P-76: Design of Facing Reset Discharge Waveform for Reducing Dark Image Sticking in AC-PDP

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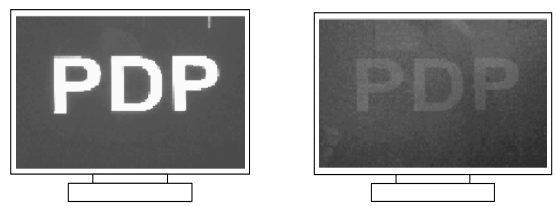
Abstract

The new facing reset discharge waveform is designed and proposed to reduce a dark image sticking in AC-PDP. In particular, the influences of two types of reset discharge (surface reset and facing reset discharges) on dark image sticking are investigated intensively. It is observed that the dark image sticking is reduced considerably when a reset discharge is produced between the scan and address electrodes instead of between the scan and sustain electrodes during a reset-period.

1. Introduction

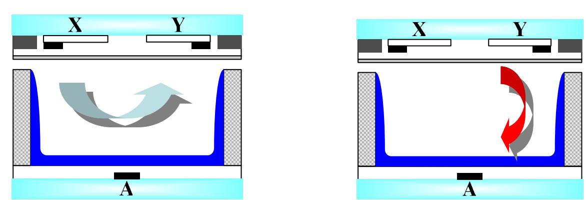
Alternate current plasma display panels (ac-PDPs) are one of the most promising candidates for digital high definition televisions due to such characteristics as their large surface area (>40-in.), slim structure, and self-emitting color image quality. However, there are still several critical issues related to the image quality of plasma display panels such as a low luminous efficiency [1], dynamic false contour [2], low color temperature [3], low gray level contours [4], and image sticking [5]. First of all image sticking is a critical issue to be solved urgently for the realization of a high image quality in AC-PDP [5, 6, 7]. However, the image sticking phenomenon has not been exactly understood so far. This paper focuses on solving a dark image sticking problem. As an example of a dark image sticking, Figs.1 (a) and (b) show that the 'PDP' character pattern still remains on the ensuing dark background image after a ten-minute sustain discharge. The dark image sticking is closely related to the reset discharge during a reset-period. Accordingly, to solve the dark image sticking, the effects of reset discharge on dark image sticking need to be investigated intensively.

In this paper, the influences of two types of reset discharges (surface reset and facing reset discharges) on the dark image sticking are examined. The surface reset discharge means a reset discharge produced between the sustain (X) and scan (Y) electrodes, whereas the facing reset discharge means a reset discharge generated between the scan (Y) and address (A) electrodes, as shown in Figs. 2 (a) and (b), respectively. The conventional ramp-reset waveform is adopted to produce a surface



(a) Original image pattern (b) Dark background

Fig. 1. Original image pattern (a) and residual character pattern under dark background (b) in conventional 42-inch PDP module.



(a) surface reset discharge (b) facing reset discharge

Fig. 2. Schematic diagram of surface reset discharge (a) and facing reset discharge (b).

reset discharge, whereas a proposed reset waveform is designed to produce a facing reset discharge. Furthermore, the effects of the surface or facing reset discharge on the subsequent address discharge and the contrast ratio are examined.

2. Experiment

Fig. 3 shows the schematic diagram of experimental setup employed in this study. The measurement system mainly consists of 4-inch test panel, digital camera, color analyzer, and driving

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circuits. The cell pitch of the 4-inch test panel is fixed to be 1080 µm. The widths of the sustain electrodes are 260 µm, respectively, and the gap between the sustain electrodes is 60 µm. The width of the address electrode is 100 µm and the height of the barrier rib is 130 µm. The red, green, and blue phosphors utilized under the current study are (Y, Gd) BO_3:Eu, (Zn, Mn)$_2$ SiO_4, and (Ba, Eu) $MgAl_{10}$, respectively. The pattern image and luminance were measured by the digital camera and CA-100, respectively. In order to produce a residual image caused by the image sticking, the sustain discharge continues for 10 minutes in the square-shaped pattern that is composed of the 87 x 10 cells of the 4-inch test panel, as shown in Figs. 5 (a) and 8 (a). The dark background image is displayed immediately after a ten-minute sustain discharge in the 4-inch test panel.

