Model Railroad Hobbyist magazine™

Price:
Forever Free
eREADER Edition

February 2012

HAVING FUN WITH TRAINS

Don Spiro's
Realistic Winter Trees

- Installing DCC decoders
- What happened to Mount Allen?
- Light up an HO brakeman's lantern!
- 22 stories up – photo backdrop
- An out-of-service train order signal

and lots *more, inside* ...

Table of contents

Main Features

Other Features

Columns

Points of Light

Using micro LEDs in your layout

– by Dr. Geoff Bunza
Model photos by the author

Reader Feedback (click here)

If you could light up the head of a pin, what would you do with it? Answer: light a model railroad, of course! In this article we'll look into new surface mounted device (SMD) light emitting diodes (LEDs), how to work with them, light them up, and put them into some interesting places.

Opportunities exist for lighting the "unlightable": desk lamps, hand kerosene lamps, headlights, marker lamps, number boards, ditch lights, vending machines, vehicle turn signals, etc.

LEDs come in many different packages, but the ones I'll talk about are a fraction of an inch on a side, the smallest being .04" by .01" – these are sometimes called 0401 LEDs. Other sizes and designations include 0402, 0603, 1206, 3528, PLCC, etc. (figure 2).

LEDs are current sensitive or current oriented devices, not power oriented like incandescent bulbs. This means the light emitted by them is proportional to the current going through them, not the voltage across them. When using different LEDs, it is very important to supply them with the proper current. When in use, we often find the voltage across them to be different, sometimes even with the same family and type of LED, operating at the same current. Later, I'll show you how to avoid these problems!

Tools

I've discovered many things since starting to use these tiny LEDs (sometimes called nano-LEDs or Micro-LEDs). Among the first lessons I learned was that handling these successfully required new approaches and some slightly different tools (figure 3).

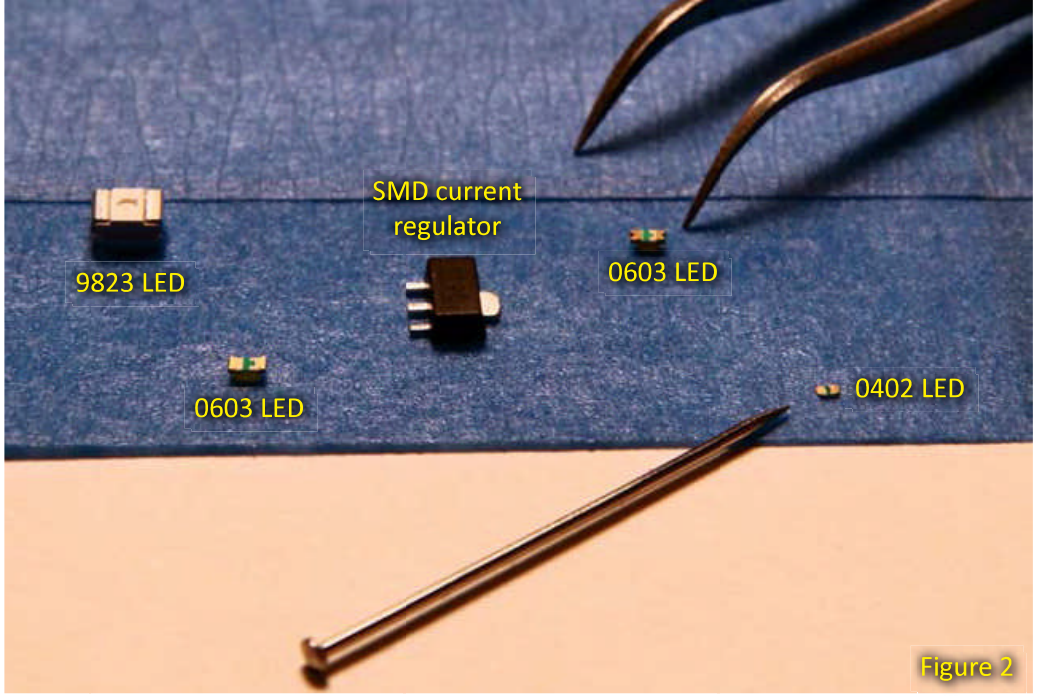


Figure 2: Different LED types. Note the wide range of sizes going down to roughly that of a pin point.

Figure 3: Tools used to work with tiny LEDs.

Figure 4: LEDs affixed to blue painter's tape.

The most important thing to remember when working with these "points of light" is to secure everything so that there is only one motion for each operation. That is, if you solder a wire to a LED, hold it and the wire in place before you move the soldering iron to make the joint. Likewise, when you glue a LED in place, hold everything tight before applying the glue, or move only the LED, having already applied the adhesive.

Which brings us to the first and most important tool: masking tape! I put down a 4" strip of Scotch blue masking tape with the adhesive side up and hold it down on a flat work surface, stretched at both ends with two short pieces of tape. This will save you from searching for more expensive two-sided tape with the right holding properties. You may wind up using this method for holding all sorts of parts (figure 4).

