# Self-Discharge Effects on Multi-Lamps Backlight Driven by a High Speed Switching Inverter

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## Abstract

*A self-discharge in multi-EEFLs and CCFLs has been found to provide a high luminance and efficiency. With a fast rising and falling times of 2μs, and the peak voltage over 1.6KV, the self-discharge occurs in EEFLs and CCFLs driven by a full bridge switching inverter. Particularly in CCFLs connected with a typical value of ballast capacitance, a self-discharge follows by the main discharge when the voltage falls to the ground.*

## 1. Introduction

Large area LCDs gain significant applications for today's and future monitors and commercial TV. To meet backlight demands of sufficient luminance level, multiple tube arrangements could be simply placed under a diffusing plate for direct lighting conditions. In most cases the cold cathode fluorescent lamps(CCFLs) have been commonly used in LCD backlighting. Recently, external electrode fluorescent lamps(EEFLs) [1-3] have been introduced as a backlight for the LCD.

This report shows that a high speed switching inverter provides a high brightness and efficiency in the backlight arrayed with the EEFLs and CCFLs regularly placed on the reflection sheet.

## 2. Discharges in Backlights

Full bridge switching inverters are used for driving backlight panels of 17 inch in diagonal with 12-EEFLs and 12-CCFLs. The fast rising and falling time in the waveforms, a duty and a frequency, are adjusted by a high speed on/off switching in full-bridge switching inverter.

### 2.1 Self-Discharge in EEFLs

Fig. 1 shows oscilloscope signals measured in the backlight driven by the square pulse from the switching inverter. The square voltage profiles with the peak voltage about $V_p$=2 kV and the duty ratio of D=24% (the pulse duration of 6 μs) are shown in Fig. 1 with the frequency of 40 kHz. In the figure the voltage and the current profiles are shown in (i) and (ii), and the optical probe signals in (iii), respectively. The current and the optical signals corresponding to the rising and falling parts of positive voltage pulses represent the main and self-discharges, while those signals corresponding to the falling and rising parts of negative voltage pulses represent also the main and self-discharges, respectively.

Particularly, the signals of self-discharge do not appear unless the driving voltage of $V_p$ is high enough to cause the self-discharge for the duty ratio less than 50%. In Fig. 1 ,with a rising and falling times of 2μs, as the driving voltage of $V_p$ is increased by firing a voltage of about $V_p$~1 kV, the signals of self-discharge are appeared at the voltage of $V_p$~1.6 kV and their intensities increase as the voltage is increased to $V_p$~2 kV.

