5th Generation vibrating ring single-axis angular rate sensor from Silicon Sensing Systems.

Developed to meet requirements for a lower cost, low-power digital gyro for next generation automotive, industrial, commercial and consumer applications.
Features

- Proven and robust 5th generation vibrating structure gyro technology (VSG)
- Class-leading bias and noise over temperature for precise dead reckoning navigation and pointing
- Planar and orthogonal packages (CRM100 and CRM200)
- User selectable dynamic ranges; 75°/s, 150°/s, 300°/s, 900°/s (max 1,000°/s), others now available.
- Bandwidth selectable:
  - Analogue to 160Hz
  - Digital to 150Hz
- Analogue and Digital (SPI®) output modes
- Low power, 3V supply, 4mA
- Excellent shock and vibration rejection
- Hermetically sealed SMD package
- Integral temperature sensor
- RoHS compliant
- AEC Q100 tested
## Performance

<table>
<thead>
<tr>
<th></th>
<th>CRM100</th>
<th>CRM200</th>
<th>CRM102</th>
<th>CRM202</th>
<th>CRM104</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>2.7V ~ 3.6V</td>
<td>2.7V ~ 3.6V</td>
<td>2.7V ~ 3.6V</td>
<td>2.7V ~ 3.6V</td>
<td>2.7V ~ 3.6V</td>
</tr>
<tr>
<td>Sensitivity</td>
<td>75mV/s, 150mV/s, 300mV/s, 900mV/s (set by using PCBA connection)</td>
<td>12mV/s, 6.0mV/s, 3.0mV/s, 1.0mV/s (Vdd = 3V, 900mV/s range)</td>
<td>225mV/s, 450mV/s, 900mV/s, 2,700mV/s (set by using PCBA connection)</td>
<td>1mV/s</td>
<td>9μV/s, 4.5μV/s, 2.25μV/s, 0.75μV/s (set by using PCBA connection)</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±1%</td>
<td>±1%</td>
<td>±4%</td>
<td>±3%</td>
<td>±3%</td>
</tr>
<tr>
<td>xVdd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>±1.5%</td>
<td>±2%</td>
<td>±4%</td>
<td>±3%</td>
<td>±3%</td>
</tr>
<tr>
<td>(75% range)</td>
<td>±1.5%</td>
<td>±2%</td>
<td>±4%</td>
<td>±3%</td>
<td>±3%</td>
</tr>
<tr>
<td>Humidity</td>
<td>±5%</td>
<td>±5%</td>
<td>±5%</td>
<td>±5%</td>
<td>±5%</td>
</tr>
<tr>
<td>(75% range)</td>
<td>±5%</td>
<td>±5%</td>
<td>±5%</td>
<td>±5%</td>
<td>±5%</td>
</tr>
<tr>
<td>Acceleration</td>
<td>24m/s² (75% range)</td>
<td>80m/s² (900mV/s range)</td>
<td>40m/s² (1,200mV/s range)</td>
<td>40m/s² (1,200mV/s range)</td>
<td>40m/s² (1,200mV/s range)</td>
</tr>
<tr>
<td>(set by customer using an external capacitor)</td>
<td>24m/s² (75% range)</td>
<td>80m/s² (900mV/s range)</td>
<td>40m/s² (1,200mV/s range)</td>
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<td>40m/s² (1,200mV/s range)</td>
</tr>
<tr>
<td>Voltage</td>
<td>0.018V/s/Hz</td>
<td>0.05V/s/Hz</td>
<td>0.018V/s/Hz</td>
<td>0.018V/s/Hz</td>
<td>0.018V/s/Hz</td>
</tr>
<tr>
<td>Temperature</td>
<td>0.28V/°C</td>
<td>0.8V/°C</td>
<td>0.28V/°C</td>
<td>0.28V/°C</td>
<td>0.28V/°C</td>
</tr>
<tr>
<td>(set by customer using an external capacitor)</td>
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<td>0.8V/°C</td>
<td>0.28V/°C</td>
<td>0.28V/°C</td>
<td>0.28V/°C</td>
</tr>
<tr>
<td>Acceleration</td>
<td>-40°C to +85°C</td>
<td>-40°C to +85°C</td>
<td>-40°C to +85°C</td>
<td>-40°C to +85°C</td>
<td>-40°C to +85°C</td>
</tr>
<tr>
<td>Temperature</td>
<td>-40°C to +105°C</td>
<td>N/A</td>
<td>-40°C to +105°C</td>
<td>N/A</td>
<td>-40°C to +105°C</td>
</tr>
<tr>
<td>Acceleration</td>
<td>-60°C to +125°C</td>
<td>-60°C to +125°C</td>
<td>-60°C to +125°C</td>
<td>-60°C to +125°C</td>
<td>-60°C to +125°C</td>
</tr>
<tr>
<td>Temperature</td>
<td>3,500g @ 500μs (unpowered)</td>
<td>500g @ 1ms 1/2 sine (powered)</td>
<td>100g @ 8ms (powered)</td>
<td>100g @ 8ms (powered)</td>
<td>100g @ 8ms (powered)</td>
</tr>
<tr>
<td>Acceleration</td>
<td>12g rms @ 10 - 5kHz (powered)</td>
<td>12g rms @ 10 - 5kHz (powered)</td>
<td>12g rms @ 10 - 5kHz (powered)</td>
<td>12g rms @ 10 - 5kHz (powered)</td>
<td>12g rms @ 10 - 5kHz (powered)</td>
</tr>
<tr>
<td>Temperature</td>
<td>&lt;0.3s</td>
<td>&lt;0.3s</td>
<td>&lt;0.3s</td>
<td>&lt;0.3s</td>
<td>&lt;0.3s</td>
</tr>
<tr>
<td>Acceleration</td>
<td>0.1 gram</td>
<td>0.1 gram</td>
<td>0.1 gram</td>
<td>0.1 gram</td>
<td>0.1 gram</td>
</tr>
<tr>
<td>Temperature</td>
<td>4mA</td>
<td>4mA</td>
<td>4mA</td>
<td>4mA</td>
<td>4mA</td>
</tr>
</tbody>
</table>

