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## Programmable Digital-Unipolar Hall Effect Sensor

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### FEATURES

- Programmable Unipolar Hall sensor
- High chopping frequency
- Supports a wide voltage range
  - 2.5 to 24V
  - Operation from unregulated supply
- Wide operating temperature range
- Factory-programmed at end-of-line for optimum
- Reverse battery protection (up to 28V)
- Over-voltage protection at all pins
- Robust EMC performance
- Solid-state reliability
- Small package
  - 3-pin SIP -(UA)
  - 3-pin SOT23 -(SO)

### APPLICATIONS

- Flow meters
- Valve and solenoid status
- BLDC motors with sensors
- Proximity sensing
- Tachometers

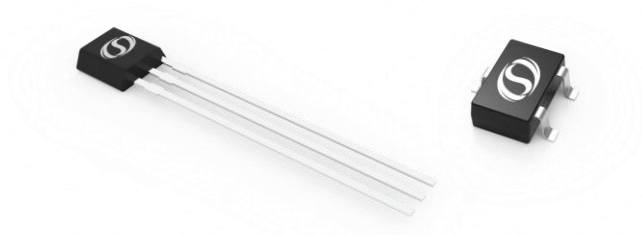
### DESCRIPTION

The SC243X family, produced with Bi-CMOS technology, is a chopper-stabilized Hall Effect Sensor that offers a magnetic sensing solution with superior sensitivity stability over temperature 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 on a single silicon chip a voltage regulator, Hall-voltage generator, small-signal amplifier, chopper stabilization, Schmitt trigger, and an open-drain output to sink up to 20mA.

An onboard regulator permits with supply voltages of 2.5 to 24V which makes the device suitable for a wide range of industrial and automotive applications

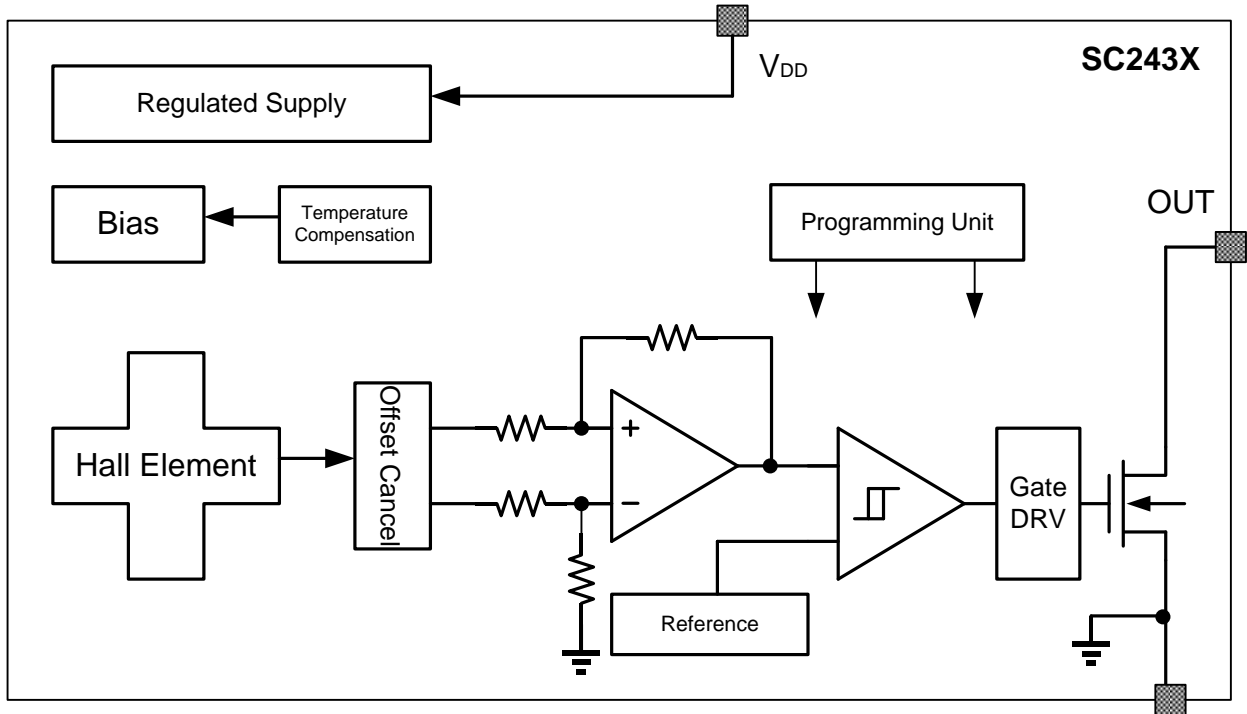
The device is available in a 3-pin SIP package (UA) and a 3-pin SOT-23 style package (SO). Both are lead (Pb) free, with 100% matte tin lead frame plating.



