LED-Driver Meets the Requirements of Automotive Applications

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In automotive applications, traditional incandescent lamps are increasingly being replaced by light-emitting diodes (LEDs). In the past, high-performance LEDs required a significant amount of circuitry. The MLX10801 driver chip meets the requirements of automotive applications by offering protection and monitoring features ensuring high reliability and a long LED operating life. Being programmable, the device supports a variety of automotive applications. Taking into account the cost and price pressure existing in the automotive industry, the device features a high degree of functional integration resulting in a minimum amount of external circuitry.

When the first LEDs became commercially available in 1962, some optimism was necessary to envisage the further development of these devices. The small spot of red light achievable at that time could only be used as an indicator lamp for electronic devices. In the next years, however, LEDs became brighter and brighter. Subsequently, green and yellow LEDs also became available. The breakthrough occurred in the early 1990's when blue and white LEDs were introduced based on advanced semiconductor materials. At the same time, light efficiency was very much improved **(Fig. 1).** The 1, 3 and 5 Watt LEDs offered by LUMILEDs represent the peak so far.

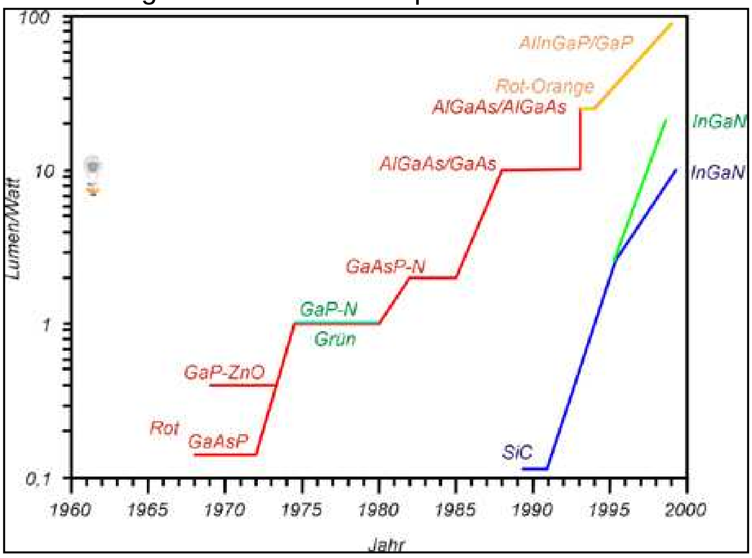

Figure 1: LED brightness increased by several orders of magnitude since the early 1990's..

The Automotive Sector as a Major Application

LEDs offer compelling advantages including a high level of light efficiency, reliability and mechanical stability, long operating life, etc. Automotive electronics has therefore become the largest consumer of LEDs. Automotive applications include dashboard illumination, signal and warning lights and interior lighting. Head-up displays and infrared cameras are among the more advanced applications, while it will still take a couple of years until LEDs will be used in headlights.

As can be seen from their characteristic curve, LEDs must be operated at a constant current. In the most straightforward applications, this current is set by a series resistor although voltage fluctuations will then result in brightness variations. Voltage independence can be achieved by using an active constant-current source. In both cases, however, efficiency is degraded by the difference between the operating voltage and the LED forward voltage. State-of-the-art approaches are therefore based on DC/DC converters with the capability to efficiently translate the operating voltage into the LED forward voltage. Converters intended for LED applications feature constant-current sources at the output.

The Use of High-Performance LEDs

Operating high-performance LEDs entails some specific challenges. Maximum light output is achieved at a current of several hundred Milliamps. Due to the LED‘s steep current/voltage characteristic, even minor voltage increases (which can be caused by noise pulses or tolerances in the system’s voltage-regulation stage) will result in an exponential rise of the LED current **(Fig. 2)**. This, in turn, will influence the LED‘s light output and operating life. Although LEDs will not be damaged immediately, it will result in a reduction of brightness. With high-performance LEDs, this effect will soon be perceptible. A driver circuit intended for this type of LED must therefore include appropriate protection features. Using a conventional DC/DC converter for an LED driver circuit would require a tremendous amount of circuitry.

