Ion-Sensitive Ta$_2$O$_5$ Field-Effect Transistor (ISFET) pHH3 Module

in cooperation with
Endress+Hauser

Fraunhofer Institute for Photonic Microsystems IPMS
Maria-Reiche-Str. 2
01109 Dresden

Contact
Dr. Michael Scholles
Phone +49 351 8823-201
michael.scholles@ipms.fraunhofer.de

Dr. Heinrich Grüger
Phone +49 351 8823-155
heinrich.grueger@ipms.fraunhofer.de

www.ipms.fraunhofer.de

Features
The pHH3 module is an ion-sensitive field-effect transistor (ISFET, PMOS-type) mounted and encapsulated on a printed circuit board (PCB).

The ISFET consists of two parts: the electronic part, including the FET and a chemical part, the sensitive layer. The device acts like a classical MOSFET where the metallized gate metallization electrode is replaced by the measured electrolyte solution which is contacted by a reference electrode.

Advantages
- Short response time
- Low long-term drift
- Wide operation range
  \( T = -10 \, ^\circ\text{C} \) to \( 75 \, ^\circ\text{C} \)
  \( P = 0.5 \) bar to \( 10 \) bar
- Sterilizable intermittently up to \( 130 \, ^\circ\text{C} \)
- Dry storage in air

The amphoteric surface groups on the boundary of the Ta$_2$O$_5$ layer to the electrolyte react with the H$^+$ ions of the electrolyte.

With changing hydrogen ion concentration the current between source and drain of the FET changes and so the ISFET is well suited for pH measurements.

The chip (size \( 3.5 \times 3.5 \, \text{mm}^2 \)) is mounted on a small PCB shown in fig. 1. The silicone encapsulation withstands the electrolytic solutions to be measured. Special housings can be developed on request.

Applications
- pH measurement
- Process control
- Medical diagnosis
- Environmental measurement

1. Image of pHH3-Module including a Pt1000 for temperature measurements. The module dimensions are \( 5 \times 40 \, \text{mm} \) (without wiring).
Technical Parameters

Tables in figures 2 and 3 show the technical parameters of pH3 module.

Exposure to absolute maximum rating conditions listed in fig. 3 for extended periods may affect device reliability.

Connections and mechanical dimensions of pH3 module are given in fig. 4.

The sensors are assembled in various configurations; some of them include elements for temperature measurement.

A possible application circuitry is shown in fig. 4, where the pH3 module is driven in constant charge mode.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sym.</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Condition</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>S</td>
<td>55</td>
<td>57</td>
<td>60.5</td>
<td>pH 7</td>
<td>mV/pH</td>
</tr>
<tr>
<td>Long term drift</td>
<td>d</td>
<td></td>
<td>80</td>
<td></td>
<td>pH 7</td>
<td>μV/h</td>
</tr>
<tr>
<td>Response time (accuracy 0.02 pH)</td>
<td>1</td>
<td>&lt; 60</td>
<td></td>
<td></td>
<td>pH 4 … 7 @ 25 °C</td>
<td>s</td>
</tr>
</tbody>
</table>

2 Parameters.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sym.</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Condition</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltages</td>
<td>U12</td>
<td>10</td>
<td></td>
<td>10</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Temperature</td>
<td>δ</td>
<td>-10</td>
<td></td>
<td>130</td>
<td>water, steam</td>
<td>°C</td>
</tr>
<tr>
<td>pH value of solution</td>
<td>pH</td>
<td>1</td>
<td></td>
<td>12</td>
<td>pH 1 … 12</td>
<td>°C</td>
</tr>
<tr>
<td>Pressure</td>
<td>p</td>
<td>0.1</td>
<td></td>
<td>10</td>
<td>bar</td>
<td></td>
</tr>
</tbody>
</table>

3 Absolute maximum ratings.

4 Sensor operation: pH3 module driven in constant charge mode.