**1 Features**

- Industry-Leading Low-Power Consumption
- Pin-Selectable Sampling Rate:
  - SEL = Low: 20 Hz Using 1.3 µA (1.8 V)
  - SEL = High: 2.5 kHz Using 142 µA (1.8 V)
- 1.65- to 5.5-V Operating $V_{CC}$ Range
- High Magnetic Sensitivity: ±2 mT (Typical)
- Robust Hysteresis: 4 mT (Typical)
- Push-Pull CMOS Output
- Small and Thin X2SON Package
- -40°C to +85°C Operating Temperature Range

**2 Applications**

- Brushless DC Motor Sensors
- Incremental Rotary Encoding:
  - Motor Speed
  - Mechanical Travel
  - Fluid Measurement
  - Knob Turning
  - Wheel Speed
- Portable Medical Devices
- E-Locks, E-Bikes, Motorized Blinds
- Flow Meters
- Contactless Activation

**3 Description**

The DRV5012 device is an ultra-low-power digital-latch Hall effect sensor with a pin-selectable sampling rate.

When a south magnetic pole is near the top of the package and the $B_{OP}$ threshold is exceeded, the device drives a low voltage. The output stays low until a north pole is applied and the $B_{RP}$ threshold is crossed, which causes the output to drive a high voltage. Alternating north and south poles are required to toggle the output, and integrated hysteresis separates $B_{OP}$ and $B_{RP}$ to provide robust switching.

Using an internal oscillator, the DRV5012 device samples the magnetic field and updates the output at a rate of 20 Hz or 2.5 kHz, depending on the SEL pin. This dual-bandwidth feature can allow systems to monitor changes in movement while using minimal power.

The device operates from a $V_{CC}$ range of 1.65 V to 5.5 V, and is packaged in a small X2SON.

**Device Information**

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>PACKAGE</th>
<th>BODY SIZE (NOM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRV5012</td>
<td>X2SON (4)</td>
<td>1.10 mm × 1.40 mm</td>
</tr>
</tbody>
</table>

(1) For all available packages, see the orderable addendum at the end of the data sheet.

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.
Table of Contents

1 Features ................................................................. 1
2 Applications .......................................................... 1
3 Description ........................................................... 1
4 Revision History ..................................................... 2
5 Pin Configuration and Functions ............................. 3
6 Specifications ........................................................... 3
   6.1 Absolute Maximum Ratings ................................. 3
   6.2 ESD Ratings ...................................................... 3
   6.3 Recommended Operating Conditions ....................... 4
   6.4 Thermal Information ............................................ 4
   6.5 Electrical Characteristics ..................................... 5
   6.6 Magnetic Characteristics ..................................... 5
   6.7 Typical Characteristics ....................................... 6
7 Detailed Description ................................................. 7
   7.1 Overview ........................................................ 7
   7.2 Functional Block Diagram .................................... 7
   7.3 Feature Description ........................................... 7
7.4 Device Functional Modes ..................................... 10
8 Application and Implementation ............................... 11
   8.1 Application Information ...................................... 11
   8.2 Typical Applications .......................................... 11
   8.3 Do's and Don'ts ................................................ 15
9 Power Supply Recommendations ............................... 16
10 Layout ................................................................. 16
   10.1 Layout Guidelines ............................................ 16
   10.2 Layout Example ............................................... 16
11 Device and Documentation Support ............................. 17
   11.1 Device Support ............................................... 17
   11.2 Receiving Notification of Documentation Updates ........ 17
   11.3 Community Resources ....................................... 17
   11.4 Trademarks ................................................... 17
   11.5 Electrostatic Discharge Caution ........................... 17
   11.6 Glossary ...................................................... 17
12 Mechanical, Packaging, and Orderable Information ...... 17

4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

<table>
<thead>
<tr>
<th>DATE</th>
<th>REVISION</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 2017</td>
<td>*</td>
<td>Initial release.</td>
</tr>
</tbody>
</table>
5 Pin Configuration and Functions

DMR Package
4-Pin X2SON With Exposed Thermal Pad
Top View

<table>
<thead>
<tr>
<th>PIN</th>
<th>I/O</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>GND</td>
<td>2</td>
<td>—</td>
</tr>
<tr>
<td>OUT</td>
<td>3</td>
<td>O</td>
</tr>
<tr>
<td>SEL</td>
<td>4</td>
<td>I</td>
</tr>
<tr>
<td>VCC</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Thermal Pad</td>
<td>PAD</td>
<td>—</td>
</tr>
</tbody>
</table>