Since these LEDs are so small, you should put away your 200 watt soldering gun and find a soldering iron with somewhere between 12 and 40 watts of power. If it's at the high end of this range, it would be better if it were temperature controlled. I find that leaded solder works better than the newer lead-free solder, but you will need some small diameter solder. I prefer separately applied, liquid rosin flux. Soldering with rosin core solder will work, too. Do not use acid core solder for this application.

Because most of the LEDs I use are 0401 and 0402 size – the smallest – and my fingers are way too big to manipulate them, tweezers are a must. Different tweezers work wonders in different places. Flat ended and needle ended tweezers were never in my toolbox before, but they are now! A tiny "Ultrabrush" applicator is great for applying liquid rosin – it's the white brush in figure 5. It's cheap so when it deteriorates too much, just toss it.

Any type of pointy tool – straight pins, toothpicks, scribers, awls, coffee stirrers, and paper clips can be used to manipulate the LEDs. I added magnifiers

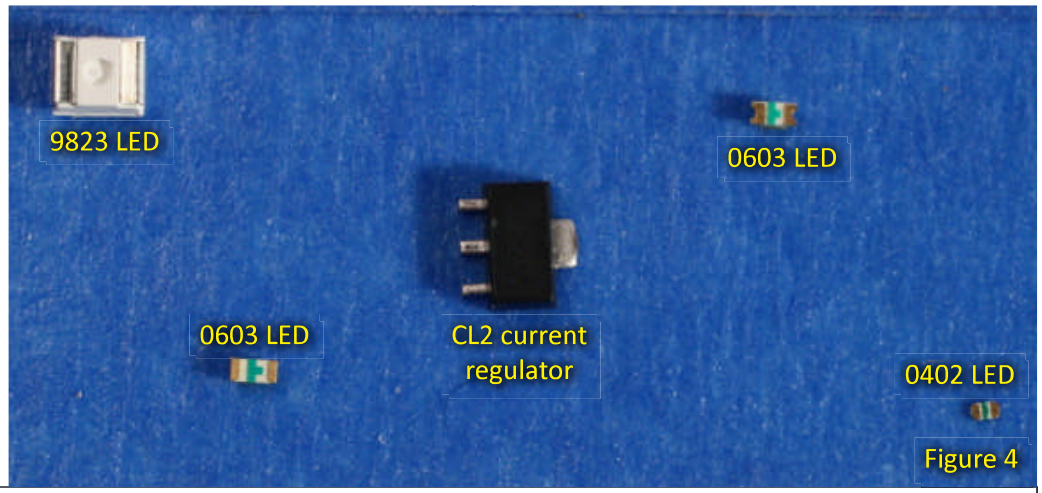


Figure 5

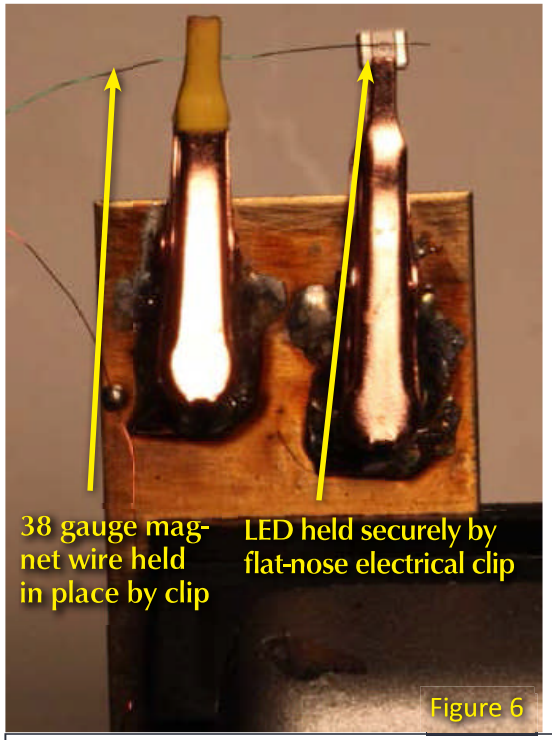


Figure 6

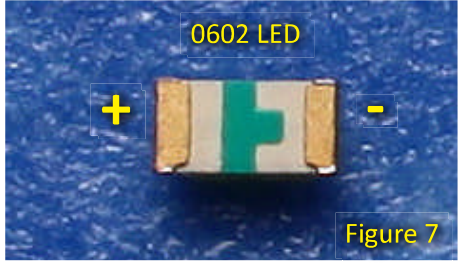


Figure 7

Figure 5: Bottle of appropriate liquid flux and some tiny applicators.

Figure 6: Homemade tool to hold LED and wires for soldering.

