A New Driving Waveform for the Dark Room Contrast Ratio and Reduction of the Reset Period in AC Plasma Display Panel

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Abstract

A new reset method for high contrast ratio and reduction of the reset time is presented. In this new reset method, except the first subfield, a new reset pulse with only ramp-up period is adopted. In this reset method, from the third subfield, the background luminance generated during the reset period is theoretically zero until the first subfield of the following frame. Employing the new reset method, the dark room contrast ratio improved to 3084.7:1 from 189.1:1 of the conventional reset method. The new reset method reduced the required time for reset per subfield to 160us except the first subfield.

1. Introduction

The plasma display panel(PDP) is one of the most promising devices for large size flat-panel display because it has advantages over other display devices in its large size, simple structure, high resolution, wide viewing angle, etc [1]. Nevertheless, it is still necessary to improve the luminance, luminous efficiency and the quality of image and to reduce the production cost of the AC PDP to compete with other display devices [2-3]. Low dark room contrast ratio is one of the problems related with the low image quality issue [4]. The ramp reset waveform proposed in [5] has been widely used in the reset period in order to reduce the background luminance, but it is still required to reduce the dark room contrast ratio even lower to compete with other display devices. The conventional ramp reset [5] method known as the most stable reset method for the AC PDP requires fairly long ramp-up and ramp-down time and both the ramp-up and ramp-down cause weak discharge. Because of the long reset period, the time for the address and sustain periods is shortened. In consequence, the maximum luminance decreases or driving the high resolution PDP is impossible. In this paper, in order to improve the dark room contrast ratio and reduce the reset period, a new waveform for the reset period is suggested.

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2. A New Reset Method

Figure 1 shows the suggested new reset method for improving dark room contrast ratio and reduction of the reset period. The reset waveforms during the first subfield are similar to the reset waveforms of the conventional ramp reset method except that the voltage on the sustain electrode ramps up while the voltage on the scan electrode ramps up. From the second subfield, the ramp reset waveform having only the ramp-up period is applied to both of the sustain and scan electrodes. Thus, the required reset time is reduced from 350us to 160us from the second subfield. Furthermore, in this new reset method, from the third reset period, the cell that was off in the previous subfield generates no weak discharge during the reset period and thus very high dark room contrast ratio is expected.

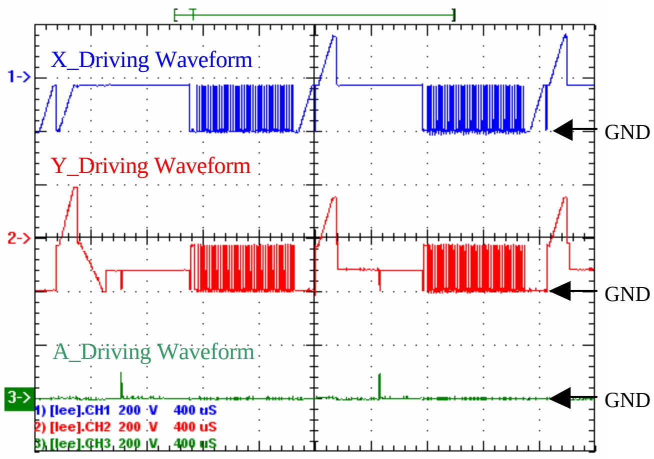


Figure 1. New driving method

Figure 2 shows the conventional driving method along with the wall charge distributions and Figure 3 shows the new driving method suggested in this paper along with the wall charge distributions. In the new driving method, during the ramp-up reset period of the first subfield, weak discharge between the scan and address electrodes first occurs, and during the ramp down reset period of the first subfield, weak discharge between the scan and sustain electrodes follows. From the second subfield, the reset pulses with only the ramp-up period are applied to both of the scan and sustain electrodes in order to reset without the ramp down period. In this method, from the third subfield, when we reset the off cells (that was off in the previous subfield), the ramp-up reset pulses do not cause any weak discharge except very negligible weak discharge for refreshing the wall charges.

