

Light up Enterprise NX-01!

by John D. Cook

I love light-up projects. There's something special about a model that lights up, it adds that extra level of realism that makes it come alive. That's why I was first at my local hobby shop to get Polar Light's Enterprise NX-01 kit. Its loaded with clear parts and just begs to be lit up. This article describes how I lit up my NX-01, focusing on LEDs and fiber optics. This is by far the most complex lighting project I've ever done but the things I learned to do will make all the rest that much better. Hopefully, you, the reader, will enjoy learning the tricks I learned and be able to make your own work all the better too.

Open the Box

OK, its big. Real big. In 1/350 scale the saucer is a whopping **fourteen** inches across which is bigger than most dinner plates. Great! Lots and lots of room for all my lighting elements.

Reinforcing the Nacelle Pylons

Polar Lights did a good job making sturdy pylons for the nacelles but I like mine a little stronger. I added some 1/32" dia steel wire inside the pylons for extra strength. I formed it to fit along the edge of the rear hull and nacelle pylons and cut it flush with the pylon tops. See Fig 11.

Stand Improvements

The clear stand rods are nice but they are brittle and break with too much handling. To improve this I drilled a #61 hole in the top of each, down about 0.1" into the thicker part of the stand. I then took a piece of #22 gauge steel wire, dipped it in super glue, and inserted it into each hole. This makes the tip of each stand rod much stronger. Each tip was also beveled and rounded at the top so it fits more loosely into the model and does not stick when you remove the model from its stand.

A Few Words on Wiring LEDs

Wiring LEDs in this article is done using 30 gauge wire wrap wire, using red wire for all positive (+) connections, and black for all ground or negative (-) connections. To make handling the wires easier, make twisted pairs of red and black wire. It's pretty easy to do this with a power drill and vise. Place one red and one black wire together in a vise. Unroll a few yards of wire and cut both colors the same length. Use a power drill, without a drill bit, to grab the free ends of wires in the drill chuck and gently twist them together by running the drill at low speed, holding the wires slightly taught while twisting. Try tying a knot in the ends of the wires too, to ensure a good grip.

To connect wire to LEDs, use a hand wire wrap tool from Radio Shack and strip off about 1" of insulation from the end of each wire. Insert the wire into the wrapping tool and wrap the RED wire to the LONG LED lead, BLACK wire to the SHORT lead. Its easy and no solder is required if the wrap is nice and tight.

A Few Words on Fiber Optics

This article uses plastic fiber optic material to conduct light from LED sources to the small openings all around NX-01. Plastic fiber optic is inexpensive and fairly easy to handle, but delicate. Some basic guidelines are as follows:

- Fiber optic uses a principle called “total internal reflection” to conduct light. This means that light is being reflected off the inside wall of the fiber as it travels along. If the fiber is bent or curved too tightly, the light no longer reflects, it just escapes out the side and is lost.
- There are two sizes of fiber used in this article: 0.25mm and 0.50mm. The small size is used for all the “spot” lights and to conduct light from LEDs to clear parts. The large size is used for the big flood lights on the saucer that light the cargo doors and insignias on top and bottom of the saucer.
- Glue fiber with epoxy, not super glue or plastic glue. Super glue makes fibers brittle. The accelerators for super glue are especially good at this. Plastic glue will melt fibers.
- Connect F.O. to LEDs by making a bundle of all the fibers to be connected to an LED. Shrink some heatshrink tubing over this bundle gently with a modest heat source like a warm soldering iron or hair dryer. Cut the bundle so the end is flat, you may want to polish it slightly. Put the flat end against the LED and heat shrink them together with another bit of heatshrink tubing.



Fig 1, joining LED to fibers with heatshrink.

- Leave about ¼” of fiber sticking out of the model after inserting and gluing. Paint the model, and trim fiber “whiskers” after painting to let the light out.
- Use strips of styrene to make “hold-down straps” to keep all the fibers and wires neatly in place. Be careful not to clamp the fibers too tightly, squashed fibers don’t carry light.

Invisible Power Wires

OK, there's no such thing as invisible wires but by being clever you can make yours *almost* invisible. The basic idea is to mount the power plug in an inconspicuous place, run the wires so they're hard to see, and adapt a common electrical connector to suit our needs. The plan is: strip about 7" of insulation from the wires, run them up the flutes of the rod, and mount the prongs of a 0.1" male connector into the top of the rod, with the rest of the wire underneath the stand.

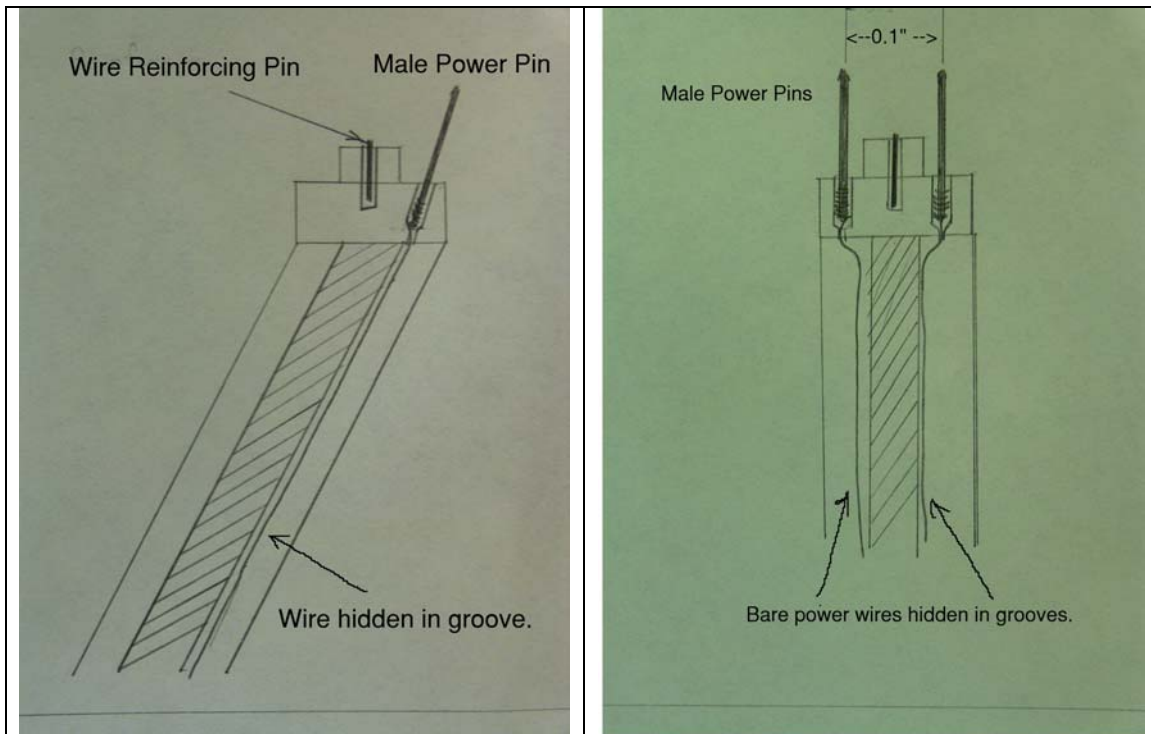


Fig 2 and 3 showing improvements to the front stand rod.