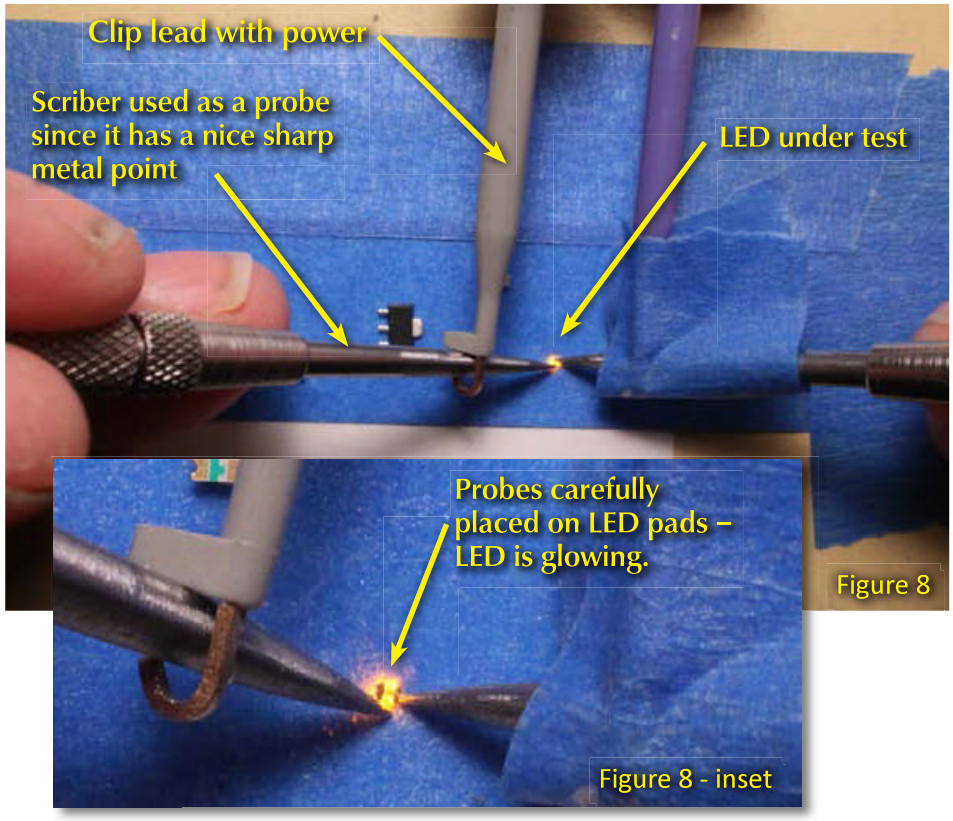
Figure 7: Bottom of a 0602 LED showing its polarity marking "T".

Figure 8: LED test probes improvised using scribers and spring loaded clip leads with hooked ends.

and extra lighting to my workbench too. They help a lot.

You can make an interesting "tool" for simultaneously holding the thin wires and LEDs in place (figure 6). This is made by soldering two flat-nose electrical clips (Radio Shack stock number 270-373) to a small piece of sheet brass (or other flat metal). Note that the clips stick out from one side and the left clip protrudes from the end about 1/8" more.

The left clip's jaws are covered with heat shrink tubing to protect the fine wire that they will hold. Place the tool in a clamp, and hold the tinned end of a very thin piece of wire (I use 38 gauge magnet wire) against the SMD LED held by the right clip, so it can be tack soldered to the LED. Remember, minimize the independent movements required in performing every step with the LEDs. A similar tool can be purchased from ngineering.com/other_cool_tools.htm#LEDholder



LEDs

The first problem, once you get one of these LEDs out of their package, is identifying which side is which! Most, but not all, of the ones I use have a green "T" on their underside. if you can find it and then see it, the head of the "T" marks the positive side of the LED. The narrow bottom marks the negative terminal (figure 7).

While trying to identify the contacts, I have "launched" more of these tiny devices than I care to think about into the farthest reaches of my workroom. So, I started simply putting them face down on the blue tape on my workbench, clipped two test leads to a scriber or pin (figure 8), then quickly touched the pins to the LED in each direction to check polarity. A current-limited low voltage source like a laboratory power supply set at 2.5V and 10ma is good for this, but I've also used a 9-volt battery with a 2000 ohm resistor just as effectively. There are many warnings not to reverse bias a LED (apply a negative voltage to the positive terminal) but I've yet to harm any LEDs with this technique. Most LEDs can take a reverse voltage for a

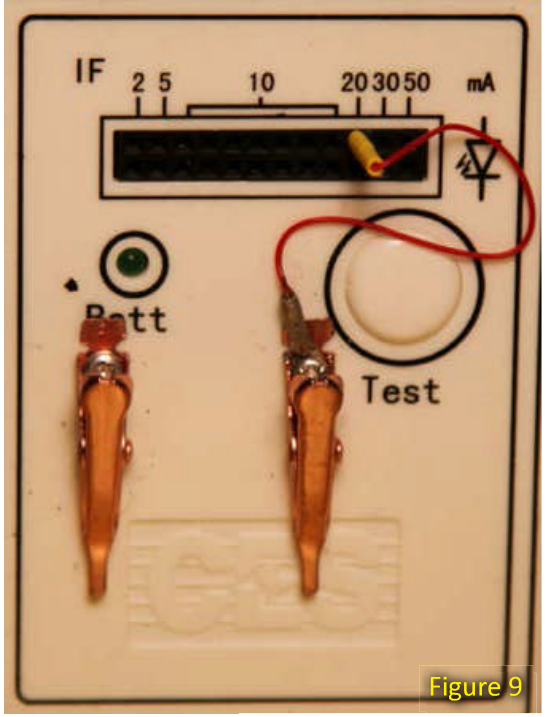


Figure 9

short period (a tap) as long as it's in the same range as the forward voltage that would be applied.