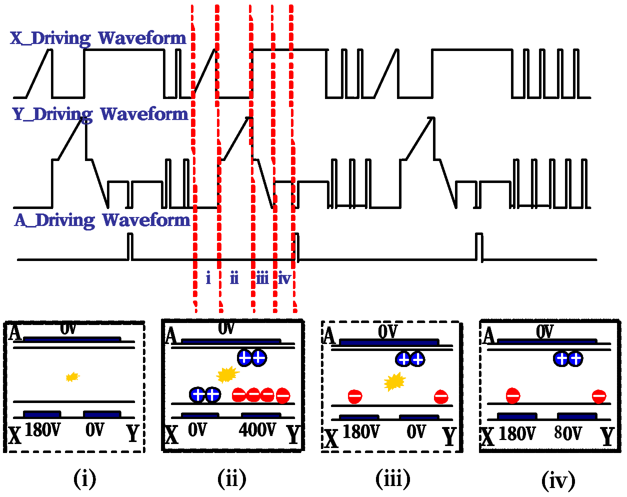


Figure 2. Conventional driving method and wall charge distribution

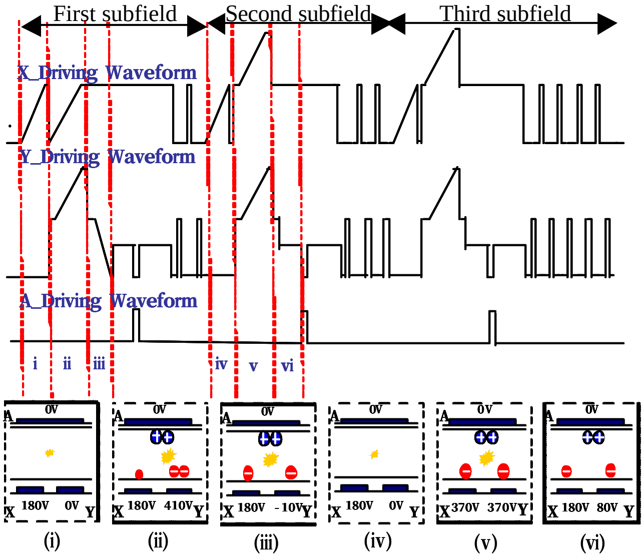


Figure 3. Suggested driving method and wall charge Distribution

3. Experiment

Figure 4, 5 show the measured conventional reset waveform and the new reset waveforms measured. The ramp-up and ramp-down rates of the first subfield were 2.19 us/V and 1.06 us/V respectively. The ramp-up reset voltage ramped up to 410 V. The total length of the reset period was 350us. From the second subfield, the ramp-up rate was 1.81 us/V and the ramp reset voltage ramped up to only 370 V. The length of the reset period was 160us. With the higher ramp voltage, the reset ramp of the first subfield generates enough wall charge and refreshes the priming effect for stable addressing. The width of the address pulse was 4us. Figure 5 (a), (b) and (c) also show the measured IR intensities during the reset periods of the first, second and third subfields when the cell was kept-on throughout the subfields. It is noticed from the measurement of the IR intensity between Figure 4, 5 that the new reset method occurs very weak discharge during the reset period occurred from the first subfield through the third subfield compared with the conventional method.

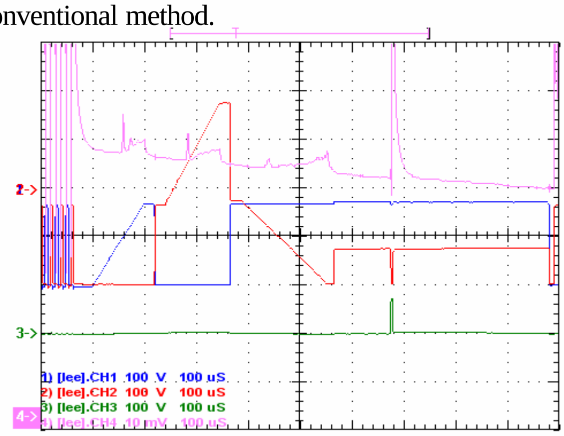
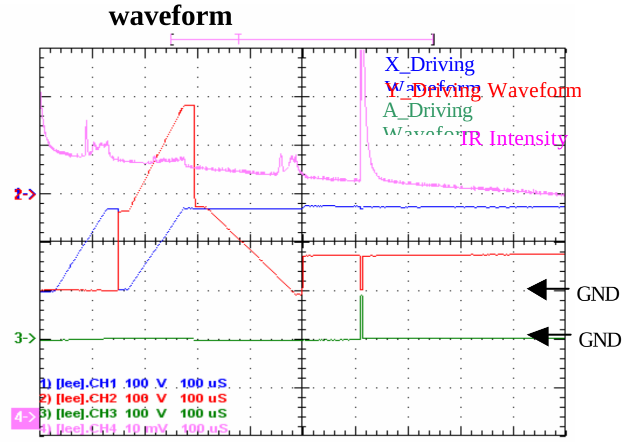
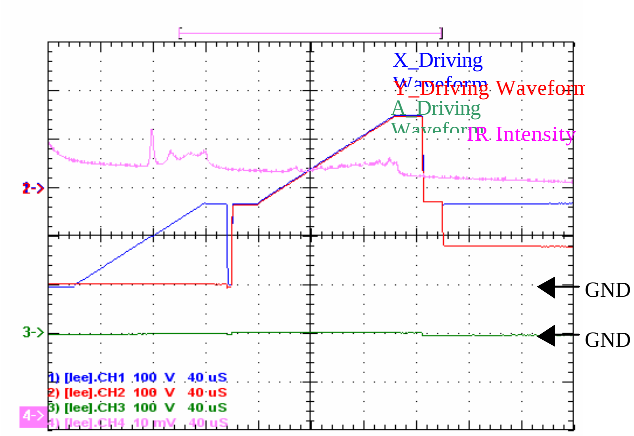


