



# Product Catalog

*Advanced Switching and Magnetic Sensing Solutions*

# REDROCK™ RR110 TMR ANALOG SENSOR



## RedRock™ RR110 TMR Analog Sensor

The RedRock 110 Series is an analog magnetic sensor, ideal for use in medical, industrial, automotive, and consumer applications. Based on patented Tunneling Magnetoresistance (TMR) technology, the RR110 Series excels even in low magnetic fields and with large air gaps. The RR110 Series offers high sensitivity in a small footprint package.

### Features

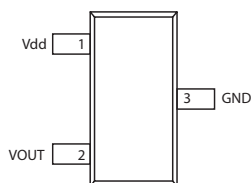
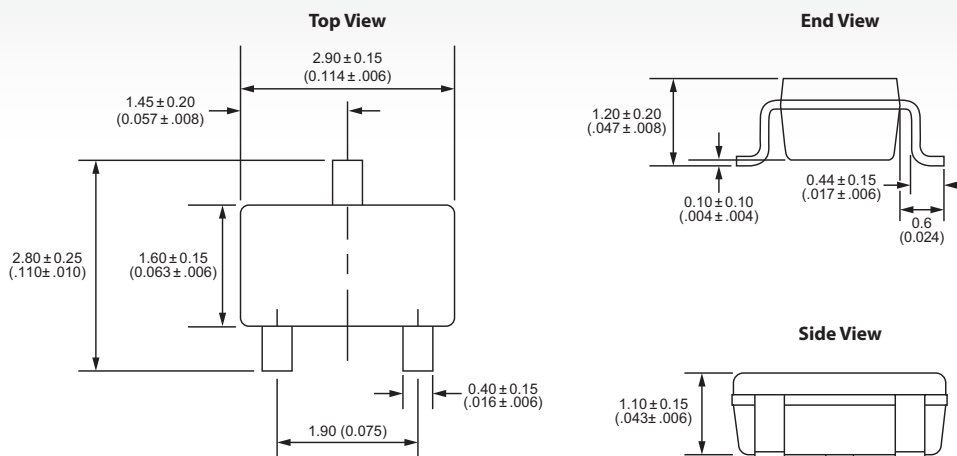
- ▶ High sensitivity
- ▶ Stable temperature performance
- ▶ Resistant to mechanical stress
- ▶ REACH Compliant
- ▶ RoHS Compliant

### IDEAL APPLICATIONS

- ▶ Door or lid closure detection
- ▶ Smart phones, tablets and laptops
- ▶ Proximity detection
- ▶ Position sensing
- ▶ Water, electric and gas meters
- ▶ Fluid level detection

## DIMENSIONS

*in Millimeters (Inches)*



### Ordering Information

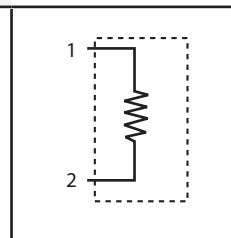
|                               |                         |                          |              |
|-------------------------------|-------------------------|--------------------------|--------------|
| <b>Part Number</b>            | RR110-A X 1 1-0 0       | <b>Package</b>           | 0 - SOT-23   |
| <b>Model Number</b>           |                         | <b>Special Feature</b>   | 0 - N/A      |
| <b>Magnetoresistance (kΩ)</b> |                         | <b>Magnetic Polarity</b> | 1 = Unipolar |
| A: 65kΩ @ 0 G, 40kΩ @ 100 G   |                         |                          |              |
| <b>Temp Rating (°C)</b>       | 1 - Industrial (-40-85) |                          |              |
| <b>Feature</b>                | 1 - Default Value       |                          |              |

# REDROCK™ RR110 TMR ANALOG SENSOR

| REDROCK™  |                 | RR110 |     |            |
|---|-----------------|-------|-----|------------|
| Parameters <sup>1</sup>   | Units           | Min   | Typ | Max        |
| <b>OPERATING CHARACTERISTICS<sup>2</sup></b>                    |                 |       |     |            |
| Resistance @0 Gauss   | kΩ              |       | 65  |            |
| Resistance @100 Gauss   | kΩ              |       | 40  |            |
| Response Time   | ns              |       | 600 |            |
| Temperature Coefficient of Resistance (at 0 field) <sup>2</sup> | Ω/°C            |       | -35 |            |
| <b>ELECTRICAL CHARACTERISTICS</b>                               |                 |       |     |            |
| Supply Voltage  | V <sub>dd</sub> |       |     | 15         |
| Operating Current <sup>4</sup>                                  | μA              |       | 1   | 100        |
| <b>ABSOLUTE ENVIRONMENTAL RATINGS</b>                           |                 |       |     |            |
| Operating Temperature: Industrial                               | °C              | -40   |     | 85         |
| Storage Temperature   | °C              | -55   |     | 150        |
| Soldering Temperature (3 cycles of 1 min.)                      | °C              |       |     | 260        |
| Operating Magnetic Field  | G               |       |     | 100        |
| ESD Level (HBM) <sup>3</sup>                                    | V               |       |     | See Note 3 |

