

## 1 Description

The RedRock™ RR131 Series is a magnetic switch with digital open drain output ideal for use in medical, industrial, automotive, and consumer applications. Based on patented Tunneling Magnetoresistance (TMR) technology with seamless CMOS integration, the RR131 is capable of multiple configurations of several parameters to enable applications like proximity sensing, limit switching, and level detection.

The RR131 features multiple operate sensitivities in both omnipolar and unipolar magnetic field responses. It has the world's lowest average current drain (200 nA) for an active magnetic switch, as well as high operating temperature ranges from -40°C up to 125°C.

## Device Information

Part Series	Package	Body Size (mm)
RR131	SOT-23-3	2.9 x 1.6 x 1.2
	LGA-4	1.4 x 1.4 x 0.45

## 2 Features

- ▶ Operate sensitivity of 30 G
- ▶ Lowest Average Current < 200 nA
- ▶ Omnipolar Response
- ▶ Operating Frequencies of 2 Hz
- ▶ Temperature Rated up to 125°C
- ▶ RoHS & REACH Compliant

## 3 Applications

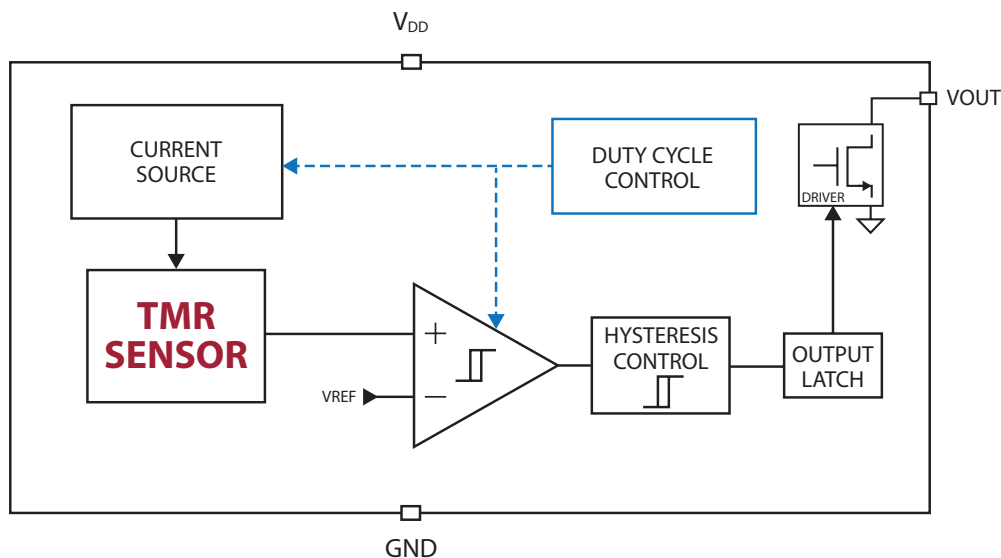
- ▶ Proximity Detection
- ▶ Limit Switching
- ▶ Fluid Level Detection
- ▶ Door & Lid Closure Detection
- ▶ Utility Meters
- ▶ Portable Medical Devices
- ▶ Motor Controllers
- ▶ Consumer Electronics
- ▶ Wake-Up  $\mu$ Processor

## Device Packages



**Please note: This Product Series is approaching end of life and is NOT recommended for new designs. For new designs, please consult the [end of life announcement](#) which specifies recommended new RedRock series replacements.**

