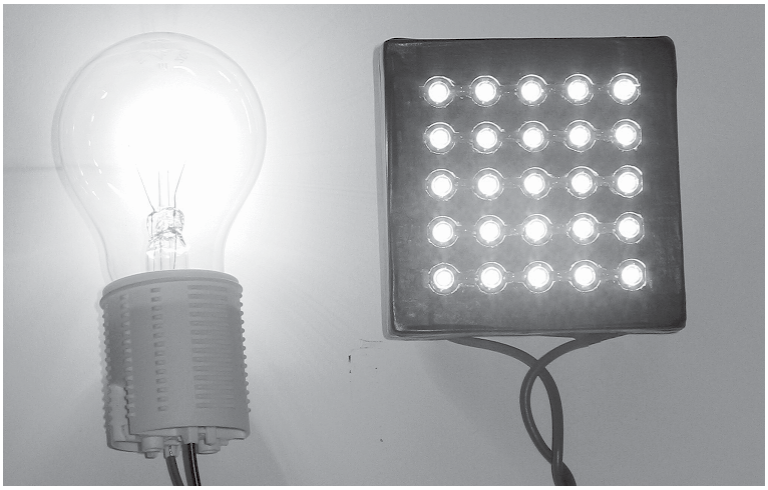
Application note MLX10803

High voltage solutions.



1 Scope

The following document describes how to create high voltage circuit designs, using the MLX10803.
The target is domestic and industrial use, or any application requiring high light levels from light emitting diodes.

The applications described in this document are applications for driving high power 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 MLX10803. This is a conceptual description and in some case 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 closest sales office or representative to learn more

2 General

It is not a trivial task to design for high voltage, great care must to be taken in respect for the high voltages involved. The examples given in this document have to be carefully designed and fabricated. Slight errors can have devastating results. These examples are not recommended for the inexperienced or untrained lay people, it is intended for electrical and electronic engineers with relevant training and experience designing and building high voltage circuits. The circuit board has to be design according to high voltage rules. **Depending on the users specific implementation these examples can have lethal voltages present.**

The circuits described in this document have a very good efficiency, converting efficiencies up to 98-99% is to be expected! This makes the circuit design fairly simple in respect of thermal handling. Please remember that if you design lamps with up to 100 watt and more, even 1% loss generates 1 watt, and more of heat.

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

3 Design tools

High volt design is more demanding than making low voltage applications using MLX10803. We strongly recommend using the following presented tools when making high volt applications. Use these tools for your own safety, before you connect your LED application to the 110/220 V net.

3.1 Coil calculation program

This Micorsoft Excel calculation sheet is a necessity when designing with high energies
.
Find this program on the Melexis web site at, http://www.melexis.com/prodmain.asp_Q_family_E_MLX10803 .
Download the coil_calc_(x).zip file and use the Microsoft Excel spreadsheet included.

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 discharging the coil. This times is a derivate from the oscillator frequency in MLX10803

After finding out coil, reference resistors and sense resistor value, 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 should make try and tests with the evaluation board. This will save you time and money understanding the function of the MLX10803 chip.

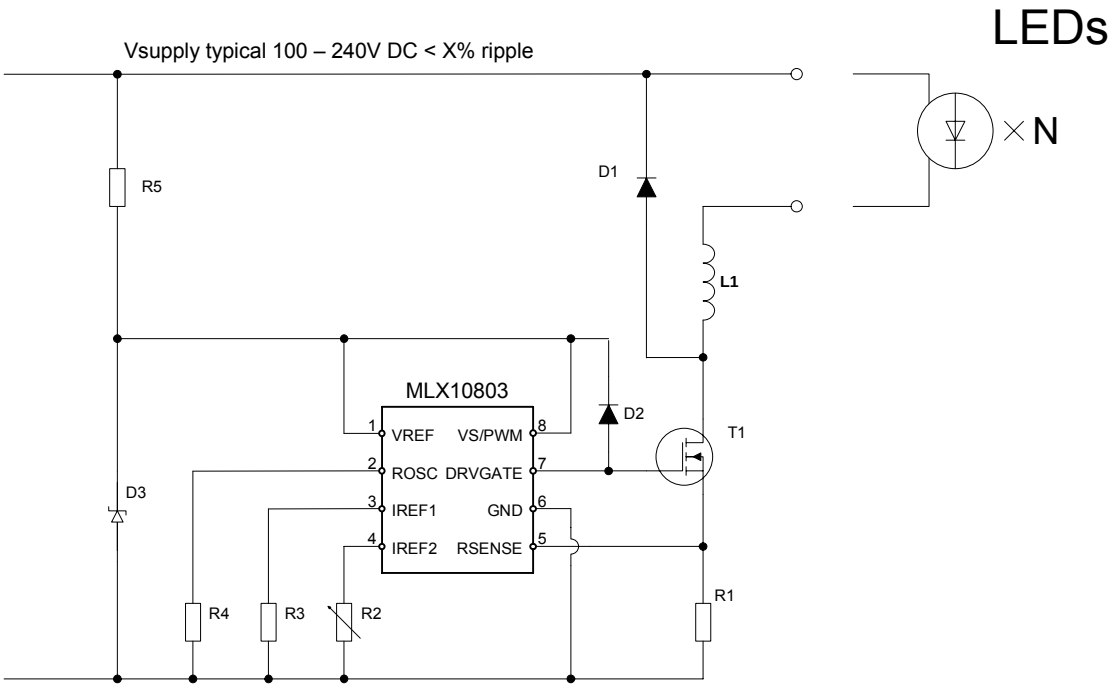
You should not design any high volt application without an understanding of the function of the MLX10803 circuit.

