High Performance Digital-Latch Hall Effect Sensor

1. Features

- AEC-Q100 qualified
- Developed according to ISO26262-10 and ISO26262-9 as SEooC with ASIL-B level
- Supports a wide operation voltage range:
  - 2.8V to 40V
- Supply voltage transient up to 60V with 200Ω R_S resistor.
- Wide operating temperature range:
  - -55℃ to 150℃
- 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 series is manufactured using advanced 60V BCD technology, developed in accordance with ISO26262-10 and ISO26262-9. As a Safety Element out of Context (SEooC), it reaches the ASIL-B level. It is a chopper-stabilized Hall effect sensor that provides a magnetic sensing solution with excellent sensitivity stability and integrated protection functions.

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 2.8V 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

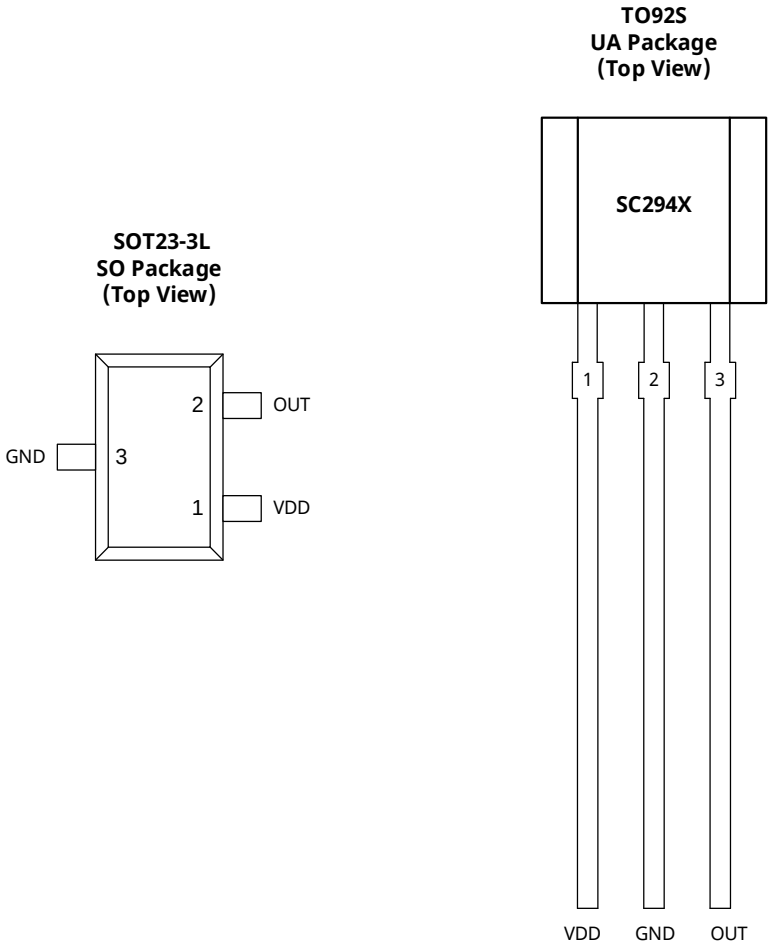


Fig.2 Terminal Configuration

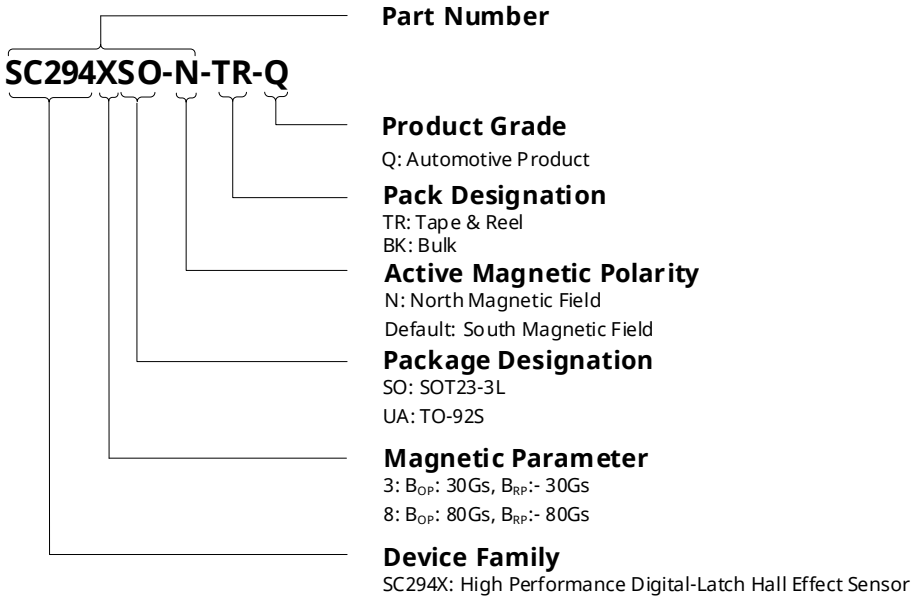
Terminal			Type	Description
Name	UA	SO		
VDD	1	1	Power	2.8V to 40V Power Supply
GND	2	3	Ground	Ground Terminal
OUT	3	2	Output	The Current Limited Open Drain Output

5. Ordering Information

Ordering Information	Mark	Option	Grade	Ambient, T_A(℃)	Package	Packing	Quantity

SC2943SO-TR-Q	2943		Q	-55 to 150	SOT23-3L	Reel	3000 pieces/reel
SC2943SO-N-TR-Q	2943	N	Q	-55 to 150	SOT23-3L	Reel	3000 pieces/reel
SC2943UA-BK-Q	2943		Q	-55 to 150	TO92S	Bulk	1000 pieces/bag
SC2948SO-TR-Q	2948		Q	-55 to 150	SOT23-3L	Reel	3000 pieces/reel
SC2948UA-BK-Q	2948		Q	-55 to 150	TO92S	Bulk	1000 pieces/bag
SC2948UA-N-BK-Q	2948	N	Q	-55 to 150	TO92S	Bulk	1000 pieces/bag

Ordering Information Format