## CONTENTS

|  |     |  |      |
|--|-----|--|------|
| <b>FEATURES</b> .....                  | 1 - | Magnetic Characteristics.....              | 8 -  |
| <b>APPLICATIONS</b> .....              | 1 - | <b>TYPICAL CHARACTERISTICS</b> .....       | 9 -  |
| <b>DESCRIPTION</b> .....               | 1 - | <b>FUNCTION DESCRIPTION OVERVIEW</b> ..... | 10 - |
| <b>BLOCK DIAGRAM</b> .....             | 3 - | Field Direction Definition .....           | 10 - |
| <b>ORDERING INFORMATION</b> .....      | 4 - | Transfer Function.....                     | 11 - |
| <b>TERMINAL CONFIGURATION</b> .....    | 4 - | <b>TYPICAL APPLICATION</b> .....           | 12 - |
| <b>ABSOLUTE MAXIMUM RATINGS</b> .....  | 6 - | <b>PACKAGE INFORMATION“ UA”</b> .....      | 13 - |
| <b>ESD PROTECTION</b> .....            | 6 - | <b>PACKAGE INFORMATION“ SO”</b> .....      | 14 - |
| <b>THERMAL CHARACTERISTICS</b> .....   | 6 - | <b>REVISION HISTORY</b> .....              | 15 - |
| <b>OPERATING CHARACTERISTICS</b> ..... | 7 - |  |      |
| Electrical Characteristics.....        | 7 - |  |      |

