

AMLCD for TV Applications - New Challenge for LCD -

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Abstract

As technology level of TFT-LCD advances, application to TV becomes an emerging important area for LCD makers. In this paper, we review current LCD technology level to be used in TV such as liquid crystal response behavior, color accuracy, contrast ratio, brightness and panel size. Based on the understanding of current limitations in LCD compared with CRT, the improvement plan to render 'near perfect motion picture' reproduction with LCD is proposed. Digital TV is a great opportunity for digital LCD panels, but we have to solve remaining technical and cost issue in order to be competitive with other large size TV technologies such as PDP, CRT or projection type. In preparing the upcoming digital TV era with advanced TFT-LCD, the hurdles and prospect of larger size LCD-TV panels will be discussed.

Introduction

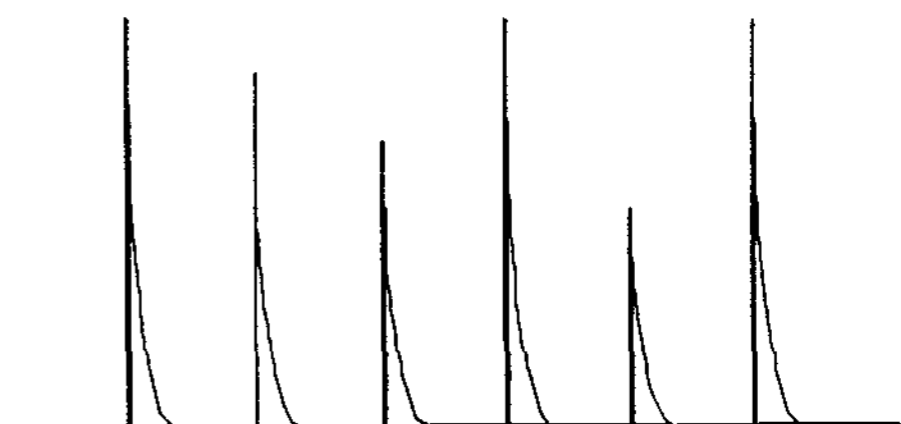
LCD-TV is an interesting but difficult subject because the field is relatively new and it has no absolute correct answer yet. However, LCD-TV is considered as a new important business territory for future growth of TFT-LCD industry. Even though current market size for LCD-TV is very small, it has a great potential for growth opportunity sometime after year 2002 as indicated in Table 1.

Requirements for LCD-TV

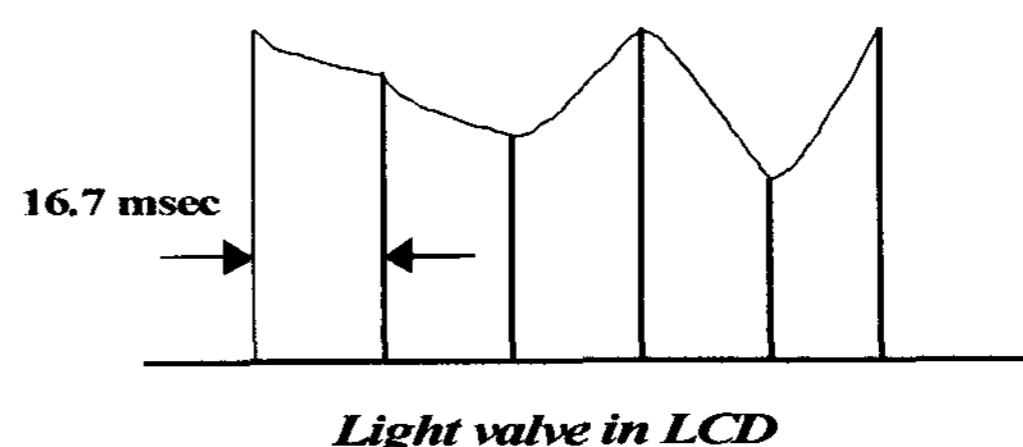
First, most concerned area is liquid crystal response time in order to accurately reproduce fast moving pictures. In principle, liquid crystal response time should at least faster than one frame time, 16.7 msec to eliminate the image dragging effect. Then, first question is "fast than 1 frame time is enough?" The answer at this time being is "may be not". Basic difference between CRT and LCD exists. We have to understand this difference in order to solve the problem of LCD-TV full motion picture dilemma. In CRT case, the decay time of phosphor is fast enough not to leave residual image on the screen. But in LCD case, the previous image will remain until next frame image overlaps because the liquid crystal maintains its position as described in Fig. 1.