6. Absolute Maximum Ratings

over operating free-air temperature range(-55°C-150°C) (unless otherwise noted) (1)

Symbol	Parameter	Test Condition	Min.	Max.	Units
V_{DD}	Power supply voltage		-28	60	V
V_{OUT}	Output terminal voltage	1.2 kΩ pull up resistor, not exceed 5 min	-0.5	60	V
I_{SINK}	Output terminal current sink		0	44	mA
T_A	Operating ambient temperature		-55	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	-8	+8	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	200 (1)	℃/W
	SO Package thermal resistance	Single-layer PCB, with copper limited to solder pads	300 (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 rang (V_{DD} = 5.0V, unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.(2)	Max.	Units
V_{DD}	Operating Voltage (1)	$T_J < T_{J(Max.)}$,	2.8	5	40	V
V_{DDR}	Reverse Supply Voltage	I_{DD} < -10mA, T_A=25℃	-28	-	-	V
I_{DD}	Operating current	VDD=2.8 to 40V, TA=25℃,	-	1.2	-	mA
$UVLO_H$	Under Voltage Lockout High	B>B_{OP}+2.0mT, VDD Rising From 1.5V	-	1.75	-	V
$UVLO_L$	Under Voltage Lockout Low	B>B_{OP}+2.0mT, VDD Decreasing From 2.5V	-	1.5	-	V
$UVLO_{HYS}$	Under Voltage Hysteresis	$UVLO_H$- $UVLO_L$	-	250	-	mV
t_{on}	Power-on time	V_{DD}⩾5V	-	25	40	μS
I_{QL}	Off-state leakage current	Output Hi-Z	-	-	3	μA
V_{SAT}	Output saturation pressure drop	B>B_{RP}, V_{DD}=5V, I_O=20mA, T_A=25℃	-	0.14	0.4	V
		B>B_{RP}, V_{DD}=5V, I_O=30mA, T_A=125℃	-	-	0.5	V
I_O	Output Sink Current	B>B_{OP}, V_{DD}=5V, VOUT=1V, T_A=25℃		40	60	mA
t_d	Output delay time	B=B_{RP} to B_{OP}	-	15	25	μS
t_r	Output rise time (10% to 90%)	V_{PU}=12V, R_{PU}(3)=1Kohm CL=50pF	-	0.2	1	μS
t_f	Output fall time (90% to 10%)	V_{PU}(3)=12V, R_{PU}=1Kohm CL=50pF	-	0.1	1	μS

