Melexis LED drivers
Automotive designs considerations

Small things make a big difference.

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Introduction

- **MLX10803 is designed for automotive applications.**
  - AECQ100 qualified
  - 80V loaddump proof
  - Jitter on the Monoflop time reduces EMC emissions.
- **This presentation attempts to give an overview of additional design considerations in order to realize a successful design in view of automotive requirements**
- **Topics**
  - Radiated emissions
  - Conducted emissions
  - Other Automotive test pulses: BCI, Cranking

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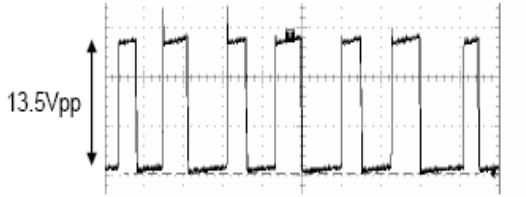
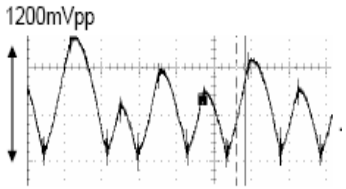
Main critical points (Pictures from Buck Example)

Radiated Emissions: RE / Conducted Emissions: CE

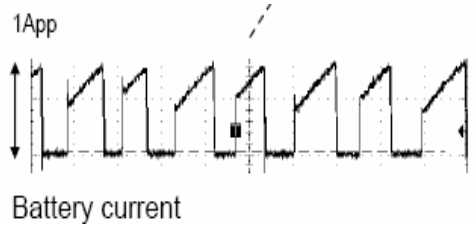


RE1. Square wave Voltage shape on FET drain (hot spot)

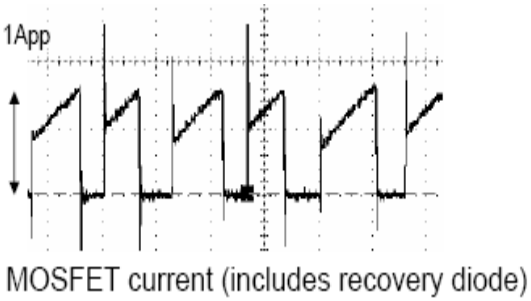


RE2. Voltage ripple on the supply line (wire in case of remote LEDs) to LEDs.

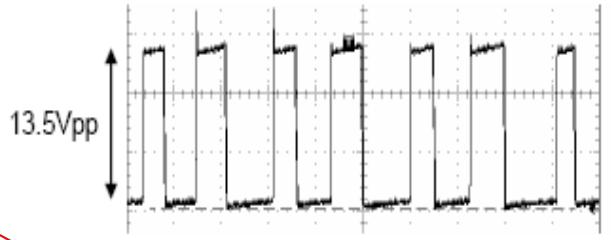
CE1.

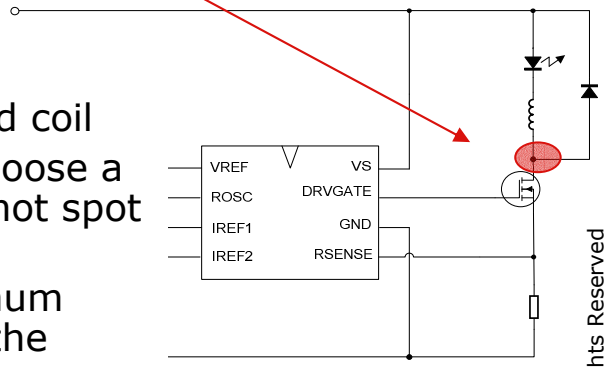


CE2.



