



A GaN based Single-mode Buck-Boost Converter without Output Capacitor

DONGSOO LEE, BYEONGIK KIM, CHAEYOUNG KANG, JEONGJIN ROH
Hanyang University



INTRRODUCTION

- Recently, buck-boost converters have been widely utilized in vehicle systems powered by batteries, functioning as LED drivers.
- The demand for high currents is necessary to operate a large number of LEDs.
- However, challenges such as wide load current ranges due to fluctuations in the input voltage of vehicle batteries are encountered.
- Conventional buck-boost converters, with their discontinuous transfer current, struggle to overcome these difficulties.
- Additionally, issues like slow output voltage response due to output capacitors exist.
- In this design, we designed a structure utilizing GaN switches, which have been garnering attention, to ensure continuous transfer current and eliminate the output capacitor.

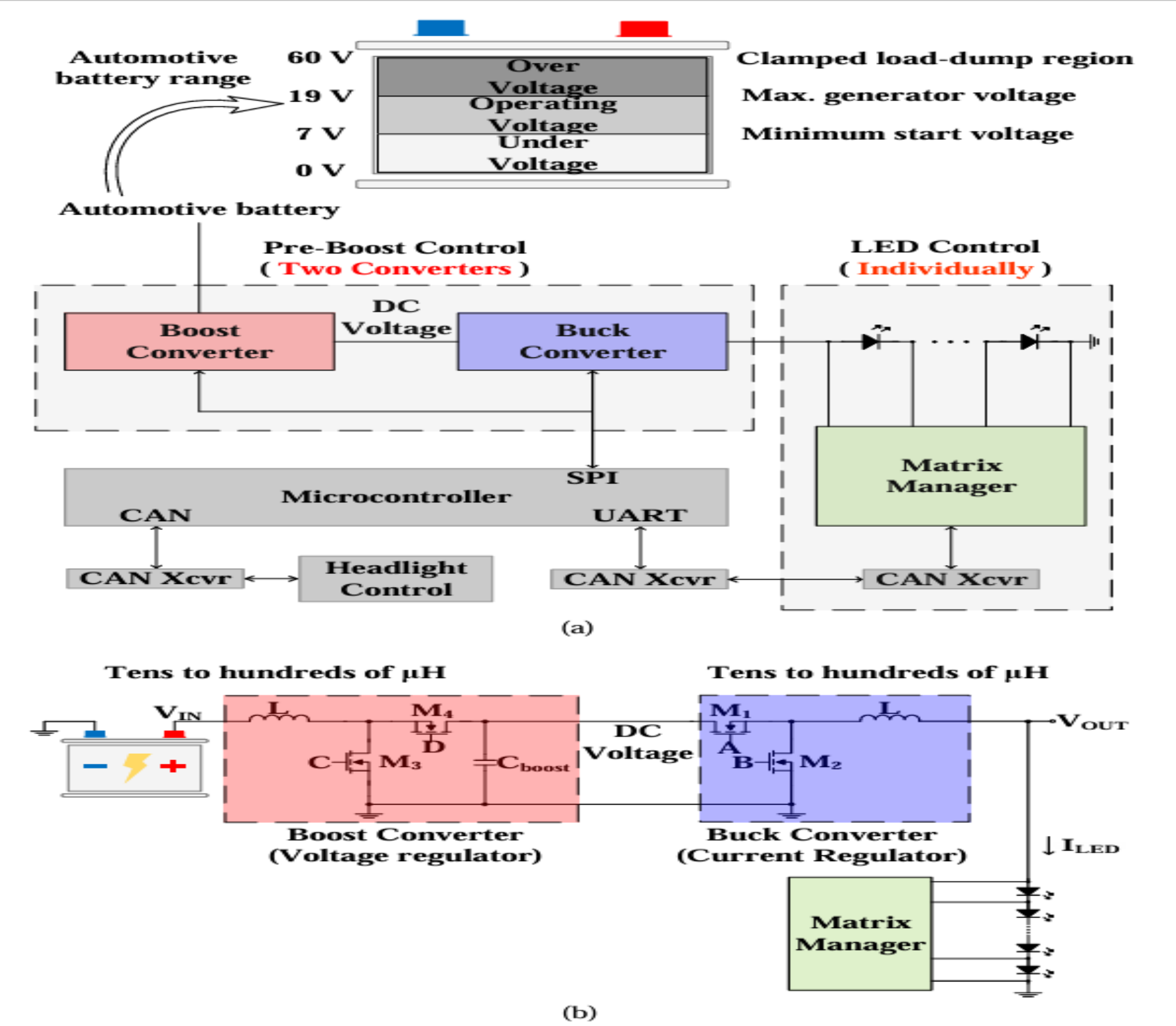


Fig. 1. Conventional LED matrix headlight system configuration: (a) block diagram, (b) schematic

