Digital current driving of AMOLED displays for improved uniformity and reduced power consumption

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As the light output of an OLED is proportional to its current, accurate control of the pixel current is of crucial importance for AMOLED displays. In current AMOLED displays, this current control is performed inside the pixel, which imposes quite some challenges (a.o. need for high output resistance to cope with resistive power line drops, need for V_T non-uniformity and bias-stress compensation, ...) and it hampers pixel downscaling, hence limiting the resolution that can be obtained with AMOLED displays.

In our work, we bring the accurate current control from inside the pixel to external silicon column drivers, where it can be done at much lower power loss. The transistors in the pixels act as a calibrated, switch allowing a unity current through the OLED. At this unity current, the impedance of all pixels is calibrated to be equal. Whenever the external column driver drives *n* times the unity current I_{ref} [1], I_{ref} is driven through each of the *n* active pixels (see Fig. 1). This approach enables the use of very short channel transistors and hence higher resolution.

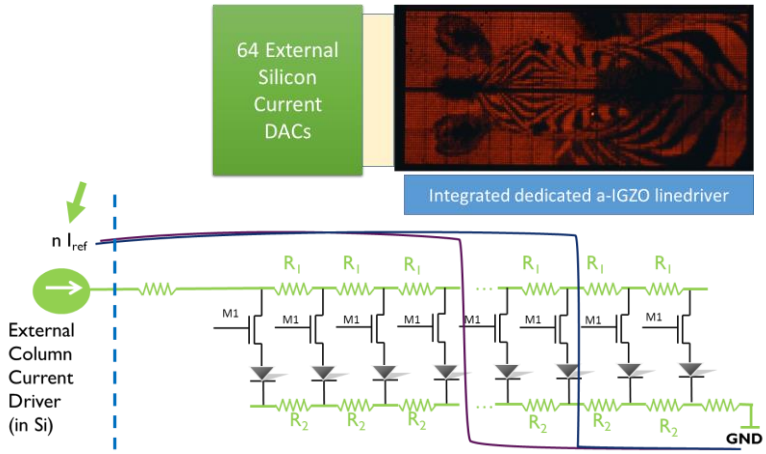

Fig. 1. Method of driving n I_{ref} through equal impedance pixels

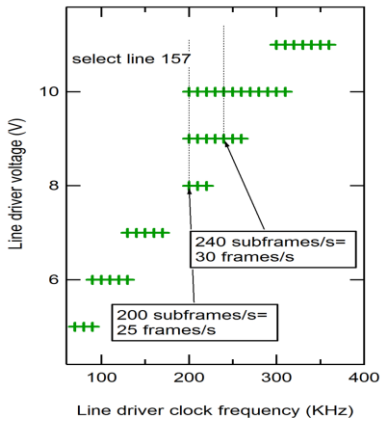

Fig.2. Shmoo plot of the dedicated linedriver

As accurate pixel impedance calibration can only be done at a specific current, a digital Pulse Width Modulation (PWM) method has been implemented that enables up to 2^{16} grey scales per color without additional pixel dark times, without motion artefacts nor pixel overdrive to get full brightness [2,3]. Dedicated integrated linedrivers have been developed in a-IGZO TFT technology to enable this digital driving. This is done by having multiple active rows at the same time without driving multiple rows at the same time. Fig. 2 shows the Shmoo plot of this linedriver [1], confirming that 256 grey scales (8 subframes) can be obtained at a refresh rate of 30 frames/s. This design has also been implemented in a small 320 ppi AMOLED display on foil: 160x64 pixels each 80µmx80µm (see inset of Fig.1). We measured a power reduction of 38%, when compared to a classical driven a-IGZO AMOLED display. Moreover, our sensitivity analysis [4] shows that the influence of TFT bias stress can be substantially reduced when the display is driven using digital current driving.

References

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