Modified Ramp Reset Waveform for High Contrast Ratio in AC PDPs

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Abstract

In general, the background light produced during the reset period deteriorates the dark room contrast ratio in AC PDP. In this paper, we propose a modified ramp reset pulse that can reduce the background light to imperceptible level. In the new reset waveform, the discharges between the scan and sustain electrodes are minimized by applying a positive bias voltage to the sustain electrode and only the weak discharges between the scan and address electrodes occur during the reset period. We adopted a MgO coated phosphor layer to get the same level of voltage margin in the new reset pulse scheme compared to that of the conventional ramp reset pulse one.

As a result, the voltage margin is maintained at the same level and the dark room contrast ratio is improved dramatically.

1. Introduction

As a display device, PDP has many merits such as it can be thin, light and easy to make large size up to 60 inches, so it is expected as one of the most important display devices for next generation digital TV but still it has many drawbacks like the low contrast ratio and moving picture noise.

In general, a reset discharge is needed to stabilize the address discharge and overcome the non-uniformity of discharge cells but it is not related to the picture image to be displayed and so the background light deteriorates the contrast ratio.

To solve this problem, there have been many activities to reduce the background light during the reset period. For example, they reduced the number of reset pulse per frame and others used weak discharges during the reset period instead of strong ones. [1] But, the background light is still perceptible in a dark room and it deteriorates the picture quality of dark image especially.

In this paper, we propose a modified ramp reset pulse to reduce the discharge between the scan and sustain electrodes. At the same time, an MgO coating on the phosphor layer is adopted to solve the narrow voltage margin caused by the weakening of reset discharges between the scan and sustain electrodes.

As a result, we can improve the contrast ratio dramatically and get the same level of voltage margin compared with the conventional method.

2. Simulations and Experiments

The active size of panel used in this experiment is 2 inches in diagonal and it has the conventional coplanar structure with three electrodes. The driving voltage waveforms used in this experiment are shown in figure 1. It shows that the voltage waveform of scan electrode is ramp shaped and the voltage of sustain electrode is biased at the positive voltage level (V_x) and the address voltage is grounded during the reset period. The bias voltage of sustain electrode is introduced to optimise the reset discharge and minimize the light output during the reset period.

