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AC PDP에서 불평형 Sustain Pulse를 이용한 휘도제어법

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LuminanceControlbytheasymmetricsustainpulseamplitudeinACPDP

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Abstract - The luminance of ac PDP has been controlled by the number of sustain pulses. Therefore, it is very difficult to control the luminance by sustain pulses for a given gray level. This paper deals with a new method to control the luminance by the sustain pulse amplitude in ac PDP. The suggested method can control the luminance by 60% without change of the number of sustain pulses.

1. Introduction

Plasma display panels (PDP) that utilize gas discharge promis e to be an attractive solution for high-definition television (HDT V) home-theater applications. Thus, a variety of intensive efforts have been undertaken to improve the luminance, luminous effici ency and image quality of the devices and to lower the cost of ac PDP in order to compete with other technologies.[1]-[3]

Both gray-scale expressions and brightness control in ac PDP is performed using pulse number modulation, which makeit diffi cult to control panel brightness flexibly according to ambient lu minance level. Independent control of brightness with the gray s cale cannot be made so far. However, the necessity of dimmer fu nction becomes more important with increasing interest on the h ome theater applications. A possible method to vary the luminan ce of the whole panel is to change the sustain voltage within the driving margin. However the dynamic margin of the panel is gen erally not permissible for large luminance variation.

In this paper, we propose simple and robust method to overco me this problem and realize independent control of panel brightn ess.

2. BasicConceptofSuggestedMethod

Fig. 1 shows the principle structure of a discharge cell in ac P DP. The size of a discharge cell is about 0.27mm0.81mm0.13m m (height). The tri-primary colors (R, G, B) are obtained from R GB phosphors excited by vacuum ultraviolet photons emitted fro m gas discharge.[4]-[5]

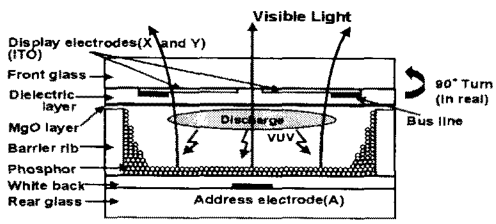
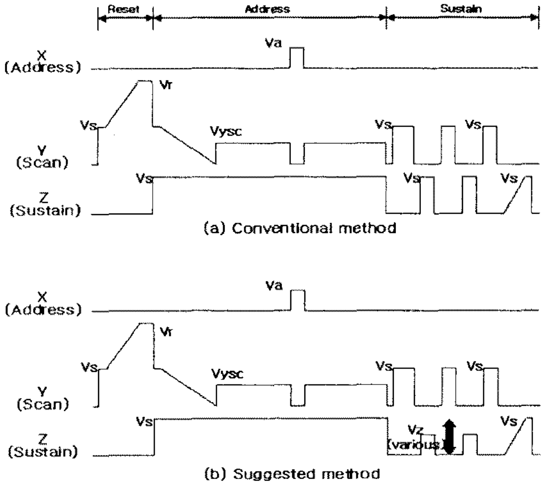


Fig. 1 Principle structure of a discharge cell in ac PDP.

As a driving method of ac PDP, address-display separated (A DS) scheme has been widely used. In ADS method, a picture of one frame is divided into eight subfields. Each subfield has reset, address and sustaining periods as shown in Fig. 2(a).

The role of the reset period is to erase the wall charge accumu lated on the dielectric surface in previous subfield, that make a s ame surface condition before next addressing. The role of addres sing period is to make new wall charge on the dielectrics of each discharge cell by applying the addressing pulses between scan an d address electrodes. The role of sustaining period is to make an image on the panel by applying the ac sustaining pulses to all dis play electrodes. In this case, only the selected discharge cells, w hich have been addressed in the address period are turned on. Th e number of sustaining pulses is decided corresponding to the we ight of luminance for each subfield.

When the discharge is successfully done at the first sustain pul se and sufficient wallcharge is left behind, the cell can be driven with low voltages down to near sustain minimum point. Therefor e it is possible to control the panel brightness by changing the su stain voltage from second to the last pulse. In this way we can m aximize the controllability of discharge cells to the degree limite d by their physical nature. Two variations, symmetric and asym metric driving is more robust and cost effective sine it needs onl y one additional DC power controller to be switched.[6]-[7]



- One subfram(8subfield):16.7ms, Address period:0.9ms
- Reset up time:100㎲, Reset down time:150㎲
- Vr:410V, Vs:180V, Va:70V, Vysc:80V, Vz:Various

Fig. 2 Schematic diagram of driving waveform

Fig. 2(b) shows the driving waveform sequence of the suggest ed method. The adopted driving scheme is same as the conventio nal method except for variable voltage sustainer. Scan preventin g voltage of scan electrode is fixed to 80V. Blocking voltage of s ustain electrode is set 180V which is same as first sustain pulse v oltage. No energy recovery circuit was applied.

