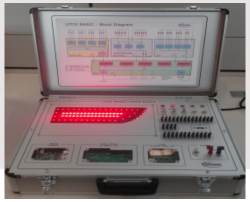
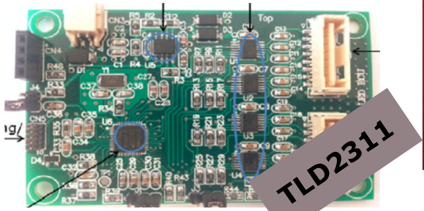
Litix Basic LED Driver for Rear Combination Light

Nick Ng, IFAP ATV SMD SAE SG

Details on the System Demonstrator

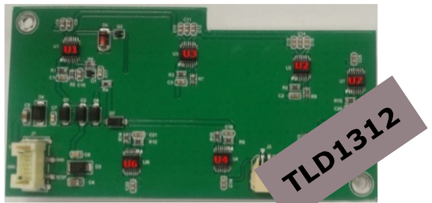


- LED topology:2s12p
(2 in serial,12 in parallel)
- 90mA per channel

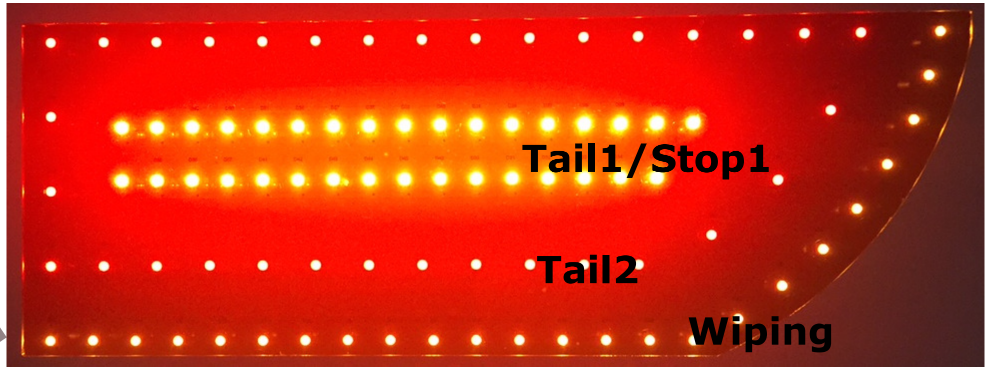


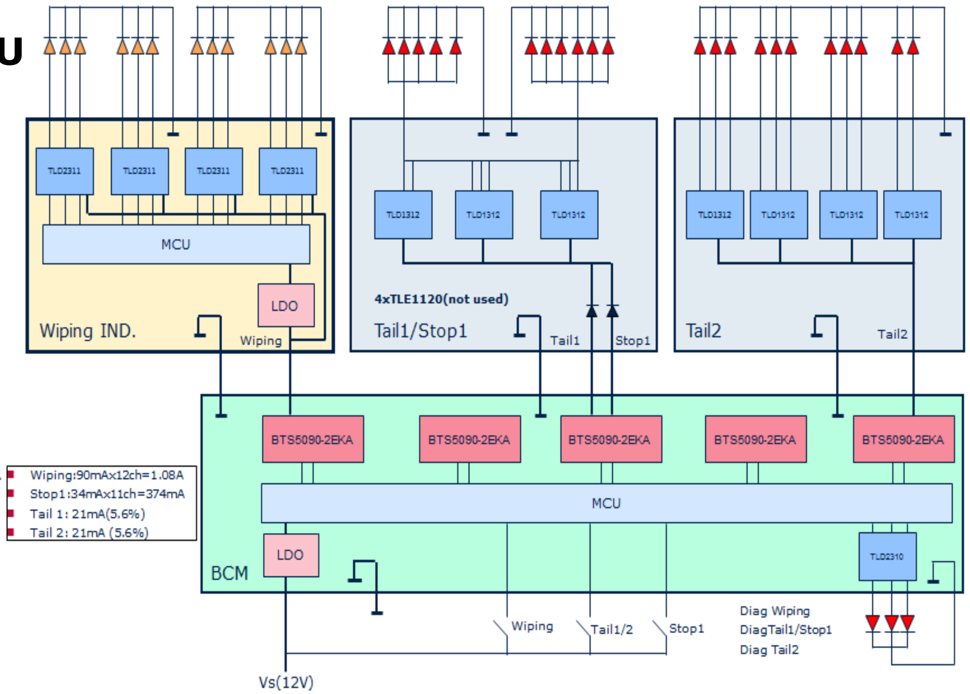
Wiping indicator ECU

- LED topology:3s11p
(3 in serial,11 in parallel)
- 34mA per channel (Stop1)
- 5.6% PWM Duty (Tail1)



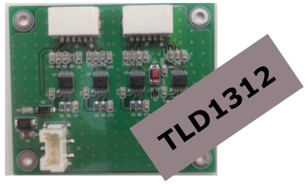
Tail1/Stop1 ECU





Overall Block Diagram

- LED topology:3s11p
(3 in serial,11 in parallel)
- 5.6% PWM Duty (Tail2)



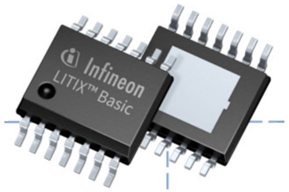
Tail2 ECU

- BCM for LED lighting

Channel 1: Wiping indicator
(1Hz frequency)
Channel 2: Tail 1 light
Channel 3: Stop 1 light
Channel 4: Tail 2 light
(Diagnostic for channel 1/2/3/4)

BCM ECU

LITIX™ Basic - a modular & flexible family of 15 linear current sources with scalable feature set



Pin-to-pin compatible SSOP14 exposed pad

Input / Output	parallel outputs 1ch/180mA	single outputs 3ch/60mA	+ PWMI	+ N-1	+ OL & SC	+ OL & SC + DEN	+ PWMI + N-1 or + OL & SC	+ Matrix + N-1 & PWMI or + OL & SC
3 IN 3 OUT		TLD231			TLD2311 OL & SC	TLD2314 OL & SC, DEN		TLD2326 Matrix, OL&SC
1 IN 3 OUT		TLD1310	TLD1312 PWMI	TLD1311 N-1	TLD1313 OL & SC	TLD1314 OL & SC, DEN	TLD1315 PWMI, N-1	TLD1326 Matrix, N-1 & PWMI
1 IN 1 OUT	TLD1120				TLD1121 OL & SC	TLD1124 OL & SC, DEN	TLD1125 PWMI, OL & SC	

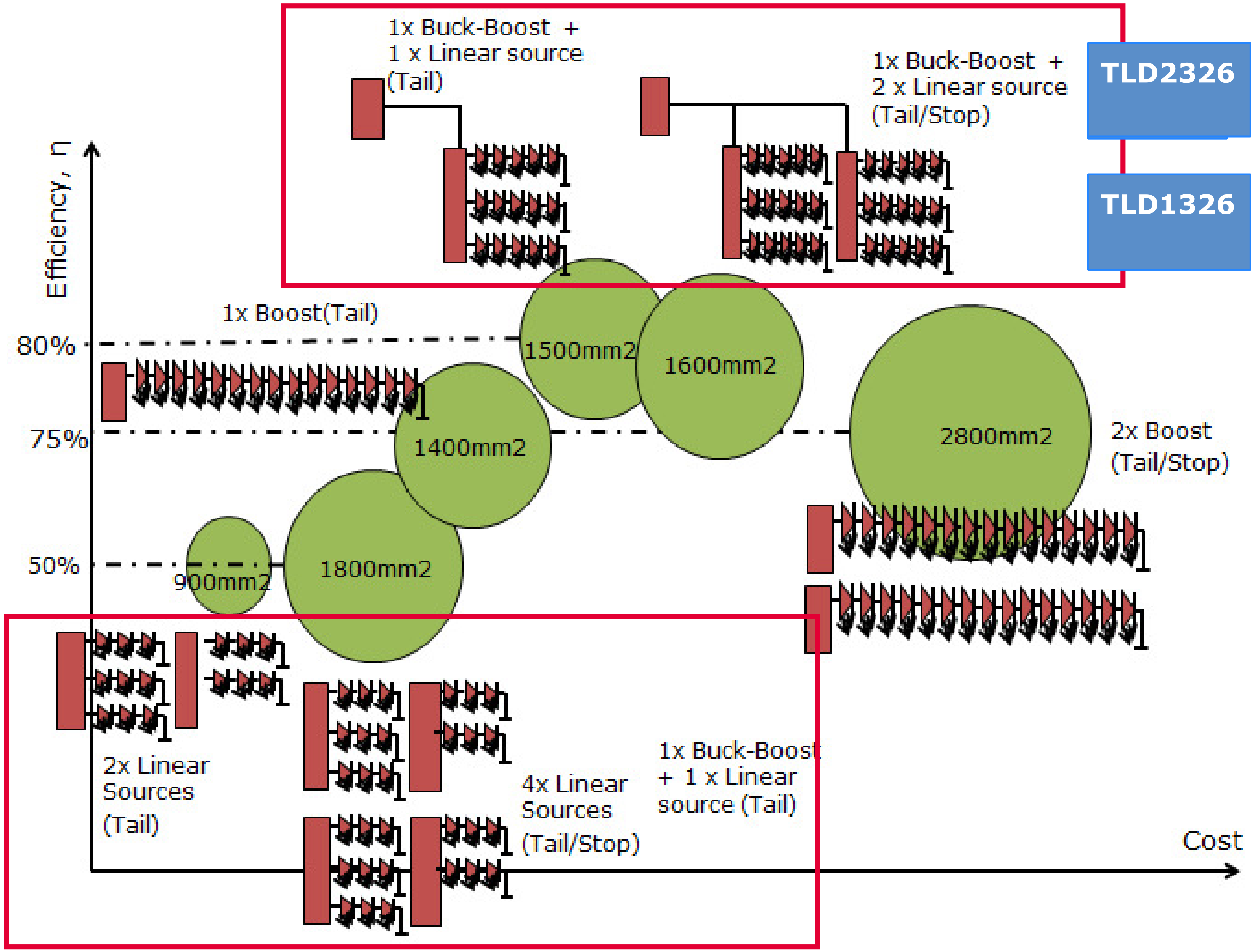
For Tail/Stop 1 LED OL,SC diagnostic not required.