## Functional Block Diagram



**Table of Contents**

1. Description..... 1

2. Features ..... 1

3. Applications ..... 1

4. Specifications for all RR131 Series Sensors ..... 3

    4.1 Absolute Environmental Ratings for all RR131 Series Sensors..... 3

    4.2 Absolute Electrical Ratings for all RR131 Series Sensors ..... 3

    4.3 Operating Electrical Characteristics for all RR131 Series Sensors ..... 3

5. Operating Characteristics for RR131-1B13-351 ..... 4

6. Operating Characteristics for RR131-2E23-351 ..... 4

7. Graphs - Typical Electrical Characteristics for RR131-1B13-351 ..... 5

    7.1 Average Supply Current vs. Supply Voltage vs. Temperature ..... 5

    7.2 Average Supply Current vs. Temperature vs. Supply Voltage ..... 5

    7.3 Sampling Frequency vs. Supply Voltage vs. Temperature ..... 5

    7.4 Sampling Frequency vs. Supply Voltage vs. Temperature ..... 5

    7.5 B<sub>OPN</sub> (Blue) and B<sub>OPS</sub> (Red) vs. Supply Voltage at +25°C ..... 6

    7.6 B<sub>RPN</sub> (Blue) and B<sub>RPS</sub> (Red) vs. Supply Voltage at +25°C ..... 6

    7.7 B<sub>OPN</sub> (Blue) and B<sub>OPS</sub> (Red) vs Operating Temperature at V<sub>DD</sub>=3.0 V ..... 6

    7.8 B<sub>OPN</sub> (Blue) and B<sub>OPS</sub> (Red) vs. Operating Temperature at V<sub>DD</sub>=3.0 V ..... 6

8. Operate & Release Lobe Plots ..... 7

    8.1 RR131-1B13-351 ..... 7

9. Application Information ..... 7

    9.1 RR131 Application Circuit (SOT-23) ..... 7

    9.2 RR131 Application Circuit (LGA-4) ..... 7

10. Part Selection & Ordering Information ..... 8

    10.1 Part Selection Table ..... 8

    10.2 Device Nomenclature Ordering Information ..... 8

11. Axis of Sensitivity ..... 9

12. Dimensions ..... 9

    12.1 LGA-4 Package Dimensions ..... 9

    12.2 SOT-23-3 Package Dimensions ..... 9

13. TMR Sensor Location ..... 10

    13.1 LGA Package ..... 10

    13.2 SOT Package ..... 10

    13.3 SOT Package - Side View ..... 10

    13.4 LGA Package - Side View ..... 10

14. Output Behavior vs. Magnetic Field Diagrams ..... 11

    14.1 Output Behavior vs. Magnetic Field - Omnipolar ..... 11

    14.2 Output Behavior vs. Magnetic Field - Unipolar ..... 11

    14.3 Magnetic Flux Response Diagram - Omnipolar ..... 11

    14.4 Magnetic Flux Response Diagram - Unipolar ..... 11

15. TMR Sensor & Switch Packaging ..... 12

    15.1 SOT-23-3 Tape & Reel Packaging ..... 12

    15.2 LGA-4 Tape & Reel Packaging ..... 13

    15.3 RedRock TMR Packaging ..... 14

16. Suggested Pb-Free Reflow Profile ..... 14

17. Suggested Solder Pad Layout ..... 14

    17.1 SOT-23-3 Solder Pad Layout ..... 14

    17.2 LGA-4 Solder Pad Layout ..... 14

## 4 Specifications for all RR131 Series Sensors

### 4.1 Absolute Environmental Ratings for all RR131 Series Sensors<sup>1</sup>

Parameters	Units	Min	Typ	Max
Operating Temperature ( $T_{OP}$ )	°C	-40		+125
Storage Temperature ( $T_{STG}$ )	°C	-65		+150
Junction Temperature ( $T_J$ )	°C			+150
Soldering Temperature (3 cycles, 1 min.) ( $T_{SOL}$ )	°C			+260
ESD Level Human Body Model per JESD22-A114	V			±4000
Magnetic Field Exposure	G			2000

### 4.2 Absolute Electrical Ratings for all RR131 Series Sensors<sup>1</sup>

Parameters	Units	Min	Typ	Max
Supply Voltage ( $V_{DD}$ )	V	-0.3		+4.0
Open Drain Output Voltage (Active Low) ( $V_{OUT\_OD}$ )	V	-0.3		+5.5
Input Current ( $I_{OUT}$ )	mA			+10

### 4.3 Operating Electrical Characteristics for all RR131 Series Sensors<sup>2</sup>

Parameters	Units	Min	Typ	Max
Supply Voltage ( $V_{DD}$ )	V	+2.7	+3.0	+3.6
Power-On Time ( $t_{ON}$ )( $V_{DD} > 2.7V$ )	μs		500	
Under-Voltage Lockout Threshold Rising $V_{DD}$ ( $V_{UVLO\_RISE}$ )	V		+2.20	+2.60
Under-Voltage Lockout Threshold Falling $V_{DD}$ ( $V_{UVLO\_FALL}$ )	V	+1.90	+2.15	
Under-Voltage Lockout Hysteresis ( $V_{UV\_HYST}$ )	mV		+50	

#### Notes:

- Exceeding Absolute Ratings may cause permanent damage to the device. Exposure at the maximum rated conditions for extended periods of time may also affect device reliability.
- Unless otherwise specified, all characteristics are measured at 25°C.
- See "Magnetic Field vs. Output Status" for more details.



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 Operating Characteristics for RR131-1B13-351<sup>1</sup>

Parameters	Units	Min	Typ	Max
Average Supply Current ( $I_{DD(AVG)}$ ) <sup>2</sup>	nA		200	700
Switching Frequency ( $f_{SW}$ )	Hz	1	2	4
Active Mode Time ( $t_{ACT}$ )	$\mu$ s		1.4	
Idle Mode Time ( $t_{IDLE}$ )	ms		500	
Operate Point ( $B_{OPN}$ )	G	27	30	38
Operate Point ( $B_{OPS}$ )	G	-38	-30	-27
Release Point ( $B_{RPN}$ )	G	18	20	27
Release Point ( $B_{RPS}$ )	G	-27	-20	-18
Hysteresis ( $B_{HYST}$ ) <sup>3</sup>	G	5	10	

## 6 Operating Characteristics for RR131-2E23-351<sup>1</sup>

Parameters	Units	Min	Typ	Max
Average Supply Current ( $I_{DD(AVG)}$ ) <sup>2</sup>	nA		230	700
Switching Frequency ( $f_{SW}$ )	Hz	6	10	14
Active Mode Time ( $t_{ACT}$ )	$\mu$ s		1.4	
Idle Mode Time ( $t_{IDLE}$ )	ms	71	100	167
Operate Point ( $B_{OPS}$ )	G	-18	-15	-13
Release Point ( $B_{RPS}$ )	G	-13	-10	-8
Hysteresis ( $B_{HYST}$ ) <sup>3</sup>	G	3	5	

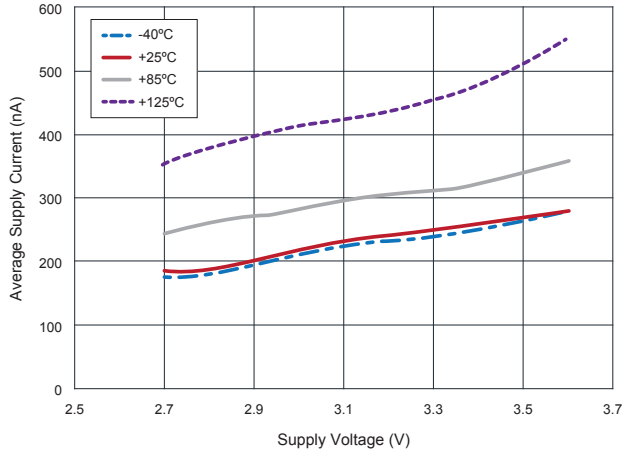
### Notes:

1. Unless otherwise specified,  $V_{DD} = 2.7$  V to 3.6 V,  $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ . Typical values are  $V_{DD} = 3.0$  V and  $T_A = +25^\circ\text{C}$ .
2. Conditions:  $t = 10$  seconds
3. Conditions:  $B_{HYST} = |B_{OP} - B_{RP}|$

