The Si7211/2/3/4/5/6/7 family of Hall-effect sensors from Silicon Labs combines a chopper-stabilized Hall element with a low-noise analog amplifier, 13-bit analog to digital converter. After A/D conversion the magnetic field data is available in analog, PWM or SENT format (depending on the part number). Leveraging Silicon Labs’ proven CMOS design techniques, the Si721x family incorporates digital signal processing to provide precise compensation for temperature and offset drift.

Compared with existing Hall-effect sensors, the Si721x family offers industry-leading sensitivity and low noise, which enables use with larger air gaps and smaller magnets.

In the simplest case, the Si721x devices are offered in a 3 pin SOT23 or TO92 packages with power, ground, and a single output pin that is signal corresponding to the magnetic field in analog, PWM, or SENT format.

The Si721x devices are also offered in a 5 pin SOT23 and an 8 pin DFN (coming soon) packages where the additional pins can be used for sleep mode (DIS) or to activate an on-chip coil for built in self-test (BISTb).

**Applications**

- Mechanical position sensing in consumer, industrial applications
- Camera image stabilization, zoom, and autofocus
- Fluid level sensing
- Control knobs and selector switches

**FEATURES**

- High-sensitivity Hall-Effect Sensor
- Low noise output corresponding to magnetic field
- Integrated digital signal processing for temperature and offset drift compensation
- Low 50 nA Typical Sleep Current Consumption
- Configurable Sensitivity, Output Polarity and Sample Rate
- Sensitivity Drift < ±3% Over Temperature
- Wide power supply voltage
  - 1.7 to 5.5 V
  - 3.3 to 26.5 V
- Configurable output options
  - Analog
  - PWM
  - SENT
- Industry-Standard Packaging
  - Surface-mount SOT-23 (3 or 5 pin)
  - TO92 package
  - DFN package (coming soon)
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### 1. Electrical Specifications

Unless otherwise specified, all min/max specifications apply over the recommended operating conditions.

#### Table 1.1. Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>( V_{DD} )</td>
<td>Si7211/7</td>
<td>2.25</td>
<td></td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Power Supply</td>
<td>( V_{DD} )</td>
<td>Si7212/3</td>
<td>1.71</td>
<td></td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Power Supply</td>
<td>( V_{DD} )</td>
<td>Si7214/5</td>
<td>3.3</td>
<td></td>
<td>26.5</td>
<td>V</td>
</tr>
<tr>
<td>Power Supply</td>
<td>( V_{DD} )</td>
<td>Si7216</td>
<td>4.0</td>
<td></td>
<td>26.5</td>
<td>V</td>
</tr>
<tr>
<td>Temperature</td>
<td>( T_A )</td>
<td>I grade</td>
<td>-40</td>
<td></td>
<td>+125</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### Table 1.2. General Specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage High</td>
<td>( V_{IH} )</td>
<td>DIS or BIST pin</td>
<td>0.7 x ( V_{DD} )</td>
<td>-</td>
<td>-</td>
<td>V</td>
</tr>
<tr>
<td>Input Voltage Low</td>
<td>( V_{IL} )</td>
<td>DIS or BIST pin</td>
<td>-</td>
<td>-</td>
<td>0.3 x ( V_{DD} )</td>
<td>V</td>
</tr>
<tr>
<td>Input Voltage Range</td>
<td>( V_{IN} )</td>
<td>DIS or BIST pin</td>
<td>0</td>
<td></td>
<td>( V_{DD} )</td>
<td>V</td>
</tr>
<tr>
<td>Input Leakage</td>
<td>( I_{IL} )</td>
<td>DIS or BIST pin</td>
<td>&lt; 0.1</td>
<td>1</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>Parameter</td>
<td>Symbol</td>
<td>Test Condition</td>
<td>Min</td>
<td>Typ</td>
<td>Max</td>
<td>Unit</td>
</tr>
<tr>
<td>---------------------------</td>
<td>--------</td>
<td>----------------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>Current Consumption</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sleep mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DD} = 3.3 , V$, $T = 25 , ^{\circ}C$</td>
<td>50</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DD} = 3.3 , V$, $T = 70 , ^{\circ}C$</td>
<td>1000</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DD} = 5.5 , V$, $T = 125 , ^{\circ}C$</td>
<td>5000</td>
<td></td>
<td></td>
<td>nA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conversion in progress</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si7211/7</td>
<td></td>
<td></td>
<td>5.5</td>
<td>6.5</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DD} = 3.3 , V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DD} = 5.0 , V$</td>
<td>7.3</td>
<td>8.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si7212/3</td>
<td></td>
<td></td>
<td>3.5</td>
<td>4.5</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DD} = 1.8 , V$</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DD} = 3.3 , V$</td>
<td>5.0</td>
<td>6.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$V_{DD} = 5.0 , V$</td>
<td>6.8</td>
<td>8.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si7214/5</td>
<td></td>
<td></td>
<td>6.5</td>
<td>8.5</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>Si7216</td>
<td></td>
<td></td>
<td>7</td>
<td>9</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>Idle mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si7212/3</td>
<td></td>
<td></td>
<td>600</td>
<td>1000</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>Si7211/7</td>
<td></td>
<td></td>
<td>950</td>
<td>1150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si7214/5</td>
<td></td>
<td></td>
<td>900</td>
<td>1200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si7216</td>
<td></td>
<td></td>
<td>1400</td>
<td>1700</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conversion Time</td>
<td>$T_{CONV}$</td>
<td>First conversion when waking from idle</td>
<td>11</td>
<td></td>
<td></td>
<td>µs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Additional conversions in a burst</td>
<td>8.8</td>
<td></td>
<td></td>
<td>µs</td>
</tr>
<tr>
<td>Idle Time</td>
<td>$T_{IDLE}$</td>
<td>Factory programmable from 0 to 200msec ±10%. See Magnetic Sensors Selector Guide for more details.</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>For Si721x analog, PWM and SENT output parts, in sleep mode (DIS high) the output is not active.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wake Up Time</td>
<td>$T_{WAKE}$</td>
<td>Time from $V_{DD} &gt; 1.7 , V$ to first measurement</td>
<td>1</td>
<td></td>
<td></td>
<td>msec</td>
</tr>
</tbody>
</table>

