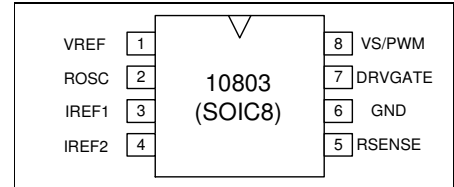


### Features

#### General

- Low cost power LED driver for external n-channel MOSFET switching transistor
- 6V to 32V DC input range
- Applications from mA to several Ampere LED current
- Possible temperature dependent regulation using external Negative Temperature Coefficient (NTC) resistor
- Small package allows compact module design with minimised wire runs and short connections to achieve improved EMC performance
- Built-in randomiser for improved EMC performance
- High temperature operation capable
- Load dump protected to 80V



#### LED driver

- High energy efficiency
- PWM dimming via VS/PWM pin
- Light output has minimised dependency on supply and temperature variations
- LED regulation parameters set with external resistors

#### **Ordering Code**

| Product Code | Temperature Code | Package Code | Option Code | Packing Form Code |
|--------------|------------------|--------------|-------------|-------------------|
| MLX10803     | K                | DC           | AAA-000     | RE                |

#### **Legend:**

Temperature Code: K for temperature -40 °C to 125 °C  
 Package Code: DC for SOIC150Mil  
 Packing Form: RE for reel

Ordering example: MLX10803KDC-AAA-000-RE

### General Description

The MLX10803 is a multi-purpose LED driver for high power LEDs designed for high current and high voltage applications. The circuit is designed for demanding automotive applications and therefore suitable in all other high intensity LED applications.

Numerous adjustment possibilities allow for the design of different LED applications using only a few external components.

The circuit is load dump protected for 80V load dump pulse.

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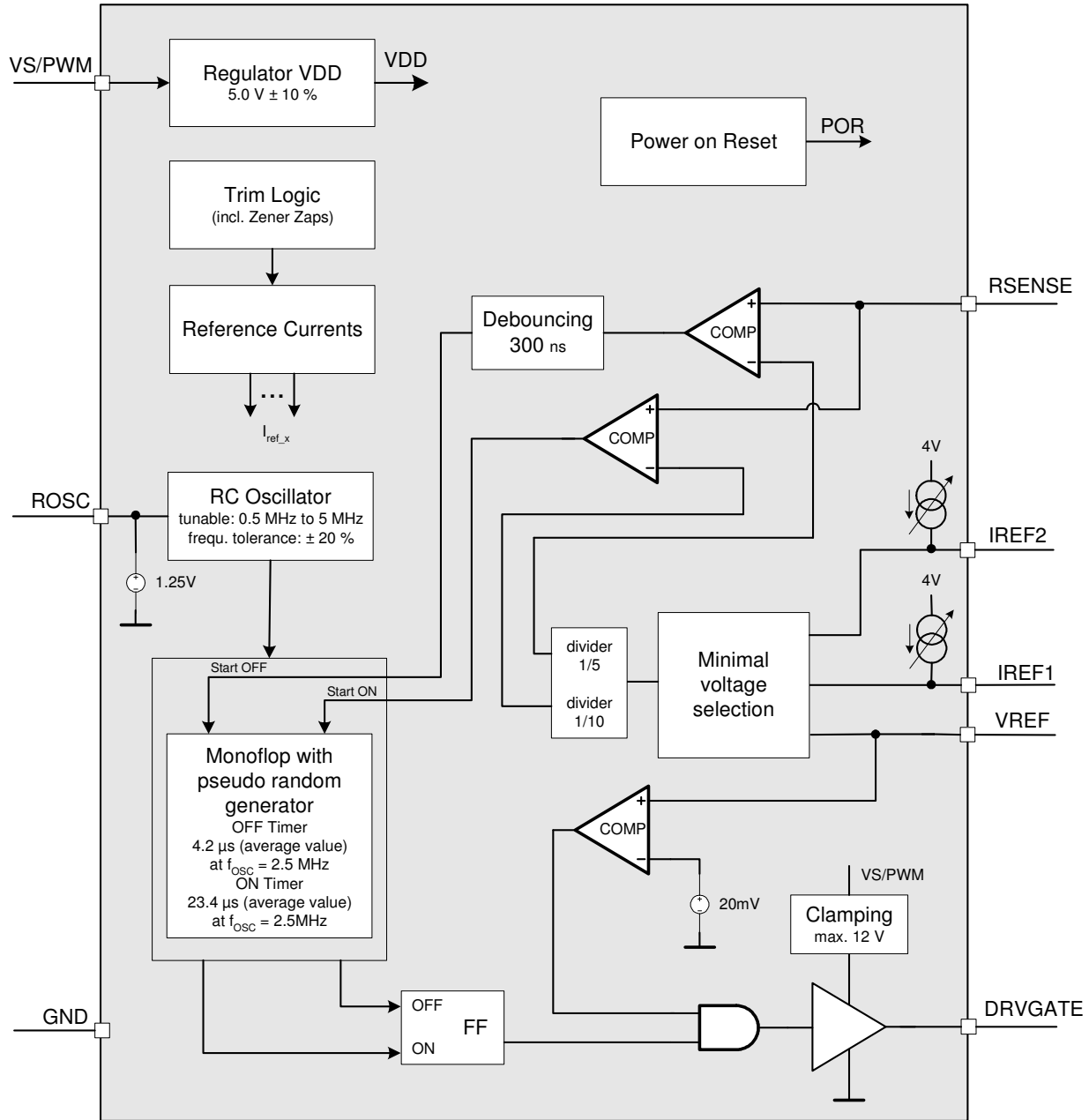
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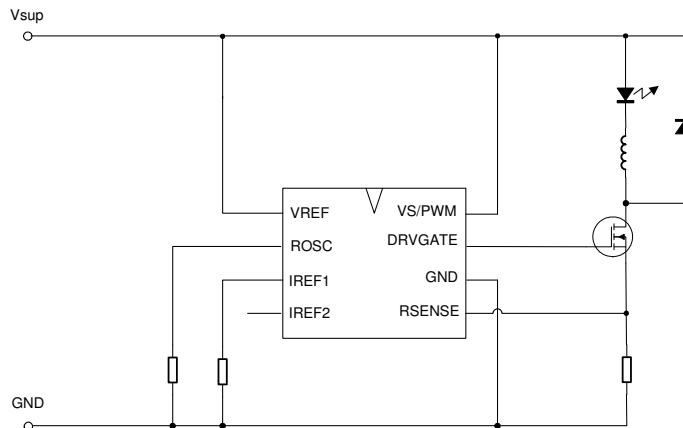
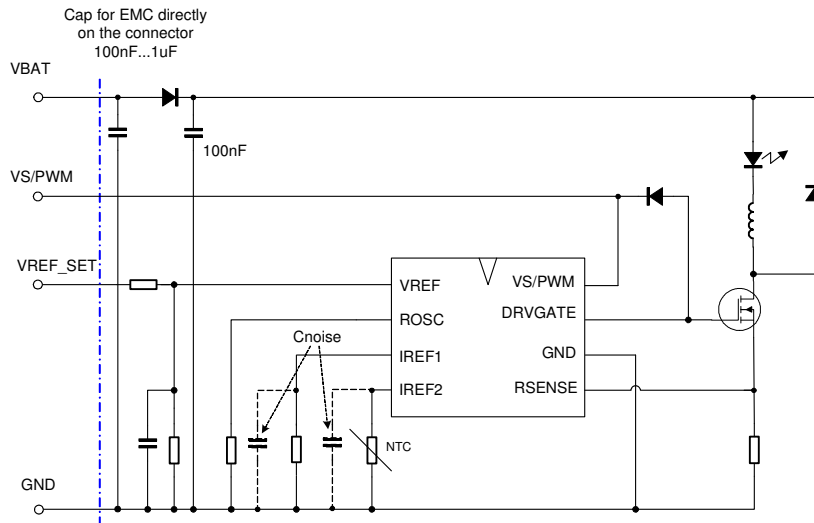
**Block diagram**