Warning:
The evaluation board EVB10803 is specified to function up to 32V, or 80V for half a second. It is not intended to be used at 220V.

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 switching 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.

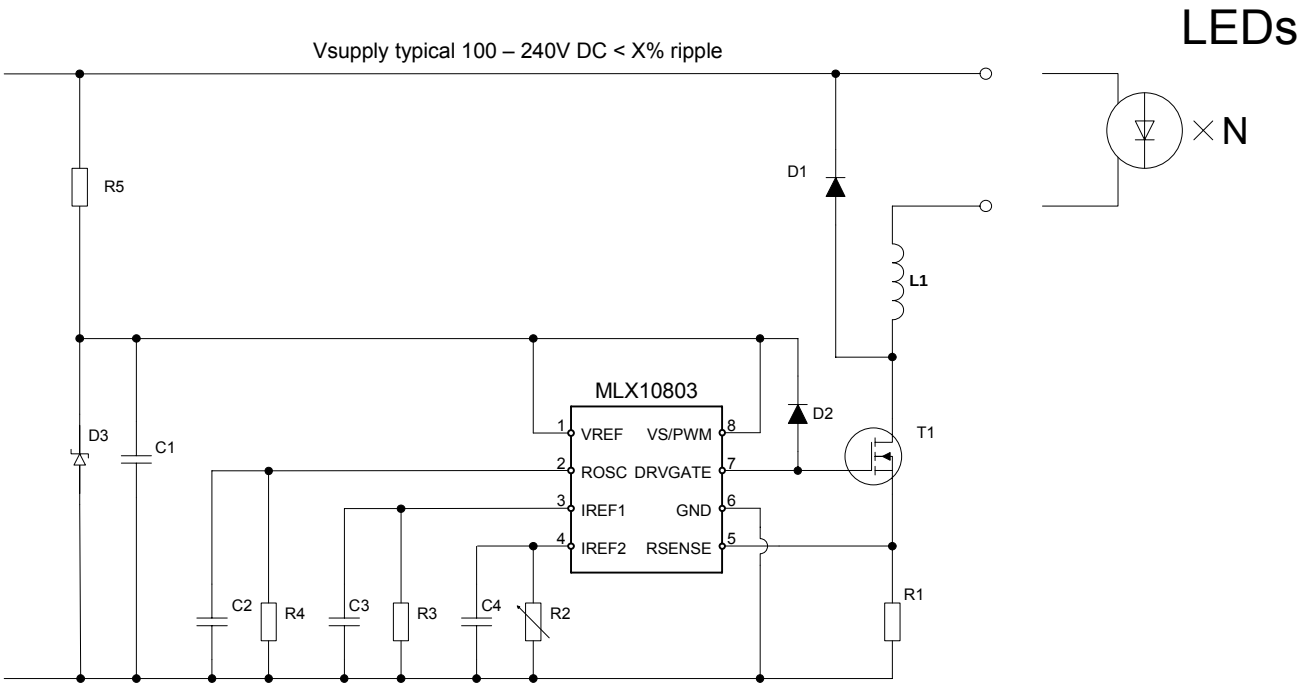
4 Applications

4.1 Simplest solution



Above circuit schematic describes the simplest possible high volt solution. The coil and the Rsense resistor have to be adapted to the type of diodes used and the number in series. Also the desired operational range has to be taken into calculation for the right size of this coil and resistor. The circuit is a down regulation, so at a given minimum operational voltage there are a maximum number of diodes possible to connect in series. This number of diodes depends on the forward voltage of that type of diode. The sum of the diode voltages must in all cases be lower than the input voltage.
Example: Typical white diodes have a forward voltage of 3.5V. 25 diodes in series results in 87.5V in total forward voltage, which will give a margin on a 110V supply. This is the recommended maximum number of diodes for 110V in this case. The forward voltage varies with many factors and one among these is temperature. The difference between 87.5V and 100V is needed for this variations of forward voltage as well as variations of the supply voltage. Note that this design will also work for much higher applied supply voltage and gives you a universal voltage lamp if so is desired.