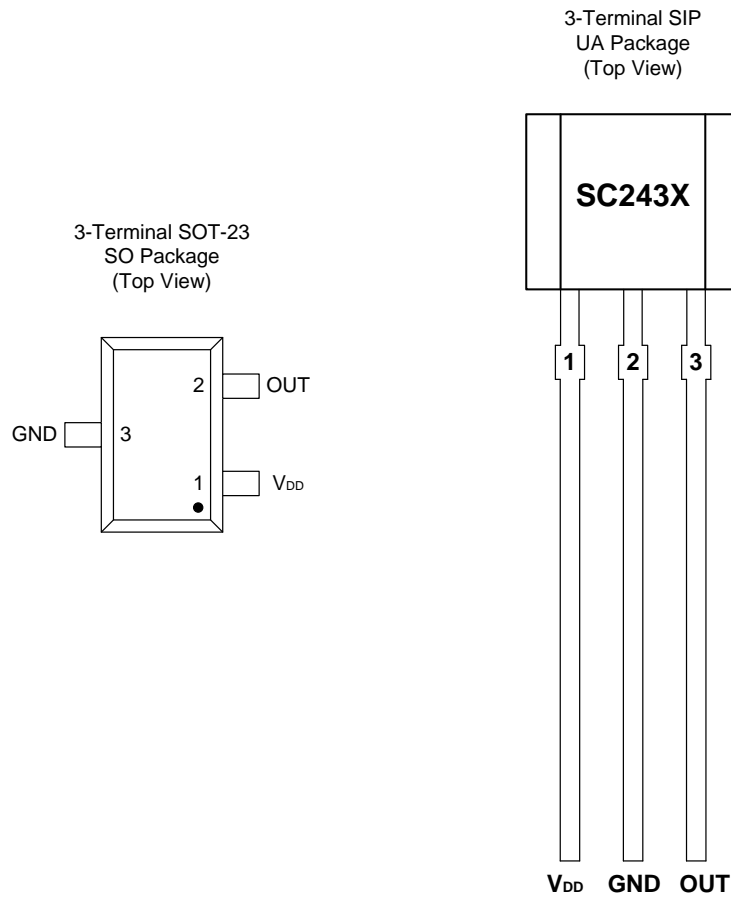
## BLOCK DIAGRAM



## ORDERING INFORMATION

| Part Number | Packing               | Mounting  | Ambient, T <sub>A</sub> | B <sub>OP</sub> (Typ.) | B <sub>RP</sub> (Typ.) |
|-------------|-----------------------|-----------|-------------------------|------------------------|------------------------|
| SC2430UA    | Bulk, 1000 pieces/bag | 3-pin SIP | -40°C ~ 150°C           | +2.0mT                 | +1.5mT                 |
| SC2430SO-N  | Reel, 3000pieces/reel | SOT23     |                         | -2.0mT                 | -1.5mT                 |
| SC2432UA    | Bulk, 1000 pieces/bag | 3-pin SIP | -40°C ~150°C            | +2.5mT                 | +2.0mT                 |
| SC2432SO    | Reel, 3000pieces/reel | SOT23     |                         | +2.5mT                 | +2.0mT                 |
| SC2432SO-N  | Reel, 3000pieces/reel | SOT23     |                         | -2.5mT                 | -2.0mT                 |
| SC2434UA    | Bulk, 1000 pieces/bag | 3-pin SIP | -40°C ~ 150°C           | +7.0mT                 | +5.5mT                 |
| SC2434SO    | Reel, 3000pieces/reel | SOT23     |                         | +7.0mT                 | +5.5mT                 |
| SC2434SO-N  | Reel, 3000pieces/reel | SOT23     |                         | -7.0mT                 | -5.5mT                 |
| SC2436UA    | Bulk, 1000 pieces/bag | 3-pin SIP | -40°C ~ 150°C           | +10.0mT                | +8.5mT                 |
| SC2436SO    | Reel, 3000pieces/reel | SOT23     |                         | +10.0mT                | +8.5mT                 |
| SC2438UA    | Bulk, 1000 pieces/bag | 3-pin SIP | -40°C ~ 150°C           | +12.0mT                | +8.5mT                 |
| SC2438SO    | Reel, 3000pieces/reel | SOT23     |                         | +12.0mT                | +8.5mT                 |

## TERMINAL CONFIGURATION



| Name            | Terminal |    | Type   | Description   |
|-----------------|----------|----|--------|---|
|                 | UA       | SO |        |   |
| V <sub>DD</sub> | 1        | 1  | PWR    | 2.5V~24 V power supply  |
| GND             | 2        | 3  | Ground | Ground terminal   |
| OUT             | 3        | 2  | Output | Open-drain output. The open drain requires a pull-up resistor |

## ABSOLUTE MAXIMUM RATINGS

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

| Parameter                     | Symbol            | Min.               | Max. | Units |
|-------------------------------|-------------------|--------------------|------|-------|
| Power supply voltage          | V <sub>DD</sub>   | -28 <sup>(2)</sup> | 28   | V     |
| Output terminal voltage       | V <sub>OUT</sub>  | -0.5               | 28   | V     |
| Output terminal current sink  | I <sub>SINK</sub> | 0                  | 30   | mA    |
| Operating ambient temperature | T <sub>A</sub>    | -40                | 150  | °C    |
| Maximum junction temperature  | T <sub>J</sub>    | -55                | 165  | °C    |
| Storage temperature           | T <sub>STG</sub>  | -65                | 175  | °C    |

<sup>(1)</sup> 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.

<sup>(2)</sup> Ensured by design.

## ESD PROTECTION

Human Body Model (HBM) tests according to: standard AEC-Q100-002 HBM

| Parameter      | Symbol           | Min. | Max. | Units |
|----------------|------------------|------|------|-------|
| ESD-Protection | V <sub>ESD</sub> | -4   | 4    | kV    |

## 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 | 166    | °C/W  |
| R <sub>θJA</sub> | SO Package thermal resistance | Single-layer PCB, with copper limited to solder pads | 228    | °C/W  |

## OPERATING CHARACTERISTICS

### Electrical Characteristics

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

| Symbol         | Parameter                        | Test Conditions                                   | Min. | Typ. | Max. | Units    |
|----------------|----------------------------------|---|------|------|------|----------|
| $V_{DD}$       | Operating voltage <sup>(1)</sup> | $T_J < T_{J(Max.)}$                               | 2.5  | --   | 24   | V        |
| $V_{DDR}$      | Reverse supply voltage           |   | -28  | --   | --   | V        |
| $I_{DD (off)}$ | Operating supply current         | $V_{DD}=2.5$ to 24 V, $T_A=25^\circ C$            | --   | 1.6  | 2.5  | mA       |
| $I_{DD (on)}$  |                                  | $V_{DD}=2.5$ to 24 V, $T_A=25^\circ C$            | --   | 1.6  | 2.5  | mA       |
| $t_{on}$       | Power-on time                    |   | --   | 35   | 50   | $\mu S$  |
| $I_{QL}$       | Off-state leakage current        | Output Hi-Z                                       | --   | --   | 1    | $\mu A$  |
| $R_{DS(on)}$   | FET on-resistance                | $V_{DD}=5.0V$ , $I_o=10mA$ ,<br>$T_A=25^\circ C$  | --   | 20   | --   | $\Omega$ |
|                |                                  | $V_{DD}=5.0V$ , $I_o=10mA$ ,<br>$T_A=125^\circ C$ | --   | 30   | --   | $\Omega$ |
| $t_d$          | Output delay time                | $B=B_{RP}$ to $B_{OP}$                            | --   | 15   | 25   | $\mu S$  |
| $t_r$          | Output rise time (10% to 90%)    | $R1=1Kohm$ $C_o=50pF$                             | --   | --   | 0.5  | $\mu S$  |
| $t_f$          | Output fall time (90% to 10%)    | $R1=1Kohm$ $C_o=50pF$                             | --   | --   | 0.2  | $\mu S$  |

