Application Note - AN1205

What to expect from your LED driver in the future.

Shane Callanan, Director of Applications Engineering, Excelsys Technologies looks at the challenges facing design teams in the design of LED drivers. He also looks at emerging trends in LED driver designs and will discuss what the future will offer in terms of feature sets.

Abstract:

LEDs are taking significant traction in the lighting market due their lifetime, low cost of running, and the ability to control them for specific requirements. However, in order to achieve all of these things you need to ensure that your power supply driving these LEDs is correctly specified in order to obtain the required performance. This discussion looks at the challenges facing a design team as they go through the specification and design stages of a power supply that will be used to drive High Brightness LEDs. It will describe the design brief, projected performance parameters of the product, standards to be complied to and operational features to be met. It will also discuss trends in power supplies and what the customer can expect to see in the future from their power supplies.

Take up of LEDs.

There is no doubt on the reasoning behind the large take up on LEDs for lighting. With a potential lifetime of 100,000+ hours (if you operate them correctly), no filaments or tubes, no mercury, easy to control wavelength of light and significantly more efficient, it is easy to convince ourselves why this is the right choice to generate our lighting requirementsgoing forward. LED chip manufacturers have been playing their part in developing more product imporvements over the last number of years, but how have the companies developing drivers being playing their part ?

What your driver should be specified to meet

First of all lets remind ourselves at what we would expect our driver to do for us. The first and foremost requirement is to convert AC power to DC power. In doing so it must also deal with PFC and THD issues since our LED load is no longer a purely resistive load. Fig 1 shows us some different results in this with respect to the mains source.

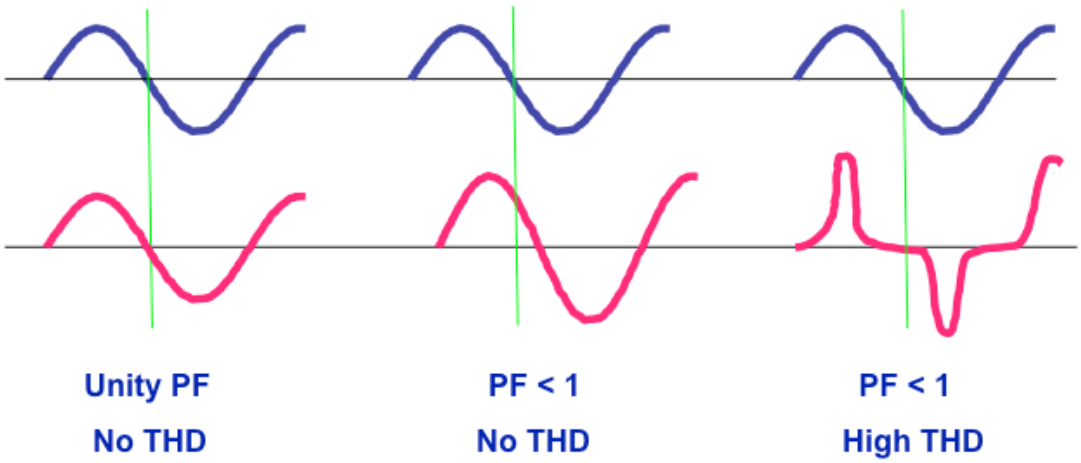

Fig 1: Incandescant light bulbs are purely resistive load, LEDs are not.

There will also be a requirement for the driver to meet additional safety requirements , and also some Electrical Magnetic Interfernce requirements. We would aslo expect to see some onbard safety requirements such as Over Current Protection (OCP) , Short Circuit Protection (SCP) , Over temparature Protection (OTP) and so on. Finally , because LEDs are non-linear devices (If vs. Vf) with a forward voltage that is temperature dependent.

