

## High Performance Omnipolar Hall-effect Sensor

### 1. Features

- AEC-Q100 Certification
- Digital Omni-polar Hall-Effect sensor
- High chopping frequency
- Very high sensitivity
- Superior temperature stability
- Supply operating range:
  - 2.5-24.0V
  - Operating from unregulated supply
- Reverse battery protection (up to 28V)
- Over-voltage protection at all pins
- Robust EMC performance
- Solid-state reliability
- Small package:
  - TO-92S (UA)
  - SOT23-3L (SO)

### 2. Applications

- Sun visor position sensor
- Flow meters
- Proximity sensing
- Garage door openers sensor
- Power sliding doors sensor

### 3. Description

The SC246X family, produced with BiCMOS 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 SC246X is available in a TO-92S (UA) and a SOT23-3L (SO) packages. Both packages are lead (Pb) free, with 100% matte tin lead frame plating.



Fig.1: Package Outline

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4. Terminal Configuration

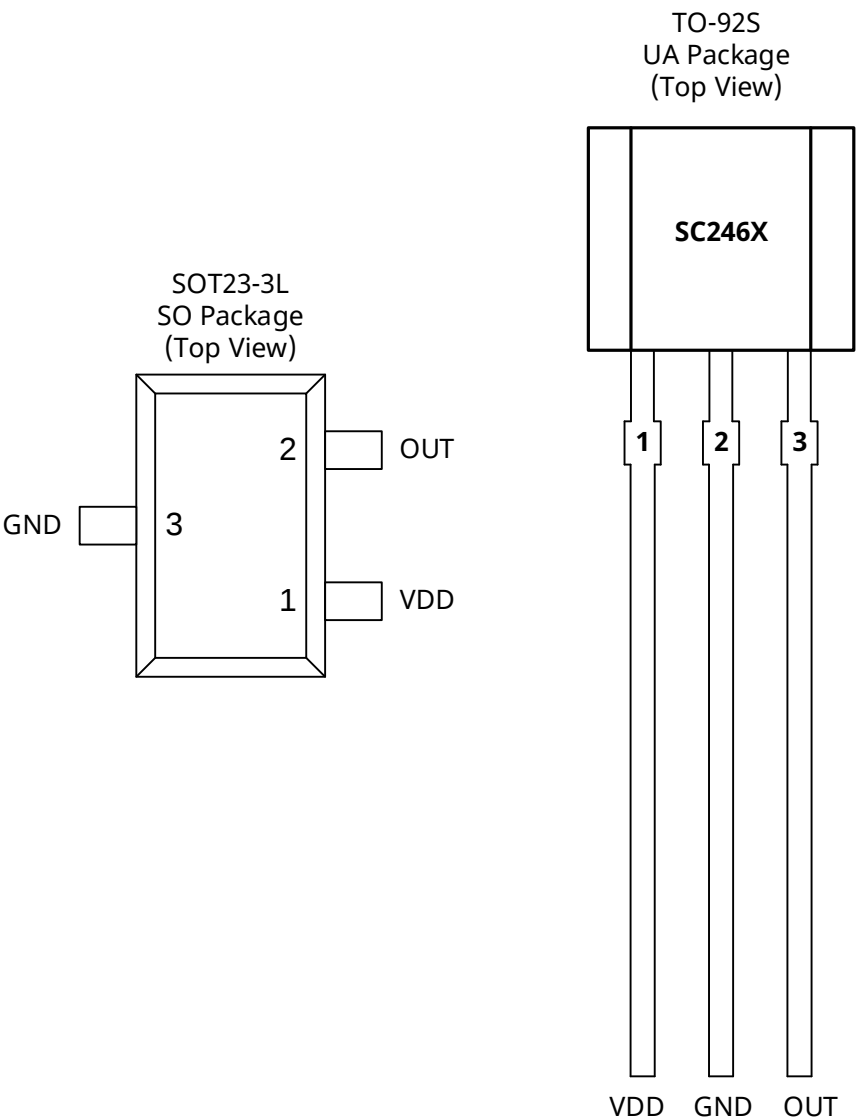


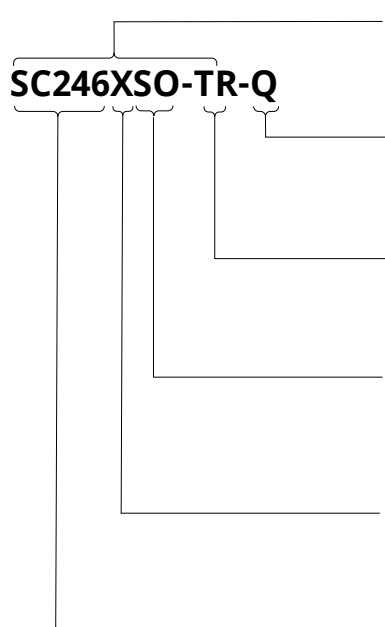
Fig.2: Pin Description

| Terminal |    |    | Type   | Description                                   |
|----------|----|----|--------|-----------------------------------------------|
| Name     | UA | SO |        |                                               |
| VDD      | 1  | 1  | PWR    | 2.5V ~ 24V power supply                       |
| GND      | 2  | 3  | Ground | Ground                                        |
| OUT      | 3  | 2  | Output | Open-drain output required a pull-up resistor |