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

## Magnetic Characteristics

| Symbol                 | Parameter       | Test Conditions        | Min. | Typ. | Max. | Units |
|------------------------|-----------------|------------------------|------|------|------|-------|
| $f_{BW}$               | BW              |                        | 20   | --   | --   | KHz   |
| SC2430 +2.0 / +1.5 mT  |                 |                        |      |      |      |       |
| $B_{OP}$               | Operating point | $T_A=25^\circ\text{C}$ | 1.0  | 2.0  | 3.0  | mT    |
| $B_{RP}$               | Release point   |                        | 0.5  | 1.5  | 2.5  | mT    |
| $B_{HYS}$              | Hysteresis      |                        | --   | 0.5  | --   | mT    |
| SC2432 +2.5 / +2.0 mT  |                 |                        |      |      |      |       |
| $B_{OP}$               | Operating point | $T_A=25^\circ\text{C}$ | 1.5  | 2.5  | 3.5  | mT    |
| $B_{RP}$               | Release point   |                        | 1.0  | 2.0  | 3.0  | mT    |
| $B_{HYS}$              | Hysteresis      |                        | --   | 0.5  | --   | mT    |
| SC2432 +7.0 / +5.5 mT  |                 |                        |      |      |      |       |
| $B_{OP}$               | Operating point | $T_A=25^\circ\text{C}$ | 6.0  | 7.0  | 8.0  | mT    |
| $B_{RP}$               | Release point   |                        | 4.5  | 5.5  | 6.5  | mT    |
| $B_{HYS}$              | Hysteresis      |                        | --   | 1.5  | --   | mT    |
| SC2436 +10.0 / +8.5 mT |                 |                        |      |      |      |       |
| $B_{OP}$               | Operating point | $T_A=25^\circ\text{C}$ | 9.0  | 10.0 | 11.0 | mT    |
| $B_{RP}$               | Release point   |                        | 7.5  | 8.5  | 9.5  | mT    |
| $B_{HYS}$              | Hysteresis      |                        | --   | 1.5  | --   | mT    |
| SC2438 +12.0 / +9.5 mT |                 |                        |      |      |      |       |
| $B_{OP}$               | Operating point | $T_A=25^\circ\text{C}$ | 10.0 | 12.0 | 14.0 | mT    |
| $B_{RP}$               | Release point   |                        | 7.5  | 9.5  | 11.5 | mT    |
| $B_{HYS}$              | Hysteresis      |                        | --   | 2.5  | --   | mT    |

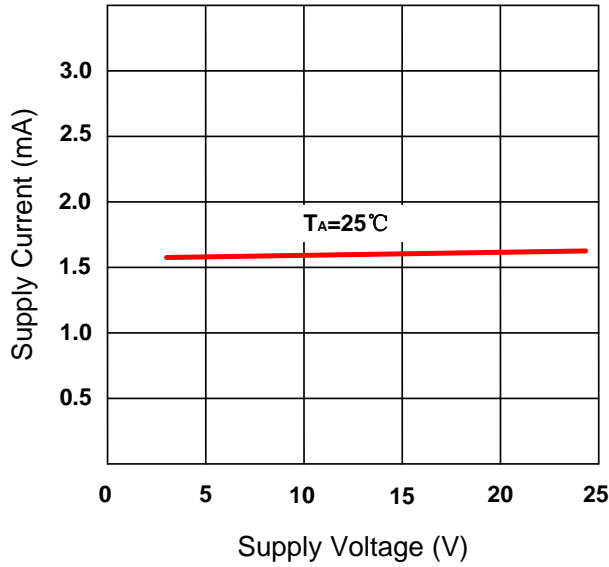
1mT=10Gs

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.

