Design of Cost-Effective Driving Waveform Based on Vt Close Curve Analysis in AC Plasma Display Panel

Byung-Gwon Cho and Heung-Sik Tae
School of Electronic and Electrical Engineering, Kyungpook National University
1370 Sankyuk-dong, Buk-gu, Daegu, 702-701, Korea

Kazuhiro Ito, Jun Weon Song, Myoung Kyu Lee, Sang-Chul Kim, Nam Sung Jung, and Kwang-Sik Lee
PDP Division, Samsung SDI Co., Ltd., 508 Sungsung-Dong, Cheonan City, Chungchongnam-Do, Korea

Abstract

A new driving waveform was proposed to reduce the cost in PDP-TV based on Vt close curve by eliminating the common (X) board under the conventional 42-inch panel structure. Due to the serious misfiring problem during a sustain-period when applying the new driving waveform, the wall voltage was measured and analyzed after the reset-period using Vt close curve. As a result of adopting the proposed driving waveform designed using Vt close curve analysis, the cost of PDP module could reduce compared with the conventional PDP module without any misfiring discharge.

1. Introduction

Plasma-TVs are considered the most promising candidate for digital television due to such conspicuous features as a slim-type large area (> 40-in.), self-emitting-based good color reproduction capability, wide dynamic contrast ratio, and fast response. Thus, to capture the TV consumer market and maintain a lead over other flat panel display devices, the development of a low-cost driving technology for plasma TVs has become a critical issue. Most recent efforts have focused on reducing the address voltage [1], a single scan method [2], and decreasing the number of electrical parts. However, if the millions of PDP cells could be driven by applying the driving waveforms to only the scan and address electrodes without applying any driving waveform to the common electrode, the driving cost could be considerably reduced due to the elimination of the common driving board alone.

This paper presents a new cost-effective driving method without applying the driving waveform to the common electrode, hereinafter, this method is simply called the *EX (Eliminating X)* driving method. In the proposed EX driving method, the V_t close curve [3, 4] method is used to analyze the changes in the wall voltage to prevent a misfiring discharge. In particular, the effect of the status of the wall charges after a reset discharge on the sustain discharge characteristics is extensively examined.

2. Operation Principle

Figs. 1(a) and (b) show the conventional and new EX driving waveforms and corresponding potential differences, $V_{(Y-X)}$ and $V_{(A-Y)}$. As shown in Fig. 1 (b), the new driving waveform, V_y applied only to the Y electrode has both positive and negative polarities, and the resultant potential difference, $V_{(Y-X)}$ between the Y and X electrodes is the same as that of the conventional driving waveform in Fig. 1(a). However, the new potential difference between the A and Y electrodes, $V_{(A-Y)}$ is quite different from that of the conventional driving waveform, especially after the ramp-up period. The different potential difference induces changes in the wall charges accumulating on the Y and A electrodes after the reset discharge. The positive and negative wall charges are accumulated on the Y and A electrodes, respectively, after the ramp-down period. In this case, because the value of $|V_{nf2}|$ at the end of the ramp-down period is much larger than that of $|V_{nf1}|$, the polarities of the wall charges are exactly opposite to those of the wall charges accumulated during the ramp-up period. Consequently, when the positive sustain pulse during a sustain period is applied to the Y electrode, a misfiring discharge can be produced in the off-cells without address discharge due to the presence of the positive wall charges accumulating on the Y electrode. This result implies that the inversion of the polarity of the wall charges accumulating between the Y and A electrodes after the reset-period is the critical factor causing a misfiring discharge during the sustain-period with the EX driving method.

