Application note MLX10803

Analog dimming solutions.

1 Scope

The following document describes how to apply a method of analog dimming of LEDs using MLX10803.

The applications described in this document are applications for driving high power LED diodes, but these applications will work for any LED if correct currents are applied

This is a conceptual description and no component values are given. The applications described in this document have in most cases been implemented. Demonstration systems and components are available at Melexis. Please contact our nearest sales office or representative to learn more

2 General

2.1 EMR/EMC

Every kind of active current regulation generates ripple on the regulated output, this ripple can generate electromagnetic radiation (EMR) and electromagnetic coupling (EMC) to the surrounding electronic circuits.

MLX10803 and the applications described in this document are designed to minimize EMR. Additional care has to be taken when designing the circuit board and the physical application. Melexis makes no claims about the suitability of any of these circuits for EMI/EMC and EMR compliance against international regulations. Compliance testing is recommended and it will fall to the user to conduct such testing prior to sale in specific countries and markets.

2.2 EMI

Very low currents are used to set the peak current sensing levels in MLX10803. It is recommended to add a capacitor in parallel to the resistors attached to IREF1 and ground and IREF2 and ground, in some cases. An alternative is to only use short wires to these inputs. MLX10803 is a very flexible circuit and uses very little energy to achieve the functions described in this application note. A person with normal electrical engineering skill should be able to decide when or if a decoupling capacitor is needed, and these capacitors will not be added in the circuit examples described in this application note.

3 Design tools

3.1 Coil calculation program in Excel[tm]

This Excel[tm] calculation sheet is necessary when designing LED driver solutions around the MLX10803.
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Find this program on the Melexis web site at, http://www.melexis.com and search for MLX10803. Look then in the list of Assets. Download the coil_calc.xls file.

The spreadsheet is self instructive. Play with it and get a feeling about the relation ship between coils, currents and sense values. The real mathematics behind the MLX10803 function is complicated, this sheet is a simplification. The tool gives only rough values, but it gives an impression what component sizes and settings are needed.

This tool will help you to find a rough value for:

- The coil
- The programmable sense voltage and the sense resistor
- The mono flop time. The time to partly discharge the coil. This times is a derivative of the oscillator frequency in MLX10803

After finding out coil, reference resistors and sense resistor values, as well as mono flop time, oscillator resistor value and sense voltage settings with this tool, it is time to apply the component values to the MLX10803 LED driver circuit and try out the values in an application.

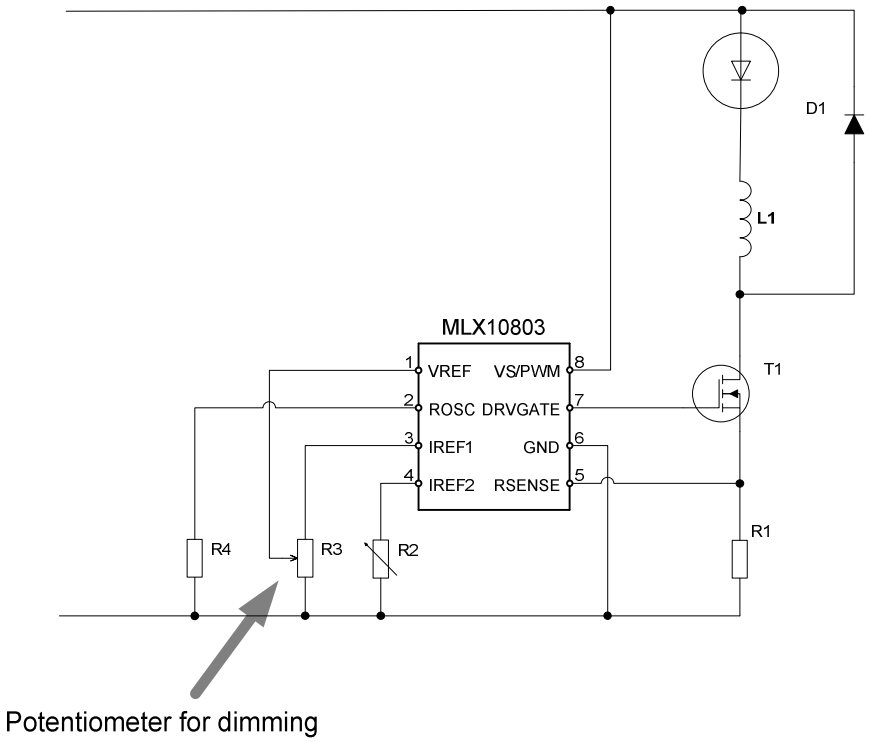
3.2 Evaluation board EVB10803

You can make trials and tests with the evaluation board available from Melexis. This will save you time and money understanding the function of the MLX10803 chip.

