An evaluation and reduction of the coupling noise in pen-based touch screen display

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ABSTRACT

Here we report the quantitative analysis of coupling noise in AHVA mobile display. Moreover, some approaches for reducing the coupling noise are demonstrated. The addition Vcom compensation circuit and moderate thickness of passivation layer is introduced to diminish the coupling noise.

1 INTRODUCTION

In recent years, touch function become a ubiquitous technology used in displays. Especially pen-based touch screens, such those found in commercially available tablet devices, is becoming increasingly popular. However, a factor directly associated with high touch accuracy and power consumption is the noise, which adversely affects the detection accuracy hereby increasing power consumption to reach a desired performance [1]. Additionally, the demand for thin and high resolution display has also increased noise [2]. In fact, there have already been lots of studies demonstrating the reduction of noise, such as a low pass spatial filtering based technique for the noise spike reduction [1], a simple integrated shift register circuit for the gate driver [3], a noise compensating circuit in the current domain [4], an inverted driving technique [2], and so on.

However, high product yield and keep the cost down in manufacturing have become the strategic objectives of great efforts for mass production by the most of manufacturers. In order to reduce the fabrication cost in TFT-LCD, a lot of approaches have been developed in many publications [5-7]. Especially, the reduction of the photo mask step in the TFT fabrication process has been developed remarkably [6].

Here, in this paper, a mask reduction TFT array process using halftone photolithography technology is produced. The coupling noise performance comparison of a conventional process and mask reduction process is investigated in this work. It's worth noting that we analyzed coupling noise and proposed some tactics that reduces coupling noise.

2 EXPERIMENT

In order to gauge the coupling noise of panels, which are measured by detecting the voltage in a copper tape with the area of 5cm × 5cm stacked directly on the LCD screens. The LCD noise from a 15.6” Advance Hyper View Angle (AHVA) panel is measured using an oscilloscope (Tektronix MSO/DPO5000B). Figure 1(a) Illustrates that the measurements of coupling noise which measure the coupling noise with the image of green (gray 256). It is the worst noise pattern of the images where each two sub-pixels are operated with the same polarity, either of positive or negative voltage, and each sub-pixel converts from high to low voltage level for data driver signal.

3 RESULTS & DISCUSSION

Figure 1(b) shows the time-domain waveforms of the coupling noise with repetition frequency for all green images on the screen. This result shows that the coupling noise is affected by the data and clock signal. Meanwhile, it could be observed that the coupling noise arise simultaneously with the data XSTB signal.

Zhuang et al. indicated that when panel works, the overlap between common lines and data lines give rise to the formation of overlap capacitances. During changing the voltage of data signal, the Vcom signal will be distorted due to the coupling effect and deviated from the setting value [8]. Moreover, in our opinion, the Vcom signal is a considerable factor in performance of coupling noise. In light of this, we introduce a Vcom compensation circuit to correct the distortion of Vcom signal. Figure 2(a) schematically illustrates Vcom compensation circuit which exploits the inverting amplifier to correct the distortion of Vcom signal during there is a discrepancy between Vcom_sense and Vcom_set. The gain of amplifier is given by

$$\mathrm{gain} = \frac{\mathrm{R2}}{\mathrm{R1}}$$

Figure 2(b) shows the coupling noise of panel with (gain=150) and without Vcom compensation circuit. As a comparison, the lower peak-to-peak voltage (Vpp) is observed for the panel with Vcom compensation circuit. It indicates that the Vcom compensation effectively stabilizing the Vcom signal and furthermore reducing the coupling noise.

Figure 3 shows the coupling noise of panel at four different gain values (40, 80, 100, and 150). As the gain increased from 40 to 150, the Vpp exhibit a nonlinear relationship of gain. At the lower gain, the effect of Vcom compensation is trifling which unable to suppress the distortion of Vcom signal. At the higher gain, the severe oscillation of waveforms is observed which cause the higher Vpp. Herein, the gain of Vcom compensation is demand to be optimized. The gain of 80 provides about 10% decreasing of Vpp.

As mention above, the Vcom signal distortion is caused by the parasitic capacitance between the common lines and data lines. Therefore, we demonstrate the thicker passivation layer (PV) which could further alleviate the coupling noise of panel. As shown in Figure 4, the panel with thicker passivation layer at gain of 30 performs the lower Vpp about 11% compare to the panel with original thickness of PV at gain of 80. It can be seen from this that the moderate thickness of PV which not only alleviate the coupling noise but also reduce the power consumption of panel owing to the less of parasitic capacitance between the common lines, data lines and, gate lines, unfortunately, the thicker PV will cause the lower storage capacitance which is not pleased to see this situation.

Figure 5 evidence the parasitic capacitance bring about the worse coupling noise of panel. The mask reduction process panel performs almost 7% that is higher than the conventional process panel. This is because the mask reduction process panel architecture by integrating active amorphous layer (AS) and second metal layer (M2) for the active-island and source/drain data-line pattern formation. However, AS protrusion (including N+) beside the M2 become the side effects of the mask reduction process, which will induce a MIS like parasitic capacity and further enhance the coupling noise of LCD panel during the irradiation by backlight. It is manifested by the mask reduction process panel which shown decrease in coupling noise while turn off the backlight. However, for the mask reduction process panel, the coupling noise of Vpp obviously alleviate by Vcom compensation with moderate gain value of and the PV thickness. Comparison the Vpp between the conventional and mask reduction process panel, the mask reduction panel possesses a lower Vpp about 5% through Vcom compensation and increasing thickness of PV. Herein, we present the moderate thickness of PV and Vcom compensation circuit at moderate gain value that effectively alleviates the coupling noise of panel.