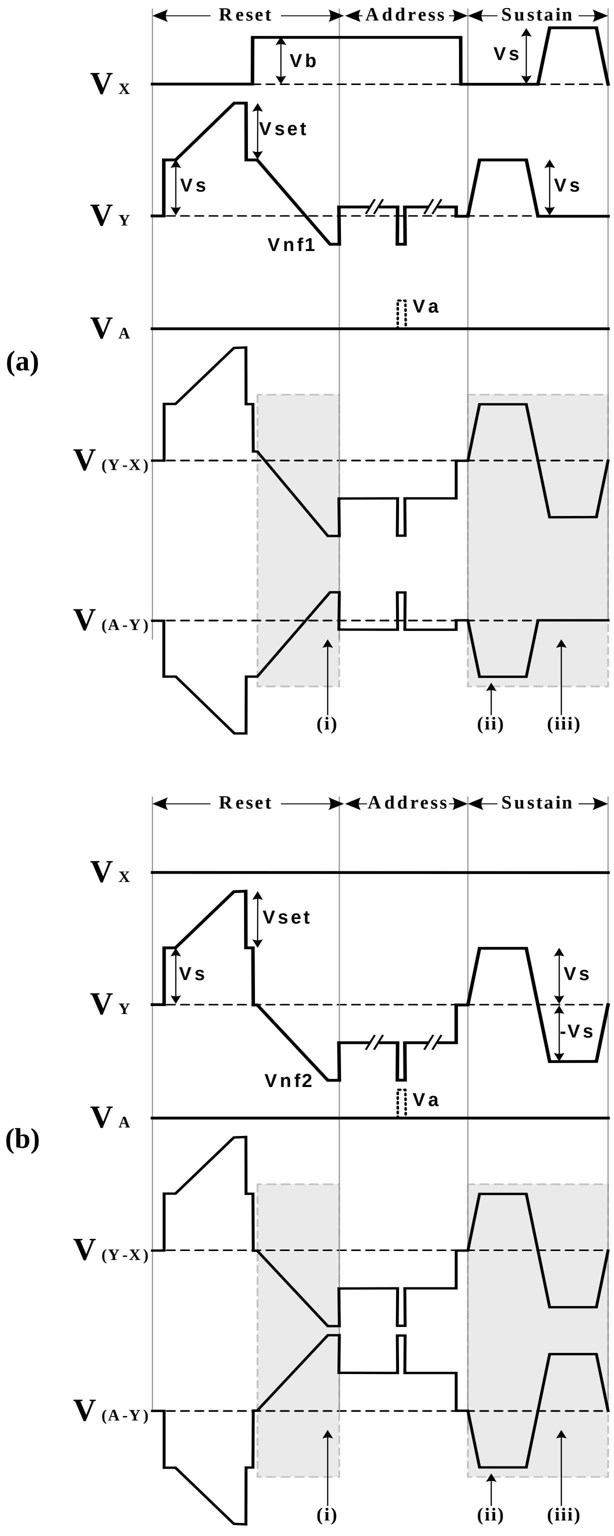
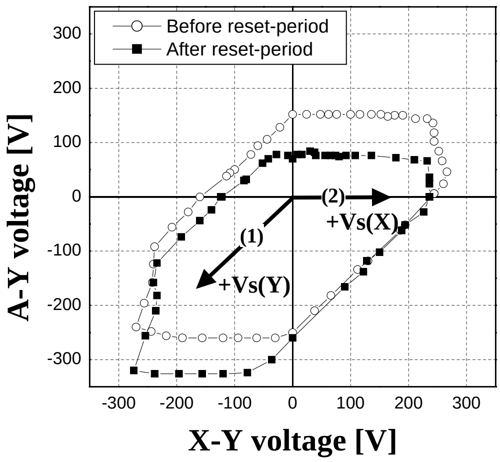


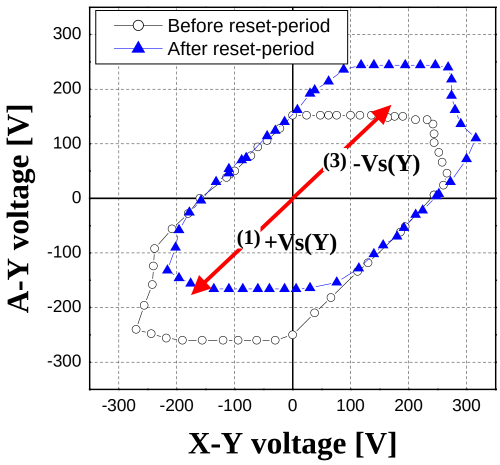
Fig. 1. Comparison of (a) conventional and (b) EX driving waveforms applied to three electrodes, X, Y, and A for off-cells in 42-inch ac-PDP.