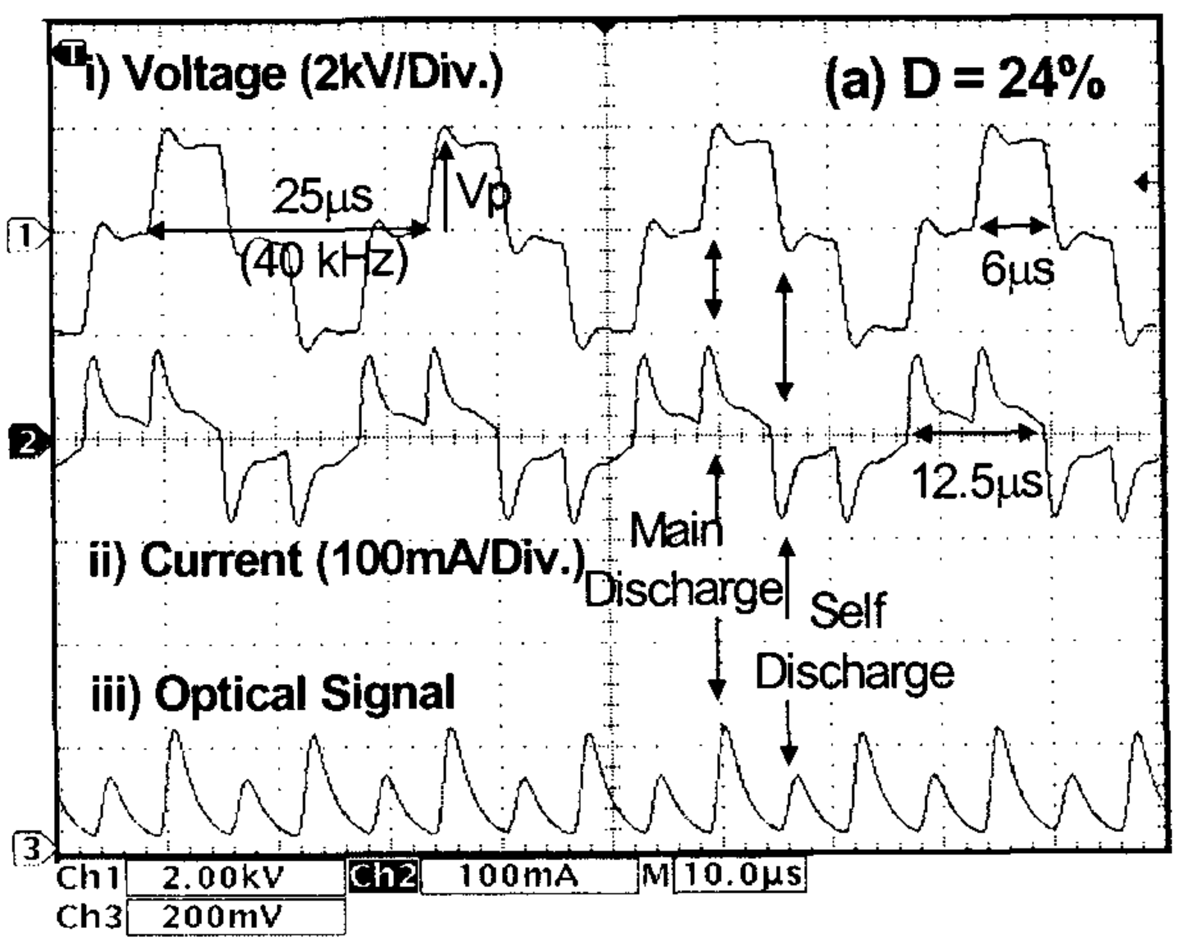



**Figure1. Oscilloscope signals measured in the backlight driven by the square pulse from the switching inverter.**

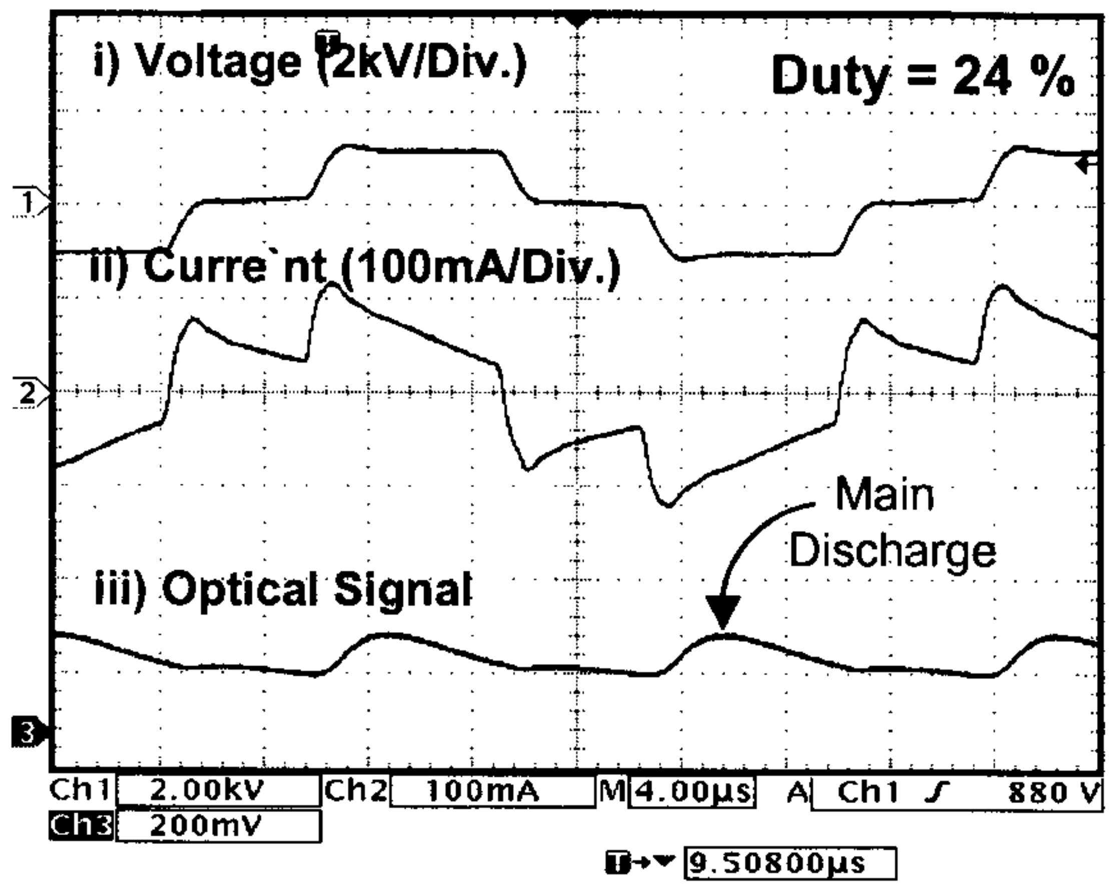
The self-discharge is the general phenomena in the AC dielectric barrier discharge of plasma display high enough to discharge, the main discharge occurs with an applied voltage and the self-discharge follows when the voltage falls to the ground.

## 2.2 Self-Discharge in CCFLs

For the operation of multi-CCFLs with a single inverter, a ballast capacitor is connected to each CCFLs for synchronizing all lamps, respectively.

Figures 2 show oscilloscope signals for the backlight of multi-CCFLs with the ballast capacitance of 47 pF in Fig.2-(a) and 18 pF in Fig.2-(b), respectively.

