High Performance Digital-Latch Hall Effect Sensor

1. Features

- Digital latch Hall sensor
- High chopping frequency 800KHZ
- Supports a wide voltage range: 2.5~24V
- Reverse battery protection (up to 28V)
- Over-voltage protection at all pins
- Wide operating temperature range: -40~150℃
- Robust EMC performance
- Solid-state reliability
- Automotive AEC-Q100 Qualified
- Small package
  - 3-pin TO-92S (UA)
  - 3-pin SOT23 (SE)
  - 3-pin SOT23-3L (SO)

2. Applications

- Automotive and Industrial
- BLDC motor commutation
- Seat motor sensor
- Window lifter sensor
- Sunroof/Tailgate sensor
- Tachometers

3. Description

The SC244X 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 a single silicon chip a voltage regulator, Hall-voltage generator, small-signal amplifier, chopper stabilization, hysteresis comparator, and an open-drain output to sink current up to 30mA.
An onboard regulator permits with supply voltages of 2.5V to 24V which makes the device suitable for a wide range of industrial and automotive applications
The device is available in a 3-pin TO-92S package (UA), a 3-pin SOT23 (SE) and a 3-pin SOT23-3L(SO) style package. All are lead (Pb) free, with 100% matte tin lead frame plating.

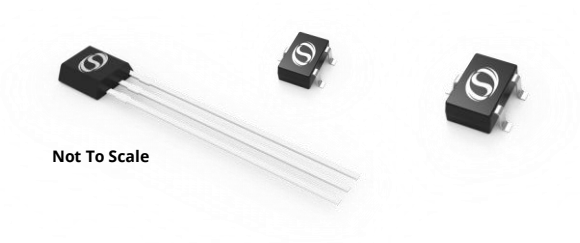

Fig.1 Package Outline

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4. Terminal Configuration

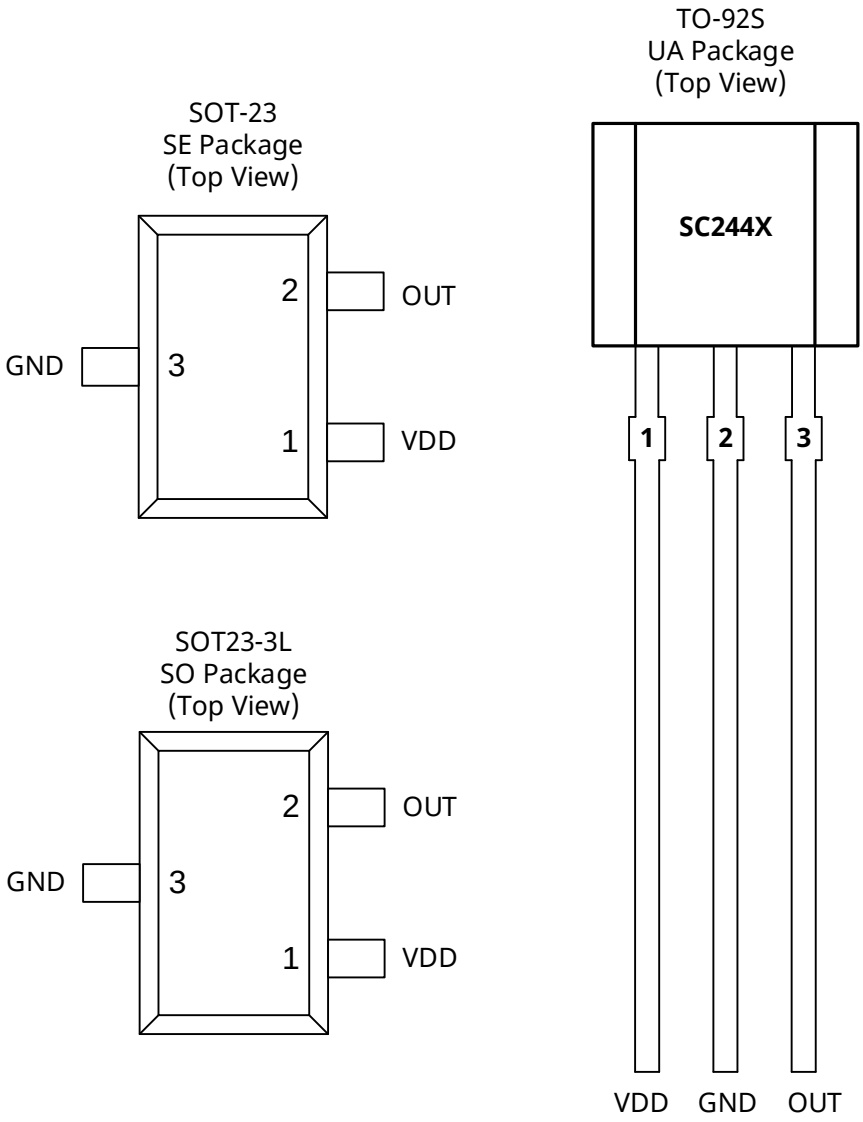


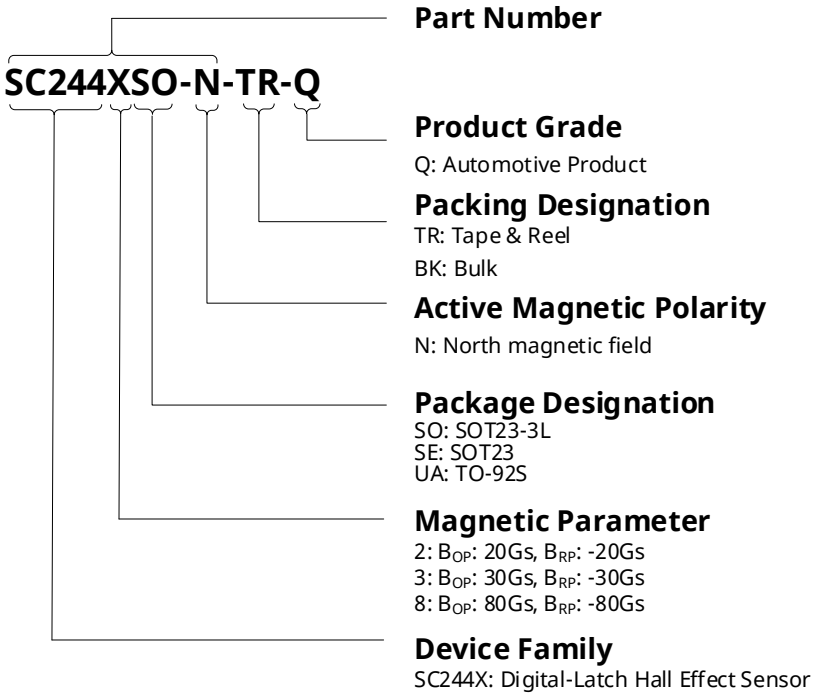
Fig. 2: Terminal Configuration

Terminal				Type	Description
Name	UA	SE	SO		
VDD	1	1	1	Power	2.5V~24V power supply
GND	2	3	3	Ground	Ground terminal
OUT	3	2	2	Output	Open-drain output. The open drain requires a pull-up resistor

5. Ordering Information

Order Information	Mark	Option	Class	B_{OP}(Gs)	B_{RP}(Gs)	Ambient, T_A(℃)	Package	Packing	Quantity
SC2442SE-TR-Q	2442		Q	20	-20	-40~150	SOT23	TR	3000/reel
SC2442SO-N-TR	2442	N		-20	20	-40~150	SOT23-3L	TR	3000/reel
SC2442SO-N-TR-Q	2442	N	Q	-20	20	-40~150	SOT23-3L	TR	3000/reel
SC2442SO-TR	2442			20	-20	-40~150	SOT23-3L	TR	3000/reel
SC2442SO-TR-Q	2442		Q	20	-20	-40~150	SOT23-3L	TR	3000/reel
