

文章编号:1007-2780(2011)04-0464-05

Analysis of Horizontal Block Stripe in TFT-LCD Panel in Switching-off Process

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Abstract: The horizontal block stripe, as an image quality defect, was analyzed by means of output signals and bias voltage stress (BVS) test. The results showed that the defect was correlated with discharging efficiency. Further, two approaches were proposed, one was to improve TFT characteristic, the other was to add reset function. The combined experiments indicated that discharging promotion can improve the defect. Especially the latter is most optimal to eliminate the phenomenon.

Key words: horizontal block stripe; discharge; switch off; bias voltage stress; drain current

CLC number: TN27

Document code: A

TFT-LCD 关机横纹缺陷分析

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摘 要: 利用输出信号波形及偏压测试方法对 TFT-LCD 产品关机过程中发生的横纹不良进行了分析。分析结果表明, 不良与像素电极放电效率相关。在此基础上提出了两种改善方法: 一是通过改善 TFT 特性提高电极充放电能力; 二是通过添加 reset 驱动电路实现像素电极同时放电。试验结果表明, 放电效率的提升对于改善横纹缺陷效果明显, 其中后者可完全消除不良现象。

关 键 词: 横纹缺陷; 放电; 关机; 偏压测试; 漏电流

中图分类号: TN27

文献标识码: A

DOI: 10.3788/YJYXS20112604.0464

1 Introduction

Recently, flat panel display (FPD) devices have been used in various fields, such as mobile phones, PCs, televisions and portable multi-media players^[1]. Especially, TFT-LCDs are dominant by its lower power consumption, slimming and weaker radiation. However, as for LCDs, many application problems still degrade

its performances^[2-3]. Here, a horizontal block stripe defect is demonstrated. This defect can be detected when LCDs' power supply is switched off and it is strongly complained due to its impact on customers' experience. The phenomenon looks like a block stripe and disappears in 2~10 s. It is most serious in the case of 0 gray display images (dark state). An asynchronous discharge above array pixels is identified. To clarify the mechanism

收稿日期: 2010-03-11; 修订日期: 2010-04-08

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of this phenomenon, more experiments were made in detail and several countermeasures were brought forth and evaluated in the following sections.

2 Experiments and Analysis

The samples research are based on LCD panels with XGA-resolution (e. g. 15 in diagonally) that typically uses three gate drivers with 256 channels each. The abnormality is shown in Fig.1 and horizontal block occurs in random position.

Originally, panel keeps in the state of “Switch ON” and displays dark. Subsequently, the power supply is cut off and the block stripe is visible. Thereafter the display image turns to whiter (normal white mode) as panel discharges.

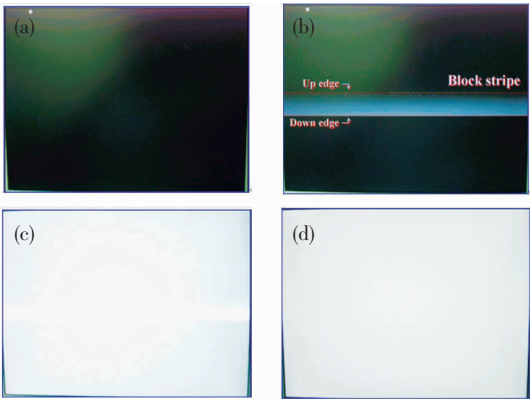


Fig. 1 Photographs of discharging course. (a) Original image(0 s); (b) On discharging(2 s); (c) On discharging(5 s); (d) Discharge over(10 s).

Ultimately, the display image becomes uniform and the block stripe is invisible.

2.1 Signal Waveforms

For this work, a digital oscilloscope (LeCroy WavePro 7100A) was applied to sampling the signal waveforms. The experimental waveforms are given as shown in Fig. 2.

The experimental waveforms validate the discharging course very well. After switched off, each functional unit starts to attenuate (point 1). However, due to slowly discharging, all units continue to operate until the power (V_{DD}) drops to a certain level in accordance with IC’s rated voltage (2’nd course). And later it takes a considerably long time to release the discharge loaded on panel pixels entirely (3’rd course).