## 1. Typical application data

### 1.1. LED driver applications

#### 1.1.1. Principle complete schematic LED driver diagram



### 1.1.2. Principle soft start up LED driver diagram

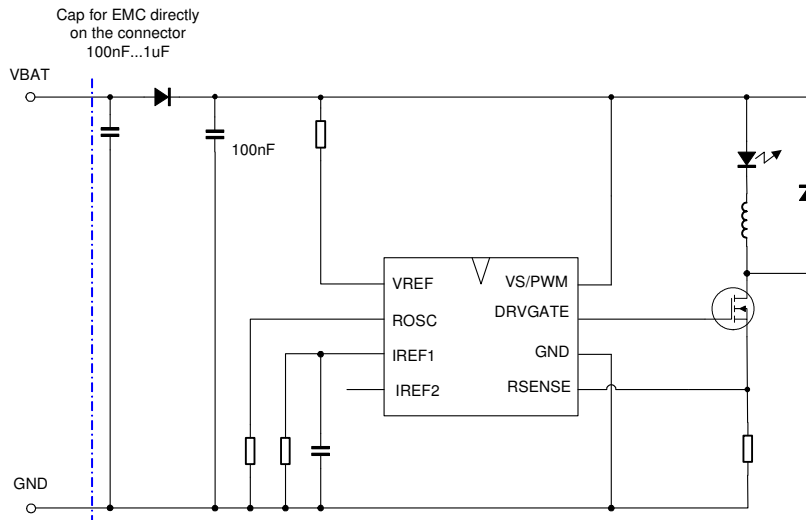


Figure 1:

### 1.1.3. LED driver application notes

The MLX10803 is optimised for the use of low cost coils and n-channel MOSFETs. For a standard application with 1 LED and an average current of 350mA, a coil of about 100 $\mu$ H...220 $\mu$ H and  $\leq 1\Omega$  DC resistance should be chosen. The sense resistor should have a value between 0.27 $\Omega$ ...0.47 $\Omega$  / 250mW.

As a general rule: for higher load current lower inductance of the coil is needed because higher currents lengthen the charging time of the coil. Thus, switching frequencies may become lower than 20kHz which is often not desired. It is possible to set the peak current and the average current of the LED by variation of the RSENSE resistor, the coil value and the internal oscillator frequency (ROCS resistor).

The flyback diode that carries the load current during the passive state (driver OFF) should be a fast switching and low intrinsic capacitance diode like ES1D or BYG80 in order to avoid parasitic spikes on RSENSE. The diode must be able to carry the LED current flowing during the OFF time of the driver.

The n-channel MOSFET should have low intrinsic capacitances, a drain-source voltage suitable for the application and must be able to carry the current flowing through the LED(s) during the ON time. To decrease the time of transistor switching and to improve the thermal behaviour of the module, the lines between transistor and IC should be minimised.

For applications that use an NTC resistor for temperature sensing, the NTC value has to be selected according to the application requirements. For most applications, a NTC value up to 470k $\Omega$  will be suitable.

In case of longer lines between the IC and the coil (which should be avoided because of EMI), a capacitor might be placed in parallel to RSENSE to avoid crosstalk and parasitic switching. Well chosen parameters for external components can help to avoid such conditions. The goal should be to unload the coil as much as possible during the selected off time (see also chapter 7).

---

To reduce an influence of noise which can be coupled to sensitive reference pins IREF1, IREF2 it is possible to connect noise-filtering capacitors in parallel to IREF1 and IREF2 resistors (see Figure 1, Cnoise capacitors). The coupling also should be reduced as much as possible by proper routing of IREF1 and IREF2 stripes on PCB. IREF2 resistor should be placed as close as possible to IREF2 pin and stripe from IREF1 pin to NTC resistor should be shielded by GND stripe.

The schematic diagram under Figure 1 is used in applications where the LED is controlled by external control electronics. A PWM with a frequency between 30Hz..5kHz can be applied to the VS/PWM pin in order to dim the light output. This frequency is limited by the time needed for recharging the coil and monoflop time selected by the resistor connected to ROSC as well as by the IC settling time after POR. This function can be used to achieve different light outputs or also be used in a temperature down regulation.

It is recommended to have the PWM frequency at least 5-10 times lower than the selected driver switching frequency.

Diode is placed between DRVGATE and VS/PWM IC pins serves as discharger of gate of FET transistor. Thus, having switched off IC at VS/PWM voltage=0 DRVGATE turns to Z-state. Charge that was stored in gate capacitor runs down to VS/PWM module pin via the diode.

The minimum schematic diagram under Figure 2 is sufficient for all applications with a constant light output.

We also recommend to compare with our other circuits in the MLX108xx family and study these application notes for suitable solutions.

## 2. Application pins

| Nr. | Name    | Function  |
|-----|---------|---|
| 1   | VREF    | Analogue input, setting of LED peak current   |
| 2   | ROSC    | External resistor sets internal Oscillator frequency. Sets the average discharge time of the coil |
| 3   | IREF1   | External NTC resistor for temperature down regulation   |
| 4   | IREF2   | External resistor sets the temperature breakpoint when the NTC resistor starts down regulation    |
| 5   | RSENSE  | External sense resistor pin for peak current detection  |
| 6   | GND     | Ground  |
| 7   | DRVGATE | Pin driving the gate of the switching transistor  |
| 8   | VS/PWM  | Supply Voltage / PWM signal   |

## 3. Absolute maximum ratings

| Parameter  | Symbol      | Condition  | Min                       | Max                    | Unit       |
|--|-------------|--|---------------------------|------------------------|------------|
| Power supply (VS/PWM)  | vs          | DC<br>max. 2h  | -0.3<br>-0.3              | 32<br>36               | V<br>V     |
| Power supply, non operational function<br>max. 0.5s (Load dump)    | vsmax       | max 0.5s   | 36                        | 80                     | V          |
| Input current in protection circuitry on any pin                   | iprot       | In case of<br>maximum<br>supply ratings                                      | -10                       | 10                     | mA         |
| Input voltage on RSENSE pin  | virsense    | normal<br>operation  | -0.3                      | 11                     |            |
| Input voltage on IREF1, IREF2, VREF pins                           | vrefmax     | without external<br>resistor<br><br>protected by<br>external 47k<br>resistor | -0.3<br><br>-80<br>(0.5s) | 40<br><br>80<br>(0.5s) | V<br><br>V |
| Input voltage on ROSC pin  | vrosxmax    | normal<br>operation  | -0.3                      | Vdd+0.3                | V          |
| Input voltage on DRVGATE pin                                       | vdrv gatmax | idrv gatmax<br>current must<br>not be<br>exceeded                            | -0.3                      | 22                     | V          |
| Input/output current on DRVGATE pin                                | idrv gatmax | pulse mode   |                           | 500                    | mA         |
| Junction temperature<br>Lifetime<br>Dynamic<br>Storage temperature | Tjunc       | normal<br>operation.<br>max. 100h  | -40<br>-40<br>-55         | 140<br>150<br>150      | °C         |
| Ambient temperature range  | Tambient    | normal<br>operation  | -40                       | 125                    | °C         |
| Thermal resistance junction to ambient                             | rth         | SOIC8  |                           | 128.4                  | K/W        |

#### 4. Electrical characteristics

Following characteristics are valid

- for the full temperature range of  $T_{ambient} = -40^{\circ}C$  to  $+125^{\circ}C$ ,
  - a supply range of  $32V \geq v_s > 6V$
- unless other conditions noted.

With  $6V \geq v_s > v_{porh}$  analogue parameters can not be guaranteed.

Note: The correct operation of the MLX10803 as a switching mode power supply for voltages lower than the nominal supply voltage is dependent on the forward bias voltage of the used LED.  
The user must ensure that at low supply voltage the peak current threshold voltage on the RSENSE pin can be reached in order to keep the switching principle working.