SC2442UA-BK-Q	2442		Q	20	-20	-40~150	TO-92S	BK	1000/bag
SC2443SO-TR-Q	2443		Q	30	-30	-40~150	SOT23-3L	TR	3000/reel
SC2443UA-BK-Q	2443		Q	30	-30	-40~150	TO-92S	BK	1000/bag
SC2448SO-TR-Q	2448		Q	80	-80	-40~150	SOT23-3L	TR	3000/reel
SC2448UA-N-BK-Q	2448	N	Q	-80	80	-40~150	TO-92S	BK	1000/bag

5.1. Ordering Information Format:



6. Absolute Maximum Ratings

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

Symbol	Parameter	Test Condition	Min.	Max.	Units
V_{DD}	Power supply voltage		-28	28	V
V_{OUT}	Output terminal voltage	For 5 Min. @1.2K pull-up resistor	-0.5	28	V
I_{SINK}	Output terminal current sink		0	30	mA
T_A	Operating ambient temperature		-40	150	℃
T_J	Maximum 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 Condition	Min.	Max.	Units
V_{ESD_HBM}	HBM	according to: standard AEC-Q100-002 HBM	-4	4	kV
V_{ESD_CDM}	CDM	according to: standard AEC-Q100-011 CDM	-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.(1)	Max.	Units
V_{DD}	Operating voltage (2)	$T_J < T_{J(Max.)}$	2.5	5.0	24	V
V_{DDR}	Reverse supply voltage		-28	-	-	V
I_{DD}	Operating supply current	V_{DD}=2.5 to 24 V, T_A=25℃	1.2	1.6	2.5	mA
t_{on}	Power-on time	V_{DD}≥5.0V	-	35	50	μs
I_{QL}	Off-state leakage current	Output Hi-Z	-	-	3	μA
V_{sat}	Output Saturation Voltage	V_{DD} =5V, I_O=20mA,	-	180	500	mV
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) Typical values are defined at T_A = 25°C and V_{DD} = 5.0V

(2) 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
SC2442, +/-2.0mT						
B_{OP}	Operating point	T_A=-40˚C to 150˚C	+1.0(1)	+2.0	+3.0	mT(2)
B_{RP}	Release point		-3.0	-2.0	-1.0	mT
B_{HYS}	Hysteresis		-	4.0	-	mT
B_O	Magnetic offset	$B_O=(B_{OP}+B_{RP})/2$	-1.0		+1.0	mT
SC2443, +/-3.0mT						
B_{OP}	Operating point	T_A=-40˚C to 150˚C	+2.0	+3.0	+4.0	mT
B_{RP}	Release point		-4.0	-3.0	-2.0	mT
B_{HYS}	Hysteresis		-	6.0	-	mT
B_O	Magnetic offset	$B_O=(B_{OP}+B_{RP})/2$	-1.0	-	1.0	mT
SC2448, +/-8.0mT						
B_{OP}	Operating point	T_A=-40˚C to 150˚C	+6.0	+8.0	+10.0	mT
B_{RP}	Release point		-10.0	-8.0	-6.0	mT
B_{HYS}	Hysteresis		-	16.0	-	mT
B_O	Magnetic offset	$B_O=(B_{OP}+B_{RP})/2$	-2.0	-	+2.0	mT

