Equipment Review: The Nova Caving Lamp

The Nova, from Speleo Technics, is the first commercially available caving lamp to use the Luxeon 5W single-chip LED. ***David Gibson*** *describes how the lamp fared underground and offers some thoughts on how the design could be enhanced.*

The name of Speleo Technics is well-known amongst cavers for their innovative battery packs, such as the FX2, and the FX-ion. Now Speleo Technics have produced another amazing product, the Nova caving lamp. This lamp is, I am sure, the first commercially-available caving lamp to use the new 5 watt LEDs that are now on the market, and possibly it is the first head torch of any type to do so. We can expect it to revolutionise cave lighting systems in a similar way to the FX2 although, at only a penny under £100, it may be too pricey for some people at the moment.

Features

The revolution will come about for a number of reasons. The Nova is small and lightweight compared with the traditional miner's caplamp, and it is fully waterproof; it is very bright, and the brightness can be adjusted; the LED is long-lasting (many thousands of hours of use can be expected) and it can be used with a variety of battery packs. There are other subtler benefits – for example, unlike a traditional lamp, the Nova does not get dimmer as the battery voltage drops. This is because it uses what is called a 'switch-mode power supply' or 'switching regulator' to convert the battery voltage to the exact voltage required by the lamp. Because of this, the lamp is not particularly fussy about the battery pack and it will operate from an FX2, FX3, Headlite or FX-ion battery pack and from alkaline cells (e.g. a 4.5V 'Duracell' MN1203).

Trials Underground

Underground, I was impressed with the brightness and the clarity of the beam. Users of LED lamps will already know that LED beams tend to be much more even and consistent than those of a filament lamp. The Nova has a bright central beam that is not too narrow, and it has just the right amount of 'spill' around the beam. Compared with a random selection of my colleagues' electric lamps, it was easily the brightest and most penetrating. On its #2 setting (with #1 being the dimmest) it outperformed my Speleo Technics Headlite, which has a similar beam spread, and had a lower power drain.

I thought the most useful feature was the ability to dim the light. Unlike a filament lamp, LEDs can be dimmed without losing efficiency or changing colour. This means that you can select the lighting level to fit your requirements. At full power the Nova uses about 5W, which would give (according to the literature) 5 hours' life from an FX3 or 2 hours from a Headlite. The Nova has five brightness settings, giving a duration of ×1, ×2, ×3, ×5 and ×6 of the full-power setting. The ×6 setting is quite dim, corresponding to that of a seven-LED lamp, or thereabouts, but obviously this setting gives a six-times increase in battery life, and it is perfectly adequate as a 'pilot' beam.

The Speleo Technics Nova
The circular disc forms a heatsink for the 5W LED. The lamp is controlled by a magnetic switch, with the magnet housed inside the flexible lever to the left of the main photo. The domed cover is a replaceable plastic 'dust cap'. The lamp uses Speleo Technics' standard moulded plug. The cable is protected with a spiral cable wrap

Although it was useful to be able to dim the light, I did find it difficult to work out which brightness setting I was using. The switch allows you to cycle through the settings, from dim to bright, back down to dim and so on, but I found the switch awkward. It is a sealed magnetic sensor that requires you to flick a small flexible lever which briefly moves the magnet away from the sensor; and it did seem, on occasions, as if it had a mind of its own. A more tactile switch would be an advantage here.

To turn the lamp off, you flick the switch lever, holding it down for two seconds. The lamp 'remembers' the setting and powers-up at that level – or at least, that is the intention. Unfortunately, the act of flicking the switch moves the lamp to the next brightness level in the sequence. This is frustrating because it means that if you set the lamp to its dimmest setting, and then turn it off and on, it comes on at level 2 and requires much fiddling to restore the level you want – even supposing you noticed the problem. If you turn the lamp off at a mid-range setting, or if you just want to boost the light level for a few minutes it is quite a palaver to restore your setting.

These difficulties make me wonder whether it would be better for the light levels to cycle from 1 to 5 and then straight down to 1 again; and whether five levels is too many anyway; and whether it would be better if the lamp always came on at level 1? One of the advantages of having a microprocessor-controlled lamp is that the software is, presumably, easily altered by the manufacturer – and the problem with the lamp changing its setting as you switch it off is surely just a software oversight? The down-side is, of course, that every customer will have a different – and perhaps vociferous – idea about what is best! I wonder if we will end up checking version numbers when we buy the lamp?

When the battery starts to fail, the lamp

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Suggested Design Improvements

We must not lose sight of the fact that a commercial design is constrained for financial reasons. For example, the magnetic switch on the Nova is a cheap solution, and it would simply not be viable for the lamp to feature a shock-proof IP68-rated waterproof switch!

Any suggestions we might make regarding design improvements have to be weighed against the cost of implementing them. However, as electronics enthusiasts, it is certainly OK for us to discuss the improvements that we would wish to incorporate into home-made lamps, even though they might not be financially viable in a commercial product.

Overheating

A small thermistor, monitored by the microcontroller would eliminate any possibility of the device overheating when left switched on in a confined space. This sounds a simple modification but, commercially, even the small cost of a thermistor may not be justified. However, we can afford to be more indulgent.