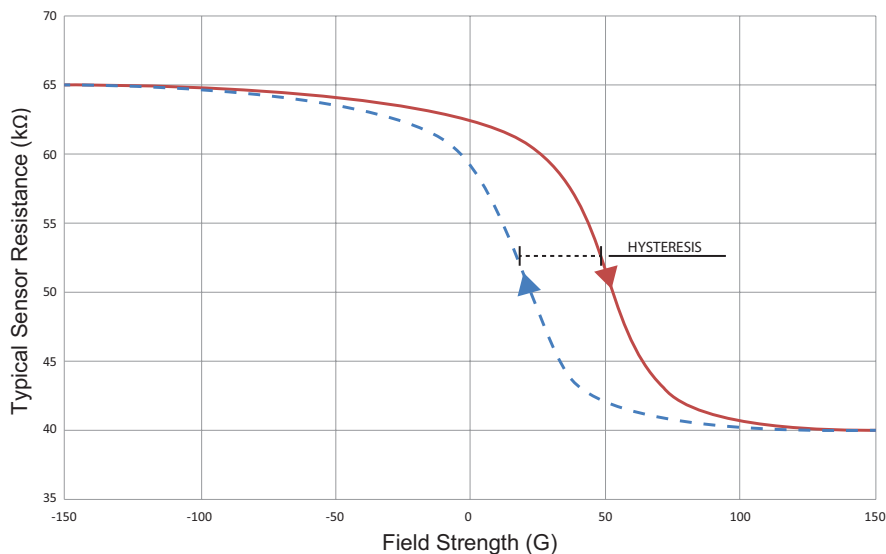
## Notes:

- Contact factory for more information on additional product offerings.
- All characteristics as measured at 25°C
- ESD PRECAUTIONS MUST BE USED WHEN HANDLING.**
- The RR110 may be operated at lower currents to reduce power consumption, or at higher currents for greater voltage output, as long as the limits noted in the electrical characteristics are not exceeded.



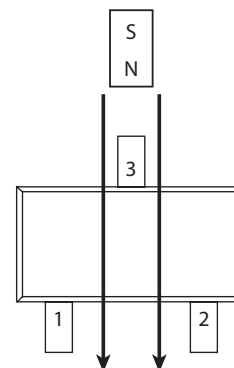
## MAGNETIC SENSITIVITY TRANSFER CURVE

The magnetic sensitivity transfer curve illustrates the characteristic behavior of an analog TMR sensor's resistance change as the strength of an applied magnetic field changes. The magnet approach curve (red line) shows the change in resistance as the strength of an applied magnetic field increases. The magnet recede curve (blue dashed line) shows the change in resistance as the strength of an applied magnetic field decreases. Alternatively, you can think of the resistance going down the red slope as a magnet approaches the sensor, and going up the blue dashed slope as the magnet moves further away from the sensor.



— N-Pole Magnet Approaching Sensor      - - - N-Pole Magnet Receding from Sensor

## SENSOR POLARITY DIAGRAM



# REDROCK™ RR120 TMR DIGITAL SENSOR



## RedRock™ RR120 TMR Digital Sensor

The RedRock 120 Series is an integrated digital magnetic sensor ideal for use in medical, industrial, automotive and consumer switching applications. Based on patented Tunneling Magnetoresistance (TMR) technology with CMOS process, the RR120 Series can function even in low magnetic fields with large air gaps. The RR120 Series provides high sensitivity with low power consumption in a small footprint package.