The electrical design of the product is only one aspect to look. We aso need to assess all aspects of the product, especially the mechanical aspect of the finshed design. Some of these items would be undersanding the manufacturing process in using either folded metal or aluminium extrusions for outer case. Inside the design we can review the use of polyurethane based potting compound, which is more cost effective than a silicon based material but with its dielectric profile will offer challenges in terms of EMI performance. Commonality of components and circuit building blocks allows better cost structure. And reducing the size will also reduce the transportation costs of moving the part from it manufacturing location ot its final place of installation. For the experienced designer , meeting all of these requirements is not complex, but there are also other challenges facing the design team , how to reduce the cost without any compromise on performance.

In many ways this is the most difficult challenge to meet. Customers are demanding cheaper product, but are not willing to comprimise on the intergrity or performance. So how can we design a product that will meet these seemingly out of phase requirements?

Let's look at a finished design as an example

In the design of the LDB series, the Excelsy design team was tasked with meeting a number of market leading requirements, and we also tasked with delivering this is a cost effective manner.

- ❑ Market leading efficiency and power density (91% eff for 100 Watts)
- ❑ EN 55015 Class B conducted and radiated emmissions
- ❑ OCP , OVP , Short Cct protection
- ❑ Universal input range , 90 to 264 VAC.

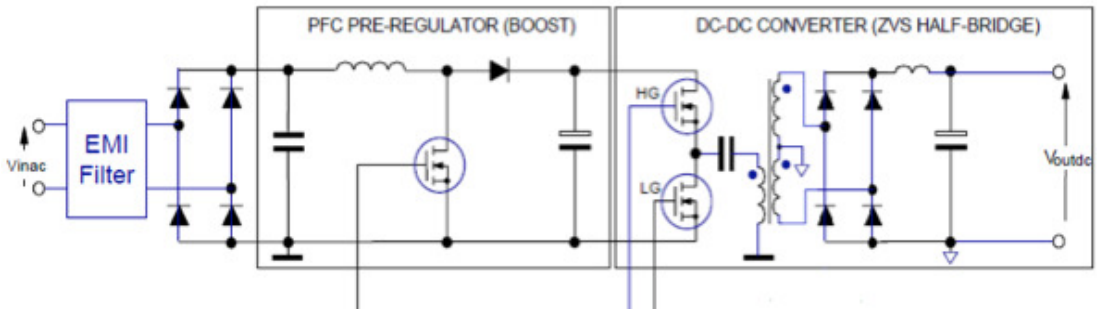

Fig 2: Chosen topology.

The overall choice of topology was determined by the efficiency and power requirements. The half bridge was selected based on the high power density and efficiency requirements. The inclusion of the LLC zero volt switching stage reduces the losses in the input to output transfer of energy, and also reduced the conducted and radiated noise. Switching at higher frequencies permits the use of small magnetics, shorter response times and low noise levels also. Finally the zero current switching on the output stage reduces the power loss, and again reduces the conducted and radiated noise.

Future of Power Supplies

We will continue to see more integrated approaches from vendors. Initially the designer will select a component for use in a circuit. This circuit will get integrated into a system. Eventually, we go the full circle and the system is designed as an integrated component, and can be used as a single part. This will lead to an overall decrease in size of the final solution.

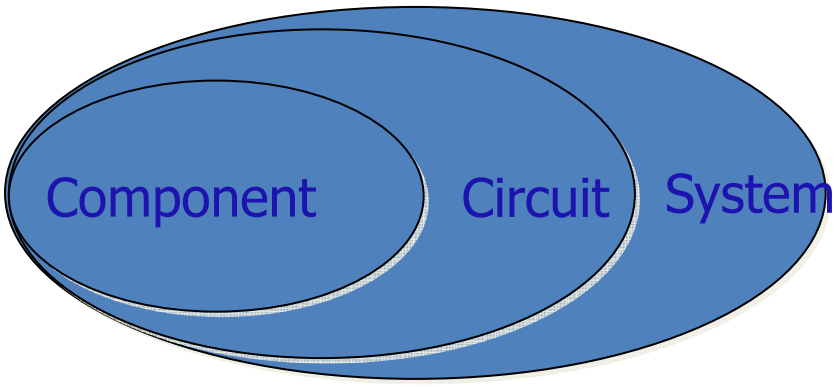

Fig 3: More integration from chip designers will mean smaller designs

However a more significant improvement will be the closing of the control loop with a digital controller. This will allow both and improved performance and further interaction with the supply. A digital control loop has many advantages over its analog counterpart in that we can now dynamically optimize the control loop for all operating conditions by moving poles and zeros on the fly.