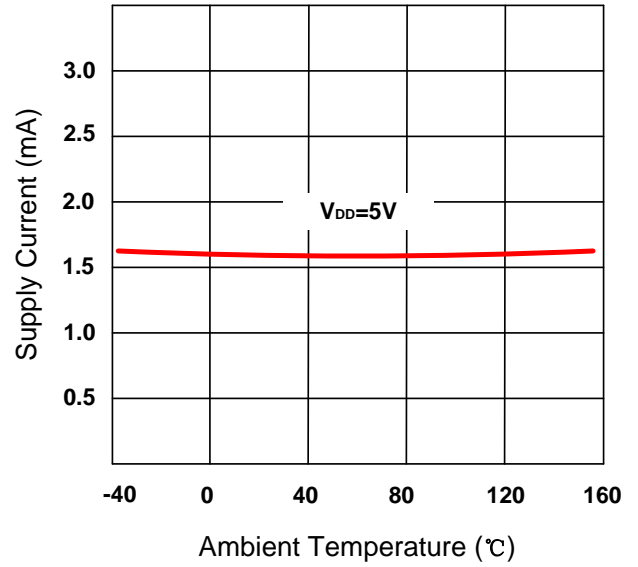


## TYPICAL CHARACTERISTICS

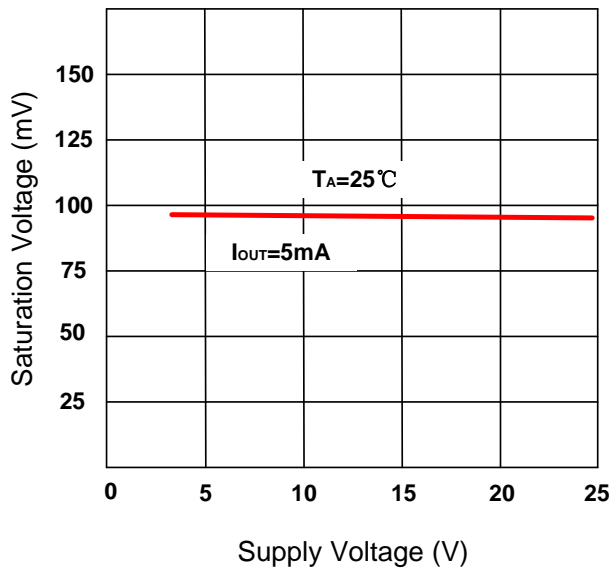
**I<sub>DD</sub> VS V<sub>DD</sub>**



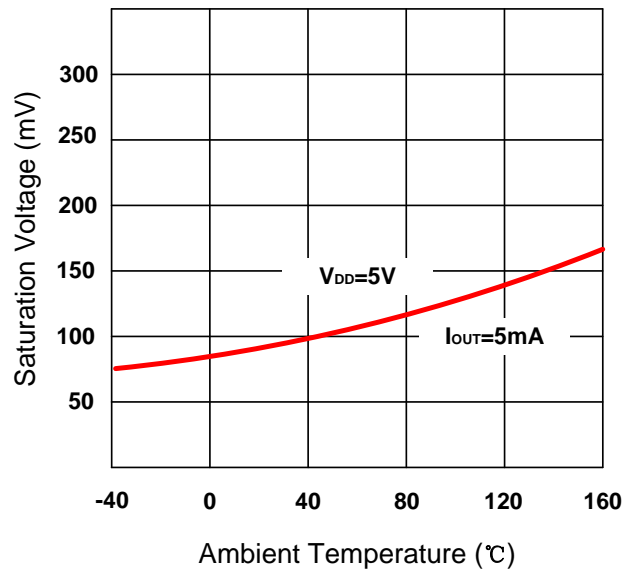
**I<sub>DD</sub> VS T<sub>A</sub>**



**V<sub>Q(sat)</sub> VS V<sub>DD</sub>**



**V<sub>Q(sat)</sub> VS T<sub>A</sub>**



## FUNCTION DESCRIPTION OVERVIEW

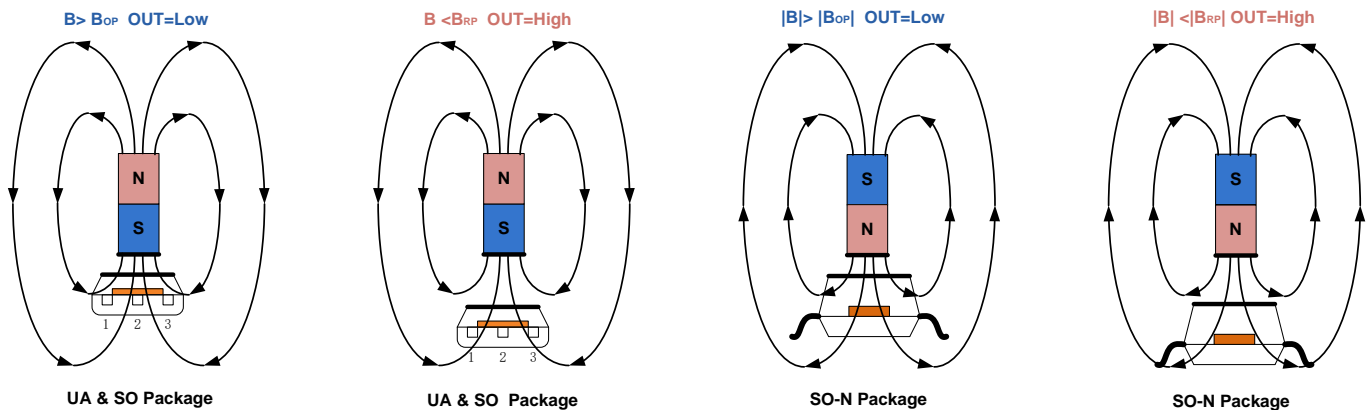
The SC243X device is a chopper-stabilized Hall sensor with a digital latched output for magnetic sensing applications. The device can be powered with a supply voltage between 2.5 and 24V, and continuously survives continuous -28V reverse-battery conditions. The device does not operate when -28 to 2.2V is applied to the VDD terminal (with respect to the GND terminal). In addition, the device can withstand voltages up to 40V for transient durations.