The LED supply can be separated from the circuit supply (VS/PWM) by removing the jumper for that on the EVB10803. See the manual for EVB10803 for instructions. When the supply to the LED is separated from the VS/PWM then the supply voltage to the LED is limited by the external N-FET transistor parameters and the fly back diode. Please use this option with great care, and check carefully what type of transistor and fly back diode your EVB10803 is equipped with before applying any higher voltage than 32V.

4 Applications

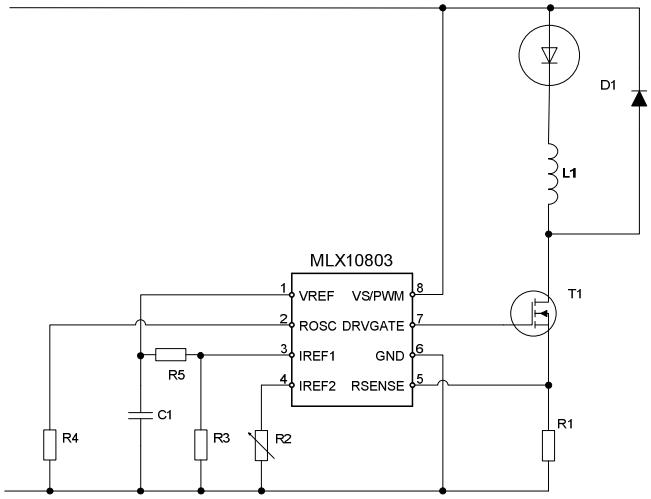
4.1 Simplest dimming



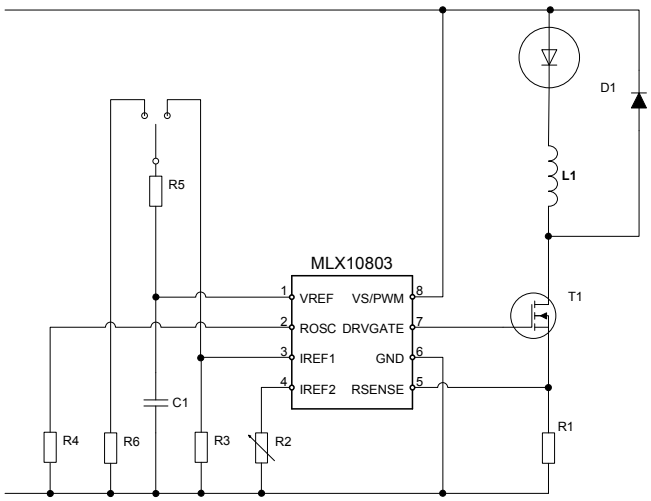
Above circuit schematic describes the simplest possible dimming solution. The lowest voltage on VREF, IREF1 or IREF2 will be used as voltage reference for the peak current. The voltage on the VREF in this case is divided by 5 and used as reference voltage for the peak voltage in the regulation cycle. The RSENS pin is the input of the sensed current. The current is sensed as a voltage across a sense resistor (R1).

IREF2 input on the figure is used as thermal protection. In case of overheating the NTC (R2) becomes a lower resistance and results in a lower voltage than detected over VREF. In this case the voltage sensed at IREF2 is lower that VREF (and IREF1) and is used as value for the current peak detection in the regulation cycle.

4.2 Slow start up LED current increase



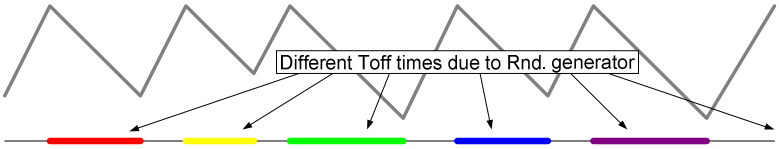
The analog dimming used in example 4.1 can also used to create an automatic slow increase of the light level when switching on power to the LED driver circuit above. The rise time is defined by the combination of R3, R5 an C1.



