UNIVERSITI TEKNOLOGI MARA

INTEGRATED READOUT INTERFACING CIRCUIT DESIGN FOR EXTENDED-GATE FIELD-EFFECT TRANSISTOR ELECTROCHEMICAL SENSOR ARRAY MEASUREMENT

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ABSTRACT

This thesis presents integrated circuit design of readout interfacing circuit to allow measuring EGFET sensing response in an array, utilizing a single reference electrode. The research area covers discrete and integrated circuit design of the proposed circuit. Two constant-voltage constant-current (CVCC) readout interfacing circuit architectures were designed and investigated. Through the experimental investigation, it was found that the CVCC readout interfacing circuit with source follower configuration has better performance than gate feedback configuration in terms of power consumption and response to pH. The chosen readout interfacing circuit was further designed in Mentor Graphics EDA tool using SilTerra's CL130G technology design kit. Based on the simulation analyses, it was found that the high-swing cascode current sources/sinks (CSS) and three-stage operational amplifier had better performances over the other sub-modules. Body-effect elimination circuit technique was also presented in this research to solve body-effect problem of the EGFET sensor and thus improved the output pH-sensitivity. The output pH-sensitivity based on the simulation results was improved from 36.4 mV/pH to 50 mV/pH, while in the post-fabrication measurement results, the sensitivity increases from 40.7 mV/pH to 51.8 mV/pH. Power consumption was successfully reduced by 250 % as a result of shifting from dual to single supply in discrete design, followed by a further 135 % as a result miniaturization from 3 V to 2.5 V supply. For the circuit array measurement, the average output pH-sensitivity for six sensors using a single reference electrode was less than 3 % error from the average input. The proposed integrated circuit was able to extract the EGFET sensing response with significant reduction of power consumption using a single reference electrode for an array setup.

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