MEMS Gas Flow Sensor Module

MFA1100R

Features
- Wide measuring range (0.27 – 100 SLM)
- Large turndown ratio (> 350)
- High measuring accuracy:
  - < 3% for 0.27 – 10 SLM
  - < 1.5% for 10 - 100 SLM
- Outstanding hysteresis and repeatability (< 1%)
- Low power consumption:
  - 70 μA on average in operating mode
  - 0.1 μA in sleep mode
- Single 2.7 - 5.5V supply
- RoHS compliant

Applications
- Residential gas meter
- Medical flow measurement and control
- Industrial flow measurement and control

General Description
MFA1100R is a gas flow sensing module based on MEMSIC’s proprietary CMOS technology for thermal mass flow sensing. It can measure up to 100SLM flow rate with +/-1.5% accuracy (after external calibration), and achieves a turndown ratio greater than 350:1. The sensing element is monolithically integrated with CMOS signal processing circuitry and embedded software capable of converting gas flow rates to a differential analog voltage with very high (better than 1%) repeatability. The module runs from a single cell battery, and has a low power sleep mode for optimal power management.

MFA1100R is a true thermal mass flow sensing module, and can easily be configured in a smart metering solution. Customized versions are available, contact MEMSIC for more information at info@memsic.com.
MFA1100R Specifications ¹ (Measurements are done with air as medium, at 25°C±2°C temperature, 1atm pressure, using a 3.3V DC power supply, unless otherwise specified)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Condition</th>
<th>Min</th>
<th>Typical</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Range</td>
<td>φ30mm tube size</td>
<td>0.27</td>
<td>100</td>
<td></td>
<td>SLM</td>
</tr>
<tr>
<td>Supply DC Voltage</td>
<td></td>
<td>2.7</td>
<td>3.3</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td></td>
<td>-20</td>
<td>60</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td></td>
<td>-40</td>
<td>85</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Sensor Output Range</td>
<td>Full scale flow range</td>
<td>0</td>
<td>600</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>Average</td>
<td></td>
<td>70</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>Power Down Consumption</td>
<td>Sleep mode</td>
<td></td>
<td>0.1</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>Zero Flow Rate Output</td>
<td>25°C</td>
<td>-0.2</td>
<td>0.2</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td>-20°C ~ 60°C</td>
<td>±0.02</td>
<td></td>
<td></td>
<td>mV/°C</td>
</tr>
<tr>
<td>Accuracy²</td>
<td>0.27 SLM ≤ Q1 &lt; 10 SLM</td>
<td>3.0</td>
<td></td>
<td></td>
<td>%</td>
</tr>
<tr>
<td></td>
<td>10 SLM ≤ Q2 ≤ 100 SLM</td>
<td>1.5</td>
<td></td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>Repeatability and Hysteresis</td>
<td>Full scale flow range</td>
<td>±1.0</td>
<td></td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>Output Temperature Sensitivity</td>
<td>10 SLM, -20°C ~ 60°C</td>
<td>-0.19</td>
<td></td>
<td></td>
<td>%/°C</td>
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<tr>
<td>Pressure Drop</td>
<td>100 SLM</td>
<td>100</td>
<td></td>
<td></td>
<td>Pa</td>
</tr>
<tr>
<td>Response Time³</td>
<td>100 SLM</td>
<td>40</td>
<td>100</td>
<td></td>
<td>ms</td>
</tr>
</tbody>
</table>

Note 1: All data are measured with a specific housing with φ30mm tube size in the medium of air, other kinds of media or higher requirements upon request.

Note 2: Measured after 9 points piecewise linear calibration at meter level (Qmin, 3Qmin, 5Qmin, 10Qmin, 0.1Qmax, 0.2Qmax, 0.4Qmax, 0.7Qmax, Qmax).

Note 3: Response time is measured from the moment of wakeup from sleep mode, to output reaching 90% of its final value, assuming no longer than 2 seconds sleep time. The typical wakeup time will increase to 75ms for longer sleep times.

Absolute Maximum Rates*  
Supply Voltage (V_{DD}) .................... -0.5 to +5.5V  
Storage Temperature .................... -40°C to +85°C  
Maximum Exposed Flow .................... 300 SLM  
Maximum Pressure ....................... 3 Bar  
Shock ...................................... 1000g, 0.5ms  
Vibration .................................. 1g, 5 to 200 Hz

*Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; the functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Fig.2 MFA1100R functional block diagram
Measurement Principle
The flow rate is detected by the MEMS thermal mass flow sensor. The sensor chip, produced in MEMSIC proprietary CMOS compatible technology, is composed of a central heater source (micro heater) and two temperature sensors (thermopiles), which are placed symmetrically upstream and downstream of the micro-heater. If no gas flows over the sensor surface, the symmetric thermopiles measure the same rise in temperature (Fig.4a), resulting in the same output voltage of the two thermopiles. If a non-zero gas flows from the inlet to the outlet of the meter, the velocity of a fully-developed laminar air flow unbalances the temperature profile around the heater (Fig.4b) and heat is transferred from upstream thermopiles to the downstream thermopiles, causing a change in the voltages of the thermopiles. Larger gas flow rates result in larger asymmetry in the temperature profile (Fig.5). Precision analog circuitry in the ASIC converts the temperature difference to a differential analog voltage at the output pins.
Applications Information (Using Sleep Mode)
The low power consumption of the MFA1100R is achieved by enabling sleep mode between measurements. When sleep mode is enabled, under maximum flow conditions, a wake up time of 100ms is required to achieve the specified accuracy (see Fig. 6). However, under low flow conditions, the device settles to its specified accuracy very quickly (see Fig. 7).
Performance Characteristics

$V_{DD} = 3.3 \text{ VDC, Temperature } 20^\circ \text{C}$

![Graph showing voltage output versus gas flow rate](image)

Fig. 8 Voltage output versus gas flow rate (measured with air)

Mechanical Dimensions

Unit: mm, Tolerance: ± 0.2 mm

![Diagram showing MFA1100R PCB mechanical dimensions](image)

Fig. 9 MFA1100R PCB mechanical dimensions
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One Technology Drive, Suite 325, Andover, MA 01810, USA
Tel: +1 978 738 0900    Fax: +1 978 738 0196
www.MEMSIC.com