

## Cost competitive Pixel Structures for Mobile PVA LCDs

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### Abstract

*We have designed cost competitive pixel structures for high performance mobile PVA LCDs. These new structures significantly bring down the price by the use of a conventional polarizer for lowest possible cost. A 4.3" prototype based on these techniques was built, achieving the world's highest mobile display contrast ratio of 1200:1, while maintaining wide viewing angle with no loss of transmittance*

### 1. Introduction

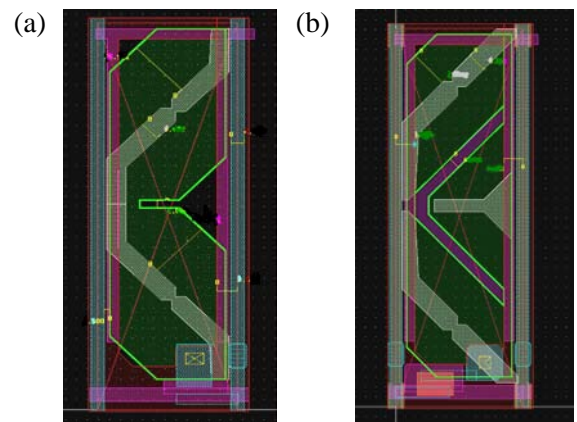
TFT-LCD has been largely focused on development of wide viewing-angle modes. Even in the display for portable devices such as mobile phone and personal digital assistant, a wide viewing angle has been regarded as main issue. Also, the growth of mobile multimedia systems demands further performance enhancement of LCD panels such as higher aperture ratio and contrast ratio. In this paper, we introduce a new a new PVA LCD to meet these requirements.

For monitor and TV PVA panels, the chevron pixel structures have been used with a conventional polarizer as shown Fig. 1. But, the Chevron pixel structures do not enable use of a mobile PVA LCDs due to low aperture ratio.

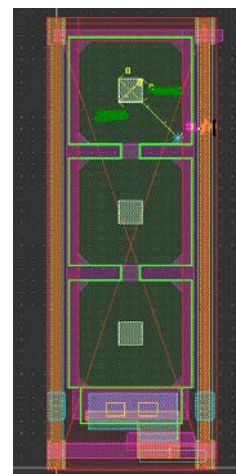
Therefore, a donut-shaped pixel structure of Fig. 2 and a polarizer with a quarter-wave plate are used in mobile PVA LCDs [1]. Because the polarizer with a quarter-wave plate is very expensive, for cost reduction, a new technique is necessary to enable use a normal polarizer without sacrificing other aspects of display performance.

This paper explains new pixel structures to prevent loss of transmittance when using a normal

polarizer in PVA mode.



**Fig. 1. Chevron pixel structures : (a) type I,(b) type II**



**Fig. 2. Donut-shaped pixel structures**

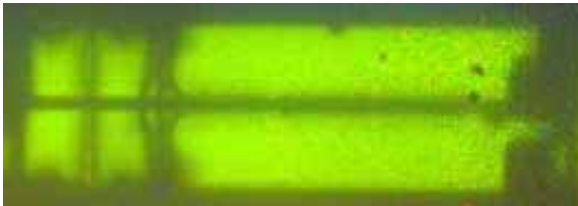
## 2. Results

### 2-1. New pixel structures with high aperture ratio

As shown in Figure 3, two pixel structures, 2-domain and 4-domain, are new pixel structures with high aperture ratio. For the maximum aperture ratio, storage capacitors are implemented under a black matrix between pixels, and gate lines are fabricated under open areas of pixel electrodes. The aperture ratio of the new pixel structure is 60%, while that of the Chevron structure is 40%.



(a)



(b)

**Fig. 3. Photographs of proposed pixel structures: (a) 2-domain PVA, (b) 4-domain PVA**

The use of a conventional polarizer has a disadvantage compared with a circular polarizer in transmittance due to the textures which are not azimuthally oriented at 45 degrees to the polarizer axis. In 2-domain PVA, textures appear in the area adjacent to a data line due to a lateral field, and are concealed by TFTs and metal. However, in 4-domain PVA, most of the textures occur at edges of pixel electrodes between two different domains. These textures are difficult to conceal and result in poorer transmittance. For off-axis image quality, 4-domain structure has better performance than the 2-domain structure.

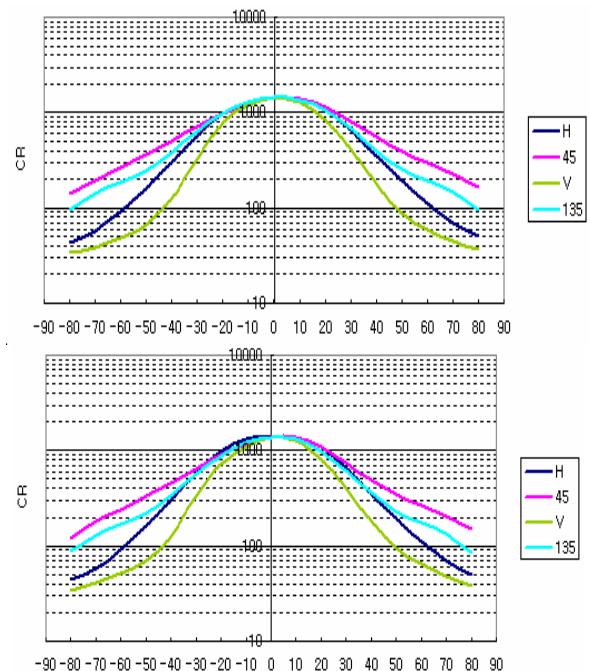
### 2-2. Display Performance

Table 1 summarizes characteristics of the new 2-domain and 4-domain PVA panels. The proposed

technologies were implemented on 4.3" WqVGA panels operating at 4.8V of operating voltage. Triple-gate circuit and amorphous silicon gate (ASG) driver circuits were adopted to further reduce system cost [2], [3].

	2-domain PVA	4-domain PVA
Transmittance ratio	6.0%	5.2%
Contrast ratio	1200:1	1200:1
Luminance	400 nit	350 nit
Color gamut	50%	50%
Color coordinates (White)	0.311, 0.337	0.311, 0.335
Ton+Toff	28ms	28ms
Viewing angle	All > 80 degrees from center	All > 80 degrees from center
Gray inversion	None	None

**Table 1. Characteristics of new mobile PVA panels (4.3"WqVGA, 128ppi)**



**Figure 4. New mobile PVA panel viewing angle: (a) 2-domain, (b) 4-domain**

The 2-domain PVA panel shows transmittance that is 90% that of TN mode. Both 2-domain and 4-

domain PVA panels achieved high contrast ratio, 1200:1, which is required for mobile multimedia applications. This contrast ratio is the higher than all existing mobile LCD displays. Viewing angle, plotted in Figure 4, was measured to be over 160 degrees according to standard measurement techniques. Even from the diagonal view, contrast ratio is over 100:1 at 60 degrees off-axis. Response time can be additionally enhanced by adjusting the physical properties of liquid crystals and optimizing the cell parameters such as cell gap.

### 3. Summary

Two new advanced PVA LCD pixel structures have been designed for use in high performance mobile applications. These new structures significantly bring down the price by the use of a conventional polarizer for lowest possible cost..

### 4. References

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