For turn indicator with OL & SC function

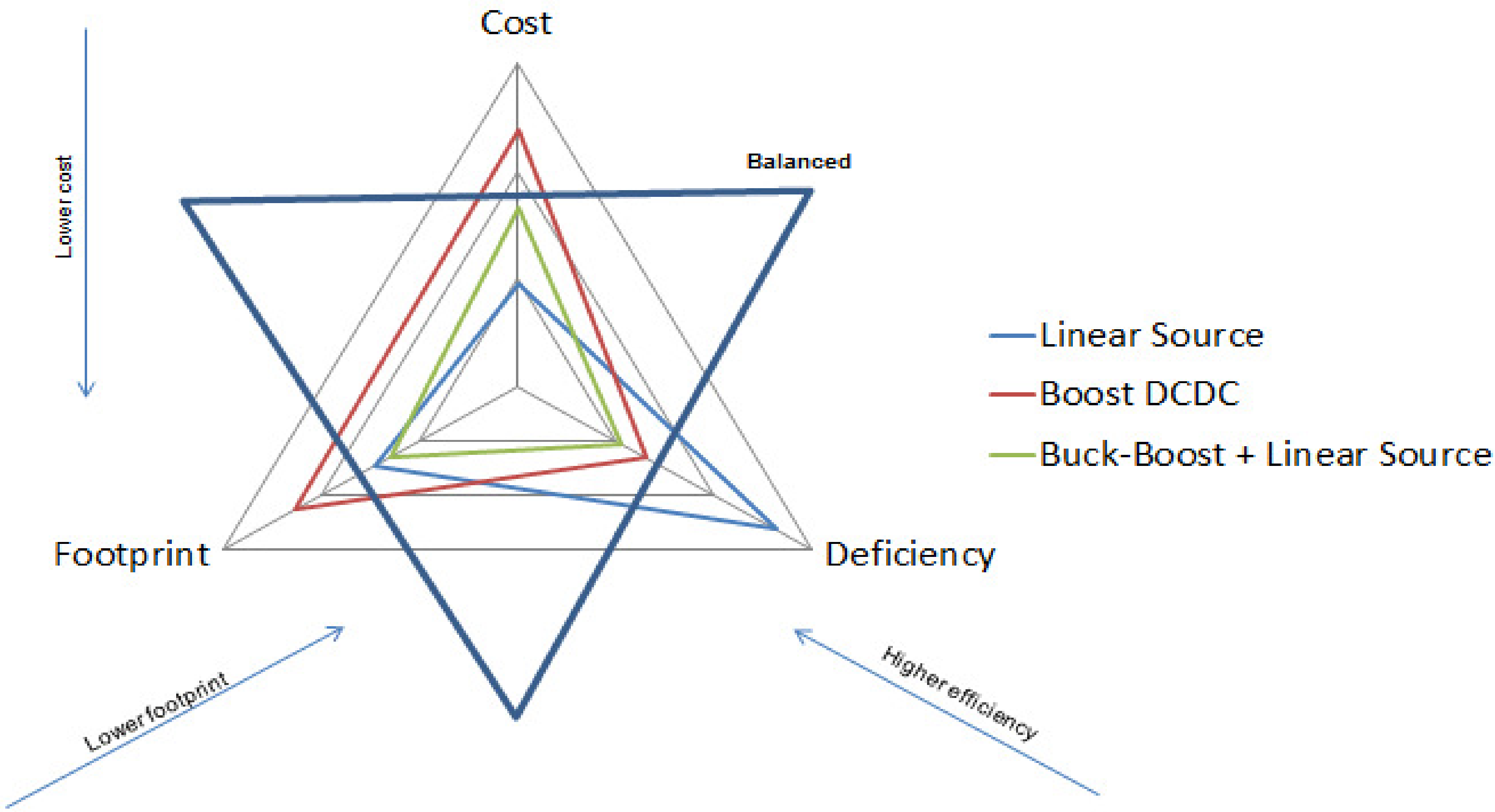
For Tail/Stop 2 LED OL,SC diagnostic required.

F e a t u r e s

Partitioning with Litix Basic LED Drivers



Trade-off between different partitioning



Benefits of Thermal Simulation

Present Customer's Methodology

Design → Prototype → Test

x4

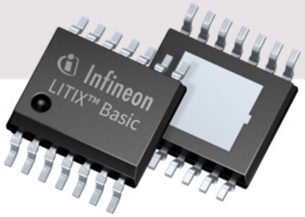
Infineon's Methodology

Proof-of-concept

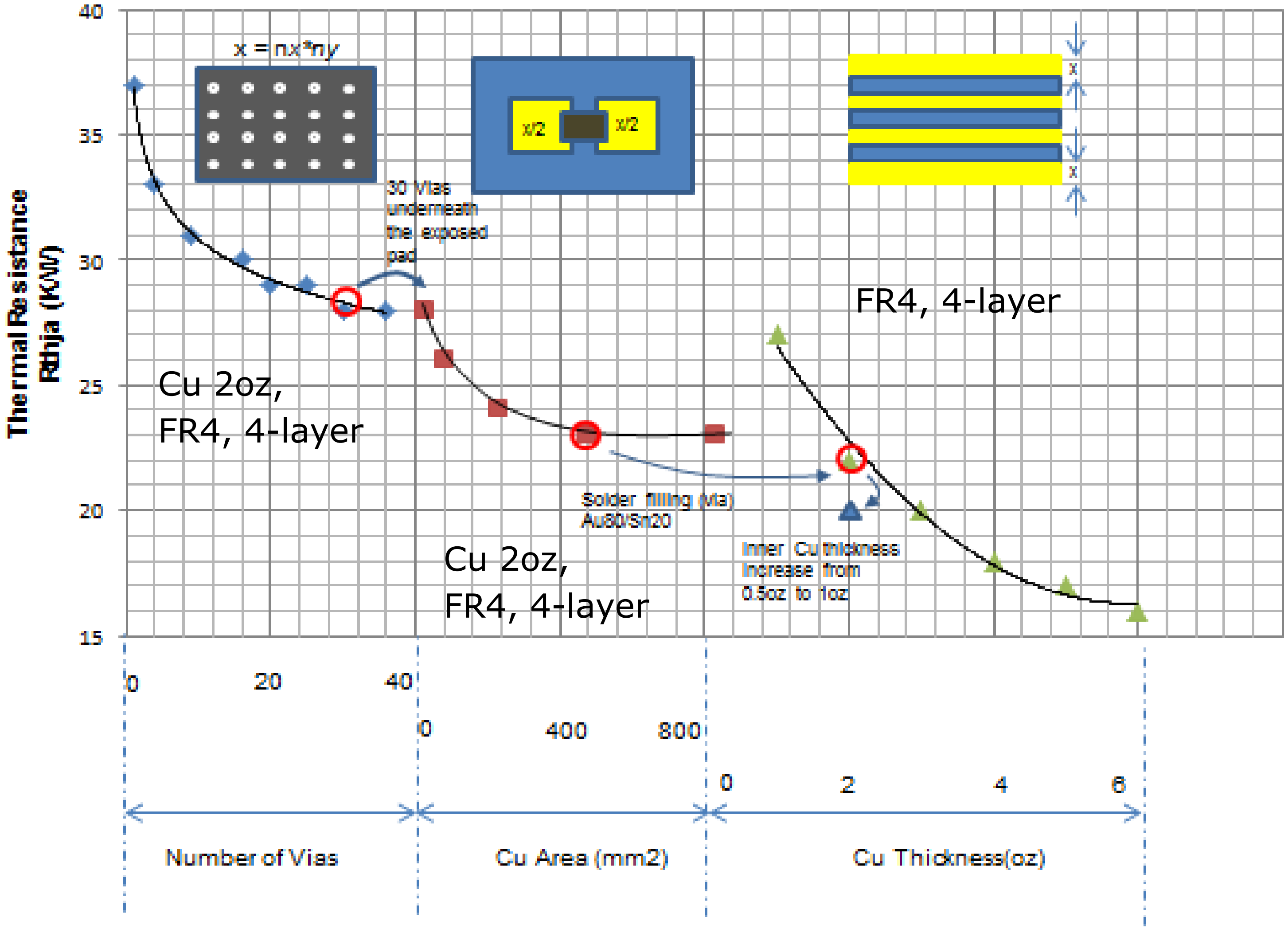
- Flotherm PCB Simulation (as Infineon's Premium Service)