## 5. Ordering Information

| Order Information | Mark | Class | B <sub>OP</sub> (Gs) | B <sub>RP</sub> (Gs) | Ambient, T <sub>A</sub> (°C) | Package  | Packing | Quantity  |
|-------------------|------|-------|----------------------|----------------------|------------------------------|----------|---------|-----------|
| SC2462SO-TR       | 2462 |       | ±25                  | ±15                  | -40~150                      | SOT23-3L | TR      | 3000/reel |
| SC2462SO-TR-Q     | 2462 | Q     | ±25                  | ±15                  | -40~150                      | SOT23-3L | TR      | 3000/reel |
| SC2462UA-BK       | 2462 |       | ±25                  | ±15                  | -40~150                      | TO-92S   | BK      | 1000/bag  |
| SC2464SO-TR       | 2464 |       | ±60                  | ±50                  | -40~150                      | SOT23-3L | TR      | 3000/reel |
| SC2464UA-BK       | 2464 |       | ±60                  | ±50                  | -40~150                      | TO-92S   | BK      | 1000/bag  |
| SC2466SO-TR       | 2466 |       | ±165                 | ±135                 | -40~150                      | SOT23-3L | TR      | 3000/reel |

### Ordering Information Format



#### Part Number

#### Product Grade

Q: Automotive Product

#### Packing Designation

TR: Tape & Reel

BK: Bulk

#### Package Designation

SO: SOT23-3L

UA: TO-92S

#### Magnetic Parameter

2: B<sub>OP</sub>: ±25Gs, B<sub>RP</sub>: ±15Gs

4: B<sub>OP</sub>: ±60Gs, B<sub>RP</sub>: ±50Gs

6: B<sub>OP</sub>: ±160Gs, B<sub>RP</sub>: ±135Gs

#### Device Family

SC246X: Omnipolar Hall Effect Sensor

## 6. Absolute Maximum Ratings

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

| Symbol            | Parameter                     | Test conditions                   | Min. | Max. | Units |
|-------------------|-------------------------------|-----------------------------------|------|------|-------|
| V <sub>DD</sub>   | Power supply voltage          |                                   | -28  | 28   | V     |
| V <sub>OUT</sub>  | Output terminal voltage       | For 5 Min. @1.0K pull-up resistor | -0.5 | 28   | V     |
| I <sub>SINK</sub> | Output terminal current sink  |                                   | -    | 30   | mA    |
| T <sub>A</sub>    | Operating ambient temperature |                                   | -40  | 150  | °C    |
| T <sub>J</sub>    | 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 conditions                                       | Min. | Max. | Units |
|----------------------|-----------|-------------------------------------------------------|------|------|-------|
| V <sub>ESD_HBM</sub> | HBM       | Refer to AEC-Q100-002E HBM standard, R=1.5kΩ, C=100pF | -4   | 4    | kV    |
| V <sub>ESD_CDM</sub> | CDM       | Refer to AEC-Q100-011C CDM standard                   | -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 | 166 <sup>(1)</sup> | °C/W  |
|                  | SO Package thermal resistance | Single-layer PCB, with copper limited to solder pads | 228 <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 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  | 5.0  | 24   | V        |
| $V_{DDR}$     | Reverse supply voltage           |                                              | -28  | -    | -    | V        |
| $I_{DD(off)}$ | Operating supply current         | $V_{DD}=2.5$ to $24$ V, $T_A=25^\circ C$     | 1.1  | 1.8  | 2.6  | mA       |
| $I_{DD(on)}$  | Operating supply current         | $V_{DD}=2.5$ to $24$ V, $T_A=25^\circ C$     | 1.1  | 2.1  | 2.6  | mA       |
| $t_{on}$      | Power-on time                    | $V_{DD} \geq 5.0V$                           | -    | 35   | 50   | $\mu s$  |
| $I_{QL}$      | Off-state leakage current        | Output Hi-Z                                  | -    | -    | 1    | $\mu A$  |
| $R_{DS(on)}$  | FET on-resistance                | $V_{DD}=5V$ , $I_O=10mA$ , $T_A=25^\circ C$  | -    | 20   | -    | $\Omega$ |
|               |                                  | $V_{DD}=5V$ , $I_O=10mA$ , $T_A=125^\circ C$ |      | 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%)    | $R1=1Kohm$ , $Co=50pF$                       | -    | -    | 0.5  | $\mu s$  |
| $t_f$         | Output fall time (90% to 10%)    | $R1=1Kohm$ , $Co=50pF$                       | -    | -    | 0.2  | $\mu s$  |