Small, low cost LED testers are also available. Most are just a 9 volt battery switched in series with one or more resistors to vary the current to the LED under test. Several places sell them, including: www.surplusgizmos.com/LED-Tester_p_1803.html. I added the clips (in figure 9) to hold the tiny magnet wire leads. The left clip is internally connected to the lower (ground) sockets.

Figure 9: A commercial LED tester with clip leads added by the author.

Figure 10: Dipping the end of a piece of 38-gauge magnet wire briefly into a ball of solder (on the tip of a small soldering iron) will strip off SODERON insulation and tin the end of the wire.

Figure 11: The tinned wire end.


Figure 10

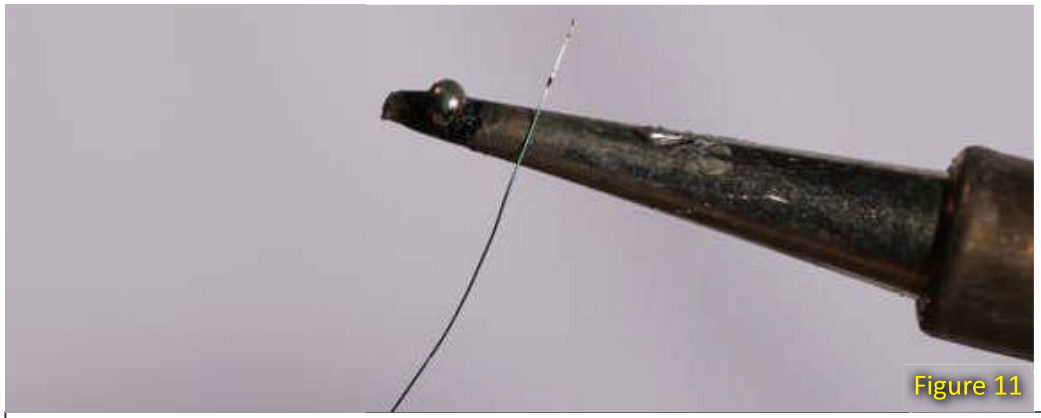


Figure 11

Wire

The intent of using these tiny LEDs is to tuck a light source into impossibly small cavities in a model. In order to do this well, the two wires powering the tiny LED must also be tiny. I use 38 gauge magnet wire, a very thin copper wire with an even thinner coating of insulation. This type of wire is sold in many diameters with at least three different kinds of coated insulation. Try to find wire with a SODERON® coating by the Essex Group or equivalent.

The coatings are available in a few colors. Try to get two different colors so the LED leads can be color coded. Red on the positive terminal and green on the negative terminal saves me a lot of time when hooking up the LEDs.

If you melt a bit of solder on the tip of your iron, and stick the end of a length of wire about 1/16" into the blob for a fraction of a second (figure 10), the insulation burns off and leaves the wire end tinned (figure 11).

Wiring the LEDs

Now the fun begins! Place a LED face down on your blue bench tape, and make sure you know which side is positive and negative. Wet each contact on the LED with a tiny amount of rosin flux. Melt a bit of solder on your iron. Then tin each contact. Place an appropriately colored wire on the LED so the tinned wire end is on the proper contact. Then press the wire onto the tape to hold it in place (figure 12).

Gently touch the LED/wire combination with your soldering iron to make the connection. You only need a fraction of a second for this. Repeat for the other side, then test the LED (figure 13).

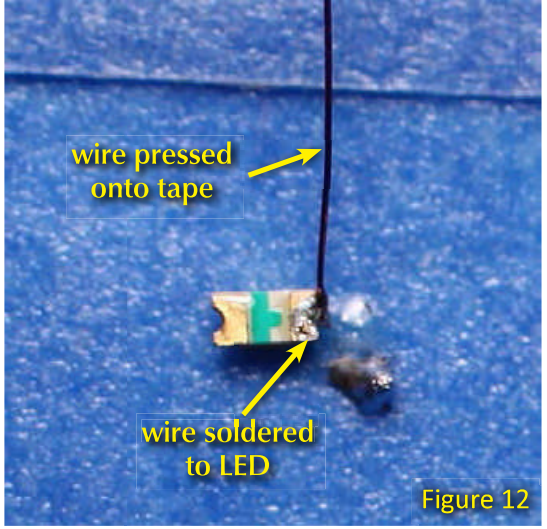
Insert the LED in your holding tool (attached to something solid). Stretch (gently!) the two LED leads out and clamp them side by side into a "twisting tool" made by soldering another flat-nosed clip to a 6" brass rod (figure 14). Hold the tool's handle between your fingers with the wire stretched out, and twirl the handle to twist the wires together. This will make the LED easier to handle. Test the LED again to make sure everything still works.