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°C and V_{DD} = 5V

(3) RPU and VPU 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)

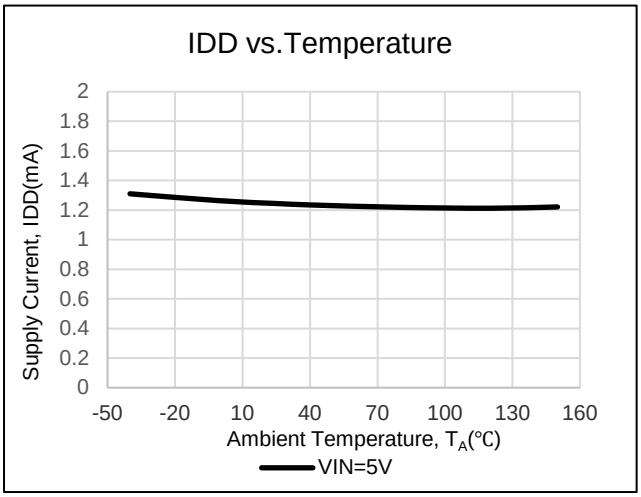
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
f_{BW}	BW		20	-	-	kHz
SC2943 +3.0 / -3.0 mT(1)						
B_{OP}	Operated point	T_A=25℃	+1.5	+3.0(2)	+4.5	mT
B_{RP}	Release point		-4.5	-3.0(2)	-1.5	mT
B_{HYS}	Hysteresis		3.0	6.0	9.0	mT
B_O	Magnetic offset	$B_O=(B_{OP}+B_{RP})/2$	-1.5	0	+1.5	mT
SC2948 +8.0 / -8.0 mT						
B_{OP}	Operated point	T_A=25℃	+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

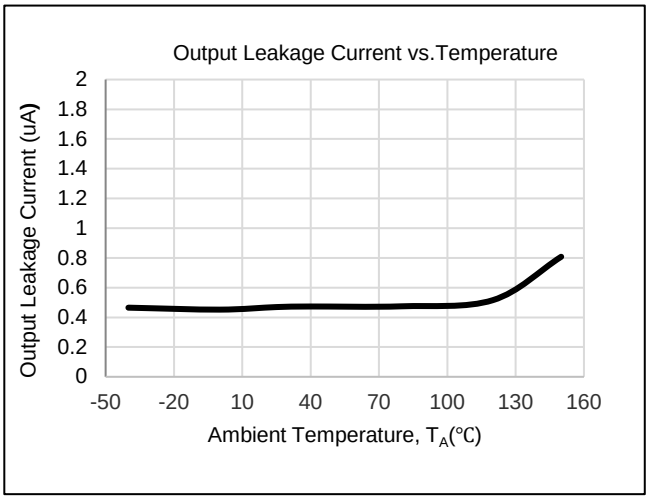
Note:

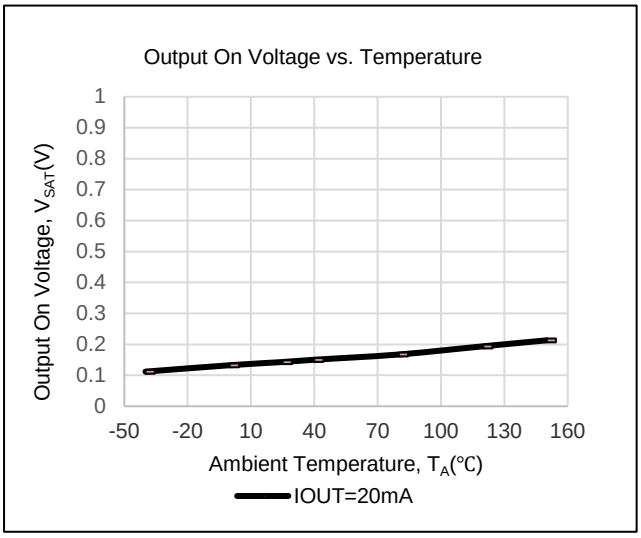
(1) 1mT=10Gs

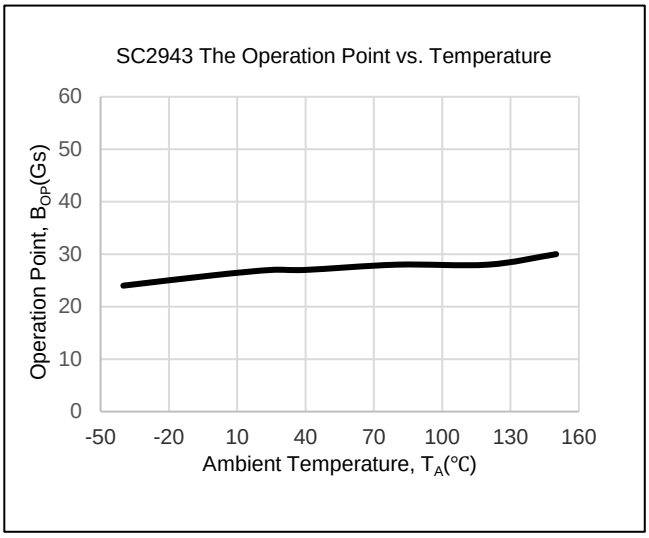
(2) Magnetic flux density, B, is indicated as a negative value for North-polarity magnetic fields, and as a positive value for South-polarity magnetic fields.