GND — Ground reference
OUT — Push-pull CMOS output. Drives a VCC or ground level.
SEL — CMOS input that selects the sampling rate: a low voltage sets 20 Hz; a high voltage sets 2.5 kHz.
VCC — 1.65-V to 5.5-V power supply. TI recommends connecting this pin to a ceramic capacitor to ground with a value of at least 0.1 µF.
Thermal Pad — No-connect. This pin should be left floating or tied to ground. It should be soldered to the board for mechanical support.

6 Specifications

6.1 Absolute Maximum Ratings
over operating free-air temperature range (unless otherwise noted)\(^1\)

<table>
<thead>
<tr>
<th></th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power supply voltage</td>
<td>VCC</td>
<td>–0.3</td>
<td>5.5</td>
</tr>
<tr>
<td>Power supply voltage slew rate</td>
<td>VCC</td>
<td>Unlimited</td>
<td>V / µs</td>
</tr>
<tr>
<td>Output voltage</td>
<td>OUT</td>
<td>–0.3</td>
<td>VCC + 0.3</td>
</tr>
<tr>
<td>Output current</td>
<td>OUT</td>
<td>–5</td>
<td>5</td>
</tr>
<tr>
<td>Input voltage</td>
<td>SEL</td>
<td>–0.3</td>
<td>VCC + 0.3</td>
</tr>
<tr>
<td>Magnetic flux density, B(_{\text{MAX}})</td>
<td>Unlimited</td>
<td>T</td>
<td></td>
</tr>
<tr>
<td>Junction temperature, T(_J)</td>
<td></td>
<td>105</td>
<td>°C</td>
</tr>
<tr>
<td>Storage temperature, T(_\text{stg})</td>
<td>–65</td>
<td>150</td>
<td>°C</td>
</tr>
</tbody>
</table>

\(^1\) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 ESD Ratings

<table>
<thead>
<tr>
<th>V(_{\text{ESD}})</th>
<th>Electrostatic discharge</th>
<th>VALUE</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(^1)</td>
<td>±6000</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Charged-device model (CDM), per JEDEC specification JESD22-C101(^2)</td>
<td>±750</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
\(^2\) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.
### 6.3 Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>MIN</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{CC} )</td>
<td>Power supply voltage (VCC)</td>
<td>1.65</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>( V_O )</td>
<td>Output voltage (OUT)</td>
<td>0</td>
<td>( V_{CC} )</td>
<td>V</td>
</tr>
<tr>
<td>( I_O )</td>
<td>Output current (OUT)</td>
<td>–5</td>
<td>5</td>
<td>mA</td>
</tr>
<tr>
<td>( V_I )</td>
<td>Input voltage (SEL)</td>
<td>0</td>
<td>( V_{CC} )</td>
<td>V</td>
</tr>
<tr>
<td>( T_A )</td>
<td>Operating ambient temperature</td>
<td>–40</td>
<td>85</td>
<td>°C</td>
</tr>
</tbody>
</table>

### 6.4 Thermal Information

<table>
<thead>
<tr>
<th>THERMAL METRIC(1)</th>
<th>DRV5012 DMR (X2SON)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction-to-ambient thermal resistance ( R_{JA} )</td>
<td>159 °C/W</td>
</tr>
<tr>
<td>Junction-to-case (top) thermal resistance ( R_{JC(top)} )</td>
<td>77 °C/W</td>
</tr>
<tr>
<td>Junction-to-board thermal resistance ( R_{JB} )</td>
<td>102 °C/W</td>
</tr>
<tr>
<td>Junction-to-top characterization parameter ( \psi_{JT} )</td>
<td>0.9 °C/W</td>
</tr>
<tr>
<td>Junction-to-board characterization parameter ( \psi_{JB} )</td>
<td>100 °C/W</td>
</tr>
</tbody>
</table>

