

Antiferroelectric Liquid Crystal Display with High Image Quality

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Abstract

The antiferroelectric liquid crystal display (AFLCD) is a unique display that can at demonstrate a moving image perfectly the passive matrix driving scheme. We optimised driving the waveform and introduced a dual-driving method. Also, by improving this driving method and using line inversion method, we realize the AFLC display of high image quality with 160(RGB) x 240, 32768 colors, crosstalk free and flicker free contrast ratio is greater than 60:1, and the brightness is above 200 cd/m^2.

Keywords : AFLCD, reset time, flicker, crosstalk

1. Introduction

Nowadays, super-twisted nematic liquid crystal displays (STN-LCDs) are widely used in small size mobile phones, personal digital assistant (PDA), and cellular phones. Thin film transistor liquid crystal displays (TFT-LCDs) are used as large size display monitors since these characteristics are rapidly approaching to those of cathode ray tube (CRT) displays in terms of cost, image quality, and viewing angle, thanks to various kinds of innovations.[1,2]

But the change in the market trend toward the IMT2000 demands displays that can show moving images. The slow response time of the STN-LCD (hundreds msec) and TFT-LCD (tens msec) does not meet the demand of the market. Not only does the AFLCD have fast response time of less than 1 ms but also has other important advantages, such as wide viewing angle characteristics of in-plane switching, continuous gray scale, and the production cost.[3] It involves going the rough the same manufacturing process with that of STN-LCD. In spite of all these attractive features, it is difficult such commercial AFLC devices available in the market. The main reasons for this are difficulty with cell gap control, bad contrast ratio, and operating temperature range. In this work, we discuss some of methods to achieve high image quality in AFLCD.

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2. Designing a AFLCD Panel

Color AFLCD panels (2.8 inch, 160(RGB× 240, 32768 color) have been prepared. The cell gap of the panel provided by patterned spacer was about 1.8㎛ and the antiparallel rubbing of the polyimide alignment layers was used.

3. The Driving Method

The driving scheme of the AFLCD is shown in Fig. 1. It is comprised of three parts, selection (1), nonselection (2), and reset period (3). In order to remove the DC effect, the waveform with opposite polarity is driven in each frame. The basic driving mechanism of the scan waveform is a two-step process. The first step is selecting a specified brightness in the selection period, and the second step is maintaining the brightness in the non-selection period by hysteresis characteristics.

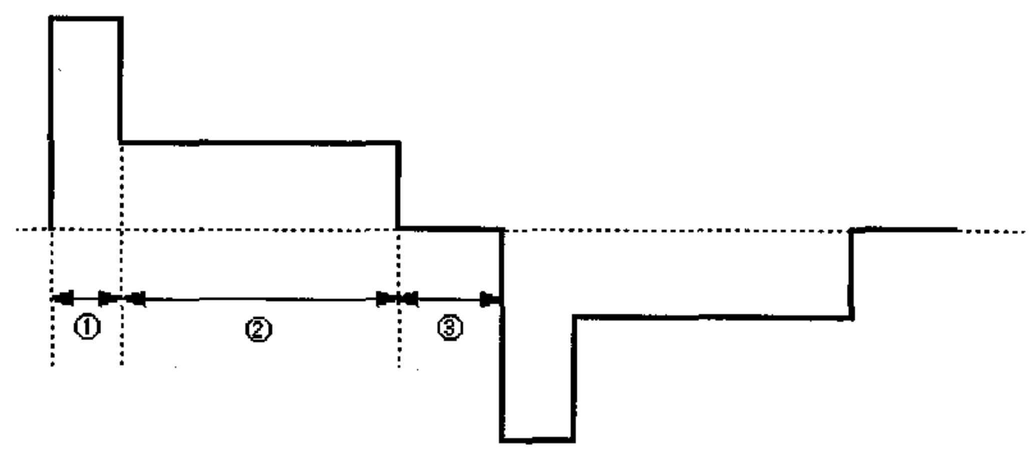

Fig. 1. Scan waveform in AFLCD. Part (1) is selection, part (2) is nonselection and part (3) is reset period.

