for accomplishing this already available and even some commercially available items.

The criteria we set out for the lights was the following in the order of importance:

- Effective
- Simple to use
- Simple to construct
- Inexpensive
- Reasonable aesthetics

We first considered buying our spotlights from Black Owl Productions. They look good, are most likely quite effective (we never tried them) and seem reasonably easy to use. But in most cases the mounting bracket would need to be altered for our use (most of our spotlights are hanging from the bottom of overhead floor joists). Also at an average cost of $8.50 each they don't really meet the inexpensive criteria (we currently use about 12 spotlights in our haunt and graveyard so even if the current spotlights can be replaced with LED spotlights on a one to one basis - not really likely - the cost of these lights would be over $100 plus shipping). **This is not to disparage the efforts and products of Black Owl Productions at all. (we haven't even tried them)** I salute anyone who makes an effort to satisfy the needs of the small home haunt market. The spotlights just didn't appear to meet our needs. Besides by purchasing the lights we give up the fun of DIY.

Next we looked at the information and how-tos available online. Wolfstone provides a wealth of information on many subjects relating to home haunting including using LEDs. HalloweenWiki has some useful information. But the most relevant to our search is the excellent how-to provided by Ugly Joe on HalloweenForum.com.

We made a couple of lights following his directions and they worked great. The were certainly effective and simple to use. They looked great and were reasonably cheap per unit. Our only problem was that they were a bit involved to construct. Not overly difficult but we wanted to see if we could simplify it even further.

So after some experimentation, and giving up some aesthetics for simplicity, the following is what we came up with. We constructed 12 of these units in a few hours and calculated that the cost per unit was less than $2 each. If you would like to duplicate our take on LED spotlights we recommend you first read through the entire how-to guide and then follow the steps while building.

If you have any questions or comments feel free to email us at ledlights@cindybob.com. When we solve our other LED lighting needs we will add further how-to guides.

Tip: If you are making a number of lights, it is quicker to complete each step for all the units before moving to the next.

Materials & Tools

The **materials used** for the LED spotlights are minimal. The housing is constructed using **PVC end caps** found in the plumping section of any hardware store. We have used 3 different sizes depending on the number of LEDs used in the spotlight. For 3 LED spotlights we use a 1 1/2" cap, for 2 a 1 1/4" cap and for single LED spotlights a 1" cap. You will need one cap per light.

Figure 1. Materials

The LEDs for spotlights should be bright with a narrow viewing angle. Ours use Ultra Bright 5MM (T 1 3/4) Pure White LEDs for white spotlights and Mega Bright Pure Red LEDs for red spotlights. Both from Performance-PCs (see the Links section for more LED sources). The number of LEDs needed will obviously depend on the types of spotlights being made. Three for each 3 array light, two for each 2 array light and one for each single LED light.

LEDs are current sensitive so in most cases you will need a **resistor** in the circuit of each spotlight. The size of the resistor needed is a function of the supply voltage, the number of LEDs used and the characteristics of the LEDs (forward voltage and forward current). Our supply voltage is 12V, the forward voltage of our white LEDs is 3.3V and the forward current is 20mA. Using the LED resistor calculator very kindly provided by the LED center we determined that we would need a 120 ohm resistor for each 3 LED array, a 270 ohm for each 2 array and a 470 ohm resistor for single LED lights. Determining the proper **resistance value is very important** to get the most light from your spotlight and to prevent burning out the LEDs so double check your calculations before you begin.

The **mounting brackets** for the spotlights are made from 1/2"x1/16" rectangular aluminum bar available at most hardware and home improvement stores. You will need 4 1/2 inches of bar and one #8 3/8" wood or sheet metal self tapping screw (for fastening the bracket to the housing) for each light.

Figure 2. Tools

Other materials needed include duct tape, paint (Krylon Fusion paints work well on PVC) and hookup wire (small gauge speaker wire or twisted pair wire is ideal).

The **tools required** include a soldering iron and solder, wire cutters, ruler, heavy pliers and/or a vise (for bending the brackets), metal shears or a hack saw (for cutting the brackets), a screw driver, a drill and bits (13/64, 3/8, 1/8).

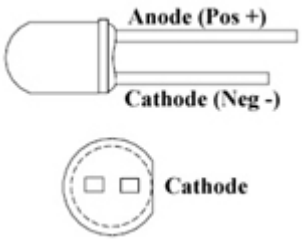
Table 1. Materials List

PVC End Caps
LEDs
Resistors
1/2"x1/16" Rectangular Aluminum Bar
Hookup Wire
Spray Paint
Glue

LED Wiring

It is **very important** to know that LEDs are polarized, they have a negative (cathode) and a positive (anode) lead, and if connected backwards they will not work. The first step in connecting the LEDs is to become familiar with the ways of determining a LED's polarity.