The output of SC243X switches low (turns on) when a magnetic field (South polarity) perpendicular to the Hall element exceeds the operate point threshold,  $B_{OP}$ . After turn-on, the output is capable of sinking 20mA and the output voltage is  $V_{Q(sat)}$ . When the magnetic field is reduced below 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.

An external output pull-up resistor is required on the OUT terminal. The OUT terminal can be pulled up to  $V_{DD}$  or to a different voltage supply. This allows for easier interfacing with controller circuits.

## Field Direction Definition

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



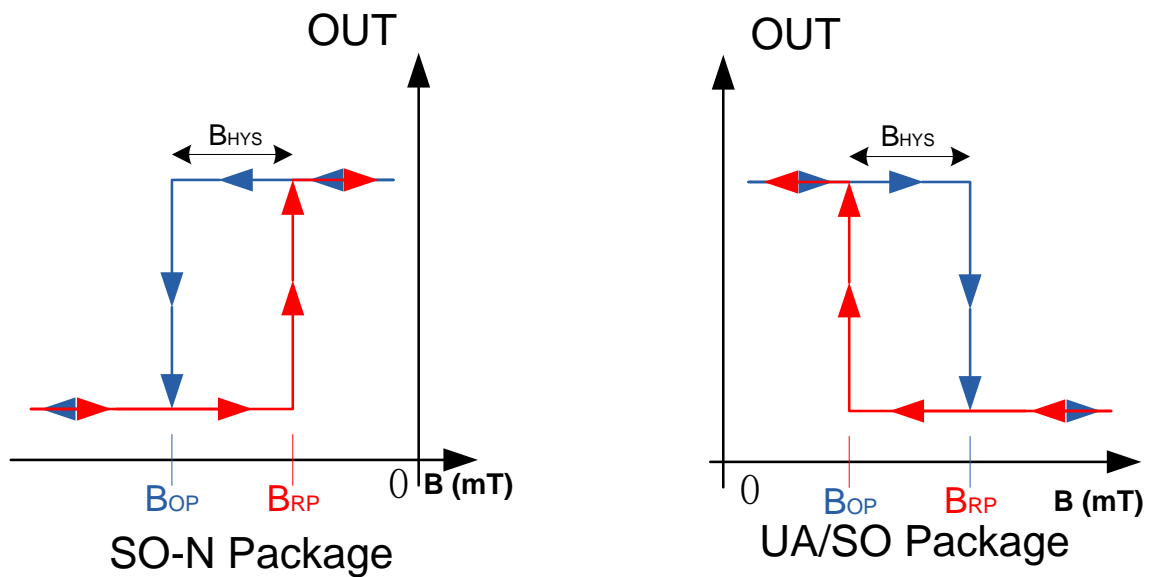
## Transfer Function

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.