RE Hot spot 1: FET Drain

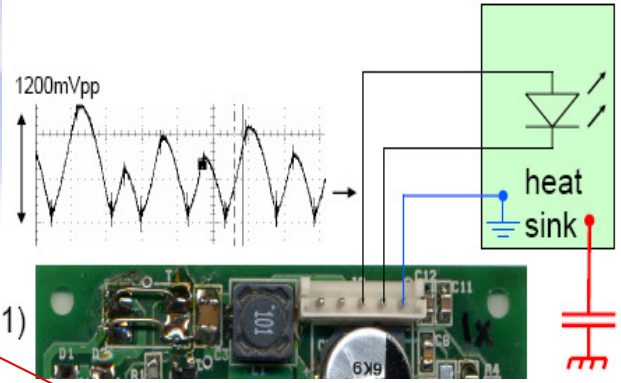




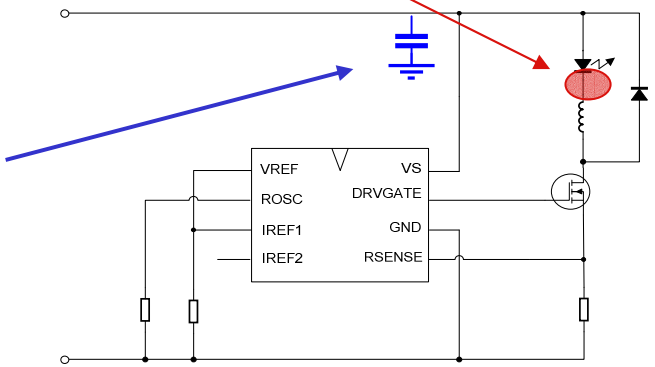
- **Main:**
  - Minimize the distance between FET drain, Flyback diode and coil
  - Make a ground plane on the bottom side of the pcb, and choose a minimum pcb thickness to have maximum coupling of the hot spot to the ground plane.
  - Put the hot spot in the center of the pcb, so there is maximum coupling with the ground plane, and minimum coupling to the outside world.

- **Additional points**
  - Consider the polarity of the coil: Connect the hot spot to the the internal wire of the coil.
  - In case a big elco is present, put it next to the hot spot as shield.
  - Worst case foresee a ground point where an additional shield can be connected to, to cover the hot spot.

RE Hot spot 2 (In case of remote LEDs)
Supply wire to LEDs - buck



- **Minimize the wire length**
- **Connect the heat sink to ground to serve as ground plane**
- **Increase the decoupling capacitor size.**
  - For instance in case an elco is present to dampen the acoustic noise of the LC filter. It's value can be increased.



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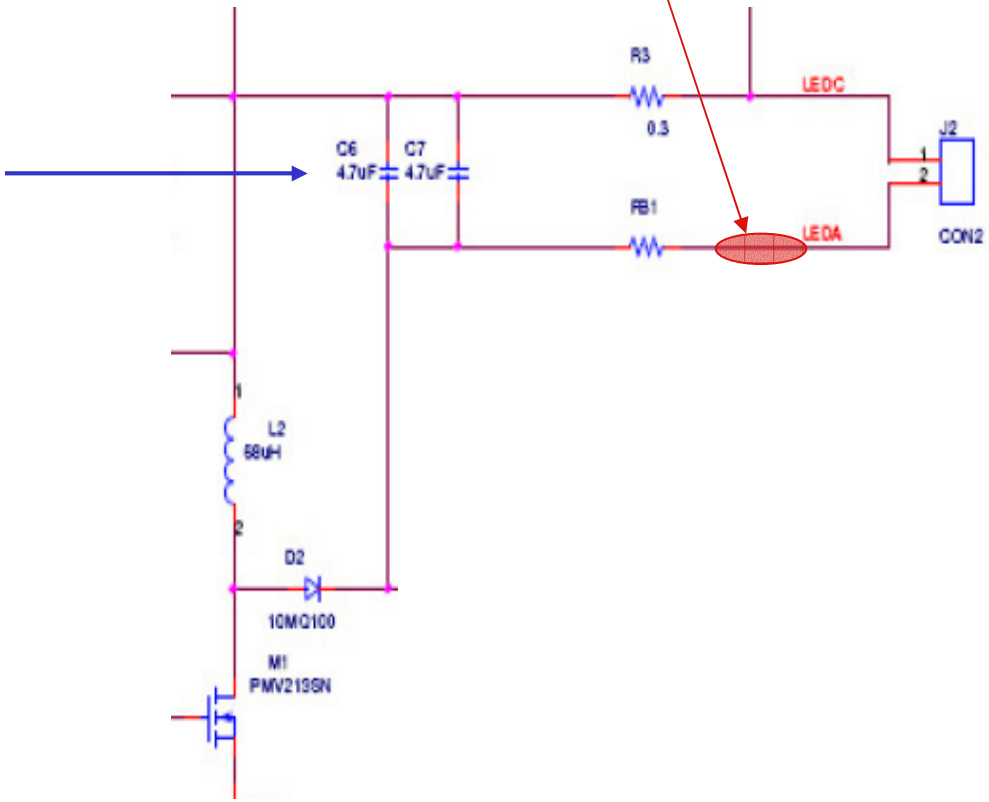
RE Hot spot 2 (In case of remote LEDs)
Supply wire to LEDs - Flyback

