대형 TFT-LCD용 SDI 신호 생성기의 개발

최대섭*, 신호철** 정회원

Development of SDI Signal generator for Large size TFT-LCD

Dae-Seub, Choi*, Ho-Chul, Sin** *Regular Members*

요 약

최근 TFT-LCD TV를 구동하는데 있어서 비발광소자인 LCD의 응답특성을 개선하기 위해서 많은 연구가 진행되고 있다. 특히 기존의 1 Frame 의 시간주기를 보다 작게 나누어 구동하는 방법에 대해서 많은 연구가 진행되고 있으며, 이 경우 화면을 구성하는 데이터의 양이 많이 소요됨과 동시에 드라이버 IC의 구동 속도가 문제가 되고 있다. 기존의 차동신호를 바탕으로 한 TFT-LCD 구동신호는 이러한 문제에 대응하는데 문제가 있으며, 본 연구에서는 Full HD를 Quad 쌍으로 구동하는 고속 구동을 위해서 기존의 신호전송방식이 가지고 있던 많은 입력선 수를 효과적으로 줄이기 위해서 직렬 데이터 전송방식의 Full HD Generator 를 제작하여 평가하는데 목적을 두었으며, 평가 결과 육안으로도 잔상이 없는 고속구동이 가능한 직렬 데이터 방식의 구동 설비를 제작할 수 있었다.

Key Words : Serial Data Interface, Full HD, SDI Generator

ABSTRACT

In applying LCD to TV application, one of the most significant factors to be improved is image sticking on the moving picture. LCD is different from CRT in the sense that it's continuous passive device, which holds images in entire frame period, while impulse type device generate image in very short time. To reduce image sticking problem related to hold type display mode, we made an experiment to drive TN-LCD like CRT. We made articulate images by fast refreshing images, and we realized the ratio of refresh time by counting between on time and off time for video signal input during 1 frame (16.7ms). Conventional driving signal cannot follow fast on-off speed, so we evaluated new signal generator using SDI (Serial Data Interface) mode signal generator. We realized articulate image generation similar to CRT by high fast full HD (High Definition) signals and TN-LCD overdriving. As a result, reduced image sticking phenomenon was validated by naked eye and response time measurement.

I. Introduction

Recently, the demands of LCD (Liquid Crystal Display) for TV increase rapidly and image quality of LCD TV at the level of existing CRT is actively investigated[1-3]. One of the most necessary factors to adapt LCD for TV is to present image without residual image. LCD operation-mode for images without residual image has been investigated for a couple of years and this has resulted in profound investigation for VA, SSFLC et al. However, if response time of LCD becomes faster, residual image problem still remains because LCD only control transmittance of light from background light source. And this problem is more prominent for TV, which displays mainly moving images while PC monitor displays still image. So, it needs another aproach to improve residual image problem. That is to provide discontinuous images as like CRT with LCD operation-mode of fast response. To achieve discontinuous image similar to CRT, high fast signal transportation methode was used as dual or quad signal division. However, difficulties arise in fast signal transportation because it costs many numbers of signal lines and high cost. At present technology, electrical circuit have to reduce their structure because low cost

* 서일대학교 전기과(choids@seoil.ac.kr), ** 삼일이엔씨
※ 본 논문은 2012년 서일대학 학술연구비에 의해 연구되었음
접수일자 : 2014년 1월 13일, 수정완료일자 : 2014년 3월 5일, 최종게재확정일자 : 2014년 3월 7일

design is strongly needed characteristics for enrich products sales.

In this paper, we investigated high speed drving signal transportation system by serial deta line. and it must support divided high resolution image data. SDI in invented for these needs but it adopted limited fields such as endoscope. because conventional SDI is using medical display for reducing data lines. It thought that SDI is best solution for reducing patients suffer as because serial data transportation method makes reducing data lines and it capable for thin endoscope. But we adopted this format to save circuit and TV costs as reducing data lines. [4-9].

Ⅱ. Simulation and Experimental

SDI simulated board consists below 9 parts as fig. 1.