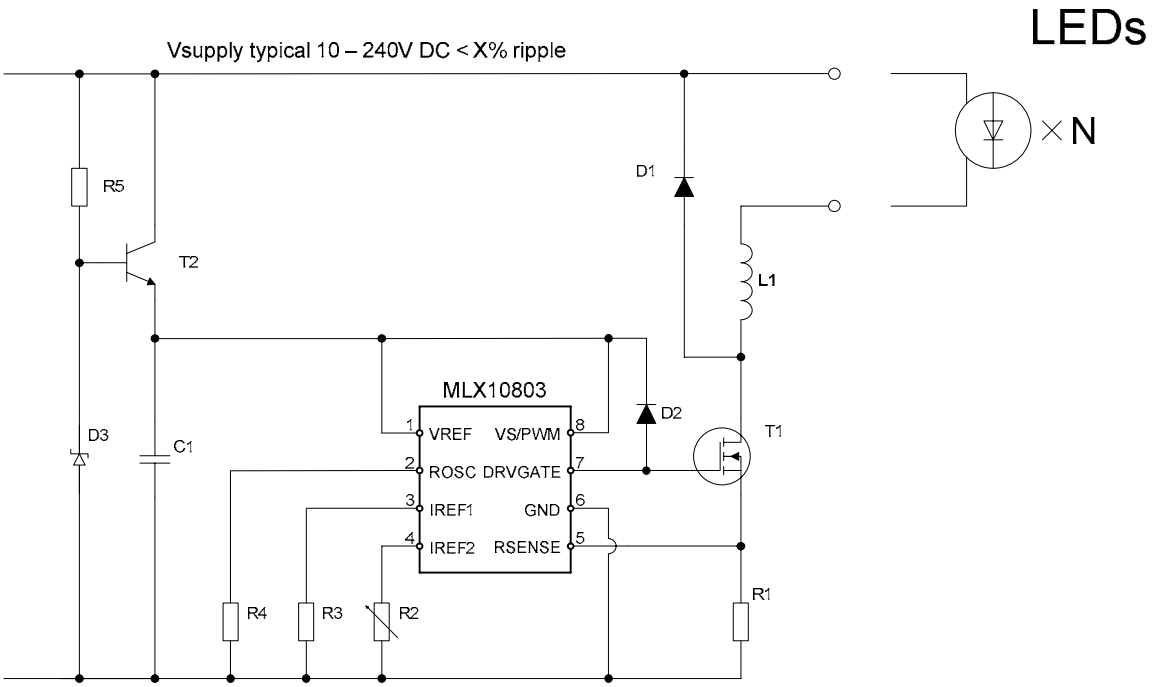
4.1.1 Component selection



Values range of components, please use coil_calc to estimate.		
R1	0.05Ω – 10Ω	
R2	NTC: 1kΩ – 2MΩ	
R3	100kΩ (MLX10803A); 20k (MLX10803)	
R4	39kΩ - 440 kΩ	
R5	150kΩ / 0.5 watt	
C1	0 - 10uF / 16V	Ceramic
C2	0 - 1nF / 16V	Ceramic
C3	0 - 1nF / 16V	Ceramic
C4	0 - 1nF / 16V	Ceramic
D1	ES2G (*check max current and voltage*)	
D2	1N4148	
D3	ZENER 12V / 2mA	
L1	0.1mH - 10mH / 4A – 10mA	
T1	SPN04N60S5 (Infineon) (*check max current and voltage*)	