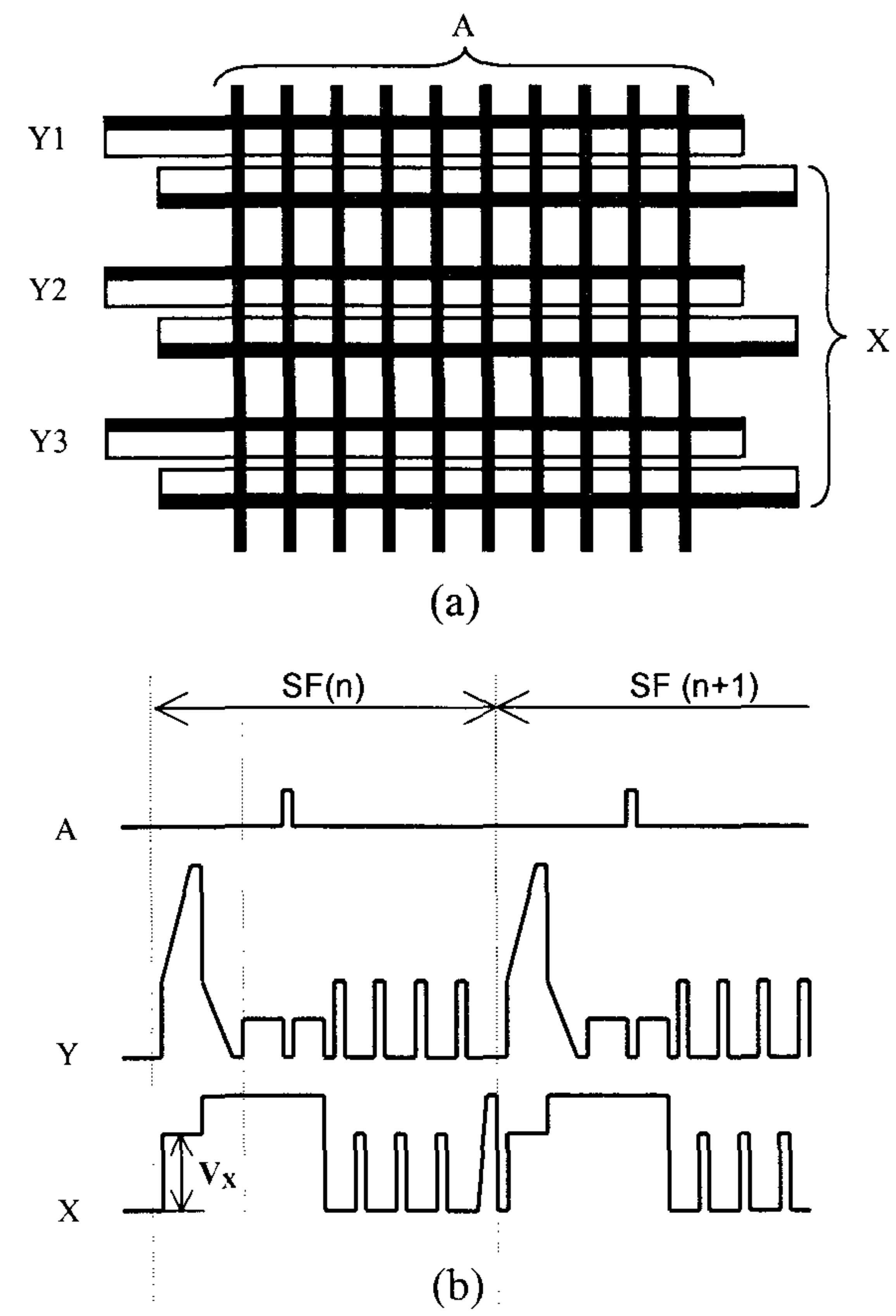


Figure 1. Panel structure and driving voltage waveform. (a) Schematic view of electrodes and (b) modified ramp reset waveform

To investigate the discharge mechanism of reset pulse, 2D simulation method is also used, which is based on the fluid model of plasma. [2]

In case of ramp reset pulse, there are many weak discharges during reset period and these discharges can be divided into two different kinds of discharges. One is a discharge between the scan and sustain electrodes and the other is a discharge between the scan and address electrodes.

To get a stable address discharge between scan and address electrodes in address period, it is needed enough wall charges between scan and address electrodes produced by reset period.

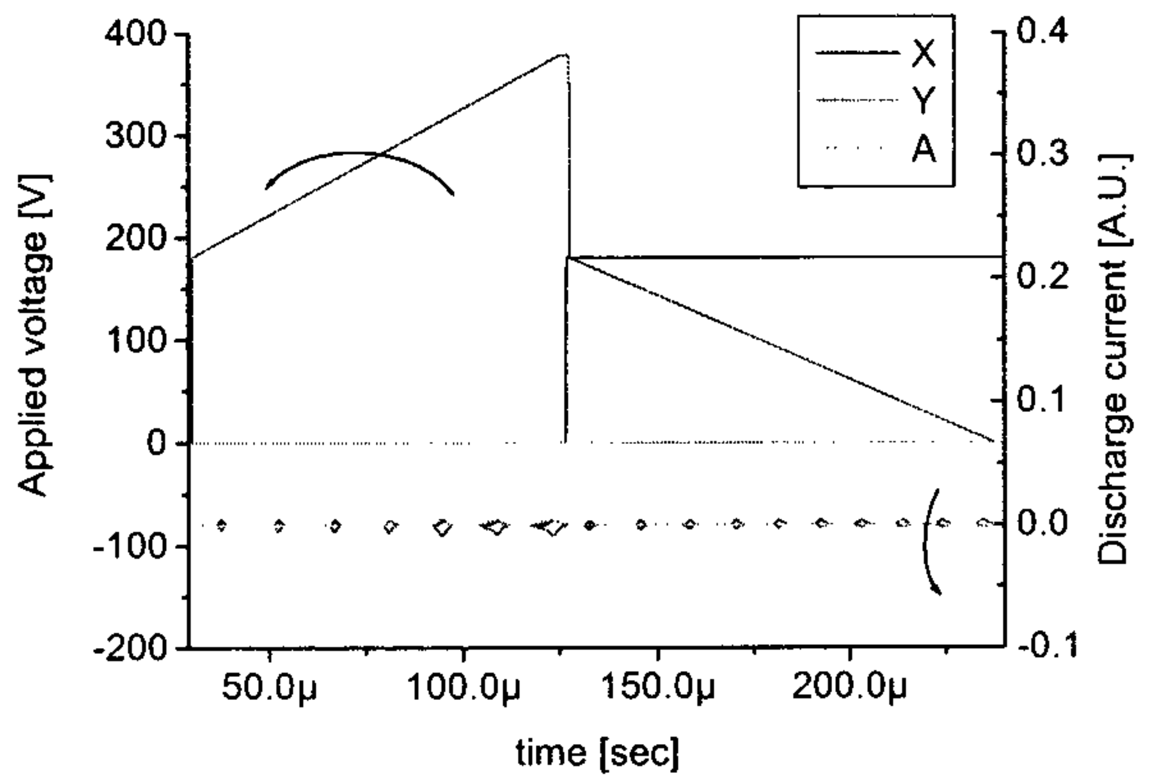
If the firing voltage between scan and address electrodes is V_{fya} and the applied address voltage is V_a, and the wall voltage between scan and address electrodes which is produced by reset pulse is V_w, the sum of V_a and V_w must be greater than V_{fya} for stable addressing and to get this wall voltage, the discharges between scan and address electrodes are more important than a discharge between scan and sustain electrodes.

If there are enough discharges between scan and address electrode, we can reduce the discharges between the scan and sustain electrodes during the reset period that are relatively less important than the discharge between the scan and address electrodes to make a wall voltage for stable addressing and can get an improved contrast ratio by applying a bias voltage on the sustain electrode because the light output between scan and sustain electrode is greater than the light output between scan and address electrode.