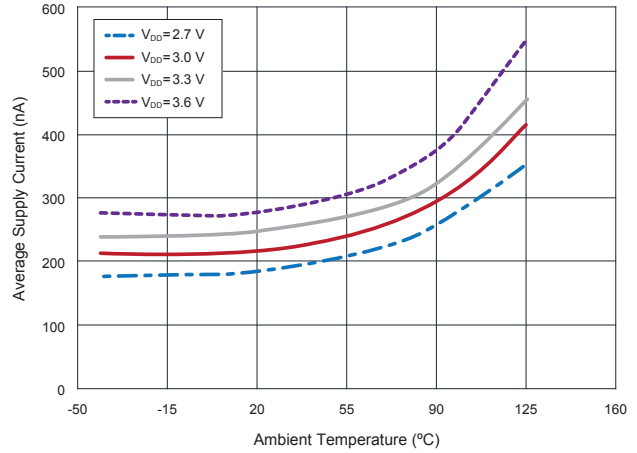
## 7 Graphs - Typical Characteristics for RR131-1B13-351

$V_{DD} = 3.0\text{ V}$  and  $T_A = +25\text{ }^\circ\text{C}$ ,  $C_{DD} = 1.0\text{ }\mu\text{F}$  (unless otherwise specified)

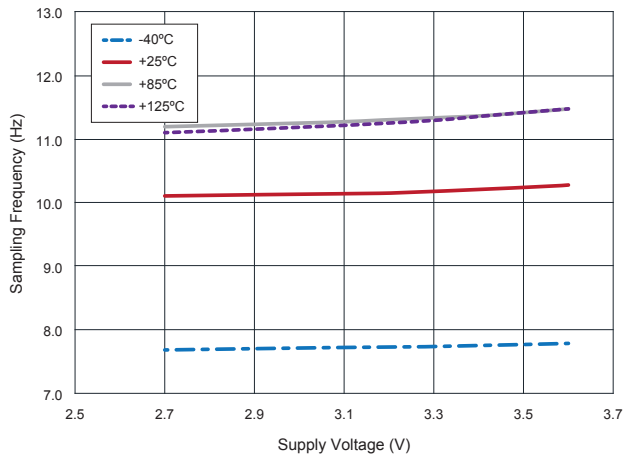
### 7.1 Average Supply Current vs. Supply Voltage vs. Temperature



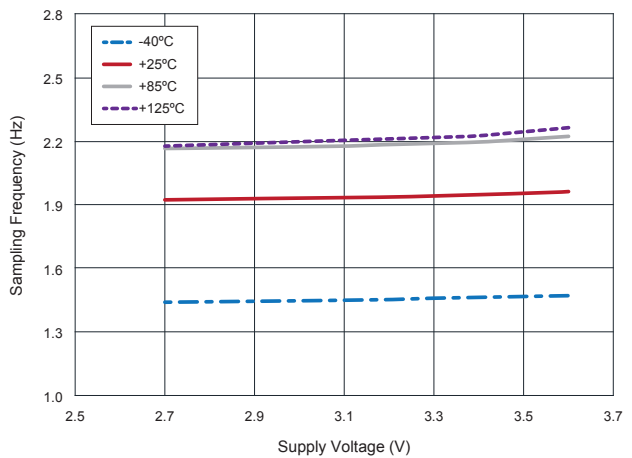
### 7.2 Average Supply Current vs. Temperature vs. Supply Voltage



### 7.3 Sampling Frequency vs. Supply Voltage vs. Temperature



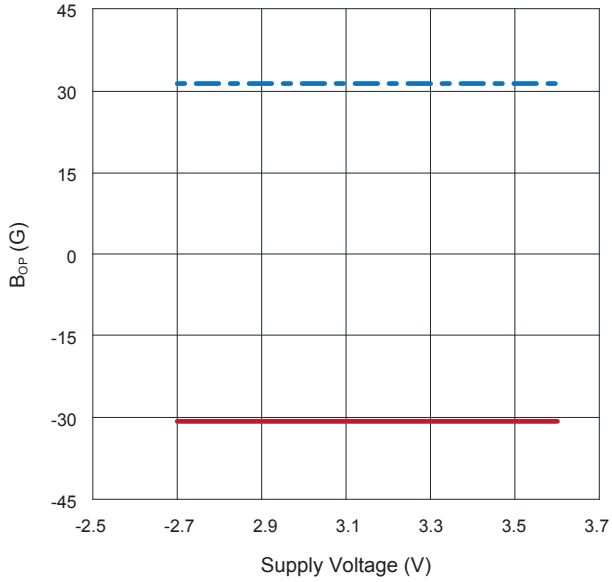
### 7.4 Sampling Frequency vs. Supply Voltage vs. Temperature



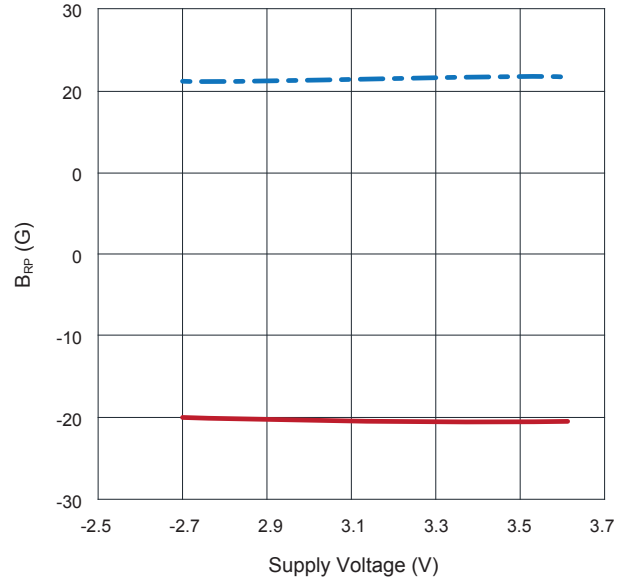
### 7 Graphs - Typical Magnetic Characteristics for RR131-1B13-351