**Note:**

1. BIST and DIS pin specifications apply when the pin is present.
2. For high voltage parts ($V_{DD} = 26.5 \, V$ maximum), the power on ramp should be faster than 10 V per second in the start-up region from 2 to 3 V.
### Table 1.3. Output Pin Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Si7211/7</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offset(^1)</td>
<td>B&lt;sub&gt;OFF&lt;/sub&gt;</td>
<td>(V_{DD} = 2.25 - 5.5 , V)</td>
<td>±300</td>
<td>±500</td>
<td>µT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(T = -40) to (+125 , ^\circ) C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V_{DD} = 2.25 - 3.6 , V)</td>
<td>±300</td>
<td></td>
<td>µT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(T = 0) to (+70 , ^\circ) C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratiometric Gain Error</td>
<td>RGE</td>
<td>Change in gain as function of supply for (V_{DD} &gt; 2.25).</td>
<td>±0.25</td>
<td></td>
<td>%/V</td>
<td></td>
</tr>
<tr>
<td>Gain Accuracy</td>
<td></td>
<td>(-40) to (+125 , ^\circ) C, (V_{DD} = 2.25 - 5.5 , V)</td>
<td>12</td>
<td></td>
<td>%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0) to (+70 , ^\circ) C, (V_{DD} = 2.25 - 3.6 , V)</td>
<td>6</td>
<td></td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Total Harmonic Distortion</td>
<td>THD</td>
<td>(V_{out}) inside 20-80% of (V_{DD}), (V_{DD} &gt; 2.5 , V)</td>
<td>0.15</td>
<td></td>
<td>%</td>
<td></td>
</tr>
<tr>
<td>Analog Noise at Output(^2)</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>µV/rtHz</td>
<td></td>
</tr>
<tr>
<td>Short Circuit Protection</td>
<td>I&lt;sub&gt;SS&lt;/sub&gt;</td>
<td>Output shorted to ground of (V_{DD})</td>
<td>±15</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td><strong>Si7212/3</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage Low</td>
<td>V&lt;sub&gt;OL&lt;/sub&gt;</td>
<td>(I_{OL} = 3 , mA) (\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ V_{DD} &gt; 2 , V)</td>
<td>0.4</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Open Drain or Push Pull</td>
<td></td>
<td>(I_{OL} = 2 , mA) (\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ V_{DD} &gt; 1.7 , V)</td>
<td>0.2</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(I_{OL} = 6 , mA) (\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ V_{DD} &gt; 2 , V)</td>
<td>0.6</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Leakage</td>
<td>I&lt;sub&gt;OH&lt;/sub&gt;</td>
<td></td>
<td>1</td>
<td></td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td>Output High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Pin Open Drain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage High</td>
<td>V&lt;sub&gt;OH&lt;/sub&gt;</td>
<td>(I_{OH} = 2 , mA) (\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ V_{DD} &gt; 2.25 , V)</td>
<td>(V_{DD} - 0.4)</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Output Pin Push Pull</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slew Rate</td>
<td>T&lt;sub&gt;SLEW&lt;/sub&gt;</td>
<td></td>
<td>5</td>
<td></td>
<td>%(V_{DD}/\text{ns})</td>
<td></td>
</tr>
<tr>
<td><strong>Si7214/5</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage Low</td>
<td>V&lt;sub&gt;OL&lt;/sub&gt;</td>
<td>(I_{OL} = 11.4 , mA) (\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ V_{DD} &gt; 6 , V)</td>
<td>0.4</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Safe Continuous Sink Current</td>
<td></td>
<td></td>
<td>20</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Leakage</td>
<td>I&lt;sub&gt;OH&lt;/sub&gt;</td>
<td></td>
<td>1</td>
<td></td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td>Output High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Pin Open Drain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Si7216 Field Output Hall Effect Magnetic Position Sensors Data Sheet

