The Novel OverDriving Technology with Optimum Look-Up-Table

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Abstract
The proposed Novel OverDriving Technology with Optimum Look-up-Table (LUT) is suggested to be a better solution to reducing the occurrence of overshooting caused by the traditional overdriving method implemented to normally liquid crystal (VA mode). Chunghwa Picture Tubes, LTD. (CPT) has successfully implement this tech into 20 inch TFT-LCD TV module at the present day. The proposed technology can speed up gray-to-gray response time of LCD less than one half of frame time. On the side, Optimum LUT construction apply the compression scheme to record total actual grayscale transfer characteristics instead of applying the normal spread method such as linear / non-linear interpolation. The memory space is been reduced and the distortion of the image quality is lesser.

1. Introduction

1.1 Background
Because LCD is becoming more and more public applied to display the motion image, moving picture quality like CRT is therefore an important issue for television displays.

1.2 The defects of previously overdriving method
It is categorically that compared with the CRT, LCD has the low quality of motion image like blur caused from the problem the response speed of liquid crystal is too slow to arrive at the target luminance that is desired. Presently, different overdriving technology [1] [2] and fast response liquid crystal have been applied into LCD to reduce the gray-to-gray response time and to display high quality motion image.

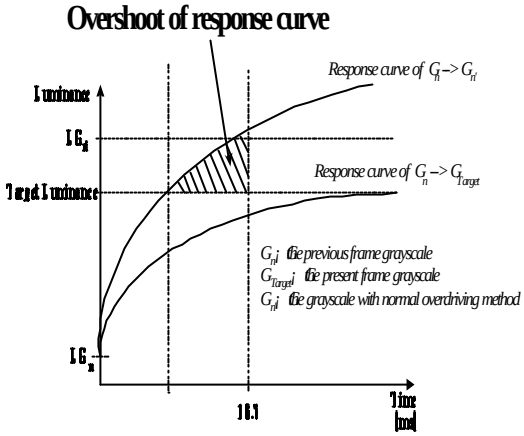

Fig. 1: The response curve of normal overdriving with traditional method

However, the response time of LCD is limited by the liquid crystal characteristic with the traditional overdriving method, so if we reduce the response time of LCD using normal method, the problem of overshooting such as Response curve of Gn --> Gn' shown on Fig.1 will occur, and this phenomenon will cause the distortion of display image

In addition, the EEPROM of normal overdriving method such as LUT has only stored the part of the TFT-LCD panel's response characteristic. For example, the LUT matrix format of 8 x 8 means that the dedicated sections of total gray-to-gray response curve are definitely defined. Likewise, a lot of grayscale transferences are computed by some arithmetic methods such as linear or non-linear interpolation or another. The result of interpolation has critical difference from real characteristic of liquid crystal. Using the normal overdriving with traditional method to improve LCD response time less then half of frame time (ex: < 8 ms) will cause the overshooting of response curve and vision destruction.

2. The Novel OverDriving Technology with Optimum LUT

The Fig.2 illustrate the common overdriving block diagram. The SDRAM is the frame memory to store the previous frame pixel data. The EEPROM involves the LUT established from some dedicated grayscale transfer of LCD panel characteristic, and the overdriving ASIC has some mechanism to compare the difference of pixel data between the previous frame and the present frame. Then the desired grayscale value of overdriving is decided by computing with the parameter of LUT. The structure of the " Novel Overdriving Technology with Optimum LUT " is the same as Fig. 2, but the effect of reducing the response time and improving the quality of vision is better than that of the tradition overdriving method.

To remain the vision quality, the parameter of TFT LCD panel characteristic established on Optimum LUT is defined with the **total grayscale transfers**, and a compression technique is adopted to reduce the EEPROM space.

