

## High Performance Digital-Latch Hall Effect Sensor

### 1. Features

- AEC-Q100 qualified
- Supports a wide operation voltage range:
  - 2.8 to 40V
- Supply voltage transient up to 60V with 200Ω R<sub>S</sub> resistor.
- Wide operating temperature range:
  - -55°C to 150°C
- Reverse battery protection: -28V
- Current limited open drain output: 40mA
- High EMC/ESD immunity
- Small package
  - 3-pin TO-92S (UA)
  - 3-pin SOT23-3L (SO)

### 2. Applications

- Automotive, Industrial and Consume
- BLDC motor commutation
- Seat motor adjuster
- Window lifter
- Sunroof/Tailgate opener
- Tachometers

### 3. Description

The SC294X family, produced with advanced 60V BCD technology, is a chopper-stabilized Hall Effect Sensor that offers a magnetic sensing solution with superior sensitivity stability and integrated protection features.

Superior high-temperature performance is made possible through dynamic offset cancellation, which reduces the residual offset voltage normally caused by device over molding, temperature dependencies, and thermal stress. Each device includes a voltage regulator, Hall-voltage generator, small-signal amplifier, chopper stabilization, hysteresis comparator, and the current limited output circuit.

An onboard regulator permits with supply voltages of 2.8 to 40V which makes the device suitable for a wide range of industrial and automotive applications.

The device is available in a 3-pin TO92S package (UA) and a 3-pin SOT23-3L style package (SO). Both are lead (Pb) free, with 100% matte tin lead frame plating.



