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

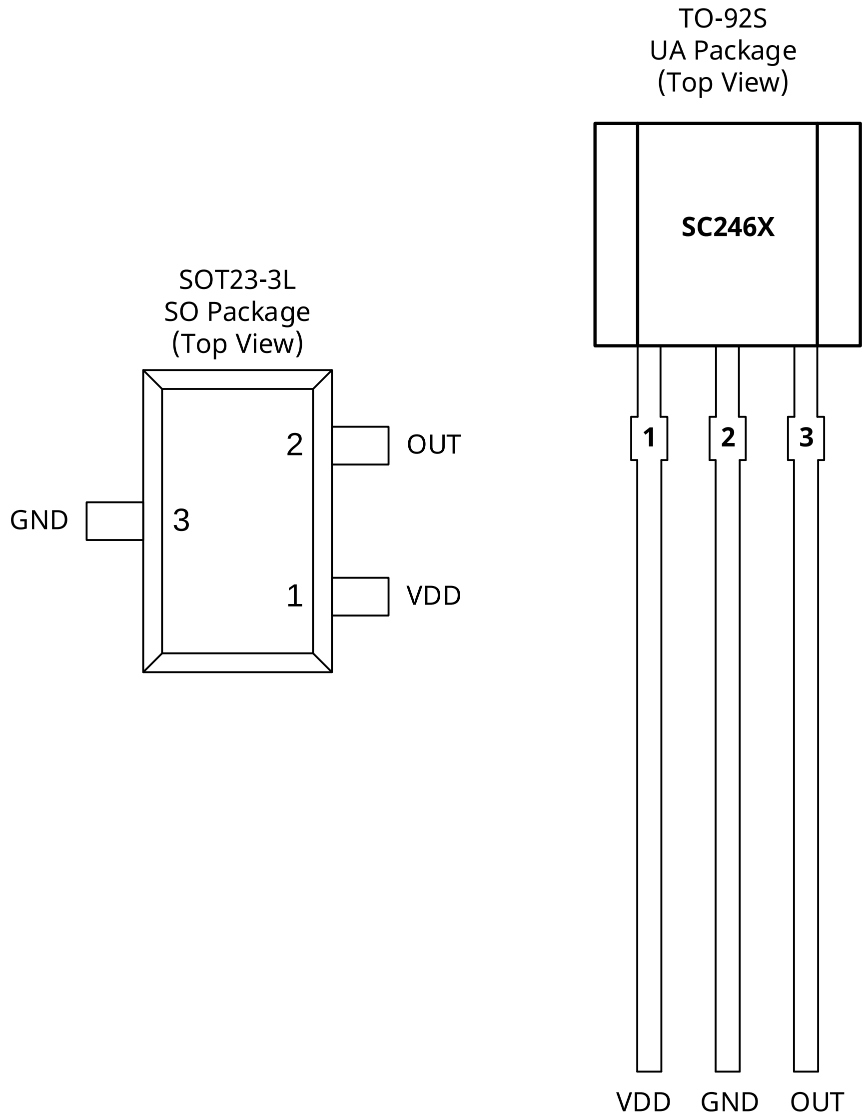


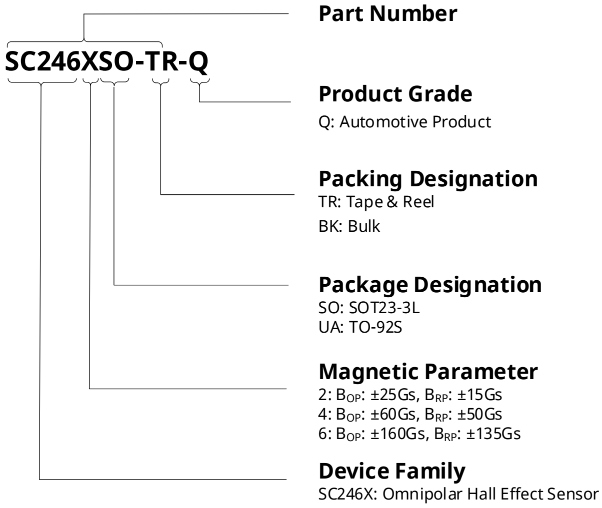
Fig.2: Pin Description

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_{OP}(Gs)	B_{RP}(Gs)	Ambient, T_A(℃)	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	3000/reel
SC2464SO-TR	2464		±60	±50	-40~150	SOT23-3L	TR	3000/reel
SC2464UA-BK	2464		±60	±50	-40~150	TO-92S	BK	3000/reel
SC2466SO-TR	2466		±165	±135	-40~150	SOT23-3L	TR	1000/bag