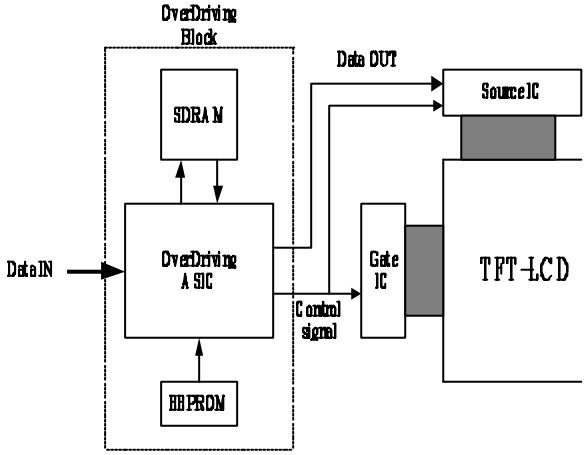

Fig. 2: The overdriving block diagram

This is the optimum method to decide the overdriving value without inaccuracy of the actual liquid characteristic because of the tradition method such as linear or non-linear interpolation or another processing method is too contrived to represent the actual grayscale transfer. In other words, we define the parameters of Optimum LUT by measuring the **total actual grayscale transfer characteristics** and using compression method to save LUT space size. Therefore, all of the grayscale response curves have been approximated to the actual liquid transfer characteristic. In the overdriving schema aspect, the Novel Overdriving Technology apply the double scanning driving method referring to accurately gray-to-gray transfer characteristic stored in Optimum LUT. At first scanning, the response time set foot on the target luminance less than one half of frame time. Then, second scanning overcomes the overshooting of response curve. Consequently, the gray-to-gray response time will be shortened effectively with maintaining the quality of image simultaneously by using the novel overdriving technology with Optimum LUT.

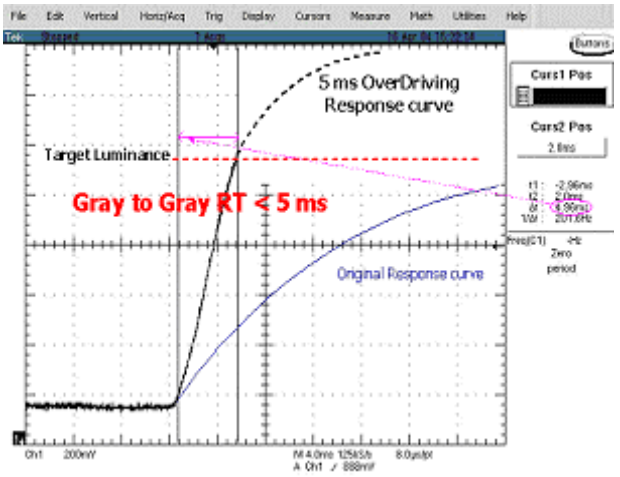

Fig. 3: The response curve of novel overdriving method

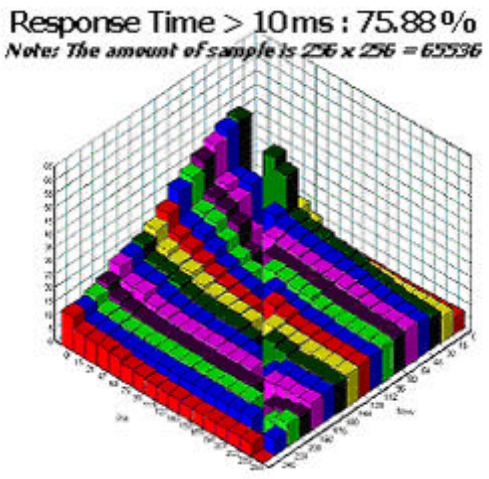

Fig. 4: The original response result without overdriving

Fig. 5: The original motion image without overdriving

3. Result

The Fig.4 and Fig.6 point the optical response results of CPT 20 inch TFT-LCD panel with VA mode liquid crystal, the Novel Overdriving Technique with Optimum LUT has been integrated into timing controller ASIC located with related circuit blocks on the control board (COB). Fig. 8 is the picture of COB substantiation. Referring to the measure result of Fig. 4 and Fig. 6, among the amount to 65536 gray-to-gray transfer samples, the original response time is about 75.88 % greater than 10 ms. On the contrary, about 97.81 % of samples' response time is less than 5 ms by novel overdriving with optimum LUT. (The response time less than half of frame time is a better result concerning the quality of motion image than that with only less than one frame time.) Moreover, reducing gray-to-gray response time less than one half of frame time using novel overdriving with optimum LUT can overcome the overshooting drawback against the traditional overdriving method without optimum LUT.