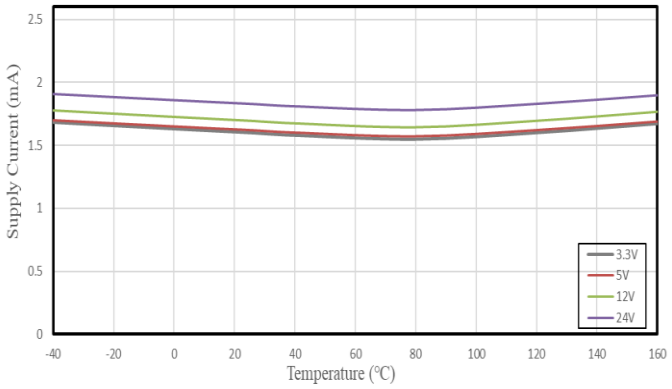
Note:

(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,

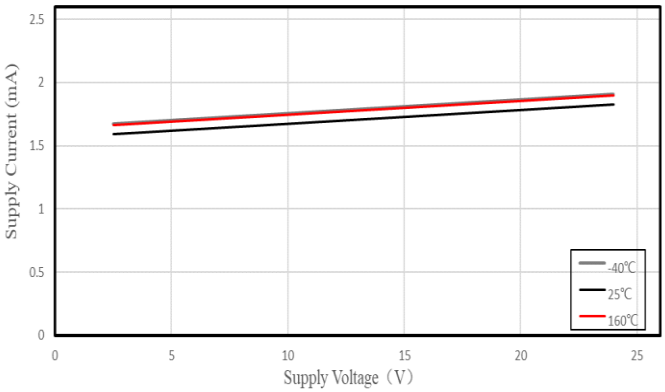
(2) 1mT=10Gs

10. Typical Characteristics

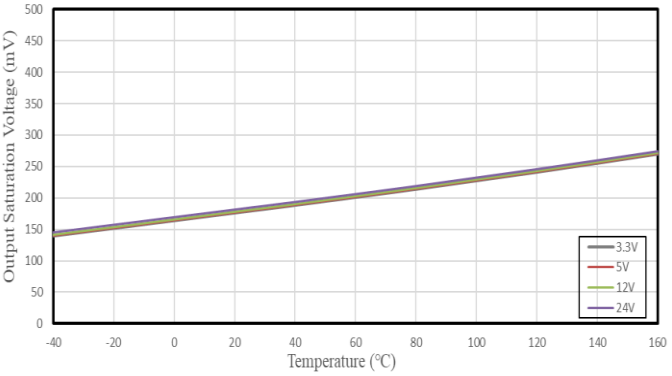
Supply current VS. Temperature



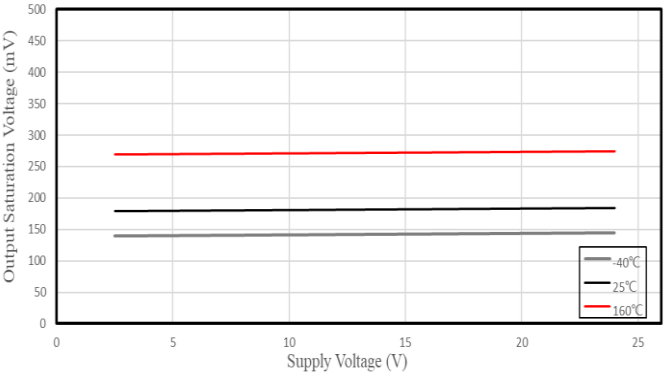
Supply current VS. Supply voltage



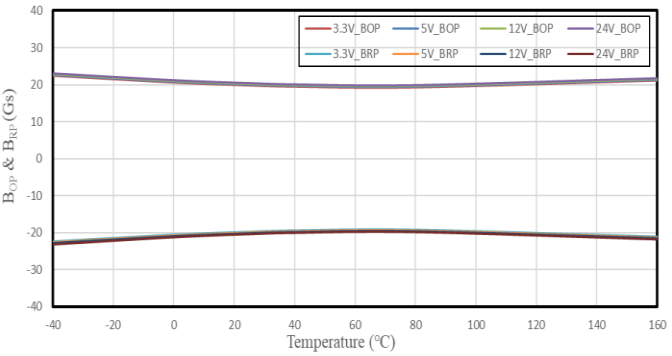
Output Saturation Voltage VS. Temperature



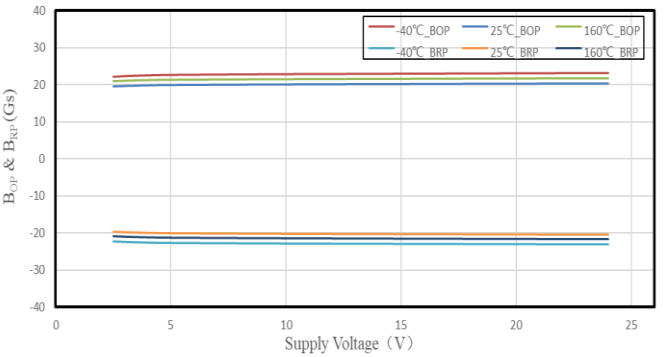
Output Saturation Voltage VS. Supply Voltage