Figure 1. LED Polarity



For new LEDs the easiest way to determine polarity is to look at the leads. The anode (positive lead) is almost always longer than the cathode (negative lead). If you are using recovered LEDs, or the lead length is not clear, look for a flat spot on the edge of the LED case, the lead next to this flat spot is the cathode (see Figure 1).

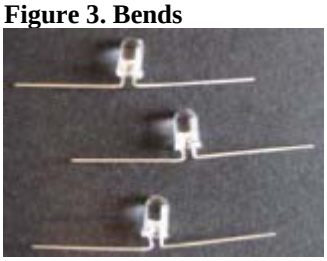
Figure 2. LED Tester

If you are still having trouble determining the polarity rig up a test circuit with a 1K resistor and a 9V battery (see Figure 2). If the LED doesn't light, reverse the polarity on the diode or battery. If it still doesn't light, it's likely a dud.

Tip: For each LED you will be using first determine the polarity and mark the anode (positive lead) with a red marker. This will help avoid reversing the polarity when connecting the LEDs together.

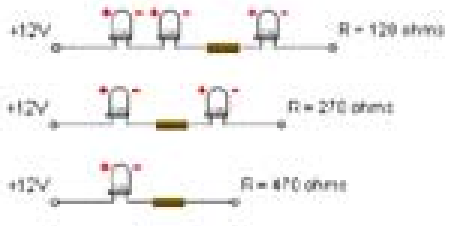
Once you are sure you can determine the polarity of your LEDs you can begin to connect them together into circuits needed for each spotlight.

Figure 3. Bends



Begin by first **carefully** bending the leads down as close to the LED case as possible (see Figure 3). A pair of small needle nose pliers comes in handy for this.

Figure 4. LED Wiring

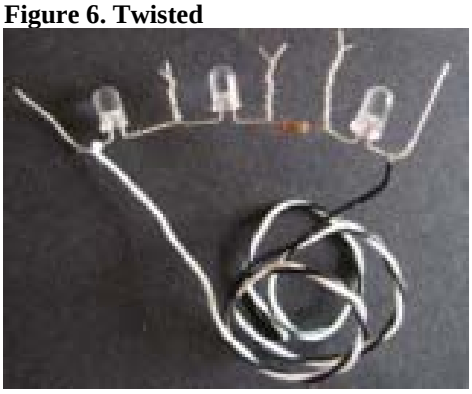


When connecting multiple LEDs in a series (such as the 3 and 2 LED spotlights) the LEDs are always connected cathode (negative) to anode (positive). The placement of the resistor in the circuit is not critical so for convenience we have placed our resistors in 2 and 3 LED circuits between the LEDs rather than on one end. Have a look at Figure 4 before proceeding further (note that your resistor values may differ).

Figure 5. Twist

For 3 LED lights take two LEDs and twist the negative lead of one to the positive lead of the other. You will want to leave about a 1" space between the LEDs (a little extra space is better than not enough) (see Figure 5).

Figure 6. Twisted

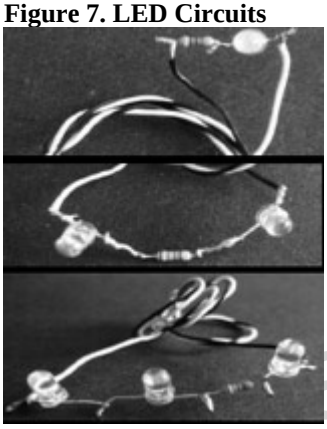


Now take the appropriate resistor and twist it together with the remaining negative lead of the 2 LEDs. Next twist the positive lead of the third LED to the remaining lead of the resistor. Finally twist the hook up wire to each of the remaining leads. When completed your circuit should resemble Figure 6.

For 2 LED lights twist the resistor between the negative and positive leads of the two LEDs (being sure to leave enough space). For single LEDs twist the resistor to the negative side of the LED.

Tip: Use different colors of hookup wire (or clearly marked speaker wire) for the positive and negative sides of each spotlight. This will later make installation much easier.

Figure 7. LED Circuits



Once you have the circuit complete test it (using the voltage that it will be run at)to be sure that the wiring is correct and you have no dud LEDs.

The final step in wiring the LEDs is to solder each twisted joint together and trim the excess wire (being sure to leave enough for a solid joint). See Figure 7 for a picture of a completed 3, 2 and 1 LED circuit.

Brackets & Housings

The majority of our spotlights will be mounted hanging from wood floor joists so our mounting bracket was designed with this in mind. However the same bracket could be used to mount the spotlight to a small wood block for free standing use. For in-ground mounting (graveyards, etc.) a longer section of metal bar will be used with a point rather then a bend. For other mounts the bracket design may need to be modified.