Note:

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

## 9.2. Magnetic Characteristics

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

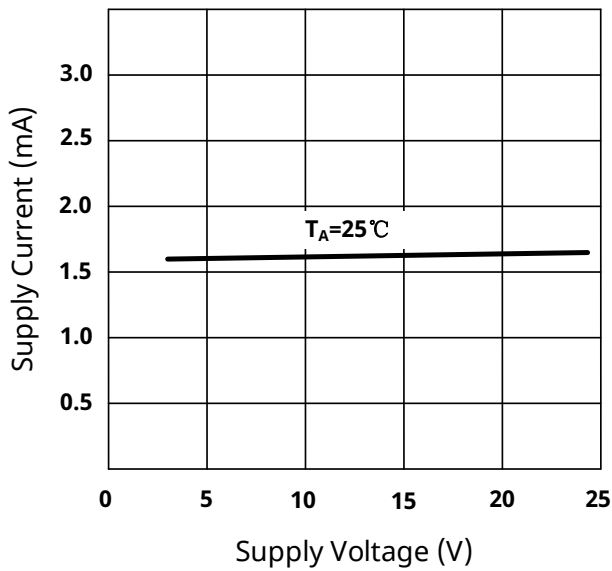
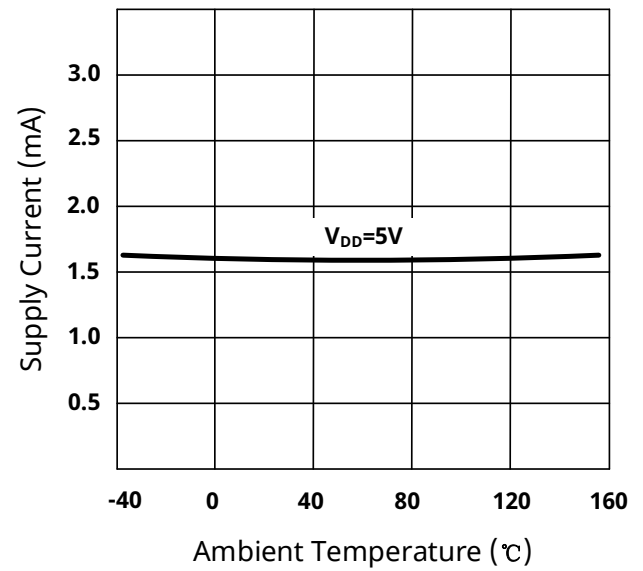
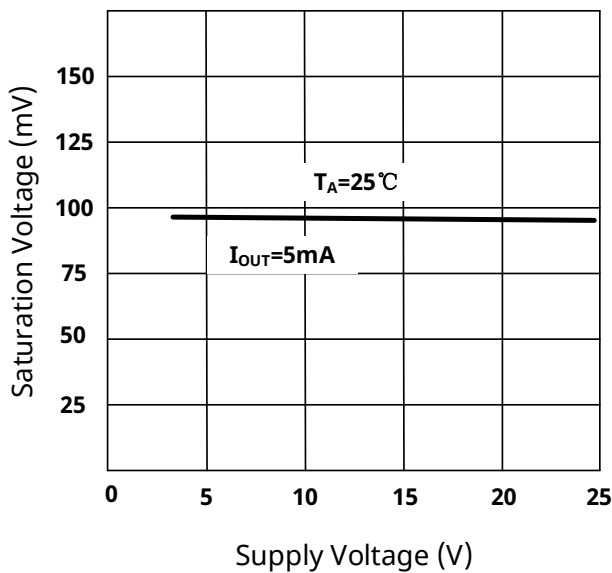
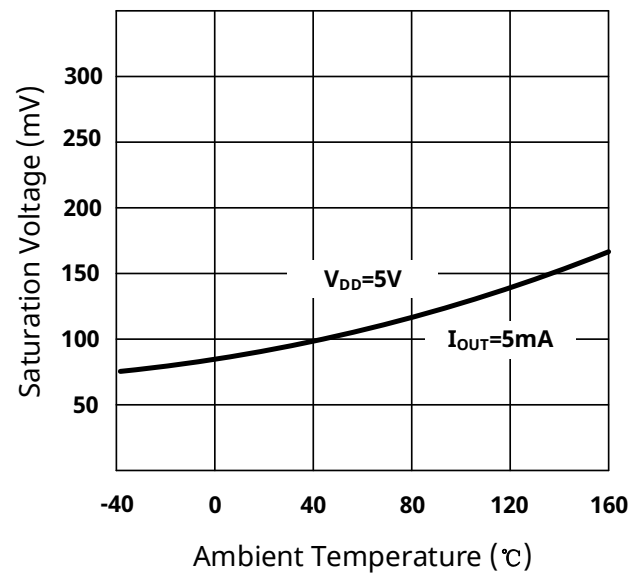
| Symbol           | Parameter       | Test Conditions                | Min.                | Typ.  | Max. | Units             |
|------------------|-----------------|--------------------------------|---------------------|-------|------|-------------------|
| f <sub>BW</sub>  | BW              |                                | 20                  | -     | -    | kHz               |
| SC2462           |                 |                                |                     |       |      |                   |
| B <sub>OP</sub>  | Operating point | T <sub>A</sub> =-40°C to 150°C | ±1.5 <sup>(1)</sup> | ±2.5  | ±3.5 | mT <sup>(2)</sup> |
| B <sub>RP</sub>  | Release point   |                                | ±1.0                | ±1.5  | ±3.0 | mT                |
| B <sub>HYS</sub> | Hysteresis      |                                | -                   | ±1.0  | -    | mT                |
| SC2464           |                 |                                |                     |       |      |                   |
| B <sub>OP</sub>  | Operating point | T <sub>A</sub> =-40°C to 150°C | ±4.5                | ±6.0  | ±7.5 | mT                |
| B <sub>RP</sub>  | Release point   |                                | ±3.5                | ±5.0  | ±6.5 | mT                |
| B <sub>HYS</sub> | Hysteresis      |                                | -                   | ±1.0  | -    | mT                |
| SC2466           |                 |                                |                     |       |      |                   |
| B <sub>OP</sub>  | Operating point | T <sub>A</sub> =-40°C to 150°C | ±14                 | ±16.5 | ±19  | mT                |
| B <sub>RP</sub>  | Release point   |                                | ±11                 | ±13.5 | ±16  | mT                |
| B <sub>HYS</sub> | Hysteresis      |                                | -                   | ±3.0  | -    | mT                |