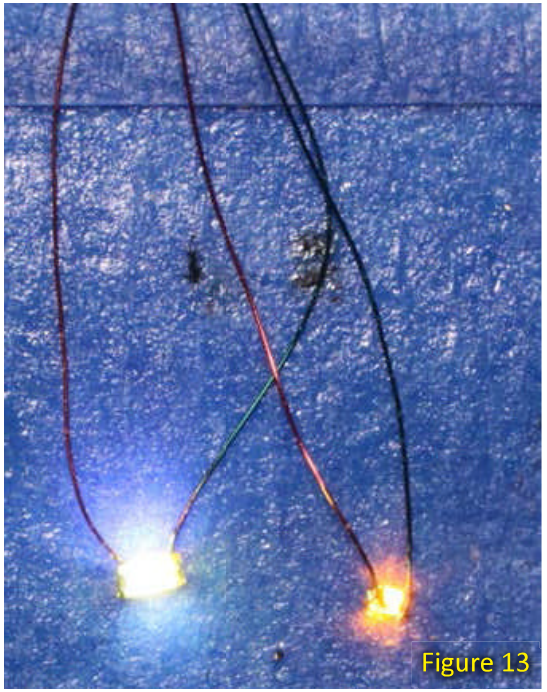
For the smallest LEDs it's easier to use sticky blue tape to hold the LED while twisting its leads. The holding tool (figure 6) has difficulty holding onto the tiniest ones, but works well on the larger devices.

Read more about LED wiring here: www.ngineering.com/micro_wiring.htm.

Light Up Your World with a Hand Lantern

Let's modify a plastic HO scale figure to hold a lighted kerosene lantern. See figure 15.





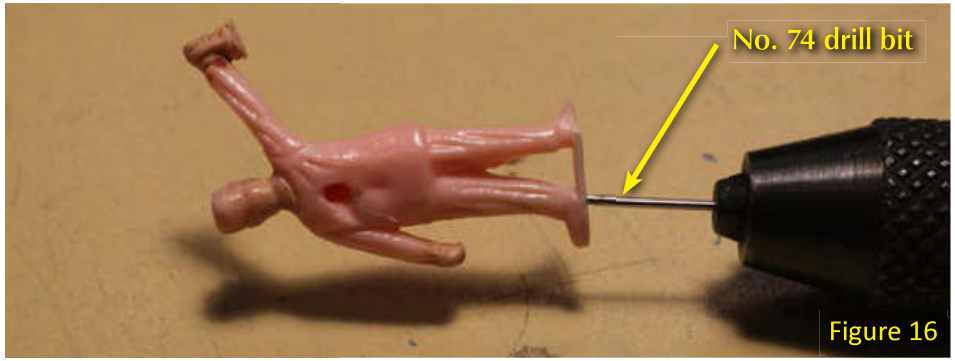


Figure 12: 38-gauge wire soldered to the negative terminal (note the direction of the "T") of a 0602 LED.

Figure 13: Testing the newly wired LEDs. Note the different colored wires – green for negative, red for positive. Color coding the wires solves the otherwise nearly impossible problem of determining which lead is which.

Figure 14: Homemade tool to twist the LED leads.

Figure 15: Bringing a kerosene lantern to life with a micro LED.

Figure 16: Talk about a root canal! Drilling a hole for the LED leads in the poor flagman's leg with a number 71 bit.

Select a figure with an appropriate pose to hold a lantern. If it has a base, remove it to allow accurately positioning the drill location. Drill through the leg up into the torso with a #74 drill bit in as light a pin vise as you have. I expand the hole by following up with a #71 bit (figure 16).

Drill from the back into the figure with a #60 bit to pick up the first hole and prepare to drill the next hole through the arm to the wrist (figure 17). Drill into the back of the figure's wrist or wherever you want the wires to exit (figure 18). I removed the bottom of the lantern from my figure.

Next, get a supply of #10 clear glass seed beads from a craft store. Seed beads come by the thousands in small tubes. If you're picky about which beads you use, a 0402 LED will fit in the hole. Otherwise, use a moto-tool with a small grinding bit to enlarge the hole until the LED fits. This takes a good eye and patience. Punch out a base for the lantern from .040" white styrene, or slice off the end of a styrene rod, and glue to the bead. I do this operation in batches (figure 19).

