Implementation of FPGA-Based Color Bistable LCD Display

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Abstract—In this paper, we propose a driving circuits using FPGA for affordable full color bistable LCD display system. The proposed FPGA-based system is compatible with various Cholesteric LCD drivers and flexible with the sizes. The implementation result will be given as the middle-size Cholesteric LCD panel driver.

Keywords—Cholesteric LCD; driving circuit; LCD display system

I. INTRODUCTION

Cholesteric LCD is able to maintain two stable states, planar texture and focal conic texture due to the electric field. Planar texture reflects external light and focal conic texture absorbs. First of all, because one of states remains stable if the field is gone, it is suitable for still images such as color e-paper. High contrast ratio as well as readability under sun light are advantages of bistable LCD display[1–4].

Up to now, there are three driving methods for Cholesteric LCD display. One is a segment driving method, another is a passive matrix method, and the last is an active matrix method. A segment driving method is used to display numbers or various symbols and easy to implement. However, applications are quite limited because only a few signs can be represented by this method. A digital clock and a table calendar are good examples. An active matrix method has wide areas such as computer monitor, portable LCD for cellular phone, LCD TV, and many billboard screens. In this method, each cell consists of very small size transistor, called Thin Film Transistor(TFT), and it pass or block the light by the driving circuit operation. While the active matrix display can show high-definition images by the cell-based control, it has a serious problem. The main reason for that is most active-method can be realized on the glass. If we can make them on the plastic, the cost, size, and process for display panel will go down drastically. But, the technical limitation has become a hurdle in the active method. On the other hand, a passive matrix method can solve all problems and limitation mentioned above. In the passive one, a display cell will be the crossing point between an electrode on the upper panel and that on the lower panel in the perpendicular manner. The passive method doesn’t need transistors to form cells any longer. No transistor let the overall process of LCD control easy and simple, and the cost be down. Furthermore, the resolution can be so high to be applicable for ESL and E-POP. Figure 1 demonstrates the configuration differences among three driving methods to understand clearly.

II. COLOR CHOLESTERIC LCD DISPLAY DRIVER

A. Design Feature

We aim for developing a new memory-type passive matrix-based flexible LCD in this work. The new LCD can provide full color display without any color filter and is controlled by a low-power driving board. Main design features in the board are summarized as follows:

• Low-power design for maintaining efficient voltage controls
• Waveform width control
• Timing control in each driving period
• Logic for phase control.
• Driving waveform ranging over 50V
• Optimization in each period to guarantee a wide driving margin

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• Contrast enhancement by extending a driving margin
• Crosstalk minimization by considering voltage of electrodes of row and column
• Integration of driving circuit using FPGA to achieve a small-size prototype board

LCD drivers are controlled by one FPGA. As shown in Fig. 3, FPGA saves images sent from PC within internal SRAM buffer and converts them to fit for driver IC format. Then, using standard serial or parallel data interface standard, they are transmitted with respect to the display timing.

![Fig.2. FPGA-based LCD driving system](image)

![Fig.3. LCD driver IC controller on FPGA](image)

### III. IMPLEMENTATION RESULT

In order to represent a color image, 3 LCD drivers are required for R, G, B component. One IC communicates control and image signals with the developed FPGA board via 50-pin connector. Altera’s Cyclone 4 (model name: EP4CE55F23C8N) is used for the LCD controller and verilog HDL language is chosen for logic design. Up to now, we have focused on the realization of bistable color LCD display which size can be variable. Moreover, we have also developed the design environment like a testing board, test image generator, still image changer, and so on. We already know there still remains small problems having to be solve. Therefore, we will try to improve the system quality continuously.

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### REFERENCES


