OII1

ISFET SENSOR for pH measurement

General Description

The OII1 sensor consists of one silicon ISFET chip for pH measurement.

The sensor makes use of the potentiometric measurement method. The potential difference developed in solution between the special sensitive gate surface and an external reference electrode (not provided with the ISFET sensor) varies with the change in negative logarithm of sensed hydrogen ions concentration.

The ISFET structure provides a sensitive, fast and repeatable pH response.

The solid state device has many advantages in comparison to the standard glass electrode sensor for its high mechanical strength and easy cleaning.

The solid state silicon device allows high integration level in different application field where an accurate pH measurement is required.

Applications

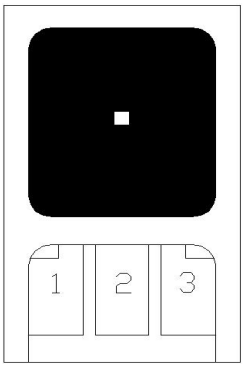
Spot checking pH Measurements

Environmental Spot Monitoring

Industrial Spot Monitoring

Bio-medical analysis

Pharmaceutical



Features

- **Ion Sensitive Field Effect Transistor (ISFET)**
- **Silicon ISFET n-channel Device**
- **Silicon Nitride Sensing Layer**
- **Small Dimensions (L=13 mm, W=7.6 mm)**
- **High Sensitivity = 55 mV/pH**
- **Fast Response Time = 1-2 s**
- **Continuous measurement up to 10 h**
- **ESD Sensitive Device**
- **No Glass**
- **Compatible with OIB40S01**

Pin Functions

No.	Name	Function
1		N.C.
2	S/W	Source - Well
3	D	Drain

Ordering Information

OII1	Silicon n-channel ISFET with Silicon Nitride Sensing Layer for pH Measurements

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Min	Max	Unit
T_A	Operating Temperature Range	0	50	℃
T_S	Storage Temperature	0	50	℃
T_{Sol}	Lead Temperature (solder) 3s		230	℃
P_D	Power Dissipation @ T_A=25℃		100	mW

