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# A High Power Driver IC for Electroluminescent Panel: Design Challenges and Advantages of using the Emerging LEES-SMART GaN-on-CMOS process

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**Abstract**

The Electroluminescent (EL) panel is an emerging backplane lighting technology and becoming increasingly popular in advertising display and facade decoration. Despite the increased popularity of the EL panel, driver circuit for large EL panel is nascent in part because of the required high output power. In this paper, a novel high power EL driver IC based on the emerging LEES-SMART GaN-on-CMOS process are presented and we show that this integrated class-D EL driver is advantageous compared to EL driver IC based on state-of-the-art silicon IC process.


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*Keywords:* Electroluminescent panel; driver circuit; GaN-on-CMOS process

## 1. Introduction

The Electroluminescent (EL) panel [1] is an emerging backplane lighting technology and becoming increasingly popular in advertising display and facade decoration. This is largely because of its significantly better illumination uniformity, (mechanical) flexibility and smaller form factor compared to its counterparts such as the LED panel.

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Despite the increased popularity of the EL panel, driver circuit for large EL panel is nascent in part because of the required high output power. For instance, to drive a 30m$^2$ EL panel, the output power needs to be >2kW. However, the reported driver IC can only provide an output power up to 600W. The lack of high power driver ICs is mainly because to the low power-efficiency (hence high power dissipation in the IC and high IC temperature) due to the limitation of state-of-the-art IC fabrication process. For instance, the power dissipation (wasted power) in the IC of a 600W driver IC can be a high 100W.

The GaN-on-CMOS process, currently being developed by LEES-SMART, integrates GaN transistors and silicon transistors on a single silicon wafer and is significantly advantageous over state-of-the-art silicon processes, particularly for high power EL driver circuit. Specifically, compared to silicon transistors, GaN transistors [2] feature a much (10x) smaller parasitic capacitance (hence significantly improved power-efficiency) for the same output impedance. We envision that by employing this process, a high output power of ≥2kW may be achieved.

In this paper, we will present the design challenges for high power EL driver ICs. A novel high power EL driver IC based on the emerging LEES-SMART GaN-on-CMOS process will be presented and its advantages over EL driver IC based on state-of-the-art silicon IC process will be discussed.

## 2. High power EL driver circuits design

As mentioned earlier, high power driver ICs are required for the large-area EL lighting applications to drive an electrically capacitive load. It is imperative for the driving circuits to have high supply voltage (~hundred volts) and high operating efficiency. GaN can provide desirable high power efficiency, high supply voltage (high output power) and faster operating speed, whilst CMOS has the capability for complex circuits. Taking the advantage of LEES-SMART GaN-on-CMOS process, a novel high power EL driver IC is designed. The block diagram of the class-D driver for EL panel is presented in Fig. 1.

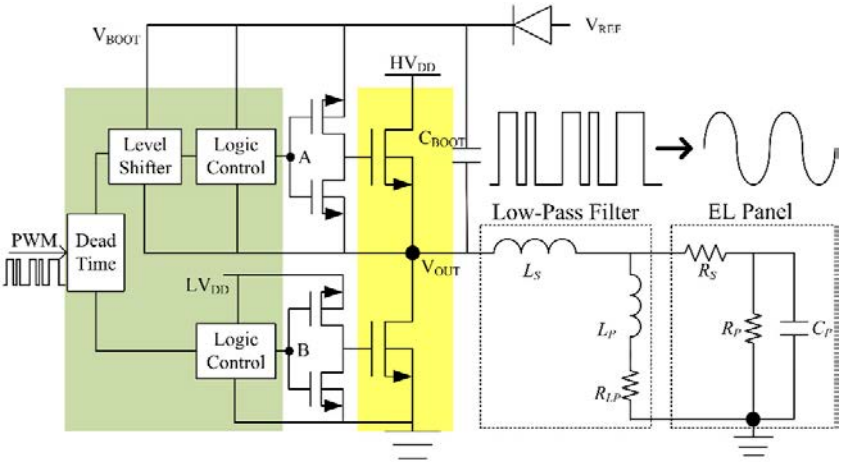


Fig. 1. Class-D driver for EL panel

It consists of a CMOS-based signal processing circuit that generates a Pulse Width Modulation (PWM) signal and logic control circuits (shaded in the grey colour), a GaN-based output power stage that drives the load (shaded in the yellow colour), and the output filter network including low-pass filter and the EL panel.

