Application note MLX10801

Power LED driver for automotive applications
Power saving low side coil driver
Electronic fuse

1 Scope

The following document describes the use of the MLX10801 as voltage step up converter and regulator. The applications described in this document are applications for driving LED diodes. The described circuits can be applied on other applications with similar circumstances as well, in case they fall within the specifications of the MLX10801. This is a conceptual description and no component values are given. The applications described in this document have although been tried out

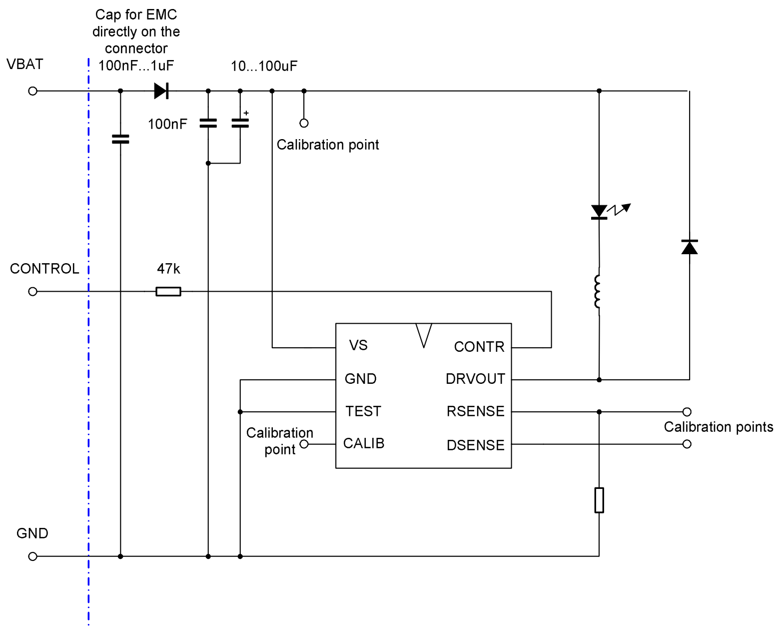
2 General

The MLX10801 is intended to be used as a voltage step down regulator but can be used as a step up converter without any problems. It has to be pointed out, that there is no significant gain using MLX10801 as a step up converter, if it itís possible to use it as a step down converter in the application.

Applications that benefits using mlx10801 as a step up converter is for instance applications like low supply voltage applications or the LED forward bias voltage is higher than the supply voltage. There are some drawbacks using MLX10801 as step up converter. If they can be accepted, the MLX 10801 will work great in step up converter mode

