

# Case Study



## Case Study: Beyond Compact Fluorescent Lighting

**LUXEON Rebel enables highly-efficient replacement for compact fluorescent lamp (CFL) downlighter.**

The promise of more efficient solid-state lighting solutions that deliver high quality light, reduced energy consumption and lower ownership costs is being met by an innovative downlighter from IST in the United Kingdom. IST's new solutions, the DL-080 and DL-090, take advantage of the latest generation of power LEDs that are smaller and provide high flux and efficiency resulting in a recessed luminaire appropriate for both commercial and residential applications.

Integrated System Technologies Ltd (IST) was originally formed as a lighting-optics and filters company, but over the last two years has focused its research and development on harnessing LED technology, which has subsequently become the core of their business.

"The potential market for more efficient solid-state lighting solutions is enormous, however the development of quality solutions that achieve the efficiency, energy savings and longevity requires significant effort well beyond what is available within most traditional lighting companies." explains Matt Fitzpatrick, Director of IST. "If designed and manufactured properly, these solutions will reduce users' energy bills and will pay for themselves in a relatively short period of time."

Regulators, utilities, and environmental concerns also recognize the potential for solid-state lighting solutions and are establishing guidelines and programs for solution developers and consumers that instill confidence and make the market more appealing. The combination of market desire and the forward development of the power LED technology spurred IST begin its development effort in late 2007.

"Convincing the market to adopt new technology means you need to aim high. A slight improvement over the incumbent technology is not a great motivator for the mass market. Lighting designers will only be concerned with LED technology if it uses significantly lower power and runs for significantly longer without maintenance."

- Matt Fitzpatrick  
IST Director



## The Technical Challenges

If LEDs offer the potential to revolutionize everyday white light applications, then why do we still see CFLs in the shops? IST soon found that improving on CFLs posed a number of design challenges.

“Convincing the market to adopt new technology means you need to aim high,” Matt clarifies. “A slight improvement over the incumbent technology is not a great motivator for the mass market. Lighting designers will only be concerned with LED technology if it uses significantly lower power and runs for significantly longer without maintenance.”

To gauge what they were up against in terms of lumens-per-Watt performance, IST had a twin 26 Watt CFL downlighter independently tested at the Photonics Cluster in the UK. It was found that

the CFL consumed around 68 Watts of input power. The lamp lumens were rated at 3600; however, when tested in an integrating sphere, the lamp only emitted 1750 lumens. This meant the actual lumens-per-Watt was 25.7 lm/W.

Replacing CFLs would require an improvement on this figure, which meant finding light source solution that offered suitable dimensions and lifetime, was available and supportable, could be affordably manufactured and that would provide the giant leaps in terms of lumens per Watt.

“What I felt was paramount for this product to be adopted by the lighting community is that we supplied data in the same format as a compact fluorescent,” explains Matt. “This meant, before I agreed for the product to be launched, we had all the photometric and polar diagrams for each option; along with TM14, IES and EuLumdat files for clients who use lighting design software.”

In conjunction with IST, Future Lighting Solutions (FLS) has been lighting their new EMEA Headquarters, based in Egham, UK, with Solid-State Lighting. In a drive to show how high-power LEDs can be used today in functional lighting, FLS has installed many LUXEON® based light fixtures including the DL-080 from IST. The first installations, pictured in this case study, are the executive meeting rooms which are entirely lit with Solid-State Lighting. This is just one of many examples within the new headquarters where SSL solutions are being introduced as part of the functional lighting. FLS isn't just making LED solutions simple with tools like the Usable Light Tool, they are incorporating LED solutions and plan to replace all conventional based lighting in the offices with LED based fixtures.

IST set out to design this downlighter in a way that installers and specifiers could work with, including the performance, physical size, and types of fitting. The new solutions had to match the broad spread of light produced by a CFL. IST found that delivering this with certain LEDs would be challenging.

Laminar products produced as a chip array were considered. These were able to offer the correct spread of light, but in production they would have been prohibitively expensive. IST also found that most of the LEDs that they trialed were intended for use with individual optics, producing light output that was far too directional. LUXEON Rebel was one of the few available high-power LED products that could deliver the required spread of light, without pushing up costs. With LUXEON Rebel LEDs, IST was able to use a reflector with a cover, instead of individual optics, achieving a 50° beam width, and closely approximating a CFL.