If several pins are charged with transients above  $VS/PWM$  and below  $GND$ , the sum of all substrate currents of the influenced pins should not exceed 10mA for correct operation of the device.

Normal operating supply voltage is supposed to be 13.8V.

| Parameter   | Symbol  | Conditions   | Limits |       |       | Units   |
|---|---------|--|--------|-------|-------|---------|
|   |         |  | Min    | Typ   | Max   |         |
| <b>Global parameters</b>  |         |  |        |       |       |         |
| Maximum current during 80V load dump                                      | ihv     | $v_s=80V$  |        |       | 10    | mA      |
| Normal supply current at highest DC voltage                               | inomdch | $v_s=32V$  |        |       | 2     | mA      |
| Normal supply current   | inom    | $v_s=13.8V$  | 400    |       | 700   | $\mu A$ |
| <b>IC settling time</b>   |         |  |        |       |       |         |
| IC settling time after power on reset                                     | tsettle |  |        |       | 10    | $\mu s$ |
| <b>Oscillator related parameters</b>                                      |         |  |        |       |       |         |
| <b>The min/max specification influences inversely all derived timings</b> |         |  |        |       |       |         |
| Min oscillator frequency  | foscmin | For a selected external resistor $R_{osc}$ of 440k $\Omega$ and room temperature               | 0.4    | 0.5   | 0.6   | MHz     |
| Max oscillator frequency  | foscmax | For a selected external resistor $R_{osc}$ of 40k $\Omega$ and room temperature                | 4.0    | 5.0   | 6.0   | MHz     |
| Extended min oscillator frequency   | foscext | For a selected external resistor $R_{osc}$ of 1200k $\Omega$ and room temperature <sup>1</sup> | 0.148  | 0.184 | 0.221 | MHz     |



| RESET related parameters                           |                           |  |           |           |          |        |
|--|---------------------------|--|-----------|-----------|----------|--------|
| Power on reset level, if VS/PWM is ramped up       | vporh                     | Reset is connected to the internal Vdd, but vporh is measured on pin VS/PWM    | 1.5       |           | 4        | V      |
| Power on reset hysteresis, if VS/PWM is drawn down | vporhyst                  | Reset is connected to the internal Vdd, but vporhyst is measured on pin VS/PWM | 0.1       |           | 0.7      | V      |
| Vdd related parameters (Vdd used internally only)  |                           |  |           |           |          |        |
| Internal supply voltage range                      | vdd                       | vs=13.8V   | 4.5       |           | 5.5      | V      |
| RSENSE related parameters                          |                           |  |           |           |          |        |
| Input leakage current                              | ileakrsense               | vs=13.8V, vrsense=0V, 5V   | -20       |           | 20       | μA     |
| Debounce time after switching on                   | tdeb                      | vs=13.8  | 200       |           | 500      | ns     |
| VREF related parameters                            |                           |  |           |           |          |        |
| Leakage current                                    | ileakvref                 | vs=13.8V, vvref=0V, 5V   | -20       |           | 20       | μA     |
| DRVGATE cessation voltage                          | vswoff <sup>2</sup>       | vs=13.8V   | 15        | 20        | 25       | mV     |
| Sensitive voltage range                            | vvrefrng <sup>2</sup>     | vs=13.8V   | vswoff    |           | 3.8      | V      |
| Linear voltage range                               | vvreflinrng <sup>2</sup>  | vs=13.8V   | 0.1       |           | 3.8      | V      |
| IREF1 related parameters                           |                           |  |           |           |          |        |
| Output current for external reference measurement  | iiref1                    | vs=13.8V, viref1=viref1rng   | 46.5      | 50        | 52.5     | μA     |
| Temperature drift of the current                   | iiref1drift               |  |           | -0.1      |          | %/°C   |
| Sensitive voltage range                            | viref1rng <sup>2</sup>    | vs=13.8V   | vswoff    |           | 3.6      | V      |
| Linear voltage range                               | viref1linrng <sup>2</sup> | vs=13.8V   | 0.1       |           | 3.6      | V      |
| IREF2 related parameters                           |                           |  |           |           |          |        |
| Difference of iiref2 to iiref1                     | difiref12                 | vs=13.8V, viref1=viref2rng   | -10       |           | +10      | %      |
| Temperature drift of the current                   | iiref2drift               |  |           | -0.1      |          | %/°C   |
| Sensitive voltage range                            | viref2rng <sup>2</sup>    | vs=13.8V   | vswoff    |           | 3.6      | V      |
| Linear voltage range                               | viref2linrng <sup>2</sup> | vs=13.8V   | 0.1       |           | 3.6      | V      |
| DRVGATE related parameters                         |                           |  |           |           |          |        |
| Max output voltage in ON state                     | vmaxdrv                   | Load current 1μA to GND, vs=13.8V  | 10        |           | 13       | V      |
| Output resistance of push-pull output              | Rdrvgateout               | To GND pin<br>To VS/PWM pin,<br>vs=13.8V                                       | 3.5<br>20 | 7.8<br>40 | 15<br>60 | Ω<br>Ω |

| ROSC related parameters <sup>3</sup>                                   |             |   |   |      |     |    |
|--|-------------|---|---|------|-----|----|
| Output voltage   | vrosc       | vs=13.8V  | 1 |      | 1.5 | V  |
| Resistance on pin to GND for 0.5MHz                                    | Roscmín     |   |   | 440  |     | kΩ |
| Resistance on pin to GND for 1MHz                                      | Roscmid     |   |   | 220  |     | kΩ |
| Resistance on pin to GND for 5MHz                                      | Roscmáx     |   |   | 40   |     | kΩ |
| Resistance on pin to GND for extended min oscillator frequency foscext | Roscext     |   |   | 1200 |     | kΩ |
| Monoflop related parameters  |             |   |   |      |     |    |
| Minimum OFF time due to the implemented jitter                         | toffmin1mhz | Oscillator is set to 1 MHz, in case the oscillator is put to an other frequency, toffmin1mhz scales accordingly |   | 9    |     | μs |
| Maximum OFF time due to the implemented jitter                         | toffmax1mhz | Oscillator is set to 1 MHz, in case the osc is put to an other frequency, toffmax1mhz scales accordingly        |   | 16   |     | μs |
| Average monoflop time for ON state of transistor                       | ton1mhz     | Oscillator is set to 1 MHz  |   | 60.5 |     | μs |

<sup>1</sup> Circuit operation with external resistor  $R_{osc} > 1200k\Omega$  is not recommended

<sup>2</sup> Guaranteed by design

<sup>3</sup> Value for the resistor  $R_{osc}$  to be connected to ROSC pin is derived from the needed monoflop time  $T_{mon}$

according to the following expression:  $R_{osc}[k\Omega] = 222.2 \cdot \left( \frac{T_{mon}[\mu s]}{12.5} - 0.02 \right)$

## **5. ESD/EMI recommendations for MLX10803**

- In order to minimise EMI, the PCB has to be designed according to EMI guidelines. Additional components may be needed, other than what is shown in the application diagrams, in order to comply with the EMI requirements.
- The MLX10803 is an ESD sensitive device and has to be handled according to EN100015 part 1.
- The MLX10803 will fulfil the requirements in the application according to the specification and to DIN 40839 part 1.
- The MLX10803 is designed with ESD protection >1000V HBM according to MIL883D.

## 6. Automotive test pulses

The following chapter is valid for a completely assembled module. That means that automotive test pulses are applied to the module and not to the single IC.

In the recommended application according to chapter 1.1, the reverse polarity diode together with the capacitors on the supply and the load dump protected IC itself protect the module against the automotive test pulses listed below.

The exact values of the capacitors for the application have to be figured out according to the automotive and EMI requirements.