3.1 The reset time

The falling time from F to AF phase is longer than the rising one because after relaxation follows the falling Long the falling time is long, usually entails image sticking in the display. The reset period in the end of the waveform is assumed to remove this image sticking and improve the contrast ratio because of the early starting for the AF phase. On the other hand, if the reset time is too long, the contrast ratio was found to become worse because of the bad transmission during the reset time. Therefore, we chose the optimum reset time for the liquid crystal. Fig. 2 shows the reset time dependence on the contrast ratio for several liquid crystals.

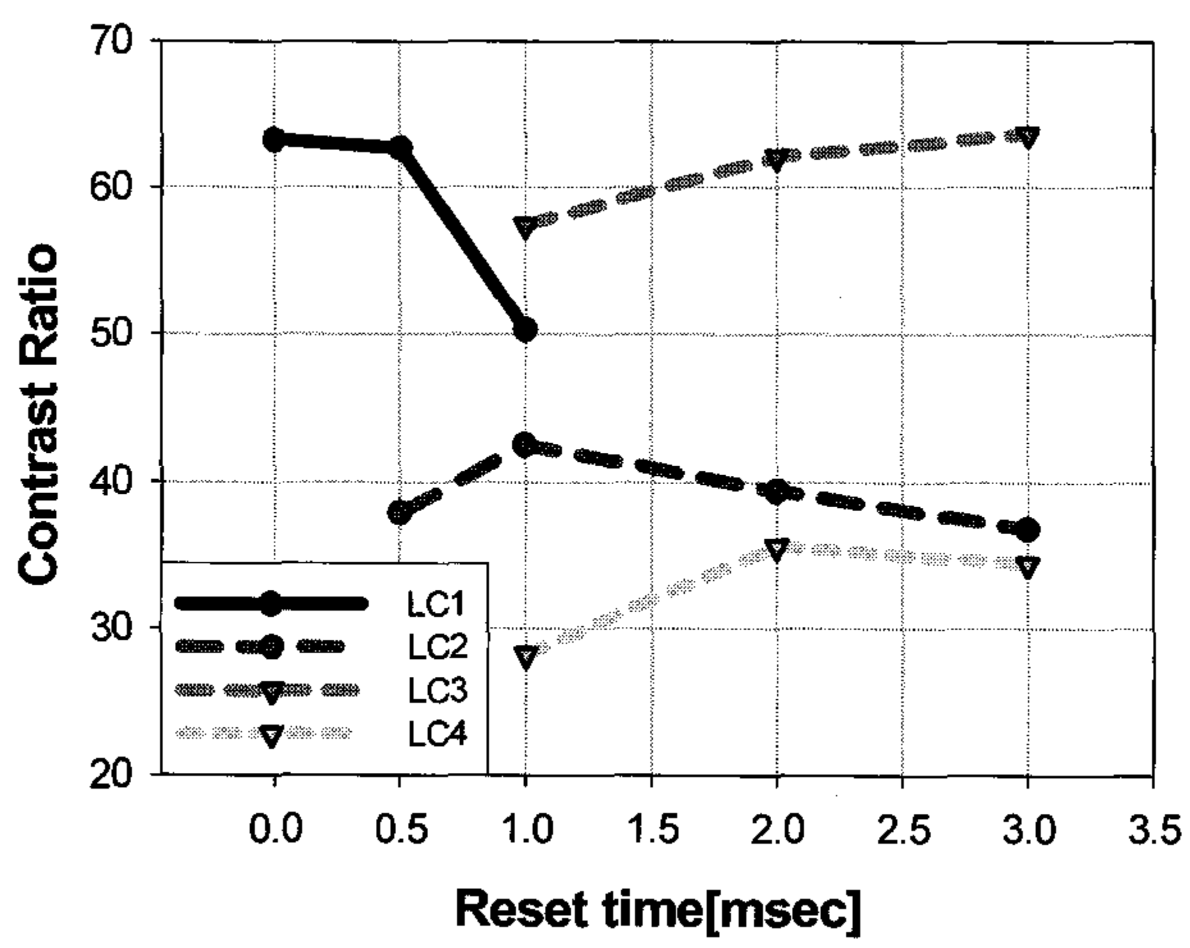

Fig. 2. The reset time dependence on the contrast ratio for several liquid crystals at 25 °C.