Design → Prototype → Test

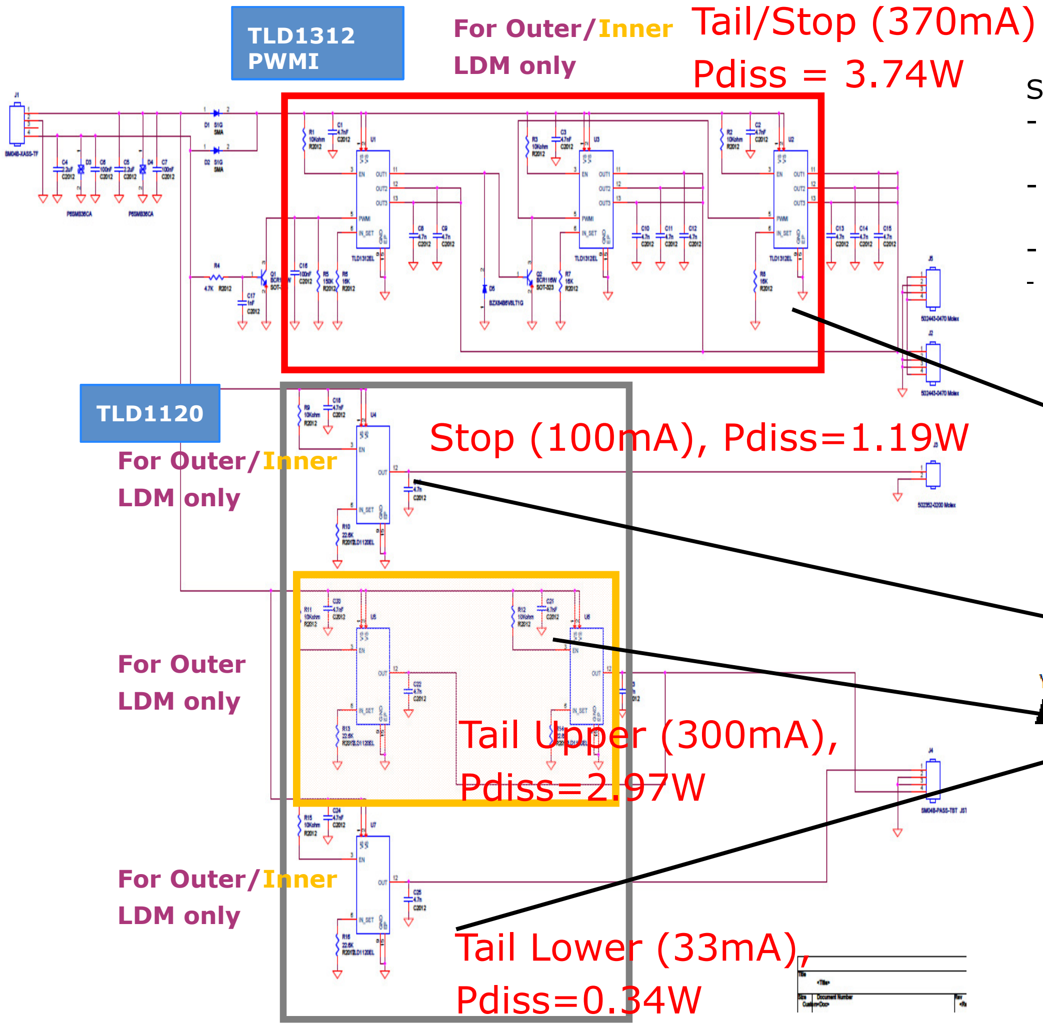
Improving Thermal Capability of SSOP14 device



FR4 Board size= 76.2mm x 116.4mm

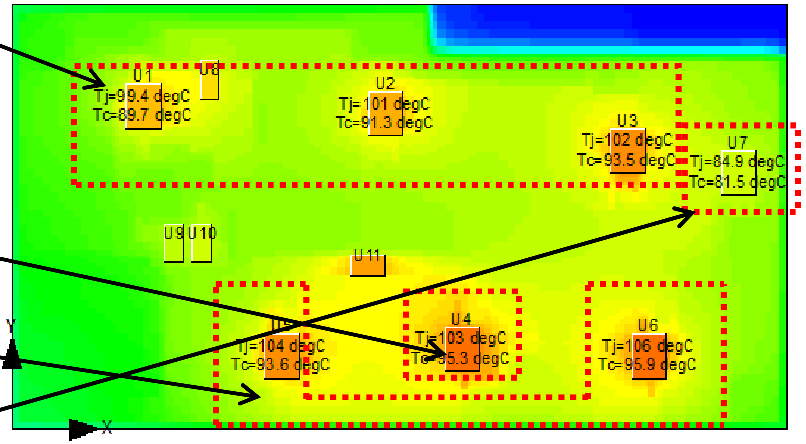


Thermal Simulations – Outer LDM
(with FloTherm-PCB)



Summary from thermal simulation:

- Maximum temperature of **4 layer 2S2P vs 2 layer PCB** is almost similar.
- Devices have to be **distributed across the board for even distribution of temperature** to prevent hot spot
- **2oz Cu** performance is much better than 1oz
- **Thermal vias and filled area** below exposed PADs will help to improve the thermal dissipation.



Simulation condition:
2 Layer FR4 (2oz, 2oz)
Ambient Temperature = 25deg
Battery Voltage = 16V
Still air environment.

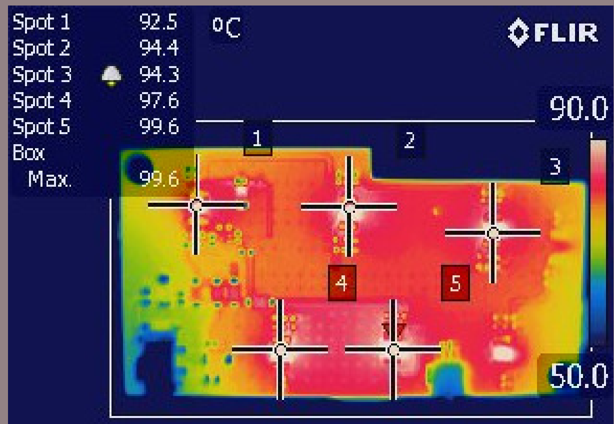
Thermal Measurement Results – Outer LDM

Outer LDM

Vbat=12.8V, Tamb=25deg

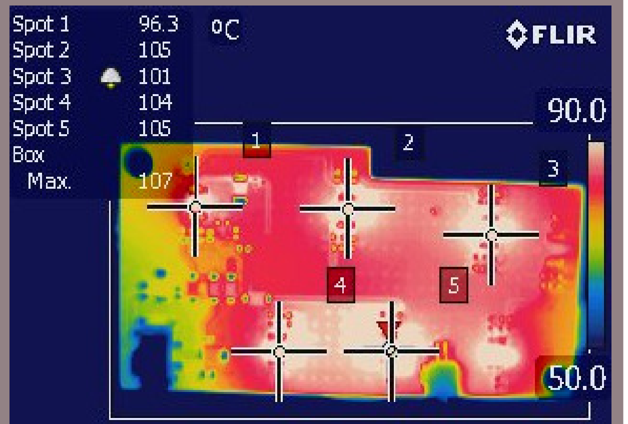
Maximum Temperature: 78deg
Channel: STOP-CENTER 100mA
Device: TLD1120

Vbat=16V, Tamb=25deg



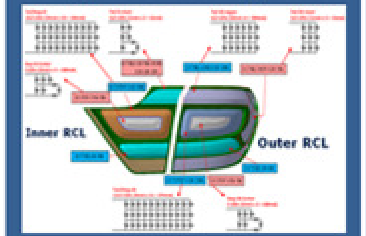
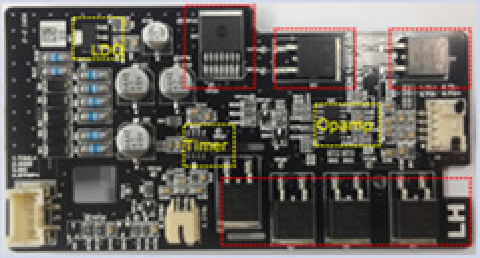
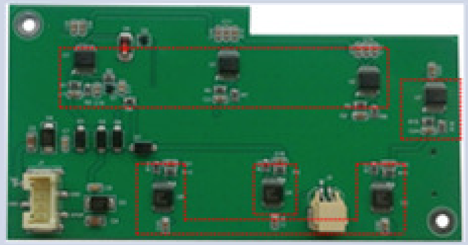
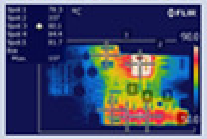
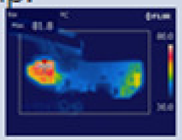
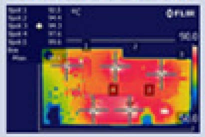
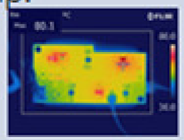
Maximum Temperature: 99deg
Channel: STOP-CENTER 100mA
Device: TLD1120

Vbat=18V, Tamb=25deg



Maximum Temperature: 107deg
Channel: STOP-CENTER 100mA
Device: TLD1120

Comparison between Litix Basic vs Discrete solution

LDM **TAIL, STOP and T/STOP** 	**Existing Solution** 	**LITIX™ Basic Solution** 
System Cost	**100%**	**~85%**
PCB Area	**Same** (for thermal reasons)	
PCB Weight	**160g**	**120g**
Thermal Performance (e.g. Vin=16V, T=25°C)	**107°C** max. case temp.  	**99°C** max. case temp.  
Time to Market	**Longer** (different driver solution for each LED load)	**Shorter** (standardization of schematic and layout)
Reliability	**Lower** (many external components)	**Higher** (integration->less components)
Flexibility	**Lower** (needs new concepts for new requirements)	**Higher** (prepared for LED diagnosis, DC/DC feedback,...)
Min. Input Voltage	Similar	
Protection	-	Over-load and over-temperature

Advanced Dynamic Turn Indicator

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Dynamic vs Static Direction Indicator

Research/Investigation Findings from OICA

Summary of Investigations

	Static Direction Indicator	Dynamic Direction Indicator	dynamic vs. static Δ
Questionnaire for distraction: Is Dynamic Better ?			70%
1-cycle correct determination of direction	60 %	84%	+ 40%
3-cycle direction found (missed)	72%	95%	+38%
Reaction time 3-cycle for correct determination	1,854 sec	1,261 sec	(- 0,593 sec) -32%

With a dynamic effect of the wiping within 150ms to 200ms, it shows improvements in the direction detection and reaction speed.