3. Experimental

Table 1shows the specifications of the 7-inch test model PDP used in this study. There are a total of 60 scan lines and 23040 c ells. The same driving conditions are employed for both convent ional and suggested driving schemes as shown in Fig. 2(a) and (b). The width of scan pulse is designed to be 2μs, and the addres s period is about 0.9ms. The reset up and down time is designed to be 100μs and 150μs, respectively. These conditions provide stable positive-resistance discharge. The voltages of Vr, Vs, Va, Vysc and Vz as shown in Fig. 2 are set to 410[V], 180[V], 70[V], 80 [V], and constant, respectively.

In this study, a total eight subfield have been used and the peri od of one subframe is 16.7ms.

In order to test the luminance control, the luminance and disch arge current are measured by the luminance colorimeter (BM-7, Topcon Co.) and current trans (CT-1, Tektronix Co.). The dyna mic characteristics for both the conventional and suggested sche me are also examined.

Table 1. Specification of 7-inch AC PDP

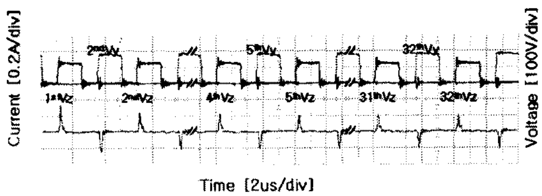
Front Panel		Rear Panel	
ITO width	270	Address electrode width	100
ITO gap	65	White back thickness	15
Bus width	85	Rib height	130
Dielectric thickness	40	Rib pitch	270
MgO thickness	5000	Rib width	75
Working gas:Ne+He(9.6%)+Xe(4%)		Phosphor thickness	20

4. Results and Discussion

Fig. 3 shows typical driving voltage and the time variation of current output for asymmetric driving case in the sustaining peri od. Current level is decreased fast during first to 2nd or 3rd pulse sequences and then maintained constant level. This means that g ap voltage between sustain electrode remain stable and constant l evel after transient state in spite of different sustain voltage appli ed, that is, the cells operate as if they are on the same location on the voltage transfer curve. We speculate that following relation s hip is satisfied for asymmetric driving condition.

$$Vg\_high = Vs\_high + Vw\_low$$
$$Vg\_low = Vs\_low + Vw\_high$$
$$Vg\_high \approx Vg\_low \text{ and } \Delta Vw \approx Constant$$

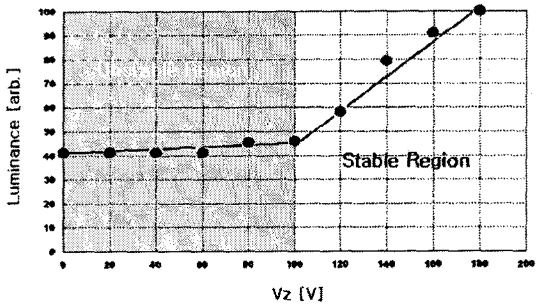
The subscripts 'g', and 's'represents gap, sustain respectively. *Vw_low* and *Vw_high*is wall voltage established after distinction o f low and high sustain voltage discharge. It should be noted that all the gap and wall voltages mentioned above is averaged over multiple cells.



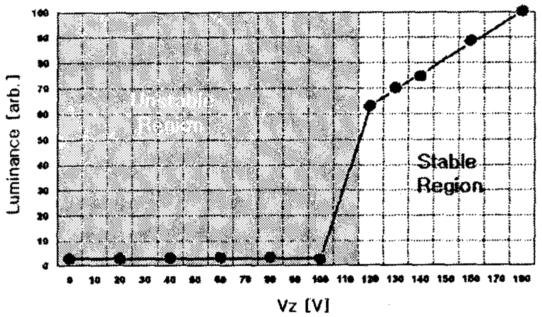
Vs=180V Vz=125V

Fig. 3 Driving voltage and time variation of current output for a symmetric driving case

Fig. 4 shows the luminance controllability for the sub-field of 2 gray and 256 gray levels with the sustain voltage of 180V at th e scan electrode. The sustain voltage of sustain electrode can be reduced down to 120V with stable driving of the cells. For the c onventional case, we can reduce, at best, the sustain voltage dow n to 170. Resulting controllability of the luminance was correspo nd to 40~60% of its maximum luminance.



