Parasitic Capacitive Housing Effects in a Multi-Lamps Backlight

Sang-Beom Kim, Mee-Ryoung Cho, Seong-Moon Hong, Yong-Kon Lee, Sang-Heok Lee, Ji-Hoon Lee, Joo-Young Lee, Jin-Woo Hong, Dong-Wook Yang, Dea-Heung Lee, Bong-Soo Kim, June-Gill Kang and Guangsup Cho

Department of Electrophysics, Department of Electronics Engineering, Kwangwoon University/
Kwangwoon Display Technology Co. Ltd., 447-1, Wallgye-Dong, Nowon-Gu, Seoul, Korea 139-701

Abstract

The parasitic capacitance between the high voltage electrodes and the backlight housing causes lowering lamp current, electric power leakage, and leading to lower brightness and efficiency in a multi-lamps backlight. In this study a new center balance swing operation method is introduced to be minimizing those housing effects.

1. Introduction

The direct lighting backlight technologies have been introduced [1-10] for the arrays of multi-lamps connected in parallel. The fluorescent lamps of backlight unit are set in metal housing to minimizing EMI radiation from the inverter and electric power systems. However this metal housing affects lowering the lamp current and the electric power leakage. The origin of lowering the lamp current comes from the electric field distortion in the longitudinal direction of lamp. The electric power leakage comes from the parasitic capacitance between the electrodes of lamps and the lamp housing due to the high electric field formulated and the field energy variation with the operation frequency. When the lamp housing was removed and the lamps are operated without housing, the lamp currents are increased at the same operation voltage.

Considering the discharge mode in a general lamp, a light emits along the lamp from the electrode of high voltage to the grounded electrode or the grounded housing. The electrons in discharge plasma of fluorescent lamps are drifting from the high voltage electrode side to the grounded electrode or metal housing. The behaviors of the electrons drifting in multi-lamp are related to the uniformity in the lamps system.

The housing effects are increased as the length of lamps and the numbers of lamps increase since high operation voltage is required as the size of backlight unit increases. It becomes serious with the problems of high voltage power leakage and unstable discharge as a BLU panel size increases.

The purpose of this study is providing a new technology for minimizing the housing effect with low voltage driving and stable discharging in the multi-lamps of CCFLs and EEFLs.