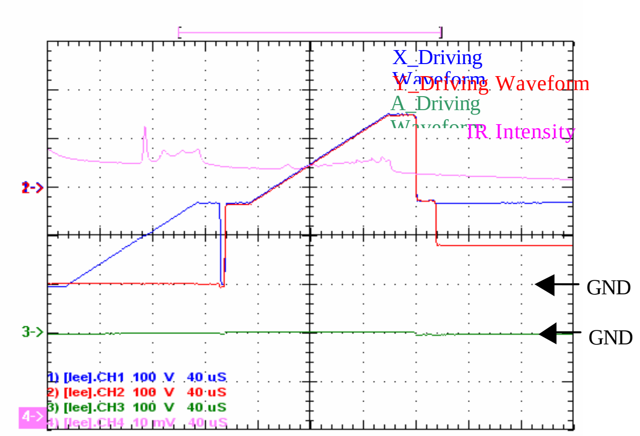
Figure 4. Measured IR intensity at conventional waveform



(a) 1st subfield



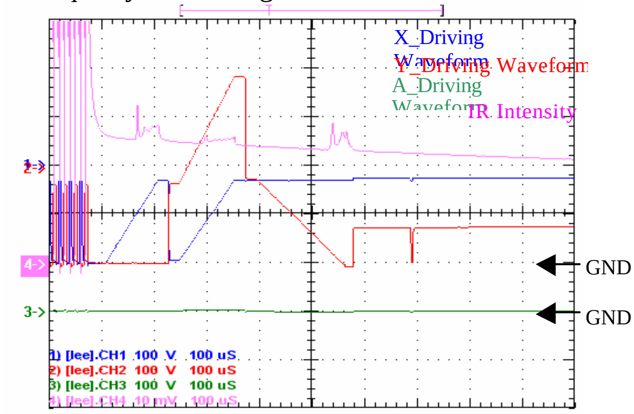
(b) 2nd subfield



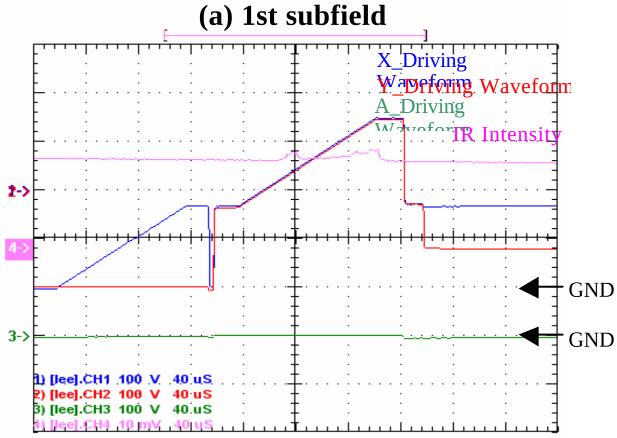
(c) 3th subfield

Figure 5. Measured IR intensity during reset period at on cell

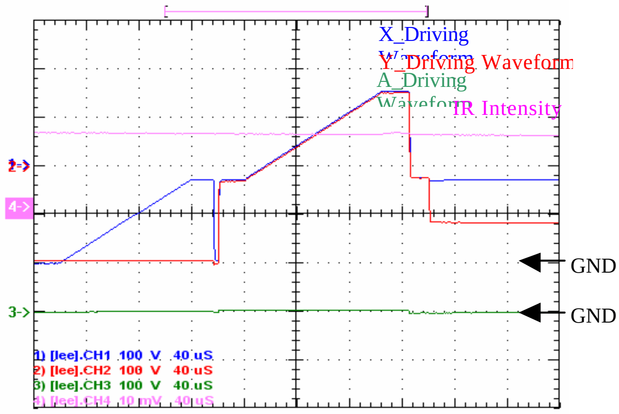
Figure 6 (a), (b) and (c) show the measured IR intensity during the reset periods of the first, second and third subfields when the cell is kept-off throughout the subfields. It is noticed from Figure 6 that the reset caused very weak discharge in the first and second subfields. On the other hand, the reset caused almost no discharge during the third subfield. This was because the distribution of the wall charge in the off-cell varied little during the reset period from the third subfield. In other words, from the third subfield, the reset did not require weak discharge except very negligible weak discharge for refreshing the wall charge. Because the new reset method induces little discharge in the off-cell during the reset period from the third subfield, it should achieve very high contrast ratio. Furthermore, the new reset method induces less weak discharge even in the on-cell during the reset period than the conventional ramp reset method. Thus, the new reset method should improve the quality of the image.



(a) 1st subfield



(b) 2nd subfield



(c) 3th subfield

Figure 6. Measured IR intensity during reset period at off cell

In the new reset method, the long reset(that includes both the ramp-up and ramp-down periods) does not has to be used only once in the first subfield. Figure 7 shows the dark room contrast ratio as a function of the number of the long reset per frame. Eight subfields were used for a frame. Using the conventional method, the background luminance was measured to be 1.152cd/m^2, display luminance 219cd/m^2 and thus the dark room contrast ratio 189.1. Employing the new reset method, the dark room