$V_{DD} = 3.0\text{ V}$  and  $T_A = +25\text{ }^\circ\text{C}$ ,  $C_{DD} = 1.0\text{ }\mu\text{F}$  (unless otherwise specified)

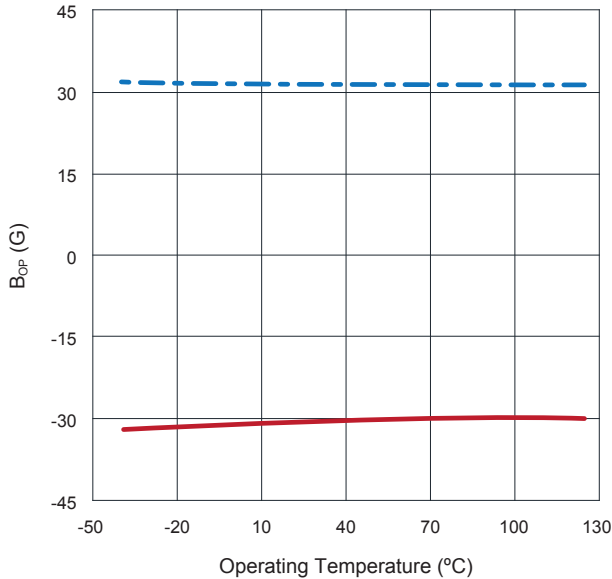
**7.5  $B_{OPN}$  (Blue) and  $B_{OPS}$  (Red) vs. Supply Voltage at  $+25\text{ }^\circ\text{C}$**



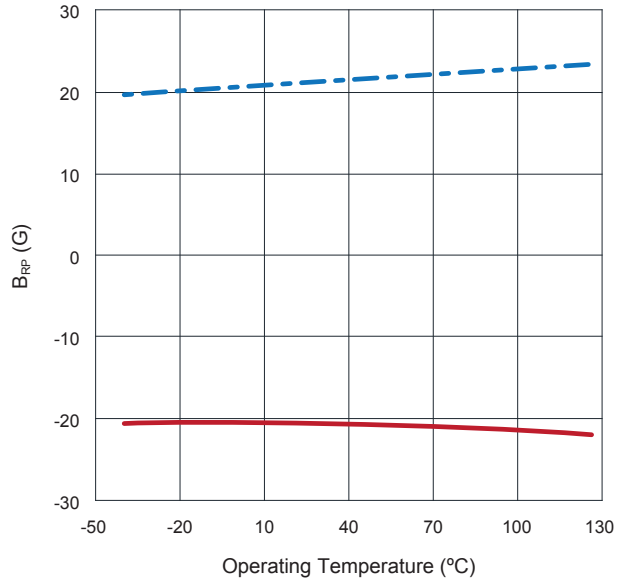
**7.6  $B_{RPN}$  (Blue) and  $B_{RPS}$  (Red) vs. Supply Voltage at  $+25\text{ }^\circ\text{C}$**



**7.7  $B_{OPN}$  (Blue) and  $B_{OPS}$  (Red) vs. Operating Temperature at  $V_{DD}=3.0\text{ V}$**



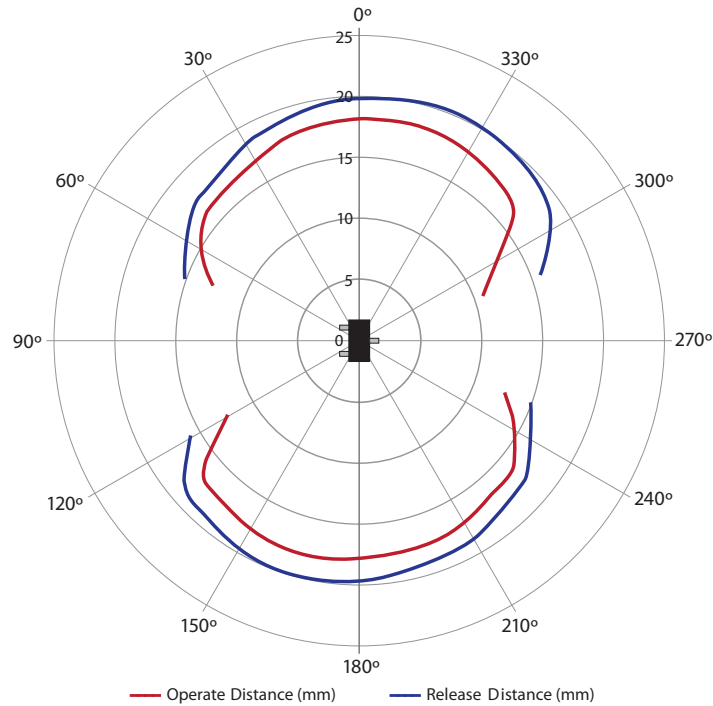
**7.8  $B_{RPN}$  (Blue) and  $B_{RPS}$  (Red) vs. Operating Temperature at  $V_{DD}=3.0\text{ V}$**



## 8 Operate & Release Lobe Plots

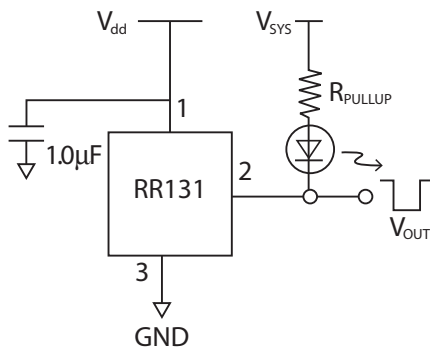
Operate and release distances show are relative. The actual operate and release distances will depend on the type of magnet that is used.