Regulatory impact on Sweeping Turn Indicator

- Is not practicable in US due to the minimum requirements of the effective projected luminous lens area:

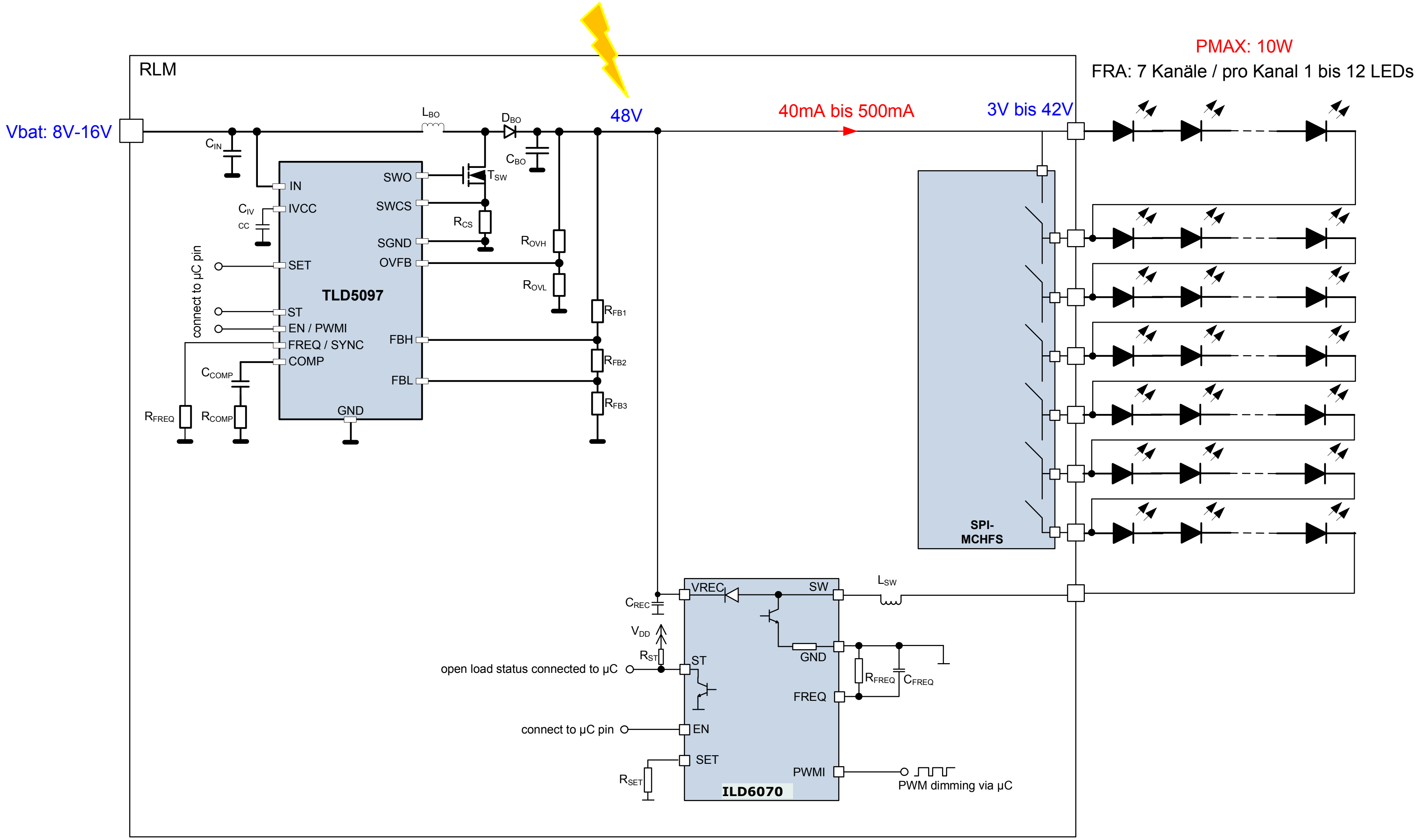
Lighting device	Passenger cars, multipurpose passenger vehicles, trucks, trailers, and buses of less than 2032 mm in overall width minimum effective projected luminous lens area (sq mm)		
	Single compartment lamp	Multiple compartment lamp or multiple lamps	
		Each compartment or lamp	Combined compartments or lamps
Front turn signal lamp ...	2200	....	2200
Rear turn signal lamp	5000	2200	5000
Stop lamp	5000	2200	5000

- ECE regulations:

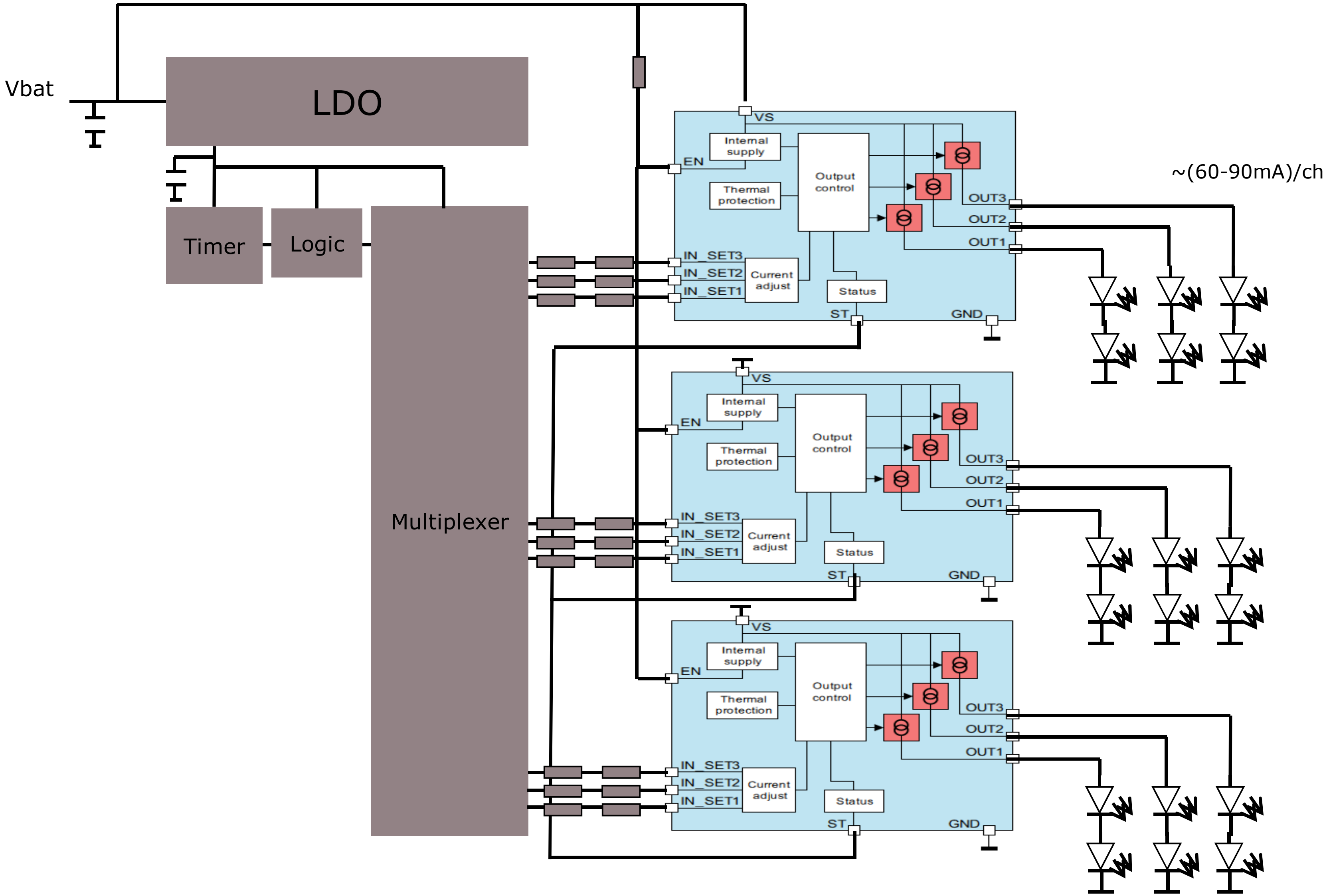
-No requirements of the effective projected luminous lens area.

- Amber direction indicator in the rear.

