

High SNR and High Frame Rate Analog Front-End ICs with Active Stylus for Capacitive Touch Screen Panels

Jae-Sung An(J.An-1@tudelft.nl)
TU Delft

Abstract

Capacitive touch systems have been used in various applications such as smart watches, smart phones, tablet PCs, desktop PCs, and interactive whiteboards due to high sensitivity, durability, and multi-touch capability. Capacitive touch systems (CTSs) are increasingly used in the high-end touch applications, for which an analog front-end (AFE) IC with a high frame rate and high signal-to-noise ratio (SNR) is required to properly respond to the fast movements of fingers and styli. In addition, styli that can represent various expressions have been demanded for the natural sense of use.

The parallel driving method (PDM) using orthogonal codes has been implemented in CTSs to achieve the high frame rate and high SNR. The PDM simultaneously drives orthogonal codes to multiple transmitter (TX) electrodes. Because a CTS with a small number of TX electrodes has a small size of the orthogonal code, it can achieve a high frame rate and SNR. However, when a CTS with a large number of TX electrodes is used, it has a large size of the orthogonal code, and thus suffering from a low frame rate, while having a high SNR.

Styli are classified into passive and active types, depending on whether the battery is included in the stylus or not. Several passive styli, including the conductive, electromagnetic resonance (EMR), and electrically coupled resonance (ECR) types, have been reported. A conductive stylus is the most widely used because it has low implementation cost, but it suffers from a low SNR and limited drawing expressions. An EMR stylus expresses pressure, but requires an additional EMR sensing panel to sense the stylus, thereby increasing the thickness, cost, and power consumption of the CTS. An ECR stylus also expresses pressure, using a pressure-to-capacitance transducer without an additional sensing panel, but requires an additional readout circuit in the AFE IC to sense the resonant signal from the ECR stylus, thereby increasing the complexity of the AFE IC. Active styli express pressure without any additional sensing panel or readout circuit in the AFE IC, but cannot express the tilt angle. Therefore, this presentation introduces a high SNR and frame rate AFE IC with multi-functional active stylus, which are suitable for high-end touch applications.

References

- [1] O.-K. Kwon, J.-S. An, and S.-K. Hong, Capacitive Touch Systems With Styli for Touch Sensors: A Review, in IEEE Sensors Journal, vol. 18, no. 12, pp. 4832-4846, 15 June 2018.
- [2] Geoff Walker, Fundamentals of Touch Technologies and Applications, Society for Information Display, June, 2014.
- [3] J.-S. An, S.-K. Hong, and O.-K. Kwon, "A highly linear and accurate touch data extraction algorithm based on polar coordinates for large-sized capacitive touch screen panels," IEEE Transactions on Consumer Electronics, vol. 62, no. 4, pp. 341-348, Nov. 2016/
- [4] J.-S. An, S.-J. Jung, S.-K. Hong, and O.-K. Kwon, "A Highly Noise-Immune Capacitive Touch Sensing System Using an Adaptive Chopper Stabilization Method," in IEEE Sensors Journal, vol. 17, no. 3, pp. 803-811, Feb. 2017.
- [5] J.-S. An, S.-H. Han, J. E. Kim, D.-H. Yoon, Y.-H. Kim, H.-H. Hong, J.-H. Ye, S.-J. Jung, S.-H. Lee, J.-Y. Jeong, K.-H. Baek, S.-K. Hong, and O.-K. Kwon, A 3.9kHz-frame-rate capacitive touch system with pressure/tilt angle expressions of active stylus using multiple-frequency driving method for 65" 104×64 touch screen panel, 2017 IEEE International Solid-State Circuits Conference (ISSCC), San Francisco, CA, 2017, pp. 168-169.
- [6] J.-S. An, S.-H. Han, J. E. Kim, D.-H. Yoon, Y.-H. Kim, H.-H. Hong, J.-H. Ye, S.-J. Jung, S.-H. Lee, J.-Y. Jeong, K.-H. Baek, S.-K. Hong, and O.-K. Kwon, A 3.9-kHz Frame Rate and 61.0-dB SNR Analog Front-End IC With 6-bit Pressure and Tilt Angle Expressions of Active Stylus Using Multiple-Frequency Driving Method for Capacitive Touch Screen Panels, in IEEE Journal of Solid-State Circuits, vol. 58, no. 1, pp. 187-203, Jan. 2018.

- [7] J.-S. An, S.-H. Han, K.-B. Park, J E Kim, J.-H. Ye, S.-H. Lee, J.-Y. Jeong, J.-S. Kim, K.-H. Baek, K.-S. Chung, S.-K. Hong, and O.-K. Kwon, Multi-Way Interactive Capacitive Touch System with Palm Rejection of Active Stylus for 86" Touch Screen Panels, 2018 IEEE International Solid-State Circuits Conference - (ISSCC) Digest of Technical Papers, San Francisco, CA, 2018, pp. 182-183.

Biography

Jae-Sung An received a B.S. degree in Media Communications Engineering from Hanyang University in Seoul, Korea, in 2010. He received Ph.D. degree in Integrated Electronics Laboratory of Hanyang University, Seoul, Korea, in 2018. Since he joined Electronic Instrumentation Laboratory of Delft University of Technology, Netherlands, in 2018, he has been investigating the ultrasound imaging system.