It is considered that the block stripe is matching with the 2’nd course of waveforms. In this period, gate electrodes are normally turned ON or OFF with the addressing signal (CPV) line by line. This allows the corresponding drain electrodes to charge to the voltage present on the source electrodes. Nevertheless, owing to attenuating power (turn-on voltage V_{on} and turn-off voltage V_{off}), gate electrodes cannot be opened or closed so completely that it is difficult to charge to the voltage level expected and also hold its value (charge). Moreover, the voltage on source electrodes (gray level voltage) also

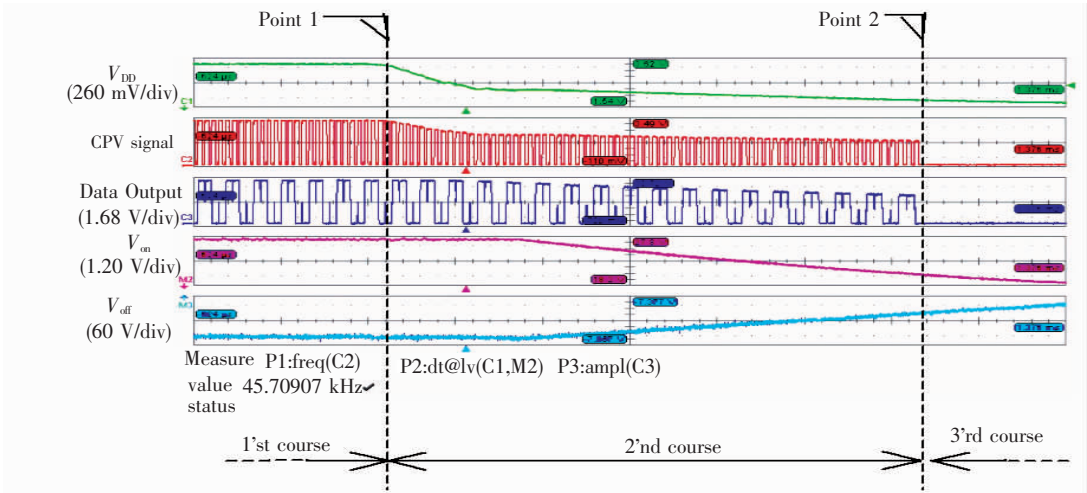


Fig. 2 Waveforms corresponding to discharging course

declines synchronously along with V_{DD} . In other words, gray level displayed becomes higher and higher (whiter image). In general, image becomes whiter and whiter which is referred to as “block stripe”.

At point 2, the addressing signal (CPV) stops and the display image freezes at the moment. In the 3’rd course, charges on TFT pixels gradually drain away spontaneously. The discharging speed just depends on the I - V characteristic of TFT (Thin Film Transistor).

2.2 Bias Voltage Stress Test

In order to verify the relationship of discharging speed and electrical characteristics of TFT, a bias stress test is done by means of semi-conductor parameter measurement system (YAF-3232M). Namely, a sustained DC is imposed on gate electrodes. The detailed condition is as follows:

$V_{gate} = -30\text{ V}, V_{data} = 0.1\text{ V},$

Time (h): 0, 0.5, 1, 2, 3 ...

The test result is summarized as shown in Fig. 3. It illustrates that discharge speed of TFT pixels increases with stress time.

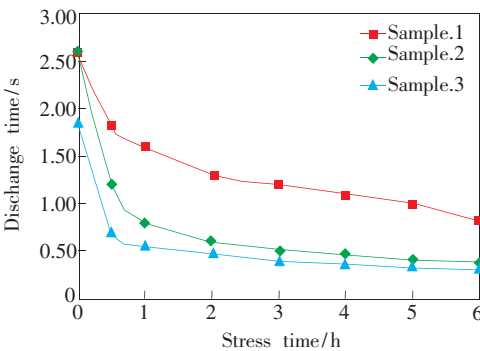


Fig. 3 Relationship of discharge time and stress time

Further, I - V characteristic of TFT is accomplished. The I_d - V_g transfer curve before and after a DC bias stress at regular intervals within five hours is shown in Fig. 4. Stressing leads to a positive rigid shift in the transfer curve. That is to say, drain current (I_d) increases following bias stress at a certain gate voltage (V_g , more than threshold voltage).