No damage occurs for any of the test pulses. A deviation of the IC's characteristics is allowed during pulse 1, 2, 4; the module returns to normal operation after the pulse without any additional action.

During test pulse 3a, 3b, 5 the module operates within characteristic limits.

| Parameter  | Symbol               | Min      | Max        | Dim    | Test condition, Functional status |
|--|----------------------|----------|------------|--------|-----------------------------------|
| <b>Transient test pulses in accordance to ISO7637 part 1 &amp; 3. Pin VREF goes outside of module via resistor of 47kΩ. Module schematic is according to application notes mentioned in 1.1.1.</b> |                      |          |            |        |                                   |
| Test pulse #1 at module pins VBAT, VS/PWM. VREF_SET, IC pin IREF1 -> GND   | vpulse1              | -100     |            | V      | 5000 pulses, functional state C   |
| Test pulse #2 at module pins VBAT, VS/PWM. VREF_SET, IC pin IREF1 -> GND   | vpulse2              |          | 100        | V      | 5000 pulses functional state C    |
| Test pulse #3a at module pins VBAT, VS/PWM. VREF_SET, IC pin IREF1 -> GND  | vpulse3a             | -150     |            | V      | 1h, functional state A            |
| Test pulse #3b at module pins VBAT, VS/PWM. VREF_SET, IC pin IREF1 -> GND  | vpulse3b             |          | 100        | V      | 1h, functional state A            |
| Test pulse #4 at module pin VBAT, VS/PWM, VREF_SET -> GND  | vspulse4<br>vapulse4 | -6<br>-5 | -4<br>-2.5 | V<br>V | 1 pulse, functional state C       |
| Test pulse #5 at IC pin VS/PWM -> GND  | vpulse5              | 45       | 85         | V      | functional state C                |

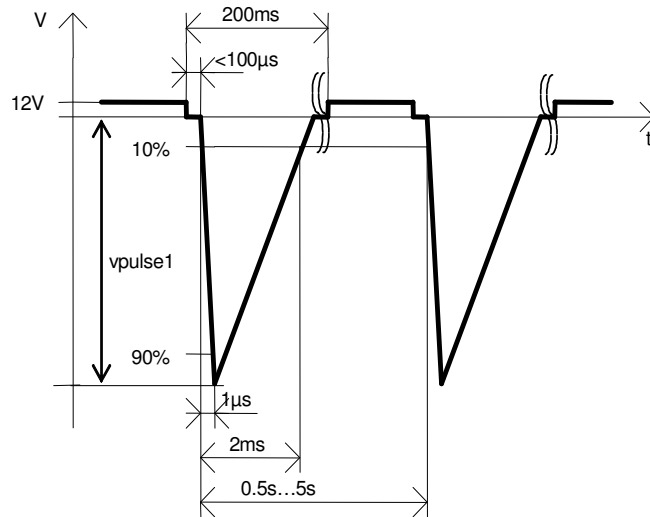
Description of functional status:

- A: All functions of the module are performed as designed during and after the disturbance.
- B: All functions of the module are performed as designed during and after the disturbance:  
However, one or more can deviate from specified tolerance. All functions return automatically to normal limits after exposure is removed. Memory functions shall remain class A.
- C: A function of the module is not performed as designed during disturbance but returns automatically to a normal operation after the disturbance.