**(a) C = 47 pF**




**(b) C = 18 pF**

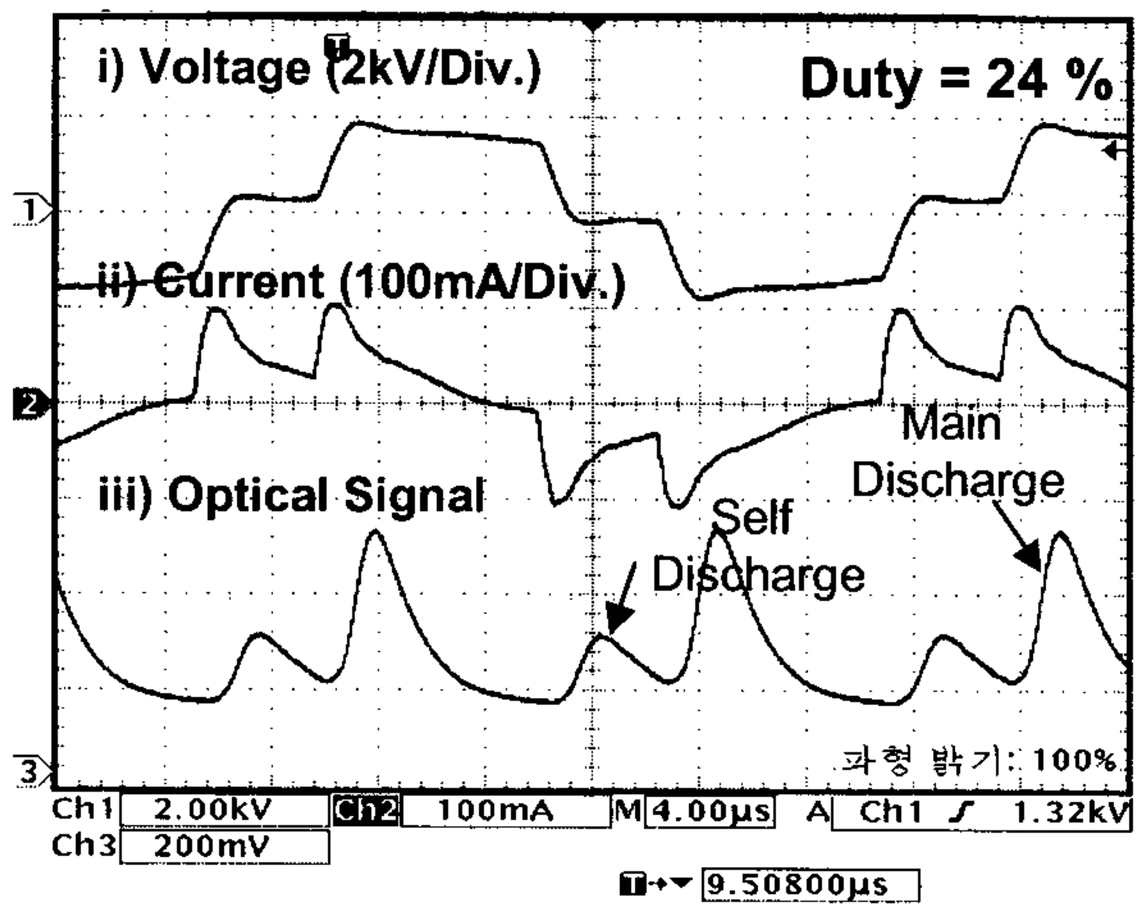



**Figure 2. Oscilloscope signals of multi-CCFLs with the ballast capacitance of 47 pF (a) and 18 pF(b).**

panels. When the driving voltage of a square pulse is

In Figure 2 (a) with the ballast capacitance of 47 pF,the peak voltage is decreased to be 1.3 kV by the cathode falling as the current increases, which is typical phenomena in the normal glow discharge of direct current through the cold cathode. In figure 2 (a-iii) of optical signals, there are no light emission corresponding to current signals of falling voltage to the ground followed by the main discharge.

In Figure 2(b) where the ballast capacitance of 19 pF is connected to each lamps of CCFLs double lightings are shown to be a main discharge and a self-discharge for one polarity pulse. The peak voltage is decreased slightly to be 1.85 kV since the cathode fall voltage is small even if the current increases.

In this experiment, the value of the ballast capacitance is important roles for the self-discharge in CCFLs.

## 3. Conclusion

The self-discharge in operating LCD backlight arrayed multi-EEFLs and CCFL lamps with a high speed switching inverter have been investigated. The self-discharge in EEFLs is general in a dielectric barrier discharge. However, the self-discharge in CCFLs found in this study, comes from over-charging the ballast capacitor during the main discharge.

The backlight with 12 lamps regularly placed at 2 cm spacing for a 17-inch diagonal is operated at a high voltage of about 1.6～2.0 kV. In the backlight driven by square pulses with an optimal frequency, a high efficiency over 60 lm/W and a luminance of 10,000 cd/m$^2$ could be obtained.

## 4. References

[1] D. G. Joh, D. H. Gill, H. S. Kim, Y. G. Kim, J. J. Ko, D. I. Kim, C. W. Lee, Y. H. Seo, E. H. Choi and G. S. Cho, *Proc. ASID'00*, 2000, p. 470-474.

[2] H. S. Kim, D. G. Joh, Y. G. Kim, J. J. Ko, D. I. Kim, C. W. Lee, E. H. Choi, G. S. Cho, B. H. Hong, H. G. Sohn, and B. G. Yu, *Proc. SID'01*, 2001

[3] T. S. Cho ,Y. M. Kim , N. O. Kwon , S. J. Kim , J. G. Kang , E. H. Choi ,and Guangsup Cho Jpn. J. Appl. Phys. Vol. J. Appl. Phys. 2002