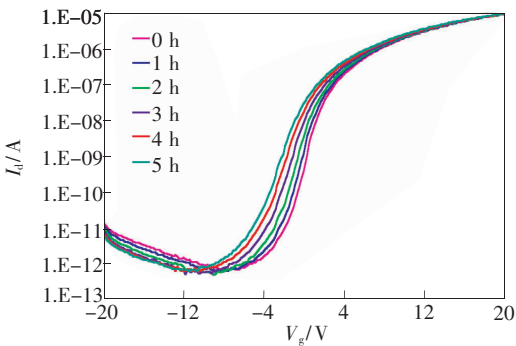


Fig. 4 I - V curves

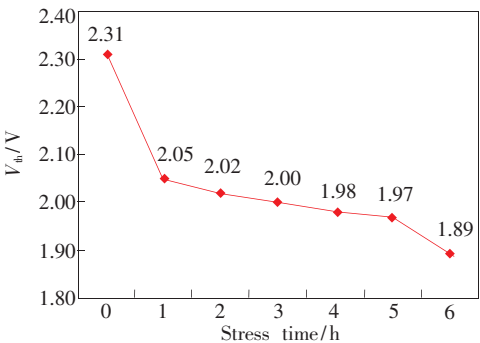


Fig. 5 Threshold voltage vs. stress time

Fig. 5 shows the threshold voltage of TFT (V_{th}) degradation during DC bias stress testing.

To sum up, discharge and TFT characteristic have close interaction mechanism and the better is TFT characteristic, the faster is discharge.

3 Discussions

3.1 TFT Characteristic

The configuration of TFT unit is shown in Fig. 6.

As is well known^[4], drain current of TFT is proportional to the factor of W/L . A theoretical equation is given as follows^[5]:

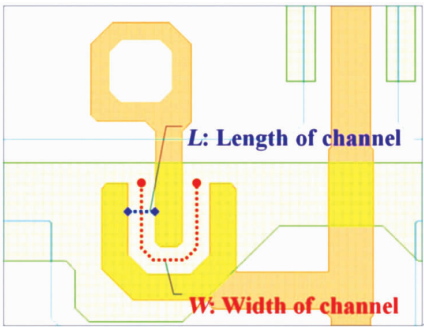


Fig. 6 Sketch map of TFT structure

$$I_d = \frac{C_{SiN} \times \mu_n \times W \times (V_g - V_{th})^2}{2 \times L} \tag{1}$$

Where C_{SiN} is capacitance of SiN_x (active layer); μ_n is carrier mobility; W/L is the ratio of width and length of TFT channel.

The drain current (I_d) with different W/L is simulated by Microelectronic Simulation Software (pspice) as shown in Table 1. However, W/L is restricted by aperture size of TFT pixels and it cannot be enlarged discretionarily. So, this has a limited effect upon the block stripe.

Table 1 Drain current vs. W/L

W/L	$I_d/\mu A$
5.32	2.84
5.50	2.90
6.06	3.03

According to section 2.2 and Equation (1), drain current is reverse proportional to the square of threshold voltage (V_{th}^2) and a bias stress imposed on gate electrodes is favorable to them. Thus, a bias voltage stress process is built in LCM production flow. The flow chart is demonstrated in Fig. 7. Correspondingly, an external driving interface is designed in the printed circuit board (PCB) as shown in Fig. 8. Through the BVS interface, external bias voltage is input onto gate electrodes. Based on mass production, the block stripe can disappear within 1 s after BVS of 3 h and it is acceptable for customers.

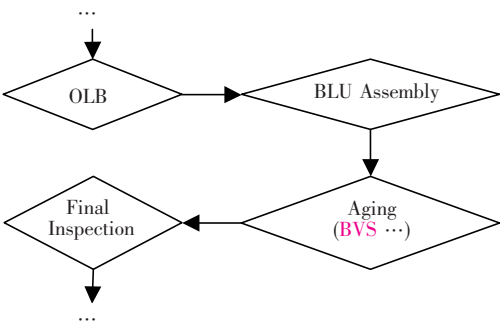


Fig. 7 Flow chart of LCM

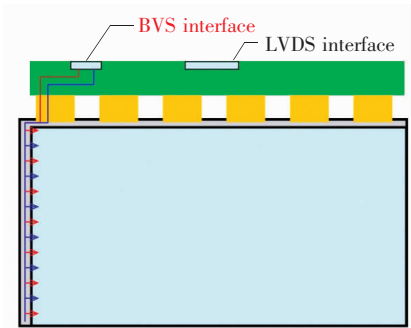


Fig. 8 Schematic of BVS interface

3.2 Driving Circuit Design

In addition, a reset function is provided to accelerate discharging as shown in Fig. 9. At first, reset output is consistent with V_{DD} . When V_{DD} falls to reset threshold (V_{th}), reset output is pulled down to 0 V. This voltage skip (trigger signal) is distinguished by gate drivers and all gate electrodes are synchronously turned to OPEN (V_{on}). As a result, charges on TFT pixels can flow out in tens of milliseconds. According to test result, no horizontal block phenomenon was observed.

