



## 1 Description

The RedRock® RR122-1A22-511/512 and RR122-1A23-511/512 are digital magnetic sensors ideal for use in medical, industrial, automotive, and consumer applications. They are based on patented Tunneling Magnetoresistance (TMR) technology with seamless CMOS integration.

The RR122-1A22-511/512 and RR122-1A23-511/512 feature an operate sensitivity of 9 G (0.9 mT), with an omnipolar magnetic field response. They offer a wide supply voltage range from 1.7 V up to 5.5 V, ideal for applications ranging from small battery-powered electronics to industrial machinery. They have the world's lowest average current drain (100 nA) for an active magnetic sensor, operating at 10 Hz and high operating temperature range from -40°C up to +125°C.

## 2 Features

- ▶ Operate sensitivity of 9 G
- ▶ Lowest Average Current < 100 nA
- ▶ Wide Supply Voltage range of 1.7V – 5.5V
- ▶ Omnipolar Push-Pull Response
- ▶ Operating Frequency of 10 Hz
- ▶ Temperature Rated up to 125°C
- ▶ RoHS & REACH Compliant

## 3 Applications

- ▶ Proximity Detection
- ▶ Rotary Sensing
- ▶ Fluid Level Detection
- ▶ Door & Lid Closure Detection
- ▶ Utility Meters
- ▶ Portable Medical Devices
- ▶ Motor Controllers
- ▶ Consumer Electronics
- ▶ Wake-Up  $\mu$ Processor

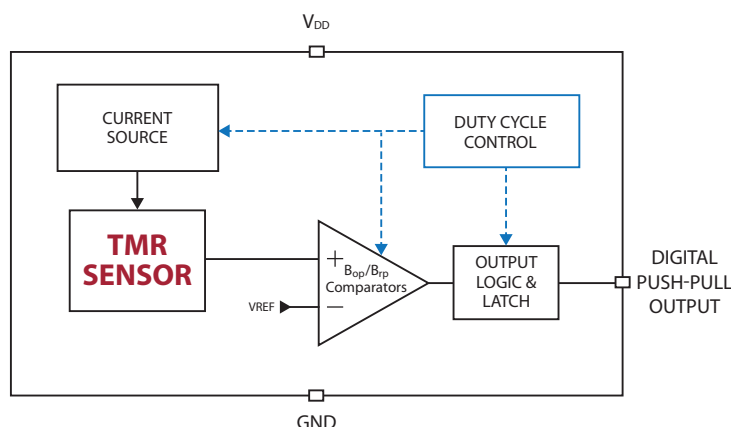
## Device Information

| Part Series    | Package  | Body Size (mm)     | Temp Rating °C |
|----------------|----------|--------------------|----------------|
| RR122-1A22-511 | SOT-23-3 | 2.9 x 1.6 x 1.2    | -40 to +85     |
| RR122-1A22-512 | LGA-4    | 1.45 x 1.45 x 0.44 | -40 to +85     |
| RR122-1A23-511 | SOT-23-3 | 2.9 x 1.6 x 1.2    | -40 to +125    |
| RR122-1A23-512 | LGA-4    | 1.45 x 1.45 x 0.44 | -40 to +125    |

## Device Packages



Functional Block Diagram  
for Digital Push-Pull Output



## Device Nomenclature

### Ordering Information

| RR122-X X X X-YYY          |  |  |  |  | Package              |
|----------------------------|--|--|--|--|----------------------|
| Series                     |  |  |  |  | 1: SOT-23-3          |
| Magnetic Polarity Response |  |  |  |  | 2: LGA-4             |
| 1 = Omnipolar              |  |  |  |  | 5: SOT-23-5          |
| 2 = Unipolar               |  |  |  |  | Output Response      |
| 3 = Bipolar/Latch          |  |  |  |  | 1: Active Low        |
| Magnetic Sensitivity (G)   |  |  |  |  | Supply Voltage (V)   |
| A: Op 9, Rel 5             |  |  |  |  | 5: 1.7 – 5.5         |
| E: Op 15, Rel 10           |  |  |  |  | Temp Rating (°C)     |
| B: Op 30, Rel 20           |  |  |  |  | 2: -40 – +85         |
| F: Op 70, Rel 50           |  |  |  |  | 3: -40 – +125        |
| C: Op 10, Rel -10          |  |  |  |  | Clock Frequency (Hz) |
| 1: 2                       |  |  |  |  | 5: 250               |
| 2: 10                      |  |  |  |  | 6: 500               |
| 3: 20                      |  |  |  |  | 7: 2500              |
| 9: 10000                   |  |  |  |  | U: 100+Turbo (10000) |

## 4 Specifications

### 4.1 Absolute Environmental Ratings<sup>1,2</sup>

| Parameters                                                    | Units | Min   | Typ | Max  |
|---------------------------------------------------------------|-------|-------|-----|------|
| Operating Temperature (T <sub>OP</sub> ) (RR122-1A22-511/512) | °C    | -40   |     | +85  |
| Operating Temperature (T <sub>OP</sub> ) (RR122-1A23-511/512) | °C    | -40   |     | +125 |
| Storage Temperature (T <sub>STG</sub> )                       | °C    | -65   |     | +150 |
| Junction Temperature (T <sub>J</sub> )                        | °C    |       |     | +150 |
| Soldering Temperature (3 cycles, 1 min.) (T <sub>SOL</sub> )  | °C    |       |     | +260 |
| ESD Level Human Body Model per JESD22-A114                    | V     | ±4000 |     |      |
| ESD Level Charged Device Model (CDM) per JESD22-C101          | V     | ±500  |     |      |
| Junction-to-Ambient Thermal Resistance (LGA-4)                | °C/W  |       | 165 |      |
| Junction-to-Ambient Thermal Resistance (SOT-23-3)             | °C/W  |       | 215 |      |
| Maximum Magnetic Field Exposure (B <sub>MAX</sub> )           | G     |       |     | ±600 |