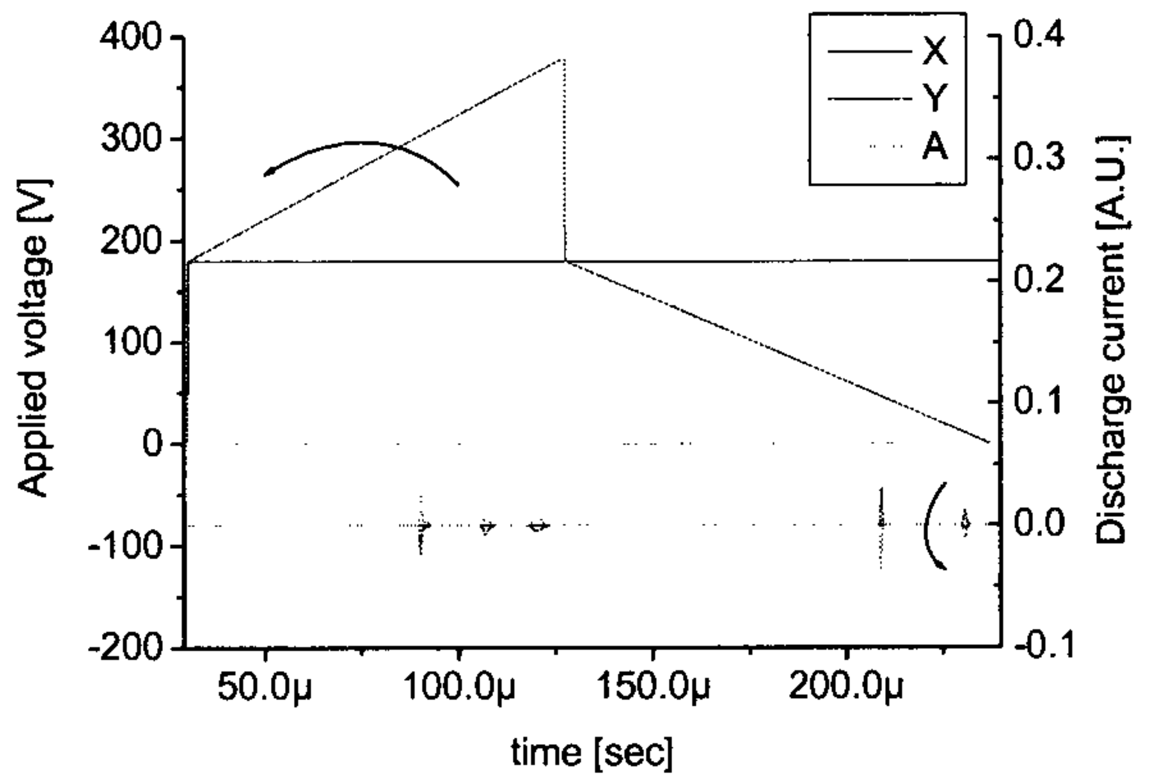
Figure 2 shows the simulation results of ramp reset pulse as a function of the bias voltage (V_x) of sustain electrode during ramp up period. As shown in figure 2, in case of V_x=0V, the reset discharges occur between scan and sustain electrodes and between scan and address electrodes both, but in case of V_x=180V, the discharges between scan and sustain electrodes are reduced and the discharges mainly occur between scan and address electrodes.

In the panel experiments, the contrast ratio is improved dramatically and it shows less background luminance than the only one ramp reset pulse per frame as shown in figure 3 and it results in a high contrast ratio more than 3000:1 which is the highest value reported previously. [3]

We also adopted the MgO coating on the phosphor layer to improve the voltage margin characteristics which may affected by the weakened discharges between scan and sustain electrode.



(a) V_x=0V



(b) V_x=180V

Figure 2. Simulation results of discharge current waveform as a function of V_x in ramp up period.