**6.1. Test pulse definition**

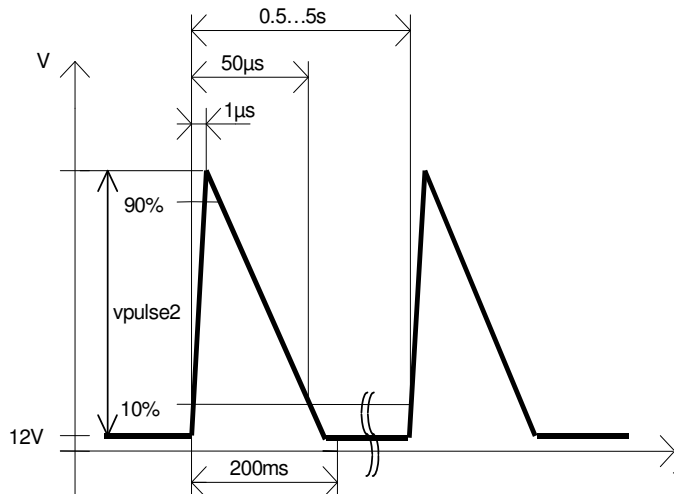
**Test Pulse 1**

Ri = 10 Ω



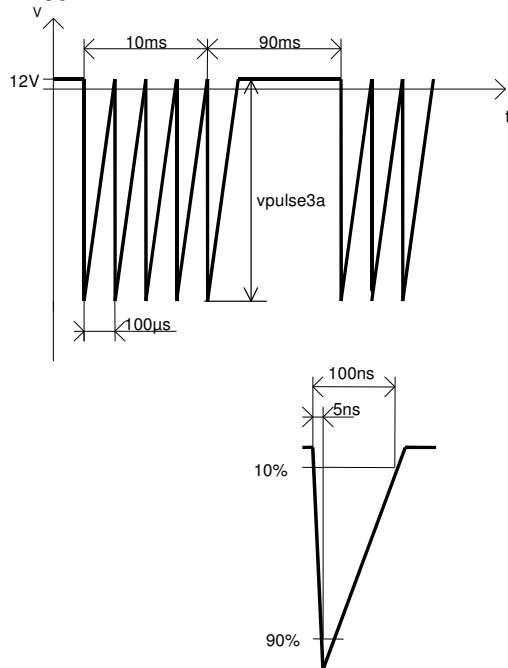
**Test Pulse 2**

Ri=10 Ω



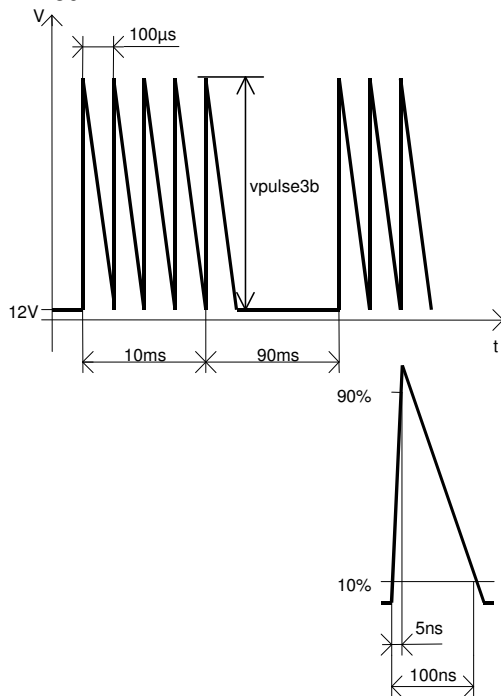
**Test Pulse 3a**

Ri = 50 Ω



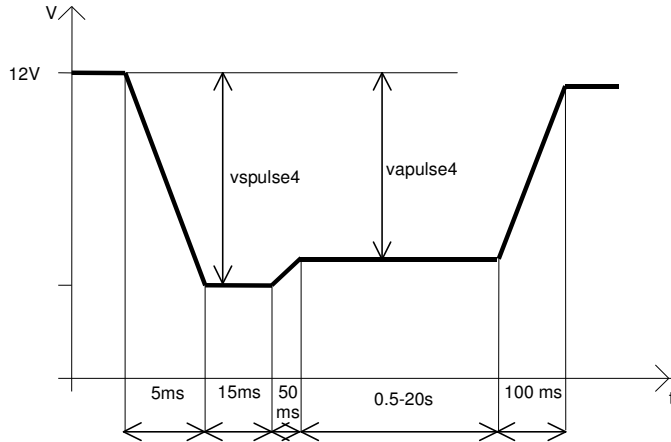
**Test Pulse 3b**

Ri = 50 Ω



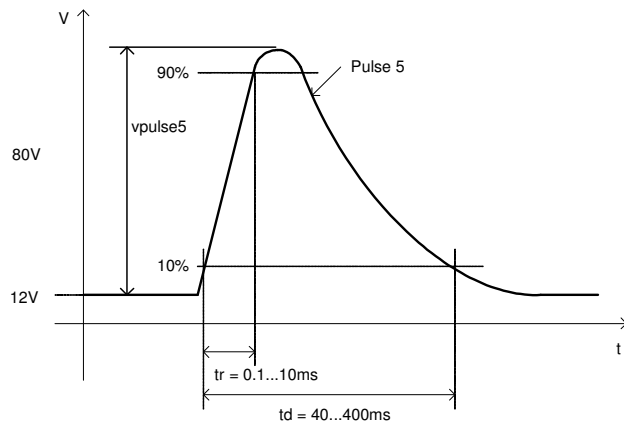
**Test Pulse 4 (Cranking)**

$R_i = 0.01\Omega$



**Test Pulse 5 (Load Dump)**

$R_i = 0.5...4\Omega$



## 7. LED driving principle

### 7.1. General

The LED is driven by a switched mode power supply using an inductor as the energy storage element. This method has several advantages. The supply voltage has to be set down to the forward bias voltage of the LED. In ordinary applications this is achieved by a resistor with the following drawbacks:

- A resistor dissipates power which is transformed to heat
- Efficiency is reduced drastically
- The light output of the LED is dependent on the supply and the temperature of the resistor

The MLX10803 avoids these disadvantages as shown by the following calculation with  $L=220\mu\text{H}$ ,  $R_{\text{SENSE}} = 0.1 \Omega$ :

Supposed:

$$V_{\text{bat}} = 13.8\text{V}$$

$$V_{\text{fLED}} \approx 3.4\text{V example 1; } 8\text{V example 2;}$$

$$I_{\text{fLED}} \approx 4\text{A}$$

$$V_{\text{f1}} \approx 0.9\text{V (reverse polarity diode)}$$

$$V_{\text{f2}} \approx 0.9\text{V (free wheel diode)}$$

$$V_{\text{RSENSE}} \approx 0.4\text{V (@} I_{\text{fLED}}, R_{\text{SENSE}}=0.1 \Omega)$$

$$V_{\text{RDS ON}} \approx 0.04\text{V (@} I_{\text{fLED}})$$

$$V_{\text{Coil}} \approx 0.2\text{V (@} I_{\text{fLED}})$$

Efficiency using a simple resistor or load dump regulation:

$$\text{Efficiency } n: \quad n = \frac{V_{\text{fLED}}}{V_{\text{BAT}}} \approx 29\% \text{ example 1; } \approx 58\% \text{ example 2;}$$

Efficiency using the MLX10803:

The following calculation is an approximation only, due to the fact that coil current is not constant. It is therefore calculated with average currents.

- 1) During OFF time, the coil acts as the storage element and delivers its energy to the flyback diode and the LED:

$$n_1 = \frac{V_{\text{fLED}}}{V_{\text{fLED}} + V_{\text{f2}} + V_{\text{Coil}}} \approx 75\% \text{ example 1; } \approx 88\% \text{ example 2;}$$

- 2) During ON time, current flows through the reverse polarity diode, LED, coil, FET driver and RSENSE, which causes the following voltage drops:

$$n_2 = \frac{V_{\text{fLED}}}{V_{\text{fLED}} + V_{\text{f1}} + V_{\text{Coil}} + V_{\text{RDSon}} + V_{\text{RSENSE}}} \approx 69\% \text{ example 1; } \approx 84\% \text{ example 2;}$$

- 3) ON and OFF times are in ratio of roughly 30:70 for example 1 and 65:35 for example 2:

$$\text{Efficiency } n: n = n_1 \cdot 0.7 + n_2 \cdot 0.3 \approx 73\% \text{ example 1; } \approx 87\% \text{ example 2;}$$

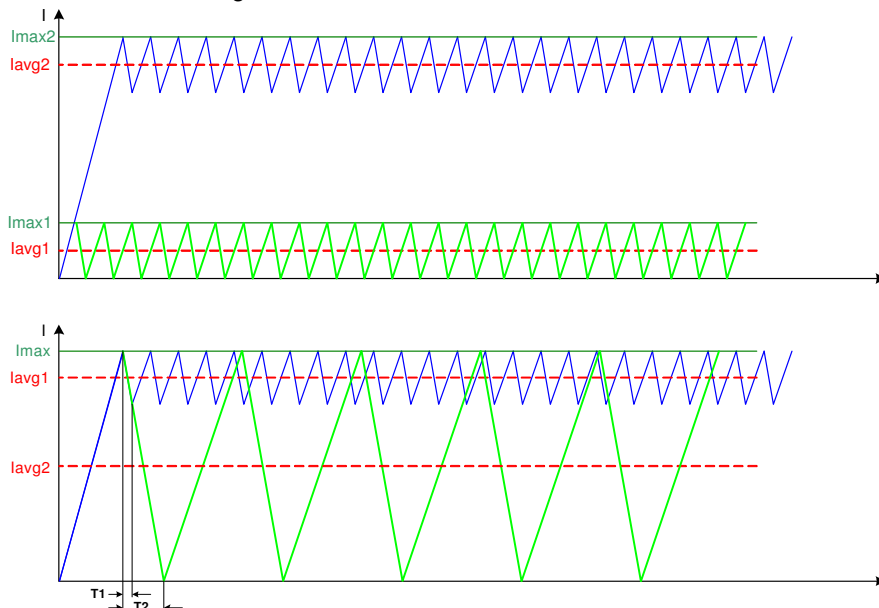


### 7.2. The principle in detail

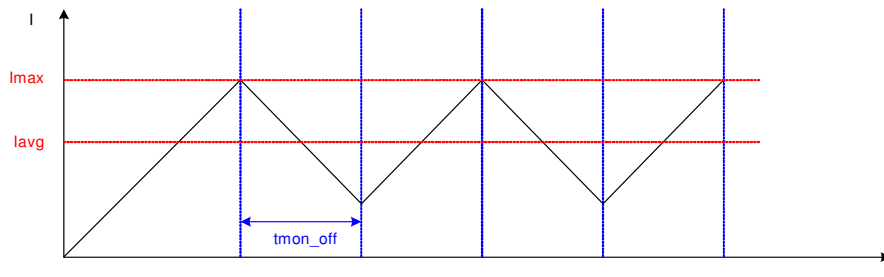
After powering on the MLX10803 the switch becomes open and the current through the LED starts to rise. The rate of current raise is limited by the value of the coil. When the current through the LED reaches half of a maximum value, the ON timer is started, and if during 58.5 clocks of the internal oscillator the maximum current value through the LED is not reached, the driver switches off. This maximum current is adjusted by the resistors on the IREF2, IREF1 or voltage applied to VREF pins (voltage on these pins is divided by 5). The minimum of these voltages is taken as a reference. The driver is switched off for a monoflop time, which is equal to 9...16 pulses of oscillator. The frequency of the oscillator can be set by the customer using the R<sub>osc</sub> value using such formula:

$$F_{osc}[MHz] = 222.2 / (R_{osc}[k\Omega] + 4.44)$$

Both parameters, the peak current threshold voltage and the monoflop time, create an ON/OFF period to form an average current through the LED. By adjusting these parameters, an adjustment of the average load current is possible in a wide range.



**Note:** The current sense comparator has a typical debouncing time of 300ns as shown in the block diagram. This delay time prevents the driver from being switched off due to short term switching oscillations. When working with very short monoflop times, this time has to be taken into account for calculations.



