

READ-OUT INTERFACING CIRCUIT FOR ISFET-BASED PH  
SENSOR  $V_{TH}$  MONITORING

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## ABSTRACT

The Ion Sensitive Field Effect Transistor (ISFET) measure the pH-value and concentration of chemical activity by detecting ion hydrogen,  $H^+$  and this will change ISFET's threshold voltage,  $V_{TH}$ . There is a need to extract the  $V_{TH}$  changes using read-out interfacing circuits (ROICs) instead of device characterization. This project focuses on the design of ROICs to detect the output voltage,  $V_{OUT}$ , whenever there is any change in  $V_{TH}$ . Four different ROICs are designed; a constant-voltage constant-current biasing circuit, a direct feedback complementary ISFET/MOSFET pair, an indirect feedback complementary ISFET/MOSFET pair and a zener-based bridge-type ROIC by modifications of standard MOSFET's model  $V_{TH}$  value using LTSPICE is made to reflect different sensor response under different chemical concentration. In this paper, ROICs are analyzed by investigating the features of operation mode, changes in  $V_{OUT}$  versus  $V_{TH}$ , changes in  $V_{OUT}$  versus temperature, and the power consumption of each circuit. Result shows that the CVCC circuit has a very sensitivity circuitry since the  $V_{OUT}$  changes is 0.9mV per pH unit and has a stability of mode of biasing operation, the indirect feedback CIMP has the highest performance due to the temperature rises, and the direct feedback CIMP has lowest power consumption. As a conclusion, the changing in  $V_{TH}$  will change the  $V_{OUT}$  with the CVCC circuit giving the most sensitive response.

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## **PART I**

### **INTRODUCTION**

#### **1.1 Background**

The words 'sensor' and 'transducer' are both widely used in the description of measurement systems. The former is popular whereas the latter has been used for many years. The word sensor is derived from entire meaning to perceive and transducer is from transducer meaning 'to lead across'. A dictionary definition of sensor is a device that detects a change in a physical stimulus and turns it into a signal which can be measured or recorded; a corresponding definition of transducer is a device that transfers power from one system to another in the same or in the different form.