Drill a hole in the rear of the base for the power plug. Drill two #65 holes into the bottom of the stand's front rod so they come out in the flutes of the rod. Drill two more #65 holes from the top of the rod into the flutes, 0.1" apart. They have to be spaced to accept a 0.1" connector. Enlarge the top holes with a #61 bit to a depth of about 0.15" Cut two lengths of wire wrap wire, one red, one black, to 14" and carefully remove the insulation from half of each. Take a two pin 0.1" male connector and break the pins out of their plastic frame. Wirewrap the end of the bare wire to each pin so one pin is wrapped to red, one to black. Thread the other end of the wire into the top holes, along the flutes, and through the bottom holes. Take a two pin 0.1" female connector and, using it to align the male pins, carefully super glue them into the holes in the top of the stand. The idea is to keep the pins properly aligned in their holes by using the female connector.

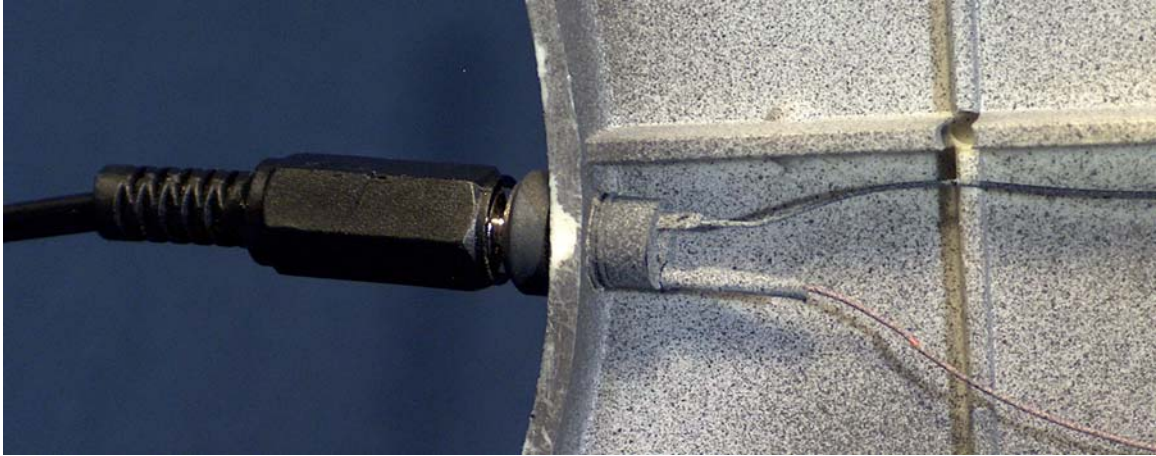


Fig 4, Power plug mounted in bottom of stand.

Once the pins are glued into the top of the rod, only bare wire should be visible along its length. Pull it taut and spot glue it into place into the flute so it's hard to see. Thread the wires through the holes in the base and mount the rod in place. Strip about 1" off the wires and solder them to the power plug, black to the center pin, red to the outer one.

Mounting the interior power plug is easy. Assemble the lower half of NX-01 and the stand so you can place the lower half of NX-01 on its stand. Drill two #60 holes in the lower saucer where the power pins from the stand enter the model and place NX-01 on its stand. With the male power pins sticking into the lower half of the saucer put the female 0.1" plug used to align the pins earlier onto the male pins and build a frame around it with sheet styrene and glue it in place. Now, when NX-01 is placed on its stand, power is automatically connected and all the wires are nearly invisible.



Fig 5, Power Pins sticking up into the lower saucer.

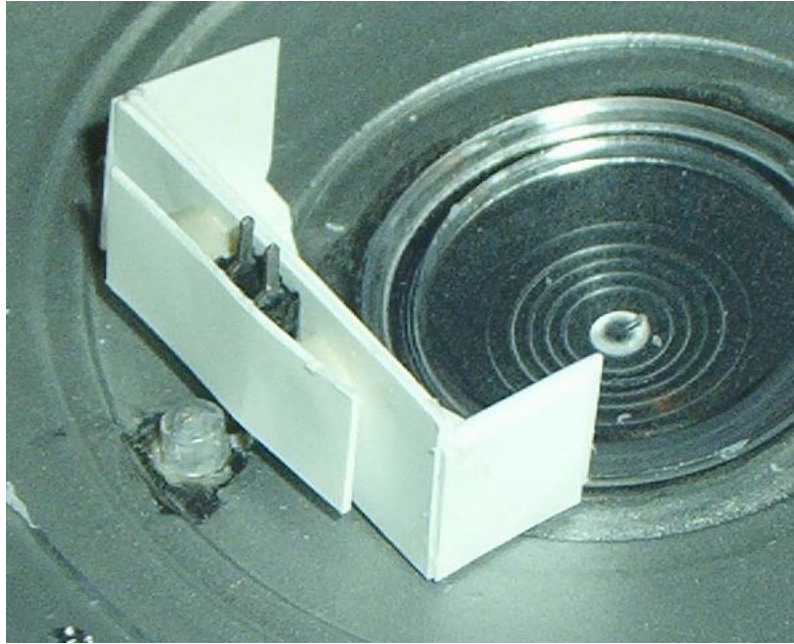


Fig 6, Female power plug with support frame.

Light Block the Interior

Like any light up project, you have to keep the light where you want it. Paint the entire inside surface with flat black. I used Polyscale Engine Black, just because it came in a bigger bottle than the usual tiny Testors bottle. Once the black is completely dry, you need to coat the inside with either flat white paint or mylar foil to reflect the light internally. Don't use metallic paint, it will actually trap light within the tiny flakes of metal that is the paint and absorb the light. I used mylar foil inside the engine nacelles because the plan called for a highly reflective interior surface to diffuse the light better. I'm sorry to say I used metallic silver inside the saucer, next time I'll use white.

