

## TFT Mobility Requirement for AMOLED HDTVs

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### 1. Introduction

Among a variety of technical challenges for AMOLEDs to be employed for HDTV applications, this paper focuses on the TFT mobility requirements for the full-spec.40-inch HDTV (1920×1080). For the target brightness of 600 Cd/m<sup>2</sup>, the required currents can be calculated with the given OLED current efficiencies and summarized in Table 1. We assume the top emission type OLEDs to fully make use of the pixel area without concern about the aperture ratio.

### 2. Basic 2TFT-1Capcitor Pixel: 2T1C Pixel

Because the OLED is basically a current-driven device, the previous literature has focused on the driving current requirements of the driving TFT,  $TFT_D$  in Figure 1 (b). However, the current capability of the switching TFT,  $TFT_S$ , is also important to adequately load the data to the pixel electrode. Therefore, we should find the minimum required mobility to meet the requirements of both TFTs, the charging ratio and the driving current. Figure 2 plots the required mobility for  $TFT_D$  and  $TFT_S$  respectively for the 40-inch HDTV as a function of  $V_{GS}$ . If the switching error of 100mV is tolerable, the mobility to meet the requirements of both TFTs is found at about 1.35cm<sup>2</sup>/Vs that is determined by the switching TFT requirement.

### 3. Vth Compensated Pixel

The pixel circuit in Figure 3 can provide the current independent of the V<sub>th</sub> variations by eliminating the V<sub>th</sub> term from the current equation of the driving TFT  $TFT_0$ . Figure 4 plots the required mobility for 40-inch diagonal HDTV. Surprisingly, the minimum required mobility is just 1.00cm<sup>2</sup>/Vs, which is lower than that of 2T1C pixel. The minimum required mobility of the 2T1C stems from the switching TFT. Whereas the width of the switching TFT of the 2T1C pixel is limited, being afraid of the switching error, the 5T1C pixel is free from the switching error. So, we can adequately size the switching TFT for the pixel charging, and the mobility requirement only comes from the driving TFT.

### 4. Conclusions

For the 2T1C pixel, the required mobility comes from the switching TFT, because the width of the switching TFT is limited with concern about the switching error. However, because the 5T1C pixel has the switching error-free structure, the mobility requirement is only attributed to the driving TFT, so that the required mobility is lower than that of the 2T1C. Thorough SPICE simulations reveal that the TFT mobility for 40-inch HDTV is 1.35cm<sup>2</sup>/Vs for the 2T1C pixel and 1.00cm<sup>2</sup>/Vs for the 5T1C pixel.

Table 1. Current requirements for AMOLED HDTV

	R	G	B
Brightness [Cd/m <sup>2</sup> ]	600		
Panel Brightness [Cd/m <sup>2</sup> ]	536.0	874.9	389.0
OLED Brightness [Cd/m <sup>2</sup> ]	1340.1	2183.3	97.6
Current Efficiency [Cd/A]	8.4	22.0	5.6
Pixel Size [μm <sup>2</sup> ]	153.7×461.2		
Current [μA]	11.284	7.048	12.312

Table 2. Panel parameters of AMOLED HDTV

Column Line	Width [μm]	10
	Resistance [kΩ]	14.1
	Capacitance [pF]	168.5
Row Line	Width [μm]	10
	Resistance [kΩ]	16.7
	Capacitance [pF]	543.3
VDD Line Width [μm]		85

Table 3. Electrical parameters of 40-inch AMOLED panel.

Von and Voff of row line [V]	20, -5
VDD [V]	15
Charging ratio [%]	99
Storage capacitor [pF]	2.5

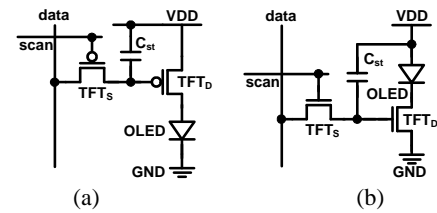


Figure 1. Basic 2-TFT-and-1Capcitor OLED pixel (a) p-channel pixel (b) n-channel pixel.

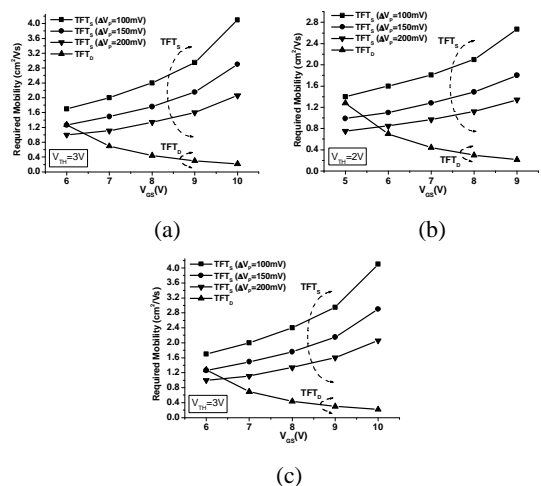


Figure 2. Required mobility of  $TFT_D$  and  $TFT_S$  of 2T1C pixel for 40-inch AMOLED HDTV.  $V_{TH}$  = (a) 1V, (b) 2V and (c) 3V.

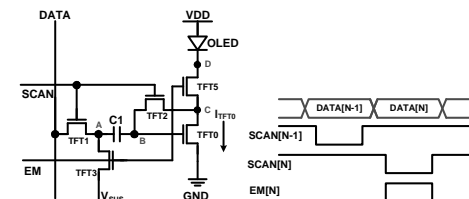


Figure 3. Pixel circuit composed of 5 TFTs and 1 capacitor and timing diagram for compensating the  $V_{TH}$  variations

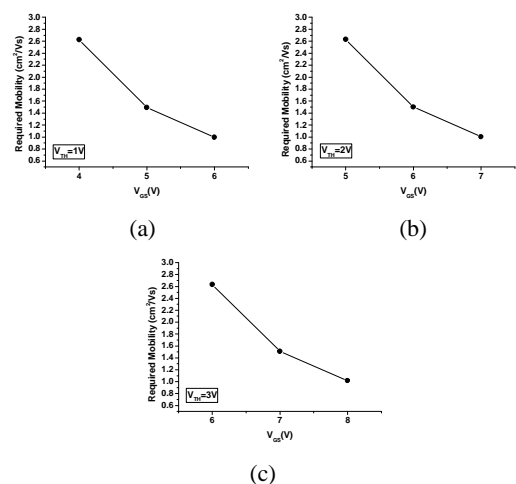


Figure 4. Required mobility of  $TFT_D$  and  $TFT_S$  of 5T1C pixel for 40-inch AMOLED HDTV.  $V_{TH}$  = (a) 1V, (b) 2V and (c) 3V.