**8.1 RR131-1B13-351**

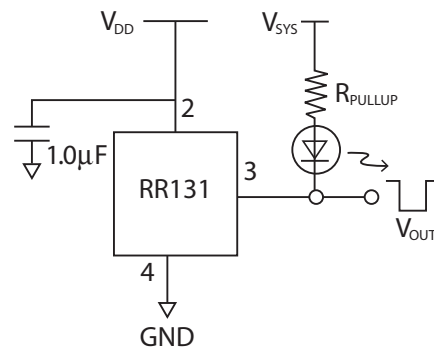


## 9 Application Information

**9.1 Application Circuit (SOT-23)**



**9.2 Application Circuit (LGA-4)**



**RR131 Application Circuit**

With the open drain output, the system voltage can range up to  $V_{dd} + 0.3V$ . Please keep in mind the supply voltage to the RR131 must not exceed 3.6V. A decoupling capacitor between the supply voltage and ground is required with placement close to the magnetic sensor. A typical capacitor value of 1.0  $\mu F$  will suffice.



## 10 Part Selection and Ordering Information<sup>1</sup>

### 10.1 Part Selection Table

Part Number	Magnetic Polarity Response	Operate Sensitivity (G)	Release Sensitivity (G)	Frequency (Hz)	I <sub>avg</sub> (μA)	Temp. Rating (°C)	Supply Voltage (V <sub>dd</sub> )	Output Response	Package
RR131-1B13-351	Omnipolar	30	20	2	0.2	-40 – +125	2.7 - 3.6	Open Drain	SOT-23-3
RR131-1B13-352	Omnipolar	30	20	2	0.2	-40 – +125	2.7 - 3.6	Open Drain	LGA-4
RR131-2E23-351	Unipolar	15	10	10	0.24	-40 - +125	2.7 - 3.6	Open Drain	SOT-23-3

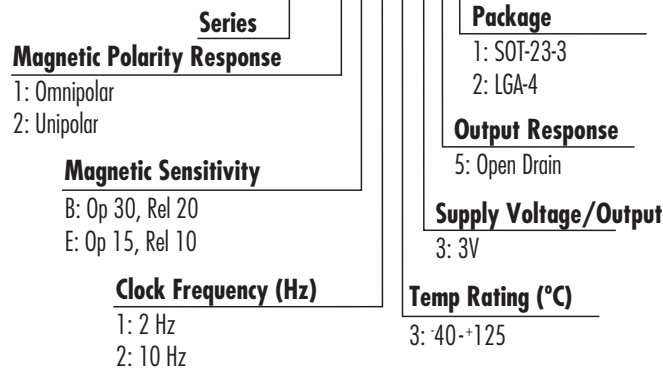
**Note:**

1. Custom options available for Sensitivity, Frequency, Temperature Rating, Supply Voltage, Output Response, Packaging & more. Please contact redrock@cotorelay.com for more details.

