P-135: Analysis on Sustain-Waveform Distortion Induced by Display-Pattern Type in AC-Plasma Display Panel

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Abstract

The sustain waveforms are distorted relative to the displayed area. The sustain waveforms are distorted relative to the displayed area, which causes the variations in luminance and luminous efficiency. It is found that the constant rising slope of the displayed are causes the sustain waveform distortion. A discharge in a cell has voltage-current (V-I) characteristics that the applied voltage waveform determines the discharge current. A circuit also has V-I characteristics that the total current of all cells determines the voltage waveforms applied to cells. Furthermore, the Y and X electrode have resistance and belong to cells aligned horizontally, accordingly, the number of on-cells in horizontal line distorts the voltage applied to each cell. This paper shows by analysis and experiments that the applied voltage and the luminance and the luminous efficiency of an AC-PDP cell are affected by the amount and distribution of displayed area.

1. Introduction

The sustain waveforms are distorted relative to the displayed area. The sustain waveforms are distorted relative to the displayed area, which causes the variations in luminance and luminous efficiency. It is found that the constant rising slope of the displayed are causes the sustain waveform distortion. A discharge in a cell has the following voltage-current (V-I) characteristics: that is, the applied voltage waveform determines the discharge current. A circuit also has the V-I characteristics: that is, the total current of all cells determines the voltage waveforms applied to cells. Furthermore, the Y and X electrode have resistance and belong to cells aligned horizontally, accordingly, the number of on-cells in horizontal line distorts the voltage applied to each cell.

This paper shows that the applied voltage and the corresponding luminance and the luminous efficiency of AC-PDP cells are affected by the amount and distribution of displayed area.

2. Experiment

Plasma-TVs are believed to have been a promising commercial product for large area (> 40 inch) digital high definition home theater TVs. However, the urgent commercialization of a full high-definition (FHD) plasma-TV requires a technique for overcoming the degradation of the luminous efficiency caused by the smaller discharge volume of the FHD PDP cells. In this sense, the effects of the sustain-waveform distortion on the discharge characteristics, especially the luminance and luminous efficiency, need to be investigated very carefully. [1][2]

In this study, the effects of the displayed patterns having the different cell configurations but the same displayed area on the sustain-waveform distortion are examined. Three types of display-pattern with the same displayed area are examined: type1 is horizontal bar pattern with horizontally aligned cells, type 2 is box pattern with mixed aligned cells, and type 3 is vertical bar pattern with vertically aligned cells. For on-cells of three types, the capacitances, ITO resistance are measured. The related luminance and luminous efficiency including the consumed power are measured.

Table 1.

Specification of 50-in. test panel employed in this study.

Pattern	Full white (Box 100%)		
Panel Cap.	700nF		
ERC Inductance	0.1uH		
ITO Resistance	100Ω		
Pattern	Type 1	Type 2	Type 3
ITO Resistance	8Ω	4Ω	2Ω
Panel Cap.	0.8nF	0.8nF	0.8nF

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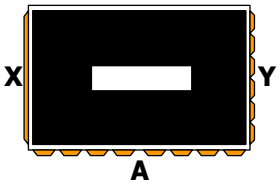
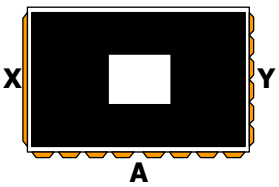


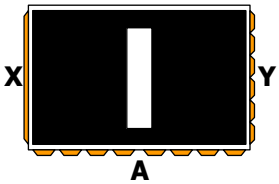
Type 1

(a) Horizontal bar pattern



Type 2

(b) Box pattern



Type 3

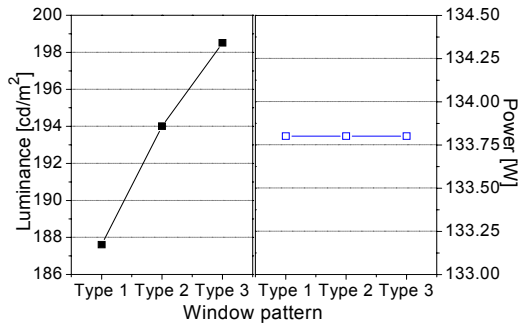
(c) Vertical bar pattern

Fig.1. Windows pattern employed (a) horizontal bar pattern: Type1, (b) box pattern: Type 2 and (c) vertical bar pattern: Type 3.

As shown in Table 1, the pixel pitch of the PDP cell employed in this research is 576㎛ × 192㎛, which corresponds to the 50-in. full high definition (FHD) PDP. The discharge gas composition is Ne+He+Xe (15 %) gas mixtures and gas pressure is 420 Torr. The 50-in. test panel has box-type barrier ribs and three electrodes such as two sustain- and one address-electrodes.