Silicon Sensing is a joint venture between Atlantic Inertial Systems and Sumitomo Precision Products
Bias Instability and ARW.

At 10 second, the AV curve is down to approximately 0.002°/s (7.2°/hr).

ARW ~ 0.18 °/√hr
Physical (P/N: CRM100 – planar package)

Dimensions in millimetres

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Physical (P/N: CRM200 – orthogonal package)

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Construction (P/N: CRM100 Shown)

Note - CRM200 construction is similar in principle, but has an ‘upright’ or ‘orthogonal’ package base
Standard Configurations
(Part Numbers CRM100/102/104 [In-Plane] & CRM200/202 [Orthogonal])

- Ceramic Single Cavity
  - Faraday shield for excellent EMC
  - Small size reduces thermal effects
- Package Lid
  - Kovar metal lid
  - Resistance seam welded to base
  - Fully hermetic seal
- Package Base
  - LCC ceramic multi-layer aluminium oxide base
  - Multi-level tungsten interconnects
  - Pads designed to ensure good solder filet
- Bond Wires
  - MEMS and ASIC connected via bond wires
  - No internal tracking reduces noise pick-up
MEMS (Silicon Ring)

- MEMS Silicon Ring Resonator
  - 3mm overall diameter, 65µm thick
  - Eight pairs of ‘dog-leg’ support spokes
  - DRIE bulk silicon process – no small gaps leading to risk of stiction
  - Excited into a ‘Cos2θ’ vibration mode at 22kHz
  - Innovative spoke design for greatly reduced quad bias variation. Inherently good bias over temperature
  - Shock and vibration insensitive due to balanced ring design (not a simple ‘tuning fork’)

- Strain Film Transducers
  - Transducer segments bonded onto Si ring periphery
  - Low noise output
  - Drives: Bending moment excites Cos2θ operation
  - Pickoffs: EMF output in response to strain input
  - Four secondary pick-offs for maximum signal:noise
Operating Principle (1)

PD Actuator to drive the ring into its primary $\cos 2\theta$ elliptical vibration mode at 22kHz about the primary axis

PPO Transducer to detect the ring’s elliptical vibration about the primary axis

SPO Transducers to detect the ring’s vibration about the secondary axis at 45°
Simplified schematic diagram of the ring when unpowered.

The primary drive actuator and pick-off transducer locations, and the secondary pick-off transducer locations, are shown.
Operating Principle

This shows the ring when powered and vibrating in its elliptical mode about the primary axes.
In this view the gyro is not rotating and therefore the nodes on the secondary axes (at 45°) are effectively stationary.
Operating Principle

This view now shows the gyro rotating. The applied angular rate induces coriolis forces which act tangentially to the ring, causing radial motion of the nodes on the secondary axes.

Resultant Radial Motion Proportional to Applied rate

$F_c = \text{Coriolis Force}$
ASIC (Functional Block Diagram)

- 3mm x 3mm
- 0.35µm CMOS process
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**Electrical Interface (CRM100)**

<table>
<thead>
<tr>
<th>Capacitive Value of C2</th>
<th>Bandwidth (reference)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33nF</td>
<td>Typ 95Hz</td>
</tr>
<tr>
<td>47nF</td>
<td>Typ 70Hz</td>
</tr>
<tr>
<td>69nF</td>
<td>Typ 60Hz</td>
</tr>
<tr>
<td>100nF</td>
<td>Typ 33Hz</td>
</tr>
<tr>
<td>120nF</td>
<td>Typ 27Hz</td>
</tr>
<tr>
<td>270nF</td>
<td>Typ 12Hz</td>
</tr>
</tbody>
</table>

**Analogue Output**

**Digital Output**
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Gyro Evaluation Boards

PinPoint® Evaluation Board - CRM100 (P/N 400046-0100)

PinPoint® Evaluation Board - CRM200 (P/N 400046-0200)

PinPoint® Evaluation Board - 3-Axis (P/N 400046-0300)

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Precision Navigation and Pointing Gyroscope

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