### 10.2 Device Nomenclature

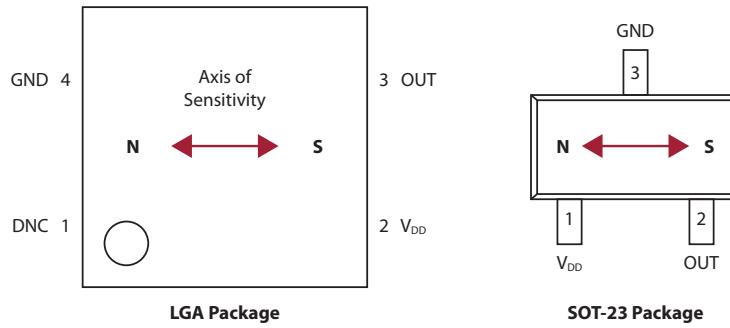
#### Ordering Information

**RR131-1 B 1 3-3 5X**



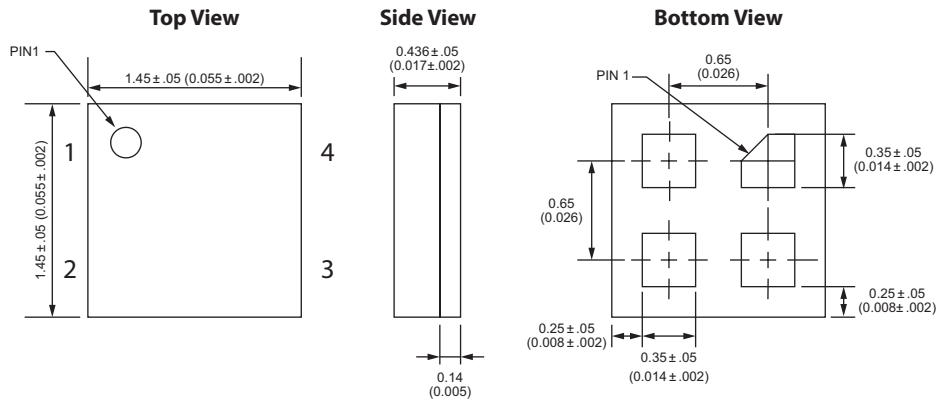


### 11 Axis of Sensitivity

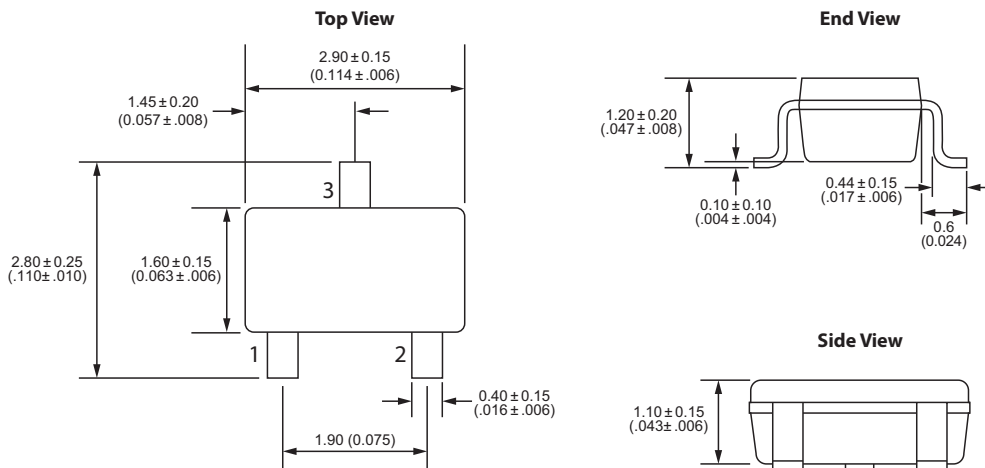


### 12 Dimensions *Millimeters (Inches)*

#### 12.1 LGA-4 Package

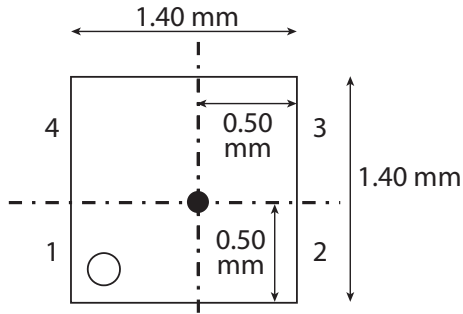


#### 12.2 SOT-23-3 Package

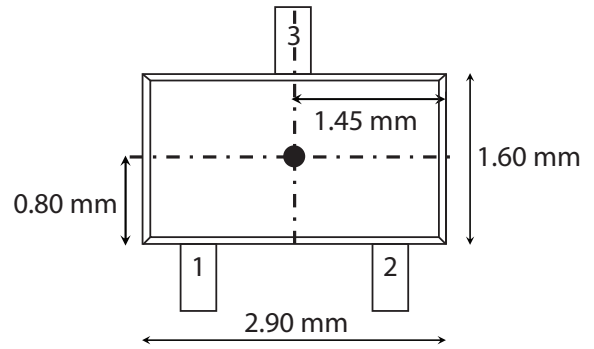


13 TMR Sensor Location

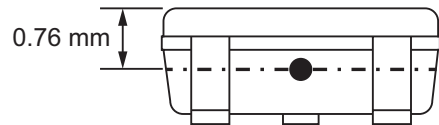
13.1 LGA Package



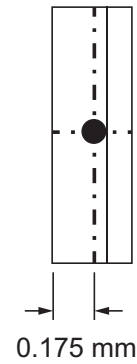
13.2 SOT Package



13.3 SOT Package - Side View



13.4 LGA Package - Side View



## 14 Output Behavior vs. Magnetic Field Diagrams

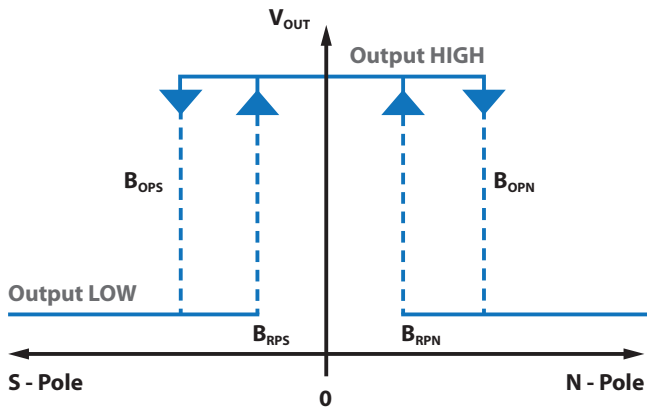
### 14.1 Output Behavior vs. Magnetic Field - Omnipolar

Characteristics	Conditions	Output
South Pole	$B < B_{OPS}$ $0 > B > B_{RPS}$	Low (ON) High (OFF)
North Pole	$B > B_{OPN}$ $0 < B < B_{RPN}$	Low (ON) High (OFF)

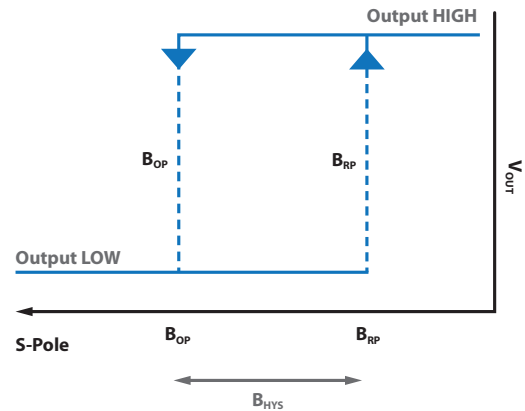
### 14.2 Output Behavior vs. Magnetic Field - Unipolar

Characteristics	Conditions	Output
North Pole	$B > B_{OP}$	High (OFF)
Null or Weak Magnetic Field	$B < B_{RP}$	High (OFF)
South Pole	$B > B_{OP}$	Low (ON)

### 14.3 Magnetic Flux Response Diagram - Omnipolar



### 14.4 Magnetic Flux Response Diagram - Unipolar



### 15 TMR Sensor & Switch Packaging

#### 15.1 SOT-23-3 Tape & Reel Packaging

Standard packaging is Tape & Reel containing 3,000 pieces. MSL Rating is 1.