Prepare a 0402 LED, solder wire leads to it, and twist the leads together all the way up to an eighth of an inch to the LED. Now, glue the light-emitting side of the LED into the bead hole with clear glue – I use watchmaker's crystal mounting glue or ACC. After the glue dries, test the LED again to make sure you didn't tear a wire loose, then glue the lantern glass to

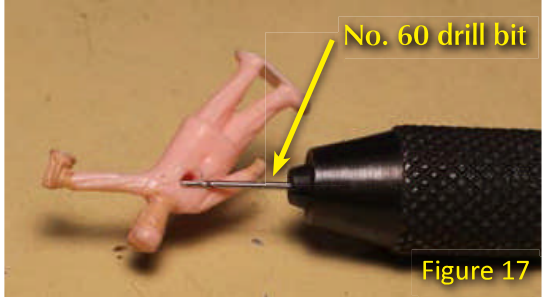


Figure 17: Drilling out the arm for the LED leads.

Figure 18: Drilling out the wrist for the LED leads.

Figure 19: Seed beads with styrene lantern bases attached.

the hand of the figure, wrap the leads around the hand of the figure and twist slightly to close the loop. Thread the wires inside the figure's arm to the torso and out, and then thread through the leg to the foot (figure 15).

Be sure to test the LED after each operation. Those tiny wires are easy to break. Finish painting the figure and mount or display. The figure here is an old Bachmann Plasticville worker, trimmed and painted with base removed. The original figure is on the left. Any figure with a suitable pose can be used.

Applying Rule 26

Railroad operating Rule 26 typically states: "A blue signal, displayed at one or both ends of an engine, car or train, indicates workmen are under or about it; when thus protected it must not be coupled to or moved. Each class of workmen will display the blue signals and the same workmen alone are authorized to remove them. Other equipment must not be placed on the same track so as to intercept the view of the blue signals, without first notifying the workmen."

You can implement Rule 26 on your railroad (or show it being done) by wiring a figure holding a blue lantern with a special mount and regulator described here. I started with another old Plasticville figure from my junk box. This time the arm holding the lantern is down. I drilled through the leg so the hole exits under the arm. The wire leads take a short run down the back of the arm to the hand for the lantern LED, and are painted over hiding them quite well. The glass seed bead is colored with Tamiya clear blue paint or with a blue permanent marker – both work well (figure 20).

After testing to see if the LED works, put the figure aside and cut a 1/8" strip of single-sided printed circuit (PC) board (PC ties work too). The length of the strip should fit loosely between the rails of HO scale track, with maybe a 1/32" clearance on both sides. Cut two piece of very thin phosphor bronze strip metal (I have used track sliders, old relay contact strips, and even flattened Kadee coupler springs) long enough to bend around the ends of the strip of PC board.

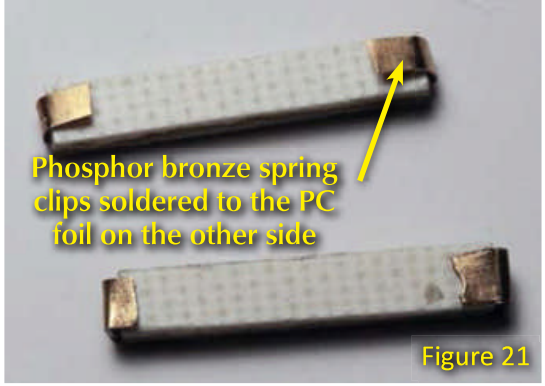
Solder a phosphor-bronze strip to each end, then bend the strips around the PC board ends, and test for a good fit between the rails. You know you've got it right when you can easily insert and remove the strip repeatedly. You can adjust the "spring" ends by bending the phosphor bronze strip away and towards the end of the PC strip (figure 21).

Quite often, LEDs are powered from a DC power source through a resistor. Here we are going to use another small SMD (surface mount device) to power our lantern – a Supertex CL2 constant current LED driver. This current regulator is specifically designed to power LEDs. You can learn more about it here: www.supertex.com/pdf/datasheets/CL2.pdf and can order it from Mouser.com and other places. It is

Figure 20: A workman carrying a blue lantern to flag under Rule 26.

placed in series with the LED and limits the current to a maximum of 20ma, regardless of the voltage placed across the pair – up to 90 volts (figure 22).

With a razor saw, make two cuts through the copper on the soldered side of the PC strip as pictured in figure 23. Remove the "V" wedge with a hobby knife. This will provide clearance



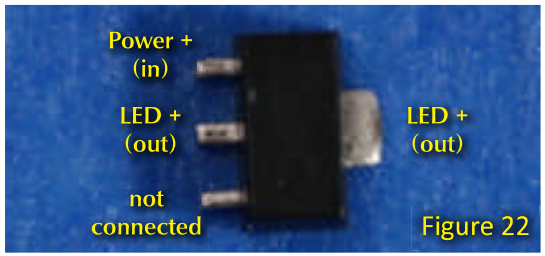
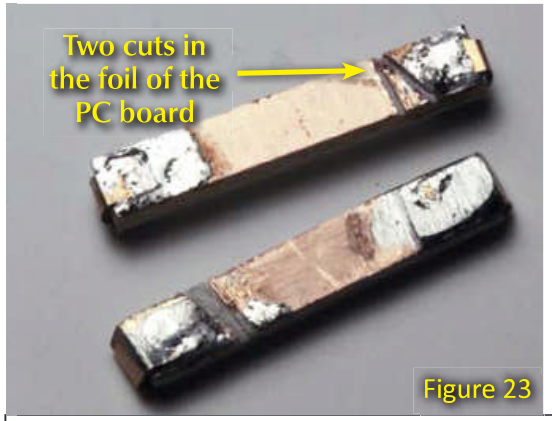