Quiescent Current

Although, as I have been careful to point out, commercial design decisions rule the day, it does seem difficult to see why the Nova design had to have such an alarmingly high quiescent current. At a guess, I am assuming that it uses a Hall-effect sensor that draws the high current. (If it is actually the MCU that is eating up the current then something is *very* wrong!). There are several easy-to-implement solutions to the high current consumption of the sensor, but the obvious one is to power it on a low duty cycle.

I think this is my main criticism of this lamp – the current drain is a very annoying problem and there is simply no need for the design to suffer from this limitation!

Voltage Limitation

The Nova uses a step-up regulator, but the control circuit is limited to 5V, which is why it will not work with an FX5 (5–8V). The 'hobbyist' solution (where expense is no object) would be to power the device via a series-pass regulator from the output in a 'boot-strap' technique. Other solutions to this problem are possible.

responds by progressively switching to lower brightness levels, which is sensible. When the battery is almost dead the lamp starts to flicker, as a warning. This starts off fast and gets progressively slower; which is a strange effect, although the warning is appreciated. I measured the battery voltage in this situation, and I think it is fair to say that the flickering really *does* mean that there is *no* useful life left in the battery! I found I had perhaps five minutes of light left in this situation.

The Nova comes with a cable and plug, suitable for Speleo Technics' range of battery packs. A helmet-mounted housing is also provided, suitable for a 4.5V alkaline battery. One point to bear in mind is that the headset has a polarity, and you must not connect the battery backwards. The supplied housing (right) has a diode built in, to protect from damage caused by a reverse connection. If you it with rechargeable Ni-MH cells – as I did – this diode is a nuisance as it prevents you from recharging through the connector. I suppose the reason the protection diode is not in the headset is that it is only needed for the customer-filled battery housing.

Alkaline batteries are not capable of providing 5W for very long and the instructions warn the user to limit himself to the lower two light levels. However, I found that the problems in keeping track of the lighting level made it difficult to use an alkaline battery successfully. One of the problems with having a very bright 5W setting is that it is all too easy to leave the lamp on this setting by accident. Entering a cave from bright daylight, you must consciously tell yourself not to turn the brightness up, but to wait for your eyes to adjust.

The Luxeon LED and its collimator (the reflector that produces the beam) is sealed in the headset along with the electronics, but there is a clear plastic cap in front of the LED to protect it from dirt. This cap is not part of the sealed unit. It did not cause me any problems, but I have heard of occasions when water has got behind this protective cap. If this happens it is possible to prise out the cap and dry it. In fact, it is not essential to use the lens cap at all, although, for caving, it serves to protect the LEDs against scratching. Unfortunately, the plastic cap is, itself, very prone to scratching. Mine was visibly scuffed after only two caving trips – possibly this was as a result of being shoved into my rucksack. Speleo Technics do provide spare lens caps, but I wonder whether a small disc of toughened glass might not have served the purpose better?

A possible longer-term cause of problems is the cable connected to the headset. Because the ends of the cable are encapsulated, repairing a damaged cable could be difficult. Speleo Technics has foreseen this and provides a length of spiral 'cable wrap' to protect the cable.

Drawbacks (see box above)

There are some words of caution that need to be observed with this lamp. For example, it draws a small current even when it is switched off. The instructions warn the user to disconnect it from the battery pack when not in use. What the instructions *don't* say is that the current drain is over 6mA and that this will drain a Headlite battery pack in only two weeks! The instructions also warn against leaving the Nova connected to a battery in your rucksack, because it could accidentally switch on and overheat. Thirdly, the lamp must not be used with an FX5, as this has too high a voltage. Given that the Nova has a 5W capability, the inability to operate with an FX5 is a disappointment.

One final point – despite the CE marking on this product, we found it to cause an intolerable level of interference to cave radio equipment. See *Further Reading* below.

The magnetic switch
I found this difficult to operate due to the lack of tactile feedback. (A switch that 'clicks' as it operates would be preferable).

Concluding Remarks

There is no doubt that the Nova is an excellent product and that, once again, Speleo Technics have shown that they lead the way in cave lighting products. But it is somewhat disappointing that the design has the drawbacks mentioned above. As an electronic engineer, I *know* that these drawbacks – the current drain when switched off, the overheating possibility and voltage limitation – are not insurmountable. Likewise, although the magnetic sensor is a neat solution to the problem of waterproofing a switch, there are other, more tactile methods of achieving the same result.

However, these drawbacks will not stop me using the lamp – it has replaced my existing lamp as part of my current caving gear. I look forward to many years of service from it and I would definitely recommend it.

In the next journal we will describe Mike Cowlishaw's home-made Luxeon design (see **www.speleogroup.org/ attinya.html**)

Further Reading

Gibson, David (2003), *The Luxeon White LED*, CREGJ **53**, pp15 & 31, Sept. 2003.
(This article lists references to previous articles on White LEDs and caving lamps)

Bedford, Mike (2003), *Cave Radio Interference from LED Lamps*, CREGJ **54**, p8, Dec. 2003.

Ross, Chris (2003), *Letter: LED Drivers & Cave Radios*, CREGJ **54**, p31, Dec. 2003

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