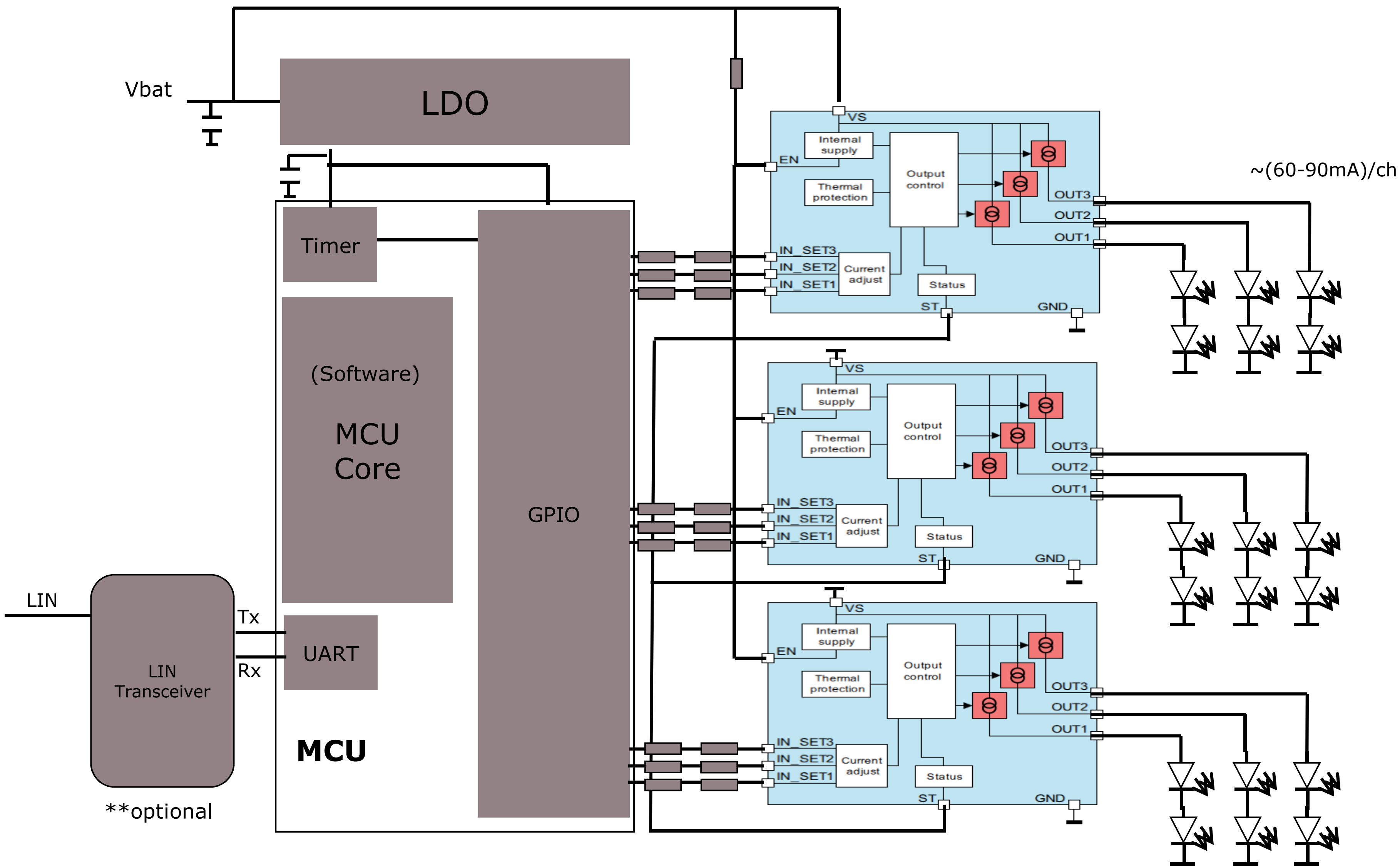
Implementation Concept for Rear Turn Indicator (DCDC + Floating gate switch)



Implementation Concept for Rear Turn Indicator (Discrete logic + Basic LED)



Implementation Concept for Rear Turn Indicator (MCU + Basic LED)



Comparison Between Solutions

	DCDC + Floating gate switch	Simple descrete timer + logic + Basic LED	MCU + Basic LED
LED topology	Serial (floating switch)	Serial + Parallel	Serial + Parallel
LED Current	Able to support high current LED >300mA depending on the Rdson of floating switch	Lower current LED (<100mA) preferred	Lower current LED (<100mA) preferred
BOM	DCDC Boost, DCDC Buck, Floating switch (SPIDER+)	Timer,logic gates, flip-flops, multiplexer, LDO, Basic LED drivers	MCU, Basic LED drivers, LDO
Estimated BOM Cost	High	Medium	Low
EMC	High	Low	Low
Board size	Big	Big	Small
Remarks:			
Pros	Suitable for high current LED, lower power dissipation, less cooling required	Low BOM cost, Open shelf components ready-to-use Lower EMC, shorter start-up time	Simple programming, smaller BOM Lower EMC, Programmable
Cons	High BOM cost, higher EMC	High heat dissipation at driver, Potential headroom issue at low supply voltage, difficult to program	High heat dissipation at driver, potential headroom issue at low supply voltage. Longer start-up time.

This configuration has been implemented in HQ

This configuration is used in this project

Wiping Indicator System Requirement

i)Full turn-on time = 150ms

ii)Number of LED and LED current needs to meet photometric requirement.

For this project,

Number of LEDs = 24pcs

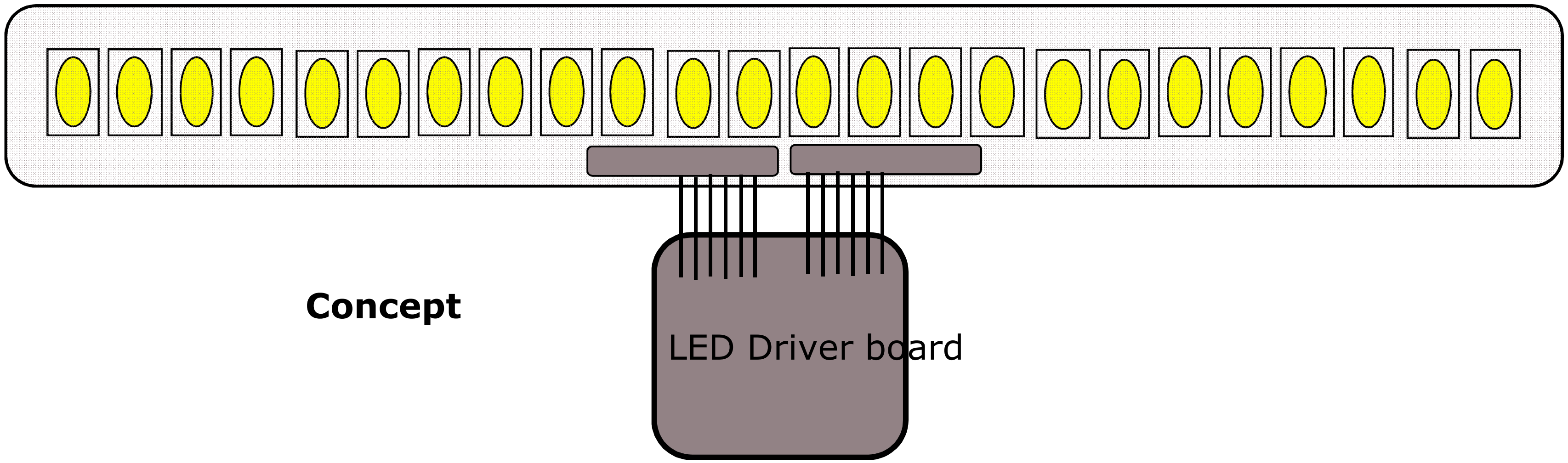
LED max. forward current = 90mA

LED color is Amber

iii) Topology: 2 in Serial and 12 parallel channels

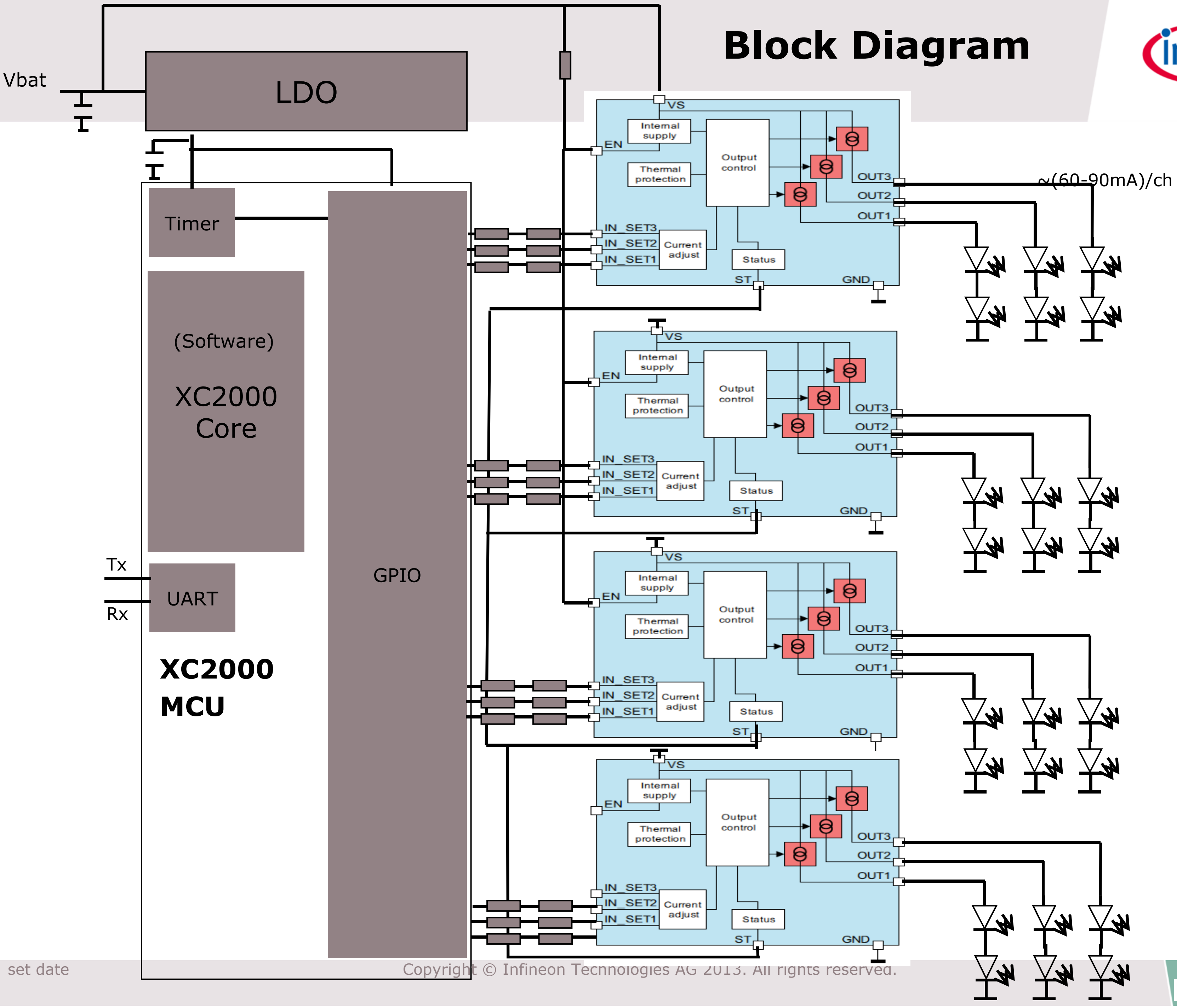
iv) VIN = 9V to 16V

LED load (24 pcs)