3.2 Flicker and the number of scan line

Flicker occurs in the display that is driven at a frame freguency of 60 Hz, because the two phases, +F, and –F, are not completely symmetric to each other, resulting in the display flickers with 30 Hz. In order to remove such flicker, the frame frequency was increased up to 120 Hz. However, for the selection period was short, and the brightness and the contrast ratio were deteorated.

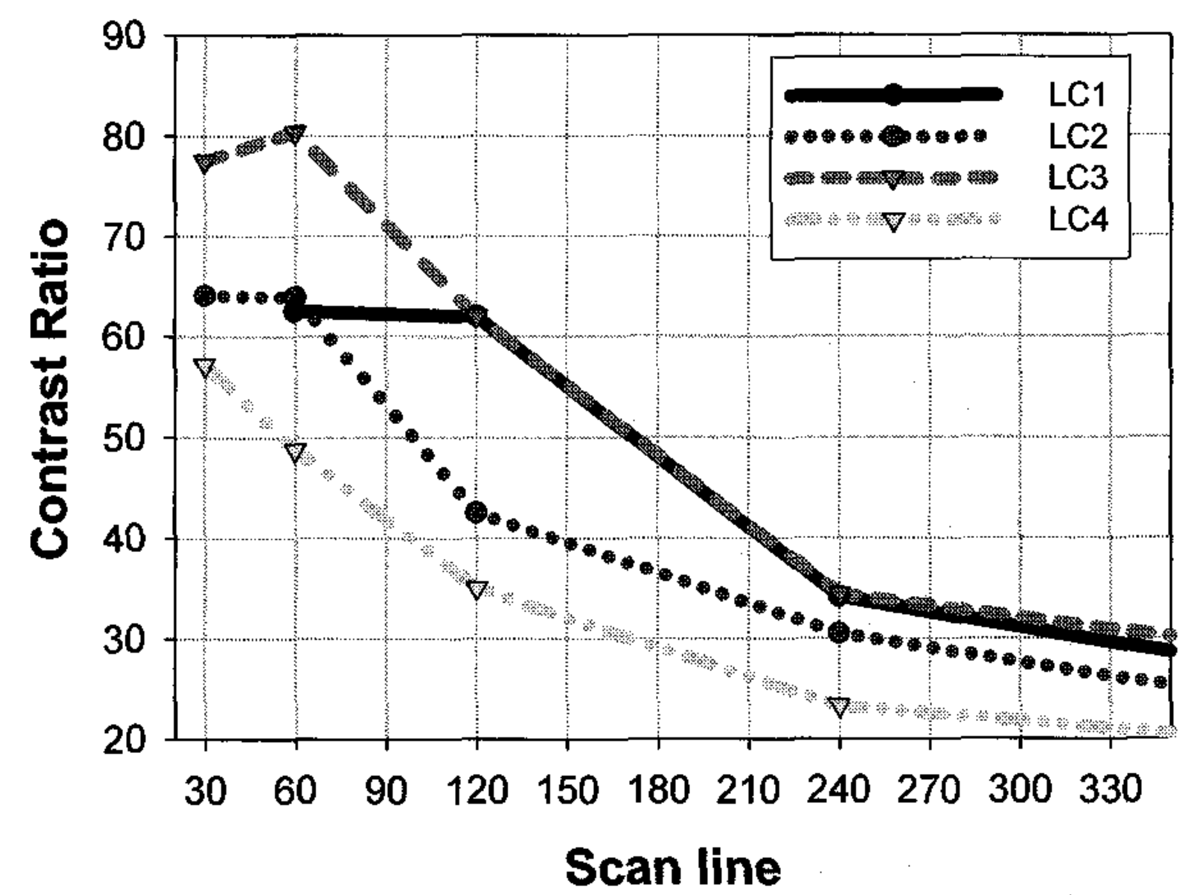

Fig. 3. The number of scan line dependence on the contrast ratio.

3.3 Crosstalk free driving method

Researches on the crosstalk in the STN-LCD have been actively undertaken so far. In the case of the STN-LCD, the crosstalk occurs due to both the voltage change of the ON/OFF applied in data line and the capacitance change of dielectric anisotropy of liquid crystal according to ON/OFF states. The crosstalk from the data line relates to the frequency and it can be removed to some degree by the modulation signal. The crosstalk from the capacitance change which usually occurs in the scan line.