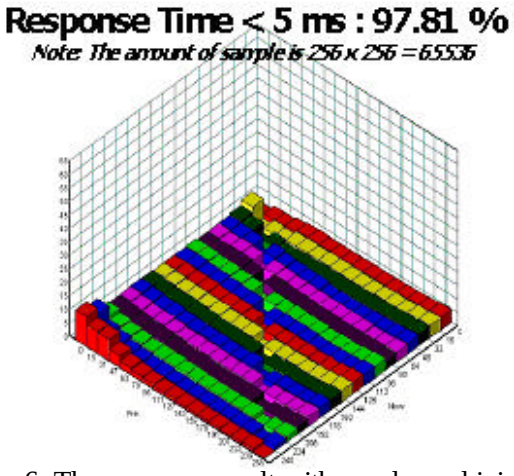

Fig. 6: The response result with novel overdriving technology

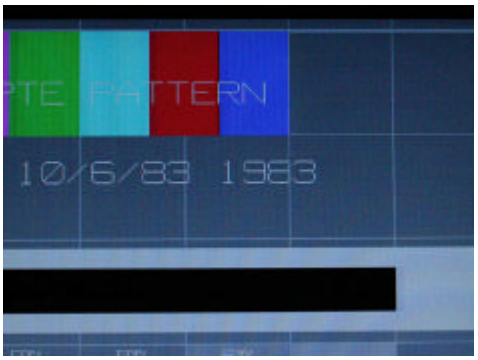

Fig. 7: The motion image with The Novel Overdriving

4. Conclusion

To reduce all gray-to-gray response time of TFT-LCD panel and improve the motion quality, a number of overdriving methods have been introduced. However, some faults such as color shift as a result of using those methods, which are without optimum LUT, will occur. We establish the optimum LUT by measuring all grayscale transfer characteristic and reducing the Optimum LUT size to save EEPROM space. Therefore, the novel overdriving technology with optimum LUT can be suitable in the common driving block diagram without changing driving method of TFT-LCD panel. We have applied this novel overdriving technology with optimum LUT into 20 inch LCD TV module already, and about 97 % of total gray-to-gray response time is less than half of frame time, with a remarkable result of less than 5 ms without motion image destruction.

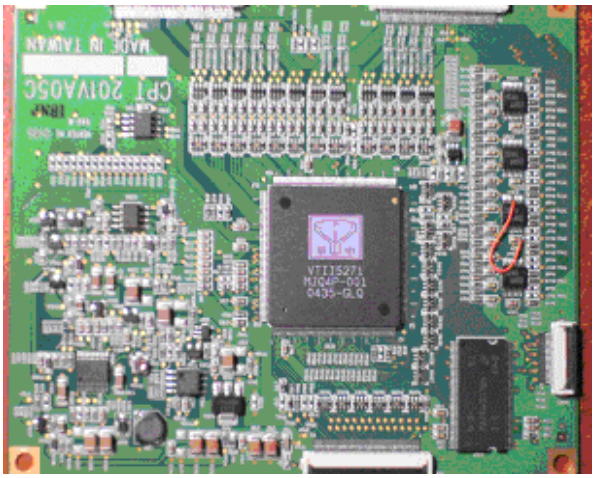

Fig. 8: The COB with novel overdriving technology ASIC

5. References

[1] K. Kawabe and T. Furuhashi and Y. Tanaka：” New TFT-LCD Driving Method For Improved Moving Picture Quality”, SID 01 35.4

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