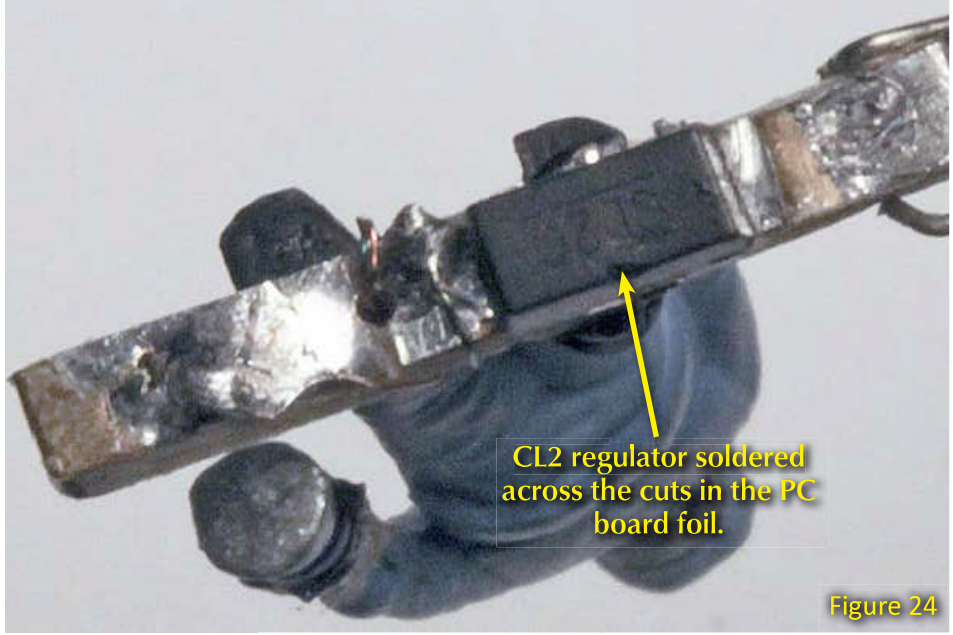
Figure 21: SINGLE-sided PC board for mounting the workman.

Figure 22: CL2 current regulator. There are two output pins (both connected to each other) leading to the LED(s) being current limited.

Figure 23: Gaps in the foil of the PC board figure base.

Figure 24: CL2 mounted on PC board.





for the back contacts of the CL2 regulator so you can solder it to the strip. Clip off the third "no connection" pin from the CL2.

Then tin, place, and solder the CL2 on the center strip. The isolated piece of copper will connect to the plus/positive/+ side of the LED leads. The end away from the CL2 will connect to the neg/negative/- side of the LED, which wires the series CL2-LED pair directly across the rails. Remember that DCC will drive an AC (varying) voltage across the rails when powered, and the regulator will limit the current to the LED (figure 24). Make another cut between the rail contact and the CL2 and solder a diode (almost any will do) across the cut with the cathode (negative side of the diode) towards the CL2 and the anode (the positive side of the diode) towards the track contact. This will protect the LED from the reverse DCC voltage and rectify the signal.

I drill a number 71 hole right at the PC cut, thread the wire from the lighted figure through, and glue the figure to the PC strip with ACC glue. Solder the LED leads to the proper contacts after very carefully trimming and tinning the leads. Paint the strip a dark brown, and place your trainman ready to signal that his train cannot be moved (figures 25 and 26)!

I also use this type of lighted figure placed alongside the track to note when I have powered off a staging or storage track. In this case the blue lantern is lighted when the power to the track is off, using a separate set of contacts on the power switch to the track. When the power is on, the lamp goes out, reminding me of track status at a glance.

Figure 25: The Rule 26 workman.

Figure 26: The Rule 26 workman with illuminated lantern powered through the rails.

Industrial Lamps and Shades

Prepare a 0603, 0402, or 0401 white or yellow LED by soldering two leads to it and twisting the wires together. Paint the contacts of the LED black to keep them together and dull the color and shine. Obtain an industrial lamp shade (Grandt Line, Tichy, Miniatronics, and Campbell Scale Models, and others offer variations. See figure 27.

Pick your favorite and paint the underside white, tan, or off-white, and the upper side a dark green or red. Some need to have a number 71 hole drilled through their middle. Thread the LED leads through the hole and cement the LED to the underside of the shade facing down. These can be hung from a ceiling, from a wall bracket, from a bracket on a pole, and from horizontal feeder wire – all prototypical locations – with great effect. Depending on the color of your chosen LED, you may wish to tint it with Tamiya clear paints or permanent marker pens, to "warm" the color to your taste, especially if you are using the bluish white LEDs.