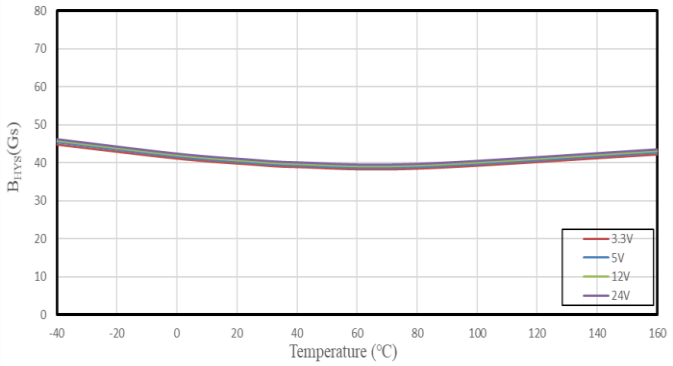
SC2442 B_{OP} & B_{RP} VS. Temperature



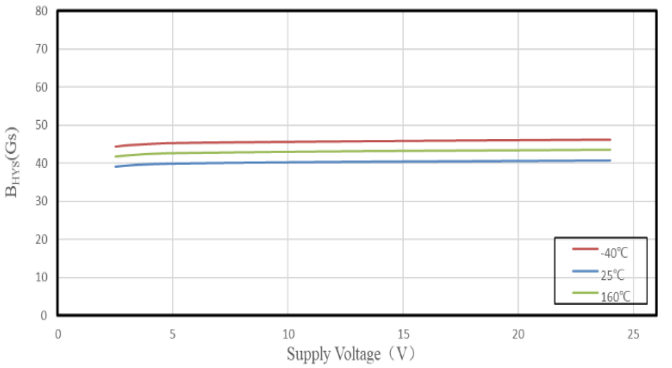
SC2442 B_{OP} & B_{RP} VS. Supply Voltage



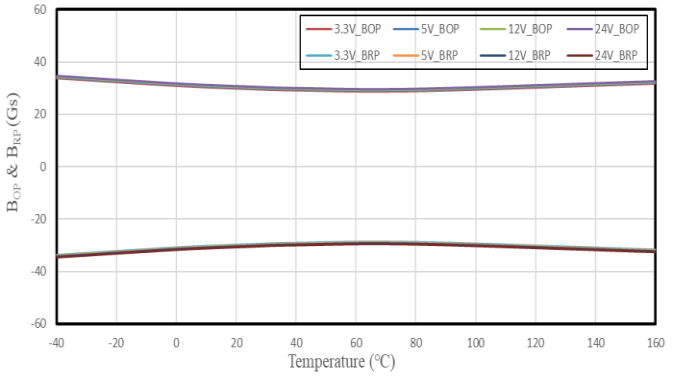
SC2442 B_{HYS} VS. Temperature



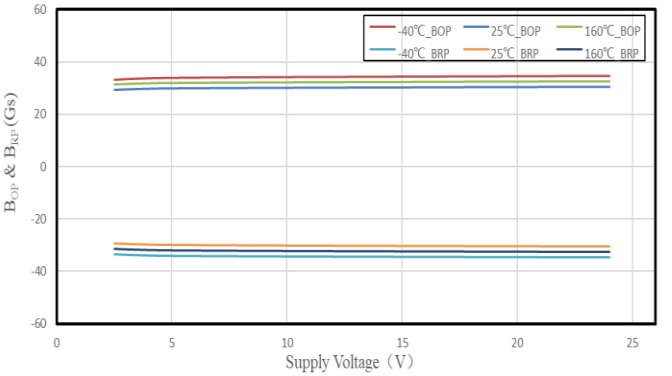
SC2442 B_{HYS} VS. Supply Voltage



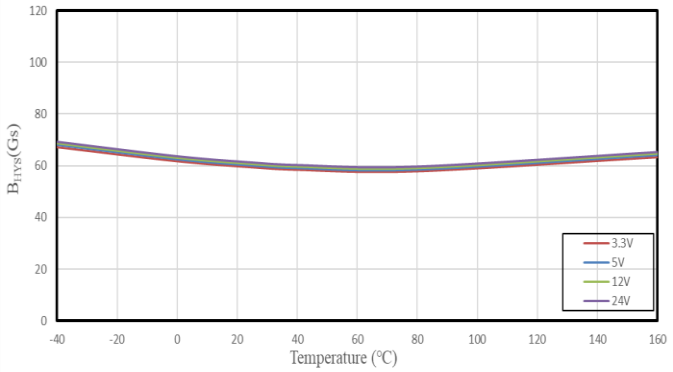
SC2443 B_{OP} & B_{RP} VS. Temperature



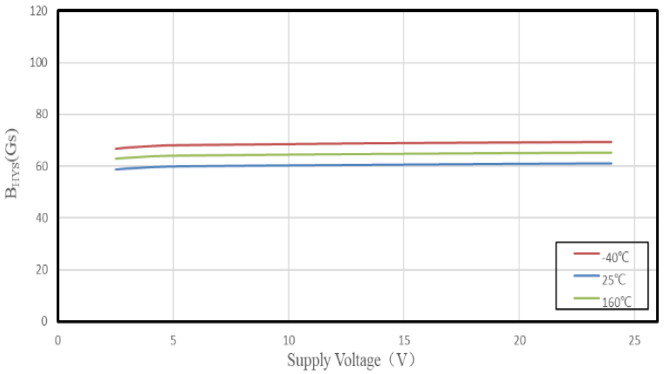
SC2443 B_{OP} & B_{RP} VS. Supply Voltage