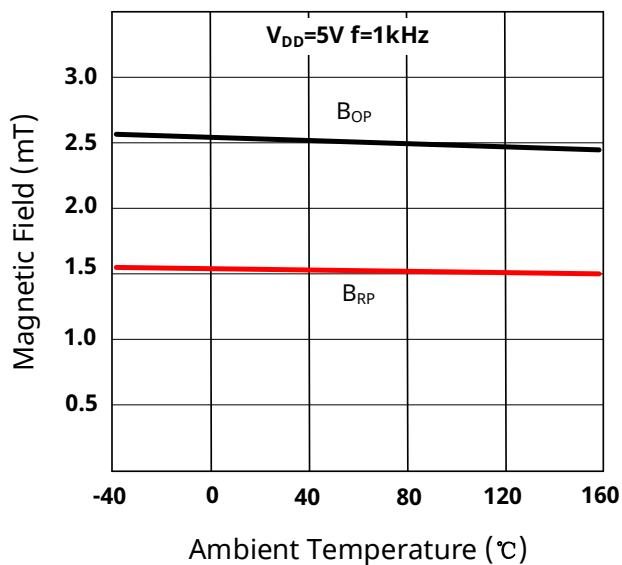
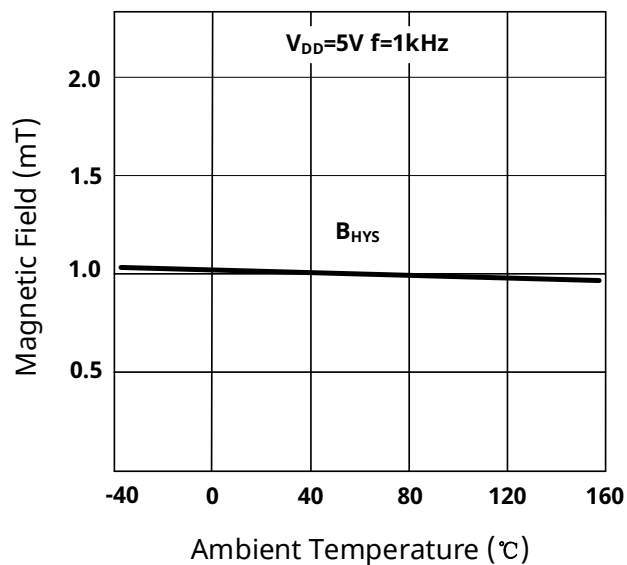
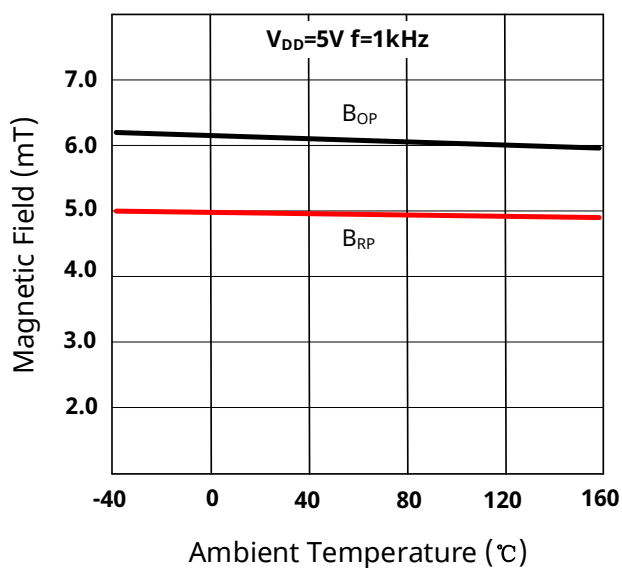
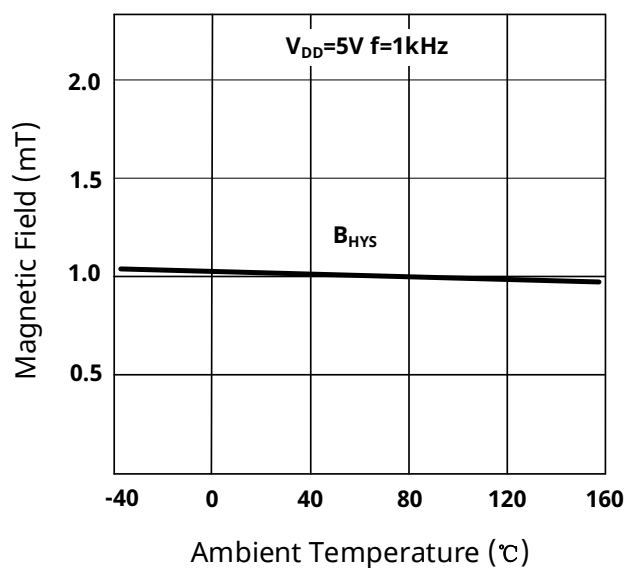
Note:

(1) 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.

(2)  $1mT=10Gs$

## 10. Typical Characteristics

 **$I_{DD}$  vs  $V_{DD}$**  **$I_{DD}$  vs  $T_A$**  **$V_{Q(\text{sat})}$  vs  $V_{DD}$**  **$V_{Q(\text{sat})}$  vs  $T_A$** 

SC2462  $B_{OP}$  and  $B_{RP}$  vs  $T_A$ SC2462  $B_{HYS}$  vs  $T_A$ SC2464  $B_{OP}$  and  $B_{RP}$  vs  $T_A$ SC2464  $B_{HYS}$  vs  $T_A$ 

## 11. Block Diagram

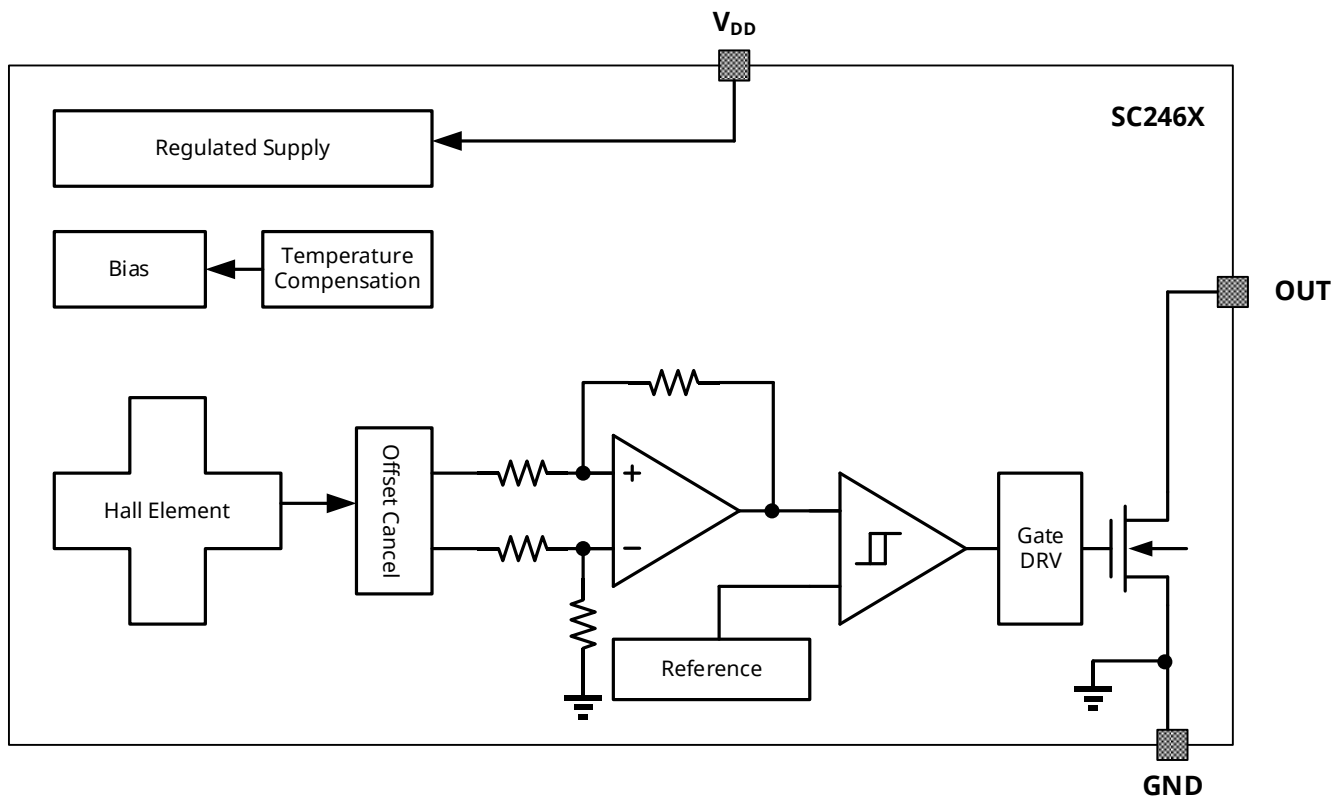


Fig.3: Block Diagram

## 12. Function Description

The SC246X device is a chopper-stabilized Hall sensor with a digital output for magnetic sensing applications. The device can be powered with a supply voltage between 2.5 and 24V, and survives continuous -28V reverse-battery conditions.

The device does not operate when -28 to 2.2V is applied to the  $V_{DD}$  terminal (with respect to the GND terminal).