Fig.1 Package Outline

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4. Terminal Configuration

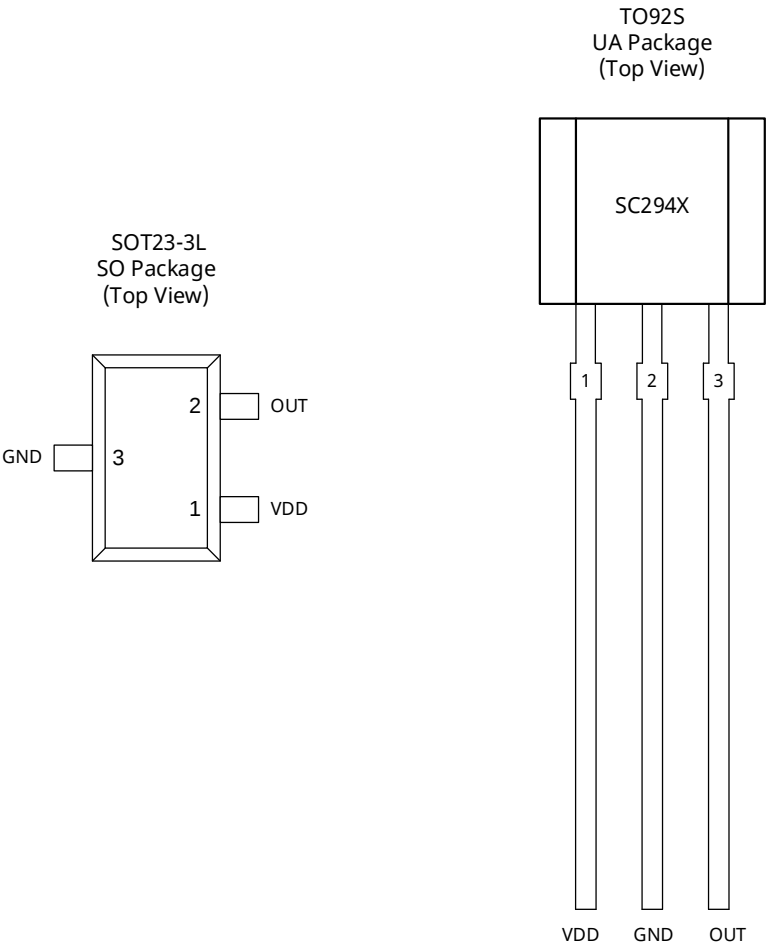


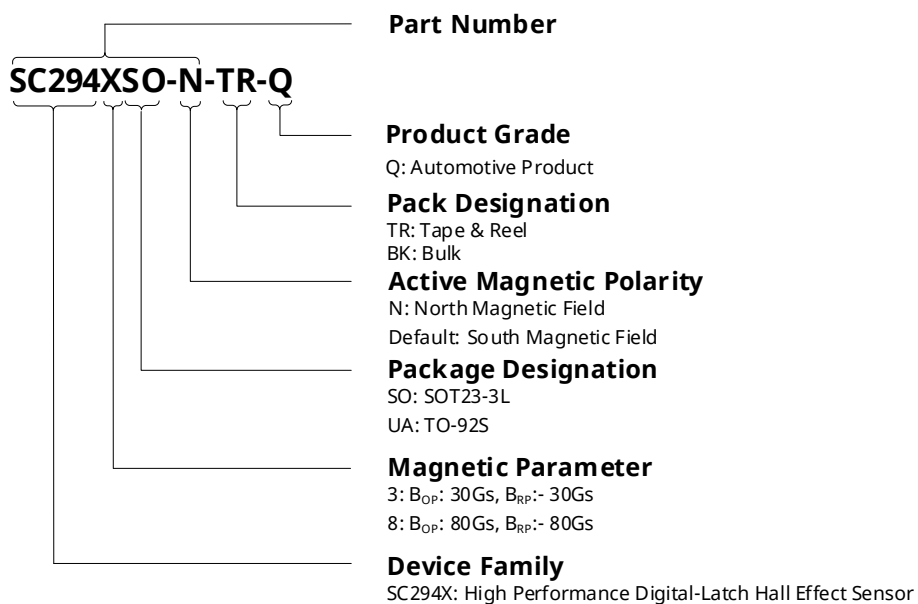
Fig.2 Terminal Configuration

| Terminal |    |    | Type   | Description                           |
|----------|----|----|--------|---------------------------------------|
| Name     | UA | SO |        |                                       |
| VDD      | 1  | 1  | Power  | 2.8 to 40V Power Supply               |
| GND      | 2  | 3  | Ground | Ground Terminal                       |
| OUT      | 3  | 2  | Output | The Current Limited Open Drain Output |

## 5. Ordering Information

| Ordering Information | Mark | Grade | Ambient, T <sub>A</sub> (°C) | Package  | Packing | Quantity         |
|----------------------|------|-------|------------------------------|----------|---------|------------------|
| SC2943SO-TR-Q        | 2943 | Q     | -55 to 150                   | SOT23-3L | TR      | 3000 pieces/reel |
| SC2943SO-N-TR-Q      | 2943 | Q     | -55 to 150                   | SOT23-3L | TR      | 3000 pieces/reel |
| SC2943UA-BK-Q        | 2943 | Q     | -55 to 150                   | TO92S    | BK      | 1000 pieces/bag  |
| SC2948SO-TR-Q        | 2948 | Q     | -55 to 150                   | SOT23-3L | TR      | 3000 pieces/reel |
| SC2948UA-BK-Q        | 2948 | Q     | -55 to 150                   | TO92S    | BK      | 1000 pieces/bag  |

### Ordering Information Format



## 6. Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

| Symbol            | Parameter                     | Test Condition                      | Min. | Max. | Units |
|-------------------|-------------------------------|-------------------------------------|------|------|-------|
| V <sub>DD</sub>   | Power supply voltage          |                                     | -28  | 60   | V     |
| V <sub>OUT</sub>  | Output terminal voltage       | For 5 min @ 1.2 kΩ pull up resistor | -0.5 | 60   | V     |
| I <sub>SINK</sub> | Output terminal current sink  |                                     | 0    | 44   | mA    |
| T <sub>A</sub>    | Operating ambient temperature |                                     | -55  | 150  | °C    |
| T <sub>J</sub>    | Maximum junction temperature  |                                     | -55  | 165  | °C    |
| T <sub>STG</sub>  | Storage temperature           |                                     | -65  | 175  | °C    |

Note:

(1) Stresses above those listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## 7. ESD Protection

| Symbol               | Parameter | Test Condition                          | Min. | Max. | Units |
|----------------------|-----------|-----------------------------------------|------|------|-------|
| V <sub>ESD_HBM</sub> | HBM       | According to: standard AEC-Q100-002 HBM | -8   | 8    | kV    |
| V <sub>ESD_CDM</sub> | CDM       | According to: standard AEC-Q100-011 CDM | -750 | 750  | V     |

## 8. Thermal Characteristics

| Symbol           | Parameter                     | Test Conditions                                      | Rating             | Units |
|------------------|-------------------------------|------------------------------------------------------|--------------------|-------|
| R <sub>θJA</sub> | UA Package thermal resistance | Single-layer PCB, with copper limited to solder pads | 200 <sup>(1)</sup> | °C/W  |
|                  | SO Package thermal resistance | Single-layer PCB, with copper limited to solder pads | 300 <sup>(1)</sup> | °C/W  |

Note:

(1) Maximum voltage must be adjusted for power dissipation and junction temperature, see Thermal Characteristics.

## 9. Operating Characteristics

### 9.1. Electrical Characteristics

over operating free-air temperature rang ( $V_{DD} = 5.0V$ , unless otherwise noted)