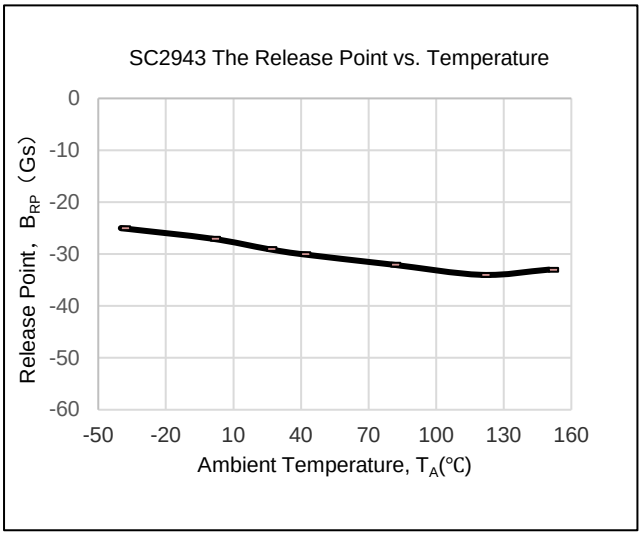
10. Typical Characteristics

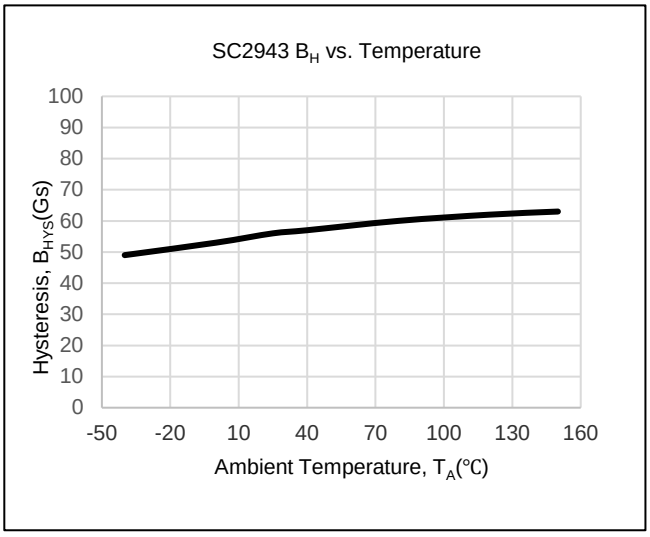


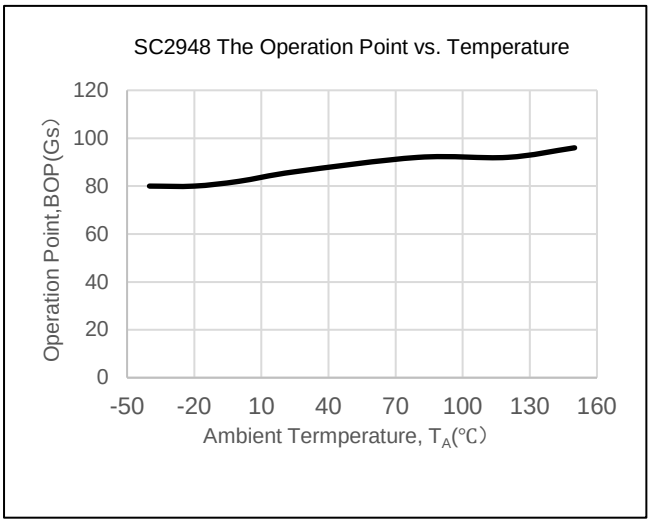


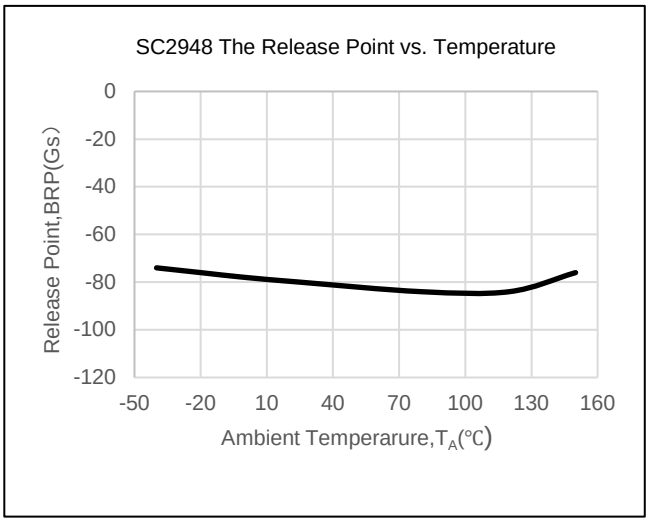


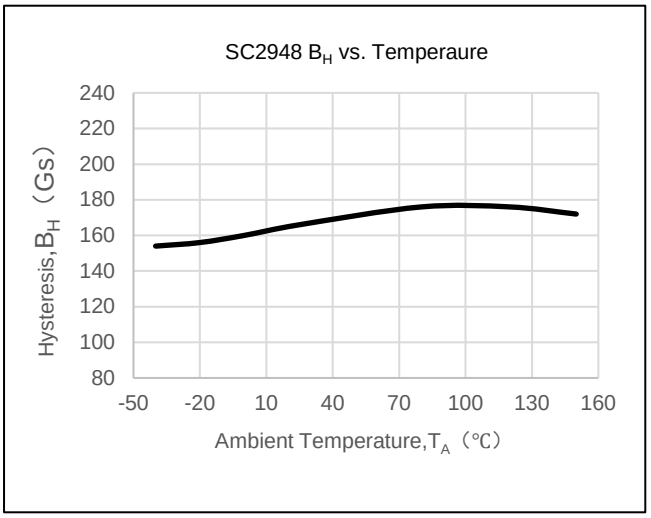







SC2948 The Operation Point vs. Temperature
Operation Point,BOP(Gs)
120
100
80
60
40
20
0
-50 -20 10 40 70 100 130 160
Ambient Termperature, T_A(℃)


SC2948 The Release Point vs. Temperature
Release Point,BRP(Gs)
0
-20
-40
-60
-80
-100
-120
-50 -20 10 40 70 100 130 160
Ambient Temperarure,T_A(℃)


SC2948 B_H vs. Temperaure
Hysteresis,B_H（Gs）
240
220
200
180
160
140
120
100
80
-50 -20 10 40 70 100 130 160
Ambient Temperature,T_A（℃）