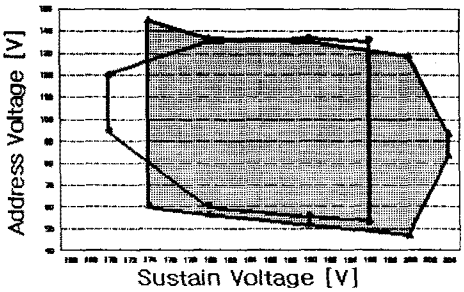
(a) The sub-field of 2 gray level



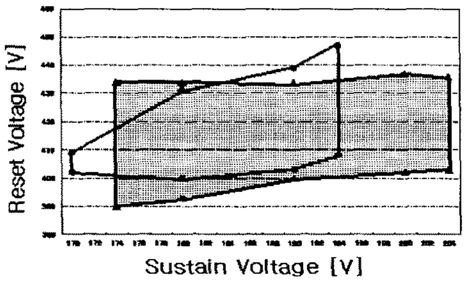
(b) The sub-field of 256 gray level

Fig. 4 The luminance controllability

Dynamic margin characteristics between address and sustain (scan electrode) voltage are shown in Fig. 5. And Fig. 6 shows d ynamic margin characteristics between reset and sustain voltage. Sustain voltage of sustain electrode was fixed to 130V in this cas e. The margin contours are shifted to higher scan electrode volta ge. These results are rather natural because lower voltage is appli ed to the scan electrode side. However, the degree of shifting is l ess than about 10V, which is far smaller than the operation volta ge reduction of the scan electrode.



Open area : Conventional Method
Hatched area : Asymmetric Method with sustain electrode voltage of 130V
Fig. 5 Address Sustain dynamic voltage margin



Open area : Conventional Method
Hatched area : Asymmetric Method with sustain electrode voltage of 130V
Fig. 6 Reset-Sustain dynamic voltage margin

5.Conclusion

In this paper, in order to control the continuous brightness, a n ew driving method is suggested. The suggested method uses a as ymmetric pulse amplitude of sustain electrode in sustain period. As a result, the maximum luminance reduction of 40~60% was a chieved in the sub-field weighted by an application of asymmetri c pulse amplitude modulation. The current level is decreased fast during first to 2nd or 3rdpulse sequences and then maintained co nstant level. Moreover, it was experimentally verified that the pr oposed method shows similar reset-sustain and address-sustain d ynamic margin performances compare with the conventional met hod.

6.References

[1] C-H Park et al., "A New Driving Waveform to Improve Dark Ro om Contrast Ratio in ac Plasma Display Panel" *IEEE Trans. Ele ctron Devices*, Vol. 49, No. 7, pp. 1143-1150, 2002

[2] C-H Park et al., "Improvement of Addressing Time and Its Dispe rsion in AC Plasma Display Panel "*IEEE Trans. Electron Device s*, Vol. 48, No. 10, pp.2260-2265, 2001.

[3] L. F. Weber, "The promise of plasma display for HDTV" *J. Info rm Displ.*, vol. 16, No. 12, pp. 16-20, 2000.

[4] W-G Lee et al., "An electrical and optical characteristics of the c olor ac plasma displays with a new cell structure", *J. Inform. Dis pl.*, vol. 2, pp. 5-9, Mar. 2001.

[5] S-H Lee et al., "A new method to reduce reset period in AC plas ma display panel", *Trans. KIEE C*, Vol. 50, pp. 517- 521, Oct. 2 001.

[6] K. Sakita et al., "Analysis of a weak discharge of ramp-wave dri ving to control wall voltage and luminance in AC-PDPs", *in SID 2000 Dig.*, pp.110-113, 2000.

[7] Shinoda, T. "High Level Gray Scale for AC Plasma Display Pan els Using Address-Display Period-Separated Sub-Field Method ", *Trans. Of IEICE* C-2, No. 3, pp.349-355, 1998.