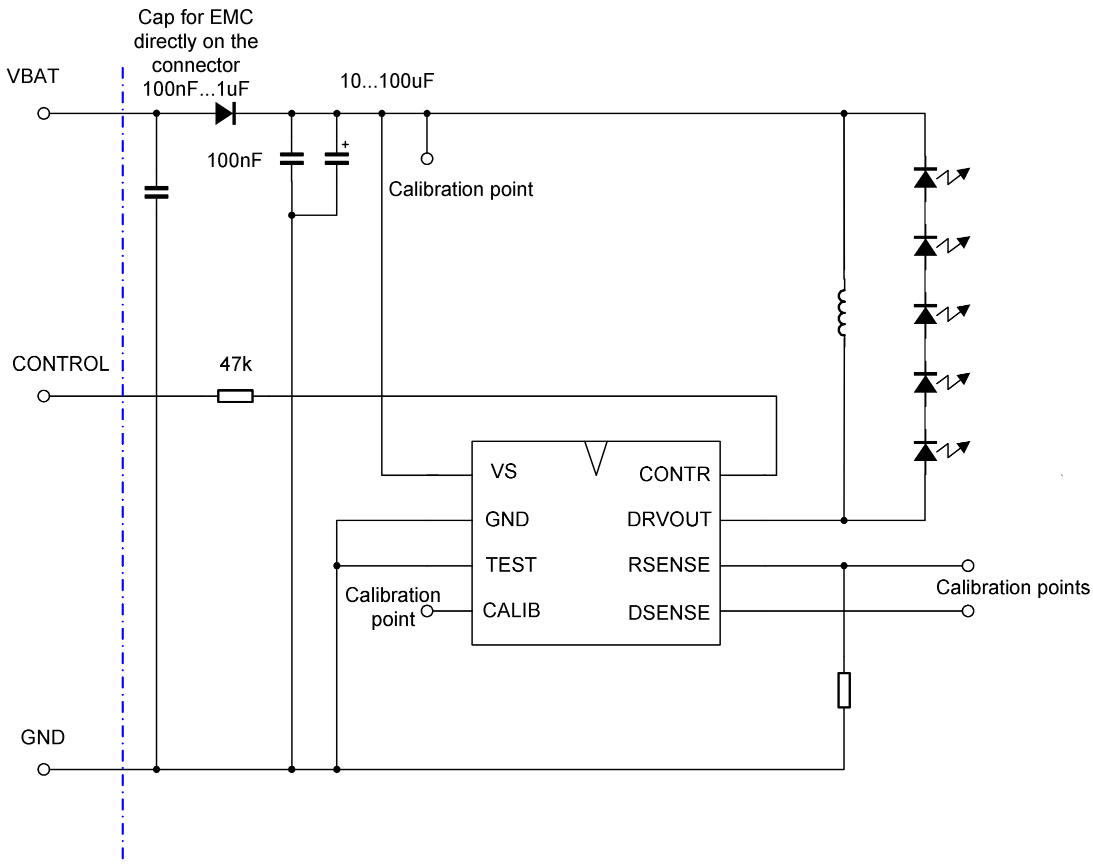
3 Application diagram

Following figure shows the standard application circuit for MLX 10801. This is a step down converter only.



3.1 Simple voltage step up converter for LED driving

The simplest way to achieve a voltage up converter is to move the LED diode or diodes to where the fly back diode is place in the original schematic.



The fly back diode is needed in this circuit now only, if high supply voltages can be expected. This circuit handles VBAT voltages from 5V to (28V - n(Diode voltage)); n = number of diodes in serie. The voltage on the DRVOUT pin should never exceed 28V.

During this type operation the voltage at DRVOUT pin can reach the supply voltage plus the sum of the forward diode voltages of the LEDs. This happens when the voltage at RSENSE reaches the switching point for the internal monoflop and the internal N-channel transistor between DRVOUT and RSENSE switches of. When this happens, the coil will continuing driving current and causes the voltage to rise to a level so it overcome the forward voltage of the LED diodes and the current loop can be closed. The current would continue until the coil has been discharged but actually the next charging of the coil will appear before it is completely discharged.

The coil will always have stored the same amount of energy, when the voltage has reached the switching point set at RSENSE. This energy is then used over the LED diode(s) during a time set by the internal monoflop.

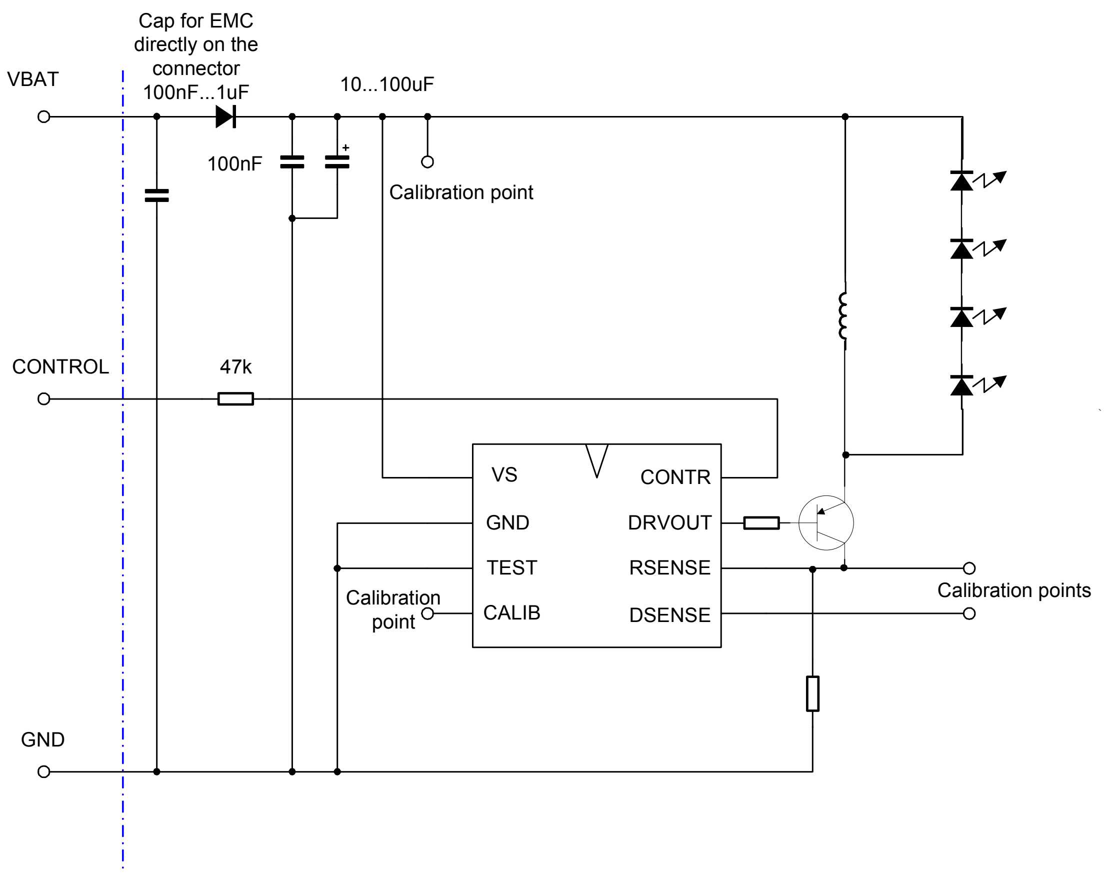
More diodes in series will give less current from the stored energy in the coil during the same time according to Ohms law. Pcoil = constant = I1d x 1Ud = I2d x 2Ud = I3d x 3Ud => I3d = 1/3 x I1d