| Symbol        | Parameter                        | Test Conditions                                              | Min. | Typ. <sup>(2)</sup> | Max. | Units   |
|---------------|----------------------------------|--------------------------------------------------------------|------|---------------------|------|---------|
| $V_{DD}$      | Operating Voltage <sup>(1)</sup> | $T_J < T_{J(Max.)}$ , $I_{DD}=1.2mA$                         | 2.8  | 5                   | 40   | V       |
| $V_{DDR}$     | Reverse Supply Voltage           | $I_{DD} < -10mA$ , $T_A=25^\circ C$                          | -28  | -                   | -    | V       |
| $UVLO_H$      | Under Voltage Lockout High       | $B > B_{OP} + 2.0mT$ , $V_{DD}$ Rising From 1.5V             | -    | 1.75                | -    | V       |
| $UVLO_L$      | Under Voltage Lockout Low        | $B > B_{OP} + 2.0mT$ , $V_{DD}$ Decreasing From 2.5V         | -    | 1.5                 | -    | V       |
| $UVLO_{HYS}$  | Under Voltage Hysteresis         | $UVLO_H - UVLO_L$                                            | -    | 250                 | -    | mV      |
| $I_{DD(off)}$ | Off Stage Operating Current      | $V_{DD}=2.8$ to $40V$ , $T_A=25^\circ C$ ,                   | -    | 1.2                 | -    | mA      |
| $t_{on}$      | Power-on time                    | $V_{DD} \geq 5V$                                             | -    | 25                  | 40   | $\mu S$ |
| $I_{QL}$      | Off-state leakage current        | Output Hi-Z                                                  | -    | -                   | 3    | $\mu A$ |
| $V_{SAT}$     | Output saturation pressure drop  | $B > B_{RP}$ , $V_{DD}=5V$ , $I_O=20mA$ , $T_A=25^\circ C$   | -    | 0.14                | 0.4  | V       |
| $I_O$         | Output Sink Current              | $B > B_{OP}$ , $V_{DD}=5V$ , $V_{OUT}=1V$ , $T_A=25^\circ C$ |      | 40                  | 60   | mA      |
| $t_d$         | Output delay time                | $B = B_{RP}$ to $B_{OP}$                                     | -    | 15                  | 25   | $\mu S$ |
| $t_r$         | Output rise time (10% to 90%)    | $R_{PU}^{(3)}=1Kohm$ $C_L=50pF$                              | -    | 0.2                 | 1    | $\mu S$ |
| $t_f$         | Output fall time (90% to 10%)    | $R_{PU}=1Kohm$ $C_L=50pF$                                    | -    | 0.1                 | 1    | $\mu S$ |

Note:

(1) Maximum voltage must be adjusted for power dissipation and junction temperature, see Thermal Characteristics

(2) Typical values are defined at  $T_A = +25^\circ C$  and  $V_{DD} = 5V$

(3)  $R_{PU}$  and  $V_{PU}$  are the external pullup resistor and external pullup voltage.

## 9.2. Magnetic Characteristics

over operating free-air temperature range ( $V_{DD} = 5.0V$ , unless otherwise noted)