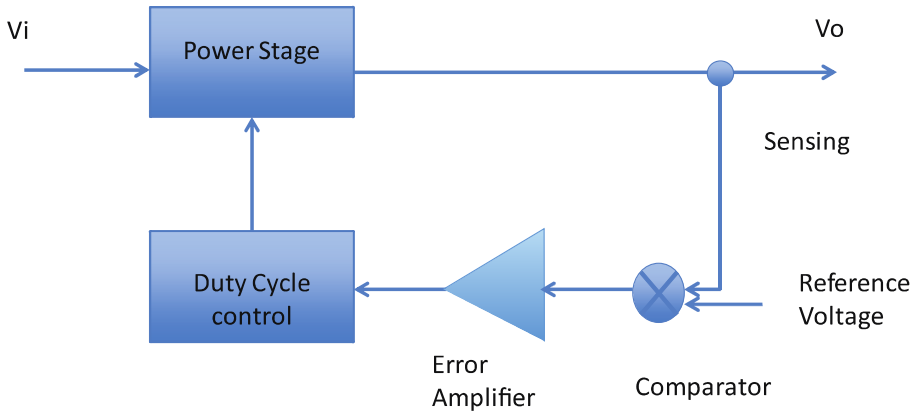

Fig 4 : Closing the loop with a digital controller

Digital control also provides us with a means to communicate with our power supplies in order to understand if they are for example operating within specified limits and get cycle-by-cycle feedback on their performance. Of course this can be achieved by adding a micro controller for digital power management, but with a digital loop you can implement this option more cost effectively. With a digital power control loop you can also integrate some additional features without increasing your analogue component count.

Ongoing research into magnetics is proving very successful, and will result in significant improvements in overall power density. Fig 5 below shows how the primary and secondary windings are incorporated into the PCB, with the core then inserted through pre-cut holes on the PCB. This reduces the height and size of the transformer design and also results in a much lighter component.

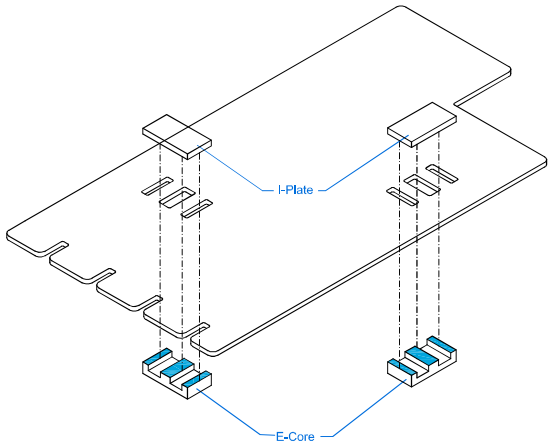

Fig 5: Transformer improvements will continue to increase power density.

In Summary

The LED driver of the future will be significantly different to the one we see available on the market now. Much higher levels of efficiency will become the norm and it will also integrate much higher levels of complexity in terms of power monitoring and performance. More integration of Systems on Chips (SOC's) will continue to reduce the size, whilst maintaining reliability of the overall design. While no single element will cause a rollercoaster effect, it will be influenced more by incremental & continuous improvements.

About the Author:

Shane holds a Bachelor of Engineering (Hons) from Cork Institute of Technology. He was also awarded the title of Chartered Engineer by the Institute of Engineers of Ireland in 2002, and was elected to Fellow in 2012.

Shane joined the Excelsys Technologies team in early 2006, and currently holds the role of Director of Applications Engineering. Prior to joining Excelsys he held a number of senior engineering positions at Artesyn Technologies and also at EMC. He has considerable power supply design engineering experience and engineering team leadership experience in product development, NPI and customer programme management.

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