- **Main Solution:**
  - The capacitors that supply the LEDs during the charging of the Flyback coil should guarantee a ripple of 10% .. 20% of the LED current.
  - Due to the exponential relation with the LED current, the voltage ripple will per default be minimized.



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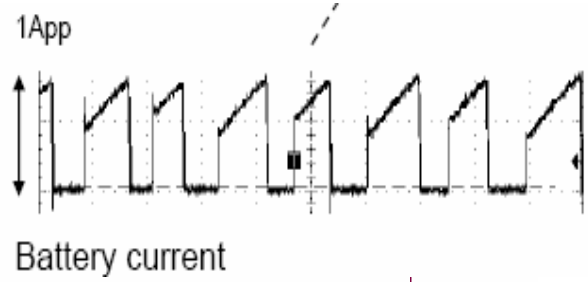
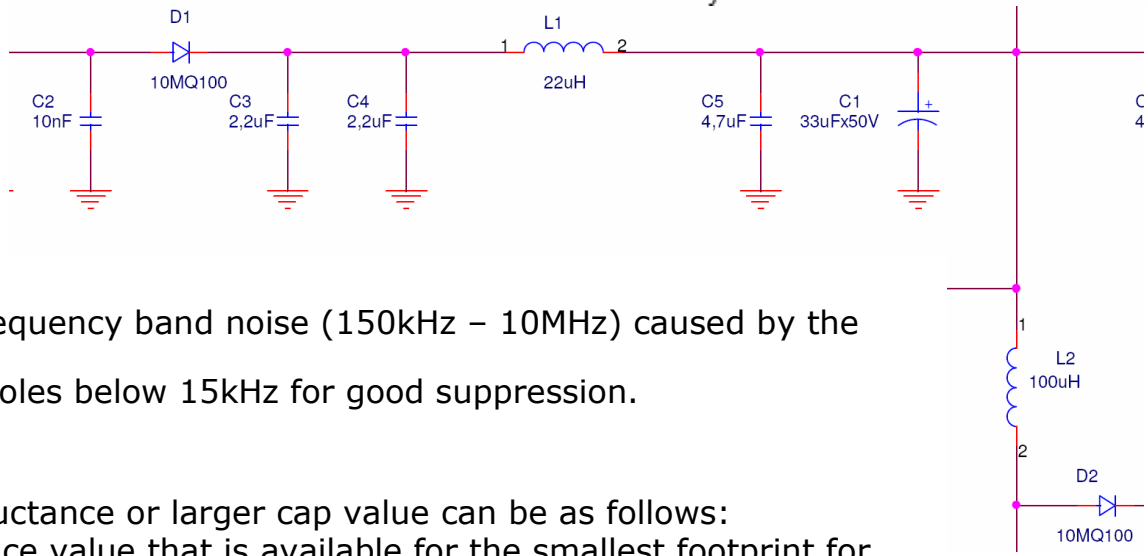
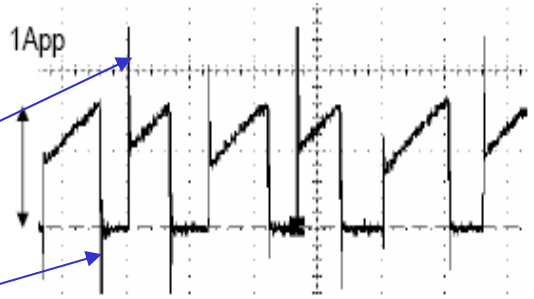
CE Hot spot 1: Battery current





- **Main solutions:**
  - Input filter will reduce the low frequency band noise (150kHz – 10MHz) caused by the ripple on the supply current.
  - As starter values try to put the poles below 15kHz for good suppression.
- **Remarks**
  - The trade off between larger inductance or larger cap value can be as follows:
    - Choose the largest inductance value that is available for the smallest footprint for the given saturation current, as this usually does not affect pricing much.
    - Remark that Larger inductance => larger series resistance: more losses
  - It may be possible to remove input coil L1 for applications that require to meet only CISPR25 class 2 for powers less than ~ 6W.
  - Elco C1 is required mainly to dampen the LC resonance peak. In case no PWM is applied on the driver, C1 may be removed.