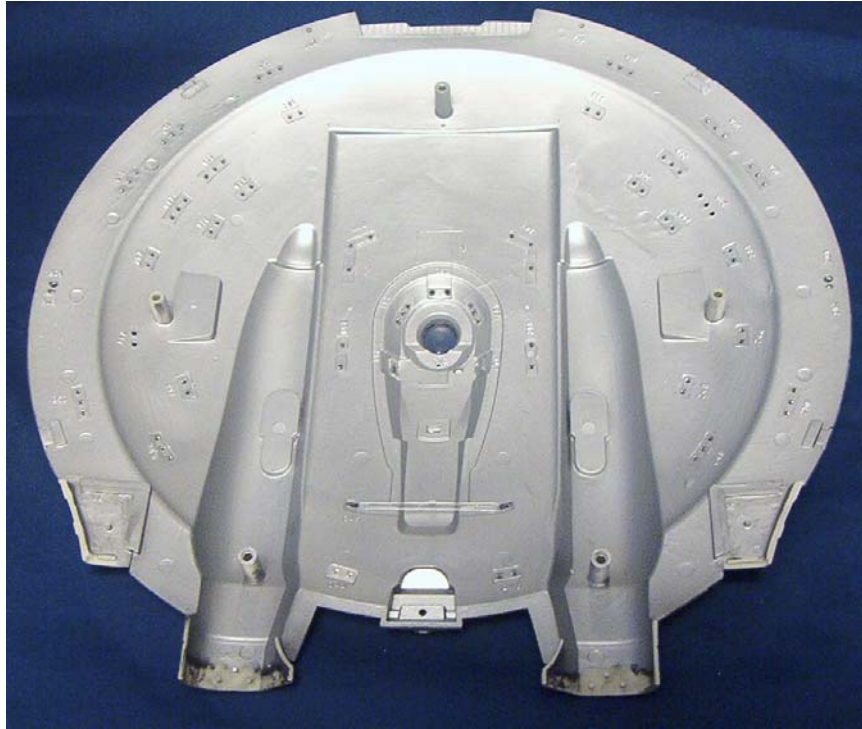


Fig 7, Upper saucer painted aluminum.

Lighting Plan

First, I'll tell you (briefly) how I did this the wrong way, then how I did it right.

Wrong Way to Light a Big Model

First, the Analysis. You have to sit down and think things through for such a big project and the first step is analyzing how many lights of each color you will need. I chose to use all LEDs for this project because of their very long life (10 years) and low heat output. Since the model will be sealed, these are both big concerns to me. All the LEDs would be either 3mm (T1 package) or 5mm (T 1 ¾ package) and draw about 20 mA (milliamperes) of current at full brightness. They would also be the new high brightness type, with a light output of several thousand millicandellas (mcd) each, to reduce part count. Here's the table:

NX-01 Lighting Analysis			
Number of LEDs and brightness for each section			
Quantity	Description	Brightness each LED (mcd)	Total Brightness (mcd)
2	Dimmed Impulse Blues	700	1400
2	Bussard Collector Red	6300	12600
4	Warp Nacelle Blue	6300	25200
1	Nacelle Marker Red	50	50
1	Nacelle Marker Green	32	32
2	Nacelle Marker White	20	40
1	Saucer Marker Red	8000	8000
1	Saucer Marker Green	6000	6000
2	Aux Engine Blue	450	900
1	Interior Flood Light White	6300	6300
2	Saucer Dome White	6300	12600
1	Saucer Spots Blue	6300	6300
2	Interior Flood Light White	18000	36000
1	Saucer Spots White	18000	18000
2	Deflector Dish Backlight Blue	450	900
1	Aft Dome Blue	450	450
1	Aft Running Lights White	1000	1000
2	Bright Impulse Blues	1500	3000
29		Total Brightness	138772

The original plan was to use an external wall mount power supply, run power into the model and use current limiting resistors for groups of similar LEDs. Then I calculated out how much current I would need and how much heat would be trapped in the model. If you assume a simple case of two 20mA LEDs per resistor and a 9V supply, then the average voltage drop on the resistor would be about 3V. Heat output from 15 resistors like this would be: $15 * (3V * 20mA) = 900mW$ and the current draw would be $15 * 20mA = 300mA$. In reality, there would be more like 20 resistors giving off 1200mW and drawing 400mA. That's too hot for me.

Lighting LEDs the Right Way.

Since trapping over a watt of heat inside NX-01 seemed like a bad idea I invented a better way. I found a tiny chip that is designed to provide a constant current source for up to three LEDs and works on 6 to 12V. With it, I invented the Delux-8 product that controls LED current and gives off very little heat. The new heat output is only about 100mW and the current draw is about 250mA. That's one-tenth the heat and nearly half the current, a huge improvement.

Mounting and Wiring Light control units

Mounting the Delux-8 units is easy. Just run some 22 gauge steel wire through the corner mounting holes, bend it into simple stands, and glue in place. Connect power to each unit from the inside power plug by “daisy chaining” power from the plug to one Delux-8, from there to the next, and from there to the last unit. All connections to Delux-8s are done with wire wrap.

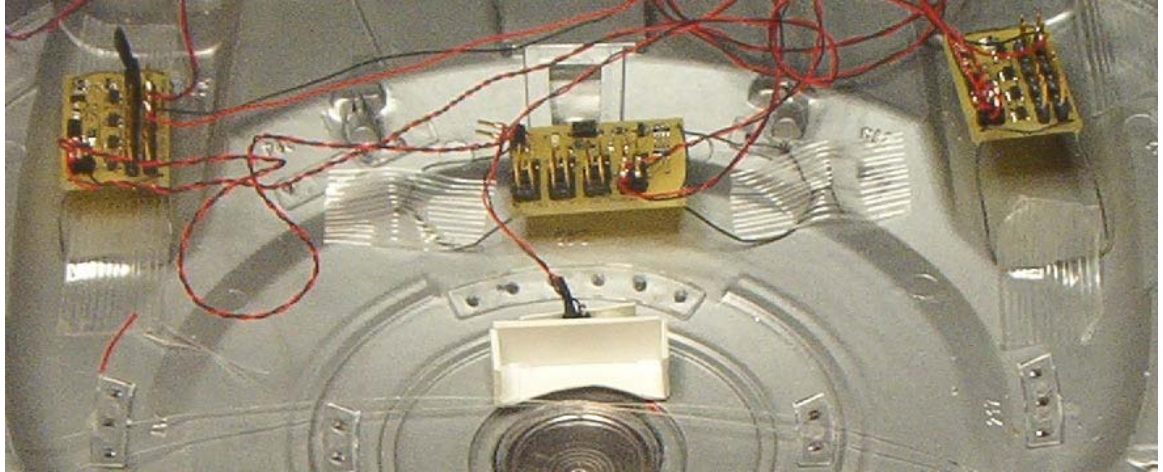


Fig 8, Delux-8 units, mounted and wired to inside power plug.