Table 1. market segment for TFT-LCD

	1998	1999	2000	2001	2002
LCD Note PC	15.5M	18.2M	20 M	23.4M	26.6M(unit)
LCD Monitor	1.4M	4.7M	7M	10M	15M
CRT Monitor	70M	80M	91M	103M	116M
CRT-TV	131M	135M	138M	141M	145M
LCD-TV (8.4" Over)		190K (0.14%)	350K (0.25%)	700K (0.7%)	1.4M (0.96%)



Phosphor emitter/ decay in CRT



Light valve in LCD

We can find many advantageous characteristics of TFT-LCD over CRT when we consider LCD-TV. In spite of these advantages, there are many obstacles for TV application with LCD in the area of;

- LC response speed
- White coordinate
- Color rendition
- Higher contrast rate
- Brightness
- Screen Size

These items must be improved before we apply to TV.

Fig.1 Difference between CRT vs LCD for motion picture

Conclusion

Currently, there are 4 wide viewing angle technologies available that can be candidate to the LCD-TV. These are PVA, Super V, IPS, and MVA. Each technology has its own advantages, but we believe that even the best candidate is not fast enough for immediate TV application. Gray to gray response time is actually more important than total response time to represent the motion picture.

We believe that even 25 msec gray to gray may be not fast enough to express motion picture like CRT. We believe 15 msec gray to gray speed is required.(Fig. 2).

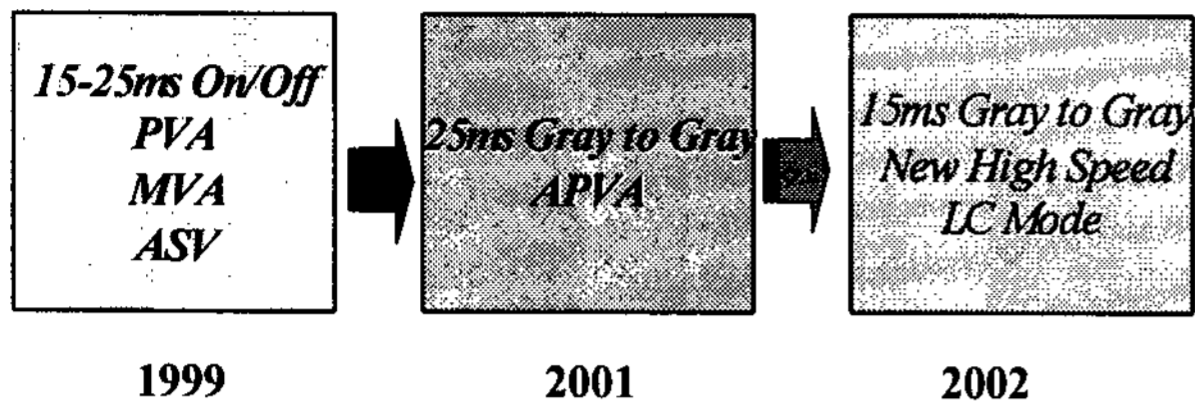


Fig 2. LC speed improvement for full dynamic picture

Next important area for TV is color reproduction. In reproducing the natural color, color temperature, white balance and gamma correction of the display are critical factors. Unbalanced color can easily misrepresent the actual scene.

TV needs higher brightness and contrast ration compared to monitor. The screen brightness requires at least 350 cd/m². In order to reproduce the details in dark image, the range of black to white must be wide. In TV, color reproduction over 70% of NTSC and color temperature over 9000K is generally required.

