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Driving the Automotive Industry towards All LED Vehicles

By Jan Polfliet, ON Semiconductor

It is no secret, that there is increasing prevalence of solid state lighting technology within automobile designs, but in most cases it is just taking care of certain elements of the illumination activity (such as side lighting, rear lighting and interior lighting). A wave of all-LED vehicles are set to enter the market in the next year - but why has this taken so long to happen? In this article an overview will be given of how LEDs are now replacing conventional lighting throughout automotive system designs, not merely in a piecemeal manner. It will also describe how innovative analog/digital devices are starting to present engineers with more effective means by which to drive and control the LED strings and modules deployed in these systems.

There are major operational benefits that can be derived from employment of LED technology through the efficiency, longevity, space saving and design flexibility characteristics it possesses. As a result the automotive industry has, over the last decade, been involved in a large scale migration away from the use of incandescent bulbs. Though there is now widespread implementation of LEDs - all the way from luxury models right down to economy ones. So far is utilization throughout vehicles in their entirety has been difficult to accomplish however.

The one exception to this so far is the new Mercedes S-Class, which is set to become the first mass production car to rely completely on LEDs to provide its illumination. This encompasses all front lighting (headlamps, daytime running lights, turn indicators, etc.) as well as things like dashboard illumination and ambient lighting. The obstacle that has held things back elsewhere has been dealing with the initial cost of implementation. One of the dynamics that is now helping manufacturers to overcome this is major advances within the supporting driver electronics.

Major Reasons to Change to LED Front Lighting

A major advantage of LED front lighting is the much greater diagnostic capabilities it affords. It allows the nature of particular faults to be determined and signs relating to where problems might occur in the future to be uncovered. Furthermore, data can be obtained on degradation over time of the light output - allowing steps to be taken to counteract this.

Beam forming of vehicle front lights can be achieved via the turning on, turning off or dimming of the constituent LEDs. As a consequence the beam can effectively be moved to help ensure that the driver’s visibility is not impaired when the vehicle travels around a bend or goes up/down hills. It also enables the blocking out of sections of the beam so as to prevent it hampering the vision of the drivers within vehicles travelling in the opposite direction. Beam formation using conventional front lighting cannot support the blocking out of sections of the beam, and even less complex functions like moving of the beam while negotiating bends requires use of electro-mechanical systems which take up space, increase the overall power consumption of the vehicle and require regular maintenance due to their moving parts.

The greater design versatility LEDs present is also of value. From a single core design engineers can create a number of different derivatives. This means that time and resources are more efficiently utilized and development projects can be completed at a much quicker pace. The number of LED channels employed within the lighting system can be scaled up or applied in different configurations, as required, but the driver electronics remains the same.

Driver Technology

The LED emitters in a contemporary lighting designs have a set current level to drive them, but as these devices continue to advance in the coming years (with better Lumen/Watt figures) it is likely that lower currents will suffice, or alternatively the lighting design will need inclusion of a lower number of LEDs to get an equivalent output. This has serious implications for the driver electronics, with the need to reprogram the existing driver IC so as to avoid having to carry out a design of the system. With, as already mentioned, the possibility to obtain data on degradation of light output over time, steps can subsequently be taken to counteract this - thereby broadening the operational lifespan of the lighting system. Binning is not necessary either as optimization of the LED output can be undertaken through the supporting driver mechanism, with adjustments made to individual emitters so that together they will deliver a uniform output.

Regulation of LED output levels allows them to be aligned with the photo sensitivity of the eye. Standardization can thus be realized, counteracting the logarithmic nature of the output of LEDs so they correspond proportionally with increments in the current applied. This too necessitates driver programmability.

All this calls for advanced driver ICs optimized specifically for next generation automotive lighting designs. These devices need to have high degrees of integration with a greater number of functions built in, so that fewer external components are utilized - reducing the associated bill-of-materials costs and keeping the board space involved to a minimum. Sophisticated on-chip diagnostics should also be included.