Ordering Information Format



6. Absolute Maximum Ratings

(over operating free-air temperature range，unless otherwise noted)[1]

Symbol	Parameter	Test conditions	Min.	Max.	Units
V_{DD}	Power supply voltage		-28	28	V
V_{OUT}	Output terminal voltage	For 5 Min. @1.0K pull-up resistor	-0.5	28	V
I_{SINK}	Output terminal current sink		-	30	mA
T_A	Operating ambient temperature		-40	150	℃
T_J	Junction temperature		-55	165	℃
T_{STG}	Storage temperature		-65	175	℃

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_{ESD_HBM}	HBM	Refer to AEC-Q100-002E HBM standard, R=1.5kΩ, C=100pF	-4	4	kV
V_{ESD_CDM}	CDM	Refer to AEC-Q100-011C CDM standard	-750	750	V

8. Thermal Characteristics

Symbol	Parameter	Test conditions	Rating	Units
$R_{\theta JA}$	UA Package thermal resistance	Single-layer PCB, with copper limited to solder pads	166[1]	℃/W
	SO Package thermal resistance	Single-layer PCB, with copper limited to solder pads	228[1]	℃/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 [1]	$T_J < T_{J(Max.)}$	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℃	1.1	1.8	2.6	mA
$I_{DD(on)}$	Operating supply current	V_{DD}=2.5 to 24 V, T_A=25℃	1.1	2.1	2.6	mA
t_{on}	Power-on time	V_{DD}≥5.0V	-	35	50	μs
I_{QL}	Off-state leakage current	Output Hi-Z	-	-	1	μA
$R_{DS(on)}$	FET on-resistance	V_{DD}=5V, I_O=10mA, T_A=25℃	-	20	-	Ω
		V_{DD}=5V, I_O=10mA, T_A=125℃		30		Ω
t_d	Output delay time	B=B_{RP} to B_{OP}	-	15	25	μs
t_r	Output rise time (10% to 90%)	R1=1Kohm Co=50pF	-	-	0.5	μs
t_f	Output fall time (90% to 10%)	R1=1Kohm Co=50pF	-	-	0.2	μs

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)

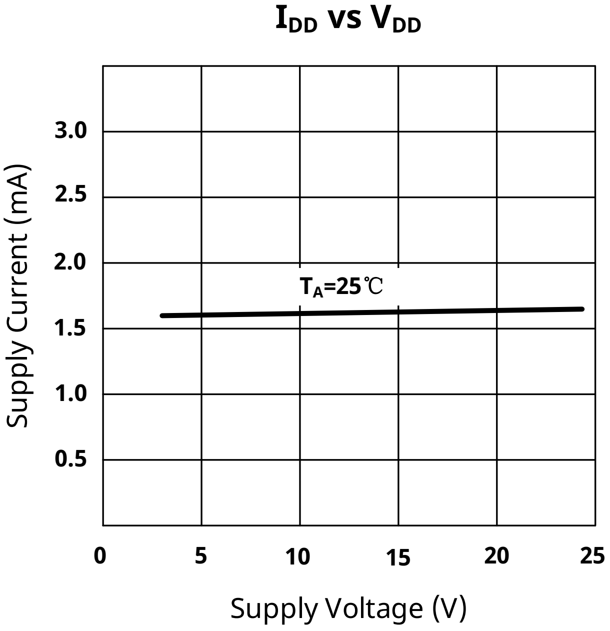
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
f_{BW}	BW		20	-	-	kHz
SC2462						
B_{OP}	Operating point	T_A=-40℃ to 150℃	±1.5[1]	±2.5	±3.5	mT[2]
B_{RP}	Release point		±1.0	±1.5	±3.0	mT
B_{HYS}	Hysteresis		-	±1.0	-	mT
SC2464						
B_{OP}	Operating point	T_A=-40℃ to 150℃	±4.5	±6.0	±7.5	mT
B_{RP}	Release point		±3.5	±5.0	±6.5	mT
B_{HYS}	Hysteresis		-	±1.0	-	mT
SC2466						
B_{OP}	Operating point	T_A=-40℃ to 150℃	±14	±16.5	±19	mT
B_{RP}	Release point		±11	±13.5	±16	mT
B_{HYS}	Hysteresis		-	±3.0	-	mT