### Features

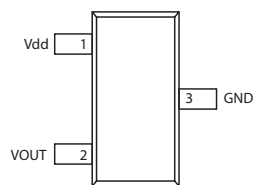
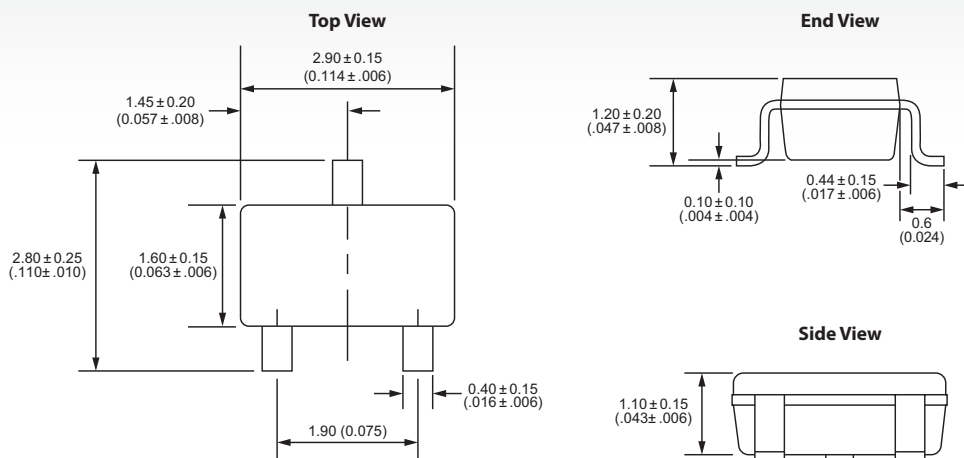
- ▶ High sensitivity
- ▶ Stable temperature performance
- ▶ Resistant to mechanical stress
- ▶ Low power consumption
- ▶ High frequency performance
- ▶ Logic output for design flexibility
- ▶ REACH Compliant
- ▶ RoHS Compliant

### IDEAL APPLICATIONS

- ▶ Door or lid closure detection
- ▶ Smart phones, tablets and laptops
- ▶ Bare glass reed switch replacement
- ▶ Motor controllers
- ▶ Proximity detection
- ▶ Open-close detection
- ▶ Water, electric and gas meters
- ▶ Fluid level detection
- ▶ “Wake-Up” functionality

## DIMENSIONS

*in Millimeters (Inches)*



### Ordering Information

|                                 |                         |                          |              |
|---------------------------------|-------------------------|--------------------------|--------------|
| <b>Part Number</b>              | RR120-A X 1 X-X 0       | <b>Package</b>           | 0 - SOT-23   |
| <b>Model Number</b>             |                         | <b>Special Feature</b>   | 0 - N/A      |
| <b>Magnetic Sensitivity (G)</b> | A - Op = 30    Rel = 15 | <b>Magnetic Polarity</b> | 1 = Unipolar |
| <b>Temp Rating (°C)</b>         | 1 - Industrial (-40-85) |                          |              |
| <b>Power Rating</b>             | 1 - Default Value       |                          |              |

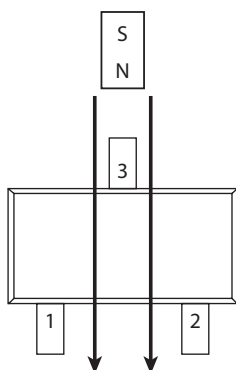
# REDROCK™ RR120 TMR DIGITAL SENSOR

| REDROCK™  | RR120 |     |       |      |
|---|-------|-----|-------|------|
| Parameters  | Units | Min | Typ   | Max  |
| <b>OPERATING CHARACTERISTICS<sup>1</sup></b>      |       |     |       |      |
| Operate Sensitivity                               | G     | 20  | 30    | 40   |
| Release Sensitivity                               | G     | 8   | 15    | 30   |
| Hysteresis  | G     |     | 15    |      |
| Operate Time                                      | ms    |     | 30    |      |
| Release Time                                      | ms    |     | 30    |      |
| Temperature Coefficient of Operate Sensitivity    | G/°C  |     | -0.07 |      |
| <b>ELECTRICAL CHARACTERISTICS<sup>1</sup></b>     |       |     |       |      |
| Supply Voltage ( $V_{dd}$ )                       | V     | 2.7 | 3.0   | 3.6  |
| Average Current Drain                             | nA    |     | 350   | 400  |
| Output Voltage (High) <sup>2</sup> ( $V_{outh}$ ) | V     |     | 2.7 V |      |
| Output Voltage (Low) <sup>2</sup> ( $V_{outl}$ )  | V     |     | 0.2 V |      |
| <b>ABSOLUTE ENVIRONMENTAL RATINGS</b>             |       |     |       |      |
| Operating Temperature: Industrial                 | °C    | -40 |       | 85   |
| Storage Temperature                               | °C    | -55 |       | 150  |
| Soldering Temperature (3 cycles, 1 min.)          | °C    |     |       | 260  |
| Operating Magnetic Field                          | G     |     |       | 100  |
| ESD Level (HBM)                                   | V     |     |       | 4000 |