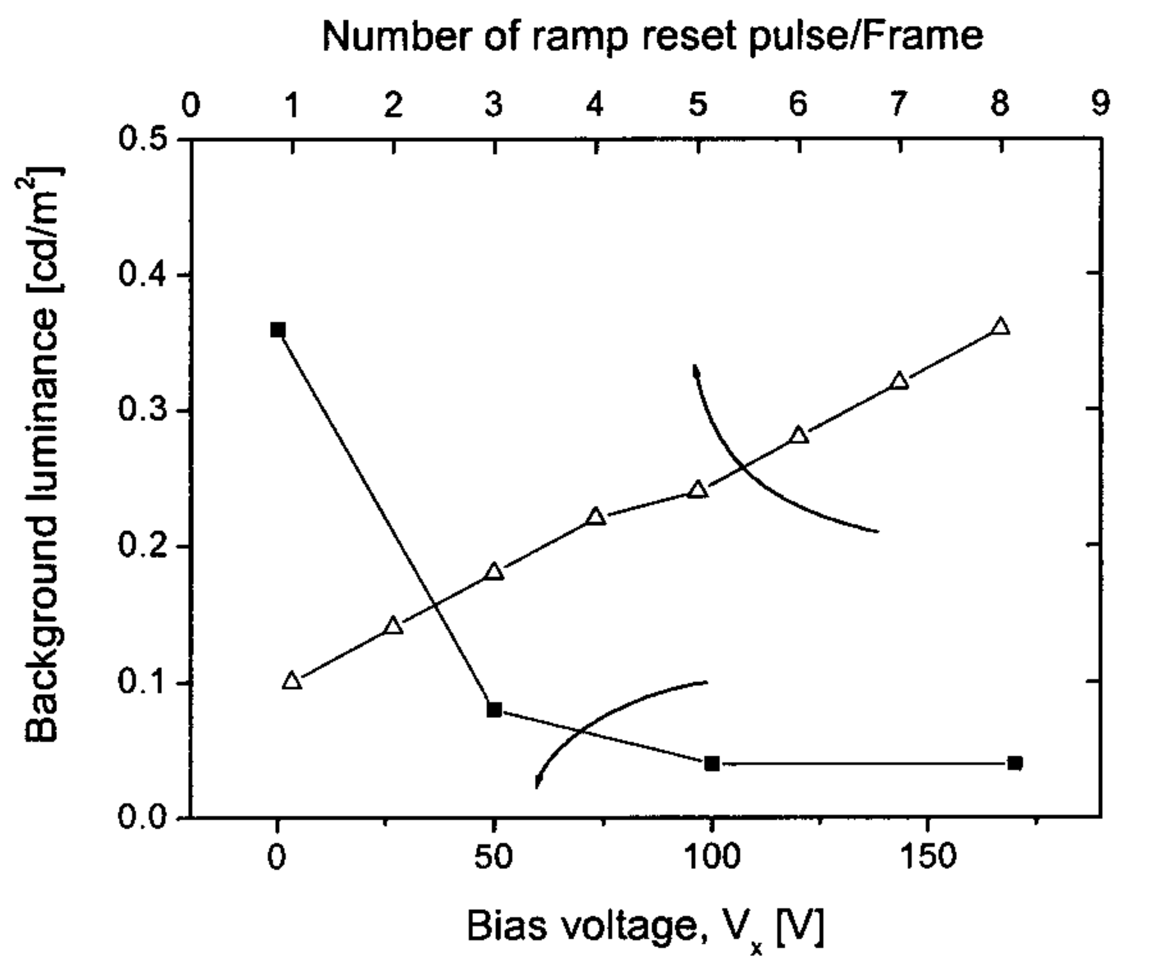


Figure 3. Experimental results on background luminance according to bias voltage (V_x) and number of reset pulse per frame

3. Results and Discussion

In general, there is a trade off relation between the voltage margin and contrast ratio according to the reset pulse. Therefore, if there are enough reset discharges before the addressing, the margin of address voltage is enlarged but the background light intensified and contrast ratio is deteriorated, so we need to optimise these two characteristics.

In this experiments, the contrast ratio is improved by applying the bias voltage to the sustain electrode during the ramp up period, however, the discharge occurs only between the scan and address electrodes and it is affected by the secondary electron emission characteristics of phosphor that is worse than those of MgO. Therefore the firing voltage increases and especially in the green cell, it is impossible to initialize the discharge cell at the normal reset voltage and it shows a narrow voltage margin.

To improve the address voltage margin as well as contrast ratio, we coated a very thin layer of MgO ~100 Å on the phosphor layer and investigated the contrast ratio and voltage margin characteristics as follows.

3.1 Contrast ratio

In case of MgO coated phosphor layer, the background light reduced to below the 0.1 cd/m^2 as shown in figure 4 with applying the bias voltage to the sustain electrode during the reset period. It can be considered the same results as shown in the simulation results. It is caused by the reduction of the discharge between the scan and sustain electrodes and in case of the weak discharge between the scan and address electrodes, it is hidden by the opaque bus area of scan electrode so the reduction of background light is more than expected.

