AMR 4-Pin Quadrature Sensor Integrated Circuit
VM821Q1

DESCRIPTION
Honeywell’s Anisotropic Magnetoresistive (AMR) 4-Pin Quadrature Sensor Integrated Circuit (IC) is designed to detect the speed and direction and position of a ring magnet encoder target using a unique* bridge design. The frequency of the output is proportional to the rotational speed of the target, and the rotational direction is encoded by the phase between the outputs. The sensor IC works over a wide range of speeds, temperatures and air gaps.

VALUE TO CUSTOMERS
The VM821Q1 sensor IC has a higher sensitivity AMR bridge array that operates with a larger airgap than Hall-effect sensor ICs, which allows for enhanced design flexibility and assembly tolerances. The sensor IC has been optimized to provide an output that is not affected by target runout or sudden air gap changes. It is insensitive to magnet pole size, allowing one sensor to be paired with different ring magnet applications.

DIFFERENTIATION
Honeywell’s unique solution utilizes the AMR bridge in saturation, which provides a more stable output response when the system has vibration, sudden air gap changes, or target runout without requiring complex magnitude compensation algorithms. The AMR signal has greater sensitivity than Hall-effect sensor ICs, and does not require automatic gain control or chopper stabilization that can lead to increased jitter over the operating range.

*Patent Pending

FEATURES
• Integrated quadrature sensor IC
• Pole size independent operation
• 4-pin quadrature, open collector outputs
• -40°C to 150°C operating temperature range
• Zero speed operation
• No calibration required
• Insensitive to mechanical vibration
• Protection against reverse polarity and short circuit

POTENTIAL APPLICATIONS
• Industrial speed and direction and position feedback
• Encoders
• Conveyor rollers speed, process line speed and direction
• Gearbox output speed
• Positioning roller speed and direction
• Garage door opening systems
• Induction motors
• Fan speed systems
• Electric actuated blind position
• Pumps and compressors
• Integrated seals and bearings

PORTFOLIO
The Honeywell VM821Q1 AMR 4-Pin Quadrature Sensor IC joins the following related products:
• VM421D1 AMR 3-Pin PWM Speed and Direction Sensor IC
• VM721D1 AMR 2-Pin PWM Speed and Direction Sensor IC
• VM721V1 AMR 2-Pin Speed Sensor IC

Datasheet
AMR 4-Pin Quadrature Sensor Integrated Circuit
VM821Q1 
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### Table 1. Operating Characteristics (At 4.0 V ≤ V_s ≤ 24 V, -40°C ≤ T_a ≤ 150°C, unless otherwise specified.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Condition</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_s</td>
<td>—</td>
<td>4.0</td>
<td>—</td>
<td>24</td>
<td>V</td>
</tr>
<tr>
<td>Supply current</td>
<td>I_CC</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>20</td>
<td>mA</td>
</tr>
<tr>
<td>Output low</td>
<td>V_sat</td>
<td>V_s = 5 V, I.ol = 5 mA</td>
<td>—</td>
<td>—</td>
<td>400</td>
<td>mV</td>
</tr>
<tr>
<td>Output leakage</td>
<td>I_oh</td>
<td>V_oh = 24 V</td>
<td>—</td>
<td>—</td>
<td>10</td>
<td>μA</td>
</tr>
<tr>
<td>Output current</td>
<td>I.ol</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>20</td>
<td>mA</td>
</tr>
<tr>
<td>Duty cycle</td>
<td>—</td>
<td>2 mm pole width</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>%</td>
</tr>
<tr>
<td>Phase</td>
<td>—</td>
<td>2 mm pole width</td>
<td>70</td>
<td>90</td>
<td>110</td>
<td>°</td>
</tr>
<tr>
<td>Output switching time:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rise time</td>
<td>t_r</td>
<td>Vs = 5 V, R_l = 1 kOhm to 5 V</td>
<td>—</td>
<td>—</td>
<td>1.5</td>
<td>μs</td>
</tr>
<tr>
<td>fall time</td>
<td>t_f</td>
<td>Vs = 5 V, R_l = 1 kOhm to 5 V</td>
<td>—</td>
<td>—</td>
<td>1.5</td>
<td>μs</td>
</tr>
</tbody>
</table>

### Table 2. Output Configuration

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Condition</th>
<th>Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of pulses per pole</td>
<td>—</td>
<td>1</td>
</tr>
<tr>
<td>Phase polarity</td>
<td>rotation from pin 4 to pin 1 as shown in Figure 4.</td>
<td>output A leads B</td>
</tr>
</tbody>
</table>

### Table 3. Application Requirements (At 4.0 V ≤ V_s ≤ 24 V, -40°C ≤ T_a ≤ 150°C.)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Condition</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnetic flux</td>
<td>B</td>
<td>D_max, max. air gap, max. temp</td>
<td>±30</td>
<td>—</td>
<td>—</td>
<td>Gauss</td>
</tr>
<tr>
<td>Magnetic flux with valid</td>
<td>B</td>
<td>D_max, max. air gap, max. temp</td>
<td>±10</td>
<td>—</td>
<td>—</td>
<td>Gauss</td>
</tr>
<tr>
<td>direction indication,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>increased jitter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metering resistor</td>
<td>R</td>
<td>—</td>
<td>50</td>
<td>160</td>
<td>—</td>
<td>Ohm</td>
</tr>
</tbody>
</table>