#### Electrical Specifications

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slew Rate</td>
<td>T(_{SLEW})</td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td>%V(_{DD})/ns</td>
</tr>
<tr>
<td>Digital Output Mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Pin Shorted to VDD</td>
<td>I(_{SHORT})</td>
<td>V(_{DD}) = 12 V</td>
<td>4</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average current as pin cycles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Si7216**

<table>
<thead>
<tr>
<th></th>
<th>V(_{OUT})</th>
<th>V(_{DD}) &gt; 6 V</th>
<th>2.4</th>
<th>2.6</th>
<th></th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gain</td>
<td></td>
<td>V(_{DD}) &gt; 6 V</td>
<td>125</td>
<td></td>
<td></td>
<td>mV/mT</td>
</tr>
</tbody>
</table>

**Note:**
1. Deviation from VDD/2. To get voltage offset, divide by gain typically 40.96 mT/VDD.
2. Analog noise is additive to magnetic sensor noise in RMS fashion. Generally magnetic sensor noise will dominate.
## Table 1.4. Magnetic Sensor

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offset</td>
<td>B_{OFF}</td>
<td>20 mT scale</td>
<td>±250</td>
<td>+450, -350</td>
<td>µT</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Full temperature range</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gain Accuracy</td>
<td></td>
<td>0-70 °C</td>
<td>5</td>
<td></td>
<td>10</td>
<td>%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Full temperature range</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RMS Noise¹</td>
<td></td>
<td>room Temp, 20 mT range, V_{DD} = 5 V</td>
<td>30</td>
<td></td>
<td></td>
<td>µT rms</td>
</tr>
</tbody>
</table>

**Note:**
1. For a single conversion. This can be reduced by the square root of N by filtering over N samples. See ordering guide for samples taken per measurement

## Table 1.5. Temperature Compensation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bop and Brp vs Temperature</td>
<td></td>
<td>Flat Tempco.</td>
<td>&lt; ±0.05</td>
<td></td>
<td></td>
<td>%/°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0-70°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Neodymium compensation</td>
<td>-0.12</td>
<td></td>
<td></td>
<td>%/°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ceramic compensation</td>
<td>-0.2</td>
<td></td>
<td></td>
<td>%/°C</td>
</tr>
</tbody>
</table>

## Table 1.6. Thermal Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Condition</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction to Air Thermal Resistance</td>
<td>θ_{JA}</td>
<td>JEDEC 4 layer board no airflow SOT23-5</td>
<td>212.8</td>
<td>°C/W</td>
</tr>
<tr>
<td>Junction to Board Thermal Resistance</td>
<td>θ_{JB}</td>
<td>JEDEC 4 layer board no airflow SOT23-5</td>
<td>45</td>
<td>°C/W</td>
</tr>
<tr>
<td>Junction to Air Thermal Resistance</td>
<td>θ_{JA}</td>
<td>JEDEC 4 layer board no airflow SOT23-3</td>
<td>254.6</td>
<td>°C/W</td>
</tr>
<tr>
<td>Junction to Board Thermal Resistance</td>
<td>θ_{JB}</td>
<td>JEDEC 4 layer board no airflow SOT23-3</td>
<td>54.8</td>
<td>°C/W</td>
</tr>
</tbody>
</table>