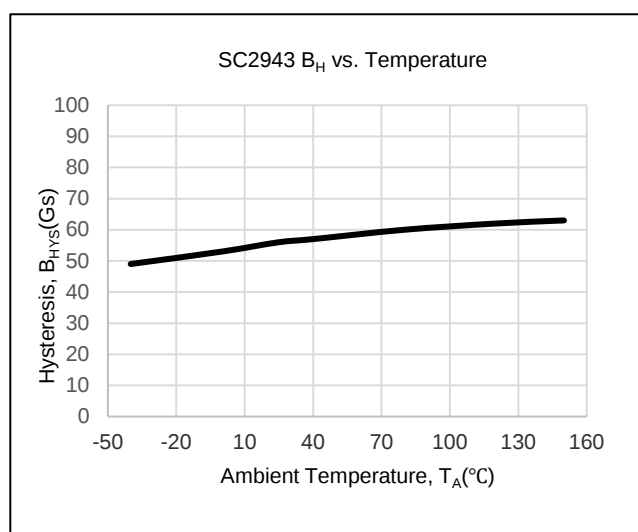
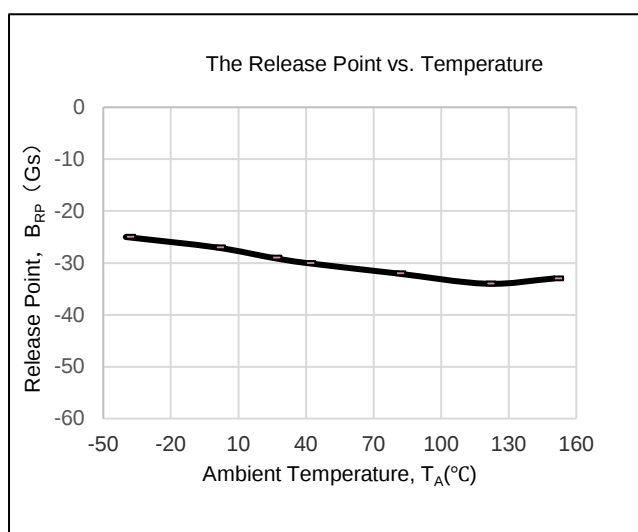
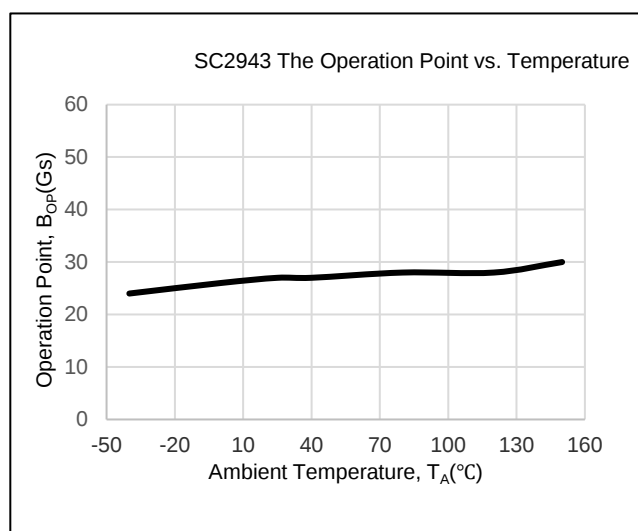
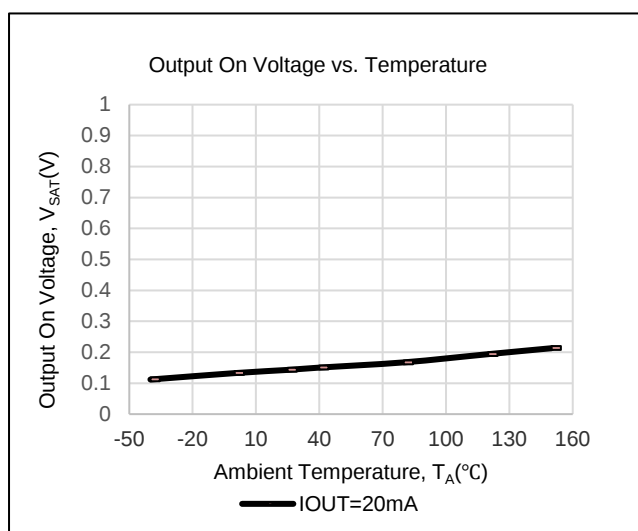
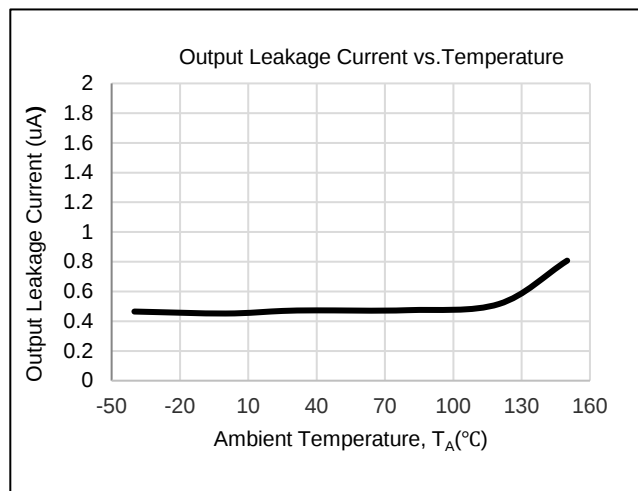
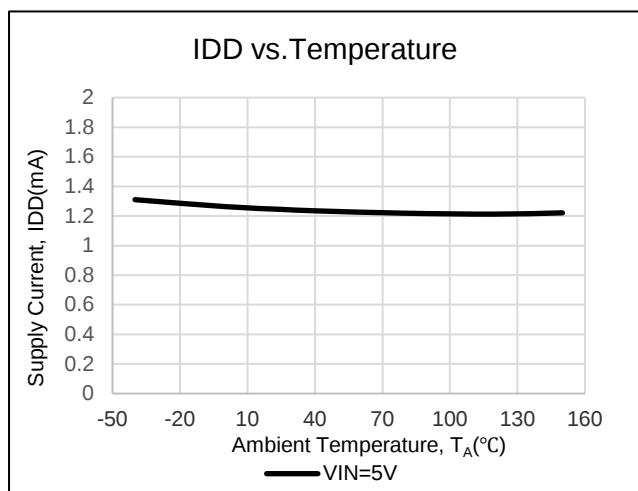
| Symbol                                     | Parameter       | Test Conditions             | Min.  | Typ.                | Max.  | Units |
|--------------------------------------------|-----------------|-----------------------------|-------|---------------------|-------|-------|
| $f_{BW}$                                   | BW              |                             | 20    | -                   | -     | kHz   |
| <b>SC2943 +3.0 / -3.0 mT<sup>(1)</sup></b> |                 |                             |       |                     |       |       |
| $B_{OP}$                                   | Operated point  | $T_A = 25^\circ C$          | +1.5  | +3.0 <sup>(2)</sup> | +4.5  | mT    |
| $B_{RP}$                                   | Release point   |                             | -4.5  | -3.0 <sup>(2)</sup> | -1.5  | mT    |
| $B_{HYS}$                                  | Hysteresis      |                             | 3.0   | 6.0                 | 9.0   | mT    |
| $B_O$                                      | Magnetic offset | $B_O = (B_{OP} + B_{RP})/2$ | -1.5  | 0                   | +1.5  | mT    |
| <b>SC2948 +8.0 / -8.0 mT</b>               |                 |                             |       |                     |       |       |
| $B_{OP}$                                   | Operated point  | $T_A = 25^\circ C$          | +6.0  | +8.0                | +10.0 | mT    |
| $B_{RP}$                                   | Release point   |                             | -10.0 | -8.0                | -6.0  | mT    |
| $B_{HYS}$                                  | Hysteresis      |                             | 12.0  | 16.0                | 20.0  | mT    |
| $B_O$                                      | Magnetic offset | $B_O = (B_{OP} + B_{RP})/2$ | -2.0  | 0                   | +2.0  | mT    |