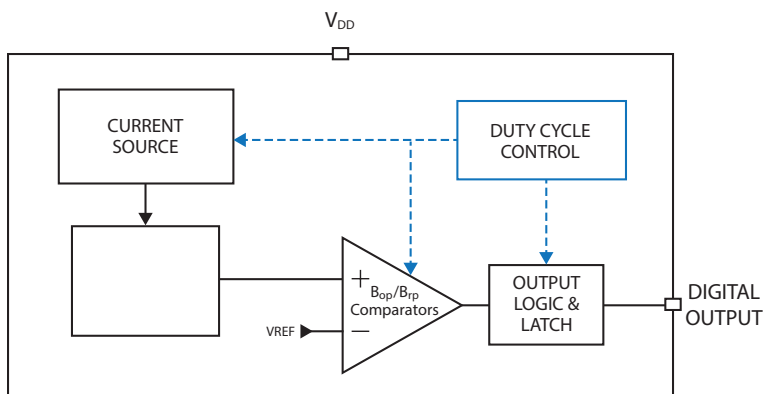
## Notes:

1. All characteristics as measured at 25°C
2. See "Magnetic Field vs. Output Status" (at right) for more details.

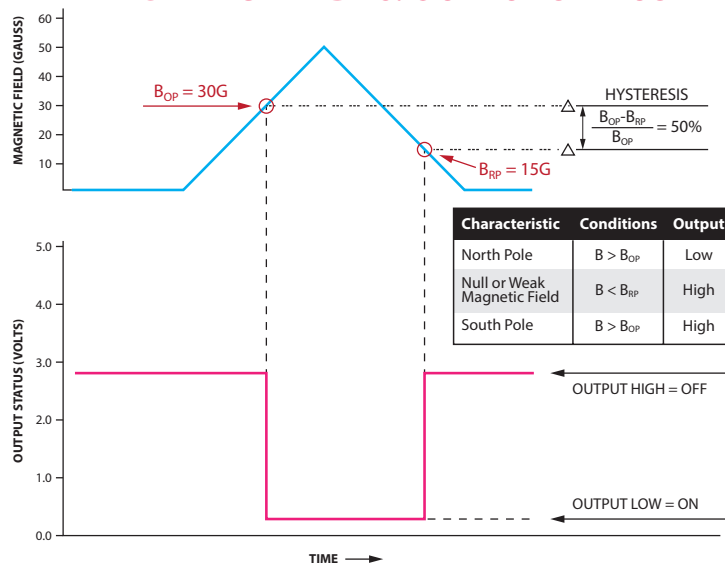
## SENSOR POLARITY DIAGRAM



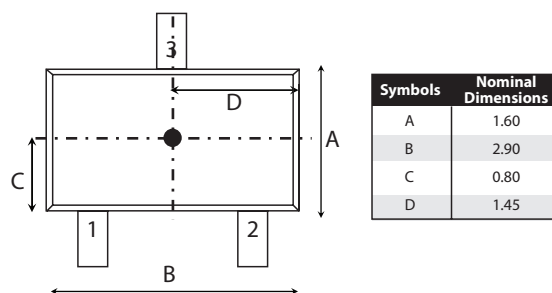
## RR120 DIGITAL FUNCTION BLOCK DIAGRAM



## MAGNETIC FIELD vs. OUTPUT STATUS



## MTJ SENSOR LOCATION DIAGRAM



# REDROCK™ RR130 TMR DIGITAL SWITCH



## RedRock™ RR130 TMR Digital Switch

The RedRock 130 Series is an integrated digital magnetic switch ideal for use in medical, industrial, automotive and consumer switching applications. It is based on patented Tunneling Magnetoresistance (TMR) technology with integrated CMOS process. The RR130 Series can operate in low magnetic fields with large air gaps. The open drain output can interface with a system voltage up to 3.9V for added design flexibility. The RR130 Series provides high sensitivity with low power consumption in a small footprint package.

### Features

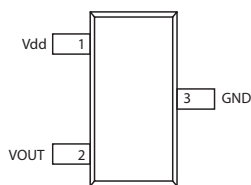
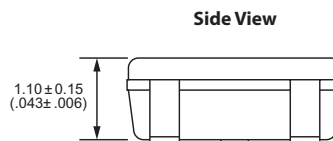
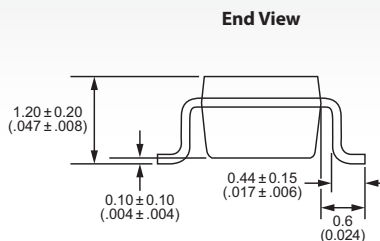
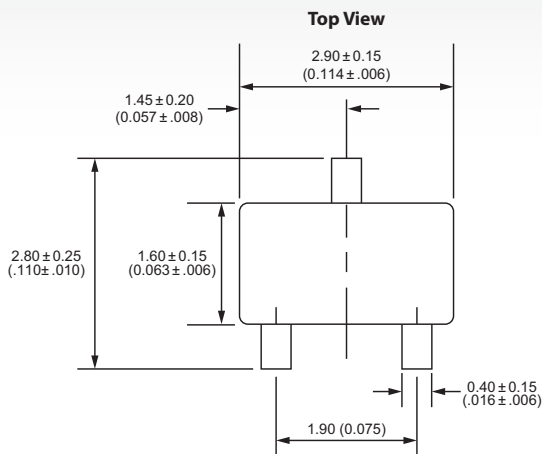
- ▶ High sensitivity
- ▶ Stable temperature performance
- ▶ Resistant to mechanical stress
- ▶ Low power consumption
- ▶ High frequency performance
- ▶ Open drain MOSFET for design flexibility
- ▶ REACH Compliant
- ▶ RoHS Compliant