### 4.2 Absolute Electrical Ratings<sup>1,2</sup>

| Parameters                                                    | Units | Min  | Typ | Max             |
|---------------------------------------------------------------|-------|------|-----|-----------------|
| Supply Voltage (V <sub>DD</sub> )                             | V     | -0.3 |     | 6.0             |
| Push-pull Output (Active Low)(V <sub>OUT_PP</sub> )           | V     | -0.3 |     | V <sub>DD</sub> |
| Input and Output Current (I <sub>IN</sub> /I <sub>OUT</sub> ) | mA    |      |     | ±20             |

### 4.3 Operating Electrical Characteristics for RR122-1A22-511 / 512 and RR122-1A23-511 / 512<sup>3</sup>

| Parameters                                                                                                 | Units | Min                 | Typ  | Max                 |
|------------------------------------------------------------------------------------------------------------|-------|---------------------|------|---------------------|
| Supply Voltage (V <sub>DD</sub> )                                                                          | V     | 1.7                 | 3.0  | 5.5                 |
| Power-On Time (t <sub>ON</sub> )(V <sub>DD</sub> > 1.7 V)                                                  | μs    |                     | 50   | 75                  |
| Peak Power-On Current                                                                                      | mA    |                     |      | 1.4                 |
| Output Voltage (High) (V <sub>OUTH</sub> )                                                                 | V     | 90% V <sub>DD</sub> |      |                     |
| Output Voltage (Low) (V <sub>OUTL</sub> )                                                                  | V     |                     |      | 10% V <sub>DD</sub> |
| Under Voltage Lockout Threshold Rising V <sub>DD</sub> (V <sub>UVLO-RISE</sub> )                           | V     |                     | 1.60 | 1.64                |
| Under Voltage Lockout Threshold Falling V <sub>DD</sub> (V <sub>UVLO-FALL</sub> )                          | V     | 1.44                | 1.53 |                     |
| Under Voltage Lockout Hysteresis (V <sub>UV-HYST</sub> )                                                   | mV    |                     | 70   |                     |
| Average Supply Current @ V <sub>DD</sub> =1.7 V, f <sub>SW</sub> =10 Hz (I <sub>DDAVG</sub> ) <sup>4</sup> | nA    |                     | 100  | 900                 |
| Average Supply Current @ V <sub>DD</sub> =3.0 V, f <sub>SW</sub> =10 Hz (I <sub>DDAVG</sub> ) <sup>4</sup> | nA    |                     | 135  | 900                 |

#### Notes:

- Exceeding Absolute Ratings may cause permanent damage to the device.
- Unless otherwise specified, all characteristics are measured at 25°C.
- Unless otherwise specified, V<sub>DD</sub> = 1.7 V to 5.5 V, T<sub>A</sub> = -40°C to +85°C (1A22), -40°C to +125°C (1A23). Typical values are V<sub>DD</sub> = 3.0 V and T<sub>A</sub> = +25°C.
- Conditions: t=10 seconds.



ESD Note: This product uses semiconductors that can be damaged by electrostatic discharge (ESD). When handling, proper ESD precautions should be taken to avoid performance degradation or loss of functionality. Damage due to inappropriate handling is not covered under warranty.

## 4 Specifications (cont.)

### 4.4 Operating Characteristics for RR122-1A22-511 / 512 and RR122-1A23-511 / 512<sup>1</sup>

| Parameters                                     | Units   | Min | Typ | Max |
|------------------------------------------------|---------|-----|-----|-----|
| Switching Frequency ( $f_{SW}$ )               | Hz      | 6   | 10  | 14  |
| Active Mode Time ( $t_{ACT}$ )                 | $\mu s$ |     | 2.6 |     |
| Idle Mode Time @ $f_{SW}=10$ Hz ( $t_{IDLE}$ ) | ms      | 71  | 100 | 166 |
| Operate Point ( $B_{OPN}$ )                    | G       | 7   | 9   | 12  |
| Operate Point ( $B_{OPS}$ )                    | G       | -12 | -9  | -7  |
| Release Point ( $B_{RPN}$ )                    | G       | 3   | 5   | 7   |
| Release Point ( $B_{RPS}$ )                    | G       | -7  | -5  | -3  |
| Hysteresis ( $B_{HYST}$ ) <sup>2</sup>         | G       | 3   | 4   |     |

#### Notes:

1. Unless otherwise specified,  $V_{DD} = 1.7$  V to 5.5 V,  $T_A = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  (1A22),  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  (1A23). Typical values are  $V_{DD} = 3.0$  V and  $T_A = +25^{\circ}\text{C}$ .