**Note:** See Magnetic Sensors Selector Guide.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Test Condition</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Temperature under Bias</td>
<td></td>
<td></td>
<td>-55</td>
<td>125</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td></td>
<td></td>
<td>-65</td>
<td>150</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Si7211/2/3/7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage on I/O Pins</td>
<td></td>
<td></td>
<td>-0.3</td>
<td></td>
<td>+0.3</td>
<td>V</td>
</tr>
<tr>
<td>Voltage on VDD with Respect to GND</td>
<td></td>
<td></td>
<td>-0.3</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>ESD Tolerance</td>
<td>HBM</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>kV</td>
</tr>
<tr>
<td></td>
<td>CDM</td>
<td></td>
<td></td>
<td></td>
<td>500</td>
<td>V</td>
</tr>
<tr>
<td>Si7214/5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage on Output Pin</td>
<td></td>
<td></td>
<td>-21</td>
<td>40</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>Voltage on VDD with Respect to GND</td>
<td></td>
<td></td>
<td>-21</td>
<td>40</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>ESD Tolerance</td>
<td>HBM</td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>kV</td>
</tr>
<tr>
<td></td>
<td>CDM</td>
<td></td>
<td></td>
<td></td>
<td>500</td>
<td>V</td>
</tr>
<tr>
<td>Si7216</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage on Output Pin</td>
<td></td>
<td></td>
<td>-0.3</td>
<td></td>
<td>+5.5</td>
<td>V</td>
</tr>
<tr>
<td>VDD with Respect to GND</td>
<td></td>
<td></td>
<td>-21</td>
<td></td>
<td>+40</td>
<td>V</td>
</tr>
<tr>
<td>ESD Tolerance</td>
<td>HBM output pin</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>kV</td>
</tr>
<tr>
<td></td>
<td>HBM VDD</td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>kV</td>
</tr>
<tr>
<td></td>
<td>CDM</td>
<td></td>
<td></td>
<td></td>
<td>500</td>
<td>V</td>
</tr>
</tbody>
</table>

**Note:**

1. Absolute maximum ratings are stress ratings only, operation at or beyond these conditions is not implied and may shorten the life of the device or alter its performance.
2. The output pin can withstand EMC transients per ISO 7637-2-2-11 and Ford EMC-CS-2009.1 with a current limiting resistor of 220 Ω to a local bypass cap of 0.1 μF and additional 22 Ω between the capacitor and ground.
3. VDD can withstand automotive EMC transients per ISO 7637-2-2-11 and Ford EMC-CS-2009.1 with a current limiting resistor of 220 Ω.
2. Functional Description

The Si7211/2/3/4/5/7 family of Hall Effect magnetic sensors digitize the component of the magnetic field in the z axis of the device (positive field is defined as pointing into the device from the bottom). The digitized field is then converted to an output format of analog, PWM or SENT and presented on the output pin.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Si7211, Si7217</td>
<td>Low voltage analog output</td>
</tr>
<tr>
<td>Si7212</td>
<td>Low voltage PWM output</td>
</tr>
<tr>
<td>Si7213</td>
<td>Low voltage SENT output</td>
</tr>
<tr>
<td>Si7214</td>
<td>High voltage PWM output</td>
</tr>
<tr>
<td>Si7215</td>
<td>High voltage SENT output</td>
</tr>
<tr>
<td>Si7216</td>
<td>High voltage V_DD, low voltage analog out</td>
</tr>
</tbody>
</table>

Refer to the Magnetic Sensors Selector Guide for the two digit number after the die revision which gives more details about output, sampling frequency and other details.

Data output is always unsigned. That is, half scale (V_DD/2 for analog out parts, 50% duty cycle for PWM output parts and 2048 (0x800) for SENT output parts) corresponds to zero field.

The parts are preconfigured for the magnetic field measurement range, idle time, temperature compensation and digital filtering and will wake into this mode when first powered. The specific configuration output type (open collector or push pull) are determined by the part number.
3. Analog Output

For the Si7211, the analog output is $V_{DD}/2$ at zero field and goes from nearly zero at large negative field to nearly $V_{DD}$ at large positive field.

$$B(mT) = (20.47 \text{or} 204.7) \times \left(2 \times \frac{V_{out}}{V_{dd}} - 1\right)$$

4- and 5-pin packages also have the option of a BISTb pin. When configured and detected low, the internal coil is turned on until the pin is detected high again. Each subsequent BISTb activation flips the polarity of the coil during BIST.

For high voltage parts (Si7216), the output is ratiometric to an internally derived $V_{DD}$ of 5V ($\pm$ 5%) so long as the input $V_{DD}$ is $> 6$ V.

$$B(mT) = (20.47 \text{or} 204.7) \times \left(2 \times \frac{V_{out}}{5} - 1\right)$$

For $V_{DD} < 6$ V the internally derived reference drops 1 V for each 1 V drop in $V_{DD}$ to the minimum recommended working voltage of 4.0 V.
4. PWM Output Description

The PWM output can be configured as open drain or push pull. High voltage parts can only be configured as open drain. The PWM duty cycle is factory configured and is normally set to in the range of 10 Hz to 1 KHz and is ±5%. See ordering guide for specific part numbers.

