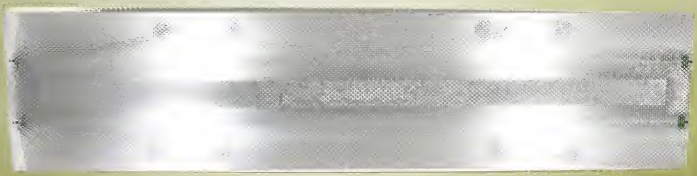
When you need to shed some light on the subject . . .



Solar-Powered Skylight

with fluoro "backup"

by Ross Tester

Why pay a lot of money for a skylight to be installed when you can take advantage of modern technology – solar panels and ultrabright LEDs – to achieve effectively the same thing – for $$$ less!

Skylights are a great idea for dark or dim rooms. I should know, I installed two on my roof about 30 years ago to light up an internal bathroom and kitchen.

But they're not cheap – expect to pay at least at least a couple of hundred dollars each – and then about the same for installation.

You have to cut a suitable hole in the roof itself, then cut an appropriate size hole in the ceiling, install a light well or tube, fit the whole lot . . . it's not a real simple job and of course, there will always be a ceiling joist or roof support just where you want to fit it!

Here's an alternative: an electronic or "solar" skylight.

You simply mount a solar panel on the outside of the roof in an appropriate spot and use its output to drive some of the ultrabright 20W LEDs which we featured in our LED Floodlamp (August 2012).

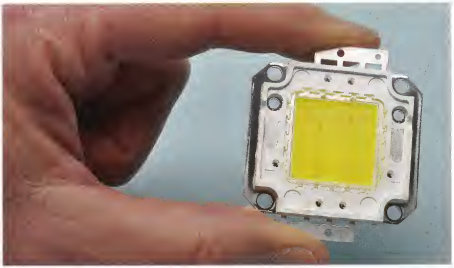
These can be located wherever you need extra light – unlike a conventional skylight, there's no need for a physical connection between the two (of course, there's an electrical connection but that can be many metres, if need be).

Installation should be a lot simpler (well within the capabilities of home handymen/women) and you can position the LEDs exactly where you want them, not where roof trusses and ceiling joists and battens dictate they must go.

This was the scenario presented to us by Oatley Electronics, the same people who provide the kit for the 10 and 20W LED floodlamps. For a little over a hundred dollars, they supply a large (1200 x 600mm) "First Solar" FS-272 solar panel and four 20W LEDs. The panel is rated at 72W; 90V open-circuit – so it's got a "bit-o-bite!".

No batteries, no controller

The LEDs are connected in series/parallel and wired straight to the solar panel. There is no battery to charge,



Four of these 20W LED arrays are supplied in the Oatley Electronics kit, along with a 90V/72W Solar Panel (see photo above right). The LED here is shown not too far off life size.

therefore there is no controller needed. Neither is there a current-limiting circuit required for the LEDs as the system is basically self-regulating. But more on this anon.

While we could see the merit in this simple system, we thought that it could be expanded somewhat. After all, no-one wants four very bright LEDs mounted on the ceiling. At minimum, they would need some sort of diffuser and some means of heatsinking.

Second problem we thought of was almost a "duh" moment. The LEDs would only be on during daylight hours (ie, when the sun is allowing the panel to produce power). Duh! Reminds us of the Irish flashlight company that went broke producing solar-powered torches . . .

What do you do at night – you'd still need a more-or-less traditional light, or perhaps you would then need a power supply to drive the LEDs?

The lightbulb moment

Then we thought "why not combine both of these ideas and mount the LEDs inside the light fitting?". We cosidered various types of light fittings which came with diffusers and, while most would be quite acceptable, we finally settled on a twin 36W fluoro "troffer".

Why did we choose this fitting? They're not the prettiest ever made but they do have a couple of big advantages – first, they're cheap. Second hand, you can almost always pick them up for next to nothing ($10 regularly on ebay, for example) but if you're a typical handyman/hobbyist, the chances are you've got one stored away somewhere. We certainly did!

Even new, they are often sub-$30 or so.