3. Analysis of misfiring discharge using V_t close curve

Fig. 2 (a) shows the two different V_t close curves on the cell voltage plane measured before and after the reset-period when applying the conventional driving waveform in Fig. 1 (a). The six sides mean the threshold voltages, thus the inner region means a non-discharge region, while the outer region means a discharge region. The horizontal axis represents the potential difference, $V_{(X-Y)}$ ($=V_X-V_Y$) between the X and Y electrodes, whereas the vertical axis represents the potential difference, $V_{(A-Y)}$($=V_A-V_Y$) between the A and Y electrodes. As shown in Fig. 2 (a), the cell voltage between the X and Y electrodes was not changed, whereas the discharge start threshold cell voltage between the A and Y electrodes was changed. This means that the changes in the accumulating wall charges occurred predominantly between the Y and A electrodes through the reset discharge. When the positive sustain pulse was only applied to the Y-electrode, the voltage vector was shown in (1) in Fig. 2 (a). Conversely, when the positive sustain pulse was only applied to the X electrode, voltage vector was located on the horizontal axis, as shown in (2) in Fig. 2 (a). In this case, in the off-cells with no address discharge, no misfiring discharge was induced during a sustain-period, because the sustain voltage vectors, was moved within the V_t close curve. On the other hand, to analyze the cause of the misfiring discharge induced when applying the driving waveforms in Fig. 1(b), the V_t close curve was measured after the reset-period in Fig. 2(b). In the conventional case of 2(a), the V_t close curve after the reset-period shifted lower, whereas in the case of Fig. 2 (b), the V_t close curve shifted upwards, meaning that the polarity of the wall charges accumulating between the Y and A electrodes was opposite to the conventional driving method. This inversion of the polarity of the wall charges is mainly due to the lower negative falling voltage, V_{nf2} ($\ll V_{nf1}$) in Fig. 1 (b). Consequently, unlike the conventional sustain waveforms in Fig. 1(a), when the sustain pulse with both positive ($+V_s$) and negative ($-V_s$) amplitudes was alternately applied to only the Y electrode, the sustain voltage vectors were moved, as shown in (1) and (3) in Fig. 2 (b). This V_t close curve measurement result confirmed that the positive sustain voltage ($+V_s$) applied during a sustain-period induced a misfiring discharge between the Y and A electrodes. In this case, the shape of the V_t close curve after the reset-period depended strongly on the value of the negative falling voltage, V_{nf2} in Fig. 1(b).



(a)



(b)

Fig. 2. Vt close curves on cell voltage plane measured before and after reset-period when applying conventional (a) and EX (b) driving waveforms.

Consequently, it was important to investigate the effects of the voltage level of V_{nf2} on the sustain discharge characteristics, including a misfiring discharge.

In Fig. 3, the value of V_{min} means the voltage level of $|V_{nf2}|$ at which all the cells in the 42-in. PDP were turned on, whereas the value of V_{max} means the voltage level of $|V_{nf2}|$ at which a misfiring discharge began to be produced in the 42-inch PDP. Unlike the typical case, V_{min} was higher than the V_{max}, meaning that the EX driving waveform has not margin in Fig. 2 (b). That is, when the voltage level of $|V_{nf2}|$ was increased, the misfiring discharge was produced,

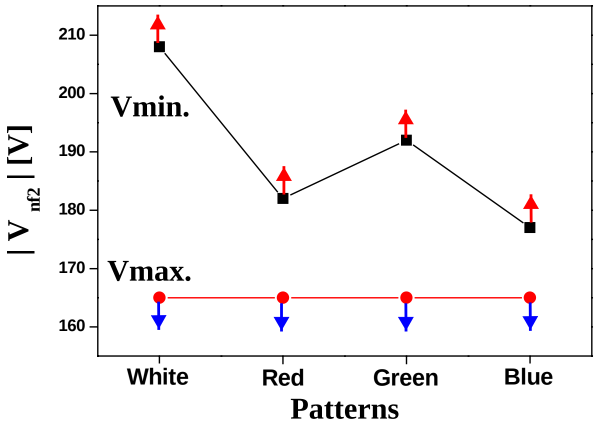


Fig. 3. Voltage margins with varied voltage level of $|V_{nf2}|$ for various image patterns, such as white, red, green, and blue images, on 42-in. ac-PDP when applying EX driving waveform in Fig. 1 (b).

whereas when the voltage level of $|V_{nf2}|$ was decreased, a weak sustain discharge was produced.

4. Proposed EX driving method for preventing misfiring discharge based on Vt close curve analysis

As seen in the V_t close curve in Fig. 2 (b), a misfiring discharge was produced in the off-cells when applying the positive sustain pulse to the Y electrode during the sustain period. Therefore, if a positive address pulse, V_a were also applied to the A electrode during the application of the positive sustain pulse, $V_s(Y)$ to reduce the potential difference between the Y and A electrodes, the resultant voltage vector $[=V_s(Y) - V_a]$ would remain within the V_t close curve, *i.e.*, the non-discharge region, as shown in Fig. 4.

Fig. 5 shows the proposed EX driving waveforms for preventing a misfiring discharge by applying a positive auxiliary pulse to the A electrode only during the application of the positive sustain pulse during a sustain period. The amplitude of the positive auxiliary pulse was the same as that of the address pulse during an address period, while its width was the same as that of the positive sustain pulse. In particular, maintaining a constant positive voltage level for the auxiliary pulse during the application of the positive sustain pulse was very important for a stable sustain discharge. The validity of the proposed EX driving waveform in Fig. 5 was also examined under various image patterns, such as white, red, and blue patterns, on the 42-inch ac-PDP in Fig. 6. Unlike the voltage

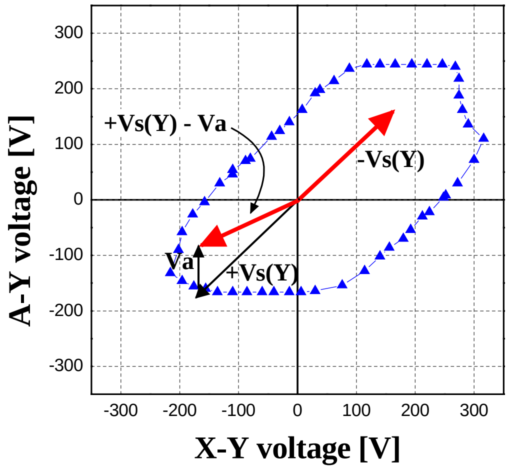


Fig. 4. Changes in sustain voltage vector when applying address pulse during application of positive sustain pulse.