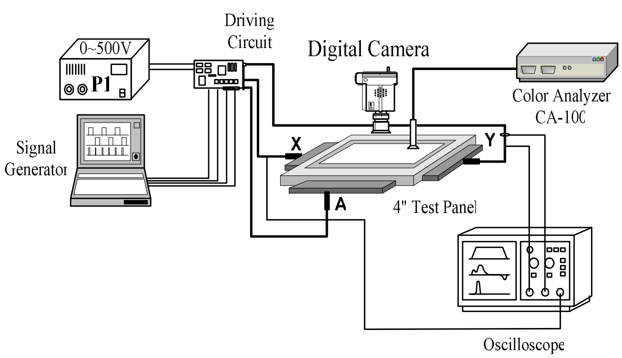


Fig. 3. Schematic diagram of experimental setup

3. Results and Discussion

3.1 Dark image sticking in conventional ramp reset discharge

Fig. 4 (a) shows the conventional ramp-reset waveform with various voltage slopes during a ramp-up period to produce a surface reset discharge. Fig. 4 (b) shows the schematic model of the temporal behavior of the wall charges during a reset period. In the ramp-up period shown in (i) of Figs. 4 (a) and (b), a surface discharge is dominantly produced between the scan (Y) and sustain (X) electrodes because the gap distance between scan (Y) and sustain (X) electrodes is shorter than that between scan (Y) and address (A) electrodes. The wall charges are accumulated on the three electrodes X, Y, and A through the reset discharge, as shown in (ii) of Fig. 4 (b). In the ramp-down period, while discharge is generated, the wall charges on each electrode are reduced, as shown (iii), (iv) of Fig. 4.

Figs. 5 (a) and (b) show the image pattern still remaining on the ensuing dark background image (hereafter this image is called 'ghost image') after a ten-minute sustain discharge in case of adopting the conventional ramp-reset waveform. The luminance difference between the ghost image and the dark background image is observed. As shown in Fig. 5 (b), the luminance of the ghost image (*i.e.*, the cells with image sticking) finds to be slightly higher than that of the background dark image (*i.e.*, the cells with no image sticking). In the case of the conventional ramp-reset

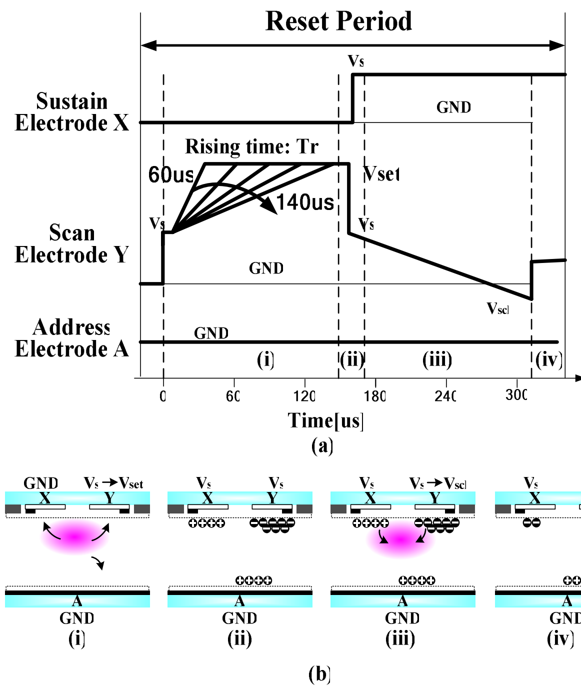
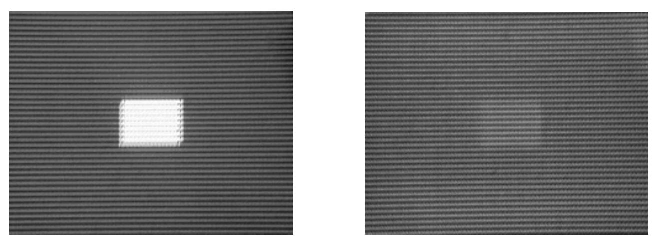


Fig. 4. Conventional ramp-reset waveform to produce surface reset discharge.



(a) (b)

Fig. 5. Original image pattern (a) and residual image under dark background (b) in case of adopting conventional ramp-reset waveform.

waveform, it is observed that the luminance difference between the ghost image and the dark background image strongly depends on the voltage slope during a ramp-up period. Fig. 6 shows the luminance changes of the ghost image and dark background image when the reset voltage rising times are changed from 60 µs to 140 µs at intervals of 20 µs during a ramp-up period in the conventional ramp-reset waveform. As the voltage slope during a ramp-up period becomes slower, the luminance level is decreased, and the corresponding luminance difference between the ghost image and dark background image tends to be decreased, as shown in Fig. 5. This phenomenon means that the ramp-reset waveform with a slow voltage slope is preferable for reducing the dark image sticking. Furthermore, it is confirmed that the dark image sticking can be eliminated considerably if the luminance level is reduced in a large degree during the reset period. However, since the reset discharge is finished within a given time, the voltage slopes during a ramp-up period should be restricted to a certain level. Accordingly, it is necessary to design a new reset waveform that can lower the background luminance level so as to reduce the dark image sticking.

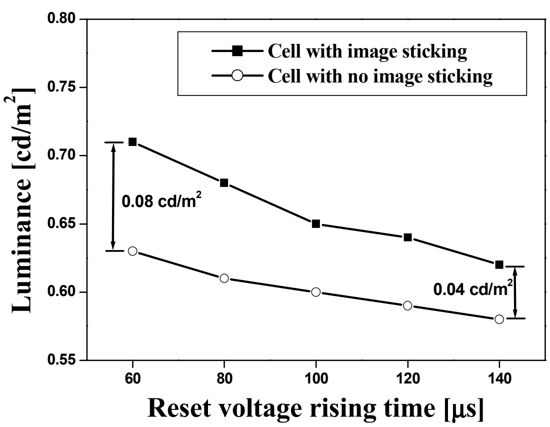


Fig. 6. Luminance changes of ghost image and dark background image relative to voltage slope during ramp-up period in conventional ramp-reset waveform.