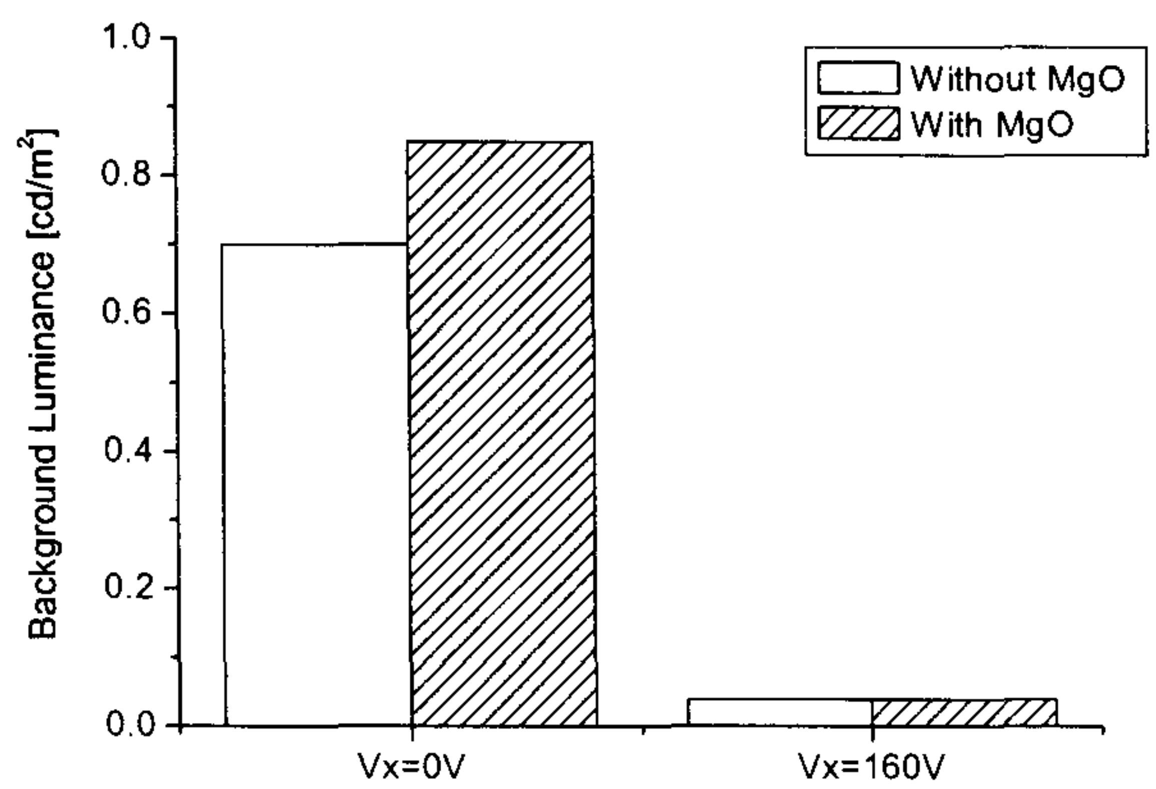
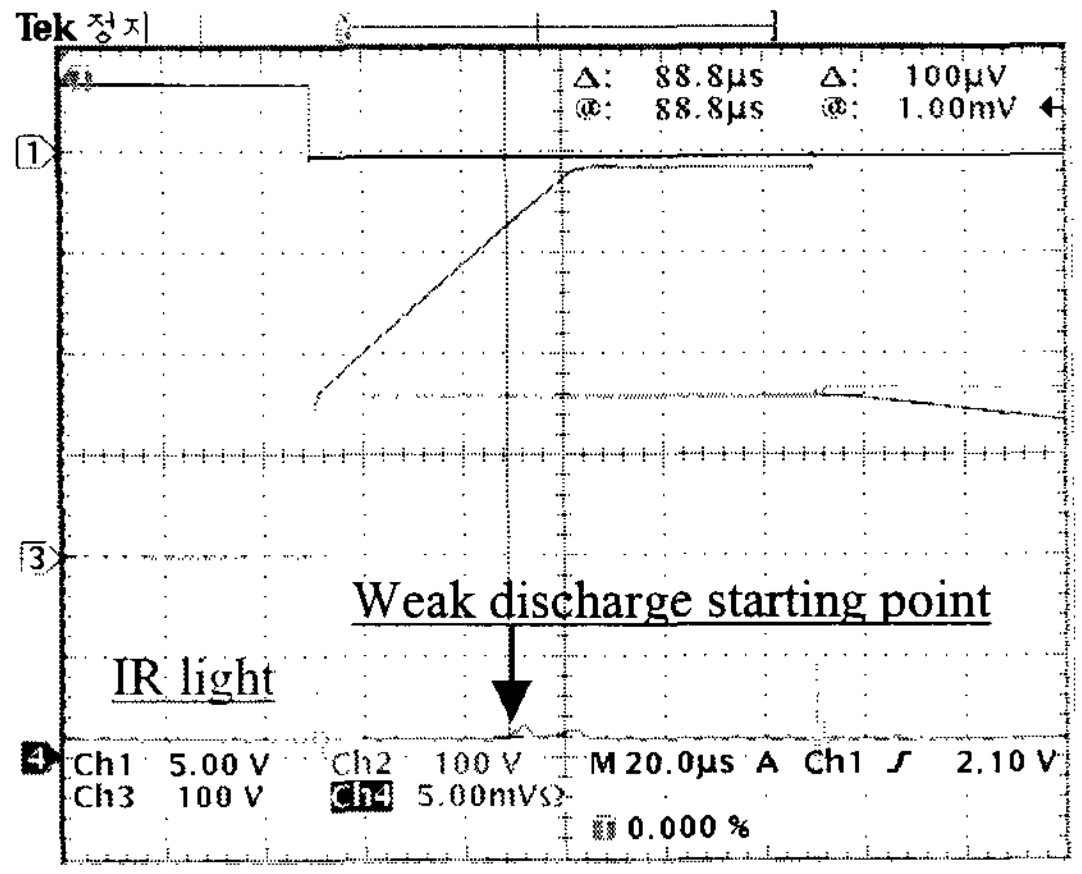


Figure 4. Background luminance with respect to the bias voltage in both without MgO coating and with MgO coating on phosphor.