Of prime importance though is that these ICs have programmability, so that engineers can implement a platform approach - with one core design forming the basis of a number of derivatives which are quicker and less costly to develop than starting from scratch with a brand new design each time. Extra LED strings can be added and configurations can be adapted as needed. Finally it is worth noting that resources will need to be conserved not only in hardware. Engineers looking to implement front light systems based on solid state technology must have access to semiconductor solutions where only minimal development of software is mandated.

ON Semiconductor’s NCV78763 is a fully programmable single-chip solution targeted specifically at use in automotive front lighting. Based on a boost-buck topology it can be used to support multiple system configurations. Every individual LED channel permits the adjustment of the output current and voltage to meet the specific needs of the application.

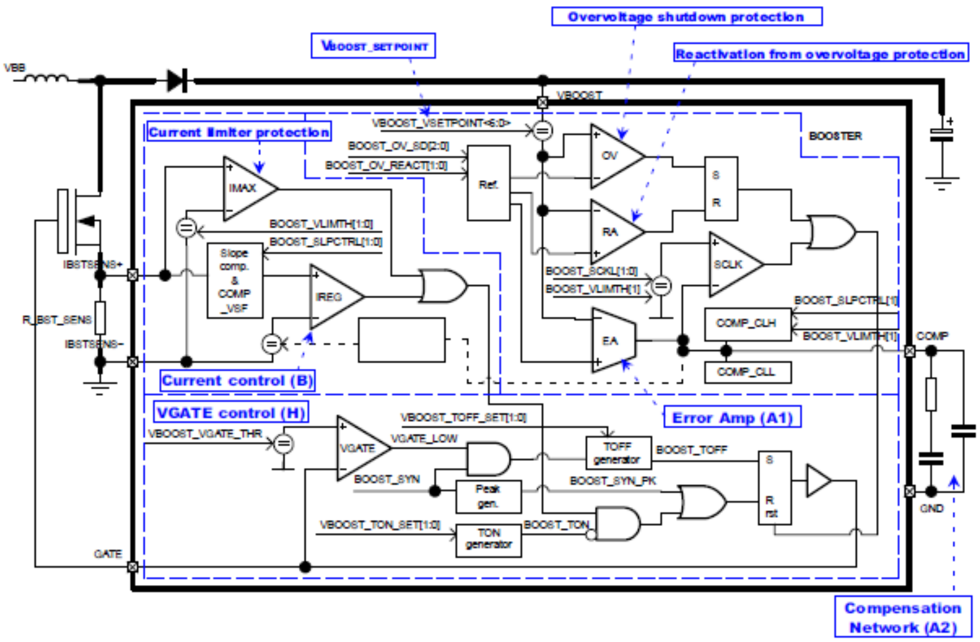

Figure 1: Functional Block Diagram Describing the NCV78763 from ON Semiconductor

The future will hold further challenges for driver technology. For example adoption of front lighting based on LED lasers could allow the illumination range to be lengthened by several hundred meters - increasing the awareness of the person driving the vehicle and improving road safety. Use of LED laser light also offers even greater energy savings than are possible with standard LED emitters. The i8 from BMW has become the precursor for this, but other manufacturers such as Audi are also developing similar laser based lighting systems.

LED front lighting facilitates the continuation of an ongoing progression that started with the move from mechanical to mechatronic systems and is now leading to fully electronic systems. It allows the shortfalls of incandescent lamps (regarding their reliability, power consumption, space utilization, etc.) to be eradicated. Though it has taken a lot longer than expected, the rewards are now being seen thanks to innovations in respect to the accompanying semiconductor technology - resulting in major improvements in the overall cost effectiveness, as well as the already recognized advantages in terms of performance and flexibility. Vehicle manufacturers will have ample opportunity to apply compelling new features that will help differentiate their models from those of the competition. In addition, the possibility to reuse the same driver electronics in multiple vehicle models will lead to a reduction in the engineering overheads associated with introducing new models and shorten the time to market.