Fig.1 shows the three types of test patterns where (a) type 1 is horizontal bar pattern, (b) type 2 is box pattern and (c) type 3 is vertical bar pattern. These patterns have the same displayed area, and the applied sustain pulse number is fixed to be 256. In three type patterns, since the number of horizontally-aligned or vertically-aligned cells is different one another, the associated discharge currents flow through different paths during the display.

This different discharge current path would affect the sustain waveform, thus causing the variation in the discharge characteristics such as the luminance and luminous efficiency.



(a)

(b)

Fig.2. Luminance and power consumption relative to case1, 2 and 3 patterns are displayed. (b) Luminous efficiency relative to type 1, 2 and 3 patterns are displayed.

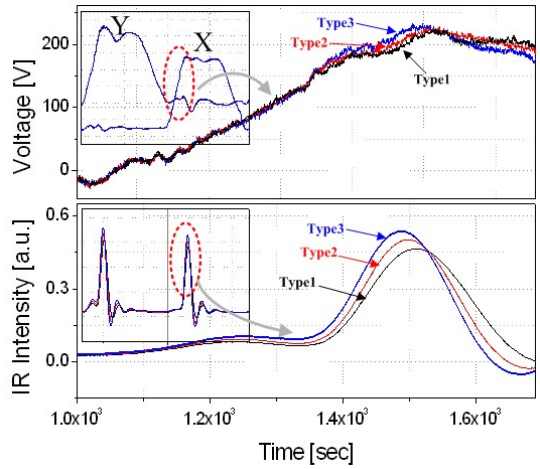
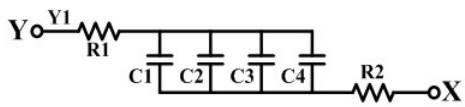


Fig.3. Distortion of Sustain waveforms and changes in IR emission waveforms when type 1, 2 and 3 test patterns are displayed.

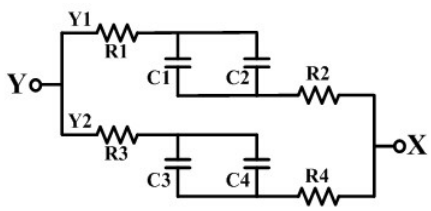
As shown in Fig. 2, the luminance and luminous efficiency changes depending on the display-pattern, where the power consumptions remain almost constant.

Fig. 3 shown the distortion of sustain waveforms for three types and the resultant changes in the IR emissions when the three patterns are displayed. It is observed that in type 1, i.e., a horizontal bar pattern, the sustain waveform and related IR waveforms are much distorted, meaning that the sustain waveform is distorted severely as the horizontal



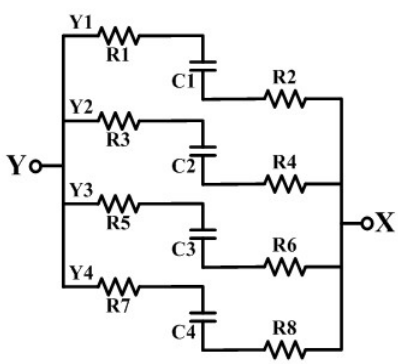
Type 1

(a) Horizontal bar pattern



Type 2

(b) Box pattern



Type 3

(c) Vertical bar pattern

Fig.4. Circuit model employed (a) horizontal bar pattern: Type1, (b) box pattern: Type 2 and (c) vertical bar pattern: Type 3.

line is increased, thus causing the distortion of the resultant IR emission characteristics.

Fig.4 shows the circuit model for three types of test patterns where (a) is horizontal bar pattern (type1), (b) is box pattern (type 2) and (c) is vertical bar pattern (type 3). Each cell is represented by a current source and resistance R, which represents the resistance of the electrode between two adjacent cells. In this case, the detailed values are assumed as follows:

R1=R2=R3=R4…=R8= 0.1, C1=C2=C3=C4=0.1nF.

Fig.5 shows the simulated result of the sustain voltage waveform obtained based on the circuit model of Fig. 4. The result of Fig. 5 implies that the increase in the parasitic resistance, ITO resistance induces the forward voltage drop, thus causing a distortion of sustain waveform. The simulated result of Fig. 5 show a good agreement with the experimental result of Fig. 3.