Lighting the Nacelles

Prepare the insides of the nacelles by first painting their interiors flat black, and then by lining them with either silver mylar tape or flat white paint over the black once completely dry. Place some flaps of material, either strips of styrene or mylar foil, over the seam in the bulkhead between the blue warp engine cavity and the red nacelle cavity, to prevent the light from leaking from one cavity into another.



Fig 9, Closeup of front of nacelle showing mylar foil lining the interior, red tinted nacelle dome and placement of nacelle red LED and one of the blue warp LEDs.



Fig 10, Red and Blue lights on!

Lighting the nacelles requires five lights:

Light	Purpose	Mounting
Nacelle Marker White	small white lights on rear tips	Inside rearmost cavity of nacelles, connect 3-4 strands of thin fiber from LED to each clear part
Nacelle Marker Red/Green	Red and Green Navigational markers on top rear	Insert into ¼” lengths of 1/8” diameter brass tube and mount under their clear parts so the light shines upward.
Warp Nacelle Blue, two per nacelle	Light the Warp Engines	Paint white around the sides of each LED so light escapes only from the curved top. Mount one at each end of the main cavity, directly facing each other.
Bussard Collector Red	Light the red Bussard collectors on front of nacelles.	Make a wire frame to hold the LED in the center of the front cavity, facing rearwards so the light is reflected off the interior.

Run all the wires as pairs, one pair per LED, out the bottom of the nacelle where it will meet the pylon and leave plenty of length, there’s nothing worse than having wires that are just a little too short!

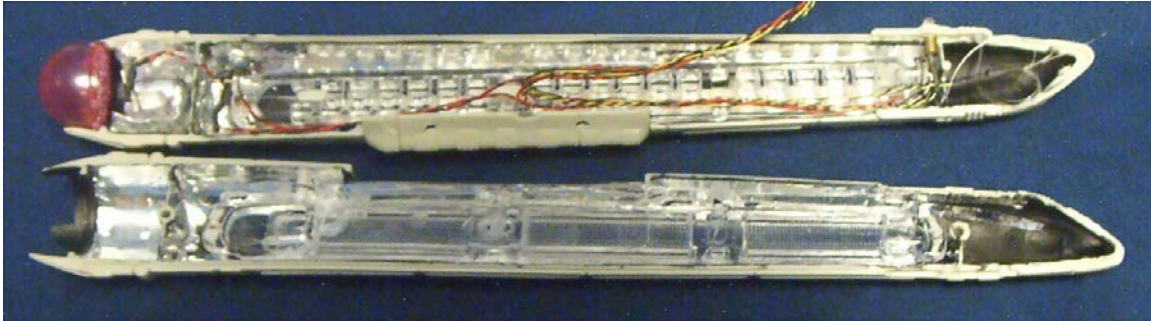


Fig 11, Fully wired nacelle. Notch for wires is visible in the center of the mounting plate.

Impulse Engines and Rear Hull

The rear of NX-01 requires six LEDs as the table below shows:

Light	Purpose	Mounting
Dimmed Impulse Blues (2)	Slightly dimmer lights for smaller, outboard impulse engines at rear. Dimming is optional, dim with a little paint on the LEDs.	Drill holes in pylon support material and insert LEDs
Impulse Blues (2)	Full brightness impulse engines at rear for larger, inboard engines.	Drill holes in pylon support material and insert LEDs. Add some teased out cotton ball between the LEDs and the clear window to diffuse the light.
Aft Dome Blue	Lights up dome in center of rear hull.	Attach wires to LED, then bend leads 90 degrees and mount LED so it shines straight up at dome interior.
Aft Running Lights White	Drives fiber optic bundles that light up running lights along rear "fin".	Attach 3-4 fiber optic strands to each clear part, run them to a bundle inside the hull. Attach bundle to LED with heat shrink tubing.
	Three blue "spots" on rear fin, next to sensor dishes.	Drill and insert three small diameter lengths of fiber optic. Place the interior end facing the blue dome LED so they pick up its light.
	Six blue "spots" on rear fin, part #13, rear edge	Drill and insert six small diameter lengths of fiber optic. Position the interior ends as above.