### IDEAL APPLICATIONS

- ▶ Door or lid closure detection
- ▶ Smart phones, tablets and laptops
- ▶ Bare glass reed switch replacement
- ▶ Motor controllers
- ▶ Proximity detection
- ▶ Power switch or open-close detection
- ▶ Water, electric and gas meters
- ▶ Fluid level detection
- ▶ “Wake-Up” functionality

## DIMENSIONS

*in Millimeters (Inches)*



### Ordering Information

|                                 |                          |                          |              |
|---------------------------------|--------------------------|--------------------------|--------------|
| <b>Part Number</b>              | RR130-A X 1 X-X 0        | <b>Package</b>           | 0 - SOT-23   |
| <b>Model Number</b>             |                          | <b>Special Feature</b>   | 0 - N/A      |
| <b>Magnetic Sensitivity (G)</b> | A - Op = 30    Rel = 15  | <b>Magnetic Polarity</b> | 1 = Unipolar |
| <b>Temp Rating (°C)</b>         | 1 - Industrial (-40-185) |                          |              |
| <b>Power Rating</b>             | 1 - Default Value        |                          |              |

# REDROCK™ RR130 TMR DIGITAL SWITCH

| REDROCK™                                       |       | RR130 |       |                |
|--|-------|-------|-------|----------------|
| Parameters                                     | Units | Min   | Typ   | Max            |
| <b>OPERATING CHARACTERISTICS<sup>1</sup></b>   |       |       |       |                |
| Operate Sensitivity                            | G     | 20    | 30    | 40             |
| Release Sensitivity                            | G     | 8     | 15    | 30             |
| Hysteresis                                     | G     |       | 15    |                |
| Operate Time                                   | ms    |       | 30    |                |
| Release Time                                   | ms    |       | 30    |                |
| Temperature Coefficient of Operate Sensitivity | G/°C  |       | -0.05 |                |
| <b>ELECTRICAL CHARACTERISTICS<sup>1</sup></b>  |       |       |       |                |
| Supply Voltage <sup>2</sup> ( $V_{dd}$ )       | V     | 2.7   | 3.0   | 3.6            |
| Average Current Drain                          | nA    |       | 350   | 400            |
| System Voltage <sup>2</sup> ( $V_{sys}$ )      | V     |       |       | $V_{dd} + 0.3$ |
| System Current <sup>2</sup> ( $I_{sys}$ )      | mA    |       |       | 15             |
| <b>ABSOLUTE ENVIRONMENTAL RATINGS</b>          |       |       |       |                |
| Operating Temperature: Industrial              | °C    | -40   |       | 85             |
| Storage Temperature                            | °C    | -55   |       | 150            |
| Soldering Temperature                          | °C    |       |       | 260            |
| Max. Exposed Magnetic Field                    | G     |       |       | 100            |
| ESD Level (HBM)                                | V     |       |       | 4000           |

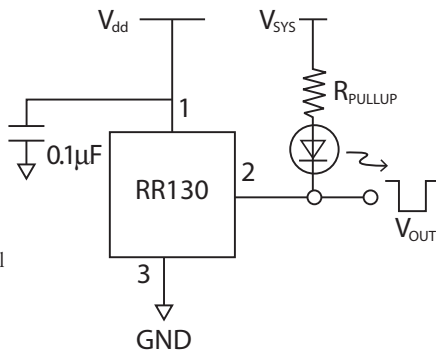
## Notes:

- All characteristics as measured at 25°C
- See "Application Circuit" for more information.

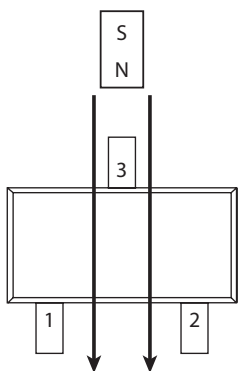
## APPLICATION CIRCUIT

### RR130 Open Drain Output Application Circuit

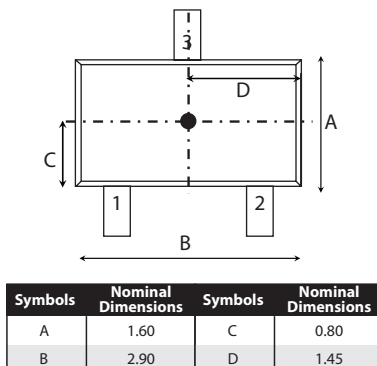
With the open drain output, the system voltage can range up to  $V_{dd} + 0.3V$ . Please keep in mind the supply voltage to the RR130 must remain at 3.6V. A decoupling capacitor between the supply voltage and ground is required with placement close to the magnetic sensor. A typical capacitor value of 0.1  $\mu F$  will suffice.