The other advantage of a fluoro light fitting is that there is plenty of room to work with. We tried a couple of different variations on the mounting-the-LED theme but finally settled on one scheme which worked well for us – you might find that another method works better for you.

Incidentally, we did go out and buy a brand-new fitting just to make sure we could use it. We could!

The fluoro fitting we bought was a "Clipsal" brand double 36W unit (model TB236NEL) which our local electrical wholesalers had on "special" for less than $30 – complete with triphosphor tubes. By the way, these fittings are referred to in the trade as "troffers". Just make sure when you get one that it comes with a diffuser.

Another advantage of using a new unit is that these days they come completely wired with cord and 3-pin 230V plug (electricians simply install them and plug them into roof cavity-mounted mains sockets).

If yours is a relatively modern home, the chances are your lighting is installed in the same way, so you won't be breaking any laws by plugging in a new fitting. You might like to fit a smaller (twin 18W) fitting if you think that the large one will look out of place.

And yet another reason for using a new fitting is that it will probably also have an electronic ballast fitted instead of the old-style iron-cored ballast – that will save you a few dollars over the years as iron-cored ballasts waste quite a bit of energy in the form of heat. (Hey, don't knock it: have you looked at YOUR power bill lately?)

So now that we had both the LED mounting method AND the diffuser problem solved, we went about fitting the troffer with the LEDs.

Heatsinking

Our first thought was that the steel case of the troffer might be adequate as a heatsink for the LEDs – but this thought quickly diminished as we smelled some LEDs getting a little upset (despite prodigious globs of heatsink compound).

So we elected to mount the LEDs on small pieces of thick aluminium and firmly bond them to the cases – again, with plenty of heatsink compound on both the back of the LEDs and between the aluminium and steel.

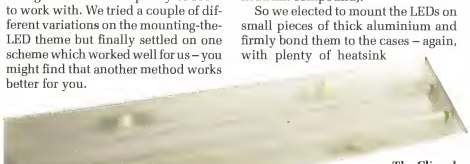
The "First Solar" FS-272 Solar Panel drives the four LED arrays direct – no controller is required. In bright sunlight, maximum output is 72W and the four LEDs are each rated at 20W (80W total).

The aluminium we used was actually some offcuts of flat bar which we happened to have on hand from a previous job. It's about 4mm thick and about 30mm wide; each piece about 100mm long.

Ideally, we would have liked it to be about 50mm or 60mm wide in order to mount the LEDs square-on but elected to use what we had rather than buy more (aluminium is expensive these days!).

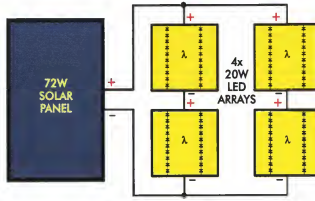
To secure the LEDs to these heatsinks we turned them through 45° and used only two of the four mounting holes. This secures them more than adequately, especially with a large dollop of heatsink compound under the LED.

Each bar was drilled with four 3mm holes – two for attaching the bar to the troffer and the other two, countersunk from the underside, were for attaching the LEDs with M3 12mm countersunk-head screws, nuts and shakeproof washers. Using countersunk-head



The Clipsal TB236NEL T-Bar Troffer we purchased for this project. It's shown here fitted with the four LED arrays, just visible through the Perspex diffuser. A diffuser is essential for use in domestic situations – the light from the four LED arrays is simply too bright without one.

The 20W LED arrays are connected in series/parallel. We didn't worry about a power switch because "normal" skylights don't have any means of turning the light on and off. While ever there is light, the LEDs will light up. While ever there is bright sunshine, the LEDs will light up brilliantly!



screws ensures that the maximum metal-to-metal contact is made when the bar is screwed onto the troffer.

Incidentally, in use the troffer case immediately under the LEDs gets barely warm, so it is achieving the aim of getting rid of the heat.

The first thing we did when we mounted the LEDs on their heatsinks was to clearly mark the heatsink with a marker pen + and -. As we explained in the LED floodlight, the markings on the LEDs themselves are quite difficult to see (impossible in low lighting) so you need to make sure you can't make a wiring error.