To have the same current in 3 diodes in series as in 1 diode when doing step up converting result in a tripling of the current through the coil when storing energy in the coil.
Result: there in no gain to putting diodes in series compare to putting them in parallel. Only when the forward voltage differs between diodes can it be an advantage to put them in series.

Attention has to be drawn as well to the fact, that the LEDs will only emit the light in the discharging mode of the coil. This is not really a problem and can be handled via selecting the right peak and average LED current.
How ever, this fact should be noticed, It is different compared to the step down converter applications.

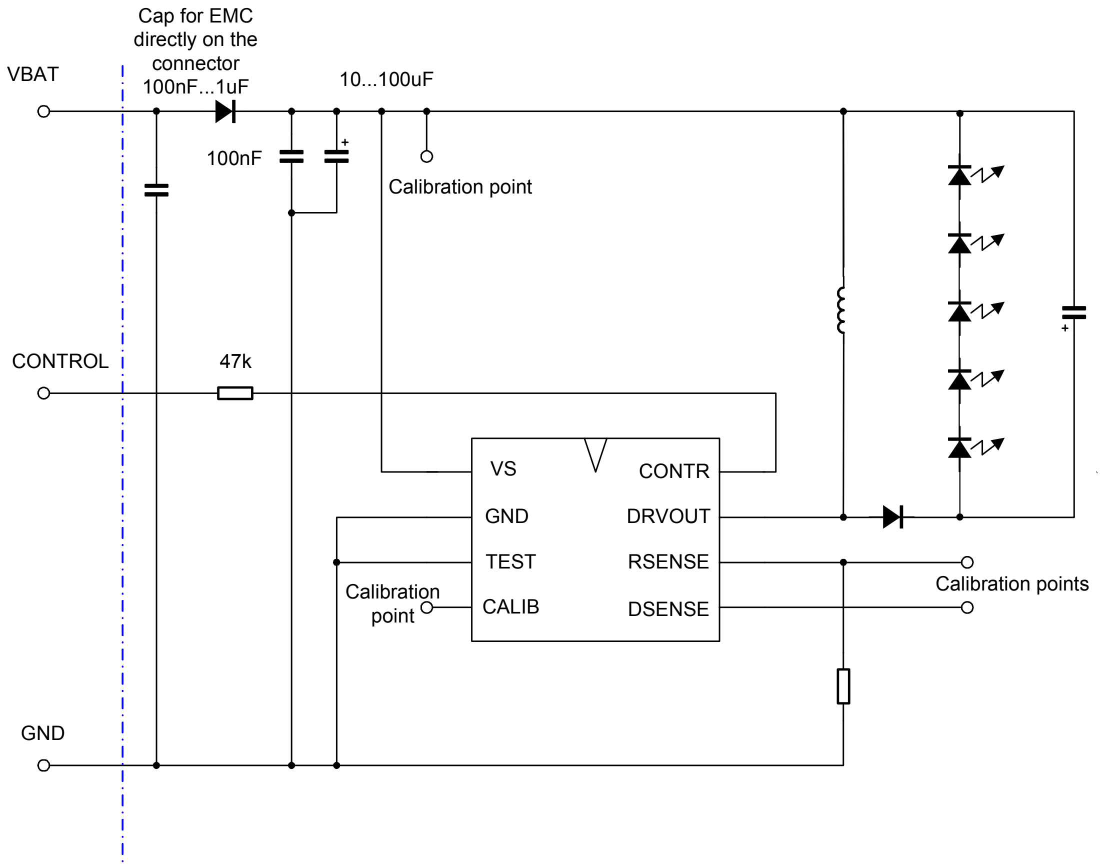
Step up converting pays its gain of increased voltage in an increased current.
Therefore it might be needed to use more current in the coil than the MLX10801 can handle. In that case the following circuit application for increased current could be used.