PROPOSED CIRCUIT DESIGN

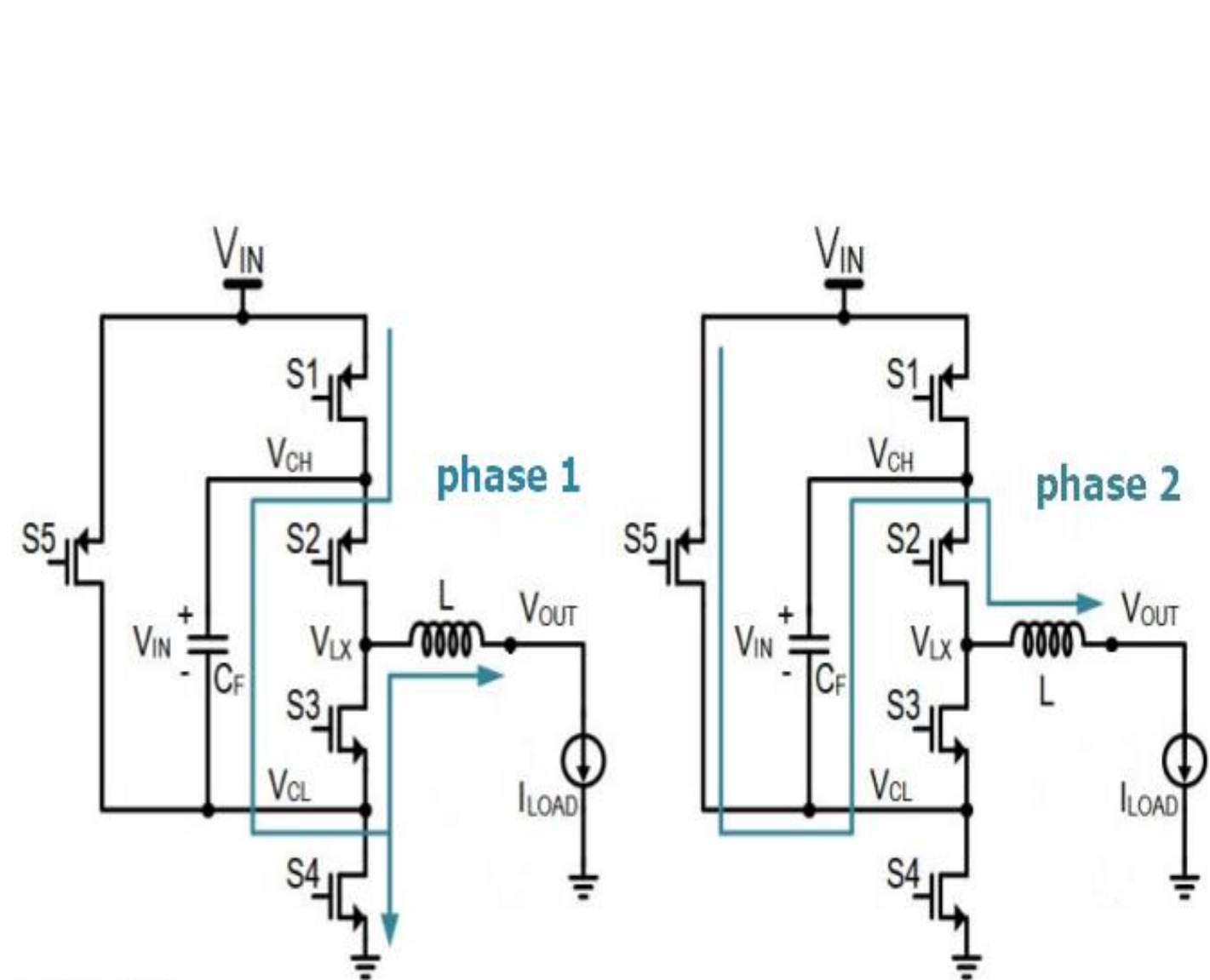


Fig. 2. Buck-Boost Converter operation