The output of SC246X switches low (turns on) when a magnetic field (South or North 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.

## 12.1. Field Direction Definition

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

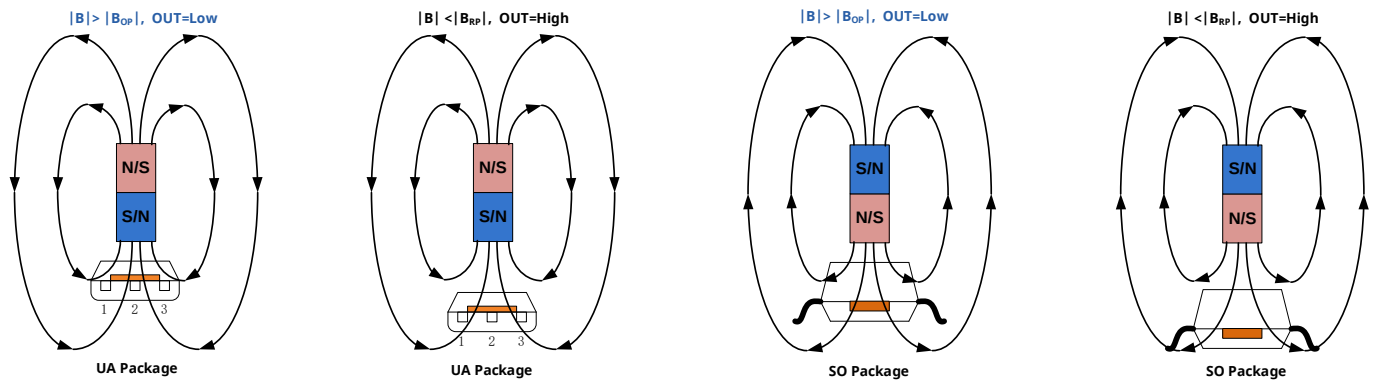


Fig.4: Switch Points versus Magnetic Signal

## 12.2. Transfer Function

The SC246X exhibits “Omni polar” magnetic characteristics. It means the device reacts to both North and South magnetic pole. The purpose is to detect the presence of any magnetic field applied on the device. This mode of operation simplifies customer production processes by avoiding the need to detect the Hall sensor pole active on the magnet used in the application. Therefore, the “Omni polar” magnetic behavior helps customers by removing the need of magnet pole detection system during production phase.

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.