2. Conditions:  $B_{HYST} = |B_{OP} - B_{RP}|$



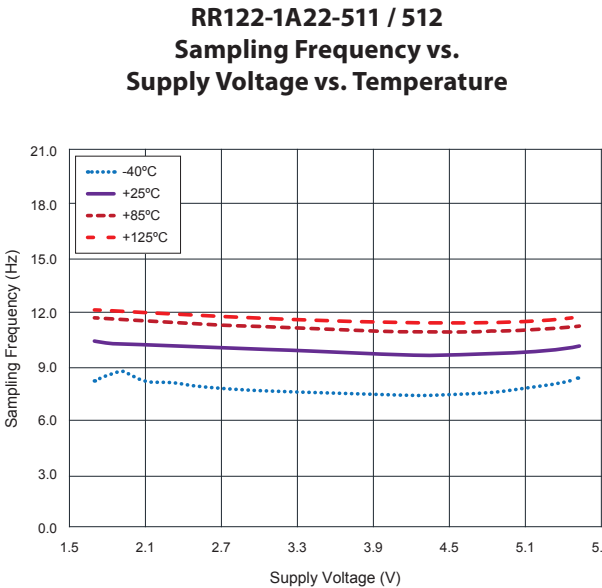
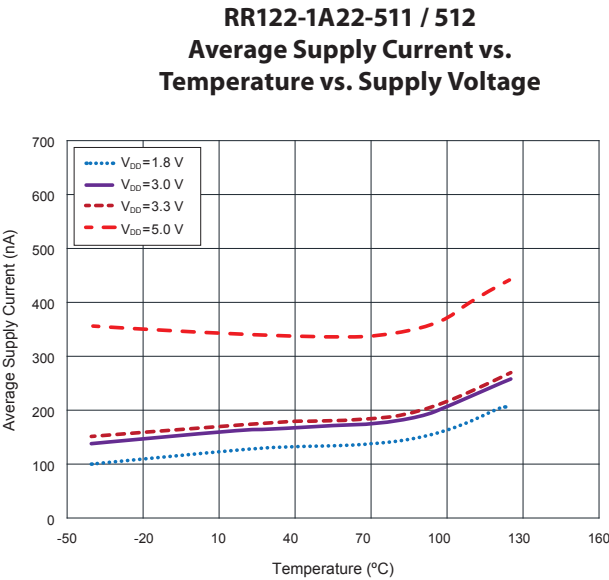
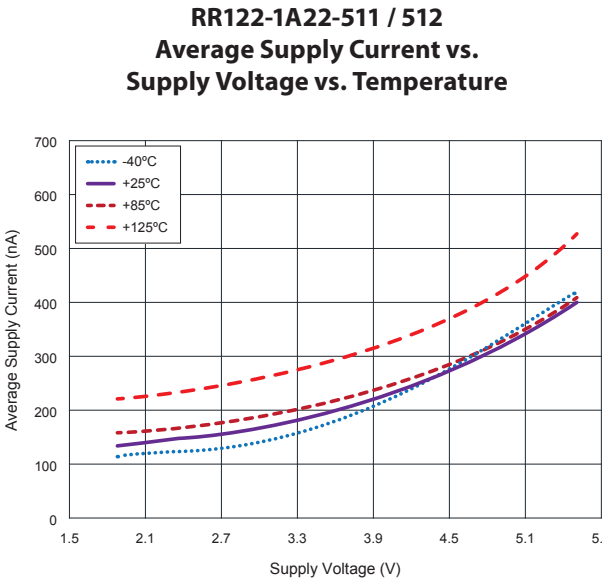
ESD Note: This product uses semiconductors that can be damaged by electrostatic discharge (ESD). When handling, proper ESD precautions should be taken to avoid performance degradation or loss of functionality. Damage due to inappropriate handling is not covered under warranty.



5 Graphs - Typical Electrical & Magnetic Characteristics

5.1 Typical Electric Characteristics

C<sub>DD</sub> = 1.0 μF (unless otherwise specified)

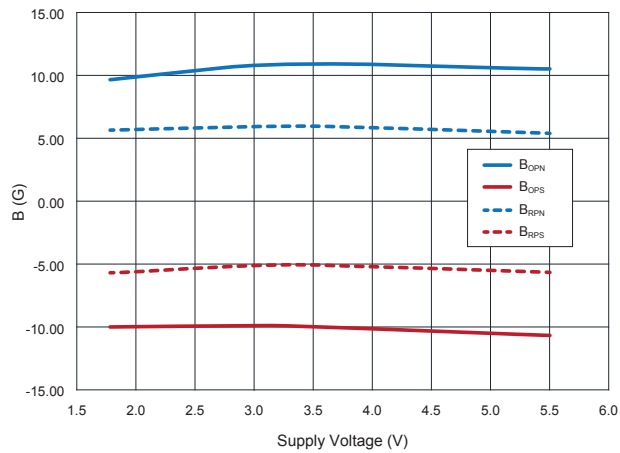


## 5 Graphs - Typical Electrical & Magnetic Characteristics

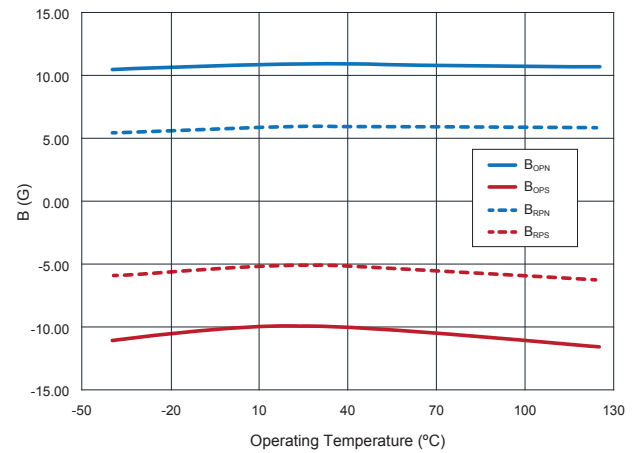
### 5.2 Typical Magnetic Characteristics

