Electrical supplies for models and modelling.

The creation of this article was prompted by the need for a power supply to the Lego serving machine, but will be an article about low Voltage power supplies in general, not the things they'll be used to supply.

Low Voltage 'Mains' Power Supplies

You've probably seen, and may possess, a power supply similar to one of these:

They are, from left to right:

1. A new 12 Volt 2 Amp LED power supply.
2. An old 6 Volt 2.1 Amp power supply (original use unknown).
3. A new micro USB power supply.

The ones pictured all fit U.K. 13A sockets, but versions are made for various countries' sockets.

Let's discuss power supply No. 2, to start with.
The first thing you'll notice if you pick one like this up is the weight. It weighs over half a kilogram, that's five times the weight of power supply No. 1, (which has twice the power output). That's because it's got a mains transformer inside it.

This is what the nameplate says:

Seems reasonable and could be useful, let's plug it in and see what we get:

Not the Voltage you might have been expecting!

These types of power supply are unregulated. That means that with no load connected and to allow for further Voltage drop on load, they will give out somewhere over 1 ½ times the nominal Voltage.

The other power supplies are what are known as 'Switch-mode' power supplies. They use electronic circuitry rather than a mains transformer, hence the difference in weight. More to the point, they are regulated power supplies and give a constant Voltage output regardless of load.
Not that it matters, but they're also far more efficient.

That doesn't mean that this particular power supply is of no use, but unless you have access to a Voltmeter and know what you're doing (or 'know a man who does'), they're best avoided.

Power supply No. 1 is designed for LED lighting. Power supplies like this are very cheap and useable without modification. This one cost £2.64, about $3.50.

Power supplies No.3 is a micro USB supply. Similar power supplies are available with a variety of USB or power connectors. Although these types of power supply are probably the most useful, the problem is connecting to them.

Power Supply Connections

Low Voltage DC power supplies are usually fitted with a co-axial connector like this:

This is the plug, because this is the supply, the plug is a female connector; the socket on the device to be powered is the male connector. There are three separate measurements to define the size of the connector: the outside diameter of the barrel (the negative connection), the diameter of the centre hole (the positive connection) and the length of the barrel. The latter measurement is relatively unimportant and isn't usually specified.
Although there is a standard for these plugs, there appear to be many other sizes available and in use to fit various manufacturers' propriety sockets.
The same can't be said for the sockets, the types and sizes available are very limited. I would suggest using a connector with a 5.5mm barrel diameter and a 2.1mm centre hole (or pin) diameter. In line and chassis mounting sockets are readily available in this size.
12 Volt power supplies seem to have 5.5mm x 2.1mm plugs fitted to them so there's no problem connecting these.
Looking at adverts for the 5 Volt power supplies, a large number show the same picture and they have the same details as each other. They give the 'dimensions' as 3mm x 1mm. Assuming that's the plug size (there is a standard size of 3mm x 1.1mm) you will have great difficulty sourcing sockets to match. There are units available with 5.5mm diameter bodies and 2.1mm or 2.5mm pins so I'd suggest buying the 2.1 mm version of one of these; alternatively, be prepared to replace the plug supplied.
There is no guidance with regard to size versus Voltage, but if you have any 12 Volt power supplies with 2.1mm plugs, be careful not to plug them into a 5 Volt circuit.

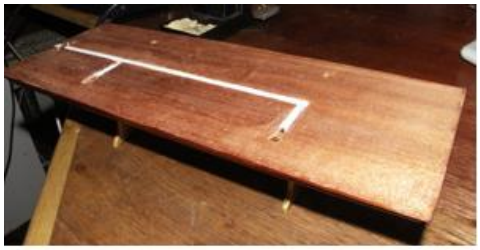
There are a couple of connectors available that were, I believe, developed for use with CCTV cameras. These convert from the DC plugs or sockets to screw terminals.

The manufacturer's part numbers of these are CLB-JL-52 and CLB-JL-53. The socket version (CLB-JL-53) will allow simple connection to Lego plugs.