As each measurement completes, the next PWM cycle will be updated to reflect the last measurement result. The duty cycle varies from 0 to 100% where 50% duty cycle means zero field, 0 % duty cycle generally means maximum negative field (-20.47 mT or -204.7 mT) and 100% duty cycle generally means maximum positive field (+20.47 or +204.7 mT). The high portion of the PWM is output first so that

\[
B(mT) = \left(20.47 \text{ or } 204.7\right) \times \left(2 \times \frac{T_{\text{high}}}{T_{\text{high}} + T_{\text{low}}} - 1\right)
\]

The host processor should look for a variation in the magnetic field to determine the entire system is working properly.

4- and 5-pin packages also have the option of a BISTb pin. When configured and detected low the internal coil is turned on until the pin is detected high again. Each subsequent BISTb activation flips the polarity of the coil during BIST.
5. SENT Output

The Si7213 and Si7215 output data in SENT (Single Edge Nibble transmission) format conforming to J2716 January 2010. All SENT output parts are configured as open collector.

SENT protocol messages consist of:

- A calibration/synchronization period consisting of 56 clock ticks
- A status and serial communication 4-bit nibble
- A sequence of up to six data nibbles
- A one nibble checksum
- Each nibble is 12 to 27 clock ticks
- An optional delay pause pulse

![SENT Timing Diagram](image)

Figure 5.1. SENT Timing Diagram

As can be seen, each part of the sequence is determined by the timing between falling edges of the open drain sent output. First, a time of 56 clock ticks is produced so that the receiver can calibrate itself to the Si7213/5 speed. Then a total of 8 nibbles (4 bits per nibble) is produced. The edge to edge time of each nibble is 12 clock ticks for a data nibble of 0000b 13 ticks for a data value of 0001b and so on up to 27 ticks for a data value of 1111b.

The nominal tick time has been standardized at 5 μsec (±5%) however this is configurable.

5.1 tSENT Status Nibble

In the Si721x the four bit status nibble is defined as follows:
- Bit 3 and Bit 2 always transmitted as zeroes (No serial message support)
- Bit 1 and Bit 0
  - 00 Normal; No error condition
  - 01 Error condition
  - 10 Positive field BIST active
  - 11 Negative field BIST active
5.2 SENT Data Nibbles

The Si7213 and Si7215 are configurable to support a variety of options. The standard option follows J2716 A.3 where:

<table>
<thead>
<tr>
<th>Signal</th>
<th>Data</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>MSB of the magnetic field data</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>MidSB of the magnetic field data</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>LSB of the magnetic field data</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>MSB of an 8 bit rolling counter</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>LSB of an 8 bit rolling counter</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>An inverted copy of signal 1 data 1</td>
</tr>
</tbody>
</table>

For magnetic field, 3 nibbles are put together for a total 12 bit data word with values that can range from 0 to 4095. For magnetic field data, 2048 corresponds to zero field. The Si7213 can be configured for ± 20.47 mT full scale or ± 204.7 mT full scale. On the 20.47 mT full scale 1 LSB is 0.01 mT and on the 204.7 mT full scale 1 LSB is 0.1 mT.

5.3 CRC Calculation

The CRC is calculated based on the 6 data nibble according to \( x^4 + x^3 + x^2 + 1 \) with a seed value of 0101 as per the recommendations in J7216 section 5.4.2.2. The legacy CRC calculation is not supported.

5.4 SENT Pause Pulse

The Si7213 and Si7215 are configurable for a pause pulse that is 12 ticks low, 256 ticks wide. However, the standard offering is no pause pulse.

5.5 SENT Frame Rate

For the standard offering with no pause pulse, each message will be 154 to 270 ticks in length. At a tick time of 5 μsec this is 770 to 1350 μsec. This gives an average frame rate of approximately 1 msec for the standard tick time of 5 μsec. Conversion start is synchronized to the start of the synch pulse and is normally completed before the synch pulse completes so the data that is reported is the data obtained during the synch pulse time.

5.6 BIST Activation During SENT Operation

For 3-pin packages BIST can be activated by holding the output pin low for the entire message.

Once BIST is activated SENT messages resume 12 ticks after the SENT IO pin is detected high. Eight positive field BIST messages are followed by eight negative field BIST messages followed by a return to normal messages.

