AMR 2-Pin PWM Speed and Direction Sensor
Integrated Circuit
VM721D1

FEATURES
• Integrated speed and direction sensor IC
• Pole size independent operation
• 2-pin Pulse Width Modulated (PWM) current interface
• -40°C to 150°C operating temperature range
• Zero speed operation
• No calibration required
• Insensitive to mechanical vibration
• Protection against reverse polarity
• Integral capacitor for EMC protection
• ESD protected
• ISO-26262 conforming
• AECQ100-H qualified

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.

POTENTIAL TRANSPORTATION APPLICATIONS
• Transmission speed and direction sensing
• Direction for Anti-lock Brake Systems (ABS) and auto parking (For ISO26262 Function Safety applications a Safety Manual is available upon request.)

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

DESCRIPTION
Honeywell’s Anisotropic Magnetoresistive (AMR) 2-Pin Pulse Width Modulated (PWM) Speed and Direction Sensor Integrated Circuit (IC) is designed to detect the speed and direction of a ring magnet encoder target using a unique* bridge design. The frequency of the digital supply current is proportional to the rotational speed of the target, and the rotational direction is encoded by modulating the pulse width of the supply current. The sensor IC works over a wide range of speeds, temperatures and air gaps.

VALUE TO CUSTOMERS
The VM721D1 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 magnets. The VM721D1 sensor IC contains an integral capacitor for EMC protection, eliminating the need for an external capacitor in most applications. The wide leads are designed for a welded assembly, making the part easier to mount in customer applications.

*Patent Pending

Sensing and Internet of Things
AMR 2-Pin PWM Speed and Direction Sensor IC
VM721D1

Table 1. Operating Characteristics (Over entire supply voltage range at -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>-40°C to 110°C</td>
<td>4.0</td>
<td>—</td>
<td>24</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150°C</td>
<td>4.0</td>
<td>—</td>
<td>9.0</td>
<td>V</td>
</tr>
<tr>
<td>Supply current: high</td>
<td>i_sh</td>
<td>digital high state</td>
<td>12</td>
<td>5.9</td>
<td>16</td>
<td>mA</td>
</tr>
<tr>
<td>low</td>
<td>i_sl</td>
<td>digital low state</td>
<td>6.95</td>
<td>14</td>
<td>8.0</td>
<td>mA</td>
</tr>
<tr>
<td>Current ratio</td>
<td></td>
<td></td>
<td>—</td>
<td>1.9</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Pulse length: forward</td>
<td>t_on</td>
<td>—</td>
<td>38</td>
<td>45</td>
<td>52</td>
<td>µs</td>
</tr>
<tr>
<td>reverse</td>
<td>t_fwd</td>
<td></td>
<td>76</td>
<td>90</td>
<td>104</td>
<td>µs</td>
</tr>
<tr>
<td>Output switching time: forward</td>
<td>t_r</td>
<td>metering resistor, no bypass capacitor</td>
<td>—</td>
<td>—</td>
<td>8</td>
<td>µs</td>
</tr>
<tr>
<td>fall time</td>
<td>t_f</td>
<td>metering resistor, no bypass capacitor</td>
<td>—</td>
<td>—</td>
<td>8</td>
<td>µs</td>
</tr>
<tr>
<td>Switching frequency: forward</td>
<td>f_fwd</td>
<td>limited by length of forward pulse</td>
<td>—</td>
<td>—</td>
<td>14</td>
<td>kHz</td>
</tr>
<tr>
<td>reverse</td>
<td>f_f</td>
<td>limited by length of reverse pulse</td>
<td>—</td>
<td>—</td>
<td>8</td>
<td>kHz</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>Forward definition</td>
<td>rotation from pin 2 to pin</td>
<td>ring magnet rotating from pin 2 to pin 1 (CCW)</td>
</tr>
<tr>
<td>1</td>
<td>as shown in Figure 5</td>
<td></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, increased</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>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>10</td>
<td>100 to 300</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>°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>°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>°C [°F]</td>
</tr>
<tr>
<td>Thermal resistance</td>
<td>R_{ThA}</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>°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>
</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 current are exceeded, nor will the device necessarily operate at absolute maximum ratings.

NOTICE
Large, stray magnetic fields in the vicinity of the sensor may adversely affect sensor performance.

Figure 1. Maximum Supply Voltage Rating

CAUTION
ELECTROSTATIC SENSITIVE DEVICES
DO NOT OPEN OR HANDLE EXCEPT AT A STATIC FREE WORKSTATION

ESD SENSITIVITY:
CLASS 3

Figure 1. Maximum Supply Voltage Rating

Normal supply voltage of 5 V applied to sensor. The supply voltage rating increases with increasing temperature; at 120°C, it is 9 V. The graph shows that the supply voltage rating decreases at temperatures above 120°C.
Figure 2. Block Diagram

One shot pulse width modulates the current regulator

Figure 3. Basic Application Circuit

Control Unit
Power Unit
Power supply
Sensor
Metereing resistor

Figure 4. Rise and Fall Time Definition

\[ t_r = 10\% \text{ to } 90\% \text{ rise time} \]
\[ t_f = 90\% \text{ to } 10\% \text{ fall time} \]

Figure 5. Transfer Characteristics

\[ \text{Current (mA)} \]
\[ \text{Time} \]
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Figure 6. Sensor IC Mounting Orientation

Radial

Axial

Figure 7. Dimensions and Product Marking (For reference only mm/[in])

Dimensions

Product Marking

Pinout

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Symbol</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vₛ</td>
<td>supply voltage</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>ground</td>
</tr>
</tbody>
</table>

Table 5. Order Guide

Catalog Listing | Description
--- | ---
VM721D1 | Anisotropic Magnetoresistive (AMR) 2-Pin Pulse Width Modulated (PWM) Speed and Direction Sensor Integrated Circuit, 2-pin SIP, bulk pack, 500 units/bag
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
- Function Safety Manual is available upon request. Contact info.sc@honeywell.com

⚠️ WARNING
RISK TO LIFE OR PROPERTY
Never use this product for an application involving serious risk to life or property without ensuring that the system as a whole has been designed to address the risks, and that this product is properly rated and installed for the intended use within the overall system.

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.

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