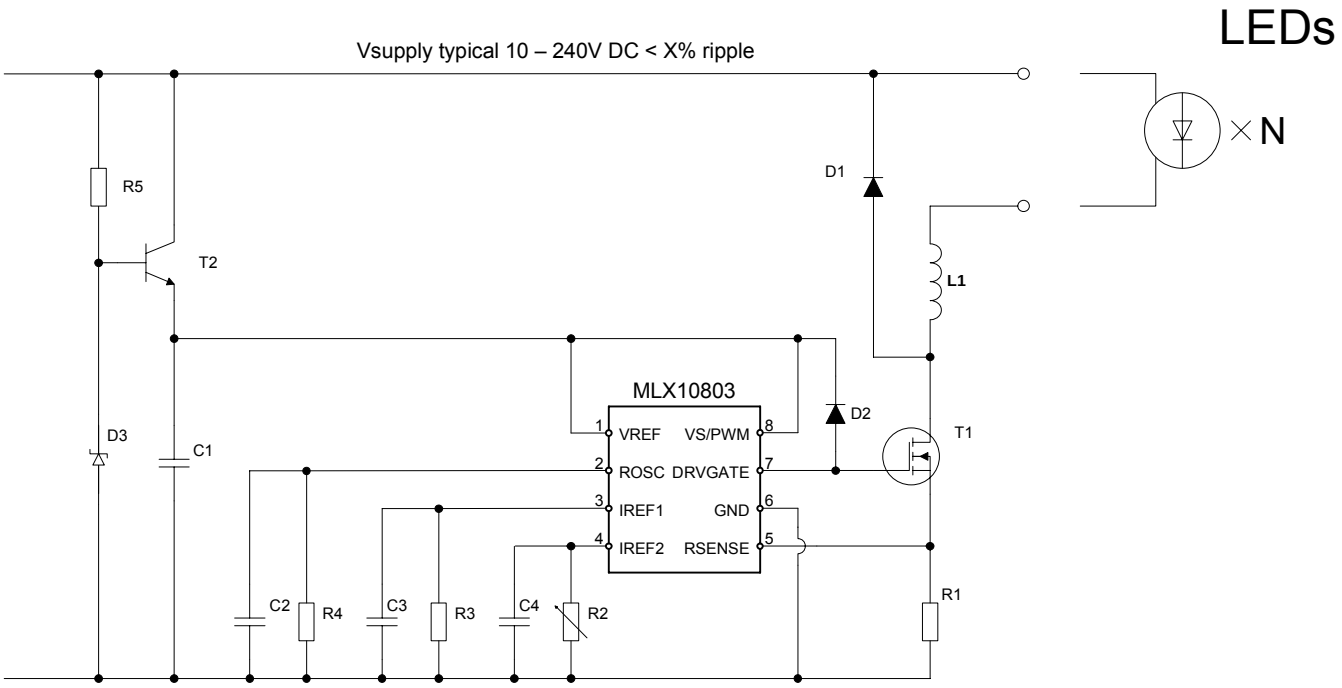
Values for 300mA application 20 LED in series 100-250V		
R1	0.4Ω => 0.5A peak => about 300mA average	
R2	NTC: aprox. 100kΩ @ 125 ºC TN05- 4W205 (MLX10803A) NTC: aprox. 20kΩ @ 125 ºC TN05- 4W474 (MLX10803)	
R3	100kΩ (MLX10803A); 20kΩ (MLX10803)	
R4	39kΩ	
R5	150kΩ / 0.5 watt	
C1	10uF / 16V	Ceramic
C2	1nF / 16V	Ceramic
C3	1nF / 16V	Ceramic
C4	1nF / 16V	Ceramic
D1	ES2G	
D2	1N4148	
D3	ZENER 12V	
L1	2.2 mH / 500mA (MLX10803A); 1mH / 500mA (MLX10803)	
T1	SPN04N60S5 (Infineon)	

4.2 More efficient solution



Above circuit schematic describes an efficient possible high volt solution. The coil and the Rsense resistor have to be adapted to the type of diodes used and the number in series. Also the desired operational range has to be taken into calculation for the right size of this coil and resistor. The circuit is a down regulation, so at a given minimum operational voltage there are a maximum number of diodes possible to connect in series. This number of diodes depends on the forward voltage of that type of diode. The sum of the diode voltages must in all cases be lower than the input voltage.
Example: Typical white diodes have a forward voltage of 3.5V. 25 diodes in series results in 87.5V in total forward voltage, which will give a margin on a 110V supply. This is the recommended maximum number of diodes for 110V in this case. The forward voltage varies with many factors and one among these is temperature. The difference between 87.5V and 100V is needed for this variations of forward voltage as well as variations of the supply voltage. Note that this design will also work for much higher applied supply voltage and gives you a universal voltage lamp if so is desired.