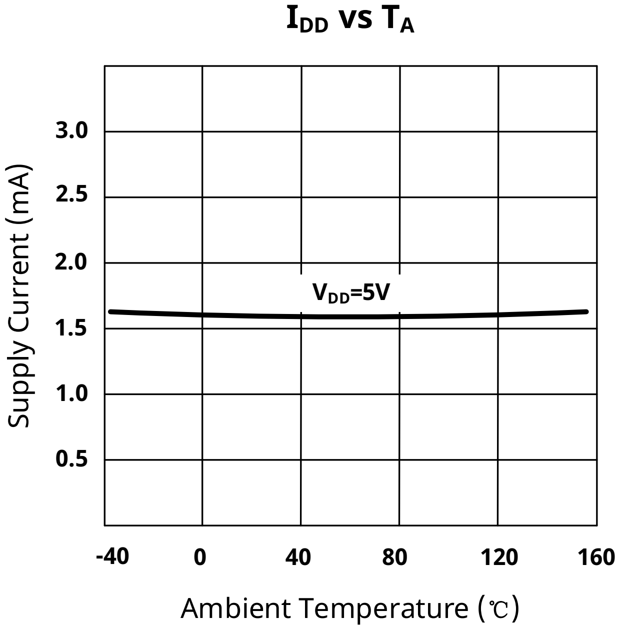
Note:

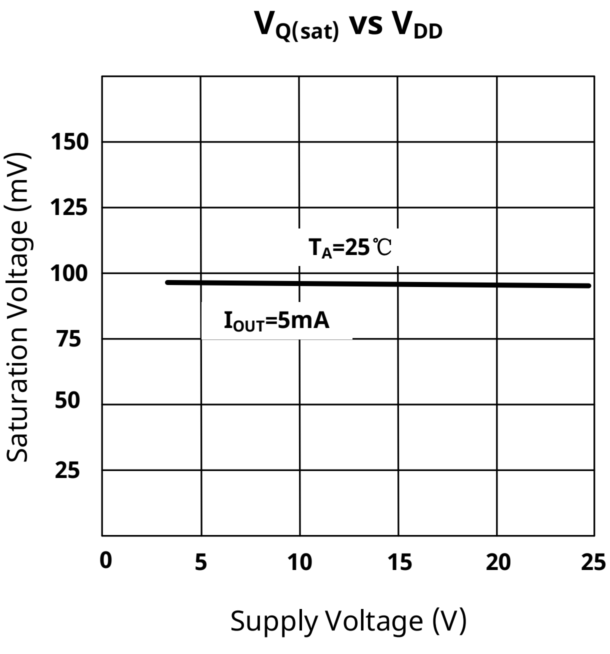
(1) Magnetic flux density, B is indicated as a negative value for North-polarity magnetic fields, and as a positive value for South-polarity magnetic fields.