The form of the downlighter itself was just as important as the pattern of the light output. To match the form factor of a conventional 2 x 26W CFL downlighter, the design required all the LEDs to be grouped on a 34mm diameter disc. The form factor of the LUXEON Rebel was key to making this a possibility, as 16 LUXEON Rebel LEDs could be grouped on a single 34mm diameter disc.



“Since the lifetime of an LED source is closely related to temperature, the small size of LUXEON Rebel provided invaluable freedom to design an effective heatsink within the physical dimensions specified,” summarized Matt. The smaller size also provided the option of using more LUXEON LEDs at lower drive current as opposed to operating the LEDs at maximum conditions which could affect our lifetime objectives.

After review and assessment of power LEDs available, the small footprint, long lifetime, and proven reliability of the LUXEON Rebel made it the right selection for IST’s downlighter project.

With the power LED selection made, development of the system could proceed.

### Delivering a New Solution

Understanding how the new downlights would be implemented and used was critical to the development of a testing regime and setting performance objectives.



#### Part L - Fuel and Power Regulations

Part L of the UK government’s building regulations addresses the conservation of fuel and power.

To be compliant Part L stipulates that new and renovated properties must have a percentage of energy-saving light fittings. These fittings must have a luminous efficacy greater than 40 lumens per circuit-Watt. For fixed internal lighting, one compliant fitting should be used per 25m<sup>2</sup> of dwelling floor area, or one compliant fitting should be used per four fixed-lighting fittings.

By achieving 45 lm/Watt, IST’s downlighter can be used by developers and lighting designers to meet building regulations in new and renovated properties. For more information, the full regulations can be accessed via: [www.planningportal.gov.uk](http://www.planningportal.gov.uk).

To assure longevity, IST’s design considered worst-case thermal scenarios, such as installation in small positions where airflow or cooling is compromised. The downlight consumes 20W, of which about 75% or 15W is heat. IST’s thermal solution fit within the confines of a CFL-sized fixture and is capable of dissipating up to 40W. In testing, IST wrapped their downlighters in foam and left them running for a 72-hour period. The heatsink reached 90°C, indicating a junction temperature between 100°C and 105°C. This was well below the 120°C maximum junction temperature in this extreme case, and when driven at 350mA in 25°C ambient temperature, the junction temperature was calculated to be only 69°C.

With confidence in the thermal design, IST was able to move forward with development and testing. The finished LUXEON Rebel based downlights deliver 40 lumens-per-Watt and 45 lumens-per-Watt for the DL-080 and DL-090 respectively. By achieving 45 lm/Watt, the DL-090 is Part L compliant in the U.K. Part L requires that new and renovated properties must have a percentage of Part L compliant light fittings to meet UK building regulations.

The light engines for the DL-090 and DL-080 were independently measured at 1060 lumens and 963 lumens. These results were from units that had been operating for 1 hour and they were measured in an integrating sphere for accuracy. A CFL does emit more light, but consumes many more Watts in doing so. The power consumed by each downlighter is around 20 circuit Watts, which is approximately a third of the CFL equivalent.

The estimated return on investment for IST’s downlighters is between 2 and 2.75 years<sup>1</sup> in applications where lighting is used for 12 hours per day. To protect a return on

#### LUXEON Rebel Benefits for IST

- Smallest power LED— enables never before possible luminaire design
- Outstanding performance and efficacy
- Industry leading reliability and lumen maintenance
- Maximum usable light
- Simplified optical design

investment, ISTs downlighters would therefore need to guarantee operation for at least 2.75 years. The flexibility and lumen maintenance of the LUXEON Rebel LEDs, therefore, enabled IST to design a lamp with a 5 year guarantee. When compared to the return on investment of period of 2 years, this guarantee creates a strong financial case for lighting designer to work with IST's downlighters.

IST has already started work on their next version which will offer a variable color temperature version and also plans to offer mains dimming, high CRI, IP addressable, emergency lighting, and light/motion detection features.

Director, Matt Fitzpatrick has confidence in these LUXEON-based CFL replacements. "I believe our product and future variants are the first LED downlighters to be suitable for true white light applications from both a technical and commercial stand point."

"The potential market for more efficient solid-state lighting solutions is enormous, however the development of quality solutions that achieve the efficiency, energy savings and longevity requires significant effort well beyond what is available within most traditional lighting companies. If designed and manufactured properly, these solutions will reduce users' energy bills and will pay for themselves in a relatively short period of time."

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IST Director

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never before possible

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## Reference

\*1 The variables are dependant upon the volume of downlighters per application.

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