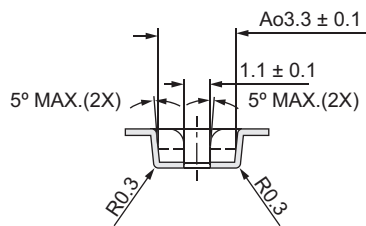
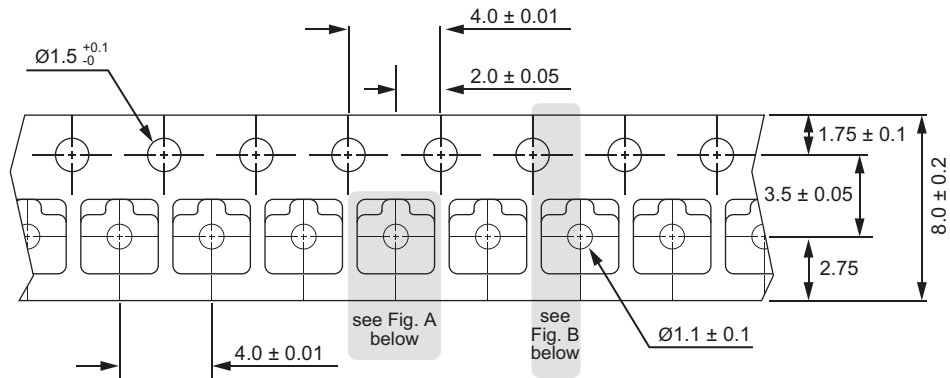


Fig. A

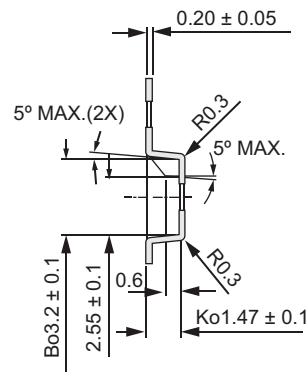
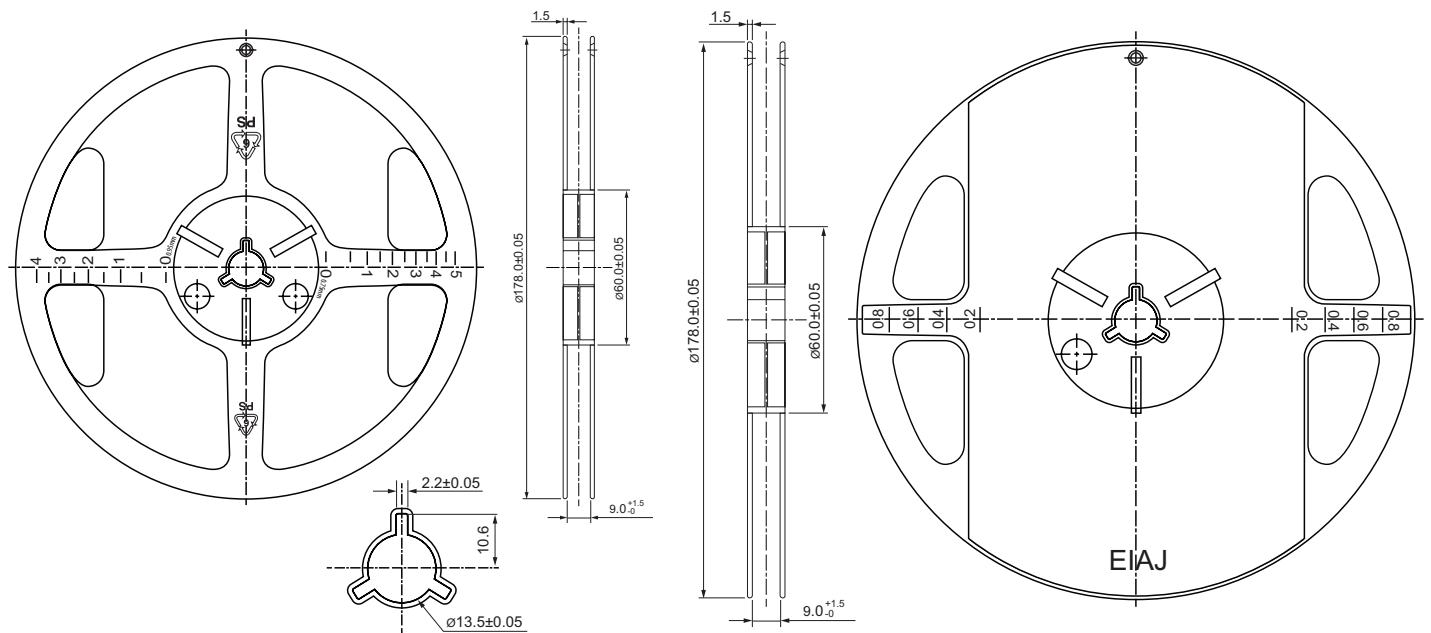


Fig. B



## 15 TMR Sensor & Switch Packaging

### 15.2 LGA-4 Tape & Reel Packaging

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

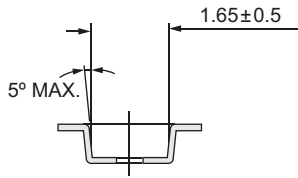
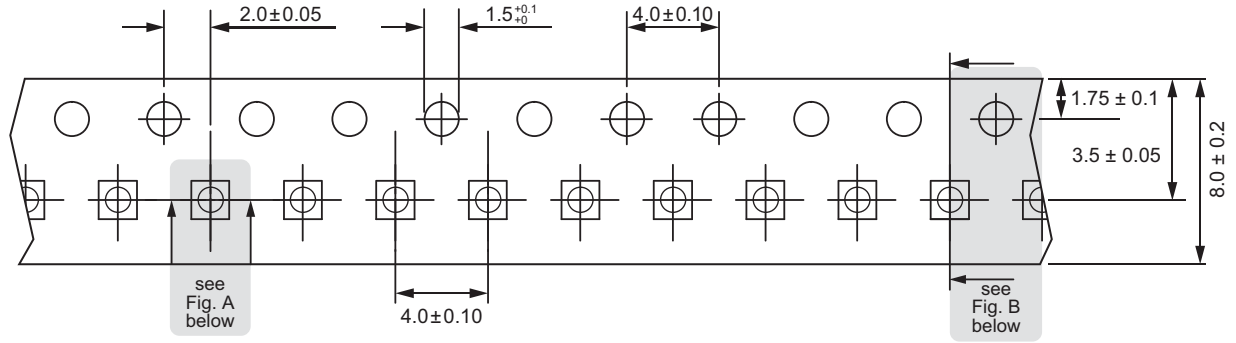