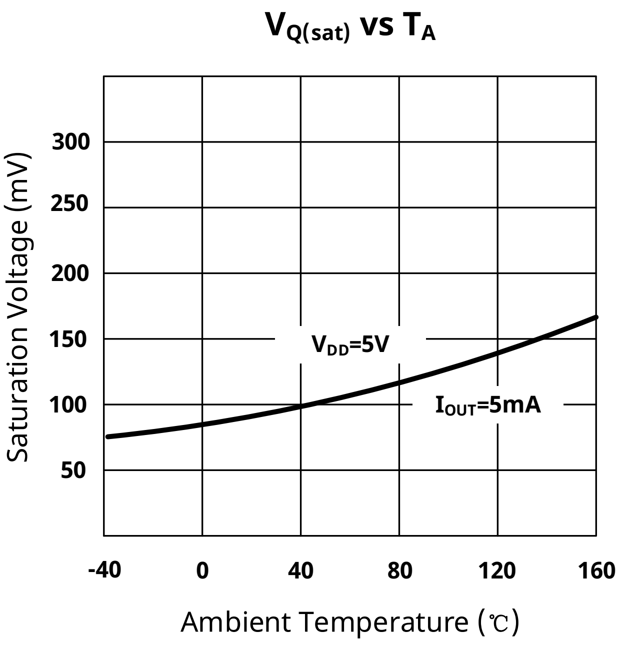
(2) 1mT=10Gs

10. Typical Characteristics

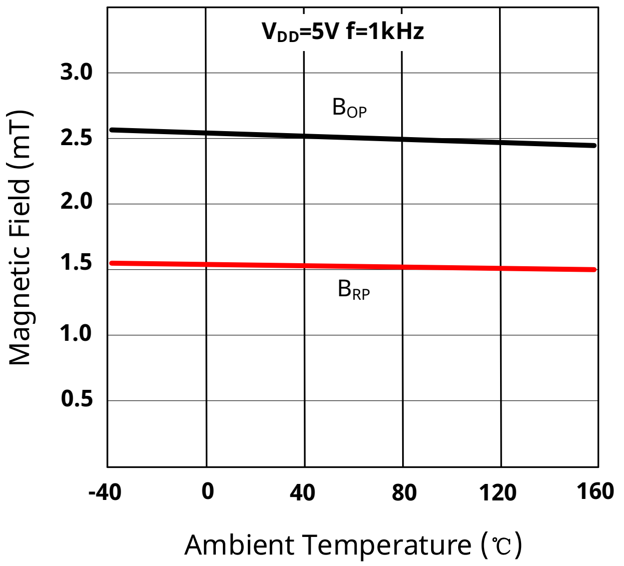




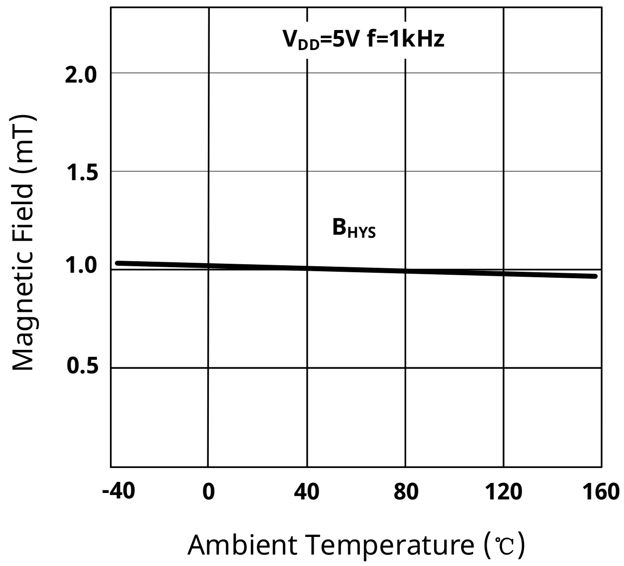




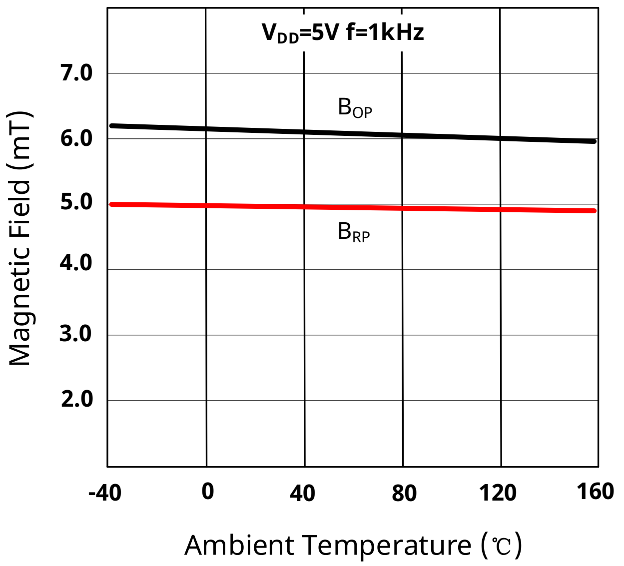
SC2462 B_{OP} and B_{RP} vs T_A