LED placement within the fitting

We had a bit of a quandary here but soon proved – by trial and error – that it didn't really matter too much where we placed the LEDs within the fitting.

In the end, we made up two fluoros with two different LED arrangements. In one, the older fitting which we had on hand, we placed the four LEDs equidistant down the centre – ie, arranged between the two fluoro tubes. This worked pretty well and had the added advantage (at least in the fitting we "doctored") that we didn't have to remove the cover to give access to the bitey bits.

The new troffer we bought specifically for this project was a bit more of a challenge. It had a centre U-shaped guard to hide the mains wiring and placing the LEDs on top of this put them too close to the perspex diffuser (in fact, virtually touching it).

We figured the diffuser would either discolour quickly or worse, melt under the heat.

And removing the guard we didn't think would be politically correct!

In the end, we tried the LEDs arranged down the sides of the troffer. This appeared to give a nice light coverage so this is what we decided on. Sure, all four LEDs are quite visible when alight, even through the diffuser – but does this really matter? We think not.

Again, the pictures tell a thousand words.

Because the LEDs get rather warm, they need to be mounted so that they are well away from ballasts, starters and so on. It also looks best if they are evenly spaced along the fitting. We tried staggering them as well as across from each other but the light output didn't seem to be affected either way.

As we mentioned earlier, the LEDs are connected in series/parallel. In other words, two LEDs are connected in parallel, then those two are wired in series with the other pair (also wired in parallel).

The wire used must have a rating of at least 2A (3A or more is better) and its insulation needs to be rated at 250V or more.

If you use an old fitting without the wiring guards of modern-day fluoros, all low-voltage wiring needs to be kept well separated from the mains wiring. Use plenty of cable ties to ensure that in the unlikely event of a cable coming loose, it would not be able to move around and short to any other wiring.

Most fluoro fittings have plenty of cutouts and tabs which can be used as handy anchor points for cable ties.

Other fittings?

Of course, the LED positions we decided on are not the only options, nor are 36W dual fluoro lamp fittings. We've already mentioned the possibility of using dual 18W fluoros but possibly bearing some further investigation would be the use of some "oyster" light fittings, the ones fitted with a metal base. That would be needed to dissipate some of the heat given off by the LEDs.

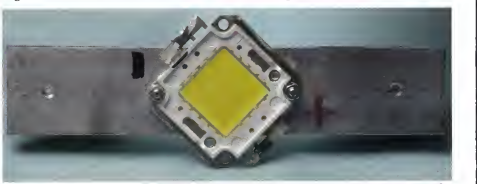
One major difficulty here would be that the amount of light from the LEDs might be considered far too high – it would be much more than the light from the (usual) 32W round fluoro tube they usually come with (or in some cases, a pair of CFLs).

We haven't tried these so can't give any guidance, except for the reminder to keep the LEDs well separated from other wiring and also to keep the maximum distance between LEDs and diffuser. Once again, wiring needs to be 250V rated and firmly anchored with cable ties, etc.

Whatever you end up using, make sure you use copious amounts of heatsink compound and, again, mount the LEDs on individual heatsinks (thick aluminum sheet?) which are themselves made secure to as much metal as possible.

Mounting and connecting the solar panel

No mounting hardware is supplied with the solar panel but brackets etc, are quite widely available so you can suit yourself how you mount it. Like all solar panels in the southern hemi-



Here's how we mounted the LED array on the aluminium bar offcuts. Ideally, the bar should be a little wider to allow "square on" mounting but this arrangement works quite well. Note the large polarity markings on the aluminium – these are to make sure that Murphy bloke doesn't put in an appearance.

Here's how we placed the four LED arrays (with heatsinks) in the quite old fluoro fitting we had on hand – obviously before wiring and without the tubes or diffuser. The LEDs actually fit the between the two tubes – there's not a huge amount of heat given off in the forward direction and the tubes seem to cope quite well with it (they actually get fairly warm themselves).

sphere, it needs to be mounted on a north-facing roof (or backyard support) with the angle above horizontal dependent on your latitude.

There's plenty of information on the net about best solar panel positioning.