Fig. A

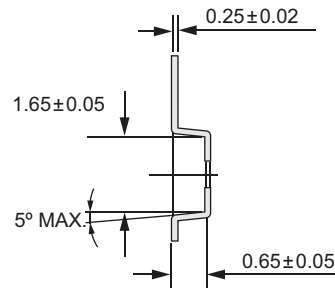
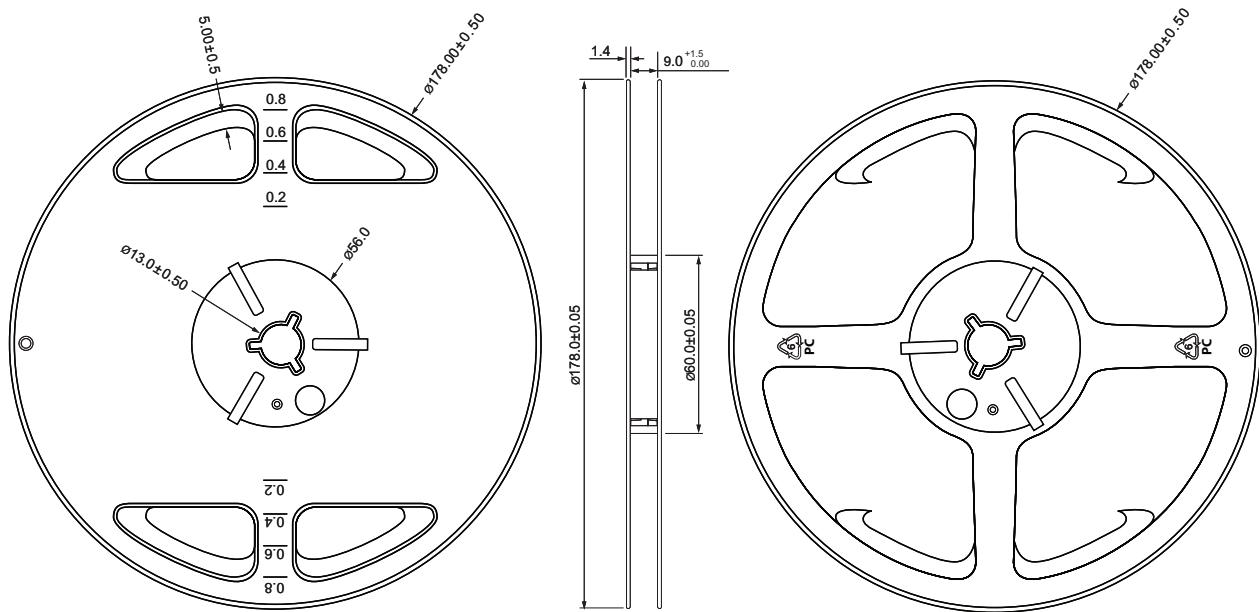


Fig. B



## 15 TMR Sensor & Switch Packaging

### 15.3 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

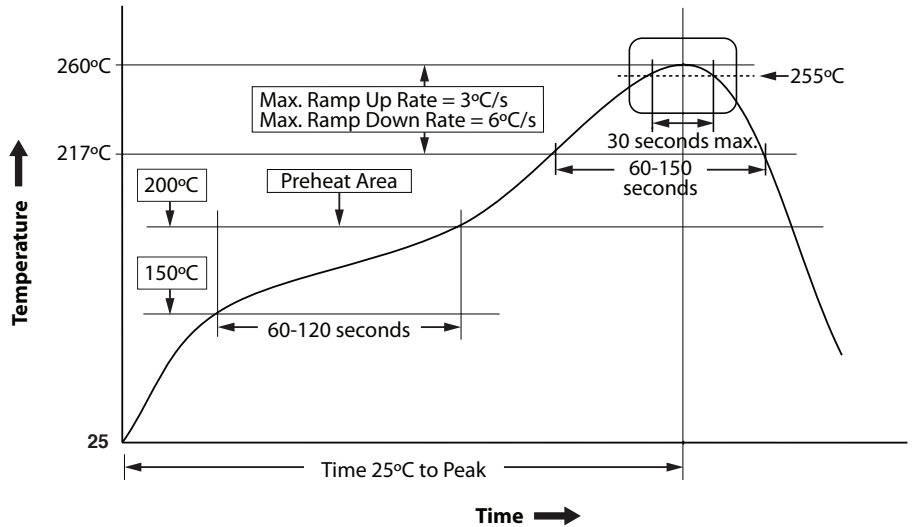
#### Box Dimensions – 18x14x12 inches

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

## 16 Suggested Pb-Free Reflow Profile

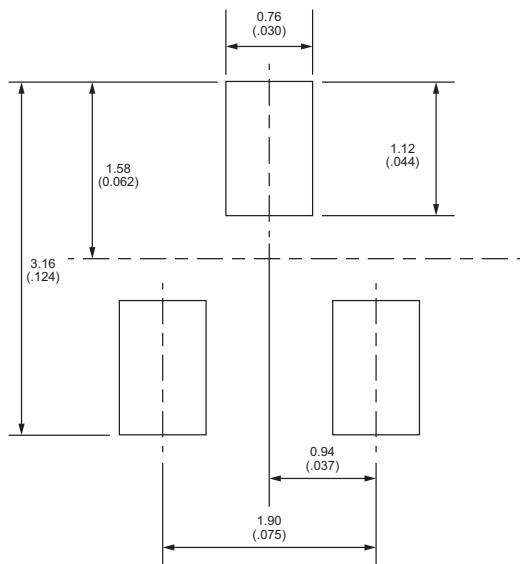
### Notes:

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 only) 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  $\pm 2\text{ }^\circ\text{C}$  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.



## 17 Suggested Solder Pad Layout

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



### 17.2 LGA-4 Solder Pad Layout

