LED 101 and Other Lessons Learned While Working on Model Railroad Engineer – Electrical.

A clinic presented by ***Glenn Edmison***, Bend, OR PNR Division 1

Good afternoon. I am Glenn Edmison. I model in N-Scale. My ***Oregon Short Line Railroad*** is a 5' X 9' layout suspended from my garage ceiling. It has been a fifteen year long spare time project. Included in your handout is a picture of that layout.,

When originally conceived I was only interested in getting trains to run and had never even heard of NMRA or it's achievement program. I would have had a better initial system if I had.read through those requirements. I depended a lot on publications available, and selected a plan from ***Kalmbach's 101 Model Railroads.*** At least this helped me understand types such as point-to-point, loop-to-loop, switching, walk-around, etc. As it was, I eventually did read the requirements and, encouraged by what I had done that did meet requirements, I decided to make the necessary additions and changes. The things I learned and the changes made, while challenging, gave me a much more satisfactory layout.

You need to know that the OSL is DC powered. This, in itself, was a challenge for me as I had little experience or training with electricity. I had taken one single short course, and that, thirty years before. Luckily, DC is pretty straight forward and logical and I found the circuitry understandable as long as I remembered polarity.

I did start with a plan. That is important. With a plan, I was able to locate bower blocks, identify switches, etc. In effect, I could control my railroad. I need to share a short story with you.

(Ad lib the history of the OSL and pending retirement plans)

When finally settled after retirement, I was ready to start again. I decided that I wanted to run two trains. To me that meant that I needed two mainline tracks. The original 4- X 8' layout did not seem to allow for this, so I thought I might expand it to make more room. What, I wondered. could do it it was were enlarged to 5' X 9' ? I am a visual thinker, so drawing plans of he variations was important so I could make comparisons. I idcovered that this made enough extra room for the double main, and expanded yard, and left room for the small town I wanted to include beyond the building or two that was suggeded in the original plan. People were required to make he railroad come alive, to give it a reason bor being. I could now accommodate that. Now that the plan was developed I was off and running.

There are a number of things I learned, and I will share as many of those with you as time permits, but I want to focus expecially on the use of LEDs for lighting various items on my layout. Let's look first at some general facts about LEDs.

Why Switch to LEDs ?

There are many reasons to swithch to LEDs rather than incandescent lighting.

* Leds do not get hot like and incandescent, so yoou will not melt the roof off you building or the housing of your train, water tower, or othe related models.
* LEDs last and last !! Over 10 year (100,ooo hours) per light. So you will not have to take apart your building, locomotiece passenger car, model, or diorama to change out the lighting when it burns out!. a standard incandescent bulb will last about 750 hours or so
* LEDs give a lot of light in a very small package. Some bright LEDs give up to 5000 milicandles of light, about 1.45 lumens. Some colors, like white have 15,000 mccl. Compare that to a GE 14 volt midget bulb which gives about 3 lumens (mscp) Che the rightness information fefore you by any LED. There is a hugh variation of brightnesses sold today. Be wary of ny vendor who does not publishe brightness numbers right out front.
* LEDs are tough and durable. There is no filament to break, and the diode is encased in solid epoxy. You can use pliers to install these lights, if you need to.

What are 5mm, 3mm, and 1.8 mm LED Lights? Sizes, Colors and Types?

The size of the light is measured across the base of the bulb. The size measurement refers to the diameter of the bulb. 5 mm (T 1-3/4) is a super sized light for building lighting, passenger cars lights, or larger scale running lights. 3 mm (T-1) lights are smaller, and better suited to street lighting, warning lights and train running lights in smaller scales. There is little difference in brightness of the 5 and 3 mm sizes. 1.8 mm LEDs are reall very small and mos useful in N-Scale and other smaller models where there is not much space to fit a bulb.

itage questions? See: AC or DC?

Assembled LEDs for all of your Model Lighting Needs

What does one need to do in order to connect LEDs to power?

If you are planning to run your LEDs on a 9V DC or 12V DC batery, or a 12v DC wall adaptor, then you will want to get some small resistors and some connector wire. Most people know how to hook an LED to DC power; just trim the two leads on the LED and solder a resstor and some connector wire to the LED leads. Depending on the voltage you plan to apply, and depending on the color of the LED, a 470 ohm or 560 ohm resistor will work fine. Use a calculator you can find on the internet, Be wary of vendors who give away 100 ohm resistors with their LEDs. These will not likely protect the LED from burnout.

The resistor is typically put on the positive or “hot” lead. You can tell the positive lead on an

LED because the leg on that side is longer. Also, looking at the diode, the positive half of the diode is smaller than the negative. Note that the leads are rather close together, and it is well to separate them with some shrink tubing on at least one leg, to avoid shorting. Shrink tubing also will help hold the solder joint together.