3.2 New reset waveform for reducing the dark image sticking

Fig. 7 (a) shows the proposed reset waveforms to produce a reset discharge between the scan (Y) and address (A) electrodes. In the proposed reset waveform of Fig. 7 (a), the ramp waveform applied to the scan electrode (Y) is a conventional type, whereas another ramp waveform is applied to the sustain electrode (X). The ramp waveform applied to the sustain electrode (X) has the same voltage slope as the ramp waveform applied to the scan electrode (Y). The ramp waveform applied to the sustain electrode (X) is varied from GND to Vr. Accordingly, the reset discharge is dominantly produced between the scan (Y) and address (A) electrodes instead of between the scan (Y) and sustain (X), thereby resulting in a very weak facing discharge, as shown in (i) of Fig. 7 (b). In conventional ramp-reset waveform, the weak discharge is produced twice during the reset period: the first discharge is produced between the scan (Y) and sustain (X) electrodes during the ramp-up period, and the second discharge is produced between the scan (Y) and sustain (X) electrodes during the ramp-down period, as shown in (i) and (iii) of Fig. 4. On the other hand, in proposed reset waveform, the weak discharge is produced once between the scan (Y) and address (A) electrodes during the ramp-up period, and its intensity is very weak due to the facing discharge, as shown in (i) of Fig. 7. As a result of adopting the proposed reset waveform, the background luminance is reduced intensively. Therefore, the dark image sticking is not observed even though the original white image pattern has been displayed for 10 min, as shown in Fig. 8 (b). Table1 shows the characteristics of the conventional ramp-reset and proposed reset waveforms. The dark room contrast ratio of the proposed reset

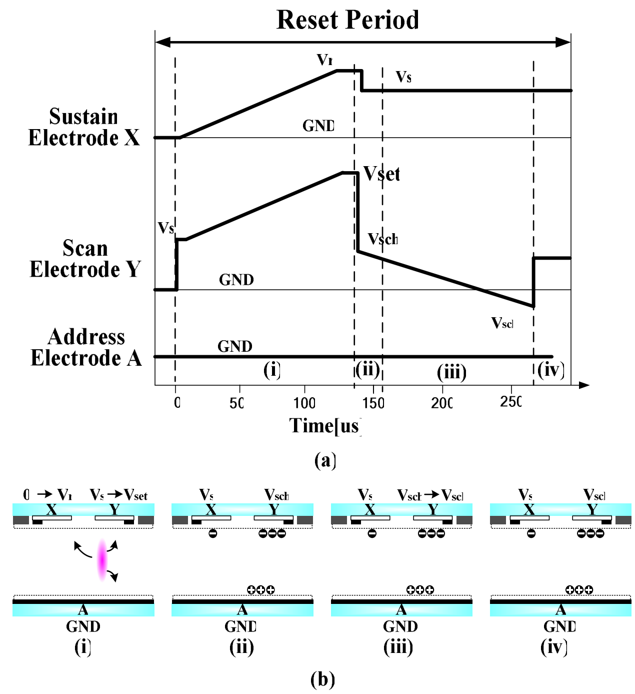


Fig. 7. Proposed reset waveform for producing facing reset discharge

Fig.8. Original image pattern (a) and dark background image pattern (b) after displaying original image pattern for 10 min. in case of adopting proposed reset waveform.

	Conventional ramp-reset waveform	Proposed reset waveform
Dark room contrast ratio	194:1	11200:1
Min. address voltage at pulse width 2us	40V	45V
Dark image sticking	Yes	No

Table1. Comparison of conventional ramp-reset and proposed reset waveforms

discharge waveform is improved considerably compared to that of the conventional ramp-reset waveform, whereas the minimum address voltage in the new reset waveform requires slightly higher address voltage. The dark image sticking in the proposed reset waveform is totally invisible.

4. Summary

The image sticking needs to be solved urgently for the realization of a high image quality in AC-PDP. However, the image sticking phenomenon has not been exactly understood so far. In conventional ramp-reset discharge, as the voltage slope during a ramp-up period becomes slower, the luminance difference between the image sticking and no image sticking cells is decreased. Accordingly, the ramp-reset waveform with a slow voltage slope is preferable for reducing the dark image sticking. In this paper, the facing reset discharge waveform is newly designed and proposed to reduce a dark image sticking in AC-PDP.

As a result of adopting the proposed reset waveform, the background luminance is reduced intensively. In particular, the dark image sticking is not observed when a reset discharge is produced between the scan and address electrodes instead of between the scan and sustain electrodes during a reset-period.

5. Acknowledgements

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