Unfortunately, the connectors on the "First Solar" panel are not the usual 4mm standard you'll find on the vast majority of solar panels. We couldn't find suitable male and female connectors so the best option appears to be cutting the connectors off and soldering your wires directly to them.

Ensure that you identify which are the positive and negative terminals – and mark them. It won't work if you get it back to front!

And just be warned, the solar panel produces a significant voltage even in subdued light (50V or so), so you don't want to get across that (especially with your soldering iron!).

Speaking of wires, it makes sense to use a cable which has minimum voltage drop between the panel and the LEDs. While the total current will only be an amp or so, small diameter cable (ergo, higher resistance) will lose more power than a larger diameter cable (more copper, lower resistance).

For the same reason, keep your cable run to the minimum possible. Mains-rated, polarised heavy-duty Figure-8 cable should be suitable but again, watch polarity. If it isn't the traditional red/black (the best choice), make sure you know which cable is + and which is – (while there is no real convention, traditionally we've made the stripe negative).

Where any cable needs to pass through a roof, ceiling, case etc, ensure that it is adequately protected against chafing and damage – things do move!

In use

One of the things we wanted to compare was the light output between the four LEDs and the two fluoros. On a fairly sunny day (sunlight through whispy cloud but throwing a distinct shadow) we measured the output of the LEDs, with diffuser fitted, as 170 lux at a distance of 2.2m.

The fluoros, same conditions, came in at 270 lux. Obviously, the fluoros are half as bright again as the LEDs.

But does this matter?

Arguably not – a traditional skylight is intended to fill in "light holes" and apart from the size of the skylight itself, you don't have much control over how much sunlight is transmitted down to the room.

It's the same with the LED version – because it has no batteries to store power, you're basically at the mercy of the weather. You should get lots of light on a bright sunny day; under heavy overcast it will be less – possibly a lot less.

But we have to qualify this by saying that even under a heavy overcast day, with the solar panel producing only about 50V open-circuit, we still got some light from the LEDs.

Of course, if lack of natural light is a problem due to the weather, you can simply flick the light switch and let the fluoros take over.

We found no problems running both the fluoros and LEDs at the same time – in fact, we didn't even worry about putting a switch in for the LEDs.

One final thing – from what we've read, the solar panel supplied (with Cadmium Telluride cells) is much more forgiving when it comes to the shading problems you've probably heard about with older panels.

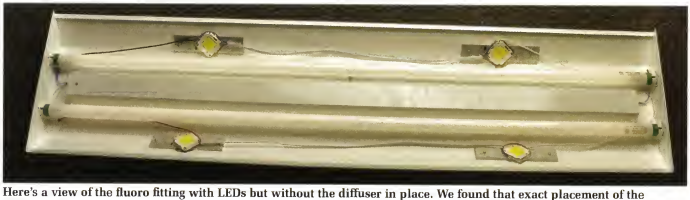
In fact, walking in front of the panel (and casting a significant shadow over it) only dropped the output by a volt or so.

We've heard of many panels which lose dramatically more than this when even very lightly shaded. **SC**

Where from, how much:

The K-328 kit from Oatley Electronics includes the First Solar 1200 x 600mm solar panel and four 20W LED arrays. It retails for $109.00 inc GST but note that due to the significant weight of the solar panel (12kg) there is a freight charge depending on distance.

Contact Oatley Electronics on (02) 9586 3564; email sales@oatleyelectronics.com; write to them at PO Box 89 Oatley NSW 2223, or visit their website: www.oatleyelectronics.com



Here's a view of the fluoro fitting with LEDs but without the diffuser in place. We found that exact placement of the LEDs was not necessary – they performed well wherever they were placed. We've spaced them out to allow better heat dissipation.

Silicon Chip Magazine has many projects that use parts that are difficult to find. Others use pre-programmed Microcontrollers

These can often be purchased from the Silicon Chip Store. Copy and paste the following URL and you may be able to find all the harder to get parts. While parts from older projects are subject to availability, they still have an amazing selection.

It is also suggested that you may want to subscribe to the online edition of the publication to get the very latest information on exciting electronic projects.

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