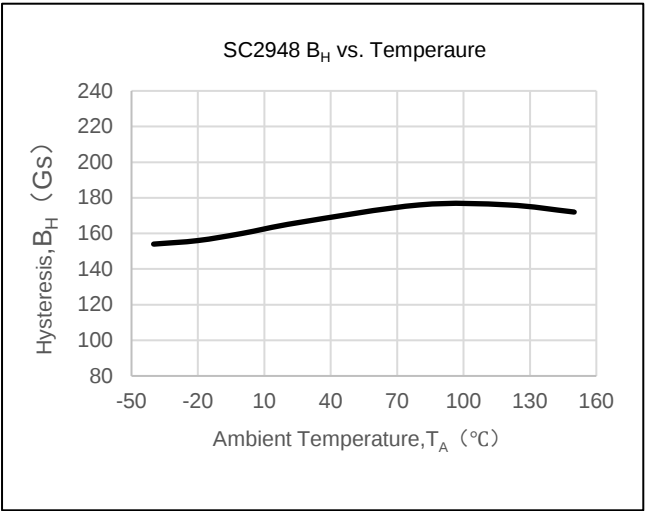
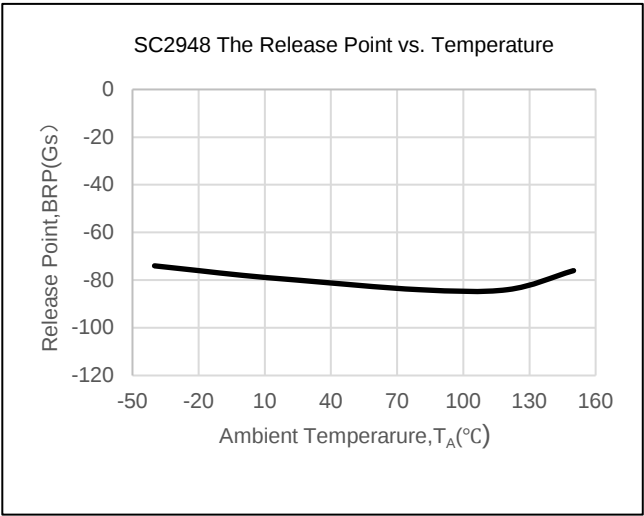
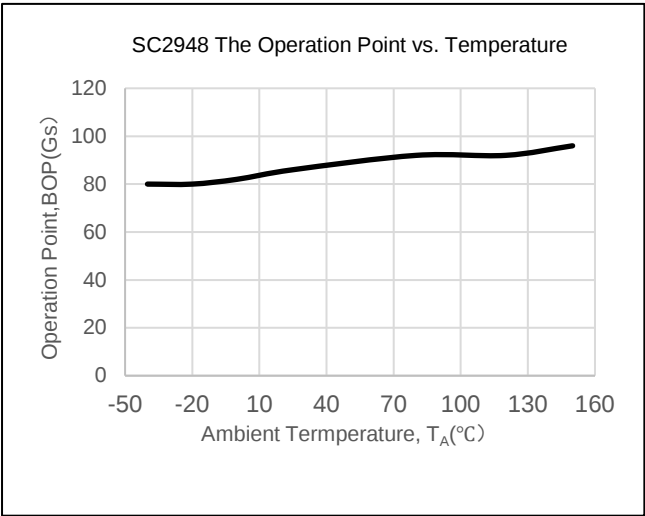
Note:

(1)  $1mT = 10Gs$

(2) Magnetic flux density,  $B$ , is indicated as a negative value for North-polarity magnetic fields, and as a positive value for South-polarity magnetic fields.