The nominal magnetic field output of the on-chip generator varies with coil current. The coil current varies with the coil resistance and power supply voltage, so the nominal magnetic field output varies according to:

\[ B_{out} = B_{perVnom} x VDD \]

\( B_{perVnom} \) is 1.6 mT/V

This can be used to calculate the expected magnetic field from the test coil for a given \( V_{DD} \). This is somewhat temperature dependent, so the actual measured field will vary according to the accuracy of the part as well as temperature. Generally, as the coil is turned on and off the measured variation in field should be within ±25% of expectation based on the calculated field generation.

The host processor should look for a variation in the magnetic field output to determine the entire system is working properly.

The 4- and 5-pin packages also have the option of a BISTb pin. When configured and detected low, the internal coil is turned on until the pin is detected high again. Each subsequent BISTb activation flips the polarity of the coil during BIST.
6. Pin Description

![SOT-23, 3-Pin Top View](image1)

![SOT-23, 5-Pin Top View](image2)

![TO-92, 3-Pin Front View](image3)

Figure 6.1. Si721x Pin Assignments

Note:

The 3-pin option includes part numbers: Si7211/12/13/14/15/16.

The SOT-23 5 pin option include part numbers: Si7217.

### Table 6.1. Si7211/12/13/14/15/16 (SOT23 3-pin Package)

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>Pin Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDD</td>
<td>1</td>
<td>Power 2.25 to 5.5 V, 1.71 to 5.5 V, or 3.3 to 26.5 V</td>
</tr>
<tr>
<td>OUT1</td>
<td>2</td>
<td>Switch/latch output</td>
</tr>
<tr>
<td>GND</td>
<td>3</td>
<td>Ground</td>
</tr>
</tbody>
</table>

### Table 6.2. Si7217 (SOT23 5-pin Package)

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>Pin Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUT2/TAMPERb</td>
<td>1</td>
<td>OUT2/TAMPERb (tamper/high field indicator)</td>
</tr>
<tr>
<td>GND</td>
<td>2</td>
<td>Ground</td>
</tr>
<tr>
<td>DIS</td>
<td>3</td>
<td>Disables part (puts into sleep mode) when high. Measurement cycle will resume when pin goes low</td>
</tr>
<tr>
<td>VDD</td>
<td>4</td>
<td>Power 2.25 to 5.5 V</td>
</tr>
<tr>
<td>OUT1</td>
<td>5</td>
<td>Switch/latch output</td>
</tr>
</tbody>
</table>
### Table 6.3. Si7211 (TO-92 Package)

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>Pin Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDD</td>
<td>1</td>
<td>Power</td>
</tr>
<tr>
<td>GND</td>
<td>2</td>
<td>Ground</td>
</tr>
<tr>
<td>OUT1</td>
<td>3</td>
<td>Output</td>
</tr>
</tbody>
</table>
7. Ordering Guide

Silicon Labs Magnetic Sensor Family

Output Type

Feature Set Major
1, 6, 7 = Analog
2, 4 = PWM
3, 5 = SENT

Revision

Feature Set Minor
See Selector Guide for breakdown of feature set

Temperature Grade
F = (0 to +70)
I = (-40 to +125)

Package
V = SOT23, B = TO92, M = DFN8

Tape and Reel (Optional)

Figure 7.1. Si721x Part Numbering

Table 7.1. Product Selection Guide

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Output Type and Polarity</th>
<th>Package</th>
<th>Sample Rate and Scale</th>
<th>Temperature Compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog output $V_{DD} = 2.25 - 5.5$ V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si7211-B-00-IV(R)</td>
<td>Analog, increasing field is increasing voltage</td>
<td>SOT23-3</td>
<td>7 kHz</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20 mT</td>
<td></td>
</tr>
<tr>
<td>Si7211-B-00-IB</td>
<td>Analog, increasing field is increasing voltage</td>
<td>TO92</td>
<td>7 kHz</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20 mT</td>
<td></td>
</tr>
<tr>
<td>Part Number</td>
<td>Output Type and Polarity</td>
<td>Package</td>
<td>Sample Rate and Scale</td>
<td>Temperature Compensation</td>
</tr>
<tr>
<td>---------------------</td>
<td>-------------------------------------------------------</td>
<td>---------</td>
<td>-----------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Si7217-B-01-IV(R)</td>
<td>Analog, increasing field is increasing voltage</td>
<td>SOT23-5</td>
<td>7 kHz</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si7212-B-00-IV(R)</td>
<td>Push pull, increasing pulse width is increasing field</td>
<td>SOT23-3</td>
<td>300 Hz</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Si7213-B-00-IV(R)</td>
<td>Open drain, increasing field gives increasing result</td>
<td>SOT23-3</td>
<td>1 kHz</td>
<td>No</td>
</tr>
<tr>
<td>Si7214 PWM output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{DD} = 3.3 - 26.5 V</td>
<td>Open drain, increasing pulse width is increasing field</td>
<td>SOT23-3</td>
<td>150 Hz</td>
<td>No</td>
</tr>
<tr>
<td>Si7215-B-00-IV(R)</td>
<td>Open drain, increasing field gives increasing result</td>
<td>SOT23-3</td>
<td>1 kHz</td>
<td>No</td>
</tr>
<tr>
<td>Analog output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{DD} = 4.0 to 26.5 V</td>
<td>Analog, increasing field is increasing voltage</td>
<td>SOT23-3</td>
<td>1 kHz</td>
<td>No</td>
</tr>
</tbody>
</table>