### Table 4. Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Symbol</th>
<th>Condition</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
<td>T_a</td>
<td>—</td>
<td>-40</td>
<td>[−40]</td>
<td>150</td>
<td>[302] °C [°F]</td>
</tr>
<tr>
<td>Junction temperature</td>
<td>T_J</td>
<td>—</td>
<td>-40</td>
<td>[−40]</td>
<td>165</td>
<td>[329] °C [°F]</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>T_s</td>
<td>—</td>
<td>-40</td>
<td>[−40]</td>
<td>150</td>
<td>[302] °C [°F]</td>
</tr>
<tr>
<td>Thermal resistance</td>
<td>R_BJA</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>°C/W</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>V_s</td>
<td>—</td>
<td>-26.5</td>
<td>—</td>
<td>26.5</td>
<td>V</td>
</tr>
<tr>
<td>Soldering temperature</td>
<td>—</td>
<td>3 s max.</td>
<td>—</td>
<td>—</td>
<td>260</td>
<td>[500] °C [°F]</td>
</tr>
<tr>
<td>ESD (HBM)</td>
<td>V_ESD</td>
<td>JEDEC JS-002-2014</td>
<td>—</td>
<td>—</td>
<td>±6</td>
<td>kV</td>
</tr>
<tr>
<td>Output short circuit</td>
<td>—</td>
<td>with no current limiting resistor</td>
<td>—</td>
<td>—</td>
<td>24</td>
<td>V</td>
</tr>
</tbody>
</table>

**NOTICE**
Absolute maximum ratings are the extreme limits the device will momentarily withstand without damage to the device. Electrical and mechanical characteristics are not guaranteed if the rated voltage and/or currents are exceeded, nor will the device necessarily operate at absolute maximum ratings.
**Phase Calculation Definition**

This method isolates phase from duty cycle. It also best correlates to analysis of the fundamental frequency in the frequency domain.

$$\text{Phase (°)} = \left( \frac{B_{\text{rising}} + B_{\text{falling}}}{2} - \frac{A_{\text{rising}} + A_{\text{falling}}}{2} \right) \times \frac{360}{T}$$

Where:

- $A_{\text{rising}}$ = rising edge of output A
- $A_{\text{falling}}$ = falling edge of output A
- $B_{\text{rising}}$ = nearest falling edge of output B to $A_{\text{rising}}$
- $B_{\text{falling}}$ = next falling edge of output B
- $T$ = period of one cycle
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**Figure 4. Sensor IC Mounting Orientation**

- **Radial**
- **Axial**

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**Figure 5. Dimensions and Product Marking (For reference only mm/[in])**

**Product Marking**

- Product ID
- Date code (three digits: year, week)
- Work order number (one digit: 1-9)
- Manufacturing code (one digit)

**Sensing Element Edge Distance**

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**Pinout**

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Symbol</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vcc</td>
<td>supply voltage</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>output</td>
</tr>
<tr>
<td>3</td>
<td>B</td>
<td>output</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>ground</td>
</tr>
</tbody>
</table>
**ADDITIONAL INFORMATION**

The following associated literature is available on the Honeywell web site at sensing.honeywell.com:

- Installation instructions
- Application notes
- Technical notes
- CAD Models
- Evaluation samples available from your local Honeywell contact

**WARNING**

**PERSONAL INJURY**

DO NOT USE these products as safety or emergency stop devices or in any other application where failure of the product could result in personal injury.

Failure to comply with these instructions could result in death or serious injury.

**WARNING**

**MISUSE OF DOCUMENTATION**

- The information presented in this datasheet is for reference only. Do not use this document as a product installation guide.
- Complete installation, operation, and maintenance information is provided in the instructions supplied with each product.

Failure to comply with these instructions could result in death or serious injury.

**Warranty/Remedy**

Honeywell warrants goods of its manufacture as being free of defective materials and faulty workmanship during the applicable warranty period. Honeywell’s standard product warranty applies unless agreed to otherwise by Honeywell in writing; please refer to your order acknowledgment or consult your local sales office for specific warranty details. If warranted goods are returned to Honeywell during the period of coverage, Honeywell will repair or replace, at its option, without charge those items that Honeywell, in its sole discretion, finds defective. The foregoing is buyer’s sole remedy and is in lieu of all other warranties, expressed or implied, including those of merchantability and fitness for a particular purpose. In no event shall Honeywell be liable for consequential, special, or indirect damages.

While Honeywell may provide application assistance personally, through our literature and the Honeywell web site, it is buyer’s sole responsibility to determine the suitability of the product in the application.

Specifications may change without notice. The information we supply is believed to be accurate and reliable as of this writing. However, Honeywell assumes no responsibility for its use.

**For more information**

Honeywell Sensing and Internet of Things services its customers through a worldwide network of sales offices and distributors. For application assistance, current specifications, pricing or the nearest Authorized Distributor, visit sensing.honeywell.com or call:

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