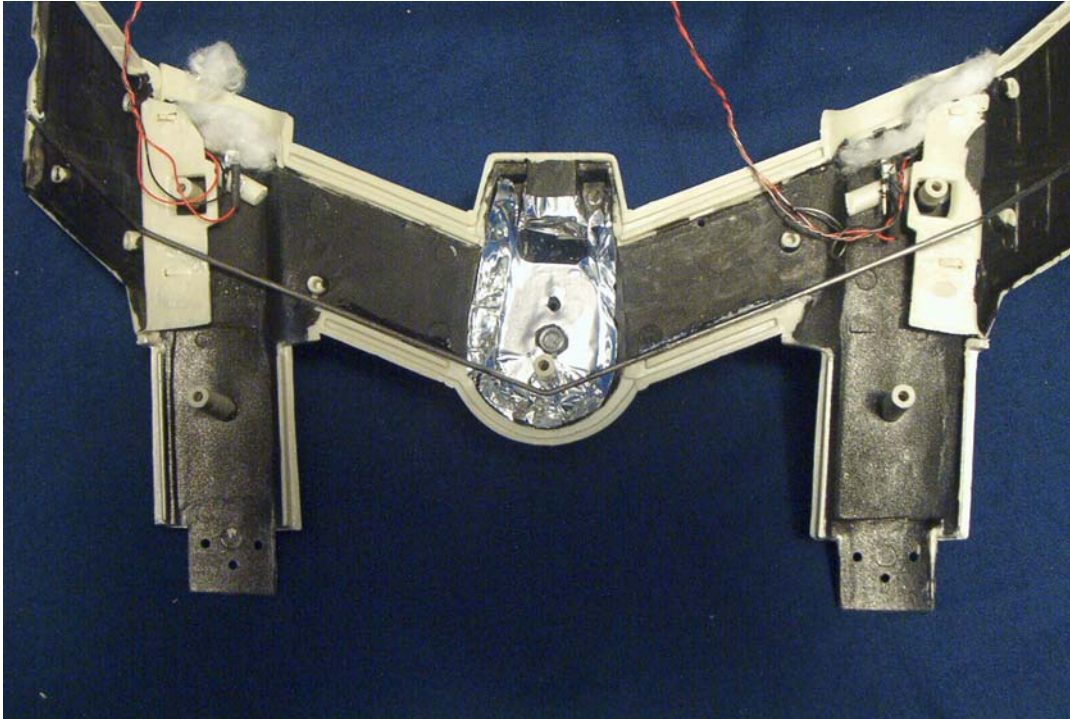


Fig 11, Upper half of rear hull showing reinforcing rod, mylar foil mirroring of hull interior, and placement of impulse engine LEDs.



Fig 12, Closeup showing blue “spots” on trailing edge of rear hull.

Make a hole in the tops of the warp nacelle pylons for the wires from the nacelles to run into. The wires should be able to run through this hole, down the insides of the pylons, and forward through the rear hull into the saucer.

Auxiliary Engines

On the rear corners of the saucer are two tiny auxiliary engines. Polar Lights chose not to supply clear parts for these engines but we can fix that. Use a Dremel tool to carefully grind the back of parts #70 and 71 so the engine port is open. Take a piece of clear sprue, flatten and polish it, and mount it on the back of the hole. Be careful not to interfere with the fit of these part, it's easy to make the clear window too large. Mount one blue LED behind each clear window.

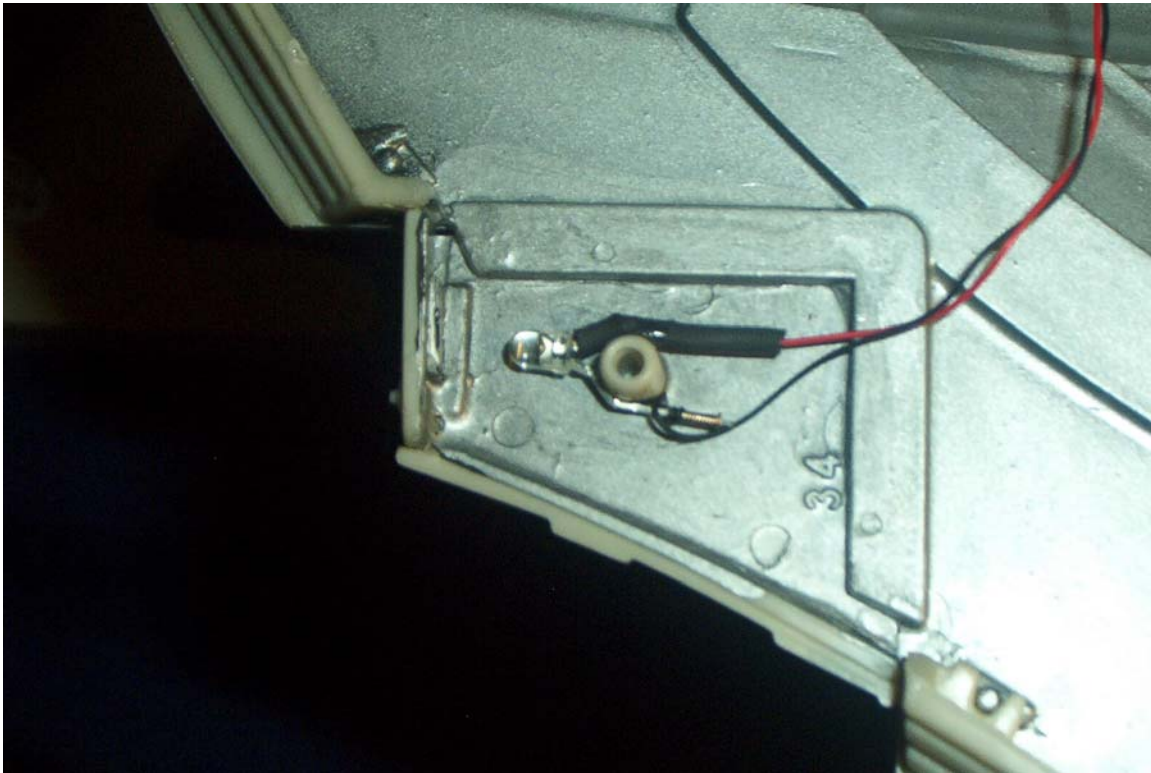


Fig 13, Blue LED mounted for Auxiliary Engine.

Deflector Dish

Backlighting the deflector dish isn't hard. First, make a simple lightbox to contain the blue light. I made mine by building up some layers of corrugated cardboard the same width and thickness as clear part #209 and about two inches deep. Place the cardboard form on a solid surface and heat form some sheet styrene to its shape with a hair dryer. Then cut and fit it so it forms a snug fit behind the deflector and paint its interior flat black, then flat white. Wire up two blue LEDs and place them behind clear part #209, close together and facing away from each other. Add some teased out cotton ball to help diffuse the light and glue down the light box.