In the AFLCD, the crosstalk, which usually occurs due to a small voltage change as in the STN-LCD, does not occur due to the hysteresis characteristics in non-selection period. But, since the scan voltage in non-selection period is not zero, the crosstalk occurs by actual voltage change according to data. Fig. 4(C1~C_4) shows the line inversion driving method in that the polarity of the scan voltage in each line converts. This line inversion of the scan voltage maintains the average

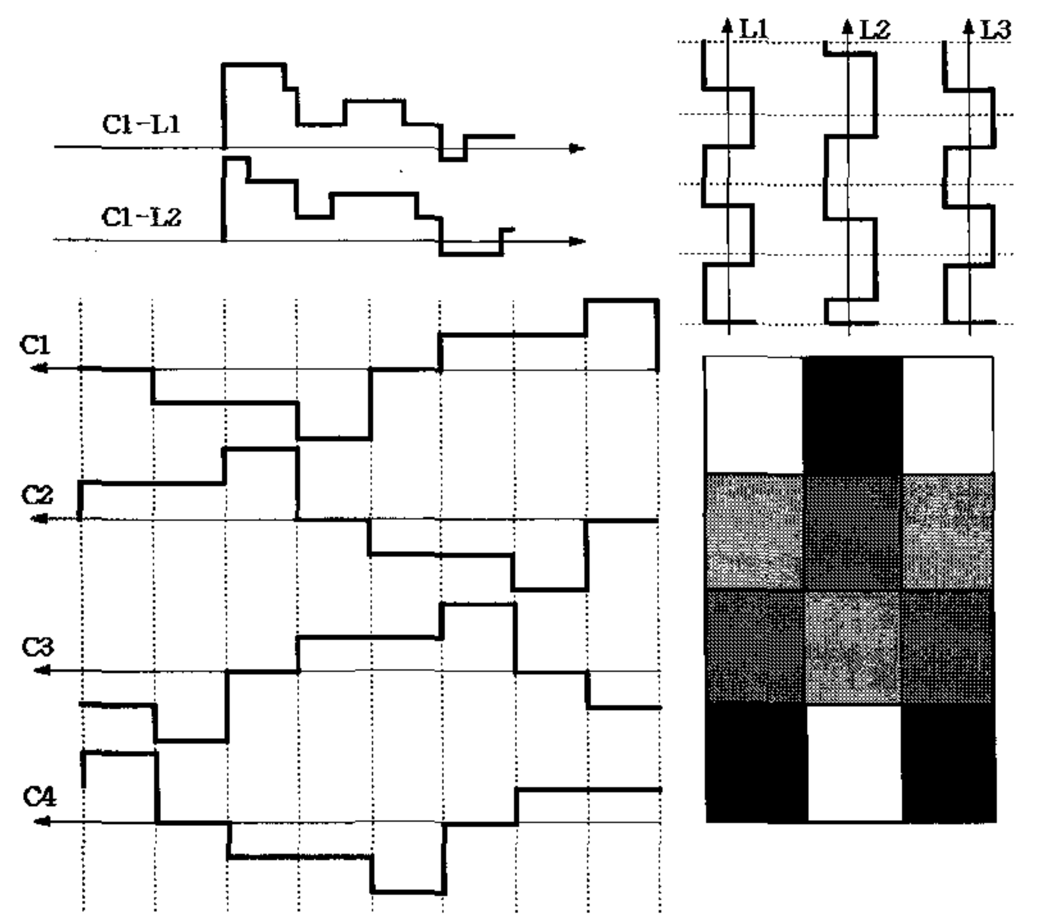

Fig. 4. Driving Scheme with line inversion method. C1~C_4 are line inversion method. L1~L3 show the data with pulse width modulation for gray scale.

