

A Novel WV-TN with Wide Viewing Angle and Fast Response Time for Multi-Functional Monitor

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Abstract

We developed new WV-TN panel which has 170/170 viewing angle and 8ms response time. This viewing characteristics almost catch up with those of VA. To extend the viewing angle we optimized the cell design and LC parameters. This new technology strongly increase the demand of TN monitors especially for the monitor market larger than 19”

1. Introduction

TN mode is mostly normalized mode in LCD Monitor and Notebook market. This mode’s advantage comes from simple produce process, fast response time and improving narrow viewing angle. Now TN mode is expanded into 15” and 17” even 19” monitor areas.

As the size of TN monitor increases, it’s competitiveness against other modes (IPS and VA) goes down because the narrow viewing angle property limits the use of large monitors. Beside even response time of 12ms is not satisfied to consumers who want to use multi-vision with monitors.

In this article, we will show viewing-angle of 170/170 with response time of 8ms, which can be used for multi-function monitors.

2. Viewing Angle

TN mode does not take a self-compensation through multi domain like other wide viewing angle modes. Thus TN mode uses a diagonal rubbing to make a horizontal symmetry. In addition the axis of polarizer must be set to diagonal direction. However this diagonal polarizer’s axis brings about narrow viewing angle because of light leakage at up, down, left and right direction [1]. Shown in the figure 1-(a). This phenomenon comes from geometric construction. Thus vertically aligned liquid crystal following vertical electric field increase the light leakage, as figure 1-(b).

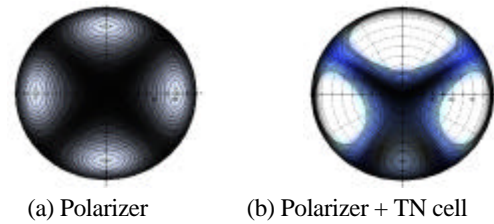


Figure 1. Simulation of black state. In the case of only polarizer black state looks like ‘X’ because of diagonal rubbing. Black region indicates viewing angle. In fig (a) up-down and left-right viewing angle is narrow and diagonal viewing angle is wider. Viewing character is also symmetric. However in fig (b) symmetry is distorted by cell and viewing angle becomes narrower than in the case of only polarizer like fig (a).

Generally we use a compensation film to reduce the light leakage on TN mode. Liquid crystal’s birefringence is dependent of viewing angle because of birefringence anisotropy. As shown in figure 2 (a) to compensate a difference of birefringence, it is used discotic liquid crystal whose shape is opposite to positive liquid crystal. When these two different liquid crystals match each other, the property has isotropy and as a result difference of birefringence depending on viewing angle is disappeared. Using this method, it can be able to compensate optical property by aligning discotic liquid crystal with opposite direction to director of liquid crystal in TN cell [2-4].

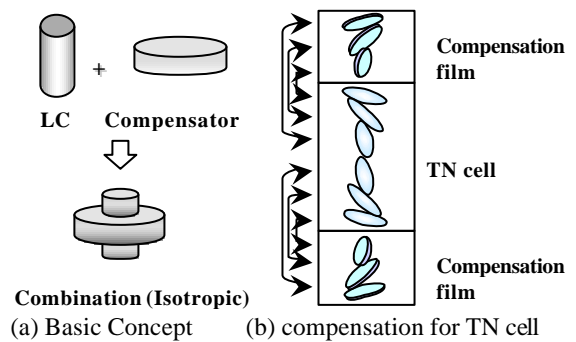


Figure 3. Used optical compensation arrangement for TN cells based on negative birefringence.

We have designed new model to enhance viewing angle with following method. Firstly, we controlled retardation of cell as well as property of back light and surface treatment of polarizer. The result shows the enhancement of viewing angle as you can see the figure3. Secondly, in order to improve color shift depending on viewing angle we enhanced property of visual sensation by controlling compensation film's n dispersion which was controlled by liquid crystal. Thirdly, we made response time as 8ms to make moving picture smoothly.

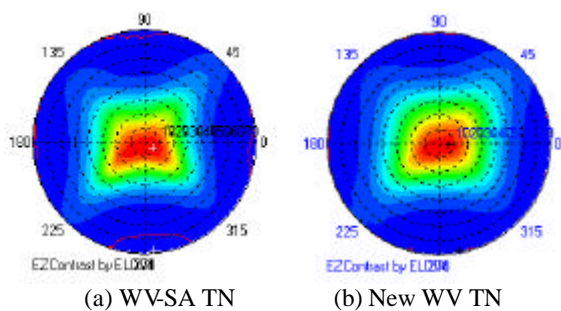


Figure 3. Newly developed TN shows better viewing character than already released TN.