This circuit handles VBAT voltages from 5V to (28V - n(Diode voltage) + V_{eb}PNP); n = number of diodes in serie.
The voltage on the DRVOUT pin should not exceed 28V.



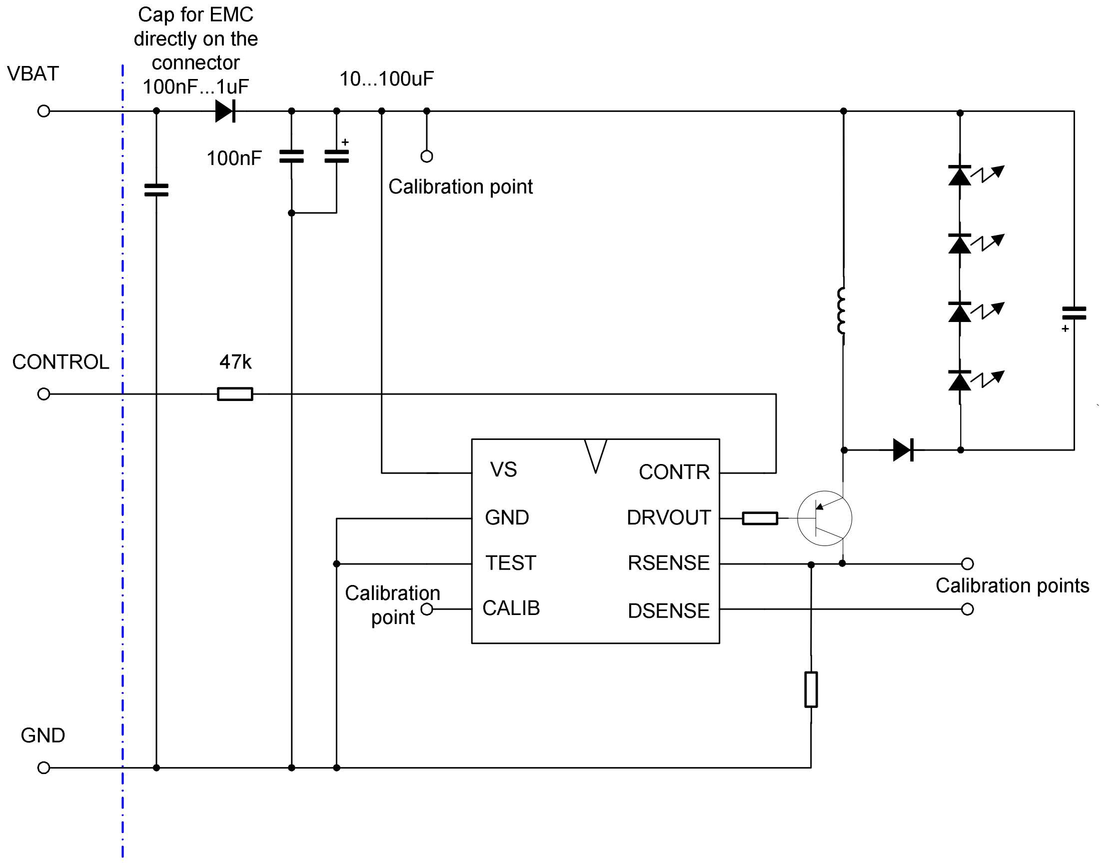
3.2 Converter with filtering of pumped voltage

To create a more constant current over the diodes in order to reduce EMC, a capacitor can be placed as shown in the figure. A diode is also the needed so the capacitor is not discharged in case the built in switch transistor opens again during the charge pump cycle. This diode will reduce the efficiency of the step up converter, but not as much as the reverse polarity diode.