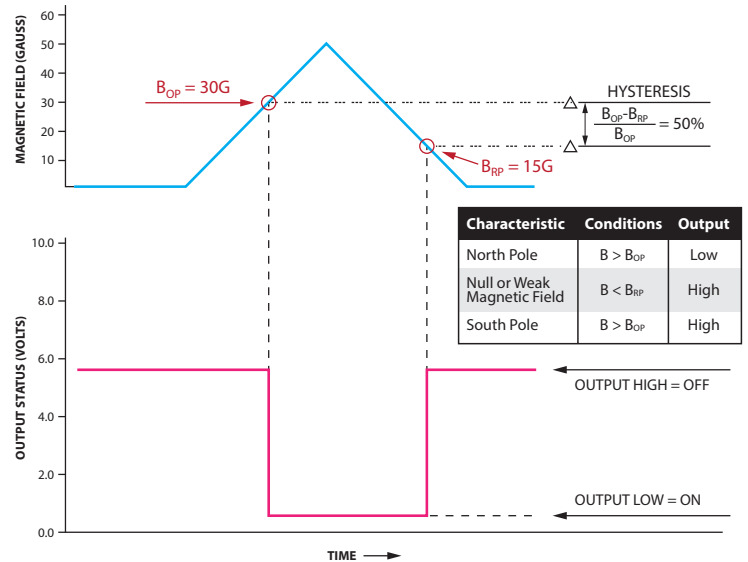
## SENSOR POLARITY DIAGRAM



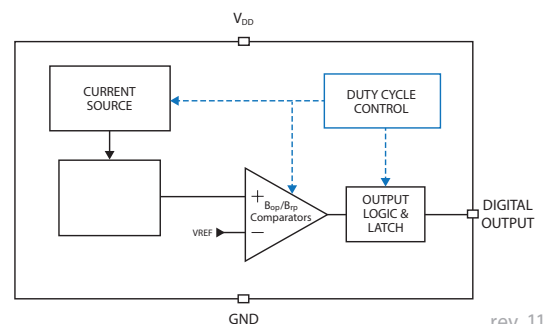
## MTJ SENSOR LOCATION DIAGRAM



## MAGNETIC FIELD vs. OUTPUT STATUS



## RR130 DIGITAL FUNCTION BLOCK DIAGRAM

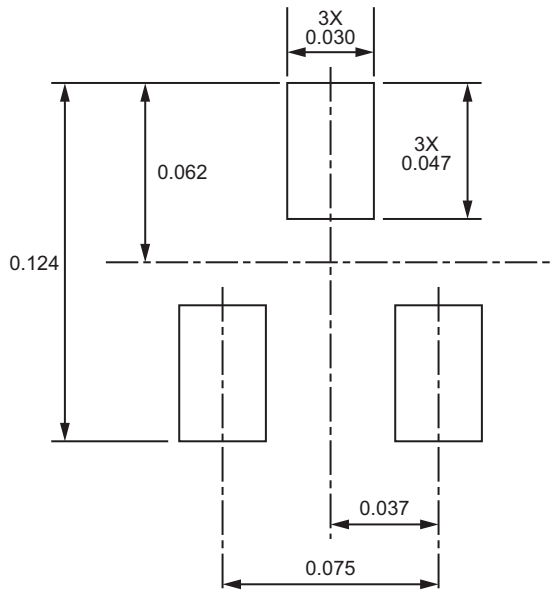






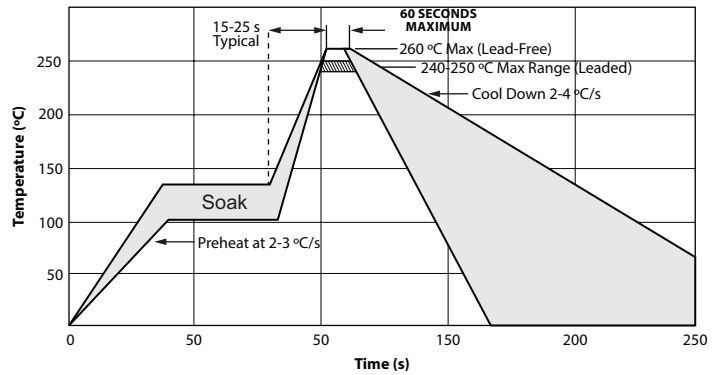
# TMR TECHNICAL & APPLICATIONS INFORMATION

