A Novel Sustain Circuit for ACPDP

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Abstract

This paper explores the influence of the ringing phenomena on the sustain waveform for AC PDP. We also announce a new circuit to improve the prior sustain circuit by reducing the ringing phenomena and thus get better performance such as increasing the operating margin, the luminous efficiency, the contrast ratio and decreasing the power dissipation.

1. Introduction

Surface discharge AC-PDP has become the mainstream in PDP industry recently. In general, the operating sequence of AC-PDP driving system includes three steps which are addressing period, sustaining period, and erasing period. Since the memorized characteristic of the plasma cell caused by the wall charge, at the addressing period, we excite the wall charge of the cells that will be lighted at sustaining period and expire the wall charge of the cells that will be unlighted. Then we supply the sustain waveform to all cells of the panel and display the image. But as the size of the panel grows bigger and bigger, uniformity of the panel is becoming more and more important. We usually use operating margin to evaluate the uniformity of the panel and larger operating margin always gets better image performance. Even though the operating margin depends on the gas mixture, pressure, secondary emission coefficient, and gap length, it can also be affected by the shape of the applied voltage, [1], [5]. Usually, we utilize the square waveform as the sustain waveform. However, as we know, the plasma panel is capacitive. As the size of panel grows larger and larger, capacitance of panel increases and the inductance of conductors, such as Li shown in Fig.1(a), also raises up. Then the ringing phenomena, as shown in Fig. 2, at both rising and falling edge of the square wave, could not be ignored any more, [4]. In our study, we explore that, operating margin, wall voltage, luminous, luminance efficiency, and contrast ratio are increased, while the power dissipation is decreased as effacing the ringing phenomena. In addition, our new sustain circuit smooth the ringing phenomena and get the better performance.

Fig. 1(a), (b) Conventional sustain circuit and its output waveform operating sequence
2. Experimental Results

Fig. 1(a), Fig. 2 separately shows the conventional sustain circuit and its output waveform, which is measured at the terminal of the panel, as taking parasitic inductance of the conductor, \( L_i \), into account. In the Fig. 2, Wave A appears that, the ringing phenomena exists at both rising and falling edge. Then we compares its driving characteristic with the other three different sustain waveforms, which is separately shown at Fig. 3(a), (b), (c). We observe that, without ringing at rising edge of driving waveform, the miss-firing phenomena of cells would be improved. Then, Since the miss-firing is improved, the brightness of the dark-state in which cells should be unlighted would be lowered down and it would result in raising the contrast ratio. Besides, as we reduce the ringing at falling edge, the wall voltage of the cell could be promoted and thus the operating margin and the luminous enormously could also be increased, as shown in Fig. 4, Fig. 5, and Table 1. Further, as decreasing both the ringing of the rising and falling edge, we can get a fairly low luminous stability \( S_L \),

\[
S_L = \frac{(\Delta \text{Lux} \ast V_s)}{(\Delta V_s \ast \text{Lux})}
\]  

which lowers down the influence of the cell’s non-image. In addition, according to the manipulated results and analysis of PSPICE, we also find that, as effacing ringing phenomena, the power dissipation for charging panel is lowered down. Moreover, most sustain circuits of AC-PDP usually include an energy recovery circuit, for example, a well-known energy recovery method presented by Weber, [2].

Fig 3(a), (b), (c) separately illustrates three different waveforms, which are Wave B, Wave C, and Wave D.

However, Since the number of lighted cells and unlighted cells is variable as the image is variable, the capacitance of panel will change dramatically and result in the miss-match between the LC value and
the energy recovery time [3]. Fortunately, We can combine the new sustain circuit, as shown in Fig. 6, with normal energy recovery circuit to form a new energy recovery sustain circuit. Under such circumstances, in despite of the influence of variable capacitance of panel, we can not only decrease the dissipated energy in charging panel but also improve the performance of the panel, such as increasing the operating margin, luminous and luminance efficiency and lowering down the power dissipation and the EMI emissions.

Table 1. The operating margin of four different waveforms

<table>
<thead>
<tr>
<th></th>
<th>Wave A</th>
<th>Wave B</th>
<th>Wave C</th>
<th>Wave D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last-On</td>
<td>212 V</td>
<td>203 V</td>
<td>209 V</td>
<td>211 V</td>
</tr>
<tr>
<td>First-Off</td>
<td>188 V</td>
<td>133 V</td>
<td>198 V</td>
<td>128 V</td>
</tr>
<tr>
<td>Margin</td>
<td>24 V</td>
<td>70 V</td>
<td>11 V</td>
<td>83 V</td>
</tr>
</tbody>
</table>

3. Propose a new sustain circuit

According to the analysis we discussed above, we propose a novel sustain circuit, as shown in Fig. 5, to produce a sustain waveform with smooth rising and falling edge, as shown in Fig. 2(a). The operation of the novel sustain circuit is described as the following with reference to Fig. 5.

During the first period (1), the waveform in case the switch SW3 is on and the switches SW1 and SW2 are off, is shown and a voltage 0V is generated to Vp.

During the second period (2), the waveform in case the switch SW1 is on and the switches SW2 and SW3 are off, is shown and the voltage of Vp is smoothly rising to Vs.

During the third period (3), the waveform in case the switch SW2 is on and the switches SW1 and SW3 are off, is shown and the voltage of Vp is smoothly falling to 0V.

During the fourth period (4), the waveform in case the switch SW3 is on and the switches SW1 and SW2 are off, is shown and a voltage 0V is generated to Vp.

With the inductor, L, in the proposed circuit, which is much larger than the intrinsic inductance Li of the conductor, we smooth the rising edge of Vp. In addition, the falling edge of Vp is smoothed by the resistor, which is accompanied by SW2. Then, we produce the desired waveform, Wave B.
4. Conclusion

We investigated another kind of viewpoint for improving the image performance of AC-PDP. Our experimental results on the Acer’s panel indicate that, by effacing the ringing phenomena at rising and falling edge of the driving waveform, we are able to get better performance on ACPDP. Firstly, the operating margin is increased when we utilize the proposed sustain circuit. Secondly, we can get better luminance stability that results in the better yield rate at mass production. In addition, the contrast ratio is also improved. At last, according to our research at the ringing phenomena of sustain waveform, we believe that we are capable of getting a better operating performance by using the wave B as the sustain pulse, the wave C as the priming pulse, and the wave D as the addressing pulse at the driving sequence of AC-PDP.

5. Literature


Fig. 6 shows the proposed sustain circuit and its operating sequence, which is including four periods.