11. Block Diagram

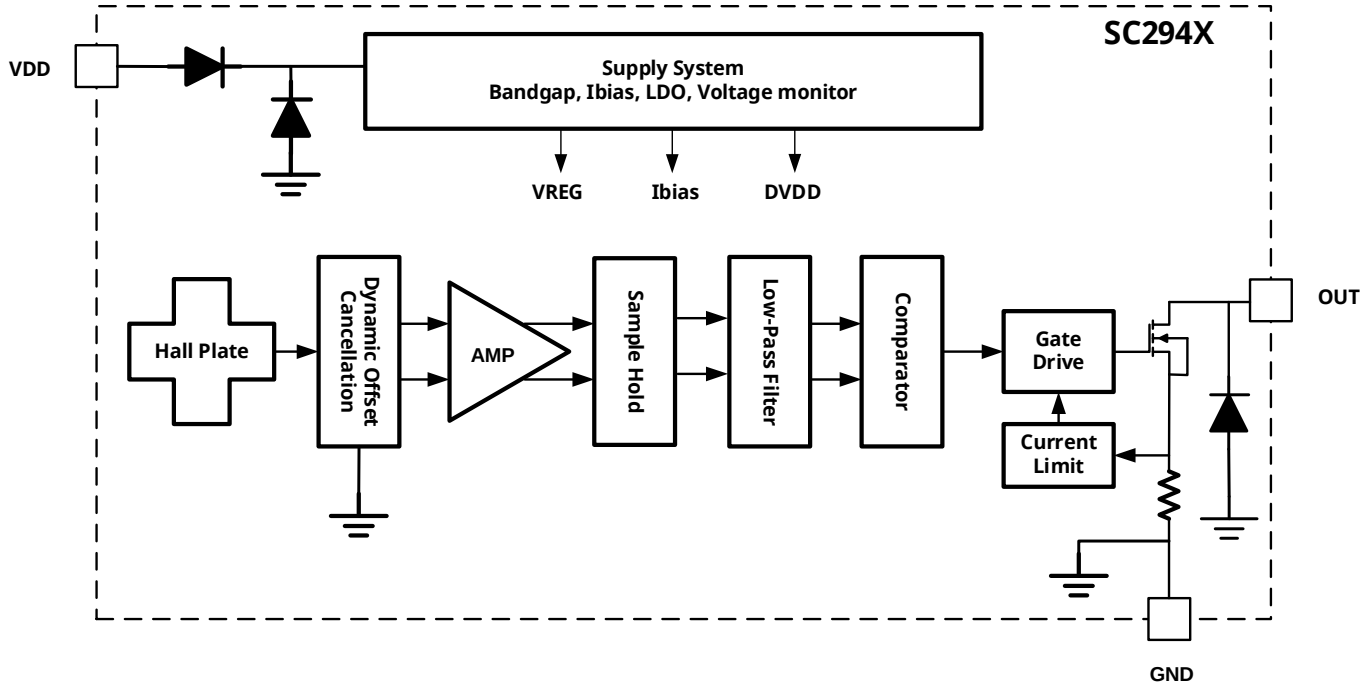


Fig.3 Function Block Diagram

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.