Manufacturing larger size panel

TFT-LCD has many advantages over other display technologies especially in the area of contrast ratio and power consumption. The manufacturing cost of LCD panels is directly related to the panel yield, on the other hand, the manufacturing cost of PDP is related to other than yields issue. The critical issues for larger LCD panels are focused to yields. 40 inch wide TV will be truly HDTV, it is feasible to fabricate with current TFT-LCD technology.

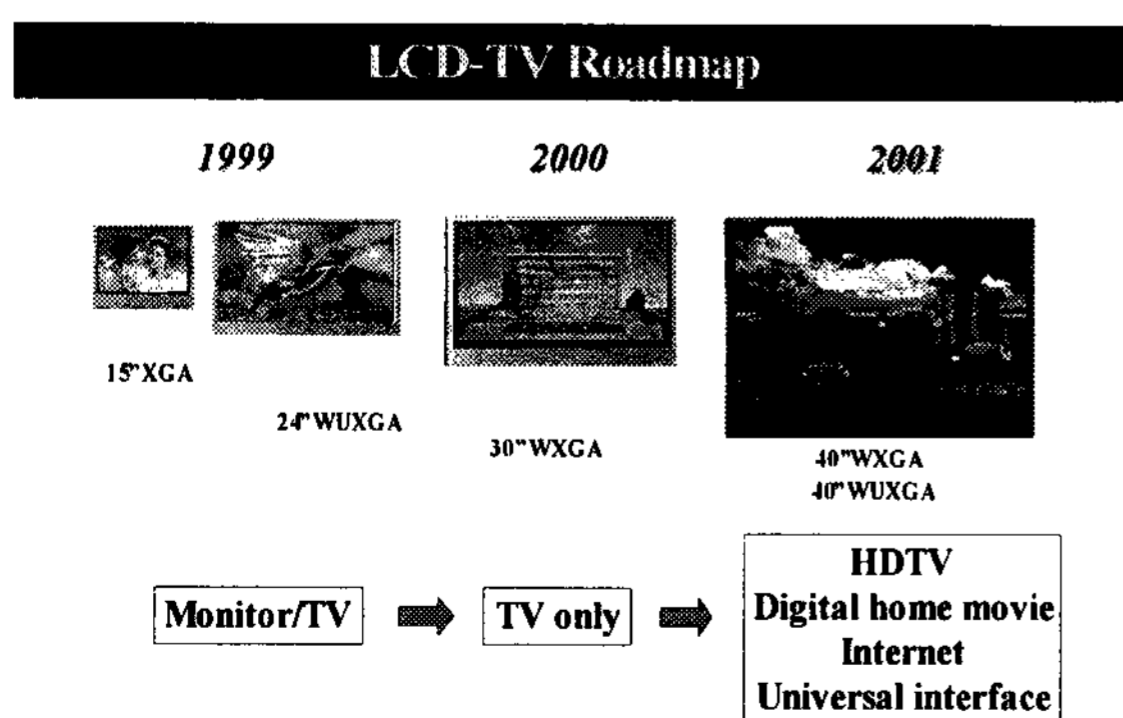


Fig 3. LCD-TV roadmap

In addition to the previously mentioned requirements in LCD-TV application, LCD panels for LCD-TV should be different to LCD monitor panel in many respect. Current LCD panels are made for the purpose of reproduction of stationary pictures and letters. In order to represent motion pictures as in TV, we have to develop best LCD panel structure for that purpose. A slight modification of pixel shape can enhance the curvature in the image. For example, a modified delta color filter array might be one of the solutions. Driving method for LCD-TV should be different in order to compensate the disadvantages of LCD.

In addition, back light system is important because it determines color temperature and color rendition range and brightness. Since the lifetime and brightness of the lamp are the minimum requirement for TV application, the backlight system needs significant improvement.

In conclusion, we have many technical issues in LCD-TV applications, however, these issues can be solved within two years. We have a tremendous opportunity ahead of us in LCD-TV area.