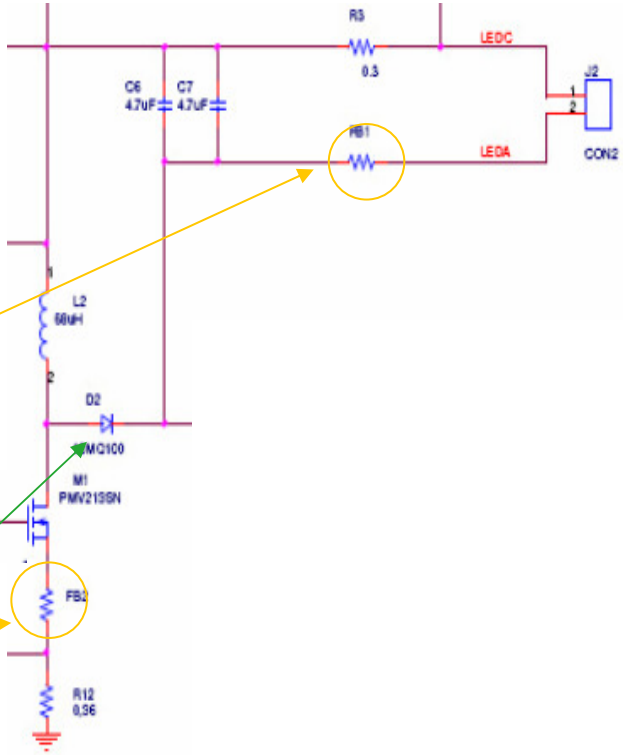
CE Hot spot 2: FET/Diode switching current - buck



MOSFET current (includes recovery diode)

- **Main: This hot spot mainly contributes to CE switching noise in the FM radio band (100MHz).**
- **The large spikes are due to the diode charge that is removed.**
  - Selecting a shottky diode will largely remove this noise in the FM radio band.
  - Adding a Ferrite bead (FB1) on the Anode will also help
- **Switching of the FET**
  - The slope of Current is controlled by the series resistance (R7) that drives the FET gate. Of course increasing the slope may adversely affect the dissipation in the FET due to switching losses.

    For SOT23 200mOhm FETs
    100 Ohm series resistance is a good starting point.
  - The switching of the FET can be reduced by adding a Ferrite bead in the source (FB2)
- **Adding Ferrite beads and choosing a shottky diode in stead of a normal diode may improve FM radio band performance from class 3 to class 5**