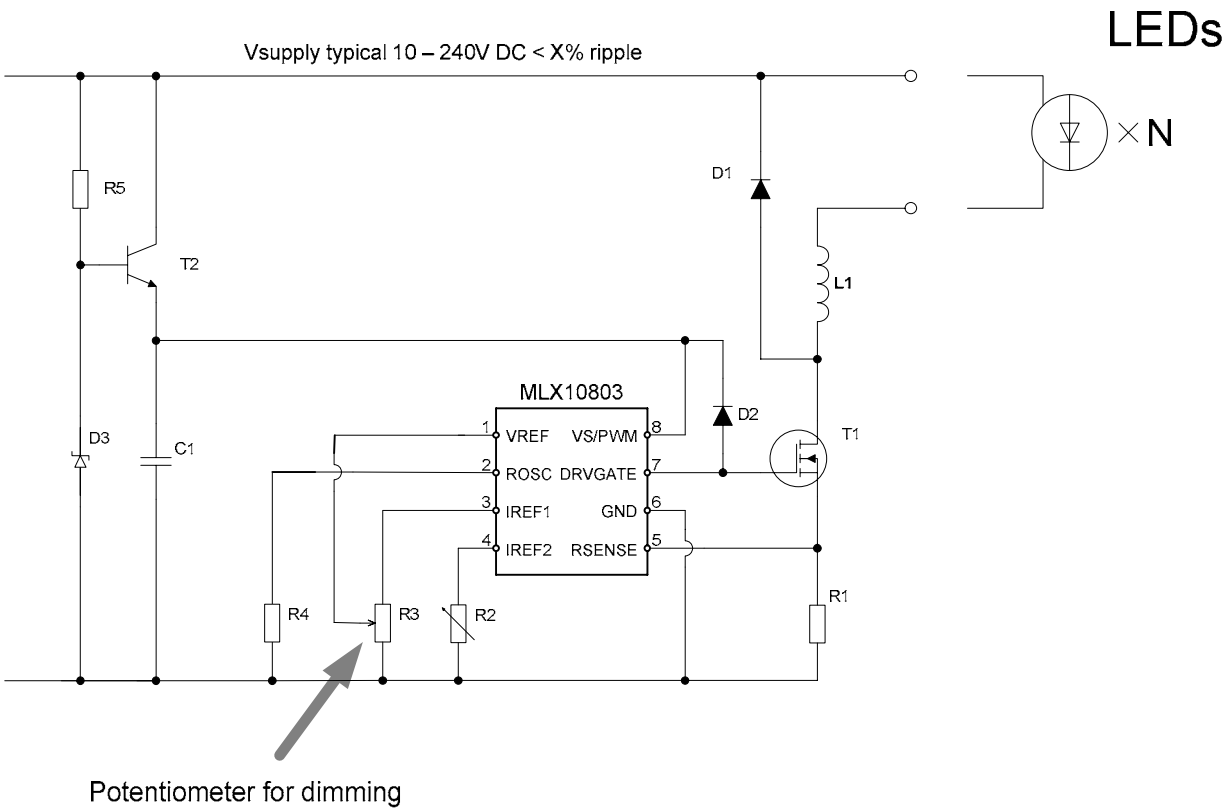
4.2.1 Component selection



Values range of components, please use coil_calc to estimate.		
R1	0.05Ω – 1Ω	
R2	NTC: 1kΩ – 2MΩ	
R3	100kΩ (MLX10803A); 20k (MLX10803)	
R4	39kΩ - 440 kΩ	
R5	1MΩ	
C1	0 - 10uF / 16V	Ceramic
C2	0 - 1nF / 16V	Ceramic
C3	0 - 1nF / 16V	Ceramic
C4	0 - 1nF / 16V	Ceramic
D1	ES2G (*check max current and voltage*)	
D2	1N4148	
D3	ZENER 12V / 2mA	
L1	0.1mH - 10mH / 4A – 10mA	
T1	SPN04N60S5 (Infineon) (*check max current and voltage*)	
T2	Highvolt NPN, hfe> 100	

Values for 30mA application 22 LED in series 100-240V		
R1	5Ω => 50mA peak => about 30mA average	
R2	NTC: aprox. 100kΩ @ 125 ºC TN05- 4W205 (MLX10803A) NTC: aprox. 20kΩ @ 125 ºC TN05- 4W474 (MLX10803)	
R3	91kΩ (MLX10803A); 18kΩ (MLX10803)	
R4	39kΩ	
R5	1MΩ	
C1	10uF / 16V	Ceramic
C2	1nF / 16V	Ceramic
C3	1nF / 16V	Ceramic
C4	1nF / 16V	Ceramic
D1	ES2G	
D2	1N4148	
D3	ZENER 12V	
L1	2.2 mH / 500mA (MLX10803A); 1mH / 500mA (MLX10803)	
T1	SPN04N60S5 (Infineon)	
T2	Highvolt NPN, hfe> 100	

4.3 LED lamp with dimming function



5 Disclaimer

Be aware that these circuit applications 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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Or for additional information contact Melexis Direct:

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