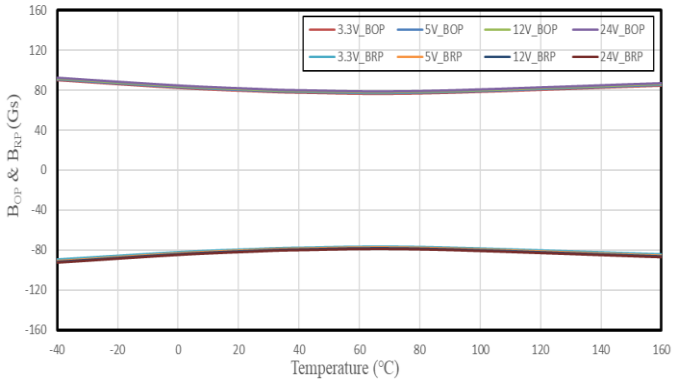
SC2443 B_{HYS} VS. Temperature



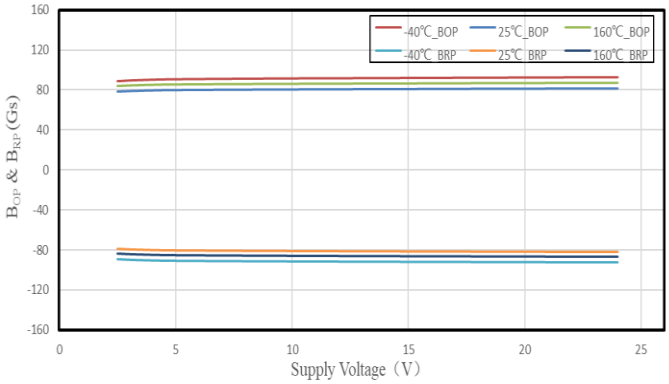
SC2443 B_{HYS} VS. Supply Voltage



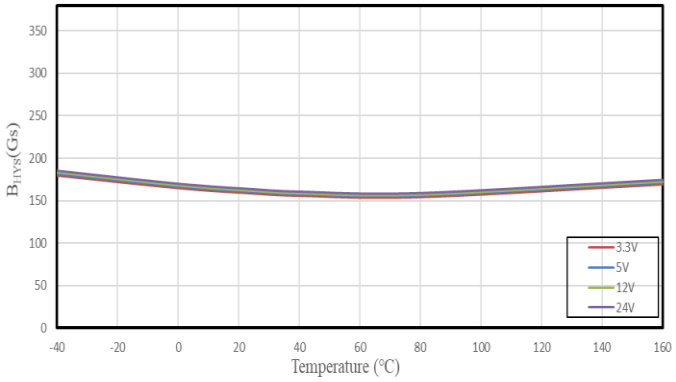
SC2448 B_{OP} & B_{RP} VS. Temperature



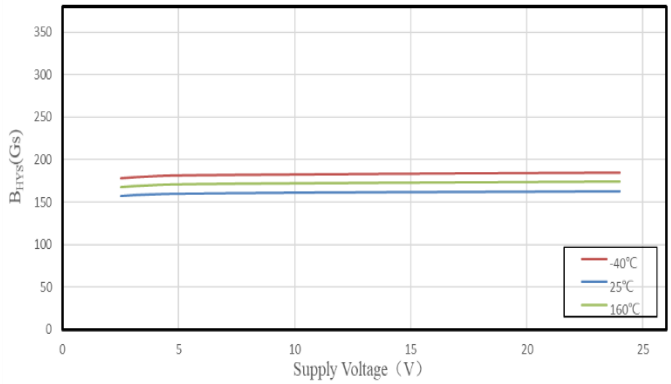
SC2448 B_{OP} & B_{RP} VS. Supply Voltage



SC2448 B_{HYS} VS. Temperature



SC2448 B_{HYS} VS. Supply Voltage



11. Block Diagram

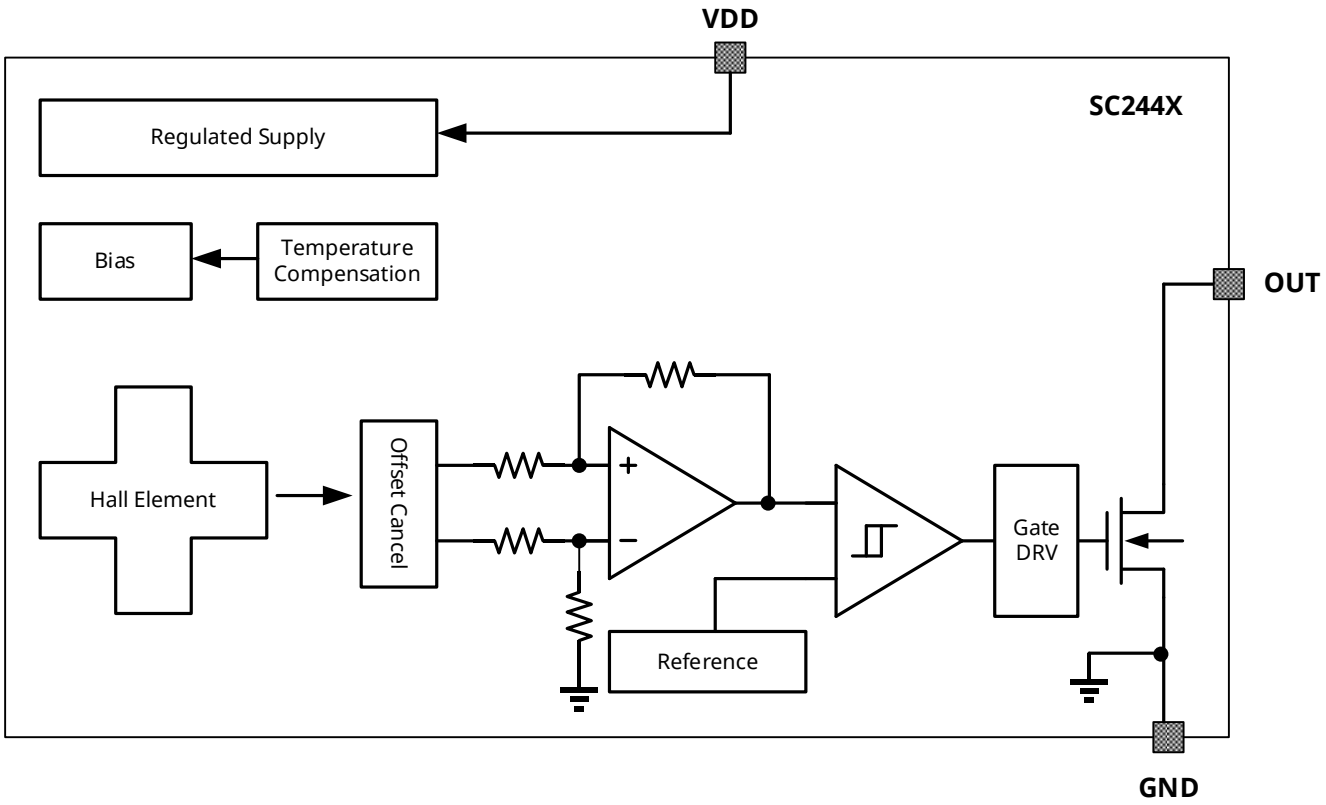


Fig. 3: Function Block Diagram

12. Function Description

The SC244X 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 2.5V and 24V, and continuously survives continuous -28V reverse-battery conditions.