$C_{DD} = 1.0 \mu F$  (unless otherwise specified)

**RR122-1A22-511 / 512**  
 **$B_{OP} / B_{RP}$  vs. Supply Voltage at +25°C**



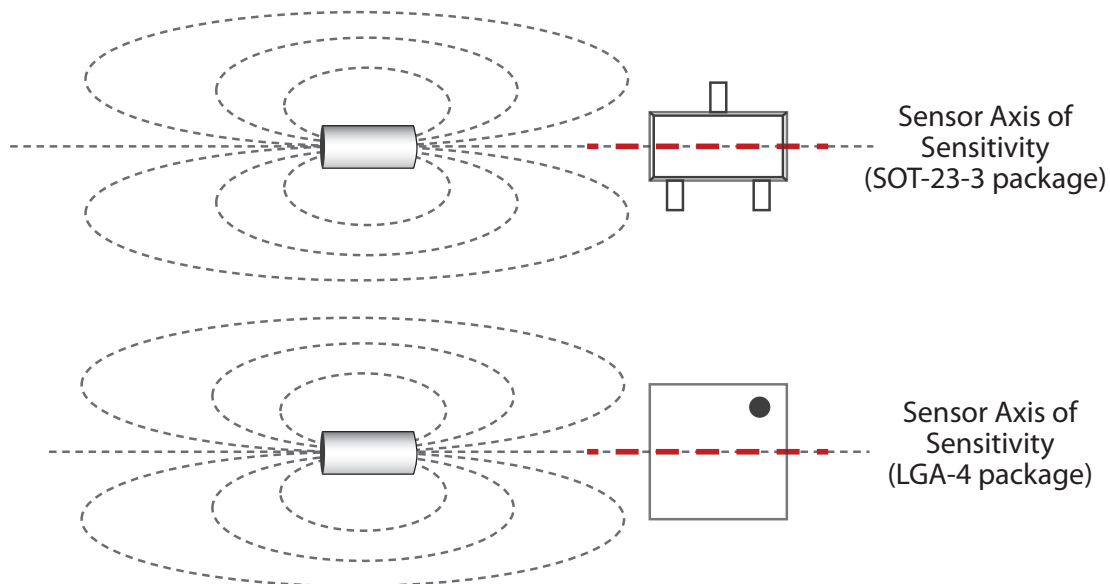
**RR122-1A22-511 / 512**  
 **$B_{OP} / B_{RP}$  vs. Temperature**



## 6 Magnetic Response

For more information please contact Coto Technology at [RedRock@cotorelay.com](mailto:RedRock@cotorelay.com).

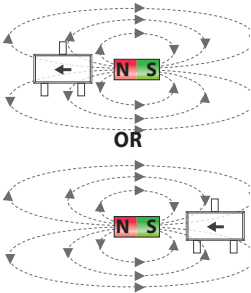
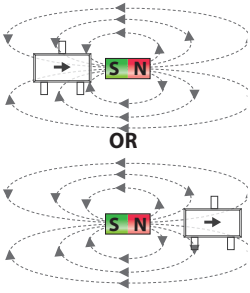
### 6.1 Axis of Sensitivity



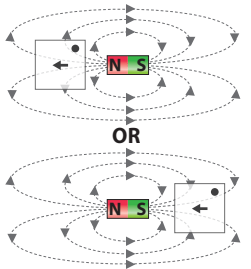
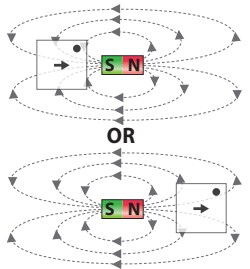
**Note:** The most straightforward way of aligning a magnet with a TMR sensor is by lining up the magnet's magnetization axis with the sensor's Axis of Sensitivity (as shown above). However, there are many other alignments and orientations that will also achieve proper operation. For any questions, or to learn more, please contact Coto Technology.

6 Magnetic Response (cont.)

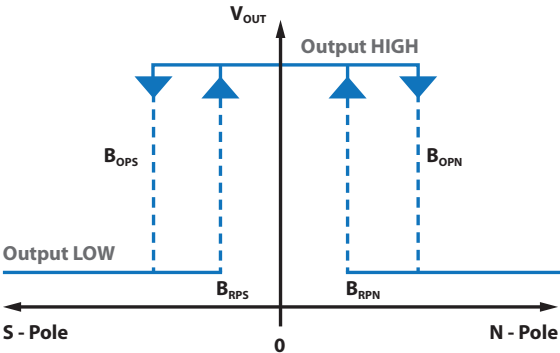
6.2 Magnetic Response Table (SOT-23-3 package)

|                               |                                                                                   |                                                                                   |                                                                                   |                                                                                     |                                                                                     |
|-------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Scenario                      | Step 1:<br>Sensor is powered<br>without magnetic field.                           | Step 2:<br>Magnet applied,<br>polarity <b>North</b> .                             | Step 3:<br>Magnet removed.                                                        | Step 4:<br>Magnet applied,<br>polarity <b>South</b> .                               | Step 5:<br>Magnet removed.                                                          |
|                               |  |  |  |  |  |
| OMNIPOLAR<br>SENSOR<br>OUTPUT | HIGH                                                                              | LOW<br>(Activated)                                                                | HIGH                                                                              | LOW<br>(Activated)                                                                  | HIGH                                                                                |