4 CONCLUSIONs

In this paper, the coupling noise performance is investigated in this work. Herein, we present the moderate thickness of PV and Vcom compensation circuit at moderate gain value that effectively alleviates the coupling noise of panel.

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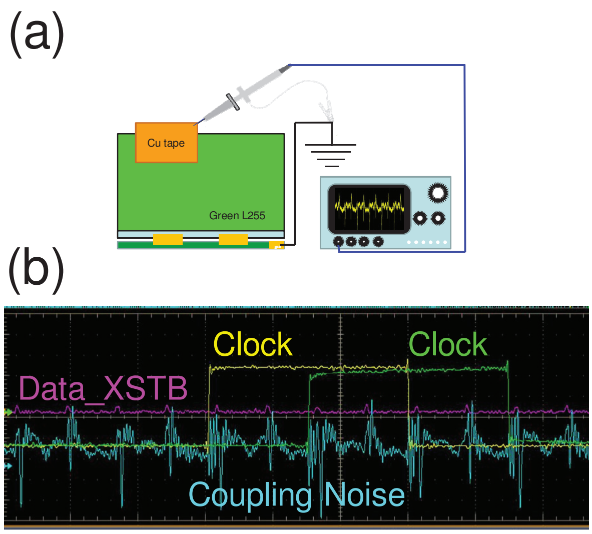

Fig. 1 (a) Illustrates that the measurements of coupling noise. (b) time-domain waveforms of the coupling noise.

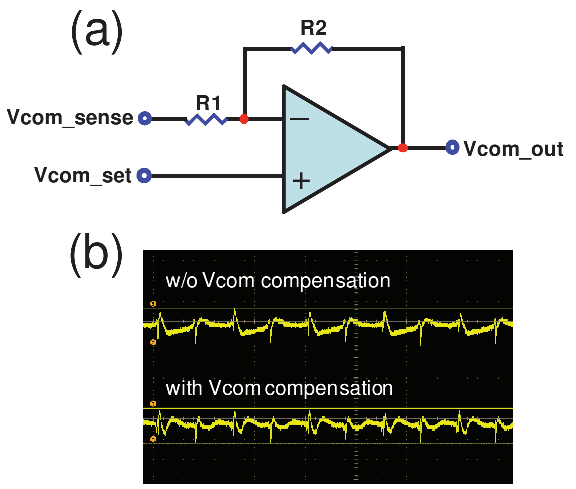

Fig. 2(a) illustrates Vcom compensation circuit. (b) time-domain waveforms of the coupling noise of panel with (gain=150) and without Vcom compensation circuit.

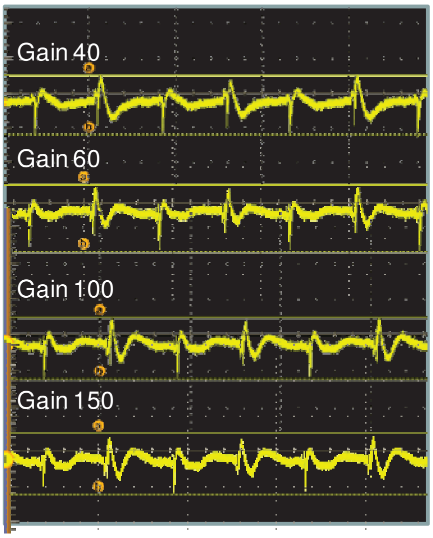

Fig. 3 Time-domain waveforms of the coupling noise of panel at four different gain values.

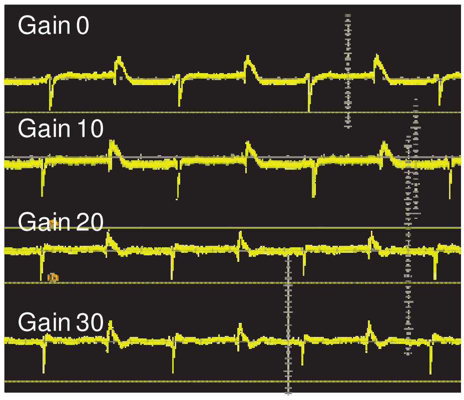

Fig. 4 Time-domain waveforms of the coupling noise of panel with thicker passivation layer at different gain values.

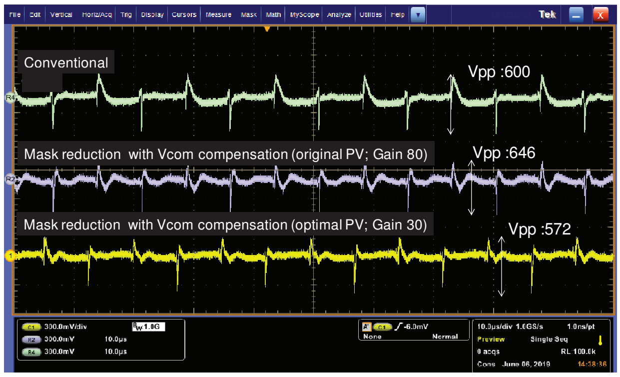

Fig. 5 Comparison of the time-domain waveforms of the coupling noise between the conventional process and mask reduction panel.