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

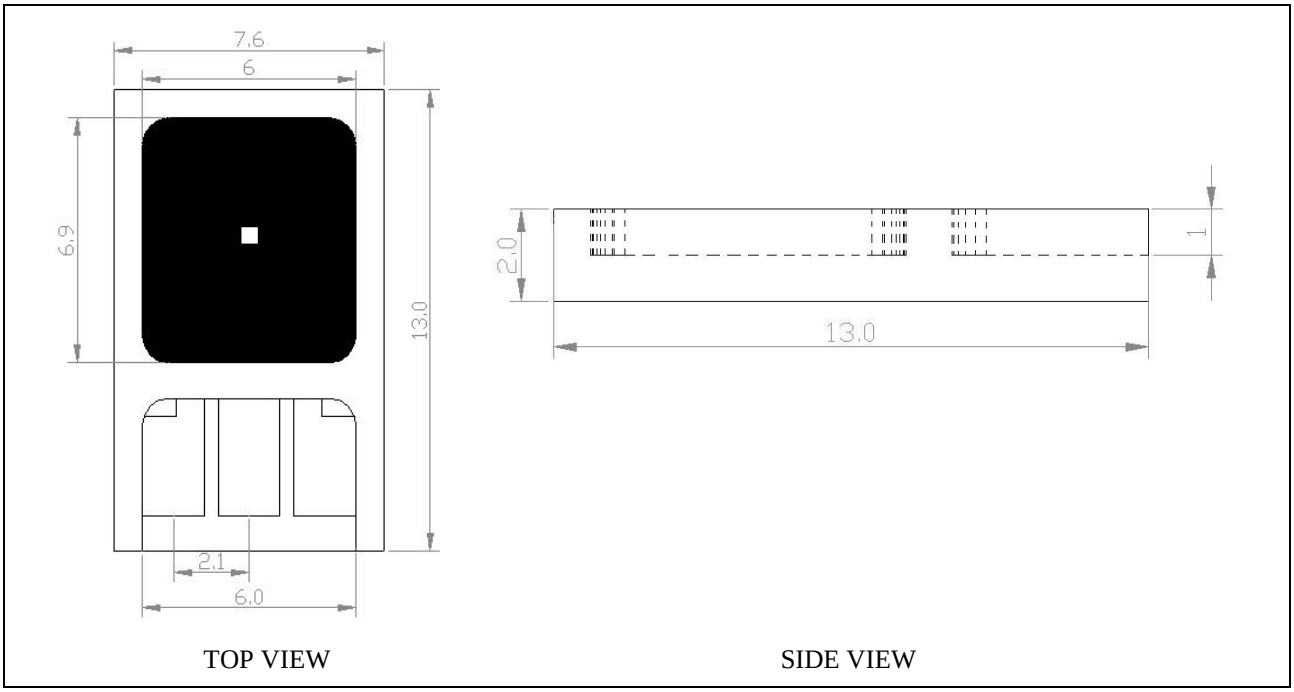
CHARACTERISTICS

T_A = 25℃ unless otherwise noted.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
	Sensitivity	V_{DS}=0.3V I_{DS}=100μA		55		mV/pH
	pH Range		2		12	pH
	Hysteresis	V_{DS}=0.3V I_{DS}=100μA pH=3-11		10		mV
	Linearity	V_{DS}=0.3V I_{DS}=100μA pH=7		0.9995		
V_{OD}	Output signal drift	V_{DS}=0.3V I_{DS}=100μA pH=7		± 0.3		mV/h
I_{LEAK}	Leakage Current	V_{REF}=3V pH=7			100	nA
V_{DS}	Drain-Source Voltage	Recommended working point V_{DS}=0.3V I_{DS}=100μA		0.3	5	V
V_{TH}	Threshold Voltage	V_{DS}=0.1V pH=7		0.4		V
G_M	Transconductance	V_{DS}=0.3V I_{DS}=100μA pH=7 V_{GS}=V_{REF}		0.3		mS
V_{BR}	Junction Breakdown		20			V

MECHANICAL DIMENSIONS

Units=mm Mechanical tolerance=+/-0.2mm Die positioning tolerance=+/-0.050mm



TOP VIEW SIDE VIEW

Application notes

Working Principle

The ISFET (Ion Sensitive Field Effect Transistor) is a silicon solid state potentiometric sensor.

The ISFET is a MOSFET (Metal Oxide Semiconductor Field Effect Transistor) based device, with the metallic gate replaced with a special oxide-coated gate, having an insulated layer (silicon nitride) which surface is sensitive to hydrogen ion concentration. A reference electrode (not provided with the sensor) must be used in the proximity of the ISFET to form nothing else than a MOSFET structure. The equivalent gate connection is realized by the reference electrode inserted in an aqueous solution, which is in direct contact with the insulated-gate sensitive layer. The positives charges due to the hydrogen ions concentration (i.e. pH) generates an electric field that modulates the current between source and drain.

The ISFET is biased at constant current and voltage drain-source by a feedback amplifier circuital configuration (Fig.1) in order to provide the best ISFET response, enhancing stability and linearity in a large range of the pH value being measured.

The reference electrode potential is referred to ground and the equivalent gate-source voltage is a function of pH in a wide working range. The output signal of the system is a potential difference whose magnitude varies with change in negative logarithm of sensed hydrogen ion concentration.

Biasing and read-out circuit

Name	Function
R1	Resistor, 150 kΩ
R2	Resistor, 470 kΩ
R3	Resistor, 10 kΩ
R4	Resistor, 9.1 kΩ
C1	Capacitor, 470 pF
D1	Bandgap voltage reference diode, MP5010 or equivalent 1.23 V
IC1	OpAmp, AD8608 (single supply), AD8674 (dual supply) or equivalent
Ref	Reference electrode (Not supplied)

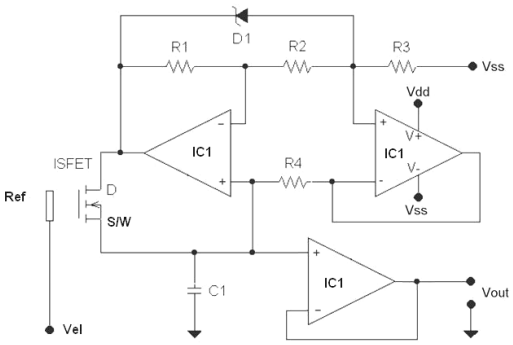


Fig.1

Feedback amplifier-based bias/read-out circuit for ISFET.