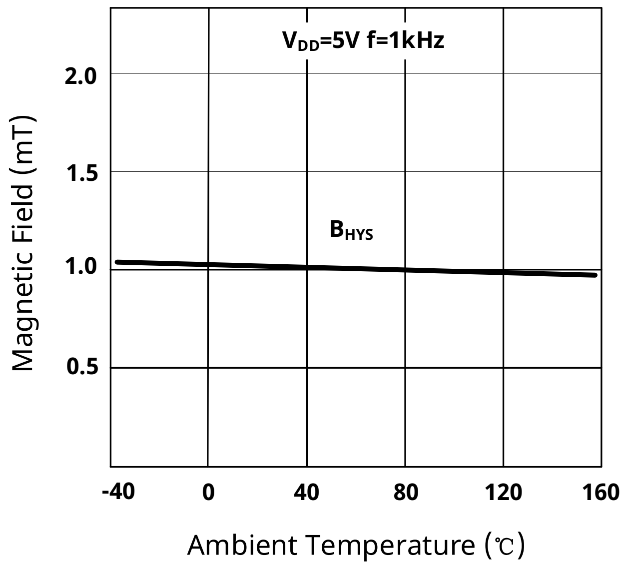
SC2462 B_{HYS} vs T_A



SC2464 B_{OP} and B_{RP} vs T_A



SC2464 B_{HYS} vs T_A



11. Block Diagram

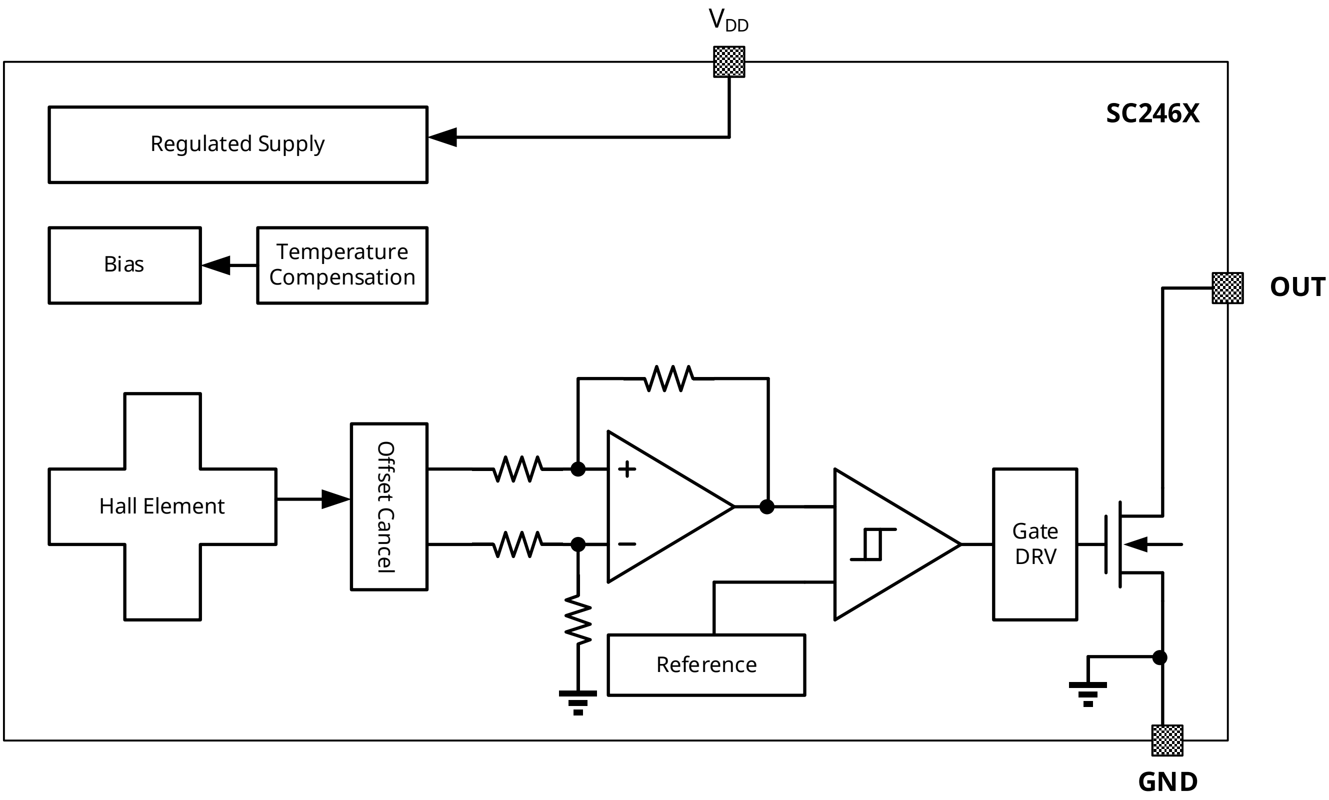


Fig.3: Block Diagram