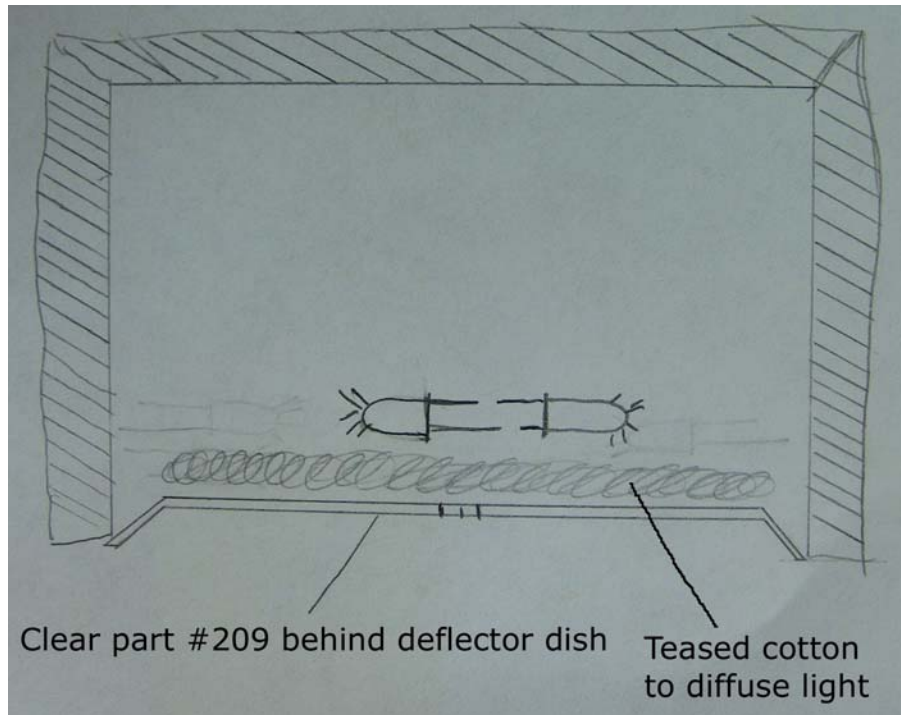


Fig 14, Blue LED placement inside deflector light box.

Saucer

Lighting the saucer is a big job. Its big, has very many windows, and there are many colors. First, lets talk about where in the build you should be do start this step. To light the saucer you should have fully assembled the lower half of the saucer and the entire rear hull. The walls of the saucer should be in place but leave off the tiny saucer details until the end, as they are fragile. The stand should be assembled and wired. All three Delux-8 lighting units should be mounted and connected to the interior power connector. When you plug in the model, the tiny “power-on” light on each Delux-8 should light up. The warp engine nacelles should be mounted on their pylons and the wires from them should be coming out of the rear hull into the saucer interior. The only things left to do at this point should be wiring all the LEDs to Delux-8s, lighting the saucer, installing deflector dish parts, and installing the clear parts for the two observation domes.

Connect the existing LEDs to the Delux-8 units. Use a wire wrap tool to strip about 1” of insulation from each pair of wires and connect each to a pair of posts on a Delux-8. Test each LED as you go by connecting power, observing the working LED, and unplugging power again to do the next one. Do NOT leave the model plugged in while working on it. You could easily short out a Delux-8 unit while wiring.

Once all the LEDs are wired, use strips of styrene as “hold down strips” to hold the wires in place and make everything neat.

Lighting the Saucer, Large Fiber Optics

First, the fiber optics. Rule #1 about fiber optics is curves. Wide ones. If the fiber is bent or curved too tightly, all the light will just leak out the sides so make all your

curves wide. Install all the fibers first, then after all the large and small fibers are placed, hookup the LEDs.

Lets do the large diameter F.O. first. Drill a #75 hole in the lower saucer to run some 0.50mm fiber to the lower observation dome. Repeat for the upper dome. Now the tricky part. To light up the large flood lights that light the cargo doors and insignia we have to drill very carefully into the small bumps on NX-01 where those lights are mounted, and through the hull.

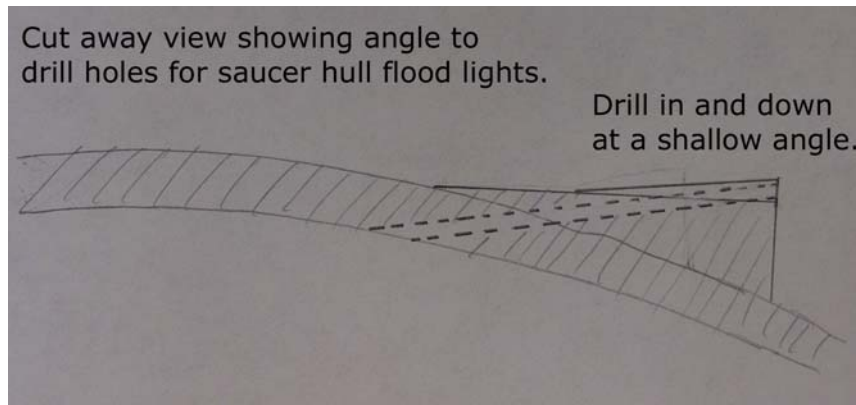


Fig 15, Drilling holes for the hull flood lights.

Once the holes are drilled insert some F.O. in them and make a loop, about 6" in diameter of all this F.O. so you can bring all the ends to a bundle. Make the loop on the underside of the upper saucer. Leave three extra long pieces of F.O. hanging as they will be used to light the two floodlights on the lower half of the saucer and the lower observation dome.

Bending the Light Fantastic

There's one more trick to these floodlights. Ever notice how they seem to shine down onto the hull? There's a way to do that here. It's possible to actually bend the light by simply cutting the end of the fiber at the correct angle to refract the light down onto the hull. Cut the fibers so the top is angled back by about 30 degrees and polish them smooth. This will cause the light to refract down at an angle and better light the model.