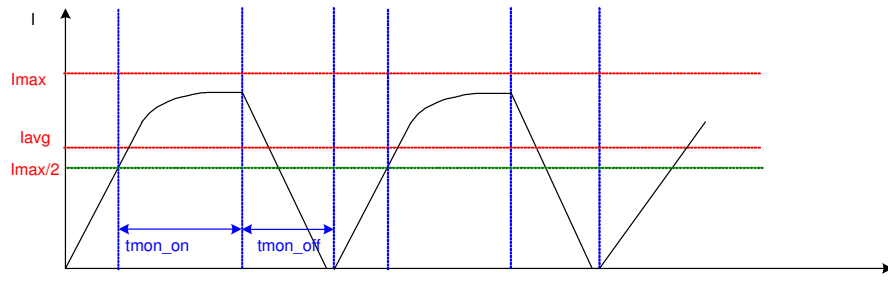
By applying a PWM signal on VS/PWM, the LED can be dimmed from 0% to 100%.

|              |  |
|--------------|--|
| VS/PWM = L   | LED permanent OFF                      |
| VS/PWM = PWM | LED dimmed with PWM between 0% to 100% |
| VS/PWM = H   | LED permanent ON                       |

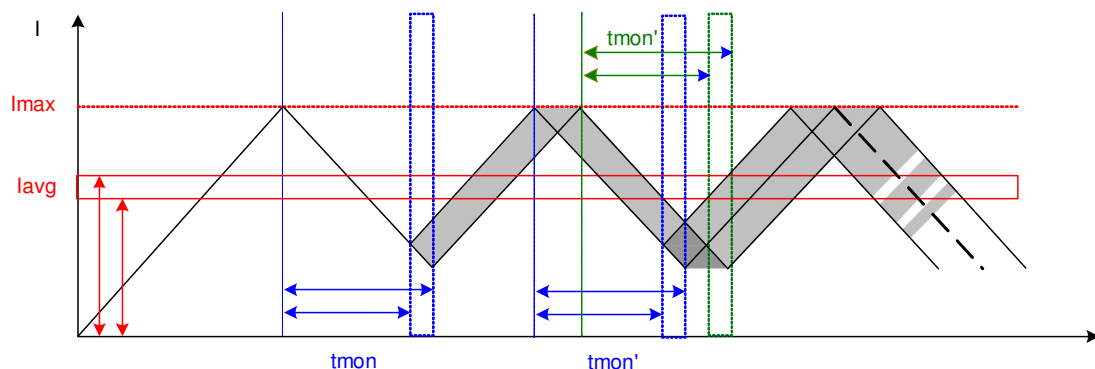
Dimming is achieved by applying a PWM directly to the module supply or by changing the reference voltage on pin VREF or the resistor's value on IREF2 pin.

IC settling times must always be considered in PWM mode. Please refer also to chapter 1.1.3 for additional PWM frequency considerations.

Limitation of the ON time prevents from exceeding the allowed average current when the power supply voltage is not sufficient for the current to reach its peak value and restricts in this case duty cycle of switching to 68%.



A pseudo random generator is applied to the monoflop time. The pseudo random generator runs with the clock derived out of the monoflop time and adds a random distribution on these 3 LSBs. Therefore, the monoflop time gets a **random** variation from its value. The EMI behaviour of the complete module is improved due to the variation of the otherwise fixed switching frequency.

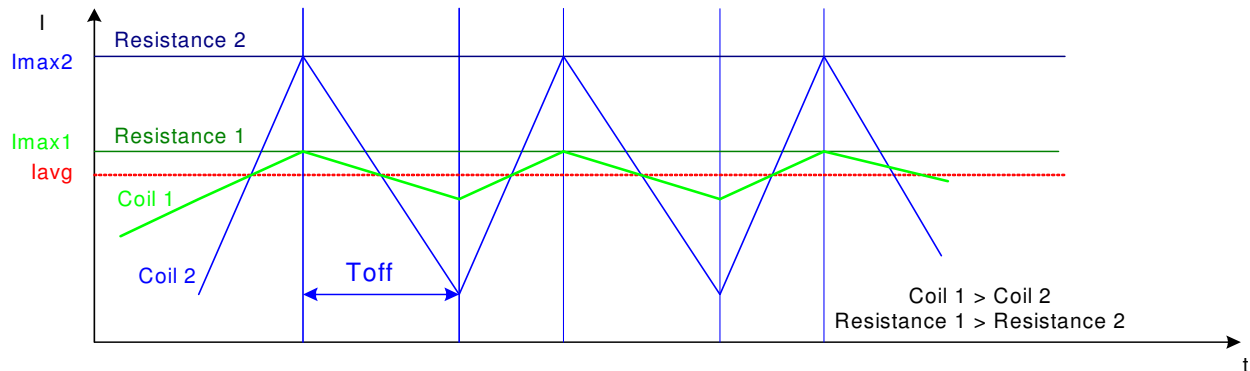


The inductance  $L$  of a coil describes the amount of magnetic energy that can be stored in it. Consequently, high inductive coils will be discharged less than low inductive coils in a given time.

Generally the coil can be driven in two different ways:

- 1) The coil is discharged partially only. That means the coil still carries a significant amount of energy when going from discharging to charging. In that moment the charging current rises immediately to the coil current that was flowing just before switching. This is connected with large  $dI/dt$  transients on the RSENSE pin that have a negative impact on EMI. This is mostly preferred way of regulation because of low influence of supply voltage and coil value on output current. Fast flyback diode is recommended and extra important in this case.
- 2) The coil discharged completely. Thus, at the end of a discharging cycle, the coil doesn't carry energy anymore. With the next charging cycle, current increases steadily from around zero. This way, large  $dI/dt$  transients are completely avoided.

Because of randomisation, the discharging time is not constant but varies within a certain range. It must be ensured that only the longest possible monoflop time completely discharges the coil. Otherwise the coil is discharged before the monoflop time ends which results in a loss of accuracy.



**Conclusion:** In most cases the coil is driven in a combination of both ways. A trade off has to be made between EMI behaviour and maximum allowed LED current. By varying these parameters, an optimum can be found for every application.

Below are some examples for typical parameter sets given for a 4A LED current and the following application data:

- RSENSE = 0.1  $\Omega$ / 2 watt
- ROSC = 270k $\Omega$
- L = 47 $\mu$ H, 4A minimum, 0.05  $\Omega$
- Normal nFET switch transistor, rds on < 0,01  $\Omega$

Remarks:

- 4A and 0.05  $\Omega$  results in 0.8 watt power dissipation over the coil.
- 4A and 0.1  $\Omega$  for the RSENSE resistor results in 1.6 watt, but only for 50% of the time in average.
- The LED(s) with this current will dissipate 32 watt if they have 8V forward voltage.

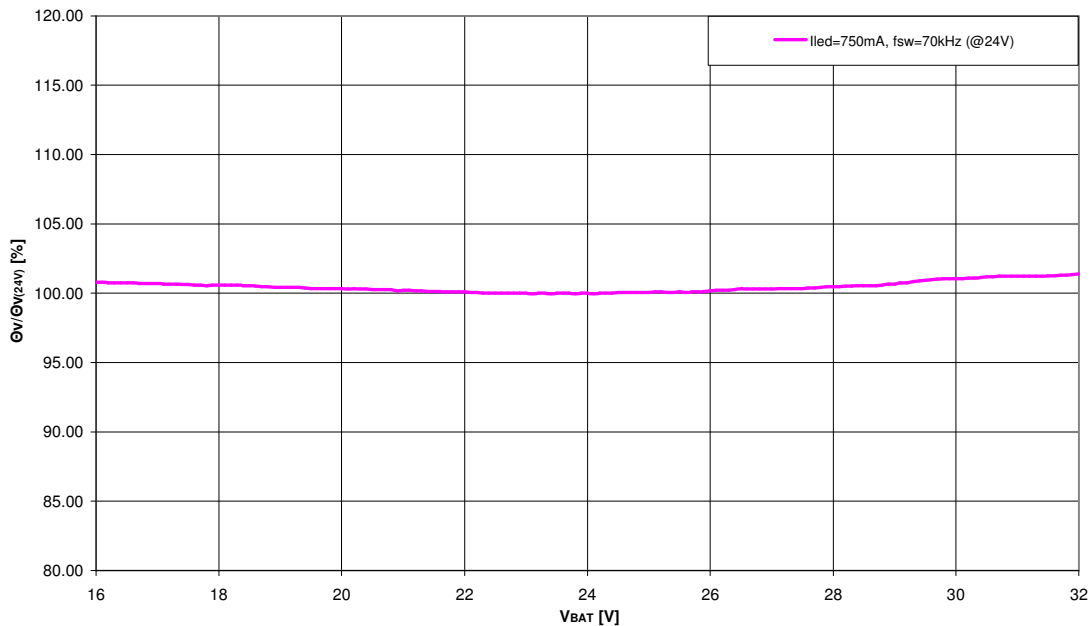
### 7.3. Switching frequency considerations and constant light output

As already shown, the switching frequency depends on the peak current as well as on the monoflop time for a given coil. Furthermore it depends on the coil inductance itself.