The signal waveforms of the class-D driver are depicted in Fig.2. The gate drivers are cascades of inverters that are sized in a tapering aspect ratio to rapidly charge and discharge the gate capacitances of the power transistors. The power transistors switch on and off according to the duration of the output pulses from the pulse-width modulator. Nonetheless, at high switching-frequencies, the power-efficiencies of conventional CMOS-based class-D drivers are reduced because of the high switching loss. [3] This loss can be very likely mitigated if we employ the GaN-based output power transistors in our Class-D driver for EL panel. This is mainly due to its lower on-

resistance and lower parasitic capacitance at high frequencies compared to their CMOS counterparts. In addition, it is worthwhile to notice that to deliver such high output power, a high supply voltage is required, normally about hundred volts, and under such high voltage stress, the reliability of the transistors can be an issue.

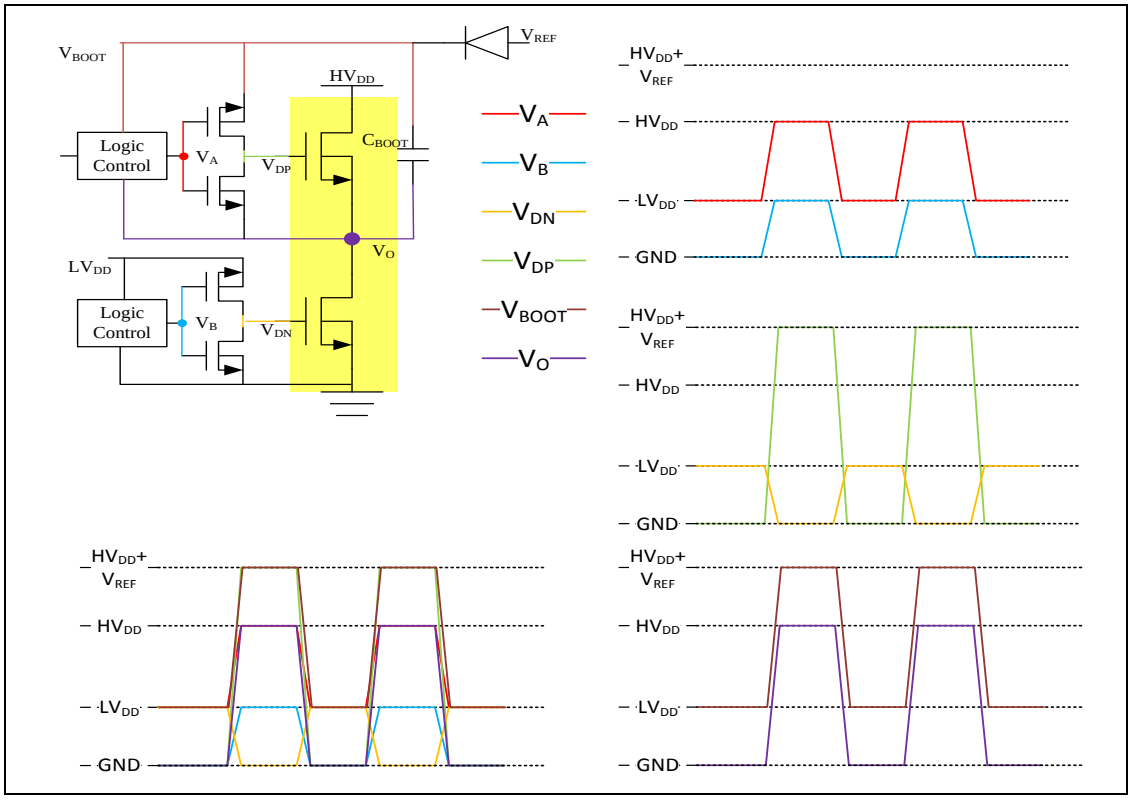


Fig.2. The signal waveforms of the Class-D driver

## 3. Conclusions

In this paper, a novel driver circuit for the emerging EL panel are presented. By taking the advantage of the LEES-SMART GaN-on-CMOS process, the driver can feature higher power-efficiency than standard commercial CMOS process.

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