A NEW DESIGN METHODOLOGY OF HIGHLY RELIABLE TFT BASED INTEGRATED CIRUCITS IN DISPLAY APPLICATIONS

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Thin-film transistors (TFTs) technology is currently the dominant technology for pixel switching in display application. The new consumer electronics requires higher resolution and brightness, lower power consumption, multi-functional with new features such as flexible and foldable display. This drives TFT devices to deliver more complex functions. Owing to a sustained, enormous effort in TFT research and development and a continuous capital investment from the display industry around the world for the past three decades, the performance of TFT has not only surpassed the display requirements in most areas, but also go beyond the simply switch to more complex digital and analogue integrated circuits, for example, the flexible and narrow bezel displays integrated row drivers with TFT technology next to the pixel array. Such integrated circuits comprise thousands of switches operating together, requires an accurate analysis during design.

In the recent years, new display technologies, such as organic light-emitting diode (OLED) display and light-emitting diode (LED) displays have been emerging and become commercial reality due to certain advantages like self-luminous, high contrast, and etc. However, the OLED device has relative shorted lifetime and the current driving TFTs typically suffer from the electrical instability issue under high temperature and long-time stress condition. Thus, the reliability concerns in display have generated a considerable number of experimental studies and require careful analysis for the design of its pixel and integrated drivers. Particularly, individual TFTs are exposed to various stress condition in display operation with different degradation such as threshold voltage shift (ΔV_{th}) or mobility (μ) decreasing result in a failure of display operation, given that the performance of an aging TFT might deviate from expectation of original design, and moreover, it might influence its neighboring TFTs. Traditional design method considering device performance variation and device-level aging approach of ΔV_{th} and μ may not appropriate given that the traditional design of display pixel and driver circuit did not consider the evolutionary effects to each TFTs and different aging rate under various stress condition.

We proposed a design methodology for highly reliable display circuits with considering the dynamic time evolutionary degradation of TFT and OLED devices. The proposed methodology addresses the devices degradation issues from the circuit-level rather than device-level during the design, which improve the accuracy of the analysis for the stress pattern and the operating conditions on each individual device in the circuit. The proposed method could also be used for the lifetime prediction during the design, which could be great useful toward developing robust TFT-based circuits.

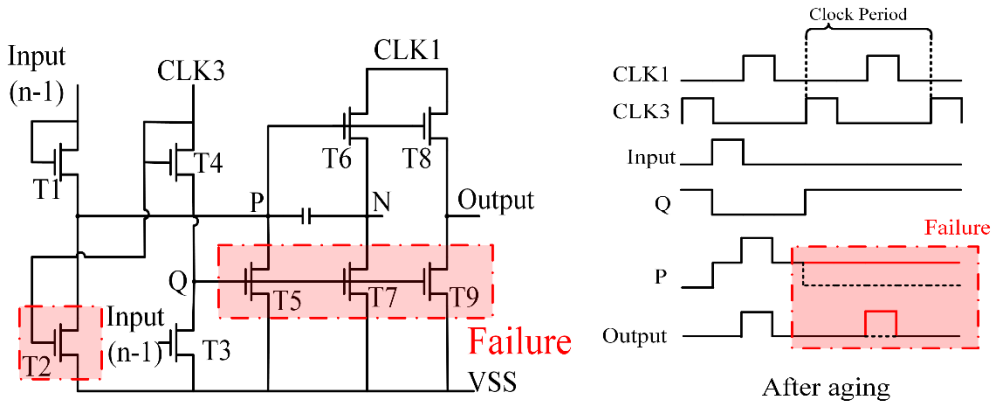

Figure 1 – The schematic diagram and timing of the scan driver with aging phenomenon