## SUGGESTED SOLDER PAD LAYOUT



(Units in mm)

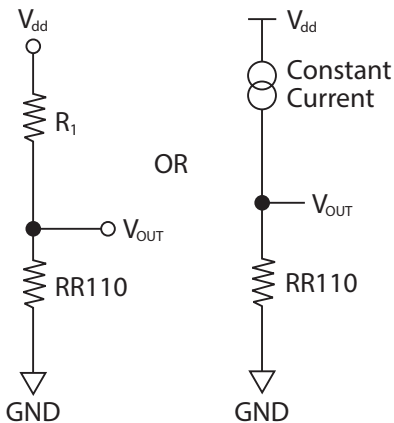
## SUGGESTED REFLOW PROFILE



### Notes:

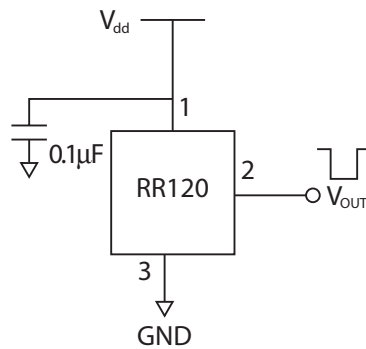
1. Fully compatible with standard no-lead solder profile, 260 °C for 1 minute max (3 cycles max)
2. Profile shown as example. Users are advised to develop their own board-level profile
3. Temperature tolerance: +0 °C, as measured at any point on the package or leads
4. MSL rating of 1 compatible with J-STD-020 or equivalent.

## APPLICATION CIRCUITS



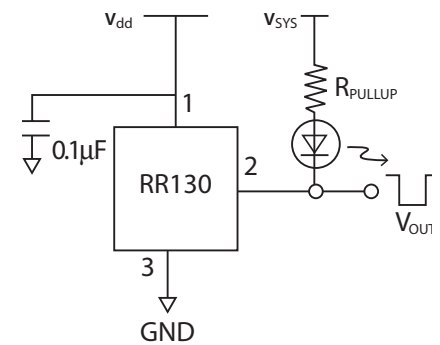
### RR110 Magnetoresistance Application Circuit

The RR110 can be configured with a constant voltage source and a fixed resistor to create a voltage divider circuit. Alternatively, a constant current source eliminates the need for a fixed resistor.



### RR120 Digital Output Application Circuit

The output voltage on the RR120 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 I/O pin on a microcontroller. A decoupling capacitor between the supply voltage and ground is required with placement close to the magnetic sensor. A typical capacitor value of 0.1 µF will suffice.



### RR130 Open Drain Output 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 RR130 must remain at 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 0.1 µF will suffice.

# TMR TECHNICAL & APPLICATIONS INFORMATION

## GLOSSARY OF TERMS

**Hysteresis:** Hysteresis refers to the difference between two points of interest for a particular device. For digital sensors and switches, it represents the difference between the operate sensitivity and the release sensitivity, expressed either as an absolute value ( $B_{OP} - B_{RP}$ ) or the % difference  $(B_{OP} - B_{RP})/B_{OP}$ . For an analog sensor, the hysteresis is the difference between the “magnet approach curve” and the “magnet recede curve.”

**Magnet Approach Curve:** The magnet approach curve is the characteristic change in resistance of an analog TMR sensor as an applied magnetic field approaches the sensor, typically plotted as a function of the magnetic field strength.

**Magnet Recede Curve:** The magnet recede curve is the characteristic change in resistance of an analog TMR sensor as an applied magnetic field recedes from the sensor, typically plotted as a function of the magnetic field strength.

**Magnetoresistance:** Magnetoresistance is a phenomenon wherein the electrical resistance of certain materials changes when exposed to an externally-applied magnetic field.

**Magnetic Transfer Curve:** The magnetic transfer curve defines the characteristic behavior of an analog TMR sensor by combining both the magnet approach curve and the magnet receive curve together.

**Magnetic Tunnel Junction:** A magnetic tunnel junction is a thin film structure consisting of two magnetic layers separated by a thin insulator. Because the insulating layer is thin enough (typically a few nanometers), electrons can tunnel from one magnetic layer into the other.

**Operate Sensitivity:** The operate sensitivity defines the upper limit of the strength of an applied magnetic field that a digital TMR sensor or switch must operate.

**Operate Time:** The operate time is the difference, in time, between the application of a magnetic field and the output response of the device. In an analog sensor, the response is a change in output resistance. In a digital sensor, the response is a change in state of the electrical output.