6.3 Magnetic Response Table (LGA-4 package)

|                               |                                                                                     |                                                                                     |                                                                                     |                                                                                       |                                                                                       |
|-------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Scenario                      | Step 1:<br>Sensor is powered<br>without magnetic field.                             | Step 2:<br>Magnet applied,<br>polarity <b>North</b> .                               | Step 3:<br>Magnet removed.                                                          | Step 4:<br>Magnet applied,<br>polarity <b>South</b> .                                 | Step 5:<br>Magnet removed.                                                            |
|                               |  |  |  |  |  |
| OMNIPOLAR<br>SENSOR<br>OUTPUT | HIGH                                                                                | LOW<br>(Activated)                                                                  | HIGH                                                                                | LOW<br>(Activated)                                                                    | HIGH                                                                                  |

6.4 Magnetic Response Output Diagram

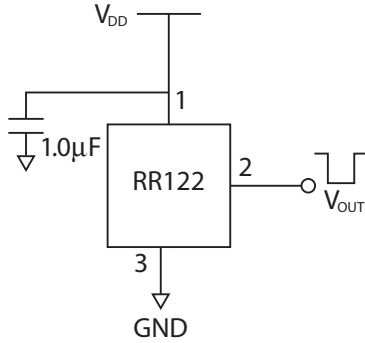


## 7 Application Information

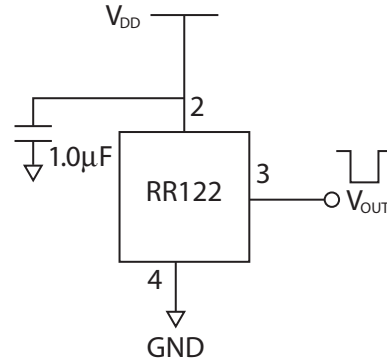
### RR122 Push-Pull Output Application Circuit

The output voltage on the RR122 is active low, meaning that while a sufficiently strong magnetic field is present, the output voltage is low. The output voltage can be connected to a digital input pin on a microcontroller. A decoupling capacitor between the supply voltage and ground is required with placement close to the magnetic sensor. A capacitor with a value of  $1\ \mu\text{F}$ , placed not more than 10 mm from the sensor, is required.

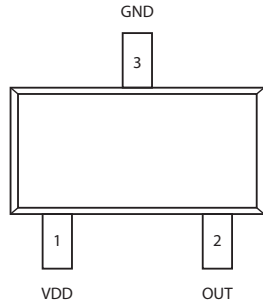
#### 7.1 Application Circuit (SOT-23-3)



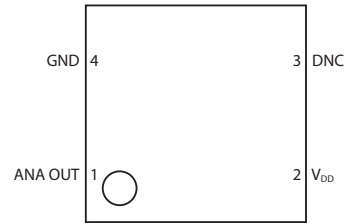
#### 7.2 Application Circuit (LGA-4)



#### 7.3 Package Pinout (SOT-23-3)

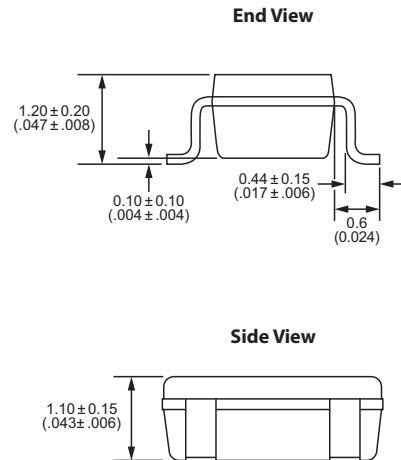
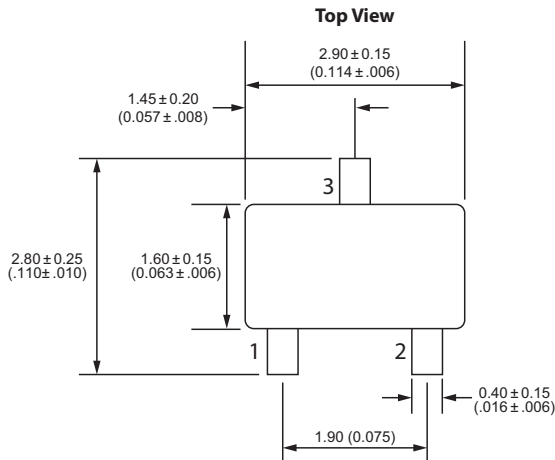