Warning: If the LED chain is broken (open connection), circuit will continue pumping up the voltage until the capacitor or the diode inline with LED diodes will break down. This will also put the MLX10801 into a situation outside its specified functionality. The resulting damage depends on the size of the coil.
This can be eliminated with a zener diode parallel to the capacitor.

This filtering can be applied to a circuit using an external PNP transistor as switch as well.



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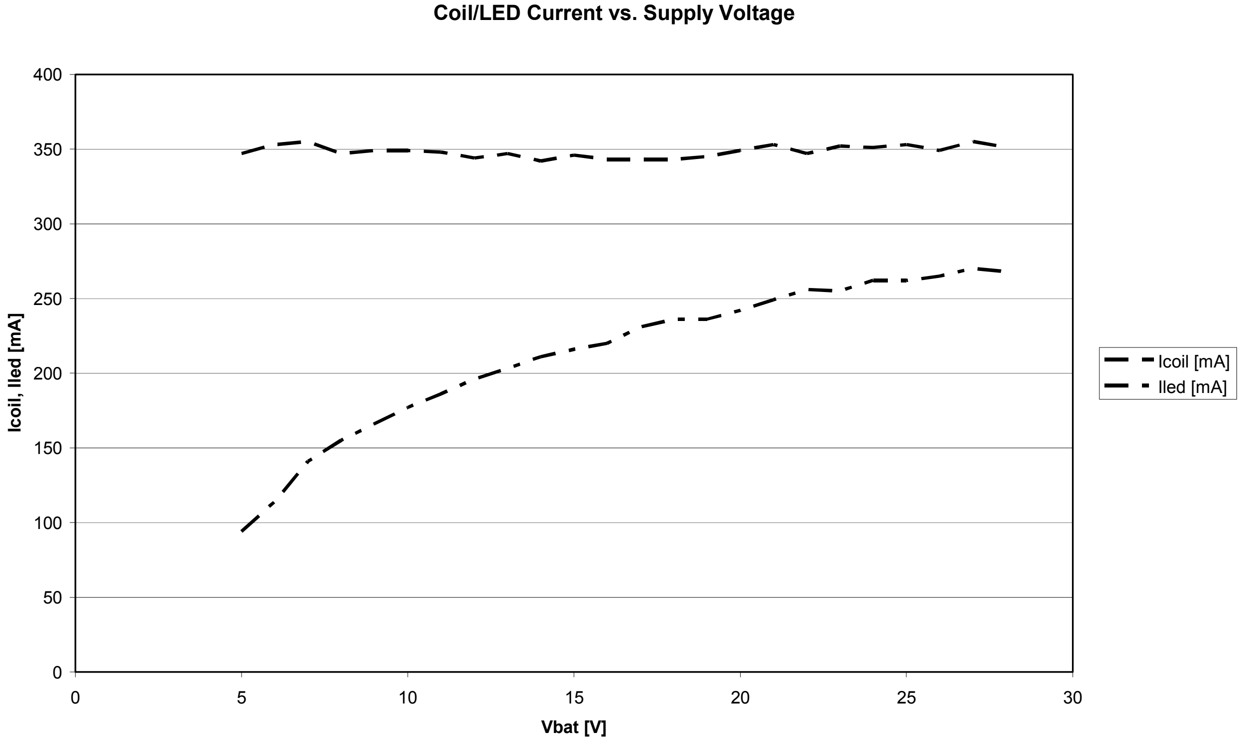
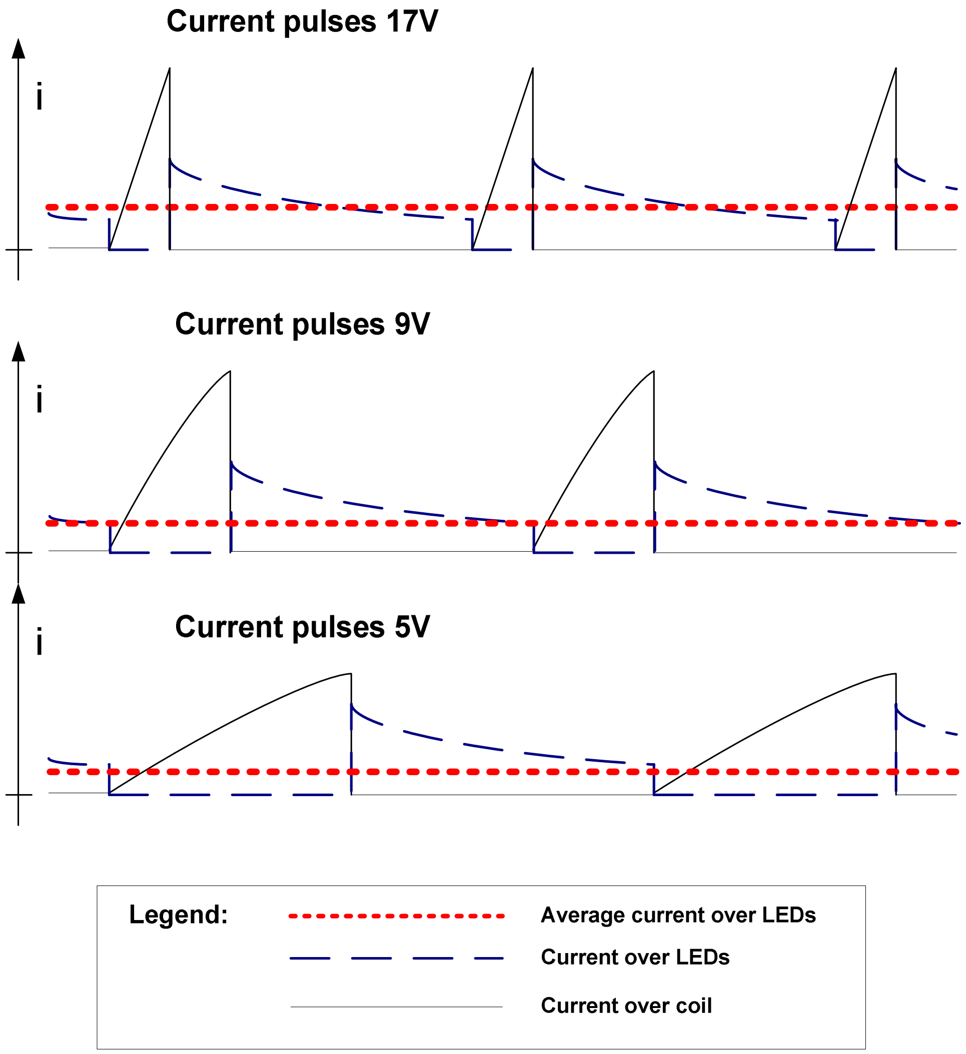
3.3 The voltage stepped up current versus supply voltage