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report.
6.5 Electrical Characteristics

for $V_{CC} = 1.65$ V to 5.5 V, over operating free-air temperature range (unless otherwise noted)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>OUT pin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{OH}$ High-level output voltage</td>
<td>$I_{OUT} = –1$ mA</td>
<td>$V_{CC} – 0.35$</td>
<td>$V_{CC} – 0.1$</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{OL}$ Low-level output voltage</td>
<td>$I_{OUT} = 1$ mA</td>
<td>0.1</td>
<td>0.3</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>SEL pin</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{IH}$ High-level input voltage</td>
<td>$V_{CC} = 1.65$ to 2.5 V</td>
<td>$0.8 \times V_{CC}$</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{IL}$ Low-level input voltage</td>
<td>$V_{CC} = 2.5$ to 5.5 V</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{IH}$ High-level input leakage current</td>
<td>$SEL = V_{CC}$</td>
<td>1</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{IL}$ Low-level input leakage current</td>
<td>$SEL = 0$ V</td>
<td>1</td>
<td>nA</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DYNAMIC CHARACTERISTICS

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$f_{S}$ Frequency of magnetic sampling</td>
<td>$SEL = Low$</td>
<td>13.3</td>
<td>20</td>
<td>37</td>
<td>Hz</td>
</tr>
<tr>
<td>$t_{S}$ Period of magnetic sampling</td>
<td>$SEL = Low$</td>
<td>27</td>
<td>50</td>
<td>75</td>
<td>ms</td>
</tr>
<tr>
<td>$I_{CC(AVG)}$ Average current consumption</td>
<td>$V_{CC} = 1.8$ V</td>
<td>SEL = Low</td>
<td>1.3</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SEL = High</td>
<td>142</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{CC} = 3$ V</td>
<td>SEL = Low</td>
<td>1.6</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SEL = High</td>
<td>153</td>
<td>370</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$V_{CC} = 5$ V</td>
<td>SEL = Low</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SEL = High</td>
<td>160</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| $I_{CC(PK)}$ Peak current consumption | 2    | 2.7 | mA   |
| $t_{ON}$ Power-on time (see Figure 11) | 55   | 100 | µs   |
| $t_{ACTIVE}$ Active time period (see Figure 11) | 40   |     | µs   |

6.6 Magnetic Characteristics

for $V_{CC} = 1.65$ V to 5.5 V, over operating free-air temperature range (unless otherwise noted)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B_{OP}$ Magnetic threshold operate point (see Figure 9)</td>
<td>0.6</td>
<td>2</td>
<td>3.3</td>
<td>mT</td>
<td></td>
</tr>
<tr>
<td>$B_{RP}$ Magnetic threshold release point (see Figure 9)</td>
<td>–3.3</td>
<td>–2</td>
<td>–0.6</td>
<td>mT</td>
<td></td>
</tr>
<tr>
<td>$B_{HYS}$ Magnetic hysteresis: $</td>
<td>B_{OP} – B_{RP}</td>
<td>$</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>
6.7 Typical Characteristics

![Graph 1. $I_{CC(AVG)}$ vs Temperature (20-Hz Mode)](image1)

![Graph 2. $I_{CC(AVG)}$ vs Temperature (2.5-kHz Mode)](image2)

![Graph 3. $B_{OP}$ vs Temperature](image3)

![Graph 4. $B_{RP}$ vs Temperature](image4)

![Graph 5. $B_{OP}$ vs $V_{CC}$](image5)

![Graph 6. $B_{RP}$ vs $V_{CC}$](image6)
7  Detailed Description

7.1  Overview

The DRV5012 device is a magnetic sensor with a digital output that latches the most recent pole measured. Applying a south magnetic pole near the top of the package causes the output to drive low, a north pole causes the output to drive high, and the absence of a magnetic field causes the output to continue to drive the previous state, whether low or high.

The device integrates a Hall effect element, analog signal conditioning, and a low-frequency oscillator that enables ultra-low average power consumption. By operating from a 1.65-V to 5.5-V supply, the device periodically measures magnetic flux density, updates the output, and enters a low-power sleep state. A logic input pin, SEL, sets the sampling frequency to 20 Hz or 2.5 kHz with a tradeoff in power consumption.

7.2  Functional Block Diagram

![Functional Block Diagram](image)

7.3  Feature Description

7.3.1  Magnetic Flux Direction

The DRV5012 device is sensitive to the magnetic field component that is perpendicular to the top of the package (as shown in Figure 7).

![Direction of Sensitivity](image)
Feature Description (continued)

Magnetic flux that travels from the bottom to the top of the package is considered positive in this data sheet. This condition exists when a south magnetic pole is near the top of the package. Magnetic flux that travels from the top to the bottom of the package results in negative millitesla values.