TO-92S package as an example, the output of SC244X 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 up to 30mA 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.

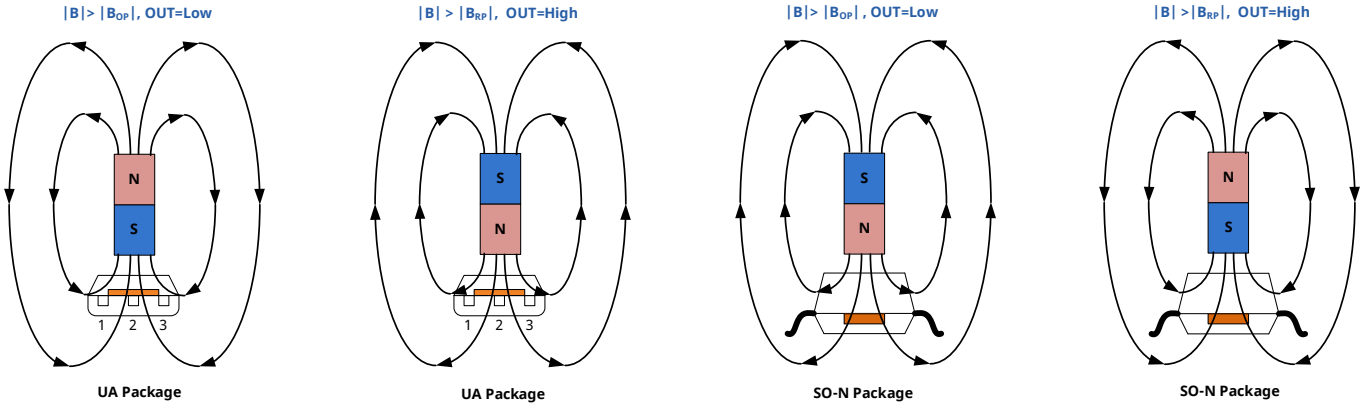


Fig. 4: Magnetic Field Direction Definition

12.2. Transfer Function

Powering-on the device in the hysteresis region, less than BOP 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}.

TO-92S package as an example, 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}

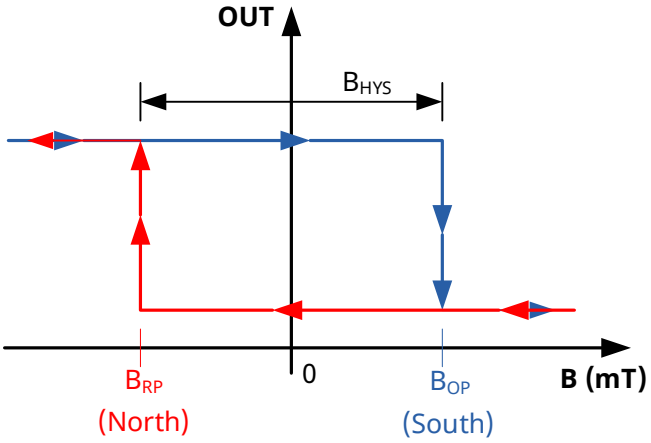


Fig. 5: TO-92S (UA) Package Magnetic Transfer Function

13. Typical Application

R_1&R_2 are the current limit resistor for the SC244X chipset application，It is highly recommend to add R_1 and R_2 in application circuit, especially R_2.

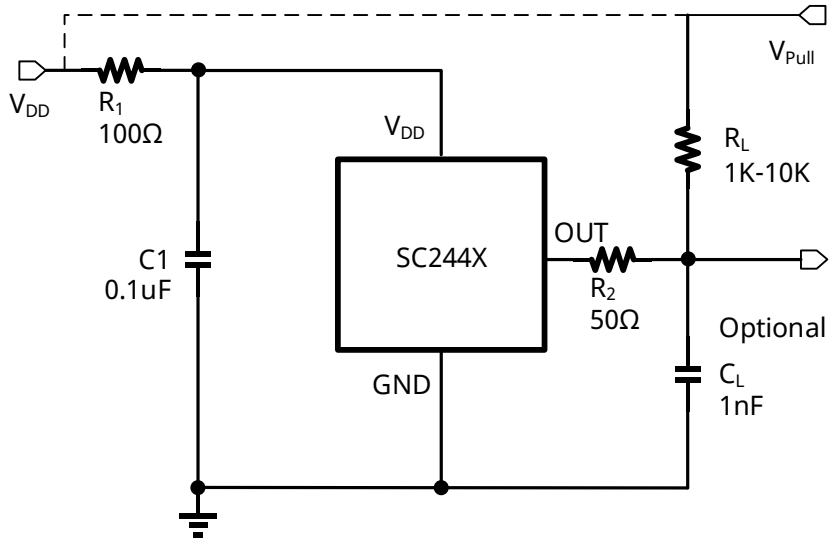


Fig. 6: Typical Application Circuit

The SC244X 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 that C1 capacitor be connected to the ground in parallel near the V_{DD} power end of the chip, with a typical value of 0.1uF. At the same time in the external optional series resistor R_1 and output capacitance C_L used for enhanced protection circuit, its typical values for 100Ω and 1nF.