Due to the principle of switch mode power supplies, the current through the LED is kept constant for any supply change. The parameter that changes in order to keep the current constant is the switching frequency itself. The lower the supply voltage, the lower the switching frequency. Furthermore, the supply current is affected by supply changes: with an increasing supply voltage the average supply current decreases.

The graph below shows the normalised luminous flux versus the power supply for a standard application with one white Luxeon III LED driven at 750mA. The parameters are optimised for the 24V board net. The luminous flux at 24V has been set to 100%. The graph indicates that the light output is minimally dependent on supply changes over the whole range from 16 to 32V.

**MLX10803**  
**Normalized luminous flux  $\Theta_V/\Theta_{V(24V)}$  vs. supply voltage**  
 $\Theta_V/\Theta_{V(24V)}=f(V_{BAT})$



## 8. Temperature regulation

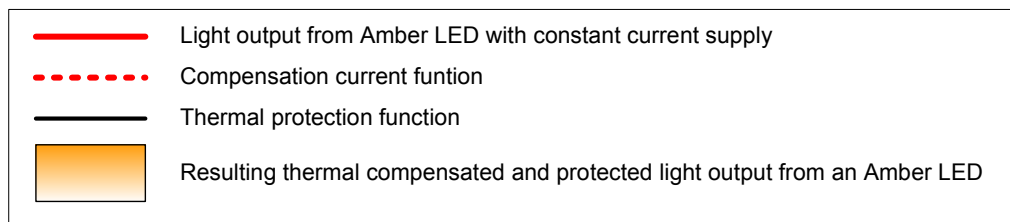
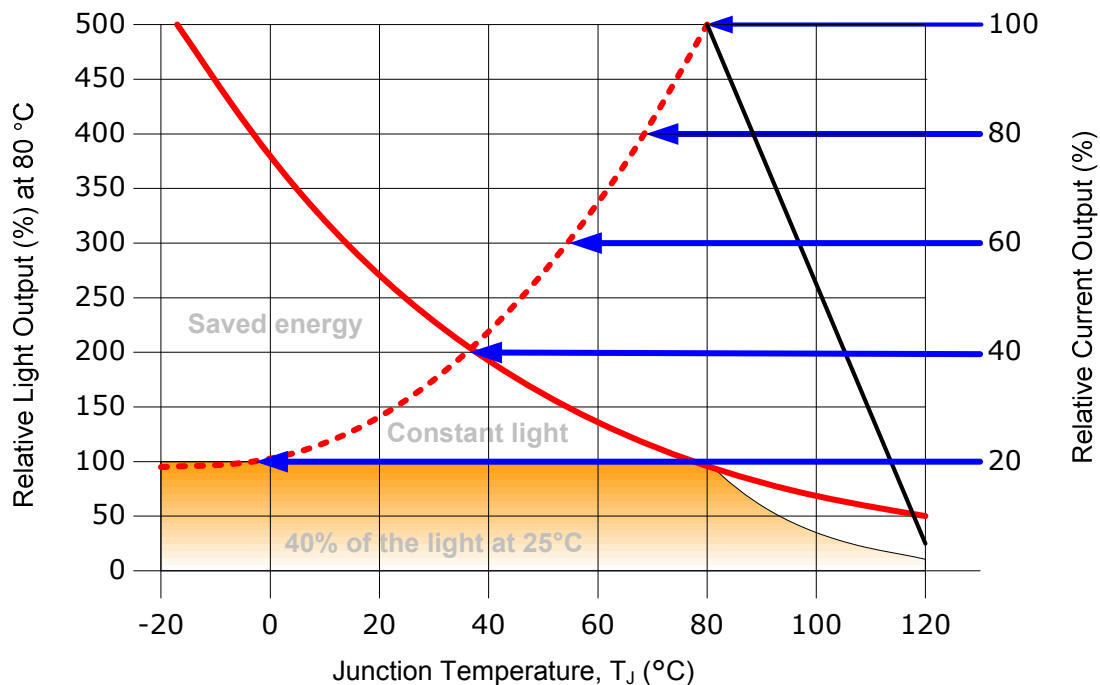
In normal mode the peak current threshold voltage is defined by the lowest voltage on pins VREF, IREF2 and IREF1. Usually the resistor connected to IREF2 pin has a small thermal coefficient and the resistor on IREF1 pin has a big negative temperature coefficient (but they also can be connected vice versa). Both of these pins have an output current of 50  $\mu$ A. When the voltage on pin IREF1 falls below the voltage on pin IREF2 or VREF, the voltage reference for the actual maximum current is taken from pin IREF1. This makes the value of the peak current sensitive to temperature and prevents overheating of LED or IC. When the voltage on pin IREF1 becomes higher than voltage on IREF2 or VREF, the reference switches back to IREF2 or VREF pin.

The thermal behaviour of the system should be characterised during the design-in of the product by the user.

For a system that is designed for thermal conditions, temperature down regulation may not be needed. In this case, it is enough to leave the IREF1 or IREF2 pin unconnected and the internal current source will pull it up to the voltage  $V_{dd} - 0.7V$ .

System behaviour can be configured to compensate the dependency of LED light output versus temperature. The example of such compensation is depicted below.

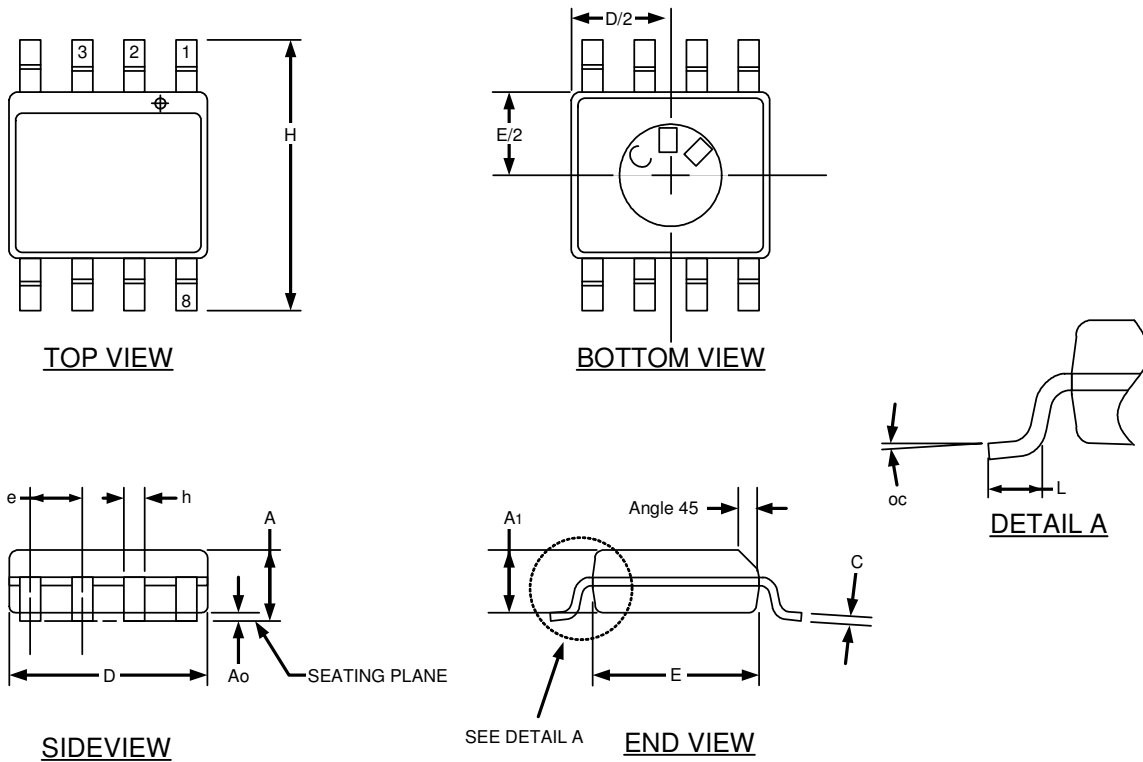
**Illustration of a possible temperature regulation**