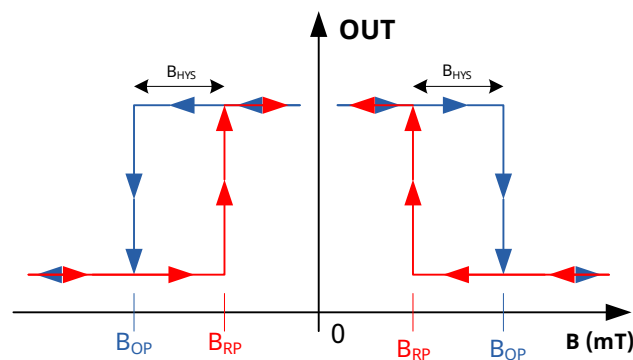


Fig.5: Magnetic Transfer Function

### 13. Typical Application

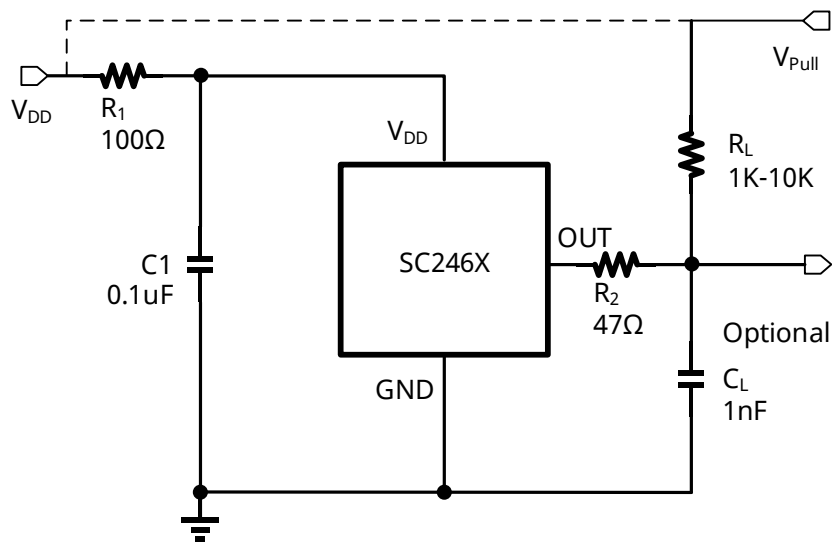


Fig.6: Typical Application Circuit

The SC246X 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 place  $C_1$  capacitors to the ground near the chip  $V_{DD}$  power supply, with a typical value of  $0.1\mu\text{F}$ . At the same time in the external optional series resistor  $R_1$  their typical values for  $100\Omega$ . The output capacitor  $C_L$  is used as the output filter, typically  $1\text{nF}$ .

Select a value for  $C_L$  based on the system bandwidth specifications as:

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

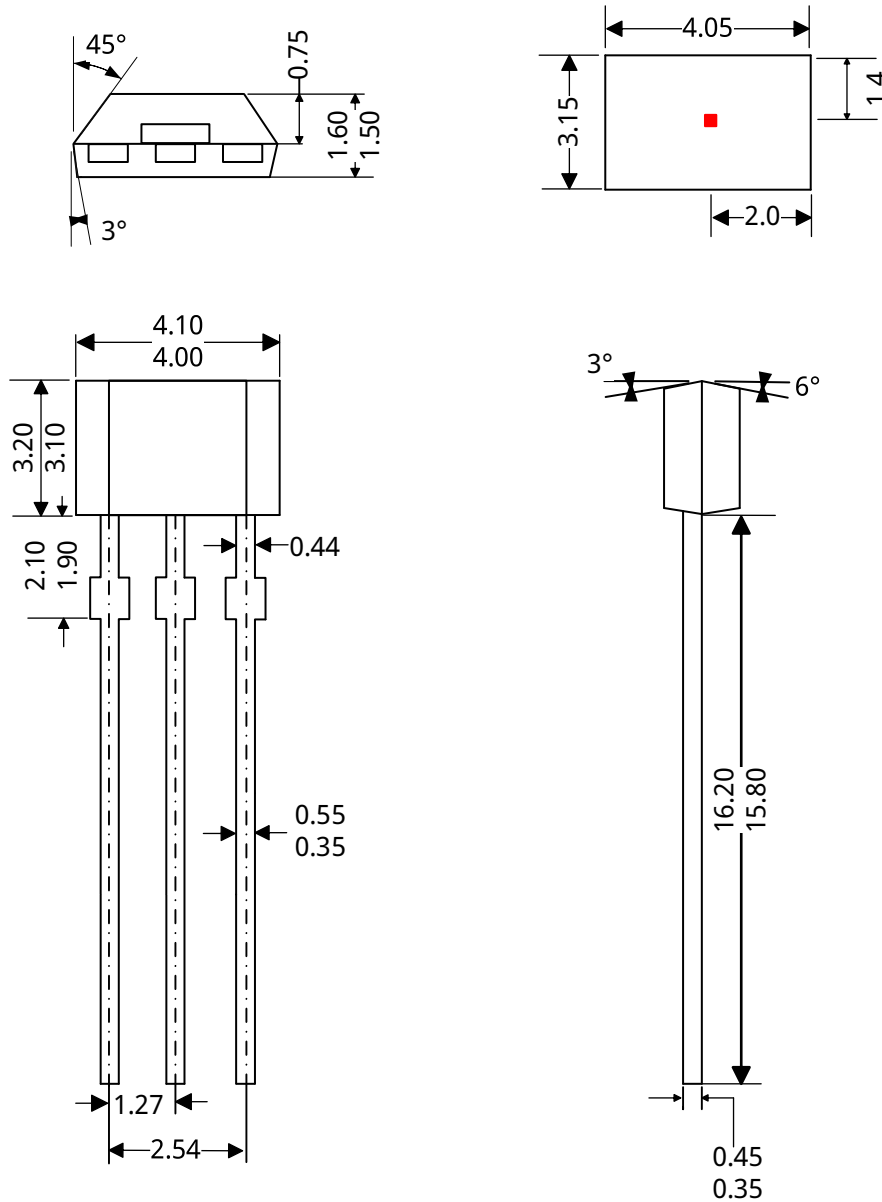
The output stage of the SC246X device is a drain open-circuit NMOS tube, which provides a load capacity of  $20\text{mA}$ . Adjust the pull-up resistor  $R_L$  to make it work properly. The  $R_L$  provides a high level for the leak-opening output. In general, less current is better, but faster transient response and bandwidth are required, with a smaller resistor  $R_L$  for faster switching.