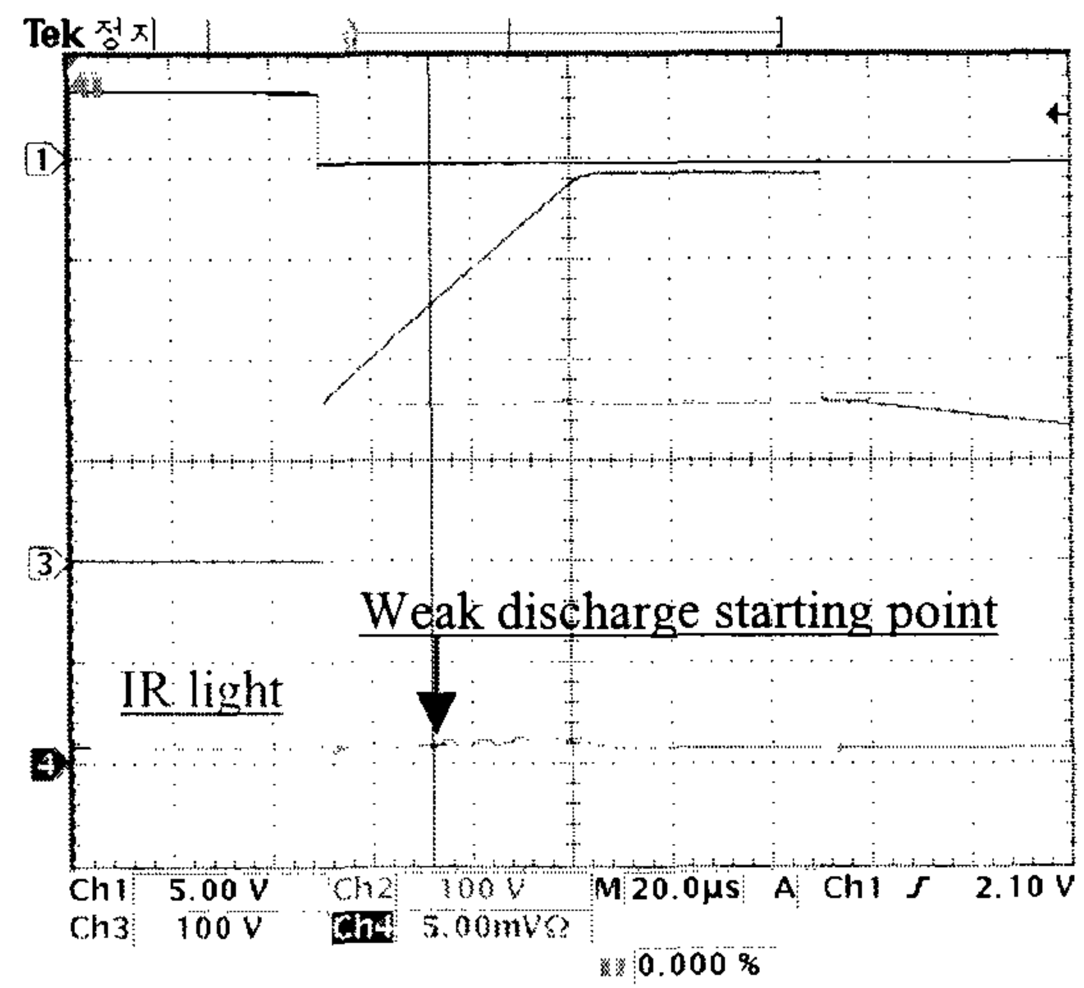
3.2 Driving voltage margin

To investigate the effect of MgO coating on the phosphor layer on voltage margin, we measured the dynamic voltage margin and compared the discharge characteristics during the reset period measuring the start point of discharge between scan and address electrode.

In figure 5, the IR(Infra Red) light output is measured to detect the starting point of the discharge between scan and address electrode and it shows weak discharge starts earlier in case of MgO coated phosphor because MgO coating reduces the firing voltage between scan and address electrodes.