Using MLX10801 as step up converter works, but have its limitations. See following diagram of a typical step up application.



The current depends over the diodes depends on the supply voltage. The degree of dependency is a function of the size of the coil and the set monoflop time. As smaller the charging time of the coils is compared to the monoflop time, as less variations of coil current compared to the supply voltage it will give.
In that case also less energy is used in the step up process.
There is a minimum time needed for the peak voltage threshold internal circuit to react, it is in the range of 1us. The charge time of the coil needs to be some factor larger than that for a proper function.

Following figure describes the effect causing this dependency on the supply voltage.



As seen in the figure: the longer time it takes to charge the coil, as lower will be the average current through the diodes in the voltage step up chain.

3.4 Conclusion

It is possible to use MLX10801 as a step up converter, but it has some limitations. The limitation can be minimised by a carefully selected coil, RSENSE resistor and the MLX10801 mono flop time.

To use a step up converter with LEDs in series instead on a step down converter with LEDs in parallel gives no benefits, except that the diodes in series can be used with very big variation of forward bias voltage.

A break to high impedance creates a serious problem for the step up converter. A similar break in the step down converter with parallel diodes creates a similar problem by overdriving the remaining LEDs in current.

Europe and Japan:
Phone: +32 13 61 16 31
E-mail: sales_europe@melexis.com

All other locations:
Phone: +1 603 223 2362
E-mail: sales_usa@melexis.com