Figure 8. Flux Direction Polarity

7.3.2 Magnetic Response

Figure 9 shows the device functionality and hysteresis.

Figure 9. Device Functionality
7.3.3 Output Driver

The device features a push-pull CMOS output that can drive a $V_{CC}$ or ground level.

![Figure 10. Push-Pull Output (Simplified)](image)

7.3.4 Sampling Rate

When the DRV5012 device powers up, it measures the first magnetic sample and sets the output within the $t_{ON}$ time. The output is latched, and the device enters an ultra-low-power sleep state. After each $t_S$ time has passed, the device measures a new sample and updates the output if necessary. If the magnetic field does not change between periods, the output also does not change.

![Figure 11. Timing Diagram](image)
Feature Description (continued)

7.3.5 SEL Pin
The SEL pin is a CMOS input that selects between two sampling rates. When the pin is low, the device samples at 20 Hz and uses low power. When the pin is high, the device samples at 2500 Hz and uses more power. The SEL pin can be tied directly high or low, or it can be changed during device operation. If the SEL voltage changes, the device detects the new voltage during the next $t_{ACTIVE}$ time.

7.3.6 Hall Element Location
The sensing element inside the device is in the center of the package when viewed from the top. Figure 12 shows the tolerances and side-view dimensions.

![Figure 12. Hall Element Location](image.png)

7.4 Device Functional Modes
The DRV5012 device has two operating modes, 20 Hz and 2.5 kHz, as set by the SEL pin. In both cases the Recommended Operating Conditions must be met.
8 Application and Implementation

NOTE
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

The DRV5012 device is typically used in rotary applications for brushless DC (BLDC) motor sensors or incremental rotary encoding.

To ensure reliable functionality, the magnet should apply a flux density at the sensor greater than the maximum $B_{OP}$ and less than the minimum $B_{RP}$ thresholds. It is good practice to add additional margin to account for mechanical tolerance, temperature effects, and magnet variation.

8.2 Typical Applications

8.2.1 BLDC Motor Sensors Application

![Diagram of BLDC Motor System](https://www.ti.com/lit/ds/symlink/drv5012.pdf)

**Figure 13. BLDC Motor System**

8.2.1.1 Design Requirements

For this design example, use the parameters listed in Table 1.

<table>
<thead>
<tr>
<th>DESIGN PARAMETER</th>
<th>EXAMPLE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of motor phases</td>
<td>3</td>
</tr>
<tr>
<td>Motor RPM</td>
<td>3000</td>
</tr>
<tr>
<td>Number of magnet poles on the rotor</td>
<td>6</td>
</tr>
<tr>
<td>Magnetic material</td>
<td>Bonded Neodymium</td>
</tr>
<tr>
<td>Peak magnetic flux density at the Hall sensors</td>
<td>±15 mT</td>
</tr>
<tr>
<td>Battery voltage range ($V_{BAT}$)</td>
<td>2 to 3.5 V</td>
</tr>
</tbody>
</table>
8.2.1.2 Detailed Design Procedure

Three-phase brushless DC motors often use 3 Hall effect latch devices to measure the electrical angle of the rotor and tell the controller how to drive the 3 wires. These wires connect to electromagnet windings, which generate magnetic fields that apply forces to the permanent magnets on the rotor.

The 3 Hall sensors should be spaced across the printed-circuit board (PCB) so that they are 120° electrical degrees apart. This configuration creates six 3-bit states with equal time duration for each electrical cycle, which consists of 1 north and 1 south magnetic pole. From the center of the motor axis, the number of degrees each sensor should be spaced equals \( \frac{2}{\text{number of poles}} \times 120° \). In this design example, 1 sensor is placed at 0°, 1 sensor is placed 40° rotated, and 1 sensor is placed 80° rotated. Alternatively, a 3× degree offset can be added or subtracted to any sensor, meaning the third sensor could alternatively be placed at \( 80° - (3 \times 40°) = -40° \).

While an ideal BLDC motor would energize the phases at the exact correct times, the DRV5012 device introduces variable lag because of the sampling architecture that achieves low power. An acceptable amount of lag can be measured by the sampling time error as a percentage of the electrical period. This design example uses 3000 RPM, which is 50 revolutions per second. Each revolution has 6 poles (3 electrical cycles), so the electrical frequency is 150 Hz, a period of 6.7 ms. The DRV5012 device in 2.5 kHz mode has a sampling period of 0.4 ms, which is 6% of the electrical period. Generally, the maximum timing error should be kept under 10% to ensure the BLDC motor spins, and timing error can reduce motor efficiency.