Type 1:

$$R_{Total} = R_1 + R_2 = 0.2\ \Omega \quad \dots (1)$$

$$C_{Total} = C_1 + C_2 + C_3 + C_4 = 0.4\ nF \quad \dots (2)$$

$$\mathbf{Z} = R_1 + R_2 + \frac{1}{j\omega(C_1 + C_2 + C_3 + C_4)} = 0.2 + \frac{1}{0.4 j\omega} = 0.2 + 2.5\frac{1}{j\omega} \quad \dots (3)$$

Type 2:

$$R_{Y_1} = R_1 + R_2 = 0.2\ \Omega$$

$$R_{Y_2} = R_3 + R_4 = 0.2\ \Omega$$

$$R_{Total} = \frac{R_{Y_1} \cdot R_{Y_2}}{R_{Y_1} + R_{Y_2}} = 0.1\ \Omega \quad \dots (4)$$

$$\mathbf{Z} = \frac{R_{Y_1} \cdot R_{Y_2}}{R_{Y_1} + R_{Y_2}} + \frac{1}{j\omega(C_1 + C_2 + C_3 + C_4)} = 0.1 + \frac{1}{0.4 j\omega} = 0.1 + 2.5\frac{1}{j\omega} \quad \dots (5)$$

Type 3:

$$R_{Y_1} = R_1 + R_2 = 0.2\ \Omega$$

$$R_{Y_2} = R_3 + R_4 = 0.2\ \Omega$$

$$R_{Y_3} = R_5 + R_6 = 0.2\ \Omega$$

$$R_{Y_4} = R_7 + R_8 = 0.2\ \Omega$$

$$R_{Total} = \frac{R_{Y_1} \cdot R_{Y_2} \cdot R_{Y_3} \cdot R_{Y_4}}{R_{Y_1} \cdot R_{Y_2} \cdot R_{Y_3} + R_{Y_1} \cdot R_{Y_2} \cdot R_{Y_4} + R_{Y_1} \cdot R_{Y_3} \cdot R_{Y_4} + R_{Y_2} \cdot R_{Y_3} \cdot R_{Y_4}} = \frac{0.0016}{0.008 + 0.008 + 0.008 + 0.008} = 0.05\ \Omega \quad \cdots (6)$$

$$\mathbf{Z} = \frac{R_{Y_1} \cdot R_{Y_2} \cdot R_{Y_3} \cdot R_{Y_4}}{R_{Y_1} \cdot R_{Y_2} \cdot R_{Y_3} + R_{Y_1} \cdot R_{Y_2} \cdot R_{Y_4} + R_{Y_1} \cdot R_{Y_3} \cdot R_{Y_4} + R_{Y_2} \cdot R_{Y_3} \cdot R_{Y_4}} + \frac{1}{j\omega(C_1 + C_2 + C_3 + C_4)} = 0.05 + \frac{1}{0.4 j\omega} = 0.05 + 2.5\frac{1}{j\omega} \quad \cdots (7)$$

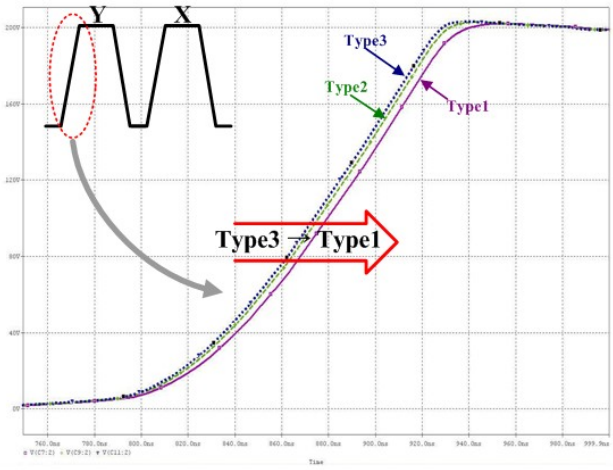


Fig.5. shows the simulated result of the sustain voltage waveform.

5. Conclusion

Despite the same displayed area, the sustain waveforms are distorted depending on the displayed patterns having different cell configurations, thus resulting in causing the variations in the luminance and luminous efficiency. This result plays a significant role in overcoming a degradation of the luminous efficiency caused by the smaller discharge volume of the Full-HD PDP cells.

6. References

[1] Jin-Sung Kimand Hyuk-Jae Lee, "Effect of Load Distribution on the Voltage Drop and the Luminance Variation in an AC-PDP." *IEEE Electron Device Letters, Vol. 28, No.10*, pp. 896-898, 2007.

[2] Ji-Hoon Lee et al., "The Method to Improve the Luminance Effciency by Auxiliary Capacitor in AC PDP." *IMID/IDMC'06 DIGEST*, pp. 913-916, 2006.