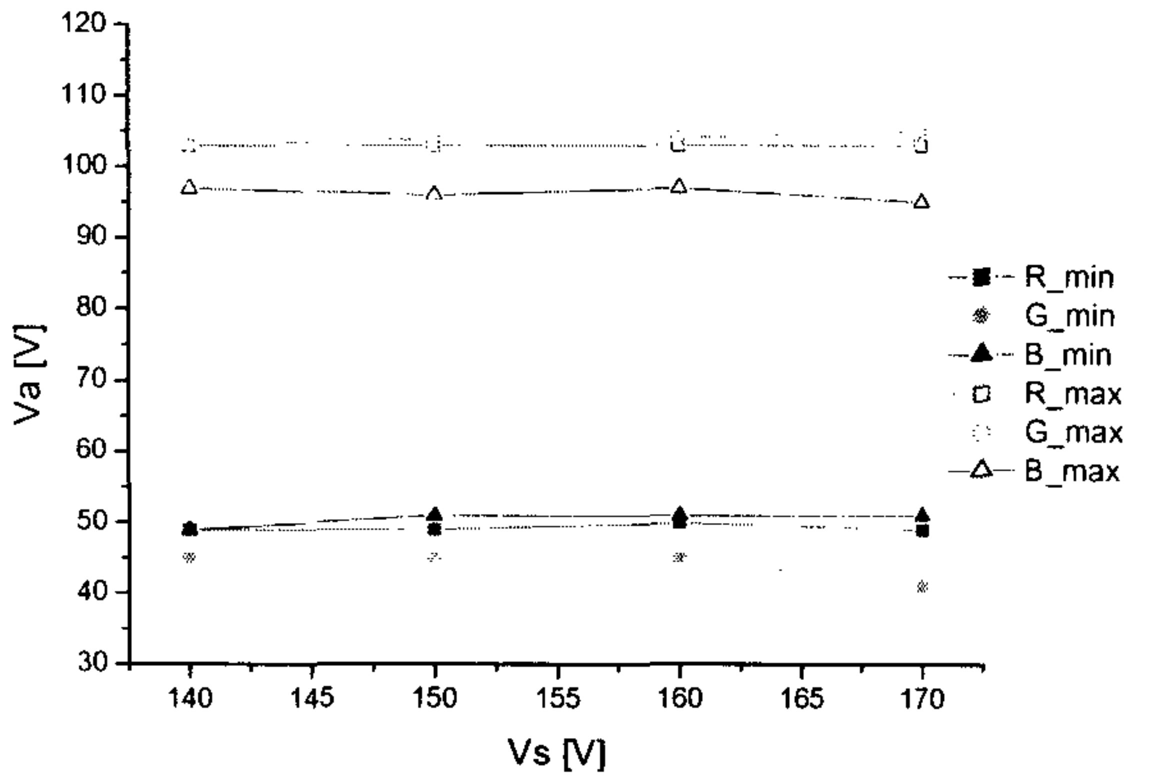


(a)

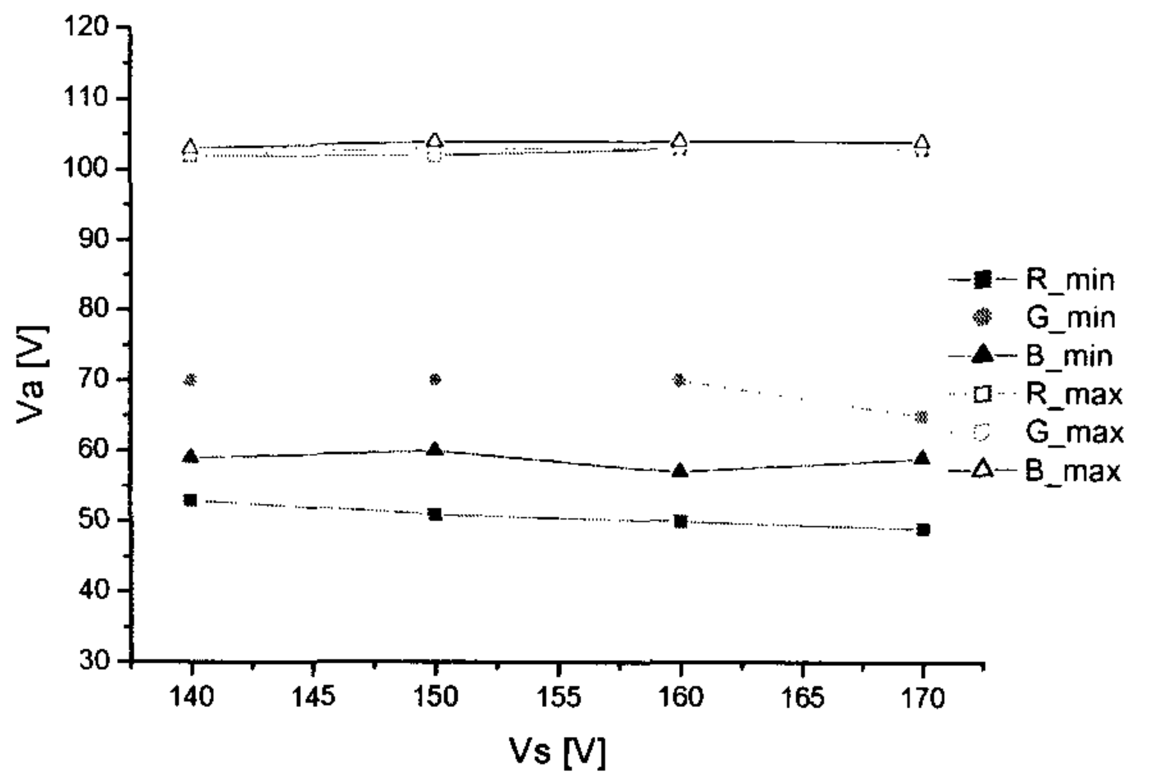


(b)

Figure 5. Effect of MgO coating on the discharge between scan and address electrode in case of V_x=160V. (a) without MgO coating on phosphor and (b) with MgO coating on phosphor



(a)