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 continuously 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.

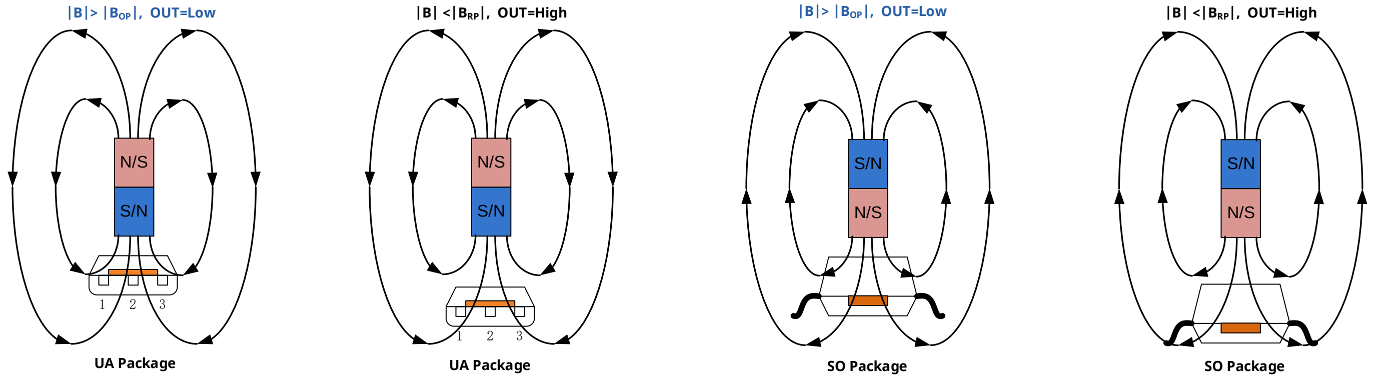


Fig.4: Switch Points versus Magnetic Signal

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.