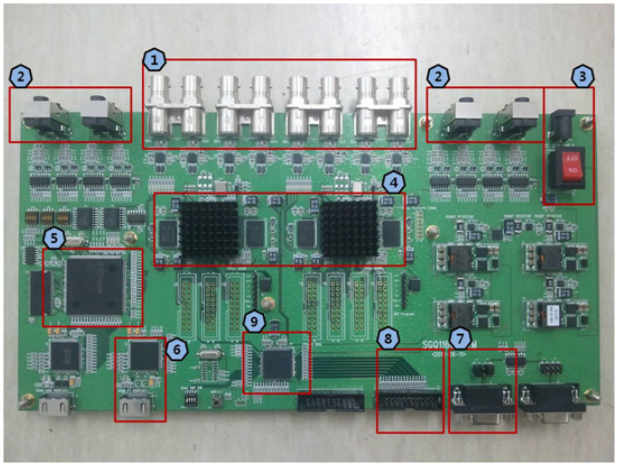


Fig. 1. SDI Board using for simulation

① HD-SDI Input Part : Input port support 1 GHz data swing speeds and 800mVp-p input voltages and it might be needed reflection phenomenon, 75Ω impednce applied. It shows stable drving as fig. 2.

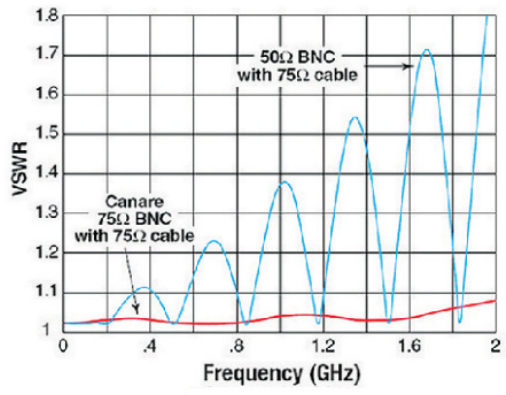


Fig. 2. VSWR curves by impedance matching

② Audio Output Part
③ Power Jack and Power Switch
④ FPGA IC : FPGA works data processing and generating SDI signal. We used SPARTAN-6 from XILINX CO., Ltd.
⑤ OSG Generating IC
⑥ HDMI Transmitter
⑦ Key Board Connector
⑧ Debugging Connector
⑨ MICOM IC : MICOM controls every function of this simulation baoard and we adopted 32-bit ARM MCU

Ⅲ. Results and Discussion

Table 1. show FPGA design. we designed FPGA using XC6SLX45T (Xilinx CO., Ltd) for 74,637 logic cells and 93,296 distributed RAM.

Table 1. XC6SLX45 feature summary

Device	Logic Cells[1]	Configurable Logic Blocks (CLBs)			DSP48A1 Slices[3]	Block RAM Blocks		CMTs[5]	Memory Controller Blocks (Max)[6]	Endpoint Blocks for PCI Express	Maximum GTP Transceivers	Total I/O Banks	Max User I/O
		Slices[2]	Flip-Flops	Max Distributed RAM (Kb)		18 Kb[4]	Max (Kb)						
XC6SLX4	3,840	600	4,800	75	8	12	216	2	0	0	0	4	132
XC6SLX9	9,152	1,430	11,440	90	16	32	576	2	2	0	0	4	200
XC6SLX16	14,579	2,278	18,224	136	32	32	576	2	2	0	0	4	232
XC6SLX25	24,051	3,758	30,064	229	38	52	936	2	2	0	0	4	266
XC6SLX45	43,661	6,822	54,576	401	58	116	2,088	4	2	0	0	4	358
XC6SLX75	74,637	11,662	93,296	692	132	172	3,096	6	4	0	0	6	408

And we designed 4 ports of SDI interface because it worked quad signal inputs for high speed driving as Fig. 3.

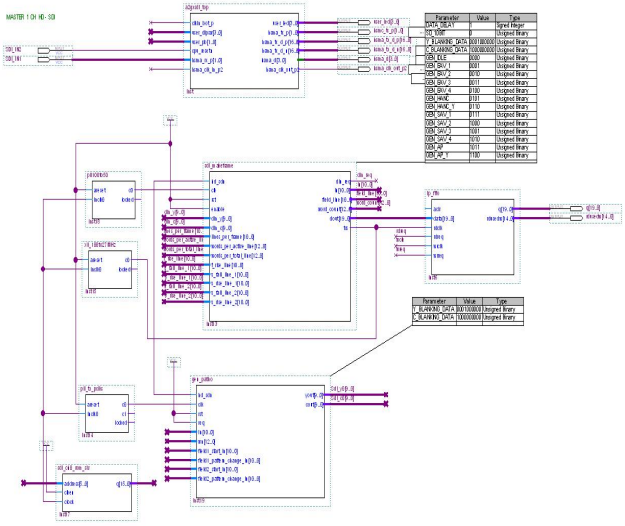


Fig. 3. HD-SDI input block design per each channel

In Fig. 4., 5., each Color images show significant

different residual characteristics and duration display time of Red and Green raster images. Conventionally, red and green images make a strong stimulation in human eyes. It shows significant improving results than conventional TV display. In Table 2, duration times of residual imagest are summarized before & after improvement of corresponding phosphor.