**Additional Information**

For information on the below specifications of each OPN refer to the Magnetic Sensors Selector Guide:

- Current consumption
- Built in self test if applicable

All Si721x parts periodically measure the field and output the data in PWM, SENT, or analog format.

The Si721x parts are factory configurable for:

- The type of output analog, SENT, or PWM
- The amount of digital filtering applied to the samples
- The time between measurements
- The output pin can be open drain or push pull (SENT and PWM parts)
- Full scale can be programmed as 20mT or 200mT
- A temperature compensation can be applied to the field data to adjust for the variation in field with temperature for common magnet types

**Note:** North pole of a magnet at the bottom of a SOT23 package, top of a DFN 8 package(coming soon), or front of a TO92 package(coming soon) is defined as positive field.
8. Package Outline

8.1 SOT23 3-Pin Package
Table 8.1. SOT23 3-Pin Package Dimensions

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>--</td>
<td>1.25</td>
</tr>
<tr>
<td>A1</td>
<td>0.00</td>
<td>0.10</td>
</tr>
<tr>
<td>A2</td>
<td>0.85</td>
<td>1.15</td>
</tr>
<tr>
<td>b</td>
<td>0.30</td>
<td>0.50</td>
</tr>
<tr>
<td>c</td>
<td>0.10</td>
<td>0.20</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>2.90 BSC</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>2.75 BSC</td>
</tr>
<tr>
<td>E1</td>
<td></td>
<td>1.60 BSC</td>
</tr>
<tr>
<td>e</td>
<td></td>
<td>0.95 BSC</td>
</tr>
<tr>
<td>e1</td>
<td></td>
<td>1.90 BSC</td>
</tr>
<tr>
<td>L</td>
<td>0.30</td>
<td>0.60</td>
</tr>
<tr>
<td>θ</td>
<td>0°</td>
<td>8°</td>
</tr>
<tr>
<td>aaa</td>
<td></td>
<td>0.15</td>
</tr>
<tr>
<td>bbb</td>
<td></td>
<td>0.20</td>
</tr>
<tr>
<td>ccc</td>
<td></td>
<td>0.10</td>
</tr>
<tr>
<td>ddd</td>
<td></td>
<td>0.20</td>
</tr>
</tbody>
</table>

Note:
1. All dimensions shown are in millimeters (mm) unless otherwise noted.
3. This drawing conforms to the JEDEC Solid State Outline MO-193, Variation AB.
4. Recommended card reflow profile is per the JEDEC/IPC J-STD-020D specification for Small Body Components.
8.2 SOT23-5 5-Pin Package

TOP VIEW
6 LEAD

SIDE VIEW
6 LEAD

END VIEW

DETAIL "A"
Table 8.2. SOT23-5 5-Pin Package Dimensions

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>--</td>
<td>1.25</td>
</tr>
<tr>
<td>A1</td>
<td>0.00</td>
<td>0.10</td>
</tr>
<tr>
<td>A2</td>
<td>0.85</td>
<td>1.15</td>
</tr>
<tr>
<td>b</td>
<td>0.30</td>
<td>0.50</td>
</tr>
<tr>
<td>c</td>
<td>0.10</td>
<td>0.20</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td>2.90 BSC</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td>2.75 BSC</td>
</tr>
<tr>
<td>E1</td>
<td></td>
<td>1.60 BSC</td>
</tr>
<tr>
<td>e</td>
<td></td>
<td>0.95 BSC</td>
</tr>
<tr>
<td>e1</td>
<td></td>
<td>1.90 BSC</td>
</tr>
<tr>
<td>L</td>
<td>0.30</td>
<td>0.60</td>
</tr>
<tr>
<td>L2</td>
<td></td>
<td>0.25 BSC</td>
</tr>
<tr>
<td>θ</td>
<td>0°</td>
<td>8°</td>
</tr>
<tr>
<td>aaa</td>
<td></td>
<td>0.15</td>
</tr>
<tr>
<td>bbb</td>
<td></td>
<td>0.20</td>
</tr>
<tr>
<td>ccc</td>
<td></td>
<td>0.10</td>
</tr>
<tr>
<td>ddd</td>
<td></td>
<td>0.20</td>
</tr>
</tbody>
</table>