When the motor in this example is not driven, the SEL pins of the DRV5012 devices are set to a low voltage, and the sensor outputs are monitored for changes. If a change occurs, the microcontroller wakes the system into a higher power state and takes other appropriate action.

8.2.1.3 Application Curve

![3-Phase BLDC Motor Phase Voltages and Hall Signals](image)

Figure 14. 3-Phase BLDC Motor Phase Voltages and Hall Signals
8.2.2 Incremental Rotary Encoding Application

![Diagram of incremental rotary encoding system]

**Figure 15. Incremental Rotary Encoding System**

8.2.2.1 Design Requirements

For this design example, use the parameters listed in Table 2.

<table>
<thead>
<tr>
<th>DESIGN PARAMETER</th>
<th>EXAMPLE VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>RPM range</td>
<td>0 to 4000</td>
</tr>
<tr>
<td>Number of magnet poles</td>
<td>8</td>
</tr>
<tr>
<td>Magnetic material</td>
<td>Ferrite</td>
</tr>
<tr>
<td>Air gap above the Hall sensors</td>
<td>2.5 mm</td>
</tr>
<tr>
<td>Peak magnetic flux density at the sensors</td>
<td>±7 mT</td>
</tr>
</tbody>
</table>

8.2.2.2 Detailed Design Procedure

Incremental encoders are used on knobs, wheels, motors, and flow meters to measure relative rotary movement. By attaching a ring magnet to the rotating component and placing a DRV5012 device nearby, the sensor generates voltage pulses as the magnet turns. If directional information is also needed (clockwise versus counterclockwise), a second DRV5012 device can be added with a phase offset, and then the order of transitions between the two signals describes the direction.

Creating this phase offset requires spacing the two sensors apart on the PCB, and an ideal 90° quadrature offset is attained when the sensors are separated by half the length of each magnet pole, plus any integer number of pole lengths. Figure 15 shows this configuration, as the sensors are 1.5 pole lengths apart. One of the sensors changes its output every $\frac{360°}{8 \text{ poles}} / 2 \text{ sensors} = 22.5°$ of rotation. For reference, the TI Design TIDA-00480 uses a 66-pole magnet with changes every 2.7°.

Because the DRV5012 device periodically samples the magnetic field, there is a limit to the maximum rotational speed that can be measured. Generally, the device sampling rate should be faster than 2 times the number of poles per second. In this design example, the maximum speed is 4000 RPM, which involves 533 poles per second. The DRV5012 has a minimum sampling frequency of 1665 Hz (when the SEL pin is high), which is approximately $3 \times 533$ poles per second.

In systems where the sensor sampling rate is close to 2 times the number of poles per second, most of the samples will measure a magnetic field that is significantly lower than the peak value, since the peaks only occur when the sensor and pole are perfectly aligned. In this case, margin should be added by applying a stronger magnetic field that has peaks significantly higher than the maximum $\text{B}_{\text{OP}}$ of the DRV5012 device.
8.2.2.3 Application Curve

Two signals in quadrature provide movement and direction information. Each 2-bit state has unique adjacent 2-bit states for clockwise and counterclockwise.

![Figure 16. 2-bit Quadrature Output](image-url)
8.3 Do's and Don'ts

Because the Hall element is sensitive to magnetic fields that are perpendicular to the top of the package, a correct magnet orientation must be used for the sensor to detect the field. Figure 17 shows correct and incorrect orientations when using a ring magnet.

![Correct and Incorrect Magnet Orientations](image)

Figure 17. Correct and Incorrect Magnet Orientations
9 Power Supply Recommendations

The DRV5012 device is powered from 1.65-V to 5.5-V DC power supplies. A decoupling capacitor close to the device must be used to provide local energy with minimal inductance. TI recommends using a ceramic capacitor with a value of at least 0.1 µF.

10 Layout

10.1 Layout Guidelines

Magnetic fields pass through most nonferromagnetic materials with no significant disturbance. Embedding Hall effect sensors within plastic or aluminum enclosures and sensing magnets on the outside is common practice. Magnetic fields also easily pass through most PCBs, which makes placing the magnet on the opposite side possible.