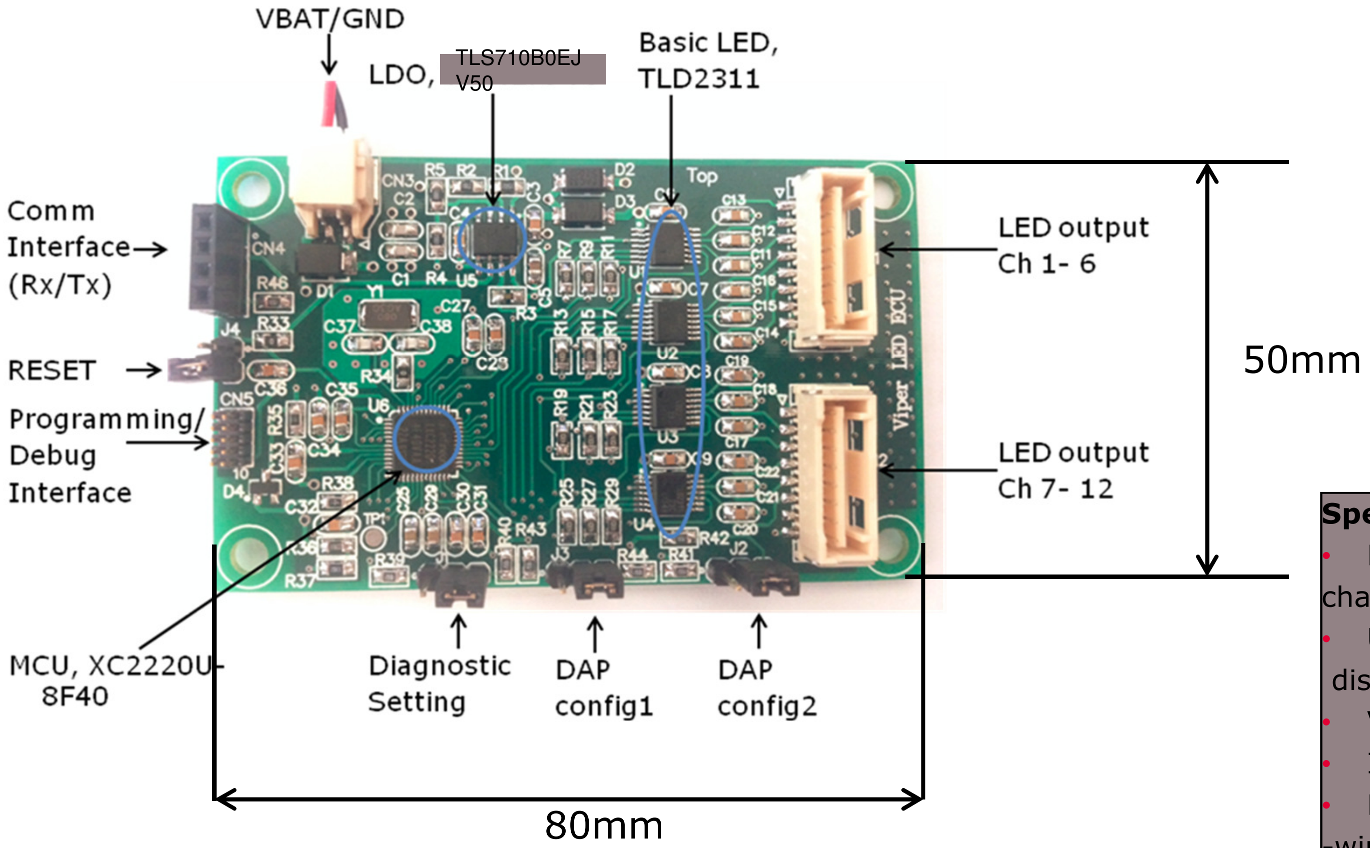


Concept

Block Diagram



Wiping Turn Indicator Hardware
(PCB FR4, 4 layer)



Specs/Features:

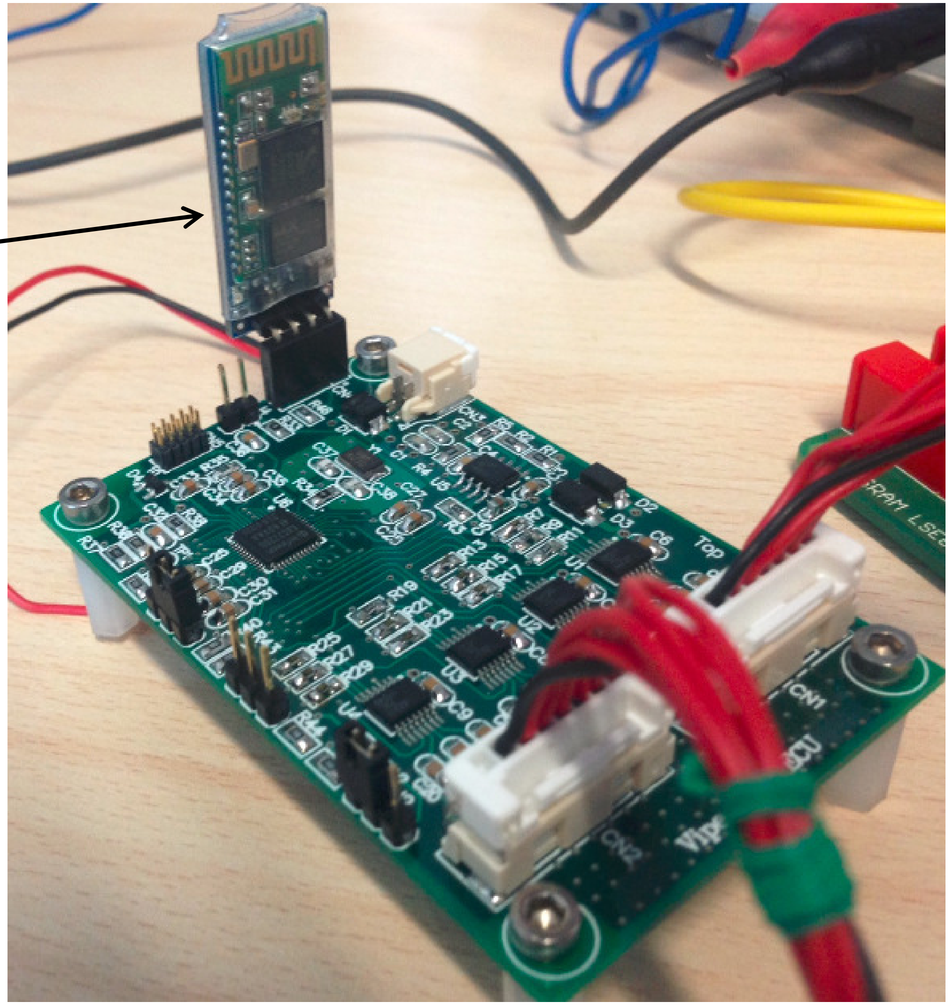
- Drive up to 12 Basic LED channels
- Up to 5W total power dissipation on Pcb board
- VBAT : 9V-16V
- ILED <= 90mA/ch ,50% DC
- Programmable LED pattern -wiping pattern, during parking
- Digital dimming support with configurable PWM DC engine
- Input short-to-battery protection against battery draining **

Communication Interface

External communication interface:

- Tx/Rx Bluetooth Board
- Tx/Rx LIN board (*future)
  - Can be used to relay ECU

diagnostic information, support LIN programming during manufacturing and ECU control.

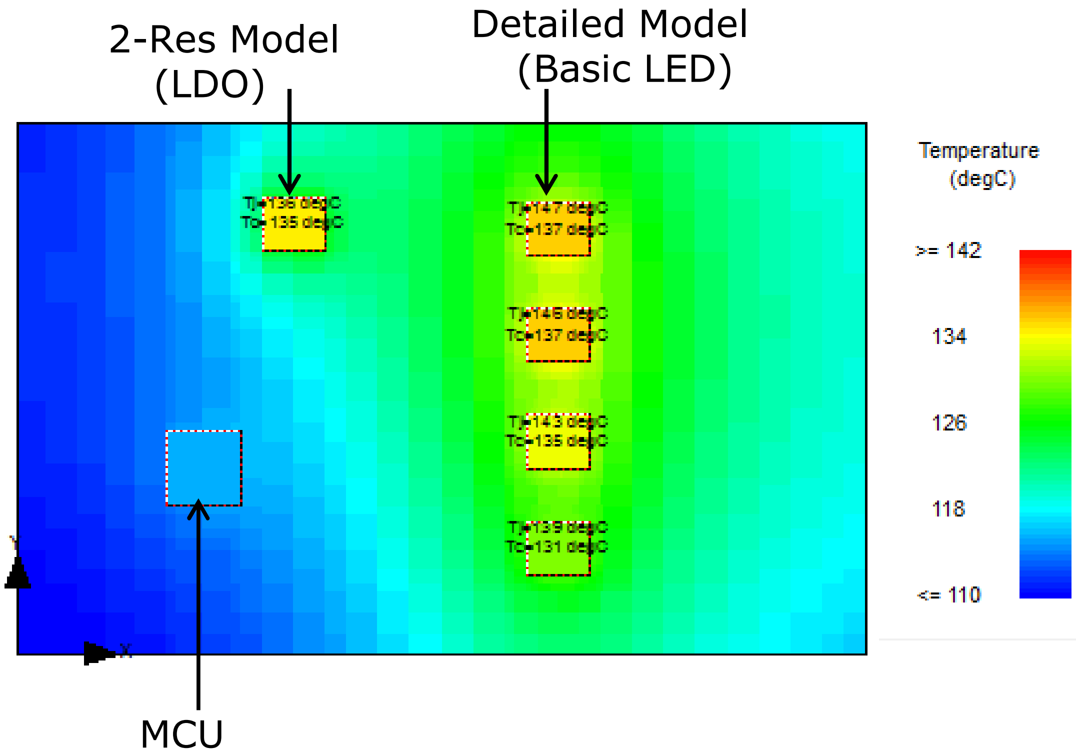


Thermal Simulation with Flotherm PCB

Condition:

- Temp: 85degC
- Environment: Still air
- Vbat_max=16V
- ILED_max=90mA

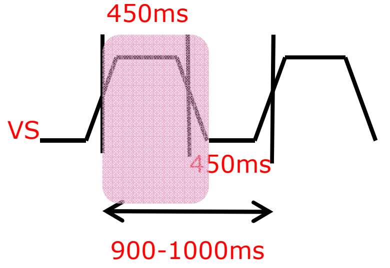
Channel No.	Duty	Width(ms)	Period(ms)	Pdiss(W)
1	0.50	450.00	900.00	0.43
2	0.48	436.36	900.00	0.42
3	0.47	422.73	900.00	0.41
4	0.45	409.09	900.00	0.39
5	0.44	395.45	900.00	0.38
6	0.42	381.82	900.00	0.37
7	0.41	368.18	900.00	0.35
8	0.39	354.55	900.00	0.34
9	0.38	340.91	900.00	0.33
10	0.36	327.27	900.00	0.31
11	0.35	313.64	900.00	0.30
12	0.33	300.00	900.00	0.29



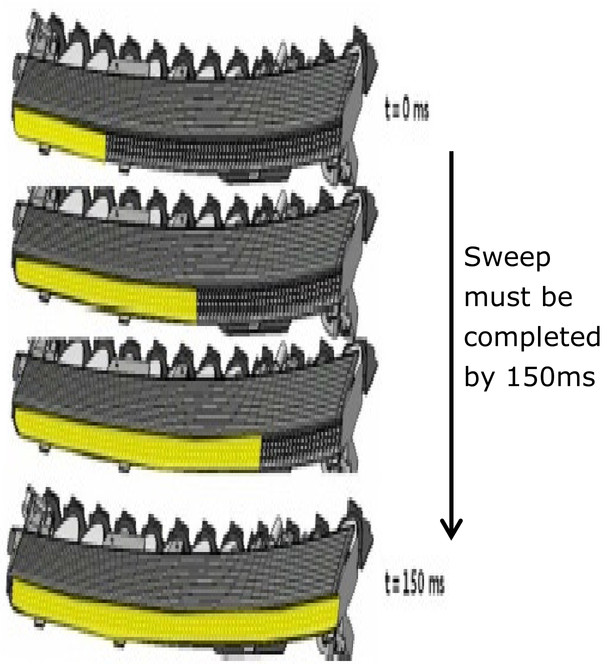
From simulation, board 80mm*50mm is optimized for dissipation of 4 Basic LED devices. Thermal vias are required below the thermal pads of the Basic LED. No hot spots observed in simulation.

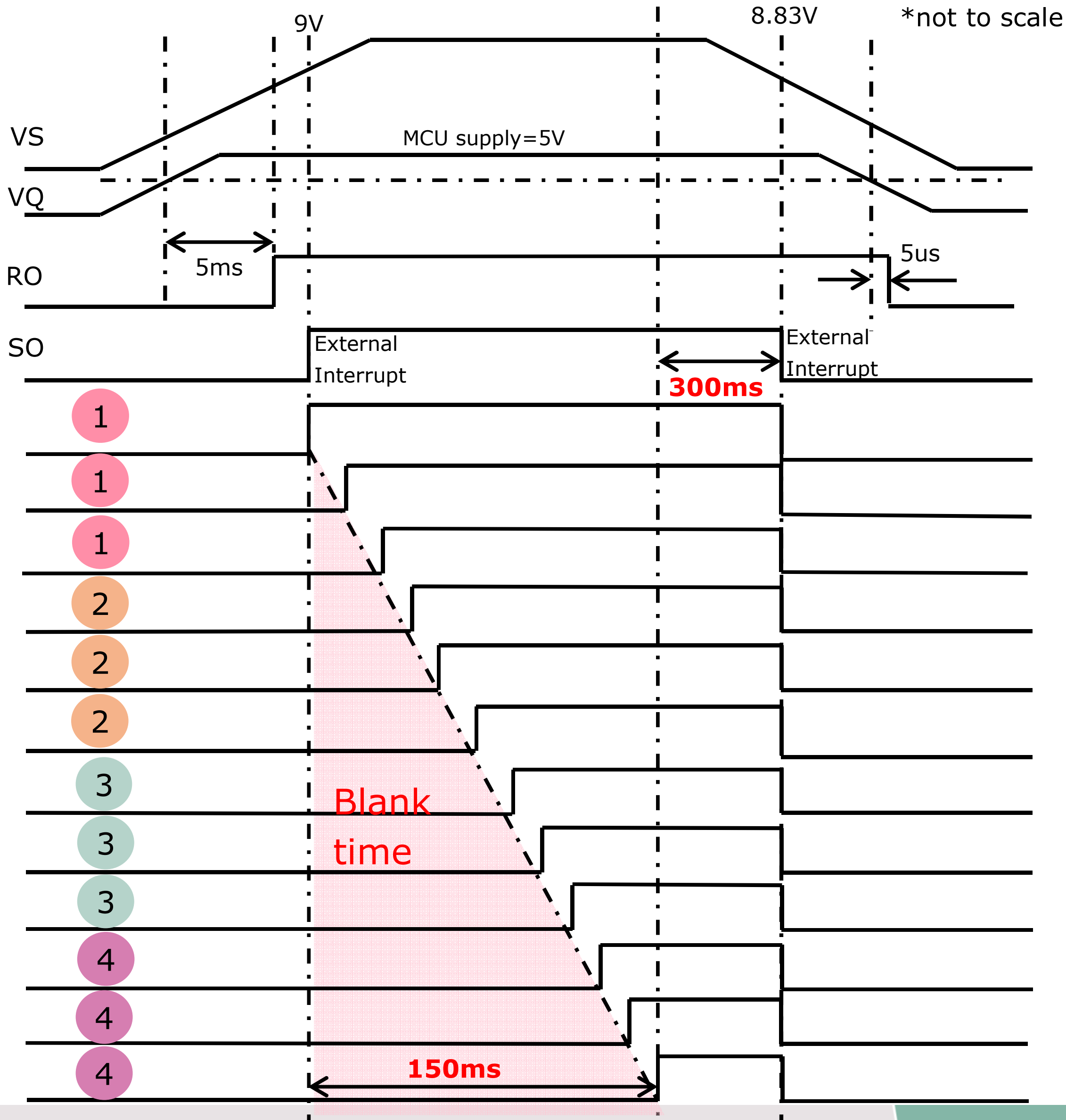
Operation of Wiping Indicator – Concept

Signal from BCM (PROFET+)

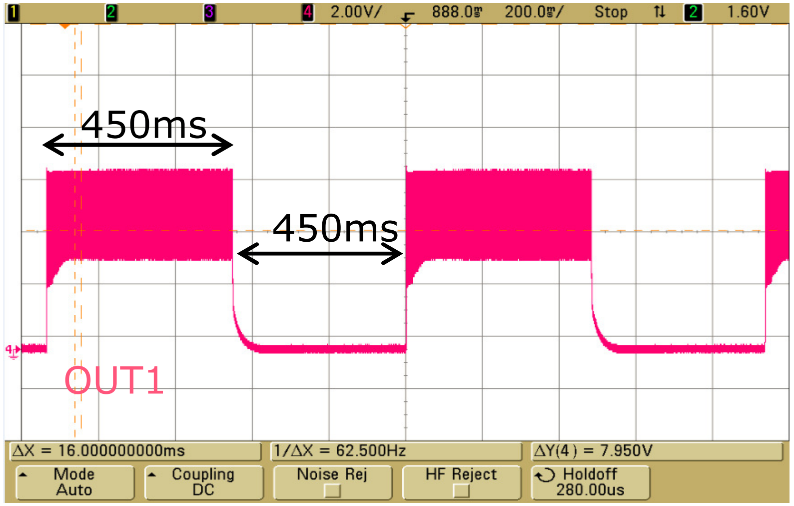


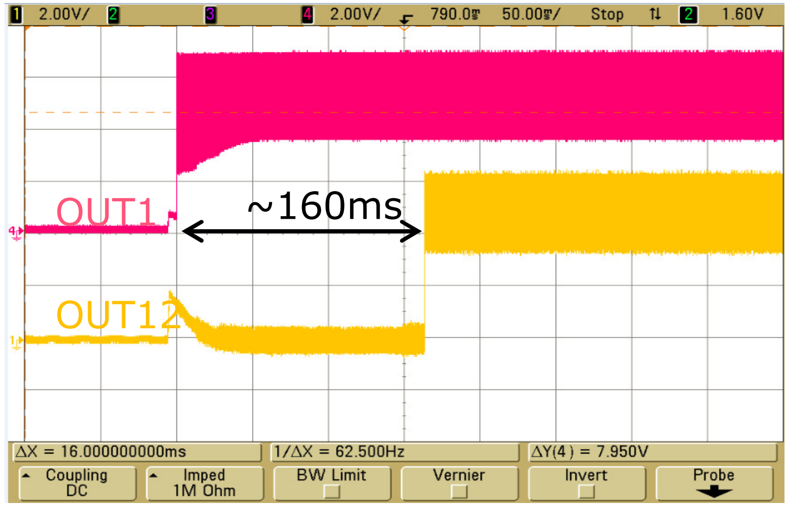
Dynamic PWM dimming @200Hz/400Hz (optional)