#### 7.4 Package Pinout (LGA-4)



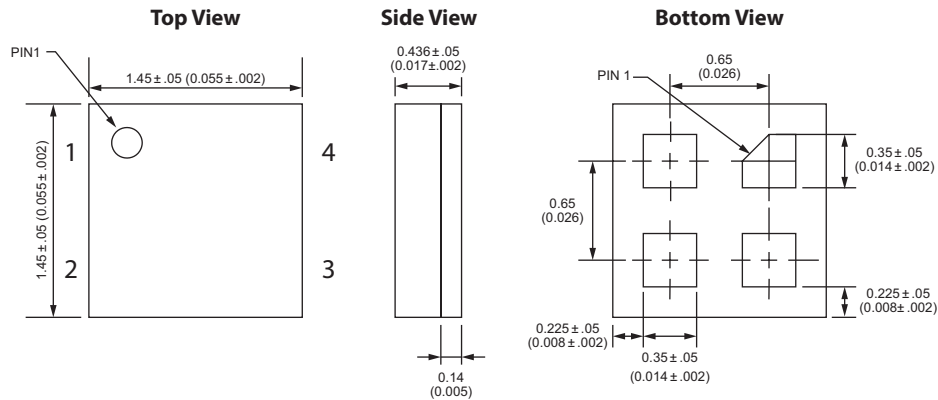
## 8 Dimensions *Millimeters (Inches)*

### 8.1 SOT-23-3 Package



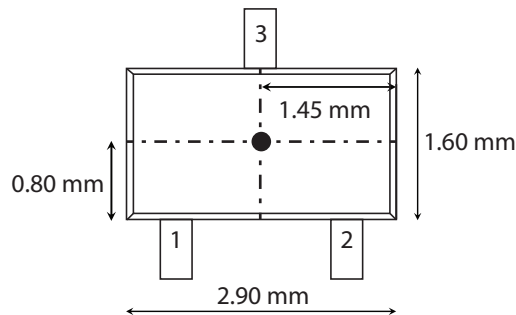
8 Dimensions *Millimeters (Inches)*

8.2 LGA-4 Package

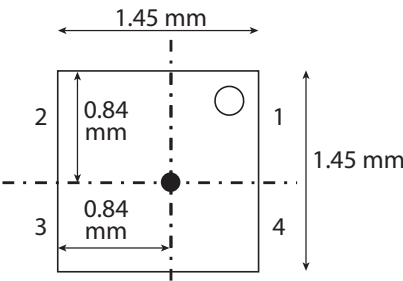


9 TMR Sensor Location

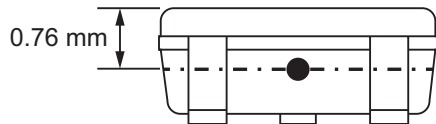
9.1 SOT-23-3 Package



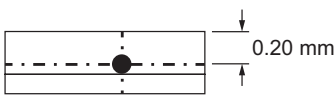
9.2 LGA-4 Package



9.3 SOT Package - Side View



9.4 LGA Package - Side View





## 10 TMR Sensor & Switch Packaging

### 10.2 LGA-4 Tape & Reel Packaging

Standard packaging is Tape & Reel containing 3,000 pieces. MSL Rating is 3.