It's definitely a good idea to check the colors of your LEDs BEFORE assembling shades or installing them in figures.

Figure 27: An assortment of different lamp shades – Grandt Line, Tichy, Miniatronics, and Campbell Scale Models.

Lighting a Loco Headlight

Prepare a 9823 white LED by soldering two leads to it and twisting the wires together. Paint the contacts of the LED black to keep them together and dull the color and shine. Punch out a piece of paper or thin plastic about 1/8 inch in diameter. Punch a small hole in the middle and thread the 9823 lead wires though the middle so the paper acts as an insulator for the LED in the headlight housing. Typically, I drill out the housing to fit the LED, and blacken the inside. The wire can come out of the headlight casing through a number 71 hole. Placing the hole at the lower rear or bottom is often the easiest for running the wires into the body shell. Punch out a small disc of clear plastic for the front lens and cement it in place after painting the headlight. If you power this LED with a CL2 regulator, it is VERY bright. So bright, in fact, that it will light up a wall from two feet away. I actually like the effect, but normal people might like to power it from a DCC decoder through a limiting resistor, valued around 1000 Ohms (figure 30) reducing the brightness a bit.

Lighting a Marker Light

Prepare a 0603 white LED by soldering two leads to it and twisting the wires together. You could also use a 0402 white LED. Once mounted, twisted, and tested, paint the contacts of the LED with a thick enough coating of your favorite paint to insure the contacts are insulated (Black enamel paint works well when used sparingly. It's thick right from the bottle and does not attack plastics). While it dries, paint the marker lamp housings (I use Utah Pacific marker lights), and let dry.

Fill in the lamp holes with either transparent color paint of choice, or micro glaze followed by a coat of transparent paint or permanent marker. You could also use transparent marker jewels.

Depending on the size of the LED, either insert it partway into the marker lamp and glue, or glue to the base and then mount the marker on the car.

Marker lights come in pairs so I use the CL25 regulator (the 25ma version of the CL2) to drive the two LEDs wired in parallel (figure 31). There is more info for the CL25 at: www.supertex.com/pdf/

Figure 28: Lamp shade parts.

Figure 29: Lamp with shade in operation.


Figure 27


Figure 28


Figure 29

 Points of Light - using micro LEDs, page 8


Figure 30

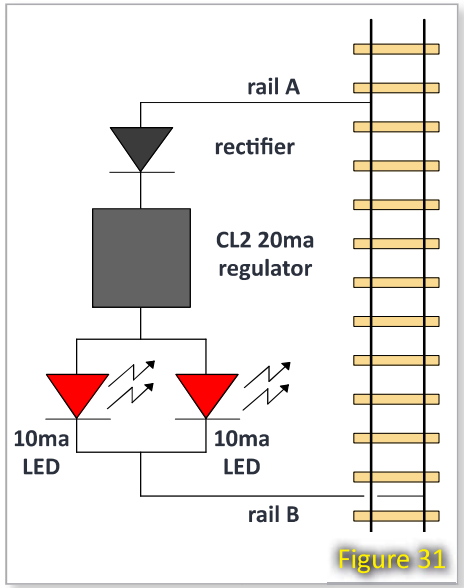


Figure 31


Figure 32

Figure 30: A LED headlight can be bright enough to really light up the track at night. It also runs cool so plastic body shells don't melt. It uses next to no current so decoder function outputs aren't strained.

Figure 31: Schematic showing two marker light LEDs wired in parallel with each other and in series with a current regulator and diode rectifier.

Figure 32: Marker light on the side of a NYC caboose.

datasheets/CL2.pdf. This way each LED is lit with approximately 12.5ma. You should use the same type LED in each marker for this to work correctly.

Experiment!

There are many variations of these lighting installations to be found. Invent some of your own.

The inspiration for my LED experiments came in part from Laurie McLean MMR. Read about his work in "Electronics and Animation – Surface Mount LEDs" by BHI Publications. He also has a number of interesting, animation related videos on youtube.com. Search using his name or YouTube id – scoopmmr.

Experimenting with tiny points of light goes much better when accompanied by large doses of patience and fine music! Have fun!

Reader Feedback (click here)

which spawned his interest in realistic animation and lighting. He models the New York Central, and sometimes the Great Northern, paying little heed to timeframe. On occasion, Geoff reverts to HOn30 modeling of strange, narrow critters from the woods of Maine.

Geoff Bunza started as a model railroader when he received a Mantua train set for Christmas, at age 6. He fed his interests through college becoming a member of the Tech Model Railroad Club (TMRC) at MIT and getting his degrees in Electrical Engineering. He has collected Lionel HO trains for many years, Geoff has been diverted from model railroading over the years by engineering and management challenges in computer design, automatic test systems, electronic design automation, and starting five companies. He is blessed with his wife, Lin, in marriage for 32 years and their two terrific sons. He is a life member of the NMRA.