If both automatic up and down dimming is desired, the circuit above can be used.
Notice; in case of down dimming in this case the circuit is still attached to the supply. If a real off-function for the down dimming is wanted, it must be combined with some kind of energy storage for the down dimming period.

5 LED current curve forms of MLX10803

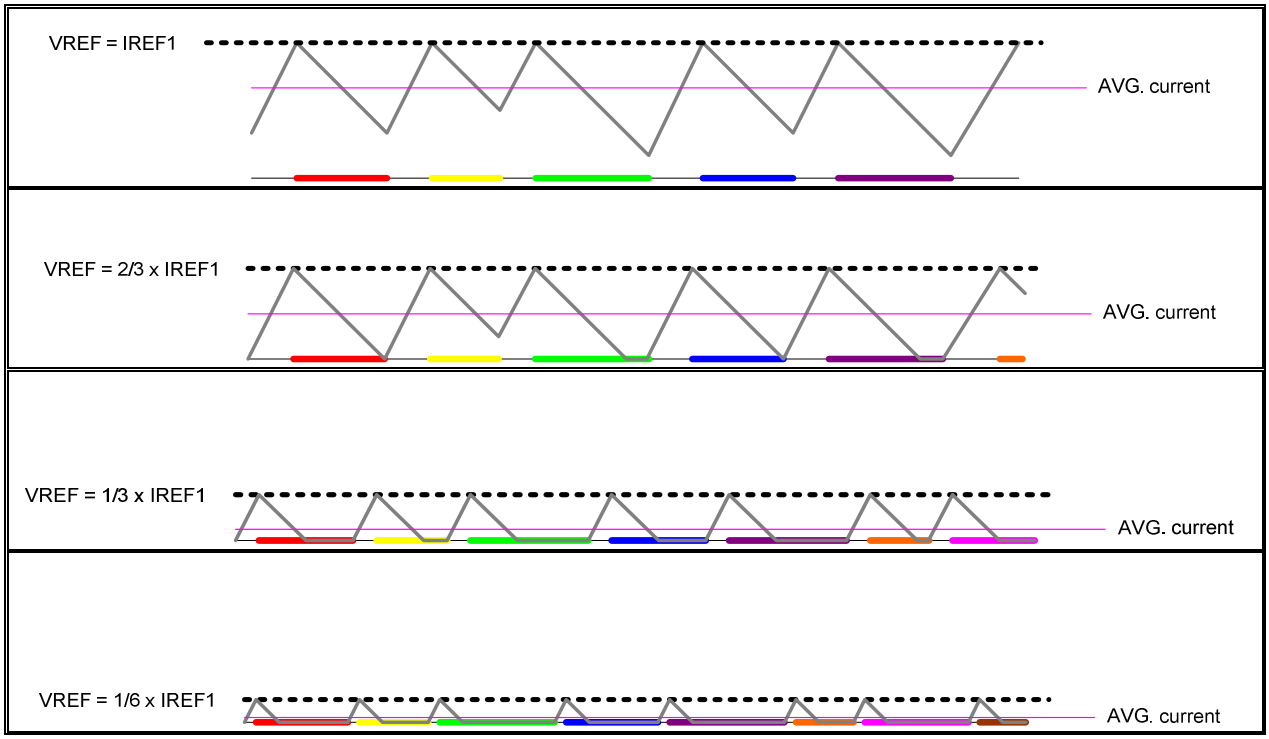
5.1 Large ripple example



Above is an example of a normal period of regulation cycles using about 60 – 70% ripple. The curve is a direct illustration of the current through the LED.

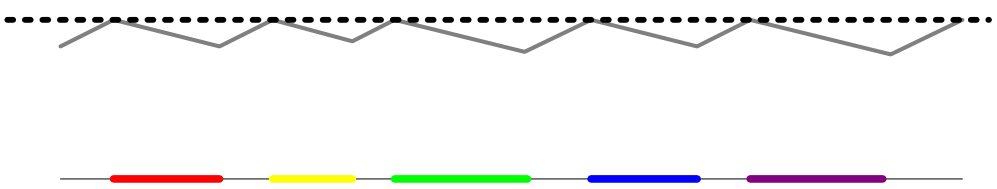
5.1.1 Dimming with VREF

Below is illustrated the effect of changing the voltage level on the VREF if IREF1 are used as reference.