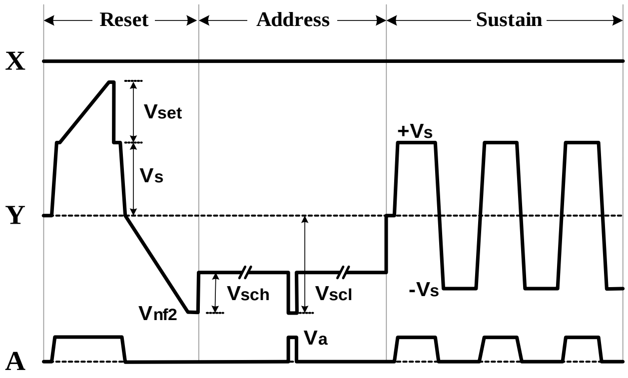


Fig. 5 Proposed EX driving waveforms during reset, address, and sustain period without inducing any misfiring discharge

margins in Fig. 3 when applying the driving waveform in Fig. 1 (b), stable margins were obtained when applying the waveforms in Fig. 5. The suppression of a misfiring discharge due to the presence of the positive auxiliary pulse enabled a stable voltage margin, thereby allowing the millions of PDP cells in the 42-in. ac-PDP to be driven, even in the case of the proposed EX driving method.

5. Conclusion

A new cost-effective driving method without applying any driving waveform to the common electrode is proposed based on a V_t close curve analysis. The measured V_t close curve showed that minimizing the potential difference between the scan and address

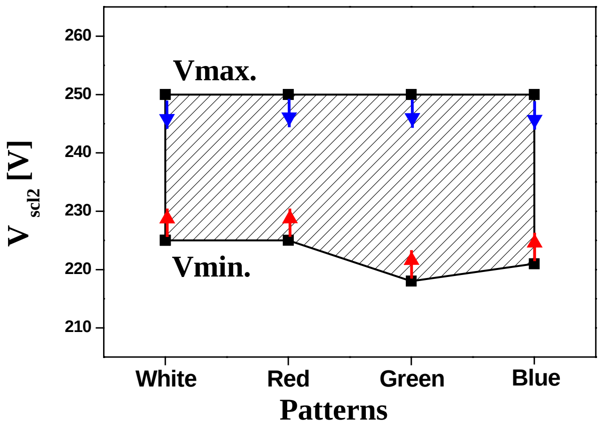


Fig. 6. Voltage margins relative to variation in voltage level of $|V_{nf2}|$ for various image patterns, such as white, red, green, and blue images, on 42-inch ac-PDP when applying proposed EX driving waveform.

electrodes by applying a positive auxiliary pulse to effective driving method can reduce the driving cost through eliminating the common driving board and successfully display various image patterns, such as white, red, green, and blue patterns, on the 42-inch plasma TV without any misfiring discharge.

6. References

[1] Y. Takeda, M. Ishii, T. Shiga, and S. Mikoshiba, “A Technique for Reducing Data Pulse Voltage in ac-PDP’s Using Metastable-particle Priming,” *IDW ’99 Digest*, pp. 747-750, 1999.

[2] J. –Y. Yoo, B. –K. Min, D. –J. Myoung, K. Lim, E. –H. You, and M. –H. Park, “High Speed-Addressing Method for Single-scan of ac PDP,” *SID ’01 Digest*, pp. 798-801, 2001.

[3] K. Sakita, K. Takayama, K. Awamoto, and Y. Hashimoto, "High-speed Address Driving Waveform Analysis Using Wall Voltage Transfer Function for Three Terminals and Vt Close Curve in Three-Electrode Surface-Discharge AC-PDPs," *SID '01 Digest*, pp. 1022-1025, 2001.

[4] Heejae Kim, Jinhee Jeong, Kyungdoo Kang, Jeonghyun Seo, Ilhun Son, Kiwoong Whang, and Changbae Park, "Voltage Domain Anyaysis and Wall Voltage Measurement for Surface-Discharge Type ac-PDP," *SID '01 Digest*, pp. 1026-1029, 2001.