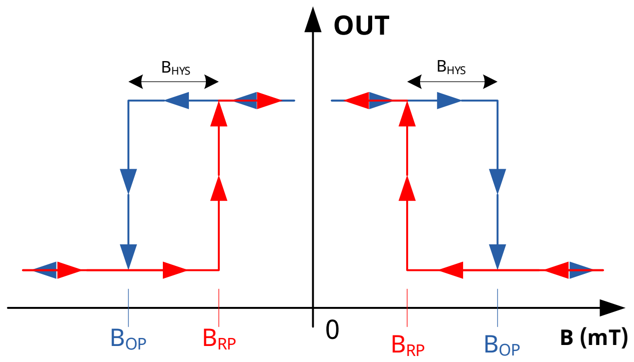


Fig.5: Magnetic Transfer Function

13. Typical Application

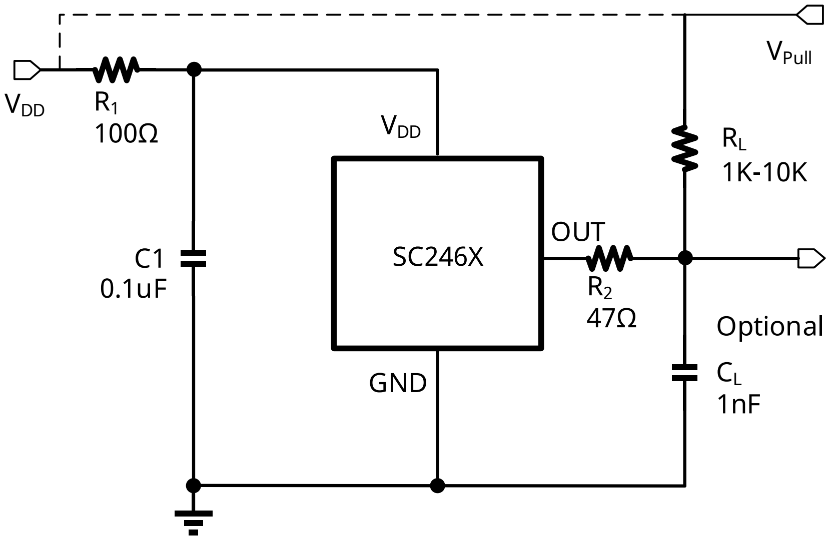


Fig.6: Typical Application Circuit

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 0.1μF. At the same time in the external optional series resistor R_1 their typical values for 100Ω.The output capacitor C_L is used as the output filter, typically 1nF.

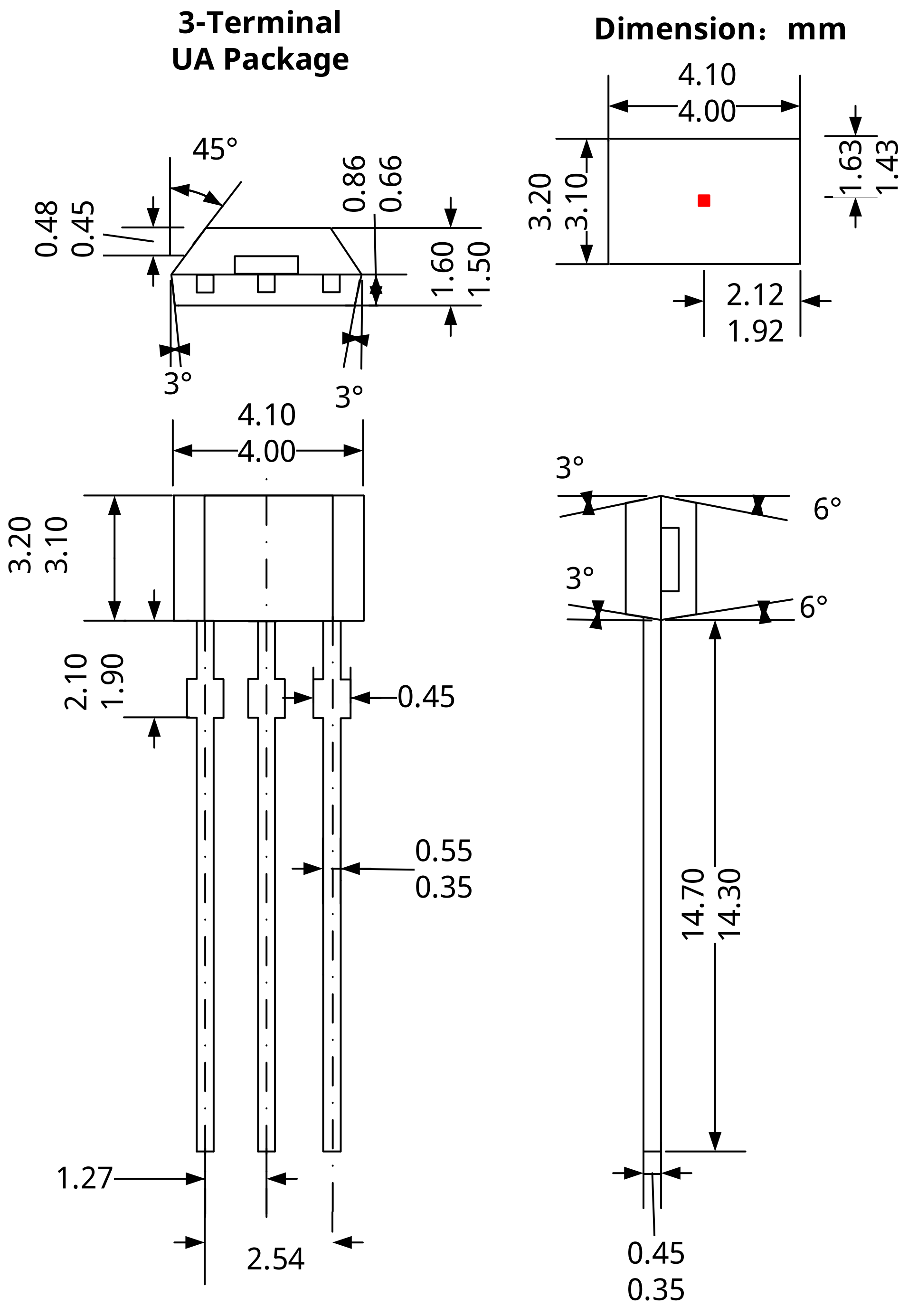
Select a value for C_L based on the system bandwidth specifications as:

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

The output stage of the SC246X device is a drain open-circuit NMOS tube, which provides a load capacity of 20mA. 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”



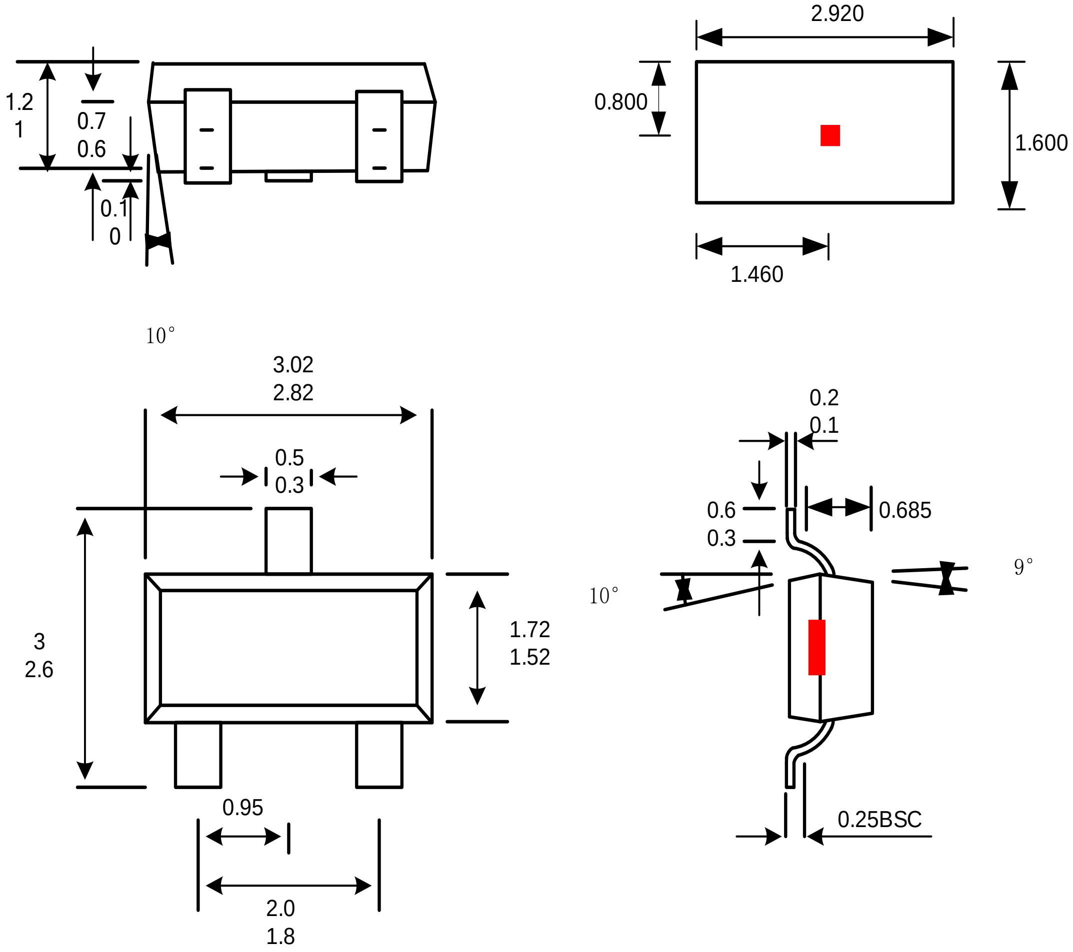
Notes:

1. *Exact body and lead configuration at vendor’s option within limits shown.*
2. *Height does not include mold gate flash.*
3. *The plating thinckness is 7-15um*
4. *Fine dimension information reference POD-TO92SS1-241115-002*

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 Hale 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