## 9. Mechanical Data

### 9.1. Mechanical data of the MLX10803 package

Package of the MLX10803: SOIC8 in accordance to the JEDEC standard.



|    | DIMENSIONS |      |       |             |      |      | Note    |
|----|------------|------|-------|-------------|------|------|---------|
|    | INCHES     |      |       | MILLIMETERS |      |      |         |
|    | MIN.       | NOM. | MAX   | MIN.        | NOM. | MAX  |         |
| A  | .061       | .064 | .068  | 1.55        | 1.63 | 1.73 |         |
| A1 | .004       | .006 | .0098 | 0.127       | 0.15 | 0.25 |         |
| A0 | .055       | .058 | .061  | 1.40        | 1.47 | 1.55 |         |
| B  | .0138      | .016 | .0192 | 0.35        | 0.41 | 0.49 |         |
| C  | .0075      | .008 | .0098 | 0.19        | 0.20 | 0.25 |         |
| D  | .189       | .194 | .196  | 4.80        | 4.93 | 4.98 |         |
| E  | .150       | .155 | .157  | 3.81        | 3.94 | 3.99 |         |
| e  |            | .050 |       |             | 1.27 |      |         |
| H  | .230       | .236 | .244  | 5.84        | 5.99 | 6.20 |         |
| h  | .010       | .013 | .016  | 0.25        | 0.33 | 0.41 |         |
| L  | .016       | .025 | .035  | 0.41        | 0.64 | 0.89 |         |
| oc | 0°         | 5°   | 8°    | 0°          | 5°   | 8°   | Degrees |
| X  | .085       | .093 | .100  | 2.16        | 2.36 | 2.54 |         |

## **10. Standard information regarding manufacturability of Melexis products with different soldering processes**

Our products are classified and qualified regarding soldering technology, solderability and moisture sensitivity level according to following test methods:

### **Reflow Soldering SMD's (Surface Mount Devices)**

- IPC/JEDEC J-STD-020  
Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices (classification reflow profiles according to table 5-2)
- EIA/JEDEC JESD22-A113  
Preconditioning of Nonhermetic Surface Mount Devices Prior to Reliability Testing (reflow profiles according to table 2)

### **Wave Soldering SMD's (Surface Mount Devices) and THD's (Through Hole Devices)**

- EN60749-20  
Resistance of plastic- encapsulated SMD's to combined effect of moisture and soldering heat
- EIA/JEDEC JESD22-B106 and EN60749-15  
Resistance to soldering temperature for through-hole mounted devices

### **Iron Soldering THD's (Through Hole Devices)**

- EN60749-15  
Resistance to soldering temperature for through-hole mounted devices

### **Solderability SMD's (Surface Mount Devices) and THD's (Through Hole Devices)**

- EIA/JEDEC JESD22-B102 and EN60749-21  
Solderability

For all soldering technologies deviating from above mentioned standard conditions (regarding peak temperature, temperature gradient, temperature profile etc) additional classification and qualification tests have to be agreed upon with Melexis.

The application of Wave Soldering for SMD's is allowed only after consulting Melexis regarding assurance of adhesive strength between device and board.

Melexis is contributing to global environmental conservation by promoting **lead free** solutions. For more information on qualifications of **RoHS** compliant products (RoHS = European directive on the Restriction Of the use of certain Hazardous Substances) please visit the quality page on our website: <http://www.melexis.com/quality.aspx>

## 11. History record

| Rev. | No. | Change  | Date     |
|------|-----|---|----------|
| 1    | 1   | Creation with MLX10801 specifications as base   | 25.07.04 |
| 2    | 1   | Gone through document VAR,ALX,RAH,LIW   | 02.08.04 |
| 3    | 1   | 4-th pin recast from TEST to VREF - linear dimming  | 07.08.04 |
| 4    | 1   | Revision of kick off meeting  |          |
| 5    | 1   | Revision before release RAH   |          |
| 6    | 1   | Improved packing information RAH  |          |
| 7    | 1   | Improved block diagram  | 7.10.04  |
| 8    | 1   | Design implementation review  | 15.01.05 |
| 9    | 1   | Updated schematic diagrams  | 16.01.05 |
| 10   | 1   | Pin order changed   | 3.02.05  |
| 11   | 1   | Temperature code changed to "K", Vmaxdrv changed, Oscillator related parameters changed, VREF related parameters changed, ROOSC related parameters changed  | 13.06.05 |
| 12   | 1   | Cosmetic changes  | 17.06.05 |
| 13   | 1   | Cosmetic changes  | 21.06.05 |
| 14   | 1   | VREF related parameters are changed   | 12.07.05 |
| 15   | 1   | Pins' names changed: RE_REF → VREF, NTC → IREF1, SETNTC → IREF2, VS → VS/PWM. Corresponding parameters' names changed. RSENSE related parameters changed  | 3.08.05  |
| 16   | 1   | LED driver applications changed   | 18.08.05 |
| 17   | 1   | Block diagram changed, Electrical characteristics: Global parameters, Monoflop related parameters, RSENSE related parameters, IREF1 related parameters, IREF2 related parameters, VREF related parameters changed, LED driving principle: The principle in detail changed | 21.09.05 |
|      | 2   | Internal review   | 23.09.05 |
| 18   | 1   | Chapter 7.3. changed: graph added, cosmetic changes   | 23.09.05 |
|      | 2   | Cosmetic changes  | 28.09.05 |
|      | 3   | Soldering information is changed  | 31.10.05 |
| 19   | 1   | Internal review   | 28.11.05 |
| 20   | 1   | Monoflop related parameters changed, IREF1, IREF2, VREF related parameters changed  | 6.01.06  |
| 21   | 1   | Figure1, Figure2 changed, 4. Electrical characteristics: changed, 8. Temperature regulation: figure added   | 23.03.06 |
| 22   | 1   | "TBD" removed, cosmetic changes   | 6.04.06  |
|      | 2   | RESET related parameters changed, ROOSC related parameters changed  | 6.04.06  |
|      | 3   | Cosmetic changes  | 14.04.06 |
|      | 4   | Chapter 8, Illustration of a possible temperature regulation changed  | 16.08.06 |
|      | 5   | Cosmetic changes  | 17.08.06 |
| 23   | 1   | Chapter 4 (parameters table ) changed   | 25.09.06 |
| 24   | 1   | Iref1 related parameters changed, Iref2 related parameters changed, DRVGATE related parameters changed, Absolute maximum ratings changed  | 7.12.06  |
| 25   | 1   | Oscillator related parameters, ROOSC related parameters changed   | 2.10.07  |
| 26   | 1   | Disclaimer, logo, information regarding solderability   | 11.06.12 |



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