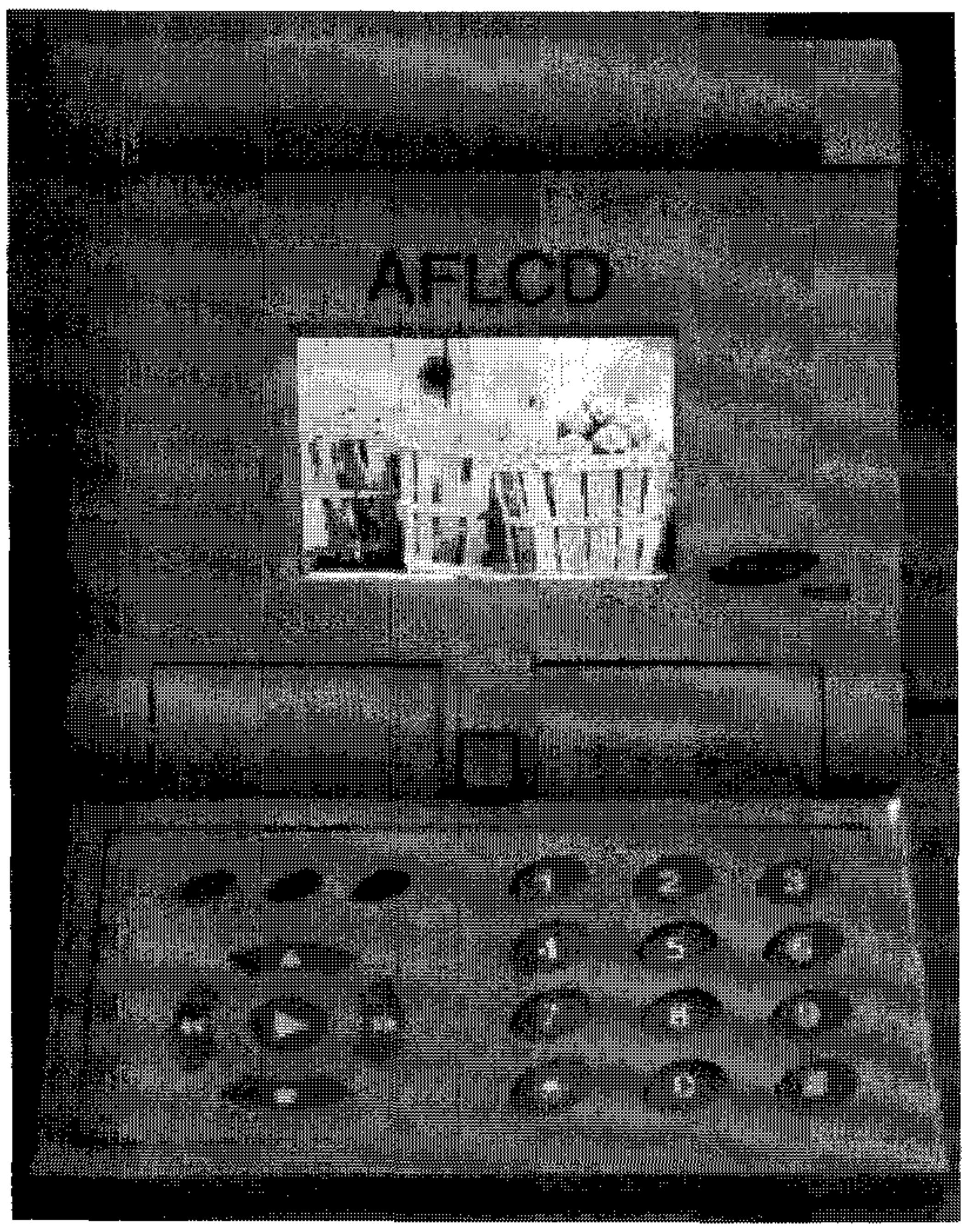

Fig. 5. The image of the AFLCD.

voltage constantly during the nonselection period. By doing so, we can use the same duty ratio and the entire selection period time. As a result, we succeeded in removing the crosstalk without any loss in the brightness and contrast ratio.

4. Conclusion

We realized an AFLC display of high quality by optimizing the driving waveform and introducing a dual driving method. Crosstalk was removed through the line inversion method. Flicker was also removed by increasing the frame frequency. We succeeded in driving a 2.8 inch AFLCD panel which is crosstalk- and flicker-free, and has 160(RGB)×240, 32768 color. The contrast ratio of the display was greater than 60:1 and the brightness was above 200 cd/m^2.

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