Novel Operational Amplifier based on a-InGaZnO TFTs for the Display Driving System

Yongchan Kim, Keun-Yeong Choi, Kichan Kim, and Hojin Lee

MEMS Display and Sensor Laboratory, School of Electrical Engineering,

Soongsil University, Seoul, Korea, 156-743

Tel.:82-2-820-0634, E-mail: hojinl@ssu.ac.kr

Generally, complementary metal oxide semiconductor (CMOS) based operational amplifier (op-amp) has been the main part for the analog circuits due to its superior performance. In display applications, the op-amp is also usually adopted in the control blocks for the power supply system, sensor system, and analog-to-digital converter to the display driving systems. Among various TFT technologies developed so far in order to integrate the display driving system on TFT arrays and, therefore, to eliminate the IC assembly [1], amorphous Indium-Gallium-Zinc-Oxide thin-film transistors (a-InGaZnO TFTs) have shown favorable electrical characteristics, including low processing temperature, good uniformity, decent mobility, low off-current, sharp sub-threshold swing, and a potentially better electrical stability, which are very favorable properties for use in integrated display driving circuitry [2]. In this study, we designed the a-InGaZnO TFT based op-amp that can be applied to various display driving system.

Fig. 1 shows the proposed circuit configuration. Different from silicon transistor based op-amp, the proposed op-amp is based on a-InGaZnO TFT and therefore, the entire circuit should be designed only with n-type transistors. The first block of op-amp consists of a fully differential-amp and source followers. The differential-amp amplifies the difference between two input signals. In order to maintain a stable gain, it needs a stable tail current source which can be obtained by a current mirror circuit. Through source followers, differential-amp output signals are safely transferred to the next second block where two common-source amplifiers are combined together sequentially. The gain of each common-source amplifier can be obtained by the ratio between trans--conductances of input and load TFTs.

Fig. 2(a) shows the frequency response of the proposed op-amp based on a-InGaZnO TFTs. The simulation results indicate that the designed op-amp is expected to have an open-loop voltage gain of 29dB at up to 2.6kHz when the supply voltage is ±15V. As shown in Fig. 2(b), the proposed op-amp can be fabricated within the area of $1288.5\mu m \times 943.5\mu m$.

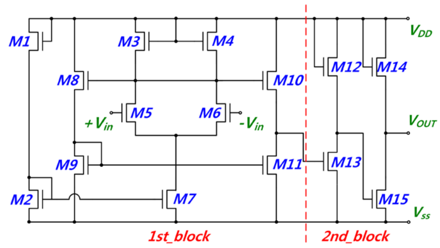

Fig. 1. Schematic of the proposed a-InGaZnO TFT based op-amp

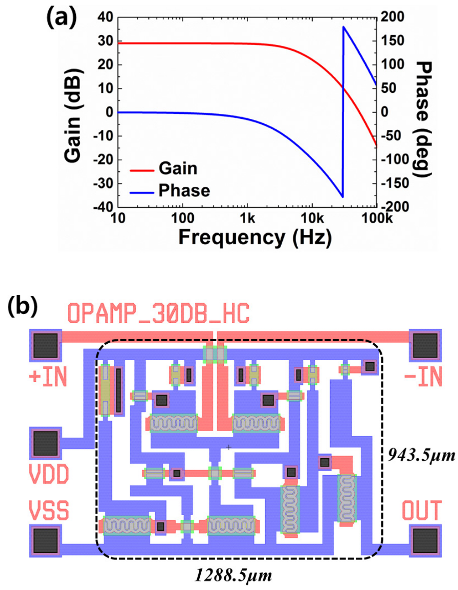

Fig. 2. (a) Frequency response of simulated gain, phase margin, and (b) layout of the proposed op-amp

Acknowledgment

This work was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (NRF-2014R1A1A2059400) and by the Human Resources Development Program within the Korea Institute of Energy Technology Evaluation and Planning, Korea Government through the Ministry of Trade, Industry and Energy under Grant 20144030200600.

References

1. K. Min, C. Yoo, *IEEE Transactions on Consumer Electronics*, vol. 53, no. 4, pp. 1226-1229, 2007.
2. K. Nomura, H. Ohta, A. Takagi, T. Kamiya, M. Hirano and H. Hosono, *Nature*, vol. 432, pp. 482-492, 2004.