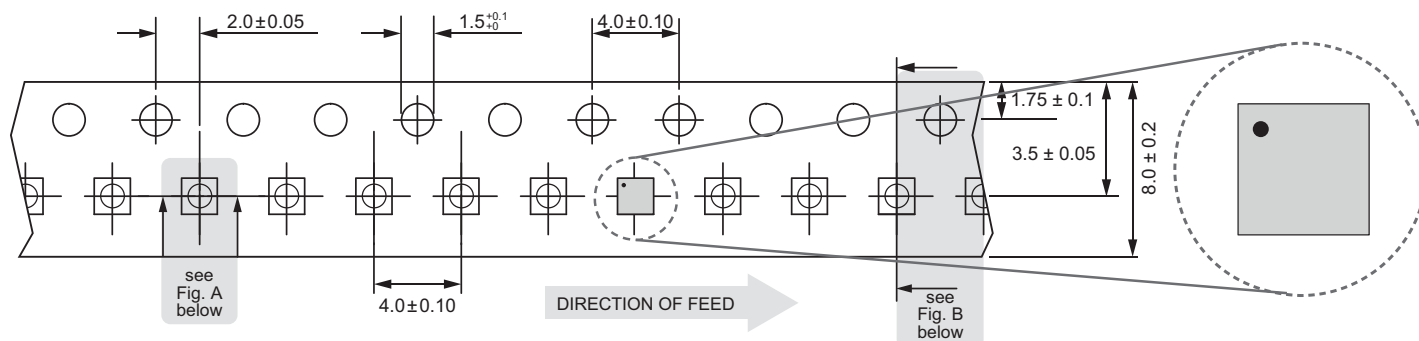


Fig. A

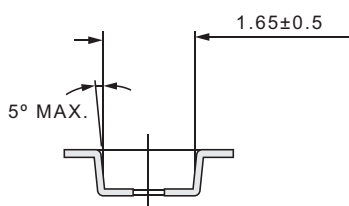
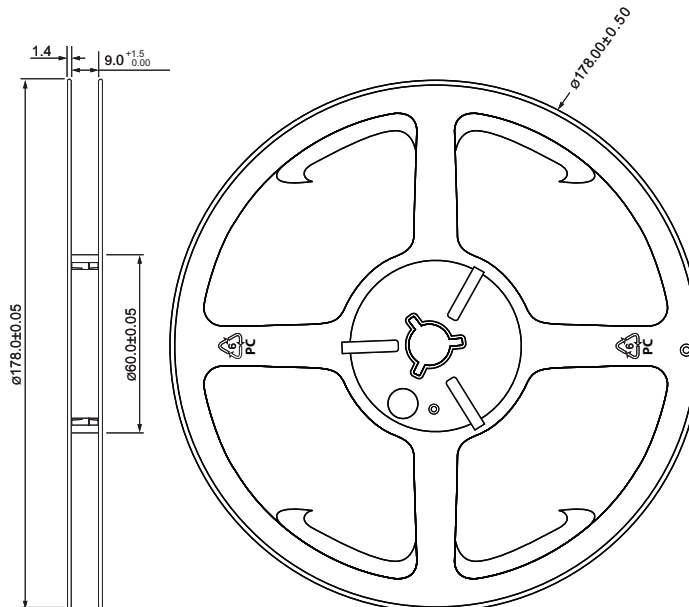
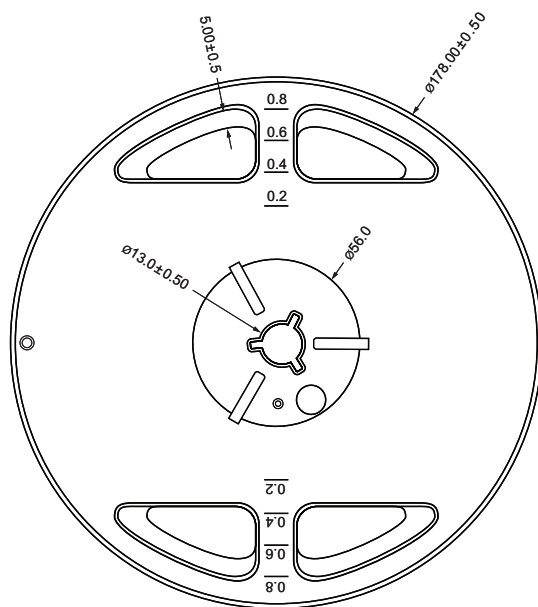
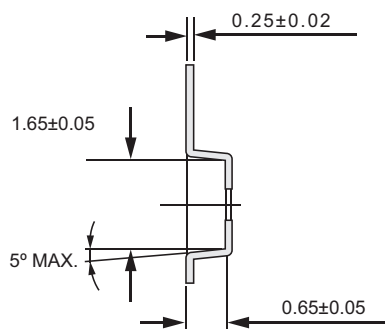


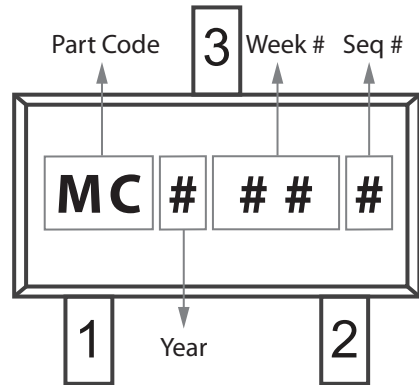
Fig. B



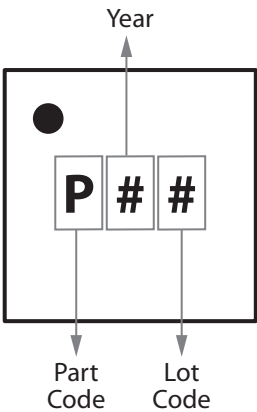
10 TMR Sensor & Switch Packaging

10.3 RedRock Package Codes

RR122-1A22-511 / RR122-1A23-511 (SOT-23-3)



RR122-1A22-512 / RR122-1A23-512 (LGA-4)



10.4 RedRock TMR Packaging

Box Dimensions – 14x10x6 inches

- Fits 1 to 3 reels = 3000 to 9000 pcs
- Weight for 3000 pcs = 0.90 kilos
- Weight for 9000 pcs = 1.00 kilos

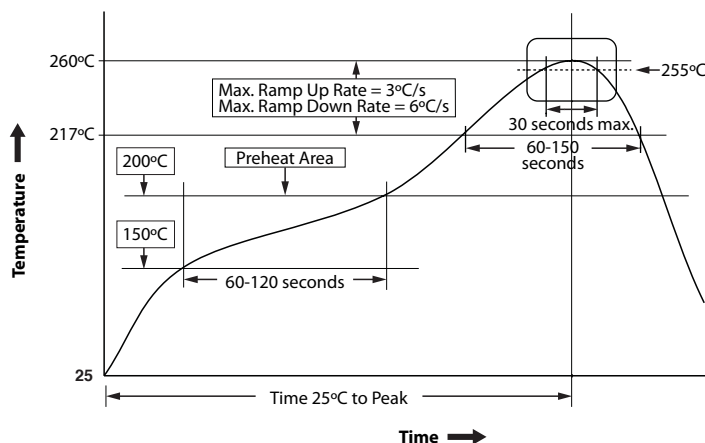
Box Dimensions – 18x14x12 inches

- Fits 4 to 24 reels = 12000 to 72000 pcs
- Weight for 12000 pcs = 1.50 kilos
- Weight for 72000 pcs = 4.90 kilos

