New First Subfield Waveform for Improving Low Gray Level Linearity in AC-Plasma Display Panel

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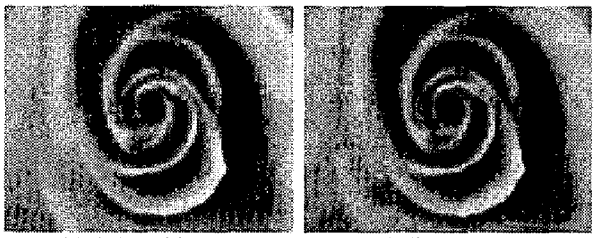
***Abstract*--A new first subfield waveform is proposed to enhance the low gray level linearity in AC-PDP. The proposed first subfield uses a ramp pulse instead of a square sustain pulse, thereby generating the lower minimum-luminance level stably and reducing a low gray level contour.**

I. INTRODUCTION

Improving an image quality in PDP is necessary for high-definition-televisions (HDTV) [1, 2]. Especially, the poor low-gray-level linearity in PDP is serious, as shown in two images of Fig. 1, which contain the gray-levels up to 50 and are stretched up to 250 gray-levels for display-purpose. This image quality degradation in AC-PDP is caused by the discrete luminance-level and inverse-gamma correction. In the current PDP driving scheme, the luminance is controlled by the pulse-number-modulation, therefore the luminance is discrete and the minimum luminance-step is relatively high compared with CRT. For compensation of nonlinear electro-optical transfer characteristic in CRT, the received video-signal is the gamma corrected signal. On the other hand, a PDP has a linear electro-optical transfer characteristic in conventional driving method, so that the inverse-gamma correction is required to display images correctly. Because of inverse-gamma correction, several gray levels are merged into a fixed output luminance-level in the low-gray-level region, as shown in Fig. 2 (b). Furthermore, as the luminous efficacy is higher, the luminance per one pulse is higher, and the resultant minimum luminance-level is also higher.

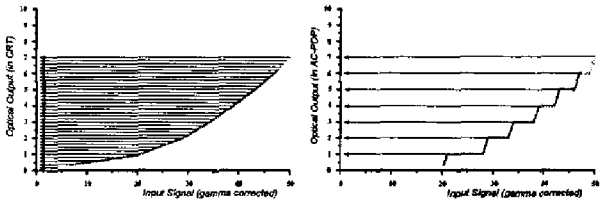
In order to improve the low-gray-level linearity, an image processing like error diffusion and dithering has been performed. Nonetheless, the image processing methods cannot be fundamental solutions for reducing a low-gray-level problem. To solve this problem fundamentally, the minimum luminance-level should be lowered further compared to that generated by the conventional first subfield. In this sense, multi-luminance-level method was proposed in the previous work [3]. However, it needed three additional subfields because the minimum luminance-level was still high.



(a) Original image (b) displayed image

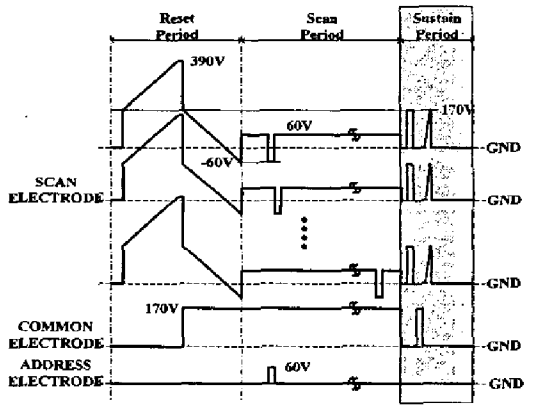
Fig. 1. Original image (a) and displayed image (b) on PDP.

This paper proposes the new driving scheme that can improve the low-gray-level linearity by adding only one first subfield, which can make about half luminance of the conventional first subfield. The new first subfield uses the weak discharge driven by a ramp pulse instead of by a square pulse.

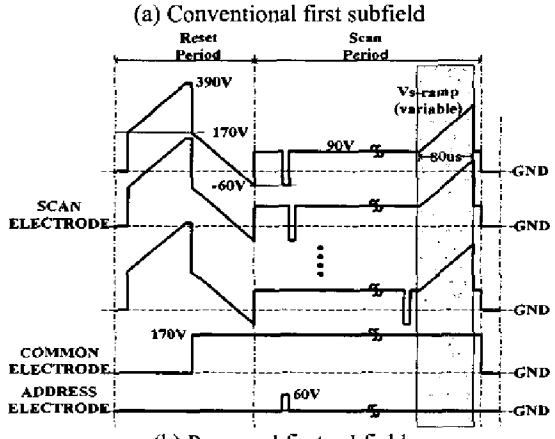


(a) CRT (b) PDP

Fig. 2. Characteristic of input signal versus optical output; (a) CRT, (b) PDP.



(a) Conventional first subfield



(b) Proposed first subfield

Fig. 3. Driving waveforms for (a) conventional first subfield and (b) proposed first subfield.