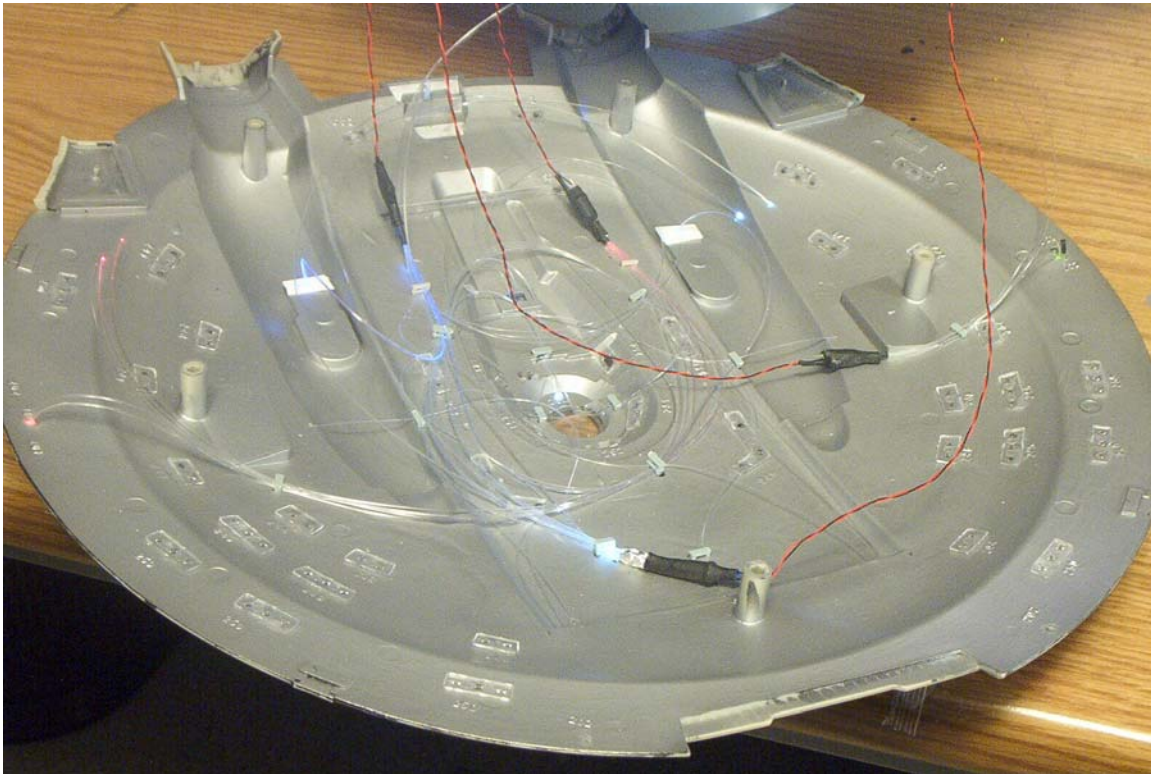


Fig 16, Saucer top showing looping of fibers and LEDs driving fibers.

The red and green marker lights are a little different. Drill #75 holes into the undersides of the clear parts, insert the fibers, and bundle the fiber ends on the underside of the saucer top and leave extra hanging for the lights on the lower half. There's no need to make a loop of fiber for these, bundle the fibers few inches from the edge where LEDs will go later.

There are two blue lights on the top of the saucer, next to the "intercoolers", part #32. Drill and insert large fibers into these holes and bundle the free ends.

Lighting the Saucer, Small Fibers

Lets do the small fibers. There are four mounts for sensor dishes around the edge of the model, each with three small blue "spots". Drill these with a #80 drill. Run these fibers along the bottom of the saucer to the blue LEDs driving the "auxiliary" engines and angle them up as to catch the light from these LEDs. Using existing light sources saves on parts.

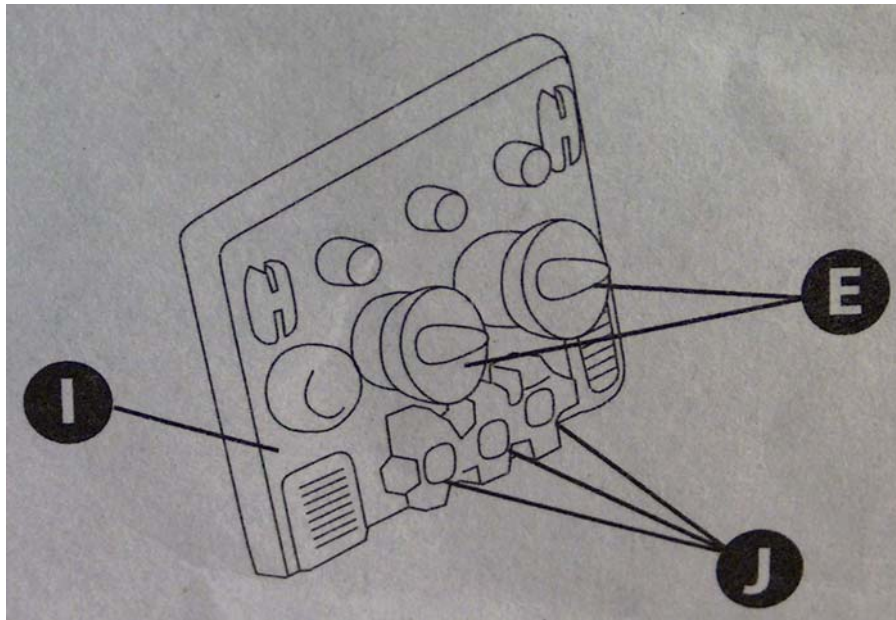


Fig 17, Drill #80 holes in all “J” locations for small blue lights.

There are two round docking ports on either side of the saucer and a third one on the rear edge of the saucer, part #53. Drill two #80 holes in the sides of each and insert a fiber to carry white light. Bundle the free ends in the center rear of the saucer.

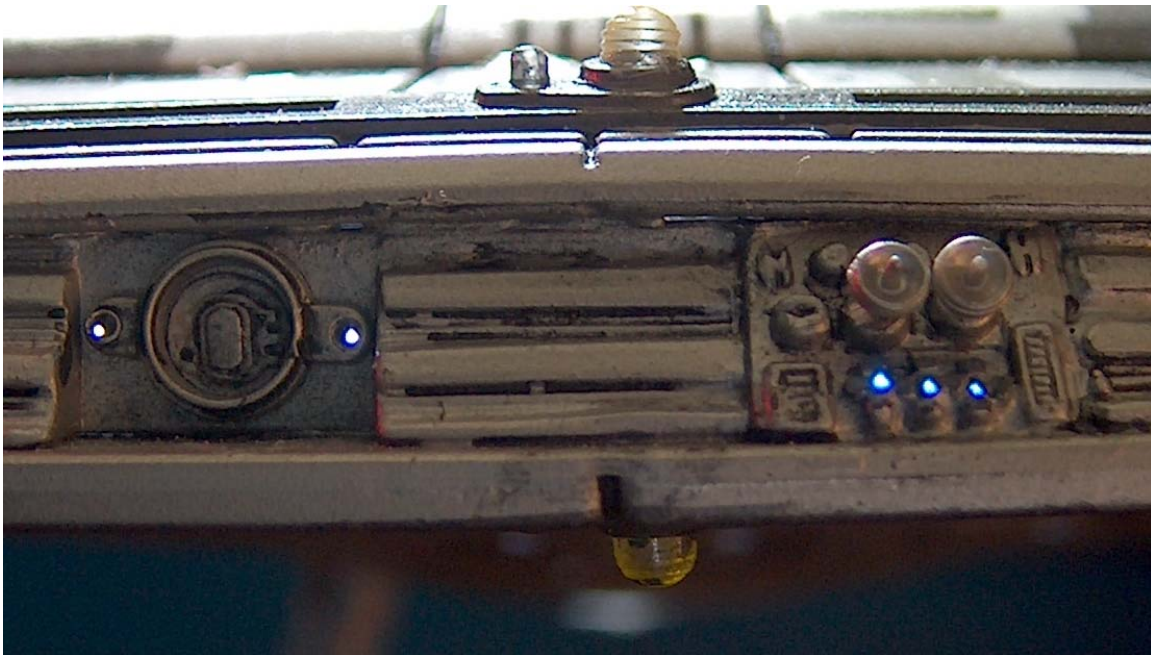


Fig 18, Docking port and sensor lighting up.