Transient Evaluation (2) with dummy load

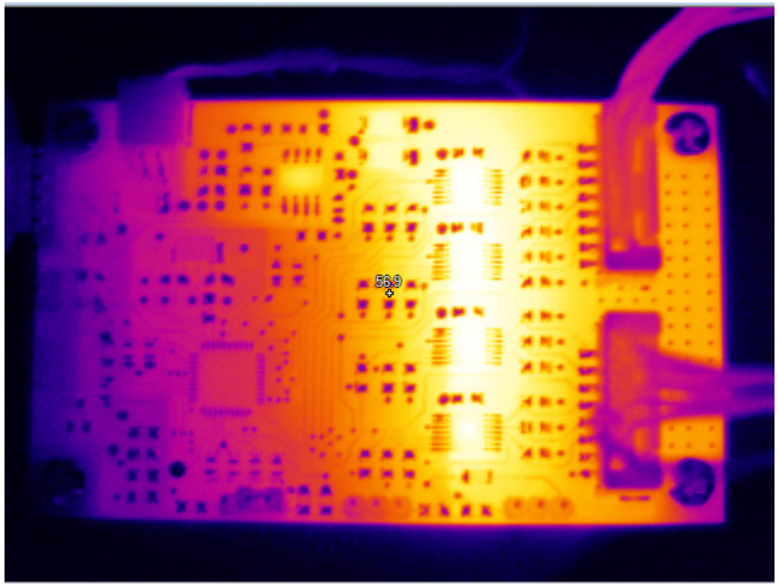




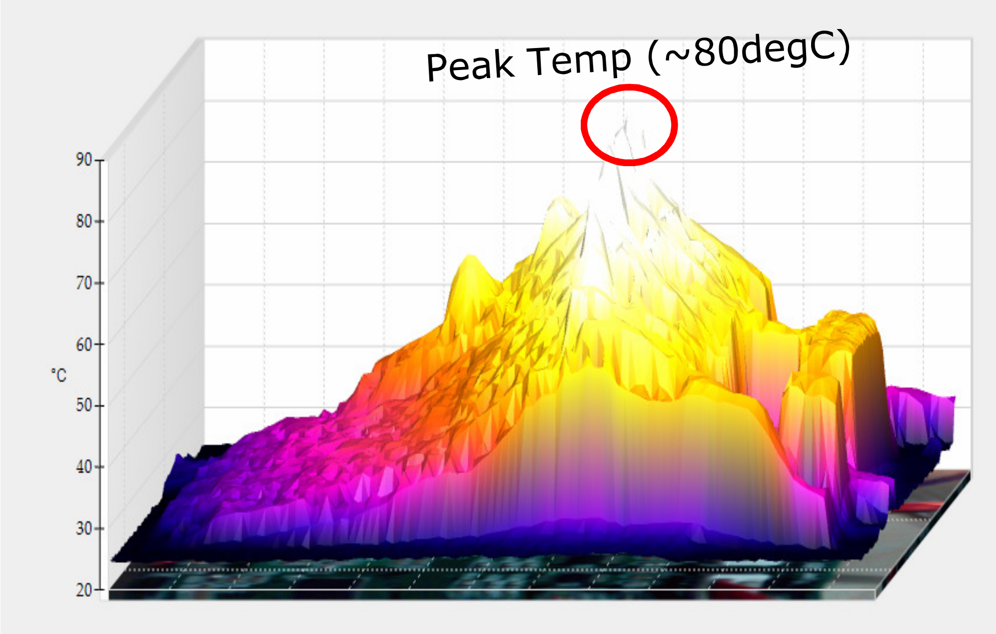
Measurement (@25degC):
1-3)ON-OFF duration = 450ms
1-4)Duration between OUT1 and OUT12
turn-on time = 160ms

Thermal Evaluation @ VBAT_Max Condition

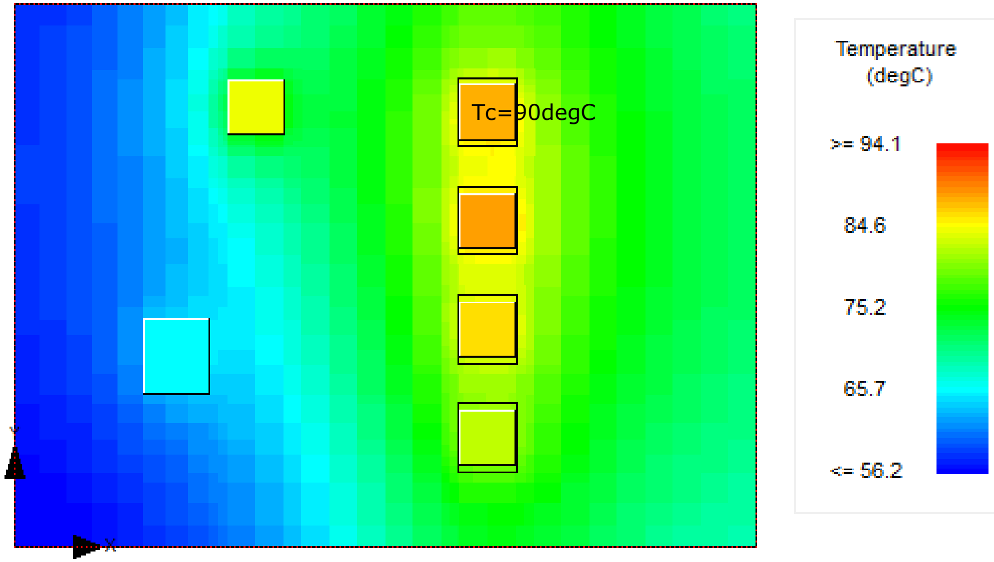
- Ta=25degC
- VS=16V, DC 50%, ~1.1Hz switching frequency

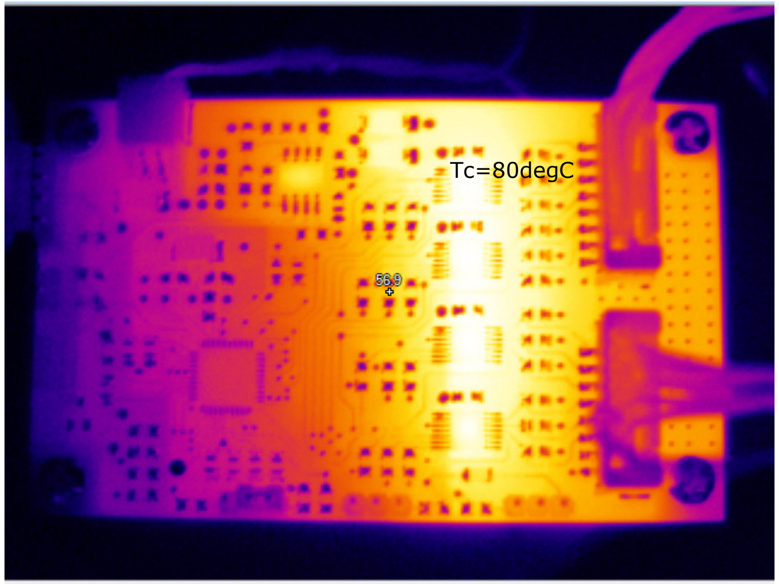


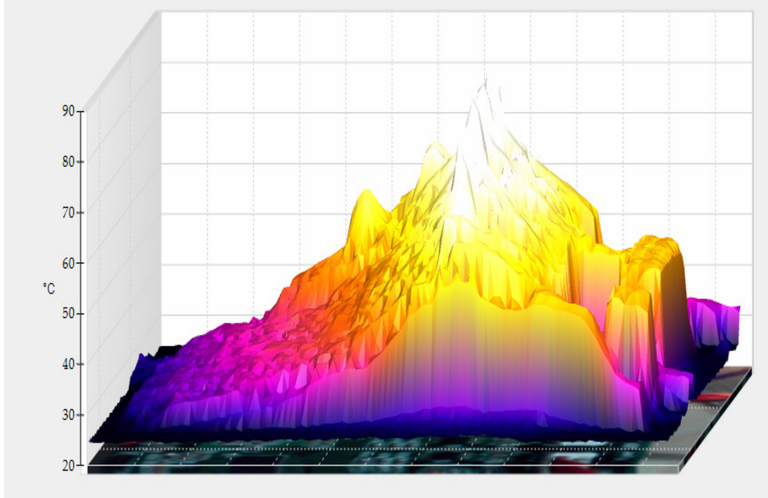
3D IR View



Thermal Simulation vs Evaluation @ Tamb=25degC





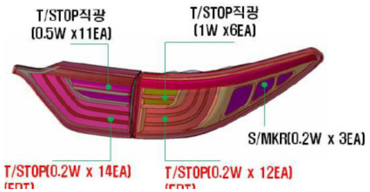


- Thermal trend is similar.
- Sim vs Eva deviation about 10%:

i)In Sim, connectors not modelled (potential heatsink), more copper area at top/bottom layer.

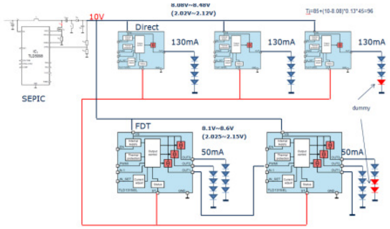
ii)In Eva, thermal equilibrium may not be reached yet at point of result captured.

LED Lighting Support Model For **Rear**

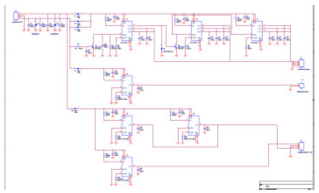


Evaluation kit

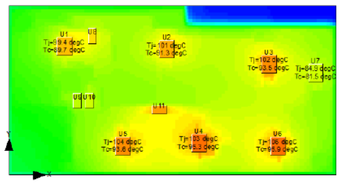
Application note



Proposal possible partitioning
(# of IC, topology)



Schematic Review



Thermal Analysis & PCB Simulation

Troubleshooting

Part of your life. Part of tomorrow.