2. Operation Methods

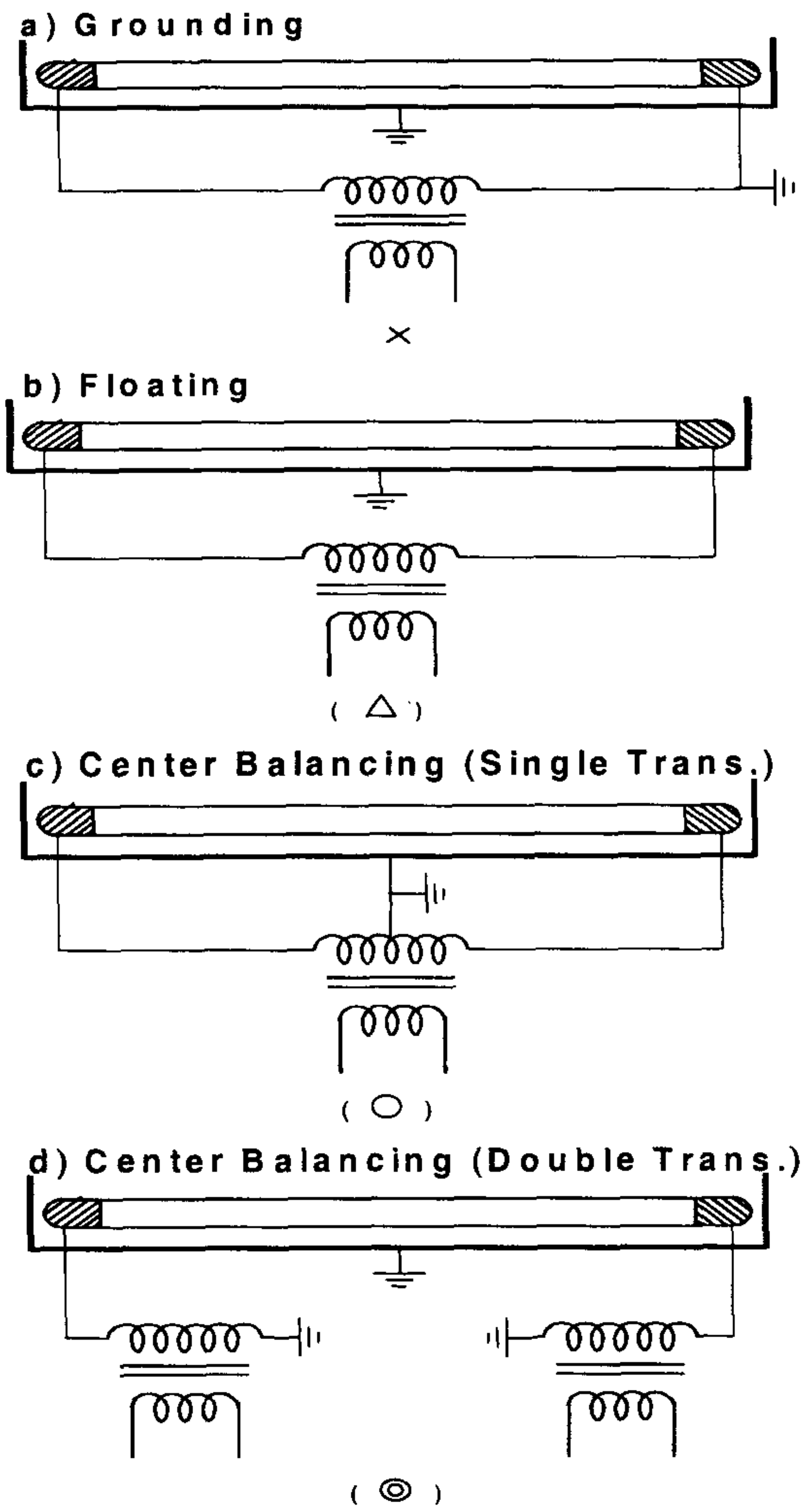

Figure 1. Schematics of various housing assembly

As shown in Figure 1, there are various kinds of assembly by connecting among the electric lines of the lamps, the housing, and the secondary coil of transformer. In the conventional method of Fig. 1(a), one ends of electrode is applied high voltage, $\pm V_0$ from the secondary coil of the transformer and another electrode of the lamp with the metal housing is grounded by connecting the ground side of transformer. This high voltage applied to the parasitic capacitance between the high voltage electrode and the grounded housing, could be caused to discharge unstable in each lamps, the electrical noise near the high voltage electrode, power leaking and safety problems. Those housing effects are so serious in the application of the large area and high brightness backlight unit. Avoiding these problems, the floating method in Fig. 1(b) could be considered with the inverter systems, while the high voltage floating electrodes without grounding could be role as an antenna which causes a electrostatic charging and a safety problem in the applications. A newly proposed method consisted in three electrodes, is the center balance swing operation as shown in Fig. 1(c) and Fig. 1(d). In Fig. 1(c), the center of the secondary coil in the transformer is grounded with the housing and both ends of the secondary coil are connected to each electrode of the lamps so that each electrode has a half of the voltage as $\pm V_0/2$ with an opposite polarity even if the voltage difference is V_0 between two electrodes.

With two transformers in the inverter as shown in Fig. 1(d), primary coils are in parallel and secondary coils are connected in series with each ends of the secondary coils are grounded with metal housing. The lamp housing remains the ground voltage and each output part of transformer has a half voltage, $\pm V_0/2$ to drive the lamp discharge. The light emission mode shows the lighting from two edge sides to center of lamps, and decreasing power leakage from the electric field energy loss in the parasitic capacitance, and safety is also granted even a high voltage driving

3. Experimental Results

Discharge lamps of Borosilicated glass of 2.6 mm diameter and 352 mm length are used in these experiments. The electrodes are aluminum foil taped at 17 mm. Fluorescent materials of RGB are coated at inside of tube, and gases are Neon 97% and Argon 3 % at 80 torr. And also very small quantity of Mercury are included.

Sample panel of this experiment is 17 inches in diagonal and has 12 EEFL lamps connected in parallel operated by single inverter. This is a direct lighting and reflected sheet used. Acrylic frame were used and Aluminum sheet attached on the frame. The diffusion sheet and lamps were in 15 mm distance, and every 20 mm lamps were located. Diffusion sheet of 2 mm is in front face of the frame and measured the brightness.