Note that the regulation goes quite quickly into discontinuous regulation mode when using large ripple regulation. It is not a problem but the linearity of the regulated current suffers.

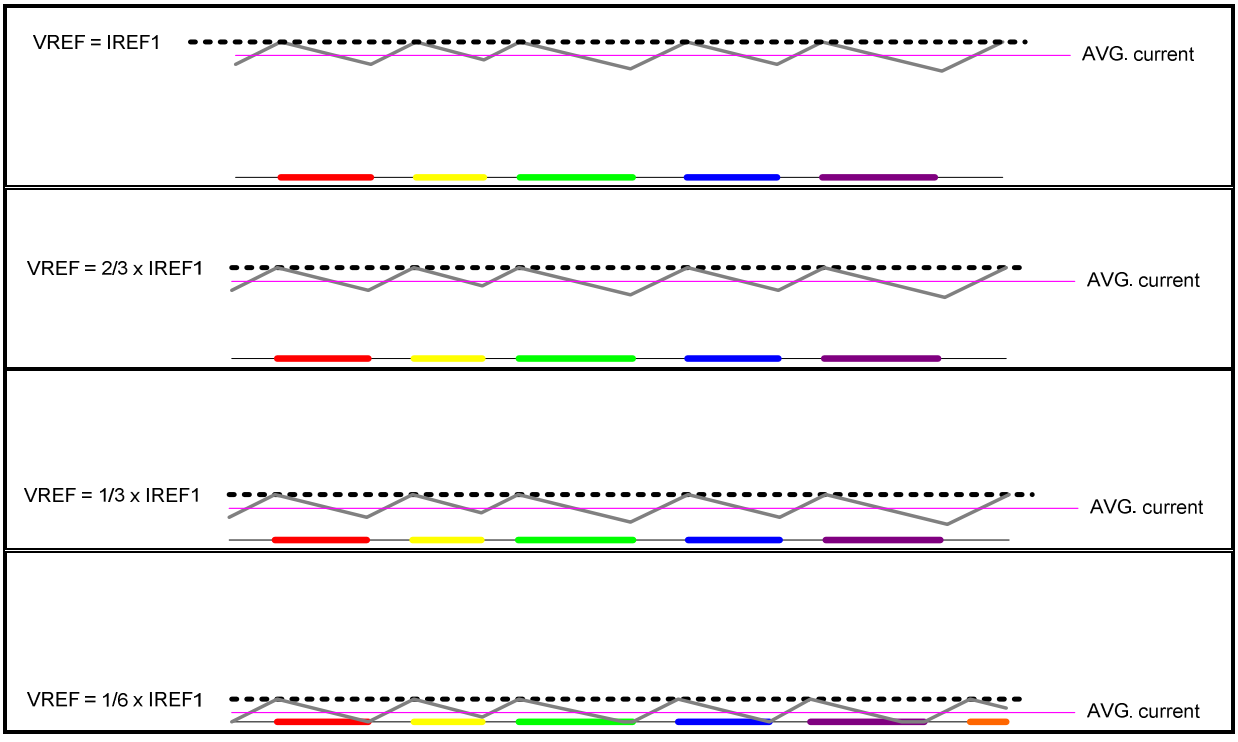
5.2 Small ripple example



Above is an example of a normal period of regulation cycles using about 10% ripple. The curve is a direct illustration of the current through the LED.

5.2.1 Dimming with VREF

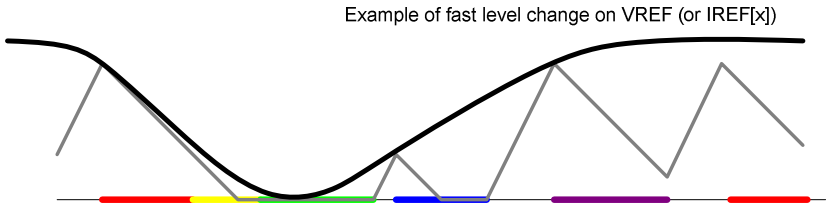
Below is illustrated the effect of changing the voltage level on the VREF if IREF1 is used as reference.