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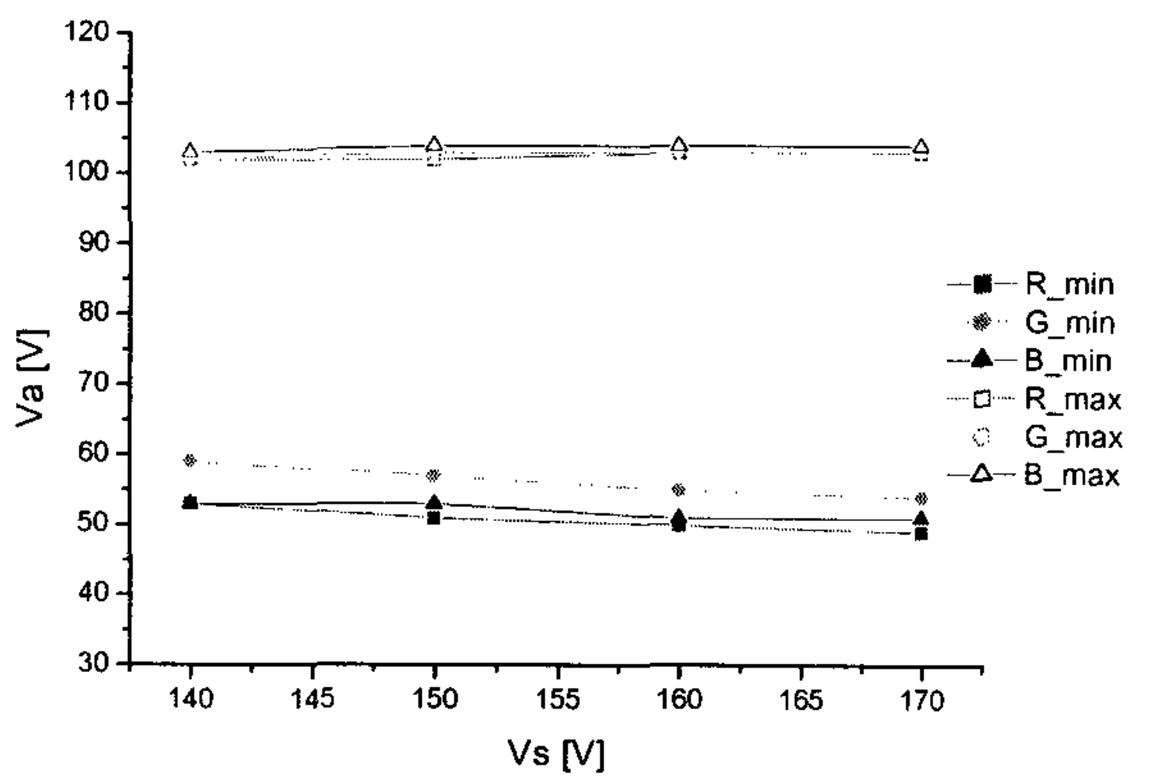

(c)

Figure 6. Effect of MgO coating on voltage margin (a) V_x=0V and without MgO coating on phosphor, (b) V_x=160V and without MgO coating on phosphor, and (c) V_x=160V and with MgO coating on phosphor.

In figure 6, applying the bias voltage to sustain electrode reduced the address voltage margin especially in green cell, however in case of MgO coating on the phosphor layer, it shows almost the same level of voltage margin compared to the conventional method.

With MgO coating on the phosphor layer in the back plate, the discharge between the scan and address electrodes starts at the lower voltage range and can accumulate enough wall charge between the scan and address electrodes as shown in figure 5. As a result, it shows almost the same voltage margin compared to the conventional case in figure 6.

In general, the MgO layer absorbs the VUV. Therefore if it is coated on the phosphor layer, it causes a reduction of brightness. However it is very thin in this experiment, it minimizes the reduction of brightness and enables to stable addressing regardless the difference in the R, G, B cell and enhances the life time of panel as shown in the previous work. [4]

4. Conclusion

A new modified ramp reset waveform is proposed to improve the dark room contrast and present a real black image. In the new waveform, the discharges between the scan and sustain electrodes can be reduced by applying a positive bias voltage to the sustain electrode and only the weak discharges between the scan and address electrodes occur during the reset period.

We also adopted the MgO coated phosphor layer to get the same level of voltage margin in the new reset waveform. As a result, the voltage margin can be maintained at the same level compared to the conventional method.

Using this modified ramp reset waveform, the contrast ratio is improved dramatically and the real black image is obtainable even in the dark room.

References

[1] Larry F. Weber, "Plasma Display Device Challenges", Asia Display 98, pp.15-27, (1998)

[2] Jeong Hyun Seo, Woo Joon Chung, Cha Keun Yoon, Joong Kyun Kim, and Ki-Woong Whang, "Two-Dimentional Modeling of a Surface Type Alternating Current Plasma Display Panel Cell:Discharge Dynamics and Address Voltage Effects", IEEE Trans. Plasma Science, vol.29, No.5, pp824-831, (2001)

[3] Kurata et al, USP6294875, (2001)

[4] Chang Hoon Ha, Thesis of Master degree, (2002)