The SC244X device output stage uses an open-drain NMOS, and it is rated to sink up to 20mA of current. For proper operation, calculate the value of the pull-up resistor R_L is required. The size of R_L is a tradeoff between OUT rise time and the load capacity when OUT is pulled low. A lower current is generally better, however faster transitions and bandwidth require a smaller resistor for faster switching.

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

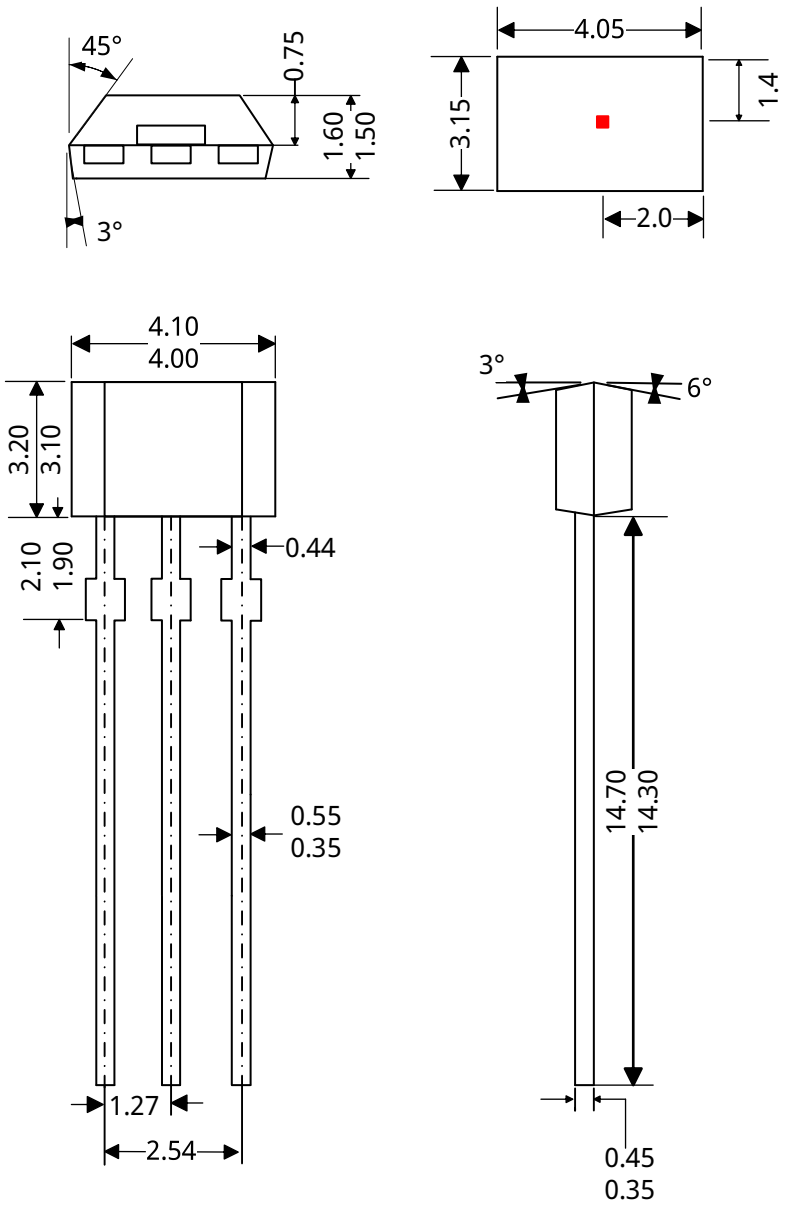
$$C_L < \frac{1}{2\pi \times R_L \times 2 \times f_{BW}(Hz)}$$

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



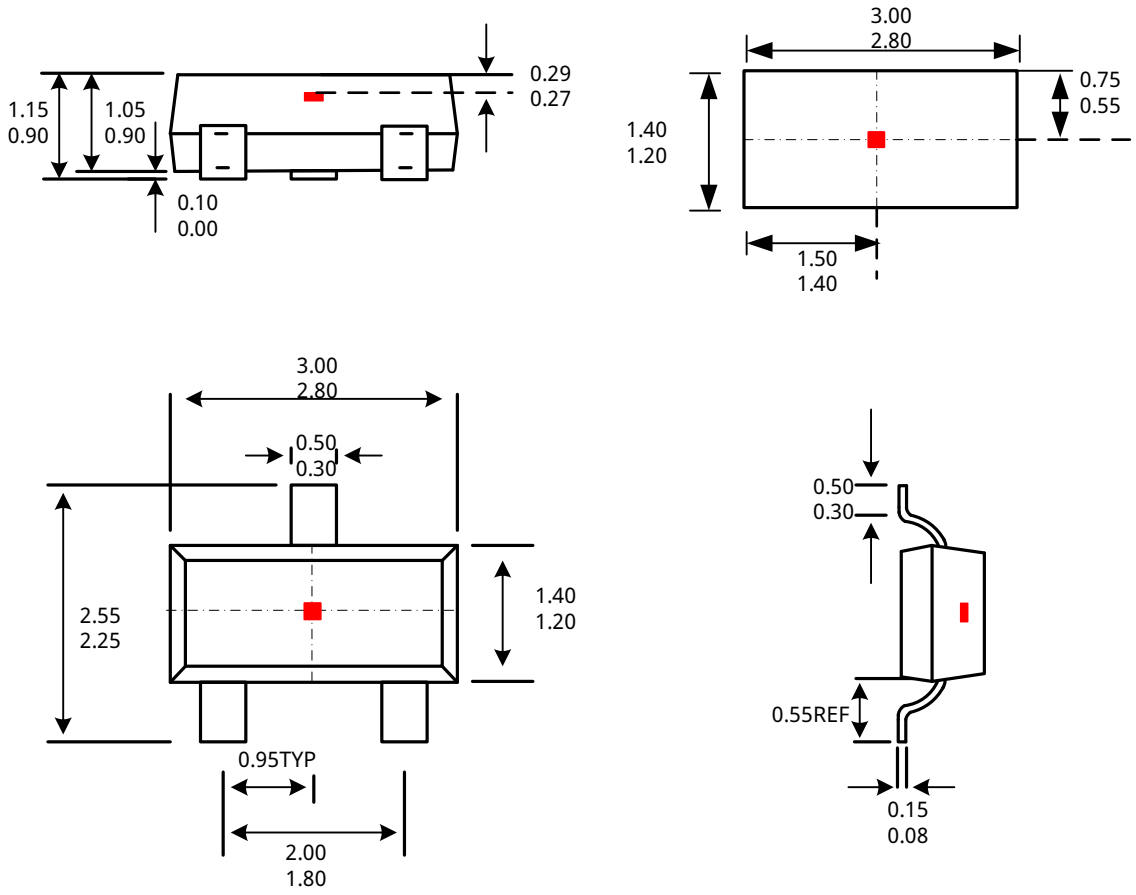
Notes:
1. Exact body and lead configuration at vendor's option within limits shown.
2. Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.

