A High Voltage, High Side Current Sensing Boost Converter

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ABSTRACT

This paper presents high voltage operation sensing boost converter with high side current. Proposed topology has three functions which are high voltage driving, high side current sensing and low voltage boost controller. High voltage gate driving block provides LED dimming function and switch function such as a load switch of LED driver. To protect abnormal fault and burn out of LED bar, it is applied high side current sensing method with high voltage driver. This proposed configuration of boost converter shows the effectiveness capability to LED driver through measurement results.

1. Introduction

Recently LED TV has reduced LED bar, which is single LED string(channel), to reducing BOM (Bill of Material) cost. LED bar is most expensive part in LED TV set, which is made by metal PCB. A main stream of LED bar is one-channel in 2012. TV set maker need high voltage to drive more LEDs in one channel. In recent, LED driving voltage of LED TV set, which has single channel LED bar, is over 200V voltage.

In general, LED TV set configure LED string with LED driver by low side FET and current sensing resistor. This configuration can make problems such as spike or ringing during high voltage driving due to parasitic inductance and capacitance and increase BOM cost by return wire on LED bar due to multi-channel driving. Major problem of edge type LED TV is burn out of LED bar by shorting with sash frame. Fig. 1 is shows configuration of LED TV set back panel. This shows position of each sash frame, LED bar and LED cable in general edge type LED TV. Normally sash frame is connected with ground pin. So in case of LED bar short with sash(chassis), it can be burn out by high current through LED string.

Fig. 2 shows normal low-side boost converter for LED driving with multi-channel LED string. If LED cable, bar or sensing resistor would be shorted with sash frame, it is very difficult to detect as a fault or error. In low side current sensing case, sometimes it would detected after burn out.

2. Proposed High-Side Boost Converter

Fig. 3 shows proposed high voltage boost converter with high side current sensing. This schematics include major three functional blocks which are high voltage driving, high side current sensing and low side boost controller. High voltage driving has level shifter(up to...
600V), signal noise cancellation, and gate driver. High side current sensing block operate as a current sensing for regulation. This block can make sure LED current level and dimming control. And low side boost controller has current mode PWM control and protection which has over temperature protection, over current protection, over voltage protection, and soft start block.

Maximun current sensing level.

**Figure 3.** Block diagram of the boost converter with high side current sensing for LED Driving

### 3. Measurement Results

This proposed schematics fabricated using 600V process on non-epi wafer. It can operate up to 600V. However this boost converter only measured under 250V for function verifying in this paper.

Fig. 4 (a) shows schematic of chassis ground test. Fig. 4(a) and (b) show there is no changed LED operation when LED return path to grounded chassis. Operation is well even under 0.5% and 90% duty dimming condition. There is no overshoot current in test results.

**Figure 4.** LED Bar chassis ground test (a) test circuit (b) 90% dimming (c) 0.5% dimming.

Fig. 5 shows general operation of proposed boost converter. This boost converter set boost gain 1.9. Input voltage is 120V and output voltage is 225V. It has 1ohm sensing resistor. And current sensing ratio is set and controlled by internal fusing block. This ratio is defined maximum operating current level.

**Figure 5.** (a) Start-up operation (b) 1% dimming operation

Fig. 6 shows fabricated microphotograph of the proposed high voltage boost converter with high side current sensing. High voltage gate driver and high side current sensing block is top left side in fig. 6. And low side boost controller with protection circuit.

**Figure 6.** Shows a die photograph of the proposed control circuit

### 4. Conclusion

We proposed newly high voltage high-side current sensing boost converter for LED driving. This converter has three major function blocks which are high-side sensing, high-side driving, and low-side boost controller. The high-side current sensing can provide protection direct short to chassis, design flexibility and reduction BOM cost. The high-side driving can be reduced abnormal phenomenon by parasitic inductance and capacitance. It is provided load switch function in boost converter. The low-side boost controller provides normal boost functions.

### Reference