Note:
1. All dimensions shown are in millimeters (mm) unless otherwise noted.
3. This drawing conforms to the JEDEC Solid State Outline MO-193, Variation AB.
4. Recommended card reflow profile is per the JEDEC/IPC J-STD-020D specification for Small Body Components.
### 8.3 TO92S 3-Pin Package

![TO92S 3-Pin Package Diagram]

#### Table 8.3. TO92S 3-Pin Package Dimensions

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.42</td>
<td>1.62</td>
</tr>
<tr>
<td>A1</td>
<td>0.66</td>
<td>0.86</td>
</tr>
<tr>
<td>b</td>
<td>0.33</td>
<td>0.48</td>
</tr>
<tr>
<td>b1</td>
<td>0.40</td>
<td>0.51</td>
</tr>
<tr>
<td>b2</td>
<td>0</td>
<td>0.76</td>
</tr>
<tr>
<td>c</td>
<td>0.33</td>
<td>0.51</td>
</tr>
<tr>
<td>D</td>
<td>3.90</td>
<td>4.10</td>
</tr>
<tr>
<td>D1</td>
<td>2.28</td>
<td>2.68</td>
</tr>
<tr>
<td>E</td>
<td>3.05</td>
<td>3.25</td>
</tr>
<tr>
<td>e</td>
<td>1.27</td>
<td>TYP</td>
</tr>
<tr>
<td>e1</td>
<td>2.44</td>
<td>2.46</td>
</tr>
<tr>
<td>L</td>
<td>15.10</td>
<td>15.50</td>
</tr>
<tr>
<td>θ</td>
<td>45°</td>
<td>TYP</td>
</tr>
</tbody>
</table>

**Notes:**

1. All dimensions shown are in millimeters (mm) unless otherwise noted.
9. Land Patterns

9.1 SOT23 3-Pin PCB Land Pattern

<table>
<thead>
<tr>
<th>Dimension</th>
<th>(mm)</th>
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</thead>
<tbody>
<tr>
<td>C</td>
<td>2.70</td>
</tr>
<tr>
<td>E</td>
<td>0.95</td>
</tr>
<tr>
<td>X</td>
<td>1.05</td>
</tr>
<tr>
<td>Y</td>
<td>0.60</td>
</tr>
</tbody>
</table>
### 9.2 SOT23-5 5-Pin PCB Land Pattern

**Note:**

**General**
1. All dimensions shown are in millimeters (mm) unless otherwise noted.
2. Dimensioning and Tolerancing is per the ANSI Y14.5M-1994 specification.
3. This Land Pattern Design is based on the IPC-7351 guidelines.
4. All dimensions shown are at Maximum Material Condition (MMC). Least Material Condition (LMC) is calculated based on a Fabrication Allowance of 0.05 mm.

**Card Assembly**
1. A No-Clean, Type-3 solder paste is recommended.
2. The recommended card reflow profile is per the JEDEC/IPC J-STD-020D specification for Small Body Components.
10. Top Marking

10.1 SOT23 3-Pin Top Marking

Note: TTTT is a manufacturing code.
10.2 SOT23-5 5-Pin Top Marking

Note: TTTT is a manufacturing code.

10.3 TO92 Top Marking

Note: TTTT is a manufacturing code. PPPP is 72xx.
11. Revision History

Revision 1.2
March, 2019
• Removed all mention of AEC-Q100 qualification in product description and feature list.

Revision 1.1
October 11th, 2018
• Added Si7211 TO92 part number.
• Added details on Si7217 part number.
• Added specifications for Si7217.

Revision 1.0
January 4, 2018
• Updated power numbers to be consistent with production test limits.
• Moved detailed ordering guide to a separate selection guide.
• Updated detailed description to be clearer and more accurate.

Revision 0.9
June 30, 2017
• Updated 1. Electrical Specifications.
• Updated 7. Ordering Guide.
• Minor typo corrections.

Revision 0.1
February 1, 2016
• Initial release.
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