## 10. Typical Characteristics





## 11. Block Diagram

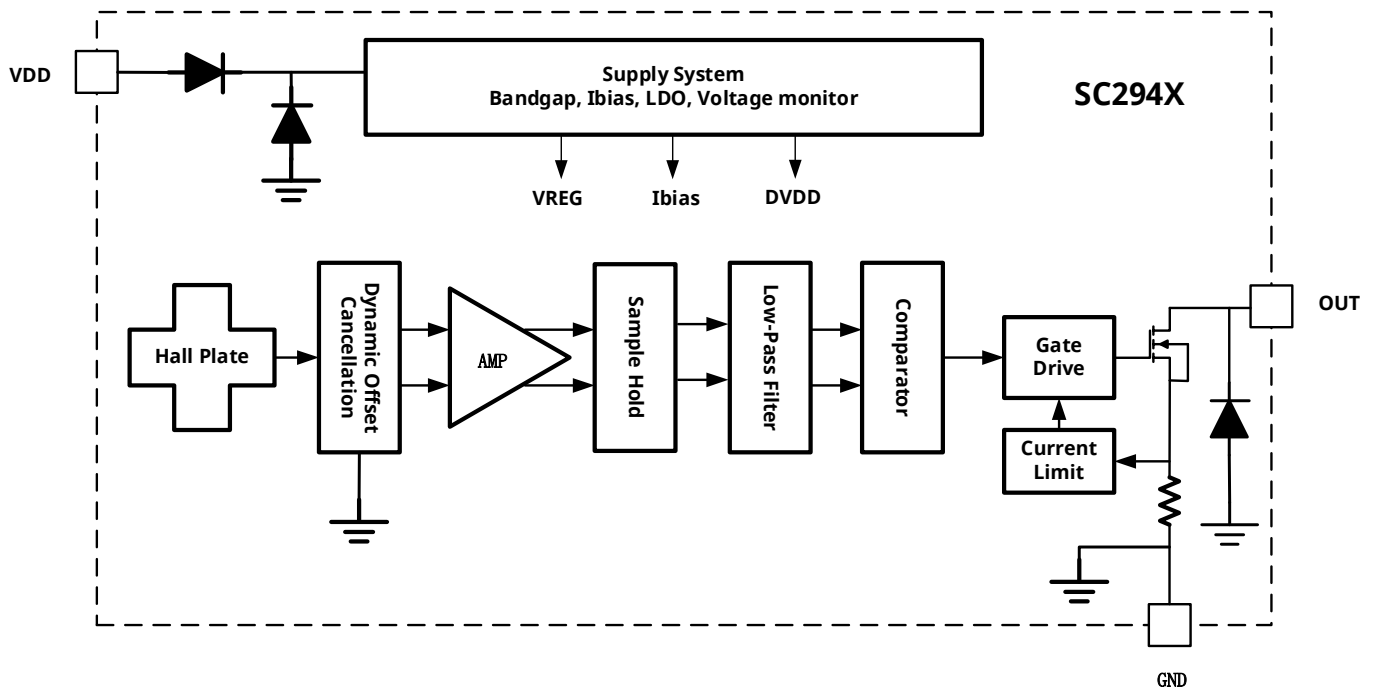


Fig. 3: Function Block Diagram

## 12. Function Description

The SC294X device is a chopper-stabilized Hall sensor with a digital latched output for magnetic sensing applications. The device can be powered with a supply voltage between 2.8 to 40V, and continuously survives continuous -28V reverse-battery conditions.

The output of SC294X switches low (turns on) when a magnetic field perpendicular to the Hall element exceeds the absolute value of the operate point threshold,  $B_{OP}$ . After turn-on, the output is capable of sinking 44mA and the output voltage is  $V_{Q(sat)}$ . When the magnetic field is reduced below the absolute value of the release point,  $B_{RP}$ , the device output goes high (turns off). The difference in the magnetic operate and release points is the hysteresis,  $B_{HYS}$ , of the device. This built-in hysteresis allows clean switching of the output even in the presence of external mechanical vibration and electrical noise.

## 12.1. Field Direction Definition

A positive magnetic field is defined as a South pole near the marked side of the package.

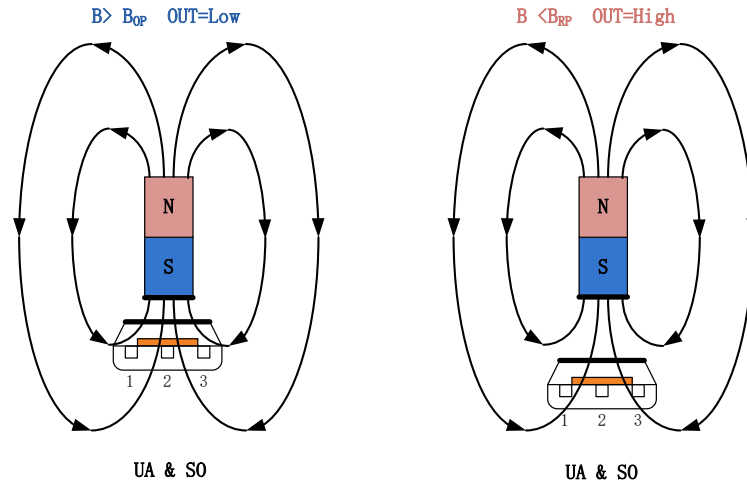


Fig.4 Magnetic Field Direction Definition

## 12.2. Transfer Function

Powering-on the device in the hysteresis region, less than  $B_{OP}$  and higher than  $B_{RP}$ , allows an indeterminate output state. The correct state is attained after the first excursion beyond  $B_{OP}$  or  $B_{RP}$ . If the field strength is greater than  $B_{OP}$ , then the output is pulled low. If the field strength is less than  $B_{RP}$ , the output is released.