contrast ratio improved significantly. When the number of the long reset per frame was 8, the dark room contrast ratio was obtained to be 899:1. As the number of the long reset decreases from 7 to 1, the dark room contrast ratio increased from 1199:1 to 3084.7:1. When the number of the long reset was 1, the background luminance was only 0.07cd/m^2 which was about 1/16 of 1.152cd/m^2 which was the background luminance of the conventional reset method. Thus the new reset method should improve the image quality significantly.

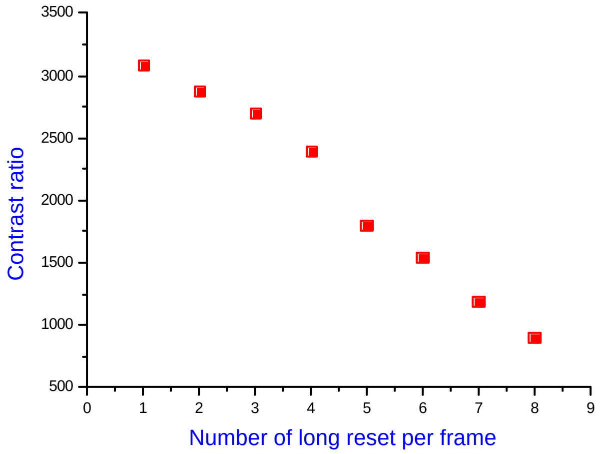


Figure 7. The contrast ratio as the number of the first subfield per frame

Table I compares and summarizes the performance of the conventional reset method and the new reset method when one long reset is used per frame. As we can see from Table I, a new reset method can reduce the required time for reset per subfield by 190us except the first subfield. The reduction of the time for reset can allow more time for scanning or sustaining. Thus should result in making it possible to drive higher resolution PDP or in improving luminance.

Table I. Reset period, sustain frequency, display luminance, background luminance and dark room contrast ratio for both conventional and new reset waveform

	Conventional Method	New Reset Method
Reset Period	350us	160us
Sustain Frequency	50kH	50kH
Display Luminance [cd/m^2]	219	216
Background Luminance [cd/m^2]	1.152	0.07
Dark room Contrast ratio	189.1	3084.7

4. Conclusion

A new reset method presented in this paper can achieve both the very high contrast ratio and the reduction of the reset time. The reduced reset time allows more time for addressing or sustaining. Thus, employing this new driving method, single scanning high resolution PDP should be possible or the maximum luminance can be increased. Also, the new driving method significantly improves the dark room contrast ratio at the same time.

5. References

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