10.2 Layout Example

![Figure 18. Layout Example](image)
11 Device and Documentation Support

11.1 Device Support

11.1.1 Development Support

For additional design reference, refer to the Automotive Hall Sensor Rotary Encoder TI Design (TIDA-00480).

11.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on Alert me to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

11.3 Community Resources

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI’s views; see TI’s Terms of Use.

TI E2E™ Online Community TI’s Engineer-to-Engineer (E2E) Community. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support TI’s Design Support Quickly find helpful E2E forums along with design support tools and contact information for technical support.

11.4 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

11.5 Electrostatic Discharge Caution

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

11.6 Glossary

SLYZ022 — TI Glossary.
This glossary lists and explains terms, acronyms, and definitions.

12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.
## PACKAGING INFORMATION

<table>
<thead>
<tr>
<th>Orderable Device</th>
<th>Status (1)</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>Package Qty</th>
<th>Eco Plan (2)</th>
<th>Lead/Ball Finish</th>
<th>MSL Peak Temp</th>
<th>Op Temp (°C)</th>
<th>Device Marking (4/5)</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRV5012AEDMRR</td>
<td>ACTIVE</td>
<td>X2SON</td>
<td>DMR</td>
<td>4</td>
<td>3000</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>SN</td>
<td>Level-1-260C-UNLIM</td>
<td>-40 to 85</td>
<td>2AE</td>
<td></td>
</tr>
<tr>
<td>DRV5012AEDMRT</td>
<td>ACTIVE</td>
<td>X2SON</td>
<td>DMR</td>
<td>4</td>
<td>250</td>
<td>Green (RoHS &amp; no Sb/Br)</td>
<td>SN</td>
<td>Level-1-260C-UNLIM</td>
<td>-40 to 85</td>
<td>2AE</td>
<td></td>
</tr>
</tbody>
</table>

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines “RoHS” to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, “RoHS” products are suitable for use in specified lead-free processes. TI may reference these types of products as “Pb-Free”.

**RoHS Exempt:** TI defines “RoHS Exempt” to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines “Green” to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) **MSL, Peak Temp.** - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a “~” will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) **Lead/Ball Finish** - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.
**TAPE AND REEL INFORMATION**

*All dimensions are nominal.*

<table>
<thead>
<tr>
<th>Device</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>SPQ</th>
<th>Reel Diameter (mm)</th>
<th>Reel Width W1 (mm)</th>
<th>A0 (mm)</th>
<th>B0 (mm)</th>
<th>K0 (mm)</th>
<th>P1 (mm)</th>
<th>W (mm)</th>
<th>Pin1 Quadrant</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRV5012AEDMRR</td>
<td>X2SON</td>
<td>DMR</td>
<td>4</td>
<td>3000</td>
<td>179.0</td>
<td>8.4</td>
<td>1.27</td>
<td>1.57</td>
<td>0.5</td>
<td>4.0</td>
<td>8.0</td>
<td>Q1</td>
</tr>
<tr>
<td>DRV5012AEDMRT</td>
<td>X2SON</td>
<td>DMR</td>
<td>4</td>
<td>250</td>
<td>180.0</td>
<td>8.4</td>
<td>1.27</td>
<td>1.57</td>
<td>0.5</td>
<td>4.0</td>
<td>8.0</td>
<td>Q1</td>
</tr>
</tbody>
</table>
### TAPE AND REEL BOX DIMENSIONS

*All dimensions are nominal

<table>
<thead>
<tr>
<th>Device</th>
<th>Package Type</th>
<th>Package Drawing</th>
<th>Pins</th>
<th>SPQ</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Height (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRV5012AEDMRR</td>
<td>X2SON</td>
<td>DMR</td>
<td>4</td>
<td>3000</td>
<td>203.0</td>
<td>203.0</td>
<td>35.0</td>
</tr>
<tr>
<td>DRV5012AEDMRT</td>
<td>X2SON</td>
<td>DMR</td>
<td>4</td>
<td>250</td>
<td>203.0</td>
<td>203.0</td>
<td>35.0</td>
</tr>
</tbody>
</table>
NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.
NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).

5. Vias are optional depending on application, refer to device data sheet. If all or some are implemented, recommended via locations are shown. It is recommended that vias under paste be filled, plugged or tented.
6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2020, Texas Instruments Incorporated