There are six small fibers for part #37, the “brow” just above the logo on the top half of the saucer. The four outer ones are red, and the two inner are blue. Drill #80 holes, and run to bundles where blue and red LEDs will be mounted.



Fig 19, Front view showing hull flood lights around bridge and "brow" lights.

The docking bay needs fibers to light the existing clear parts and I chose to add several more "spots" of white light. I also added two "spots" of white to the docking control booth, just forward of the docking bay. Bundle the free ends in the center rear of the saucer.



T
Fig 20, Docking Bay with extra lights.

Lighting the Saucer, Mounting the LEDs.

This is the last step in lighting NX-01 so before you begin take inventory of what should be done by now.

- All the fibers should be placed and bundled, waiting for LEDs or already connected to LEDs.
- The only parts not attached should be the saucer top, observation domes, deflector dish parts, and delicate sensor dishes.

- There should be five lengths of thick fiber hanging loose from the saucer: three whites for the lower hull floodlights and observation domes and one each for the lower red and green markers.

Mount the two “Saucer Dome White” LEDs by forming stands from 22 gauge steel wire and aiming them so the light shines on the clear parts in the center of the saucer. The lower LED should light the top and the visa-versa.

Mount the “Interior Flood Light White” LEDs in the center rear of the lower saucer. Aim them forward and about 60 degrees apart, so the light is evenly spread around to light all the saucer windows.

Mount the bundle of small fibers that drives all the small white “spots” in front of one of the white flood LEDs so the bundle picks up their light but does not block it.

TBD refer to earlier inside of saucer picture.

Connect LEDs to all the bundles of fiber in the saucer top and wire them to the Delux-8 units, testing each as you proceed.

Once all the LEDs are wired close up NX-01 and take a moment to appreciate it. Even without paint, it’s a very impressive lightup!



Fig 21, All lights on, ready for paint.

Painting and Finishing

Painting NX-01 is another article all by itself, with its complex metallic Aztec paint scheme. I won't cover painting NX-01 here except to pass on what I learned:

- Plan your paint job carefully. It's big and complex, requiring multiple maskings. I recommend using the kit specified colors.
- The kit instructions recommend painting first, then installing all the clear parts. That's a little hard considering what we've done but you can leave off most of the saucer windows, the observation domes and some other parts as well by not gluing down the saucer top and painting. This will save a lot of time masking and unmasking all those clear parts. I glued mine shut before painting, with windows installed, and spent a lot of time masking and unmasking windows.
- Metalizer paints are hard to work with, requiring polishing after painting and then sealing. They also "pull up" easily if your masking tape has too much "stick" to it.

Finished Pictures

Its only fair to include a few professional pictures of the final product.



Fig 22



Fig 23



Fig 24



Fig 25



Fig 26

Conclusion

This article is all about how to use LEDs and fiber optics to light a big model and I hope you've enjoyed it. My goal was to cover tricks and techniques I learned by doing such a big project so others will be able to tackle large lightup projects with greater ease. I covered invisible wires, LEDs, fiber optics and the product I invented to make driving LEDs easier.

About the Author

John Cook has a BS in Computer Engineering and is owner of Madman Lighting Inc. which produces the Delux-8 product. He has built numerous models and won awards for several of them. When not building models John works as a Computer Network Admin and spends time with his wife, Icie.

Tools:

Tools	Tool Vendor
Wire Wrap tool	Radio Shack
Set of Micro-drills, including several extra #80	Micro-Mark, many hobby shops.
Pin Vise for holding micro drills	
Hand or power drill	
Xacto knife, various blades	
Set of needle files	

Parts and Supplies:

Part	Part Vendor	Vendor Part Number
1/32" dia. steel wire	Micro-Mark, hobby shops	
Silver mylar foil tape, self adhesive	craft stores	
Delux-8 lighting kit, 3 units	Madman Lighting Inc, www.StarshipModeler.com, www.MonstersInMotion.com	
Extra wire wrap wire	Radio Shack, www.CircuitSpecialists.com	
0.5 mm unjacketed fiber optic, 6 ft	www.fiberopticproducts.com	
0.1" pin strip header, 3 pins,	www.mouser.com	517-834-01-03
0.1" pin strip socket, 2 pins	www.mouser.com	517-974-01-02
12V Power Supply	www.mouser.com	552-PSA-05A-120
Female Power Plug	www.mouser.com	163-4302

NX-01 LED parts list

Quantity	Description	Vendor	Part Number
2	Dimmed Impulse Blues	superbrightleds.com	RL3-B2030
2	Bussard Collector Red	superbrightleds.com	RL5-8030
4	Warp Nacelle Blue	superbrightleds.com	RL5-B5515
1	Nacelle Marker Red	mouser.com	638-204HD
1	Nacelle Marker Green	mouser.com	638-204GT
2	Nacelle Marker White	superbrightleds.com	RL3-W3030
1	Saucer Marker Red	superbrightleds.com	RL5-R-8030
1	Saucer Marker Green	superbrightleds.com	RL5-G8020
2	Aux Engine Blue	mouser.com	638-1224SUBCC470S
2	Saucer Dome White	superbrightleds.com	RL5-W6030
1	Saucer Spots Blue	superbrightleds.com	RL5-B5515
3	Interior Flood Light White	superbrightleds.com	RL5-18015
1	Saucer Spots White	superbrightleds.com	RL5-18015
2	Deflector Dish Backlight Blue	mouser.com	638-1224SUBCC470S
1	Aft Dome Blue	mouser.com	638-1224SUBCC470S

1	Aft Running Lights White	superbrightleds.com	RL3-W3030
2	Bright Impulse Blues	superbrightleds.com	RL3-B2030

Note:

Madman Lighting sells these parts as a complete kit. Contact [johndavidcook@verizon.net](mailto: johndavidcook@verizon.net) for details and pricing.