There is an alternative way of obtaining and connecting 5 Volt supplies, especially connecting to the stand if you intend to power LED lighting through the model's pillars/mounting screws. You can buy USB leads that run to DC plugs and also leads with a DC socket running to open ends:

This combination will get you a 5 Volt DC supply from any USB socket, e.g. a modern mains outlet of the type with a built in USB socket, one of the mains power supplies of the type shown below, or even your PC.

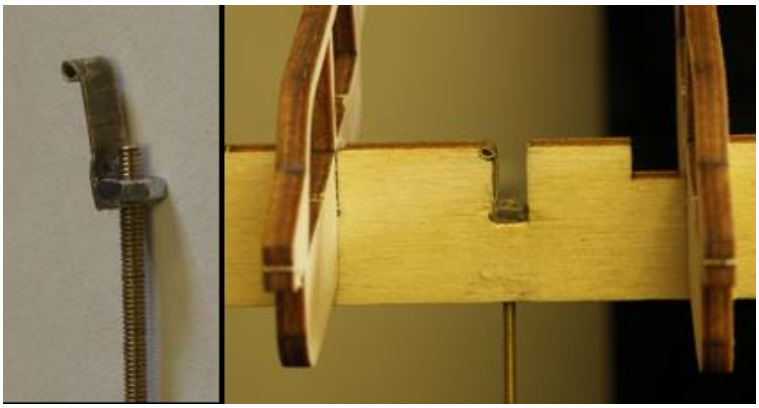
Connecting the supply to the models mounting screws can be done using the DC connecting lead with the open ends something like this:



(In the example above, there were four mounting screws rather than the normal two along the centre line.)

Here are a couple of examples of how to get the power from the mounting screws inside the model.

In this example, the model was mounted using screwed rods:



Another bulkhead fits in slot above the rod.

In the next example, the model was held in position with wood screws screwed into the keel:

The bronze strip is springy and reaches down to the centre line of the screw hole.

If the 5 Volt supply is to power Lego (the Lego 4.5 Volt motors will run with no problems on a 5 Volt supply), you will need at least one Lego plug like these:

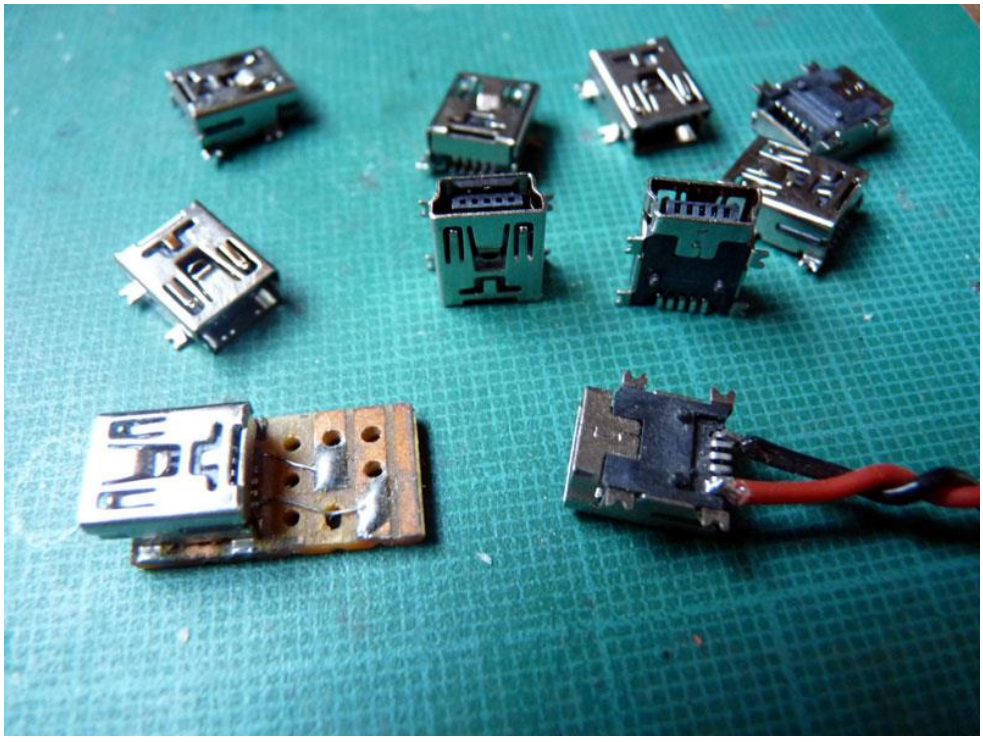
Plug bb81c01

Plug 766c01

These two plug types are identical other than the addition of a central hole and plastic pin on the 766c01 plug.
I have no idea why there are two types. The only things I've found that the 766c01 plug wont plug into are some of the 6216m electric motors. Strangely, there are two versions of motor, one with a hole in the end to accept the pin and one without which you can only use with the bb81c01 plug. The answer's simple, buy whichever motor or plug you want. If the ones you've got don't fit together, either cut the plastic pin off the plug or drill a matching hole in the end of the motor (or do both!)

If you're planning to only use the power supply to power the Lego, you can forgo the DC plug completely and simply screw the Lego plug onto the power supply leads. Otherwise, use an in-line power socket to connect to the Lego plug.

If you are wanting to power LED lighting on your model, but don't want a permanently attached power lead as described above. there is another option. You can buy USB sockets and install them either in the base, as above, or directly into your model.



The advantage of using these is that you can use a standard USB lead or plug top power supply and the sockets are neat, inconspicuous and extremely cheap.
The disadvantage is that you're faced with a delicate soldering job!

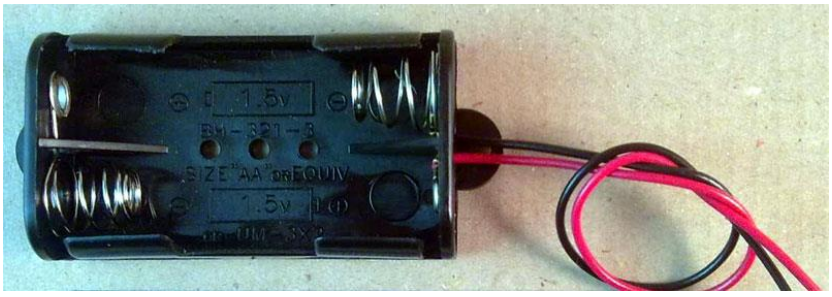
You can simply solder the leads directly to the socket pins, but there's not much clearance between pins and you then need some way of mounting the socket.
The sockets do have two tiny locating pins on the base so they can be clamped down, but they are designed to be soldered to a printed circuit board.
The socket at the bottom left has been soldered to a small piece of strip board (Veroboard). The two thin strands of wire were relatively easy to solder to the socket pins and the tracks were cut away in the area under the leads. The unit can easily be epoxied into position.

If you are using an Arduino to control the lights as per this topic, you can power the Arduino via its 5 Volt input from this usb socket, but the recommended method is to supply it via its on-board regulator. You can do this by connecting a 12 Volt supply either to the Arduino's V_{in} supply terminal or its on-board power socket.

Battery Supplies

This article is not intended to cover radio controlled models. The most likely use of batteries on a ship model is therefore for lighting.

An LED operates at around 2 Volts so you need at least two 1 ½ Volt cells to power them.
The power consumption of LED lighting is relatively low, but still significant. An LED will typically take between 10 and 20 mA so a load of several hundred mA is possible if you have a large number of lights. That means that your batteries may only last for a few hours. If you're only turning them on for a short period you can use normal non rechargeable AA batteries in a holder like this:



The problem is that you need reasonable access to replace the batteries. Even if you use rechargeable batteries, you probably need to remove them to charge them. Rechargeable batteries are now usually NiMH rather than NiCad and ideally need a special type of charger that stops charging when the battery is fully charged. These chargers usually require you to remove the batteries from whatever they're powering and insert them into the charger. That's not really a practical option with model sailing ships but may be viable on other model types.

In most cases, I'd suggest using a mains power supply for a static model.

Arthur Wallis – May 2018