$B_{OP}$ —magnetic threshold for activation of the device output, turning in ON (low) state

$B_{RP}$ —magnetic threshold for release of the device output, turning in OFF (high) state.

$$B_{HYS} = B_{OP} - B_{RP}$$

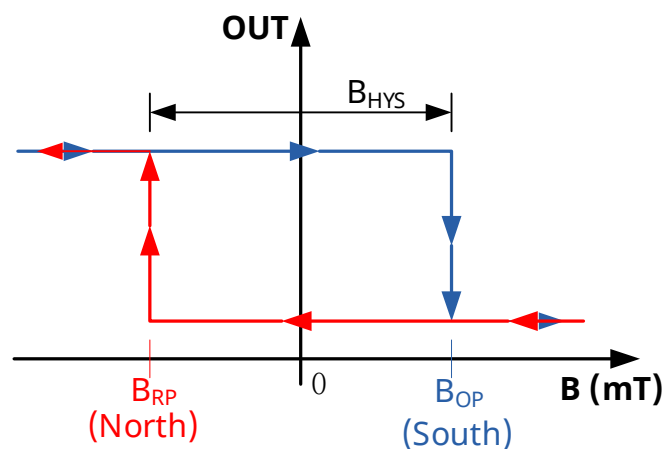


Fig.5 Magnetic Transfer Function

### 13. Typical Application

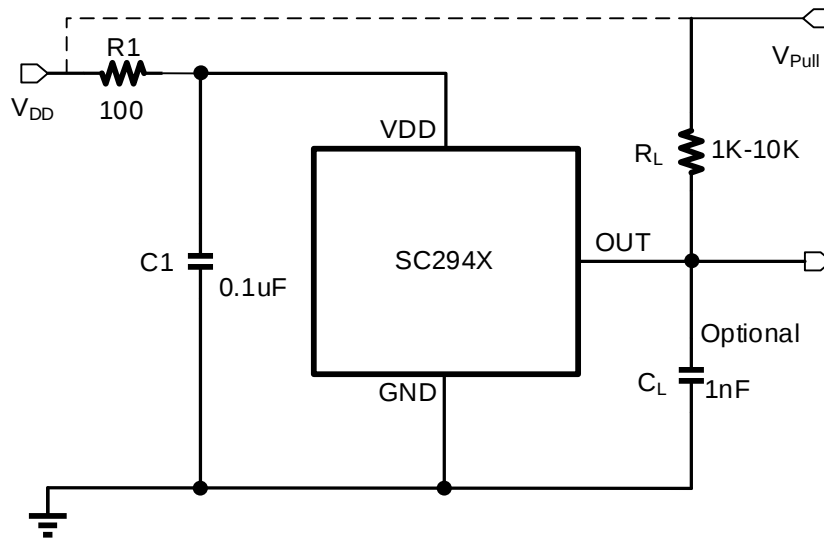


Fig.6 Typical Application Circuit

The SC294X contains an on-chip voltage regulator which makes the device operate over a wide supply voltage range. In the applications that operate on an unregulated power supply, the external line protection should be added. And the applications using a regulated line, for the EMI/RFI protection purpose, to connect the shunt C1 capacitors which typically is 0.1μF to the ground near the chip VDD power supply as close as possible and the 100Ω external optional series resistor R1. The output capacitor CL used as the output filter is typically 1nF. Select a value for CL based on the system bandwidth specification as follow:

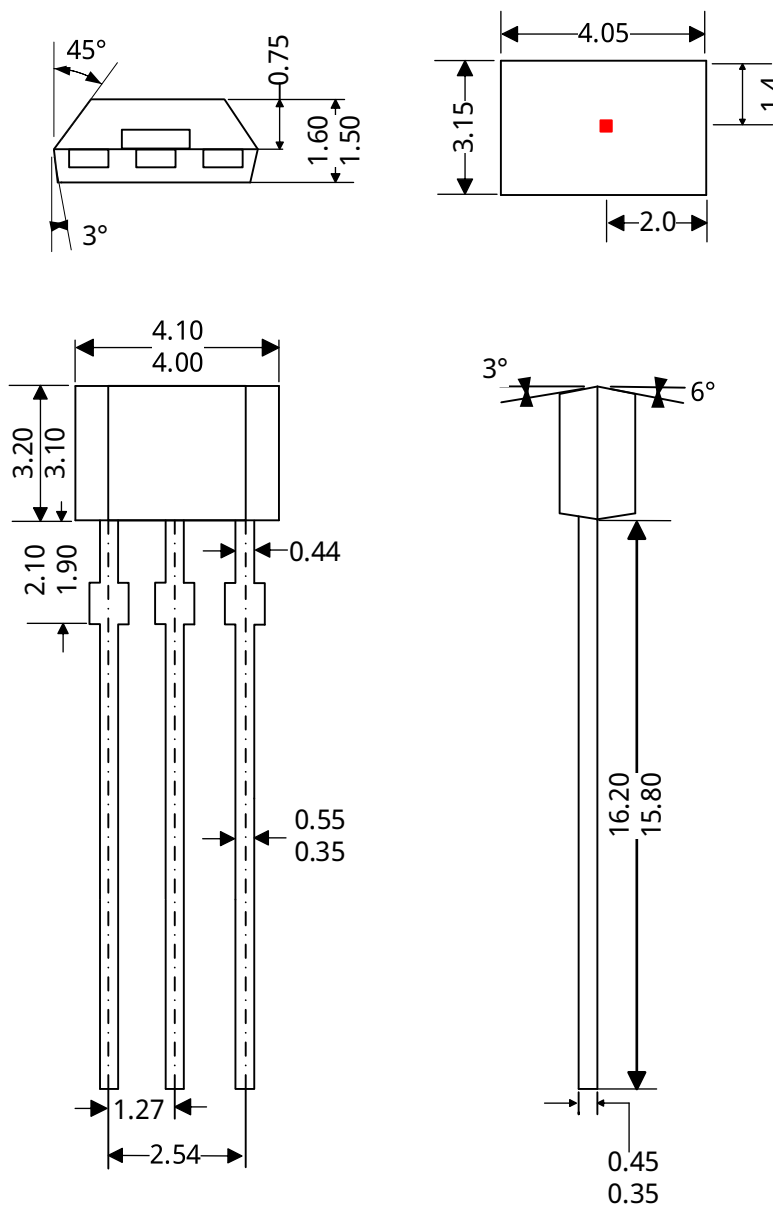
$$C_L < \frac{1}{2\pi \times R_L \times 2 \times f_{BW}(Hz)}$$