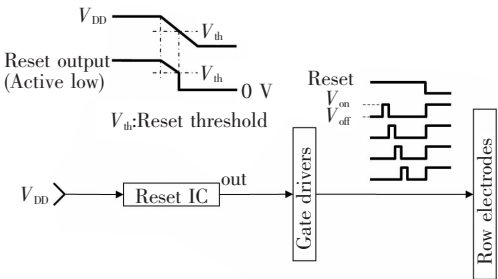


Fig. 9 Configuration of reset function

4 Summary

A horizontal block strip defect is investigated and it is concluded that the defect is attributed to slowly discharging. To improving discharging, the factor of W/L of TFT channel is discussed and a BVS aging is imported into LCM production chain. In addition, a reset function is introduced to accelerate discharging. The experiments indicated that the defect can be greatly improved and especially the latter is most optimal. It is expected that the significative approaches can be useful to practical industry production.

References:

[1] Uchida T,Ishinable T. Progress of the high performance LCD[C]//*Proceedings of IDW’08*,Niigata,Japan;International Display Workshops,2008:1531-1534.

[2] Hong Sunkwang,Oh Jaeho,Park Poyun,*et al.* Enhancement of motion image quality in LCDs[C]// *SID’04 Symposium Digest* ,San Jose,USA;SID,2004:1353-1355.

[3] De Ridder H. Image processing and the problem of quantifying image quality[C]//*ICIP 2001 Proceedings*,Thessaloniki,Greece;IEEE Signal Processing Society,2001:3-6.

[4] Lin L,Liang B J. Charge-discharge identified time extension driving method[C]//*SID’06 Symposium Digest* ,San Francisco,USA;SID,2006:370-373.

[5] Miwa K,Maekawa Y,Tsujimura T. V_{th} shift overcompensation in AMOLEDs for differential aging compensation [C]//*SID’09 Symposium Digest* ,Texas,USA;SID,2009:1148-1151.



物理量量值表示法

物理量量值必须用阿拉伯数字表示。按规定,阿拉伯数字后的单位必须使用我国法定计量单位,在非普及性的科技书刊中,还应使用单位的国际符号。例如:1 m, 5 d,12 m²,4 A,2 000 m³/s,273 K,100~150 kg,30 多 V,400 余 t 等。

在非普及性的科技书刊中,非量值情况下也使用单位的国际符号。例如:“速度的单位为 m/s”,“每 mL 溶液……”等,只要不会引起误解,单位的国际符号可以用于一切使用单位的场合。

对于非物理量的量词前面的数字,一般也应使用阿拉伯数字,包括整数一至十。例如:1 支铅笔,2 台电视,3 组数据。

组合单位加词头的规则

- a. 通过单位相乘构成的组合单位,通常词头加在第 1 个单位前面。例如:N·s 加词头 k,应为 kN·s。但常见的法定单位中有 2 个单位例外。一个是电阻率的单位 $\Omega\cdot\text{m}$,通常写成 $\text{k}\Omega\cdot\text{m}$, $\text{M}\Omega\cdot\text{m}$,但当加词头 c 时,则要写成 $\Omega\cdot\text{cm}$;另一个是货运量单位“吨公里”写成 $\text{t}\cdot\text{km}$ 。
- b. 通过单位相除或相乘除(分数形式)构成的组合单位,词头一般加在分子的第 1 个单位前,分母一般不加词头。例如:摩尔熵单位 $\text{J}/(\text{mol}\cdot\text{K})$ 加词头 k,应写成 $\text{k J}/(\text{mol}\cdot\text{K})$,不能写成 $\text{J}/(\text{mmol}\cdot\text{K})$,虽然 $\text{kJ}/(\text{mol}\cdot\text{K})=\text{J}/(\text{mmol}\cdot\text{K})$,但 $\text{J}/(\text{mmol}\cdot\text{K})$ 是不规则的。
- c. 一般不在组合单位的分子分母同时加词头。
- d. 组合单位的分母为长度、面积、体积单位或分子为 1 时,分母可按习惯与方便选用某些词头。
- e. 质量单位 kg 例外。