Table 2. Duration time of residual light before and after improvement with respect to phosphor [9].

	Red Raster	Green Raster	Blue Raster
Before	4.7 ms	4.5 ms	**1 ms**
After	**2 ms**	1 ms	Not evaluated

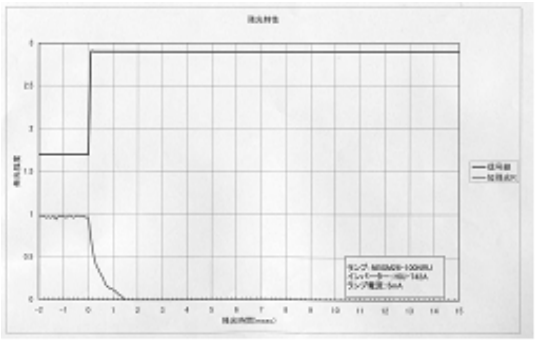


Fig. 4. Redual time curves in red raster

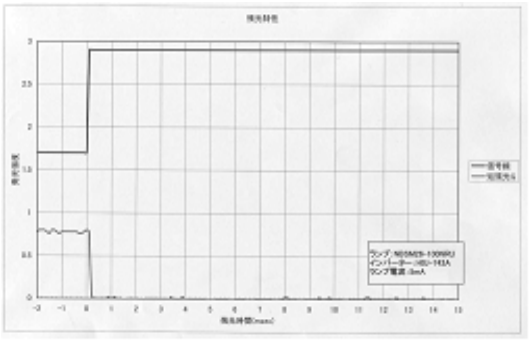


Fig. 5. Redual time curves in green raster

We inserted black for improving moving images using discontinuous driving as it called blinking section. Reduced residual image has brightness of 20% smaller than that of conventional image and there is more reduction of brightness by blinking operation. So, to verify the effect of blinking driving in LCM, a prism sheet is added to get higher brightness.

Blinking signal is applied to driving signal with being synchronized with Vsync signal and it divided 1 frame to 60% turn on time and 40% turn off time. To get the same brightness to conventional backlight was over-driven from general 6mA to 10mA.

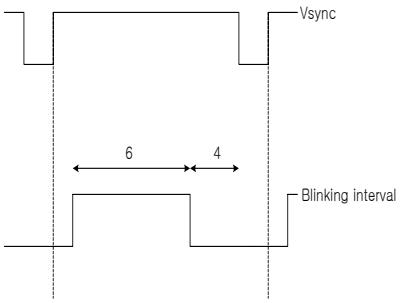


Fig. 6. Generating blinking signal using Vsync signal

In case of 32 inch full HD (1920×1080 resolution), there is 1920 de(data enable) signal within 1 frame and blinking signal is generated by counting de signal. To get proper timing, delayed de signals d_de and dd_d were made from flip-flop as shown in Fig. 6.

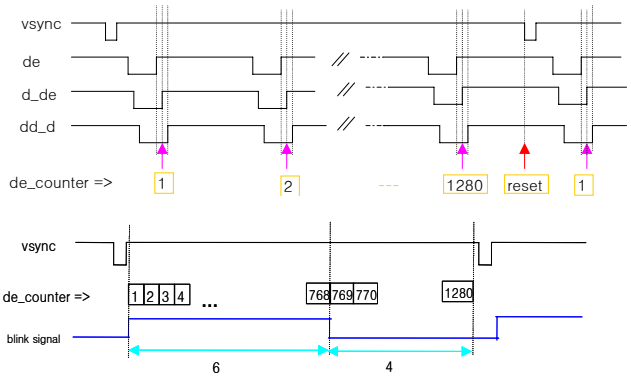
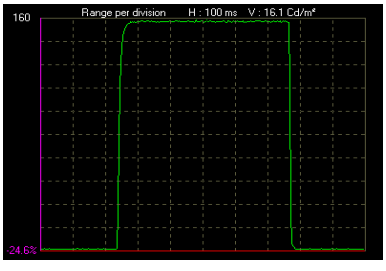


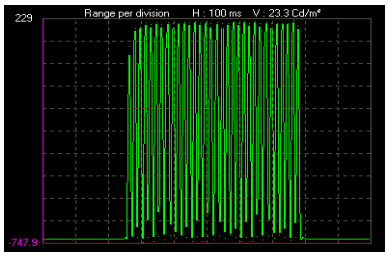
Fig. 7. Generating blinking signal using de signal counting

6:4ratio of white-period to black-period was obtained by appointing 1152(60%) dd_d's of 1920 as white-period and 768(40%) dd_d's as black-period. This method is very simple algorithm to get stable blinking signal at Vsync.