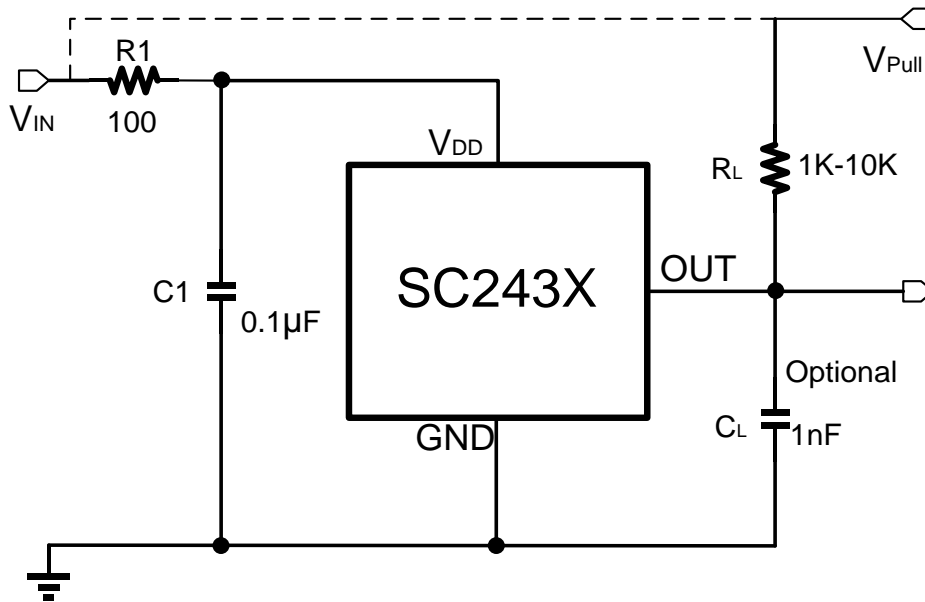
$B_{OP}$ —magnetic threshold for activation of the device output, turning in ON (low) state

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

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



## TYPICAL APPLICATION



The SC243X contains an on-chip voltage regulator and can operate over a wide supply voltage range. In applications that operate the device from an unregulated power supply, transient protection must be added externally. For applications using a regulated line, EMI/RFI protection may still be required. It is recommended to shunt C1 capacitors to the ground near the chip V<sub>DD</sub> power supply, with a typical value of 0.1 μF. At the same time in the external optional series resistor R1 their typical values for 100 Ω. The output capacitor C<sub>L</sub> is used as the output filter, typically 1 nF.

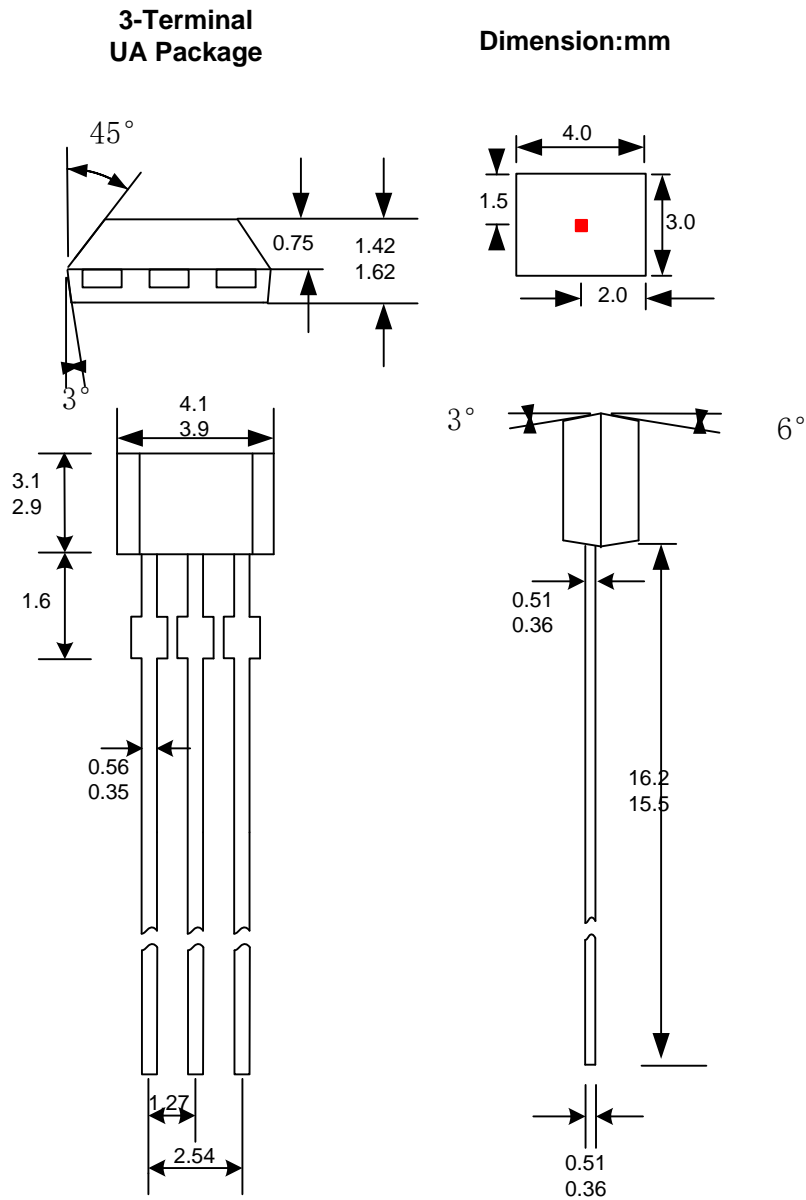
Select a value for C<sub>L</sub> based on the system bandwidth specifications as:

$$C_L = \frac{1}{2\pi \times R \times f \text{ (Hz)}}$$

The output stage of the SC243X device is a drain open-circuit NMOS tube, which provides a load capacity of 20mA. Adjust the pull-up resistor R<sub>L</sub> to make it work properly. The R<sub>L</sub> provides a high level for the leak-opening output. In general, less current is better, but faster transient response and bandwidth are required, with a smaller resistor R<sub>L</sub> for faster switching.

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

## PACKAGE INFORMATION “UA”



**Notes:**

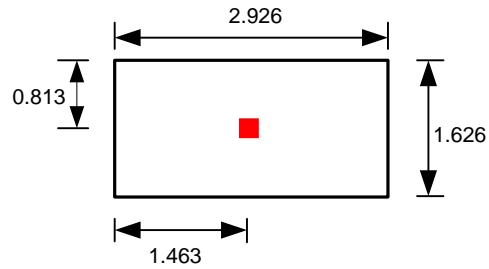
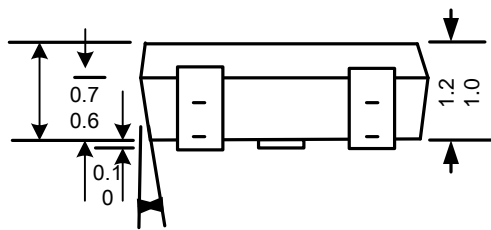
1. Exact body and lead configuration at vendor's option within limits shown.
2. Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.

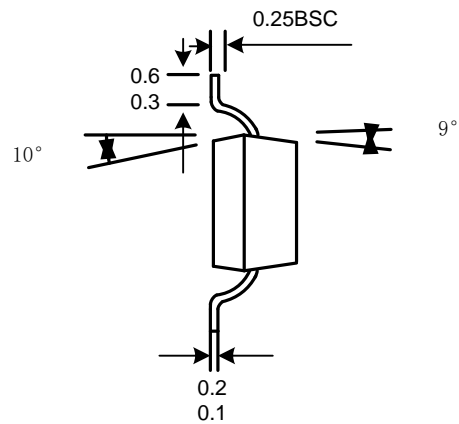
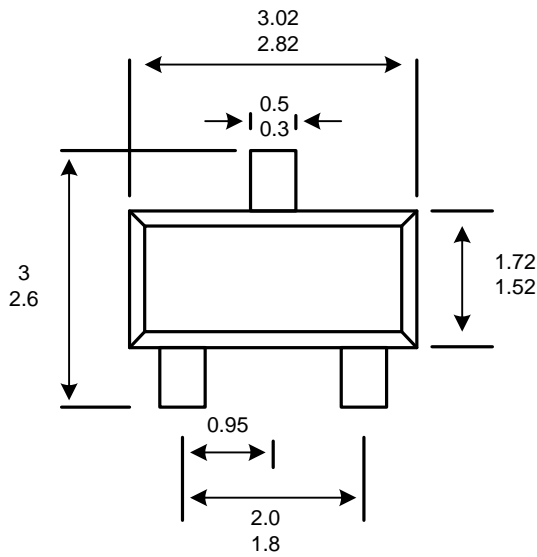
## PACKAGE INFORMATION “SO”

**3-Terminal  
SO Package**

**Dimension:mm**



10°



**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.

## REVISION HISTORY

| <b>Revision</b> | <b>Date</b> | <b>Description</b>                  |
|-----------------|-------------|-------------------------------------|
| Rev1.0          | 2016-05-10  | Preliminary datasheet               |
| Rev1.1          | 2017-08-06  | Add order information of SC2438SO   |
| Rev2.3          | 2019-05-06  | The final revision of old datasheet |
| RevA/1.0        | 2021-01-04  | Unified datasheet format            |