V<sub>PULL</sub> is not restricted to V<sub>DD</sub> and could be connected to other voltage power supply. The allowable voltage range of this terminal is specified in the Absolute Maximum Ratings.

## 14. Package Information “UA”

3-Terminal  
S3 Package

Unit:mm



**Notes:**

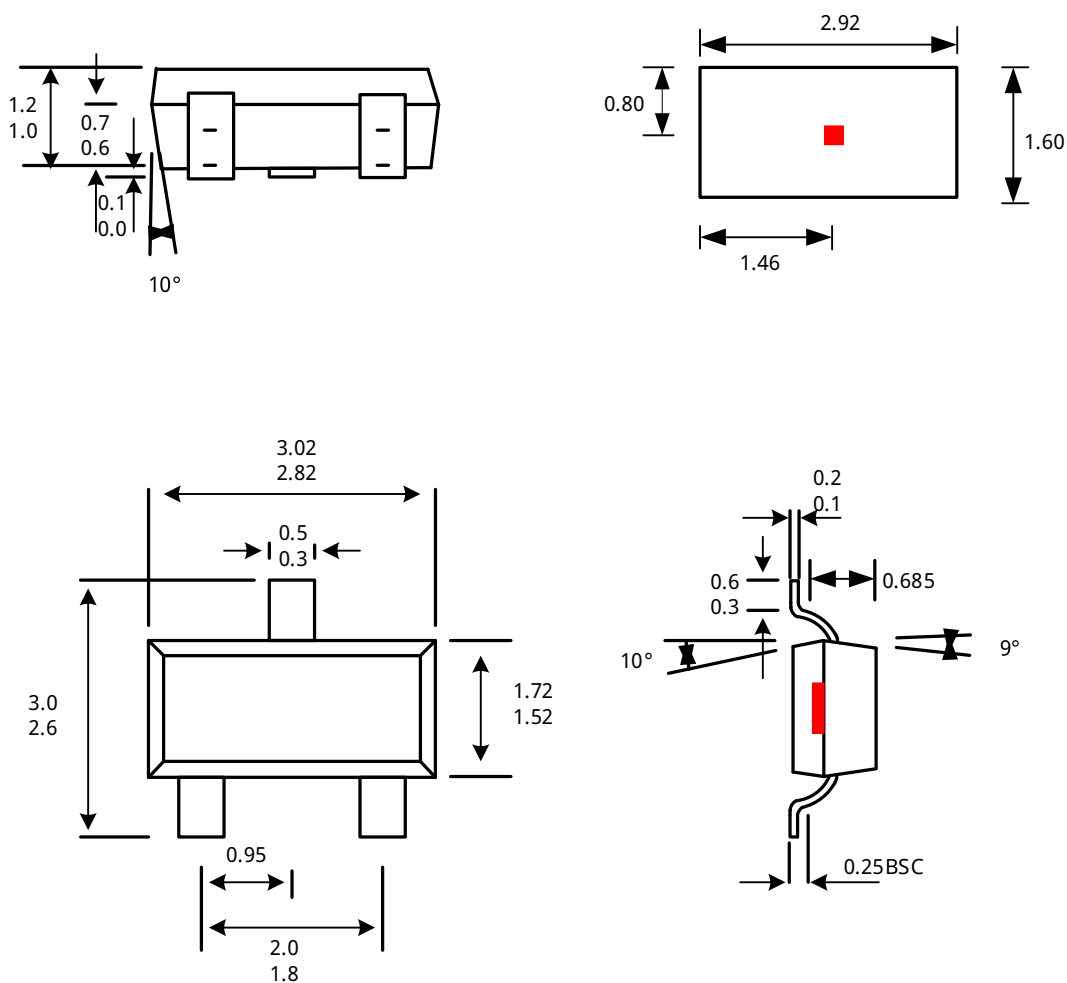
1. Exact body and lead configuration at vendor's option within limits shown.
2. Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.

## 15. Package Information "SO"

3-Terminal  
SO Package

Unit:mm



**Notes:**

1. Exact body and lead configuration at vendor's option within limits shown.
2. Height does not include mold gate flash.
3. The red mark is Hall element.

Where no tolerance is specified, dimension is nominal.

## 16. Revision History

| Revision | Date       | Description                   |
|----------|------------|-------------------------------|
| Rev.E0.1 | 2024-05-02 | Preliminary datasheet         |
| Rev.A1.0 | 2024-10-26 | Uniform specification release |