Display quality with blinking backlight was evaluated by measuring response waveform and by nakedeye. Fig. 8 represents response characteristics with and without blinking drive. Black screen is successfully inserted made by blinking drive as shown in Fig. 6 (b), and effect on image sticking in moving picture was excelled. Figure 9 is photograph of vertically moving image with 1/22.8sec shutter speed.

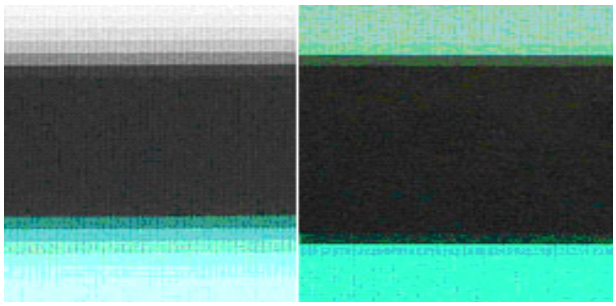


(a) Conventional LCD driving.



(b) Blinking and overdriving LCD driving.

Fig. 8. Improvement of response characteristics in blinking & overdriving method.



(a) (b)

Fig. 9. Photographic result of conventional driving and blinking&overdriving method.

Figure 9 (a) is photographic result without blinking and Figure 9 (b) that with blinking and over-driving. In these photographs, improvement of residual image is easily verified.

Ⅳ. Conclusion

We studied improvement of image-sticking using SDI as high speed driving signal transportation and it worked generating flasher images by creating CRT-like moving picture image. Algorithm to make blinking signal with 6:4 ratio was proposed by using de counter with synchronized with Vsync signal. The improvement of dynamic picture image embodiment was verified by experimental results, and these results are expecting to be applied to the development of TV and Multimedia LCD hereafter.

Reference

[1] H. Zou, K. W. Besson, J. Wilson, S. Zimmerman, and M. McFarland, "Required and achievable backlight luminance for CRT-replacement LCD monitors", SID Digest 1997, pp. 373-376 (1997).

[2] T. Fukuzawa, T. Toyooka, Y. Sakaguchi, K. Takeda, and F. Yamada, "Rapid-response fluorescent lamps for field sequential full-color LCDs", SID Digest, pp. 247-250 (1998).

[3] J. F. Saver, M. V. Hoffman, and F. A. Hummel, "Phase equilibria and Tin-activated luminescence in strontium orthophosphate systems", Journal of the electrochemical society, pp. 1103-1110 (1961).

[4] T. Uchida, K. Saitoh, T. Miyashita, and M. Suzuki "Field sequential full color LCD without color filter for AM-LCD", IDRC Digest of Technical papers, pp. 37-40 (1997).

[5] A. C. Newport and A. Vecht, "Optimized photo-luminescent phosphors for UV-excited light-emitting systems", SID Digest 1998, pp.239-242 (1998).

[6] W. Sautter, T. Kallfass, G. Bader, and E. Lueder "A backlight system providing variable viewing angles for transmissive LCDs", SID Digest 1998, pp. 235-238 (1998).

[7] K. Hathaway, J. Hawthorne, and A. Fischer, "Advancements in backlighting technilogies for LCDs", SPIE Vol. 1664, High-Resolution Display and Projection Systems, pp. 106-108 (1992).

[8] Y. Mesaki, A. Sotokawa, A. Tanaka, M. Tomatsu, K. Kaiwa, H. Yuzu, and M. Kato, "New backlight technologies for LCDs", SID Digest 1994, pp. 281-284 (1994).

[9] Matsushita West Electric Co., Ltd.

저자

최 대 섭 (Dae-Seub, Choi) **정회원**

・1995 2월 : 북해도 대학교 대학원 박사
・1985년~현재 : 서일대학교 전기과 교수

<관심분야> : 정보디스플레이, 태양광발전, 이동무선통신

신 호 철 (Ho-Chul, Sin)

・1996년 2월 : St,Johns University Computer Science 석사
・2005년~현제 : 삼일이엔씨 이사

<관심분야> : 무선통신, 정보디스플레이, 안테나