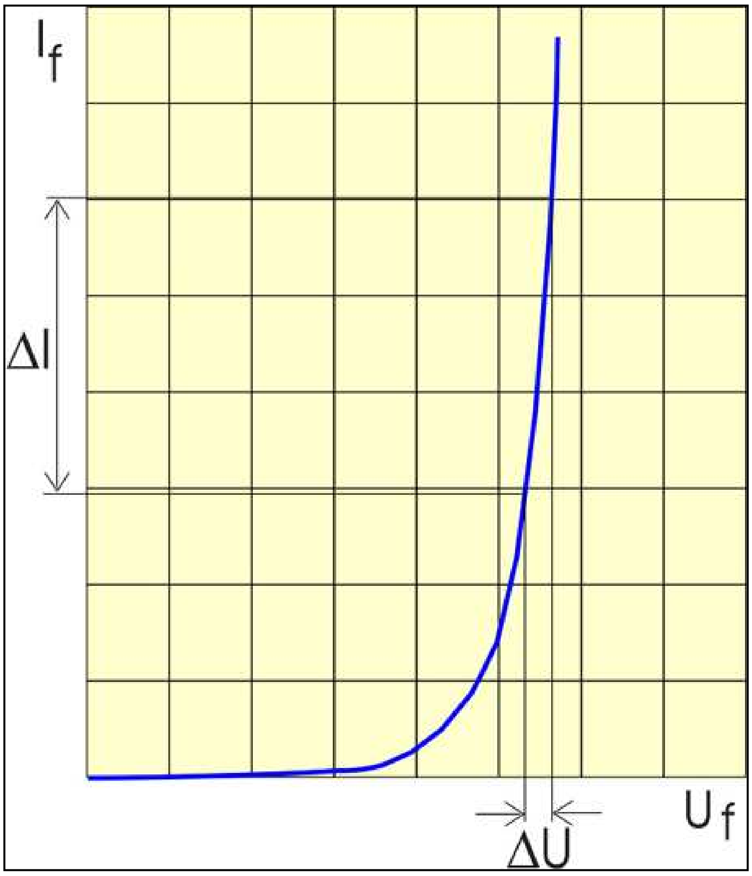

***Figure 2:** Due to the characteristic curve of an LED, even a minor rise of the LED‘s forward voltage will result in an exponential current increase.*

Melexis, a semiconductor manufacturer with many years of experience in the development and production of highly reliable circuits for the automotive industry, offers a solution for the problem described above. Representing the first circuit specifically developed for high-performance LEDs, the MLX10801 offers attractive features including:

- Switched-mode operation
- High energy efficiency
- Minimum LED parameter drift over temperature and operating voltage variations
- Programmable LED parameters
- Dimmer function
- Sleep mode
- Overvoltage protection
- Overheating protection for IC and LED
- Wide input voltage range
- High EMC tolerance
- Also usable as a relay driver
- Diagnosis function supported

***Fig.ure 3:* The MLX10801 (front) can be used as a driver for high-performance visible-light and infrared LEDs**

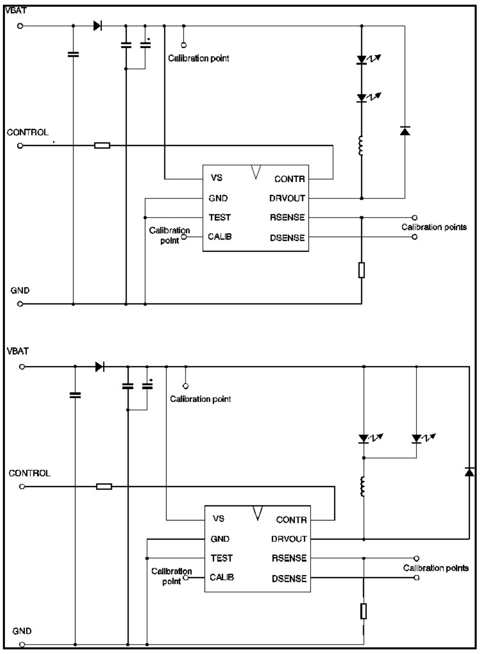

***Figure 4:* The MLX10801 can be used as a driver for single or multiple LEDs in a serial or parallel configuration**

Based on the operating principle of a switch-mode controller, the MLX10801 **(Fig. 4)** achieves a high level of efficiency converting the input voltage into the voltages required by LEDs. As the circuit regulates the average LED current, no additional current-stabilization components are required.