2-1. Left – Right Viewing Angle

Figure 4 shows that WV-SA TN mode 140 degree of left-right viewing angle that satisfies the definition of viewing angle saying contrast ratio must be higher than 10:1. On the other hand a newly developed WV TN reaches to 170 degree. This viewing angle covers most viewing area people can see.

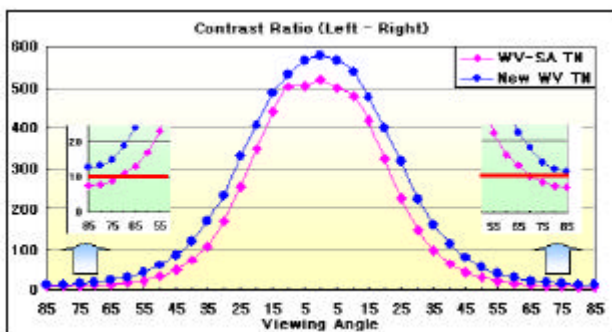


Figure 4. New WV TN has wider viewing angle than WV SA TN. Inset graph shows that new WV TN has 170 degree of left-right viewing angle.

As shown in figure 5, newly improved WV TN mode is comparable with other wide viewing modes like S-IPS and wide view VA.

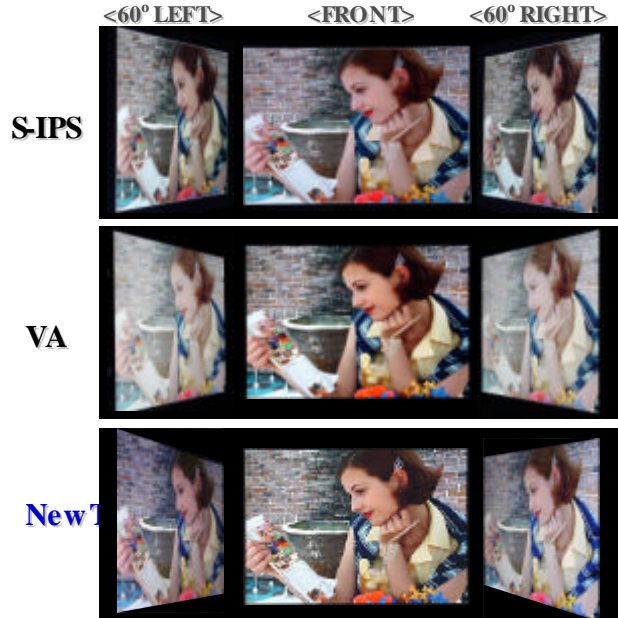


Figure 5. Although we can not say new TN is better than others, it can have competitiveness against S-IPS and VA in CR and viewing angle.

2-2. Up – Down Viewing Angle

Figure 6 shows the character of up-down viewing angle of 170 degree as same as case of left-right viewing angle. WV-SA TN shows CR graph moved toward down viewing angle, on the other hand new WV TN has symmetric shape at the center in the graph. However we could not improve gray inversion at down viewing angle that is unique character of TN mode.

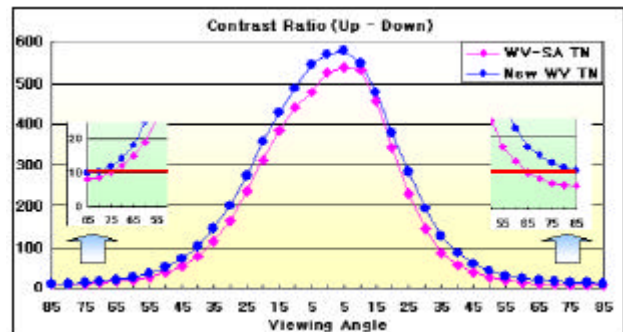


Figure 6. Up-down viewing angle also reaches to 170 degree comparing with figure 4.

4. Summary

We developed the TN panel having 8ms response time as well as improved viewing angle of 170/170, which is enable to apply multi function monitor. Newly developed TN mode has improved characters of brightness, response time and wide viewing angle, which can compete with other IPS and VA mode. With this developing wide viewing angle model, we have come to secure technologies to apply larger than 19" size monitor in TN mode.

5. Acknowledgement

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6. Reference

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