15. Package Information "SE"

3-PIN
SE Package

Unit:mm

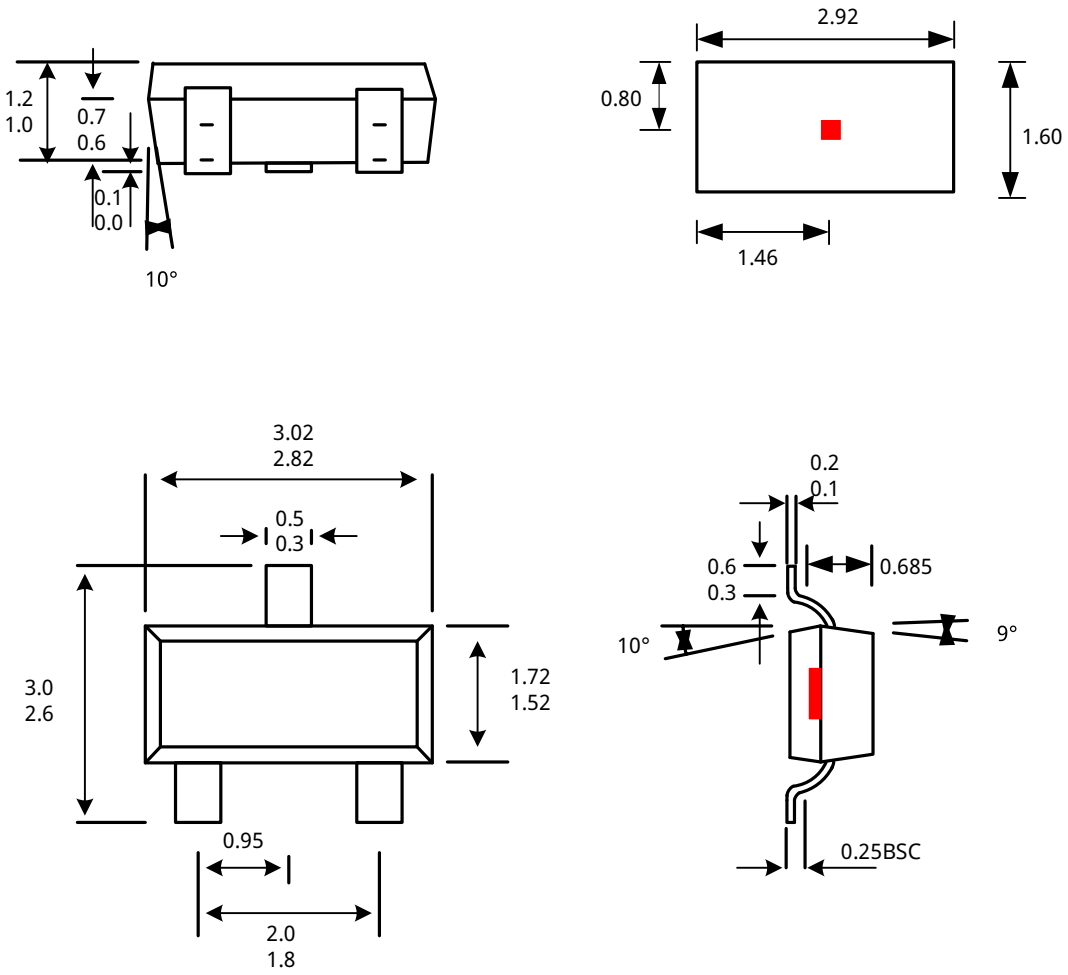


Notes:
1.Exact body and lead configuration at vendor's option within limits shown.
2.Height does not include mold gate flash.
3.Red mark is Hall element
Where no tolerance is specified, dimension is nominal.

16. 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.

17. Revision History

Revision	Date	Description
Rev1.0	2016-05-10	Preliminary datasheet
Rev1.1	2017-08-06	Add ordering information SC2448SO
Rev2.3	2019-05-06	The final revision of old datasheet
RevA/1.0	2021-10-09	Unified datasheet format, update AEC-Q100
RevA/1.1	2022-04-03	Add ordering information of SC2443SO and SC2443UA
RevA/1.2	2023-02-10	Add IDD Minimum limit / Update sensing point vertical position
RevA/1.3	2023-06-08	Add order information of SC2442SE
RevA/1.4	2023-08-07	Add R2=50 ohm in application circuit Update part number in order information
RevA/1.5	2024-11-28	Update part number in order information
RevA/1.6	2025-03-12	Update TO-92S POD