**Release Sensitivity:** The release sensitivity defines the lower limit of the strength of an applied magnetic field that a digital TMR sensor or switch must release.

**Release Time:** The release time is the difference, in time, between the removal of an applied magnetic field and the output response of the device. In an analog sensor, the response is a change in output resistance. In a digital sensor, the response is a change in state of the electrical output.

**Tunnel Magnetoresistance (TMR):** Tunnel Magnetoresistance is the magnetoresistive effect that occurs in a magnetic tunnel junction.

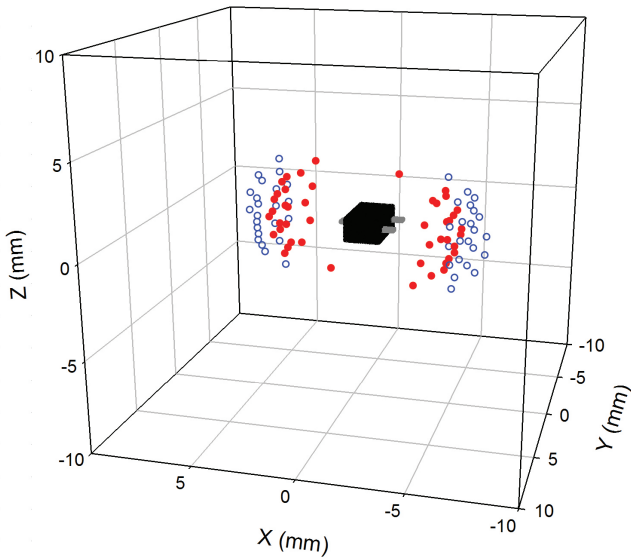
# TMR TECHNICAL & APPLICATIONS INFORMATION

## MAGNETIC SENSITIVITY MAPS

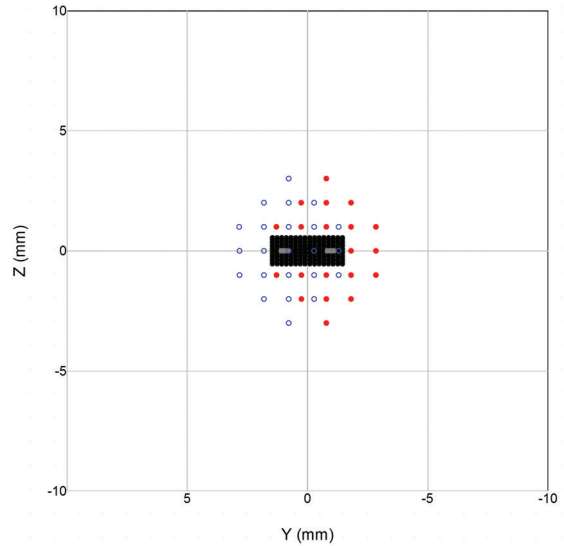
Magnetic sensitivity maps show the operate and release loci in three-dimensional space when a magnet is presented to a magnetically operated switch or sensor. The absolute operate and release distances between the magnet and the sensor will vary depending on the sensitivity of the switch and the strength of the magnet. However, the

shape and direction of the operate loci stay relatively constant except for cases where the magnet is physically much larger than the sensor. These plots were generated using a 2mm<sup>3</sup> cubic shaped NdFeB N52 magnet with its North pole presented to the ground pin and a South pole presented to the opposite side.

RR120/RR130 Magnetic Sensitivity Pattern, perspective view

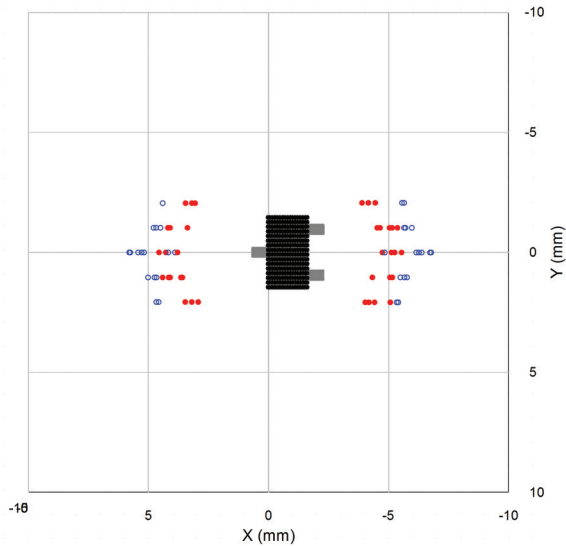


RR120/RR130 Magnetic Sensitivity Pattern, YZ plane



- Operate Points
- Release Points

RR120/RR130 Magnetic Sensitivity Pattern, XY plane



RR120/RR130 Magnetic Sensitivity Pattern, XZ plane