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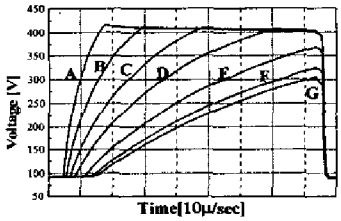
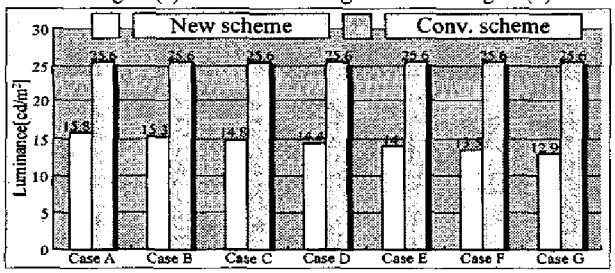


Fig. 4. Measured ramp pulse of proposed first subfield in end of scan-period.

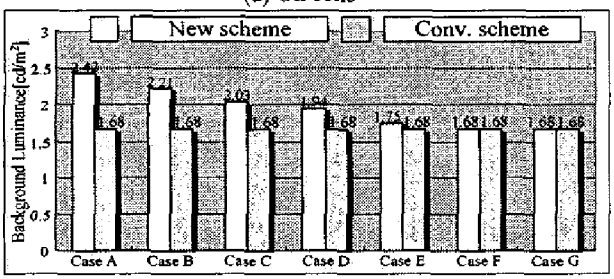
II. PROPOSED WAVEFORM

Fig. 3 shows the waveforms for conventional (a) and proposed (b) first subfields. Comparing the conventional first subfield, the proposed first subfield shows that the ramp pulse is applied to the scan electrode for controlling the minimum luminance-level during scan-period. Fig. 4 illustrates the measured ramp pulses with various voltage slopes. Fig. 5 shows the luminance values measured from the test panel when the driving waveforms when both conventional and proposed first subfields with a period of 1500 μs are applied repeatedly. The proposed first subfield with the voltage slope of 3.06 V/μs (Case G) can generate about half luminance, compared to the minimum luminance generated by the conventional first subfield without an increase in the background luminance.

The address-display-separated (ADS) driving scheme used in a commercial PDP is comprised of eight subfields, each of which consists of the reset-, scan- and sustain-periods, as shown in Fig. 6 (a). The new driving scheme of Fig. 6 (b) adds

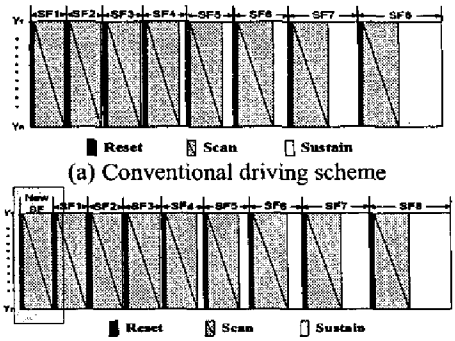


(a) On cells



(b) Off cells

Fig. 5. Changes in (a) luminance and (b) background luminance when driving waveforms for both conventional and proposed first subfields with period of 1500 μs were applied repeatedly.



(a) Conventional driving scheme

(b) New driving scheme

Fig. 6. Subfields comprised of reset-, address-, sustain-periods for 1 TV-field in ADS driving method.

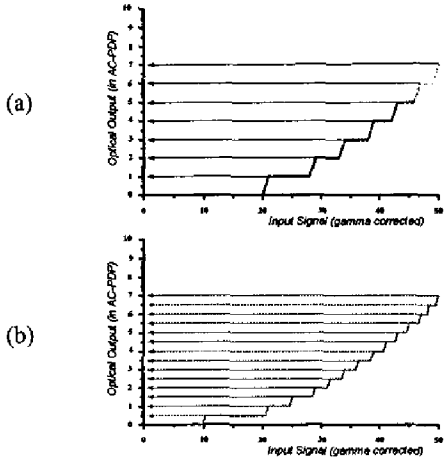


Fig. 7. Characteristic of input signal versus optical output when (a) conventional driving scheme and (b) new driving scheme was applied in AC-PDP.

the one new first subfield. Fig. 7 (b) shows that the low-gray-level linearity was improved by adding only one new subfield, compared to that of Fig. 7 (a) showing the input-output characteristic in conventional scheme.

III. CONCLUSION

A new first subfield waveform is proposed to enhance the low gray level linearity in AC-PDP. It is expected that the addition of the new first subfield driven by the proposed waveform can lead to more powerful low gray level expression.

REPERENCE

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[2] S.-H. Jang, H.-S. Tae, and S.-I. Chien, "New driving scheme for white color balancing of plasma display panel television," IEEE Transaction on Consumer Electronics, vol. 48, No. 3, pp. 340-387, August 2001.

[3] K.-D. Cho, H.-S. Tae, and S.-I. Chien, "Improvement of low gray scale linearity using multi-luminance-level subfield method in plasma display panel," IEEE Transaction on Consumer Electronics, vol. 48, No. 3, pp. 377-381, August 2002.