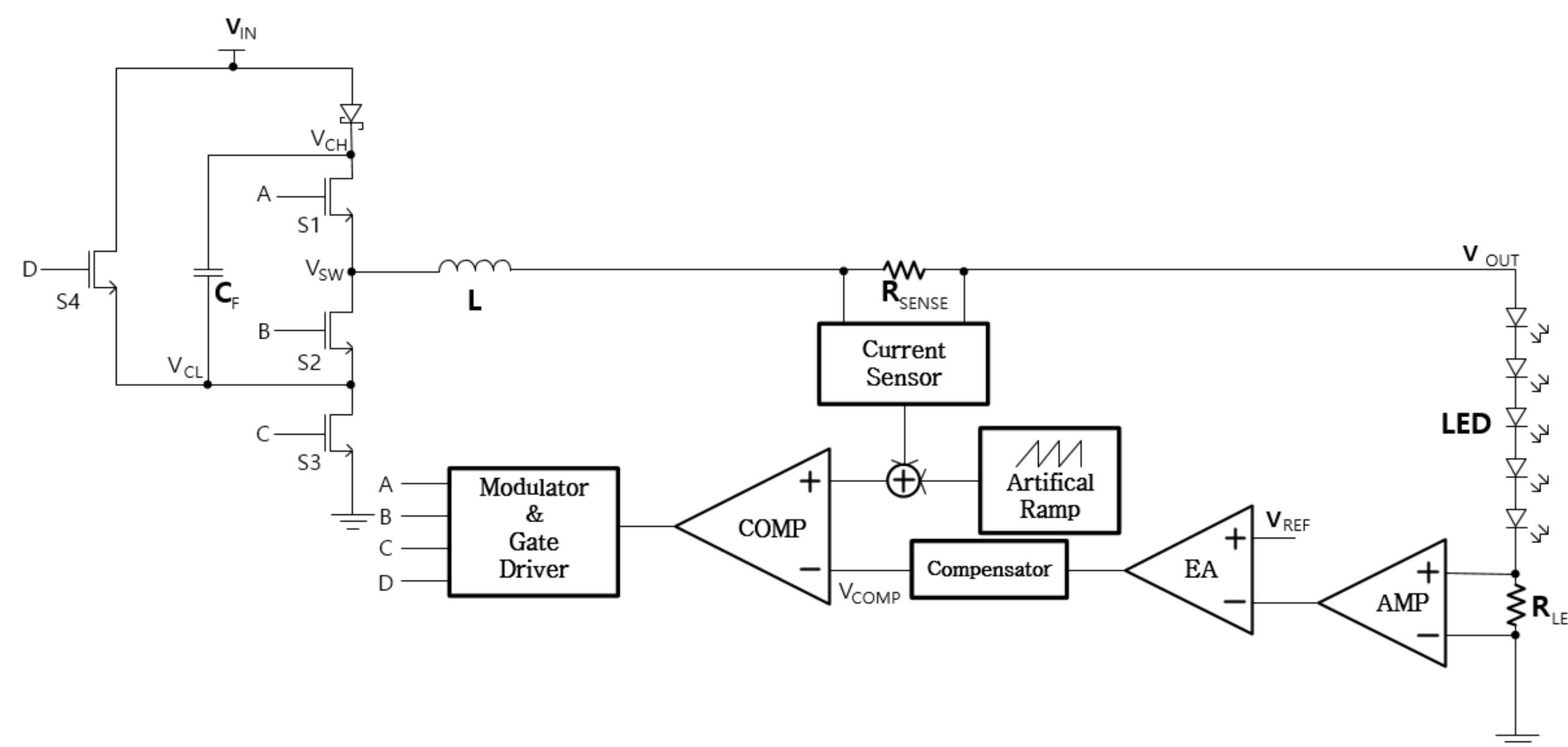


Fig. 3. Schematic of the designed GaN based Buck-Boost Converter with current feedback