## 11 Suggested Pb-Free Reflow Profile

### Notes:

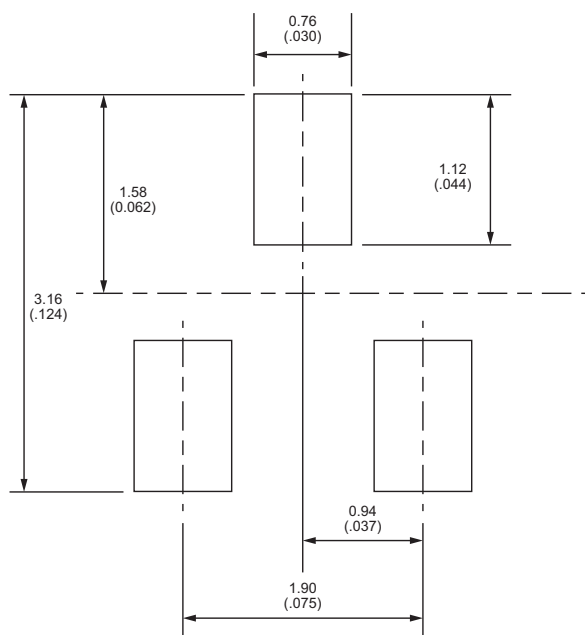
1. Fully compatible with standard no-lead solder profile, 260°C for 30 seconds max (3 cycles max).
2. Profile shown as example. Users are advised to develop their own board-level profile.
3. Suggested Pb-free reflow profile derived from IPC/JEDEC J-STD-020E.
4. Temperature tolerance: +0°C, as measured at any point on the package or leads
5. MSL rating of 1 (SOT-23-3 only) compatible with J-STD-020 or equivalent.
6. MSL rating of 3 (LGA-4 and Leaded LGA-4) compatible with J-STD-020 or equivalent.
7. All temperatures refer to the center of the package, measured on the package body surface that is facing up during assembly reflow (e.g., live-bug). If parts are reflowed in other than the normal live bug assembly reflow orientation (i.e., dead-bug),  $T_p$  shall be within  $\pm 2^\circ\text{C}$  of the live bug  $T_p$  and still meet the  $T_c$  requirements, otherwise, the profile shall be adjusted to achieve the latter. To accurately measure actual peak package body temperatures, refer to JEP140 for recommended thermocouple use.
8. Reflow profiles in this document are for classification/preconditioning and are not meant to specify board assembly profiles. Actual board assembly profiles should be developed based on specific process needs and board designs and should not exceed the parameters in this table.



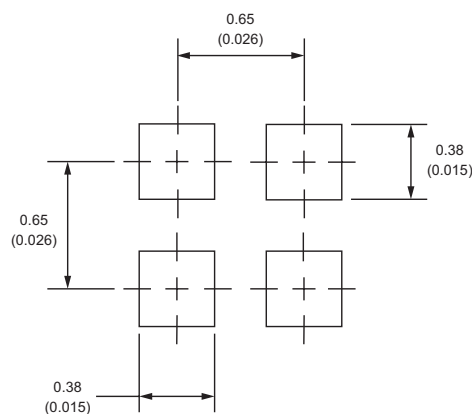
## 12 Suggested Solder Pad Layout

Dimensions in mm (inches)

### 12.1 SOT-23-3 Solder Pad Layout



### 12.2 LGA-4 Solder Pad Layout



## Revision History

|    | Date       | Description                                                                                                          |
|----|------------|----------------------------------------------------------------------------------------------------------------------|
| 1  | 10/13/2020 | Added Maximum Magnetic Field Exposure Value (Table 4.1)                                                              |
| 2  | 10/13/2020 | Modified Input and Output Current (Table 4.2)                                                                        |
| 3  | 10/13/2020 | Modified UVLO Rise Value (Table 4.3)                                                                                 |
| 4  | 10/13/2020 | Modified UVLO Fall Value (Table 4.3)                                                                                 |
| 5  | 10/13/2020 | Added Supply Voltage, Typical (Table 4.3)                                                                            |
| 6  | 10/13/2020 | Modified Switching Frequency MIN & MAX Values (Table 4.4)                                                            |
| 7  | 10/13/2020 | Modified Active Mode Time Value (Table 4.4)                                                                          |
| 8  | 10/13/2020 | Added MIN & MAX Values to Idle Mode (Table 4.4)                                                                      |
| 9  | 10/13/2020 | Modified Operate Point (BopN) MIN Value (Table 4.4)                                                                  |
| 10 | 10/13/2020 | Modified Operate Point (BopS) MAX Value (Table 4.4)                                                                  |
| 11 | 10/13/2020 | Modified Hysteresis MIN Value (Table 4.4)                                                                            |
| 12 | 10/13/2020 | Modified Average Supply Current @ $V_{DD}=1.7\text{ V}$ , $f_{SW}=10\text{ Hz}$ ( $I_{DD_{AVG}}$ ) Value (Table 4.3) |
| 13 | 10/14/2020 | Modified Supply Voltage MAX Value (Table 4.2)                                                                        |
| 14 | 10/15/2020 | Added $I_{DD_{AVG}}$ MAX Value (Table 4.3)                                                                           |
| 15 | 09/14/2021 | Modified Axis of Sensitivity on LGA-4 Package (Section 7.2)                                                          |
| 16 | 10/29/2021 | Modified Bottom View Dimensions (Section 8.2 LGA-4 Package)                                                          |
| 17 | 02/01/2022 | Revised/expanded Magnetic Response Section (Section 5)                                                               |
| 18 | 02/01/2022 | Removed sections 7 and 10, consolidating information within new Section 5                                            |
| 19 | 02/01/2022 | Modified packaging drawings (9.1 and 9.2)                                                                            |
| 20 | 02/17/2022 | Modified LGA Sensor Location package drawings (8.2 and 8.4)                                                          |
| 21 | 02/17/2022 | Added RedRock Package Code section (9.3)                                                                             |
| 22 | 03/04/2022 | Added Package Pinouts (Section 6)                                                                                    |
| 23 | 03/04/2022 | Modified Power On Time (Table 4.3)                                                                                   |
| 24 | 03/08/2022 | Added ESD Level Charged Device Model (Table 4.1)                                                                     |
| 25 | 03/08/2022 | Modified Under Voltage Lockout Hysteresis (Table 4.3)                                                                |
| 26 | 03/29/2024 | Modified Format of Typical Electrical & Magnetic Characteristics Graphs (Section 5)                                  |
|    |            |                                                                                                                      |
|    |            |                                                                                                                      |

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