LED current is sensed by a series resistor. The voltage derived from this resistor is also used for brightness control according to the programmed values. Average current and peak current can be programmed by the user. As the programmable parameters are loaded into a non-volatile EE latch, they are retained even when the device's power supply is switched off.

A sensor monitoring the chip's temperature has also been integrated into the circuit, while the LED temperature can be measured using an external temperature sensor. A simple silicon diode is sufficient for this purpose. If any excessive temperatures should occur, the LED is switched off by the IC for protection. As this feature is not allowed in warning and signalling lamps, it can be disabled in the programming stage. Protection against excessive output currents is inherently ensured by the circuit's operating principle.

The Rsense pin can be used for system diagnosis in connection with an external circuit.

Although switch-mode controllers normally require a precisely calculated inductor value, various inductance values can be used with the MLX10801. This is because the device can be adapted to specific circuit parameters during the programming stage. The respective set of data is loaded into the EE latch by means of a PC and a programming board. Consequently, no variable resistors are required. Application notes published by the manufacturer include information on how to determine the parameter set.

Special features include the dimmer function. LED brightness may be controlled by connecting an external PWM signal to the CRTL input.

As long as the maximum power rating is not exceeded, multiple LEDs can be driven by a single MLX10801 in a parallel or serial configuration. Alternatively, the chip can drive an external transistor if the current level is too high.

Although the MLX10801 is specified for electrical systems with a nominal voltage of 12V, it can also be used at any operating voltage between 6V and 28V. Functionality is guaranteed from -40 to +105℃. Depending on the ambient temperature, retention of the programmed data is guaranteed for 10 to 20 years. Manufacturer guidelines should be followed to ensure EMC compliance of completed assemblies **(Fig. 5).**

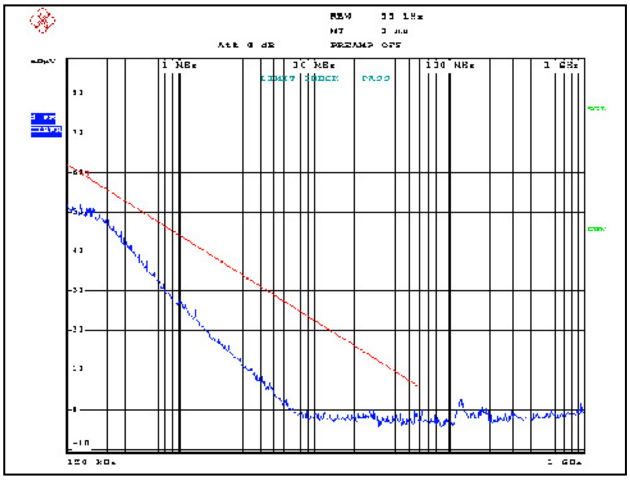

Figure 5: Optimized circuit layout ensures EMC compliance.

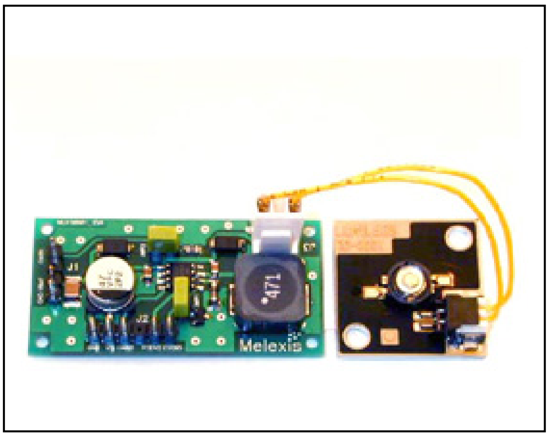

Figure. 6: The EVB10801 evaluation board can be used for testing the MLX10801

Evaluation boards (Fig. 6) and a programming board are available for a quick start [1, 2]. The IC's features for a specific application can be efficiently evaluated using these tools and the free FL10801 software [2]. Additionally, a so-called ‚Module Trimmer' will soon be available for automatic calibration to a specific optical power. A light source having known parameters is used as a calibration reference. The light flux of the LED to be calibrated is measured using a photoresistor and automatically adjusted to the reference value.

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Links and References

- www.melexis.com
- www.sander-electronic.de
- Data Sheets and Application Notes from MELEXIS