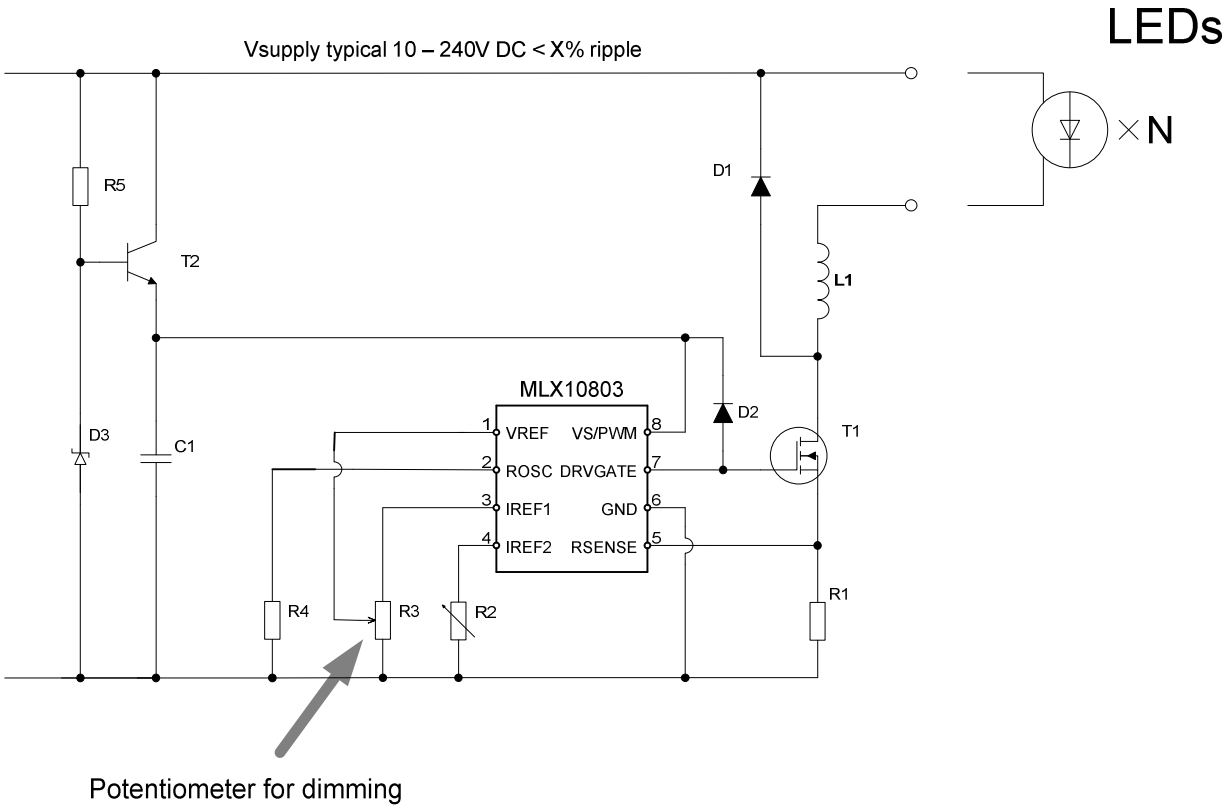
Note that the regulation does not go into discontinuous regulation mode until very low values on VREF, now when using small ripple regulation.

5.3 Fast variation of VREF or IREF[x]

Even fast variation of the VREF signal or IREF[x], is no problem, the effect will be as the figure below illustrates.



6 HV LED lamp with dimming function



7 Disclaimer

Be aware that some circuit applications in this document works directly with 220V or 110V supply. There are national and international safety regulations for this type of electrical circuits. This document does not cover any safety issues for electric circuit designs.

The circuit applications in this document have been thoroughly tested by Melexis when not otherwise mentioned; and have worked satisfactorily in described applications. However, Melexis does not assume any legal responsibility or will not be held legally liable in the use of these circuit applications, under any circumstances.

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