Full bridge inverter with four switching circuits are used for high voltage output in square wave. This system can be operated in high voltage and high power transformation upto 200 watts which can control high current by current switching.

Single transformer for 1.6 – 1.8kV are used at about 70 kHz, and varied input voltage at 10V – 14V dc. Data in table 1 shows the results of different ways of the systems, Grounding and CBS according output connections. At the grounding method shows the brightness of 3,900 – ,9383 (cd/m^2) along the input currents of 3.89 – 6.48 (A). And at CBS methods, 4,250 – 8,725 (cd/m^2) along with 2.4 -3.21(A). The data of these are shown in Fig. 2 along the input power. This results show the efficiency of the lamps, the efficiency of CBS is better than Grounding method about two times.

In CBS, half of the voltage to each side is supplied as +1/2Vo and –1/2Vo. But in grounding method, one of the output line is grounded as a conventional connection.

Parasitic capacitance between output and ground could be decreased by opposite polarity of output voltage.

Table. Experimental results from the multi-EEFLs backlight panel of 17 inch in diagonal.

	Input voltage (V)	Current (A)	Power (W)	Brightness (cd/m^2)	Efficiency (lm/W)
Grounding	10	3.89	38.9	3900	28
	11	4.71	51.8	5220	28.1
	12	5.23	62.7	7097	31.6
	13	5.81	75.5	8211	30.4
	14	6.48	90.2	9383	28.9
Center Balance Swing	10	2.4	24	4250	49.5
	11	2.67	29.3	5260	50.1
	12	2.91	34.9	6311	50.5
	13	3.1	40.3	7572	52.5
	14	3.21	44.9	8725	54.3

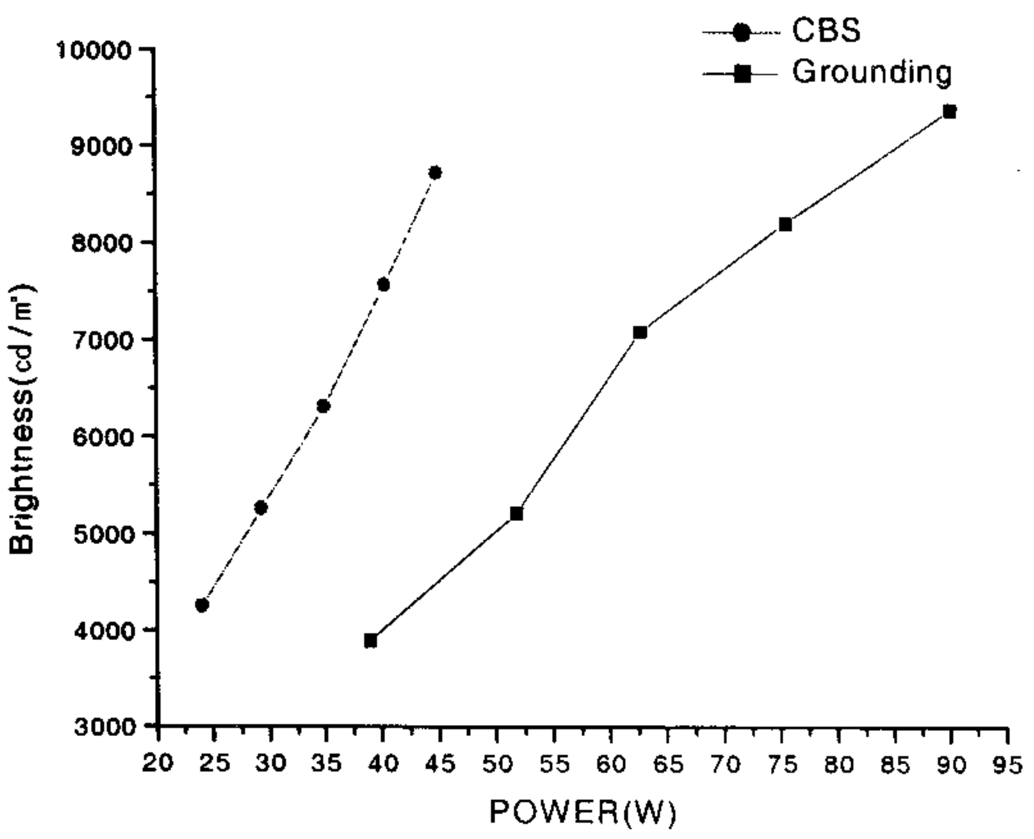

Figure 2. Variation of Brightness-Power between CBS Method and Grounding Method.