Use Shrink Tubing

A few things to keep in mind when soldering LEDs.

* Do not solder too close to the bulb; the recommended distance away is at least a few millimeters. .
* Do not let you solder gun temperature get over 240 degrees Celsius. Check what temperature your soldering gun or irn get up too since LEDs are heat sensitive. One could protect the bulb by clamping a heat sink between the joint and the bulb.
* LEDs are also sensitve to static electricity (before the resistor is added), so try not to give them "a shock" when you are handling them. Solder in a humid room if ossible, or wear a static wrist guard, and don't drag your feet across nylon carpet.

If you are running your LEDs directly on your railroad track, as in the locomotive or passenger car, or if you plan to hook them to the accessor outlet on you train's AC, DCC or DC power pack, then you will need to do more to protect your LED. Even DC trains tend to switch polarity (whenever you back up) and the lights are also subjected to voltage "spikes" and surges and the occasional interruption and re-start when the track is not perfectly clean. To protuect the lights from all of this, you will need to add a full wave bridge rectifier in addition to the previously mentioned voltage dropping resistor. So even if you have a DC train, and you only plan to run your train at 12 volts or less, like the N-Scale Kato power supplies, it is recommended that you use bridge rectified LEDs. You could use a single rectifier diode like 1N914, to block the reverse polarity, but there are two problems with this approach:

* The LED will only be half as bright because it is only on half of the time. This did not sound right to me, but it appears to be tru. I have tested it with a light meter.
* The LED will flicker slightly because it is goin on an off rapidly. You may not see this flicker easily, or you may be used to flicke from looking at your TV, but when the LED moves, as in a loco or passenger car, you will see flickering.

If you are going to run one of the new integrated circuit Flashing LEDs on AC or DCC power, there is another step to take as well. I am advised that the IC Flashing LEDs wrk better with a

small (1 pico farad) capacitor in addition to the full bridge rectifier in order to flash reliably with AC or DCC.

Another thing to check on when ou are looking at buying flashing LEDs is the rlash ratio. For older diecast models and for model trains, radiotowers, water towerw, warnking signs, etc., a nive relatively "slow" flash rate is 1.5 Hz or one and one half flashes per second. A lot of the LEDs produced today have a faster rate and become increasingly too fast for most applications

Normal – Yelo Glo White - Blinking - Surface Mount - etc.

LEDs come in a great variety of sizes and types. Some sellers package the necessary resistors with the LEDs. Example: 270 or 540 Ohm with yelo glo.

Can LEDs work outdoors?

Yes! Leds are commonly used around license plates and in flashlights.

Can I Wire these into my rolling stock?

Yes. Refer to the diagram that came with your locomotive to check where to attach the leads for your particular loco. To light a passenger car, you will need to run the wire down to the track throght the "Truck". In general the red wire goes to the positive lead of the LED and black to the negative. You will need some kind of polarity protection if you are using track power, as it is reversible. Check the internet and magazine issues for articles on how to proceed with installation.

Does Reverse Polarity Damage LEDs?

Yes it does. Not immediately, but over time, reverse polarity will burn out an LED. This is the case when you run an LED without a single diode rectifier or a full wave bridge rectifier on AC or DCC current. Both AC and DCC switch polarity from + to - and back again many times per second. The LED will run fine under the condition for up to 12 hours, but after time it will dim and burn out if you do not have a rectifier. These act as one-way valves to only let the + polarity through to the LED. In reversing circuits diodes are used in pairs, in reverse polarity, so the wrong one is blocked.

How Many LEDs Can I Wire in Parallel?

Most LEDs draw less than 20 milliamps of power. So check your power source. If you have a small wall plug power source with 500 milliamps of power you can run (500/20) or 20 LEDs in parallel.

Assuming that your source is 12v DC, you can connect four white LEDs **in series**. BE SURE TO ADD A SMALL RESISTOR, like 220 to 820 ohms, in series. This assumes WHITE LEDs. For colored LEDs, the voltage drop will be less and the resitor will need to be larger.

Note that one function of the resistor, besides saving the LED's life, is to keep you in control of the current and therefore light intensity. It is recommended that you always keep at least 100 ohms in the circuit that includes a 12 v. source and four white LEDs. A common rule of thumb is that the current limiting resistor for a single LED should be between 470 and 4700 ohms.

Jim Hinds of Richmond Controls has a thorough explanation on line, through the company web page.

Can I Mix Colors, Sizes, Flashing and Solid in the same circuit?

Yes. A little experimentation will show you that this will work. Use your breadboard to save soldering.

Some Ideas: See handout.

Summary

We have talked about why to choose LEDs for a variety of purposes, primarily with lighting structures.

We looked at some precautions and procedures.

I hope I have convinced you, or at least, given you some ideas about using LEDs on your layout or your various locomotives and rolling stock.

Thanks for listening.