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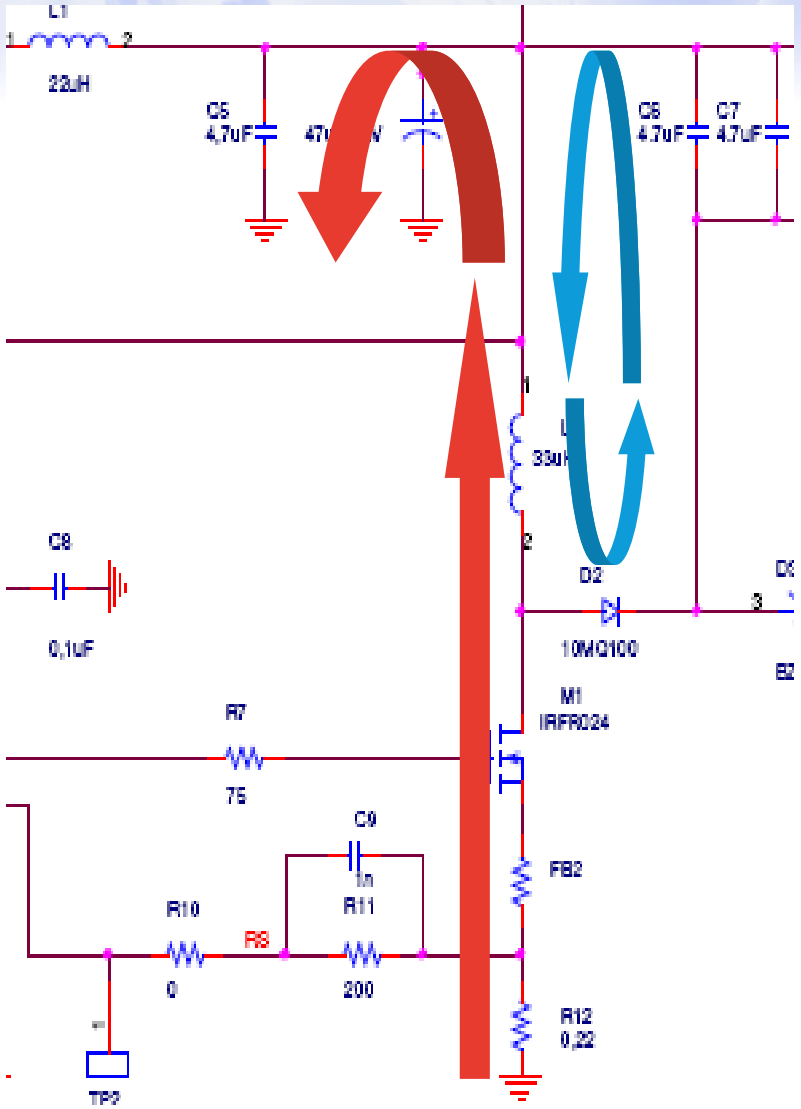
Current loops: FET/Coil/Diode/CAP

- **Consider at start the layout floorplan:**
- **Minimize current loops on**
  - FET closed: Red (primary)
  - FET open: Blue (secondary)



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EMC trade off
One 900mA LED Vs. Two 600mA LEDs

- **The 900mA application has a larger total switched current on the FET and the diode. Therefore conducted emission results may be expected to be worse.**

- **The total LED forward voltage of the 600mA application is larger, so the total voltage swing (and thus the Radiated emissions) on the FET drain will be larger. Especially for applications with remote LEDs and long wires this may be important.**

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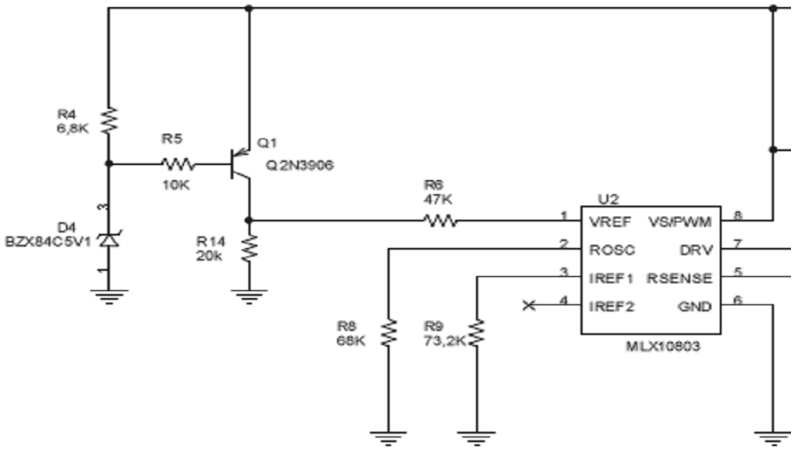
Other automotive test topics

- **During BCI testing some sensitivity of the IREF pins may be noticed.**
  - This can be simply resolved by adding decoupling caps on these pins.

- **During cranking test flickering of the LEDs may be noticed**
  - When the supply of the 1080x drops below 6V (typically around 5.3V) the 50uA current sources on the IREF pins will reduce current, therefore reduce the peak voltage and thus also the average LED current.
  - The power down level of the MLX10803 lies below 3V
  - As soon as the cranking pulses are removed, normal operation comes immediately back.
  - In case no flickering is allowed:
  - the 10803 can be made to shut down by a Zener/pnp aux. circuit that pulls VREF below 20mV as soon as VS reaches 6V.



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