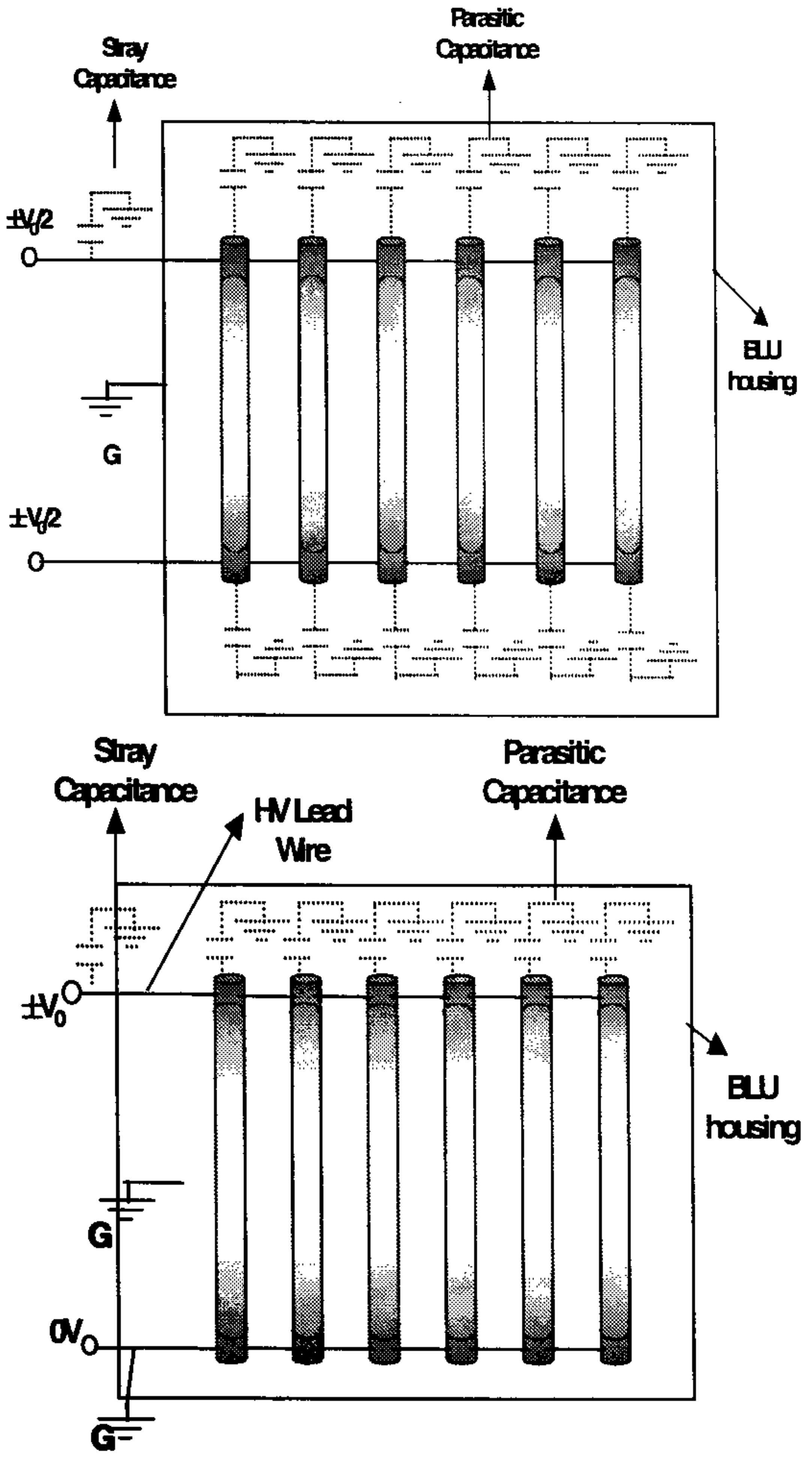

Fig.3 shows the concept of housing effect to CBS and Grounding method.

4.Conclusion

Direct light backlight unit of this study shows the efficiency is effected by parasitic capacitance between electrodes of lamp and housing, and the power loss are occurred at housing. CBS method in wiring the lamps and inverter can be achieved higher brightness and efficiency, so the lamps could be operated at lower voltage compared to conventional method.

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