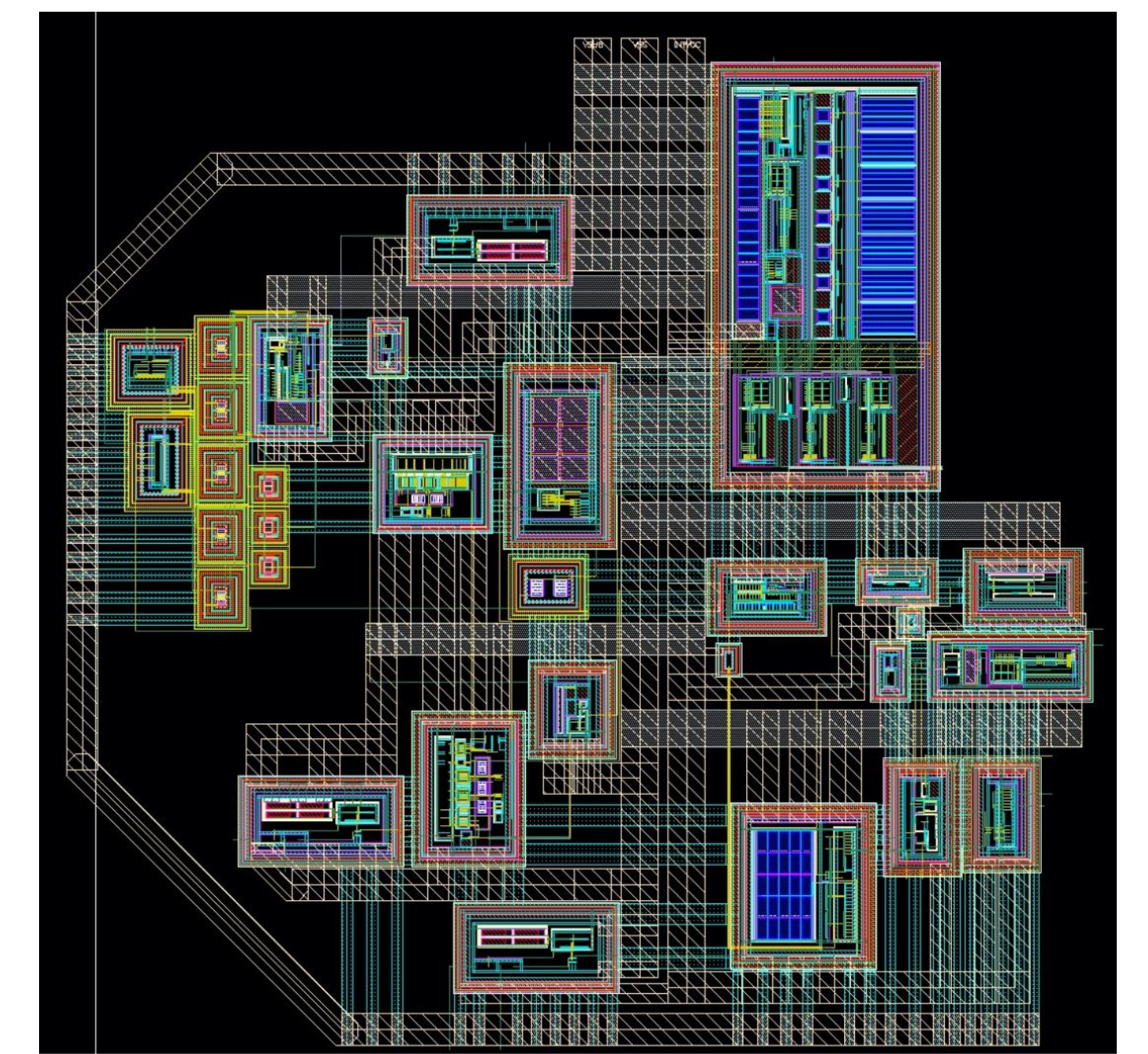


Fig. 4. Chip layout

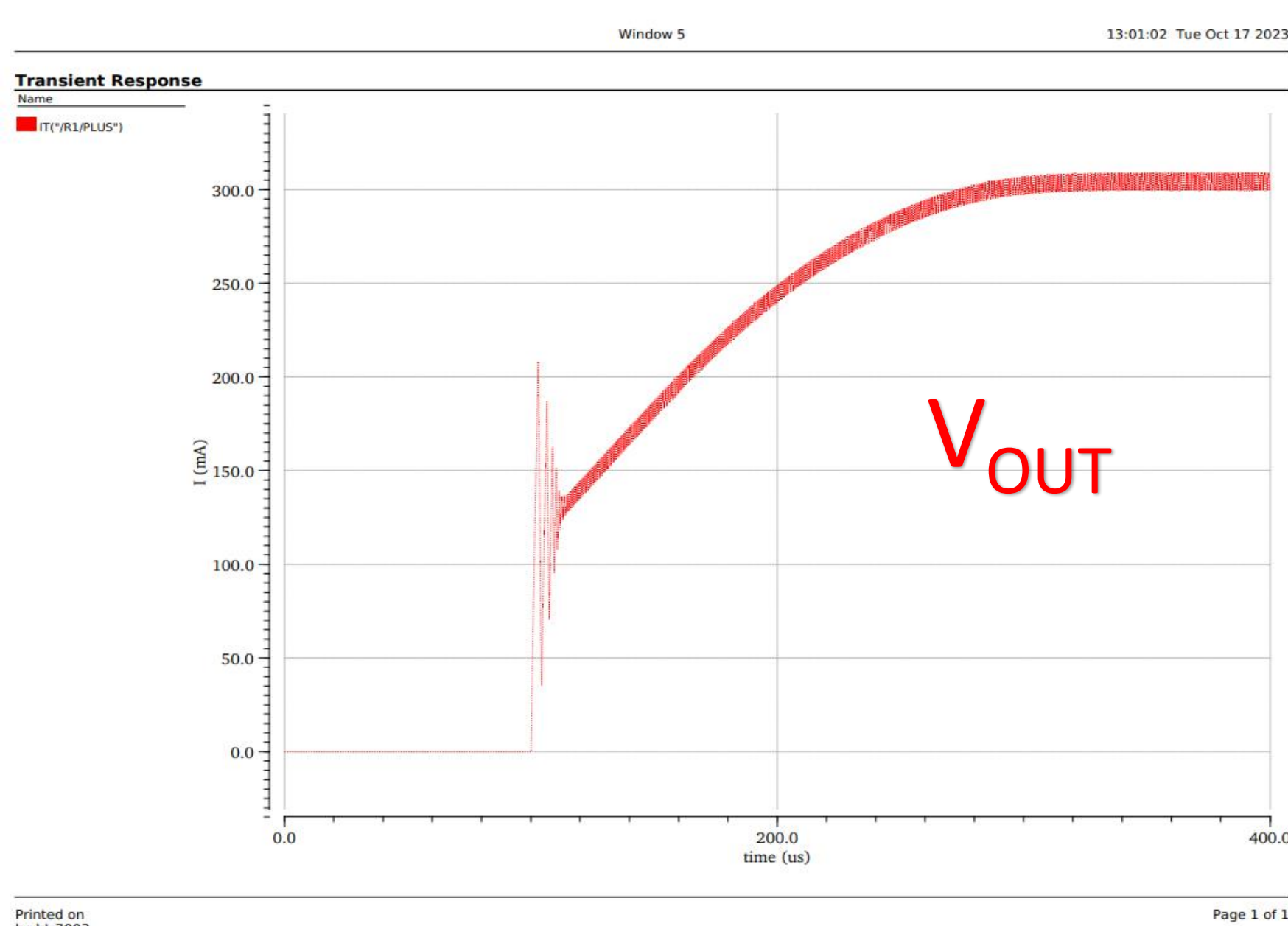
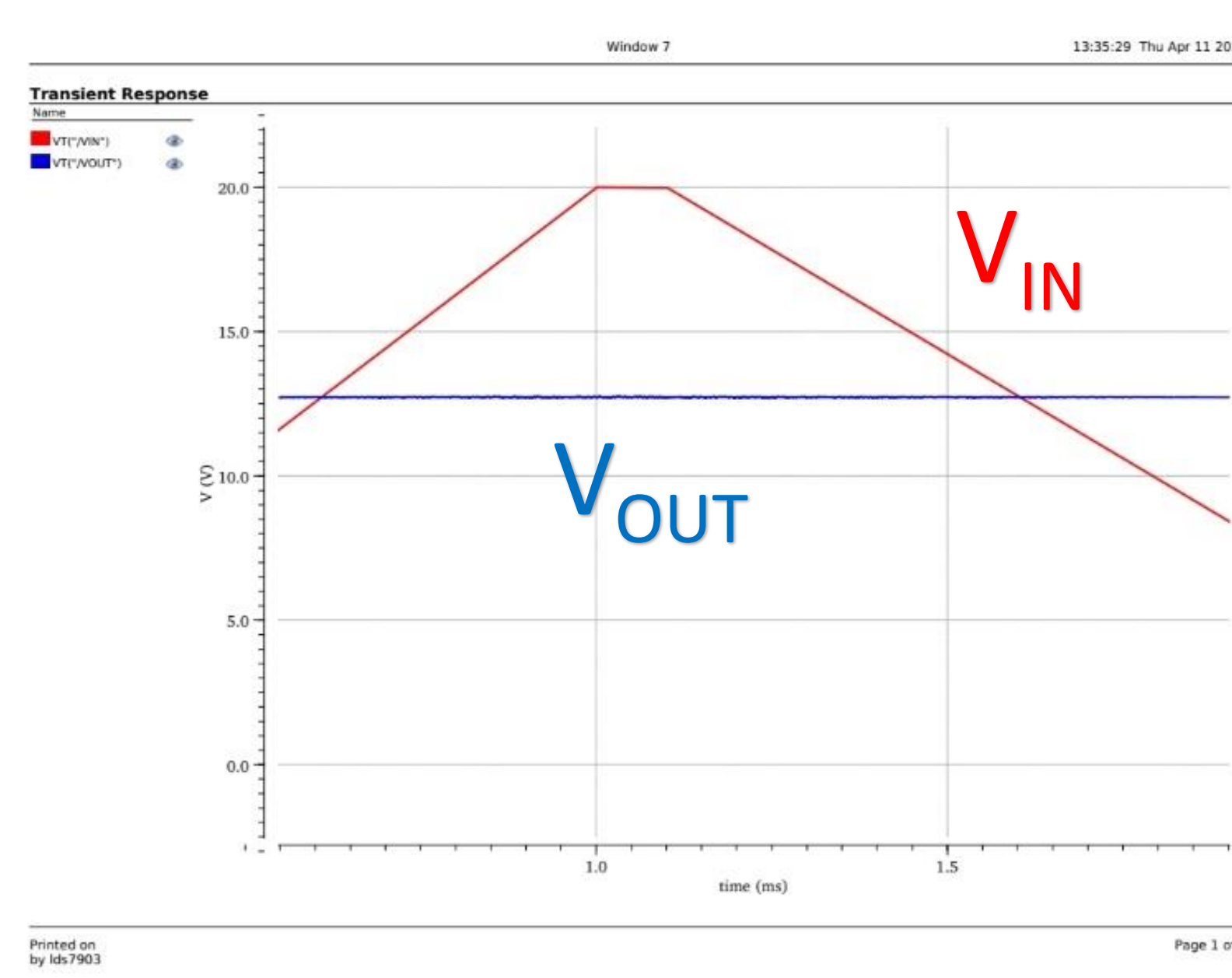


Fig. 5. Simulated transient response of designed Buck-Boost Converter



Specifications	
Technology	TSMC 180nm BCD
Chip area	3mm * 3mm
V _{IN}	7~60V
V _{OUT}	7~60V
Switching frequency	5MHz
Inductor	100uH
Bootstrap capacitor	10uF
Efficiency (@I _{load} = 300mA)	92% (simulation result)

Table 1. Design result

CONCLUSION

- In this design, to effectively drive an automotive LED matrix, a structure without an output capacitor was designed using LED current as feedback.
- GaN power switches were employed to operate at 5MHz.
- By eliminating the output capacitor, the output voltage can change rapidly, enabling quick response to various conditions.
- Additionally, the removal of the current regulator and reference voltage controller was possible.