Name	Function
D1 to D6	Diode, 1N5061 or equivalent
Var	Varistor, SIOV-S05K17 or equivalent. Important: the varistor should be connected as closed as possible to the S/W pin.

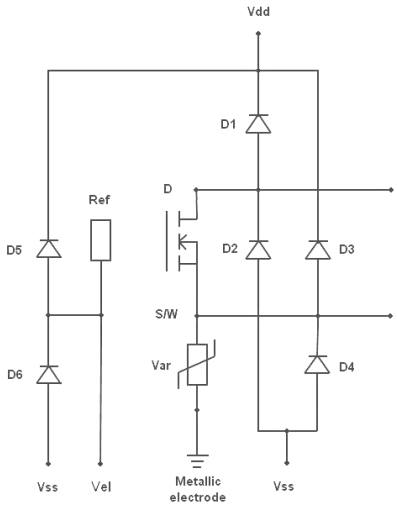


Fig.2

ESD protection circuit for ISFET.

Notes

1. Operating voltage

   This circuit can be powered by a single (+5V) or dual (± 5V) power supply.

   1.1. Dual supply voltage (recommended)

   V_{el} should be connected to GND.

   1.2. Single supply voltage (V_{ss} tied to GND)

   V_{el} should be connected to Vdd/2.

   (half supply buffered voltage can be generated by a voltage divider and a buffer configured op.amp)

2. The output buffer op.amp is optional if an high impedance measuring stage follows the bias/read-out circuit.
3. The output voltage value is negative referred to the reference electrode potential and circuital response is 55mV/pH.
4. Operating conditions

   V_{DS} = 0.3V, I_{ds} = 100µA

Circuit components determination

Calculating components values (Fig.1)

1. R2 value

   Choose R2 value

2. R1 value

   $V_{DS} = V_{R1} = V_{D1}$ x R1 / (R1+R2) thus giving R1 = R2 / ((V_{D1} / V_{DS}) – 1)

3. R4 value

   $I_{DS} = I_{R4} = V_{R4}$ / R4 = V_{R2} / R4 = (V_{D1} - V_{R1}) / R4 = (V_{D1} - V_{DS}) / R4 thus giving R4 = (V_{D1} – V_{DS}) / I_{DS}

4. R3 value

   R3 value should be chosen in order to guarantee, in all operating condition (i.e. pH values), a minimum current flow into D1 as stated in the relative datasheet.

Caution

ESD (Electrostatic Discharge) sensitive device.

Permanent Damage may occur on devices subjected to high energy electrostatic discharges (i.e. Electrostatic charges accumulated on human body). Proper precautions are recommended to avoid performance degradation.

Metal case shielding is recommended in final application for ESD protection.

Storage

Unlike glass electrodes, ISFET pH probes are stored dry.

Initial conditioning

Before use, a minimum hydration period in water of 18 hours is recommended.

Cleaning

Silicon chip pH sensors are easy to clean with a toothbrush and mild detergent.

If food particles, grease, fat or other materials cover the sensor, a wooden toothpick and a drop of isopropyl alcohol can even be used to gently clean the sensor itself.

There is no polarization effect from scrubbing such as can occur with glass pH electrodes.

Prolonged exposure to strong organic solvents can delaminate the silicon chip from the chemical resistant epoxy used to isolate the sensor's electrical connections from the solution.

Abnormal measurement drift phenomenon

Some output signal drift phenomenon may occur in solutions that contain chlorine compound, even at low concentration.