Figure 1. Bracket Sections

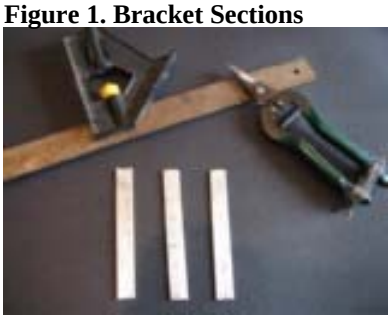


Figure 2. Bracket Holes

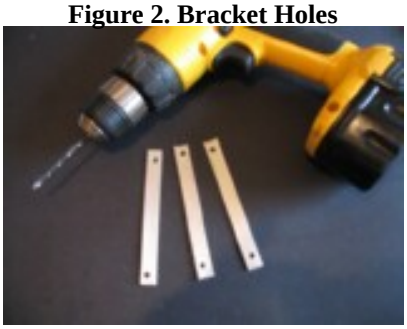
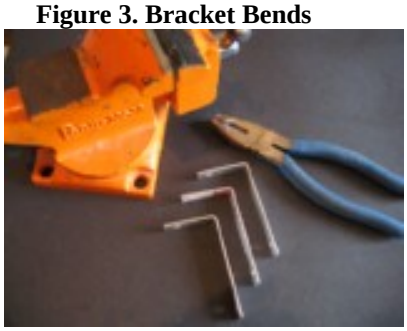


Figure 3. Bracket Bends



To make the **mounting brackets** first measure 4 1/2" sections on the 1/2"x1/16" rectangular aluminum bar (one for each light) and cut (see Figure 1).

Next drill a 3/8" hole 1/4" from each end of each section (see Figure 2). **Caution:** You may want to clamp the bar material down before drilling to prevent it from spinning around.

Finally, measure 1 1/2" from one end of each section and make a 90 bend (see Figure 3).

Figure 4. Led Housings

Figure 5. Drilling Templates

The **spotlight housings** are made by drilling one 13/64" hole in the top of the PVC end cap for each LED used in the spotlights.

For multiple led lights the holes should be drilled 1" apart. We have arranged our 3 LED lights in a triangle pattern, the 2 LED lights straight across and single LEDs in the center (see Figure 4).

On the side of each housing, in approximately the middle, drill a 1/9" hole. This will be used for fastening the bracket to the housing.

Tip: When making a number of spotlights, drilling the LED mounting holes can be greatly sped up by first making a drilling template out of thin scrap wood (see Figure 5). You can download a Word document version of our templates

Assembly

Figure 1. LED Placement

Assemble the spotlights by first placing the LEDs into the holes drilled into the top of the PVC end cap. Carefully press the leads as flush as possible.(see Figure 1)

Figure 2. Tape

Figure 3. Paint

Figure 4. Painting Tip

Next cut a piece of duct tape slightly smaller then the top of the cap. Press the tape solidly over the leads and LEDs (see Figure 2). The tape serves three purposes. It holds the LEDs in place, it prevents light from leaking from the back of the spotlight and it covers any sharp edges left from trimming the wires.

Paint the outside of the housings, the brackets and the bracket screws (Figure 3). **Tip:** Place the end cap over a corresponding size piece of PVC pipe before painting. This will

mask the inside of the light and give you a handle and stand to make painting easier (see Figure 4).

Finally, screw the bracket to the housing using the pre drilled hole and bracket screw. To make it possible to mount the spotlights without having to remove the brackets from the housing the bracket bend should face away from the light (see Figure 5). Loop and tie the wire around the bracket so that bracket will take any strain rather than the LED circuit.

Figure 5. Fianl Assembly

You should now have a number of LED spotlights ready for use.

Powering and Mounting

One of the most useful things about using LED lighting is that **powering** them is relatively easy. They aren't voltage specific, don't require a particularly well regulated supply and draw very little current.

Figure 1. Power Supply

Pretty much any DC power supply will work for powering the spotlights (even batteries) provided you don't exceed the maximum current capabilities of the supply. Our spotlights will draw only about .02 amps each so even using the home built power supply detailed in our circuits section we would be able to power +50 spotlights with current to spare.

Our plan is to use a single power supply to power all the low voltage lighting in the haunt. From a central location 12V lines will be run to each a distribution point in each room of the haunt. The power supply we will be using is a converted computer power supply capable of delivering up to 12A at 12V (see Figure 1) so should be more than powerful enough for our needs. Instructions for converting a PC power supply to a desktop supply are available here and here.

Figure 4.

Figure 3.

In our case **mounting the spotlights** will be as simple as using a wood screw and a power drill to hang the light from an over wood floor joist (see Figure 2). In some cases we will need stand alone lights so the brackets will be fastened to a small square of wood (see Figure 3) and, for the outside graveyard, the short bend bracket will be swapped for a longer one that comes to a point for pressing into the ground (see Figure 4).

Figure 5. Focusing

Adjusting the aim of the lights is done by loosening the bracket screws and moving the light left or right and up and down until the desired aim is reached and then retightening the screws. The focus of the light (beam spread) can be adjusted by fitting small lengths of PVC pipe into the end caps. The longer the length the more focused the light (see Figure 5).