$V_{PULL}$  is not restricted to  $V_{DD}$ , and could be connected to other voltage reference. The allowable voltage range of this terminal is specified in the Absolute Maximum Ratings.

## 14. Package Information “UA”

3-Terminal  
UA Package

Dimension:mm



**Notes:**

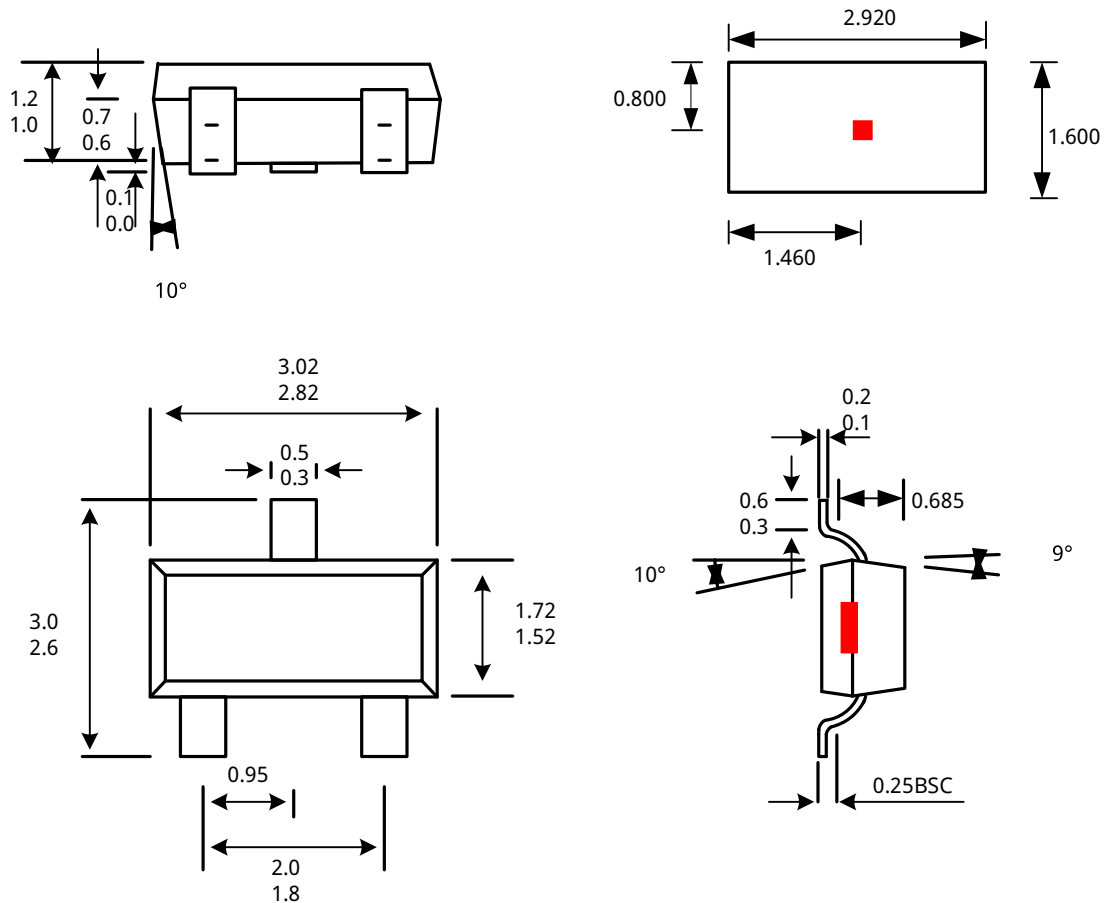
1. Exact body and lead configuration at vendor's option within limits shown.
2. Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.

## 15. Package Information “SO”

**3-Terminal  
SO Package**

**Dimension: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                         |
|-----------|------------|-------------------------------------|
| Rev0.1    | 2016-08-19 | Preliminary datasheet               |
| Rev2.3    | 2018-05-06 | The final revision of old datasheet |
| Rev A.1.0 | 2020-11-19 | Unified datasheet format            |
| Rev A.1.1 | 2024-05-07 | Add SC2466                          |
| Rev A.1.2 | 2024-11-28 | Update ordering information         |