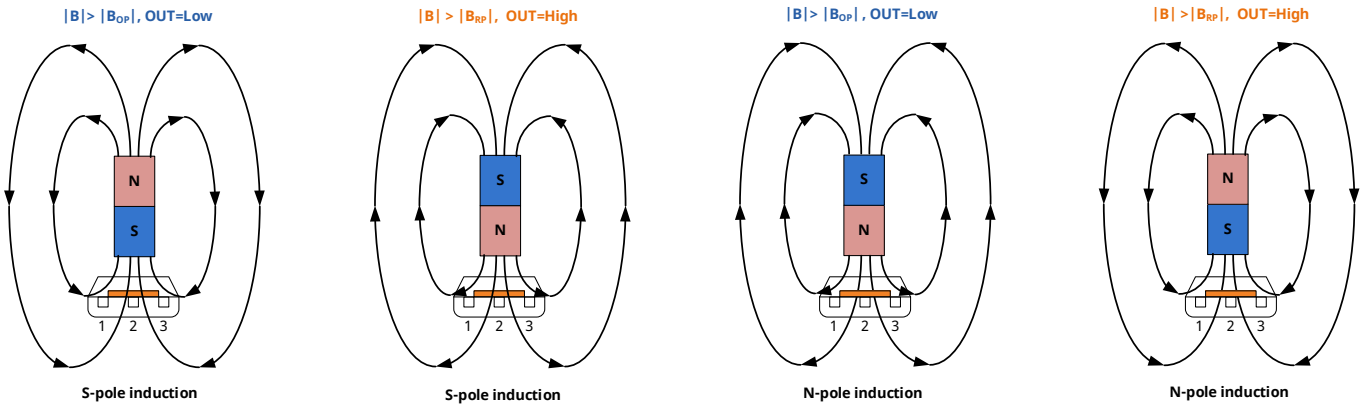


Fig.4 Magnetic Field Direction Definition

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}

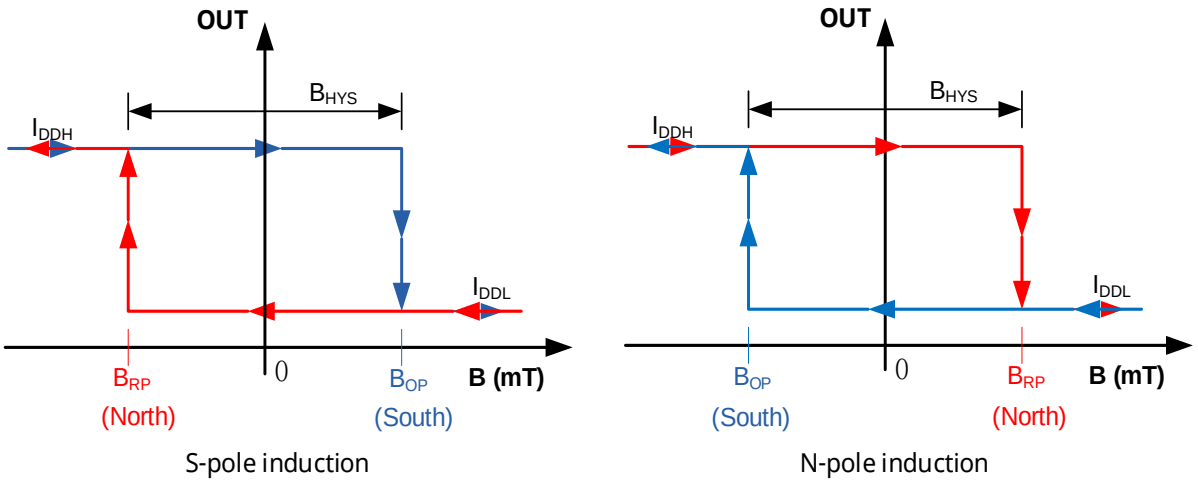


Fig.5 Magnetic Transfer Function

13. Typical Application

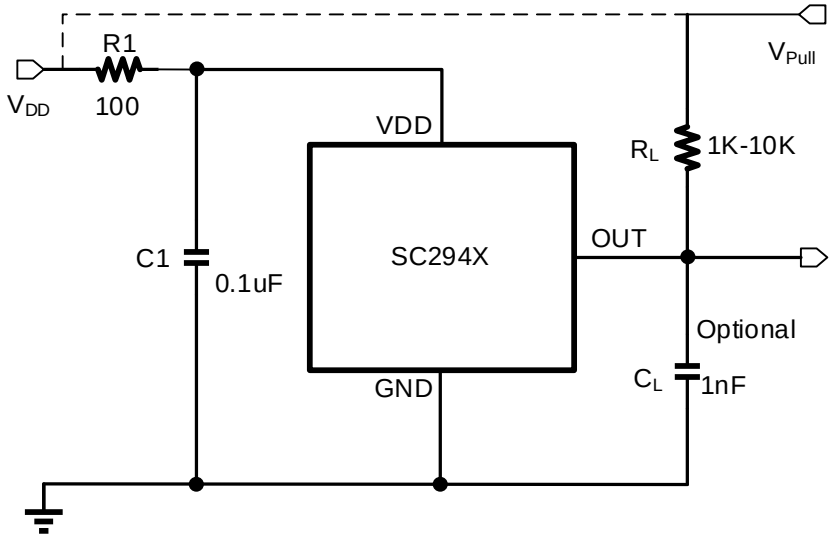


Fig.6 Typical Application Circuit

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 V_{DD} power supply as close as possible and the 100Ω external optional series resistor R1. The output capacitor C_L used as the output filter is typically 1nF. Select a value for C_L based on the system bandwidth specification as follow：

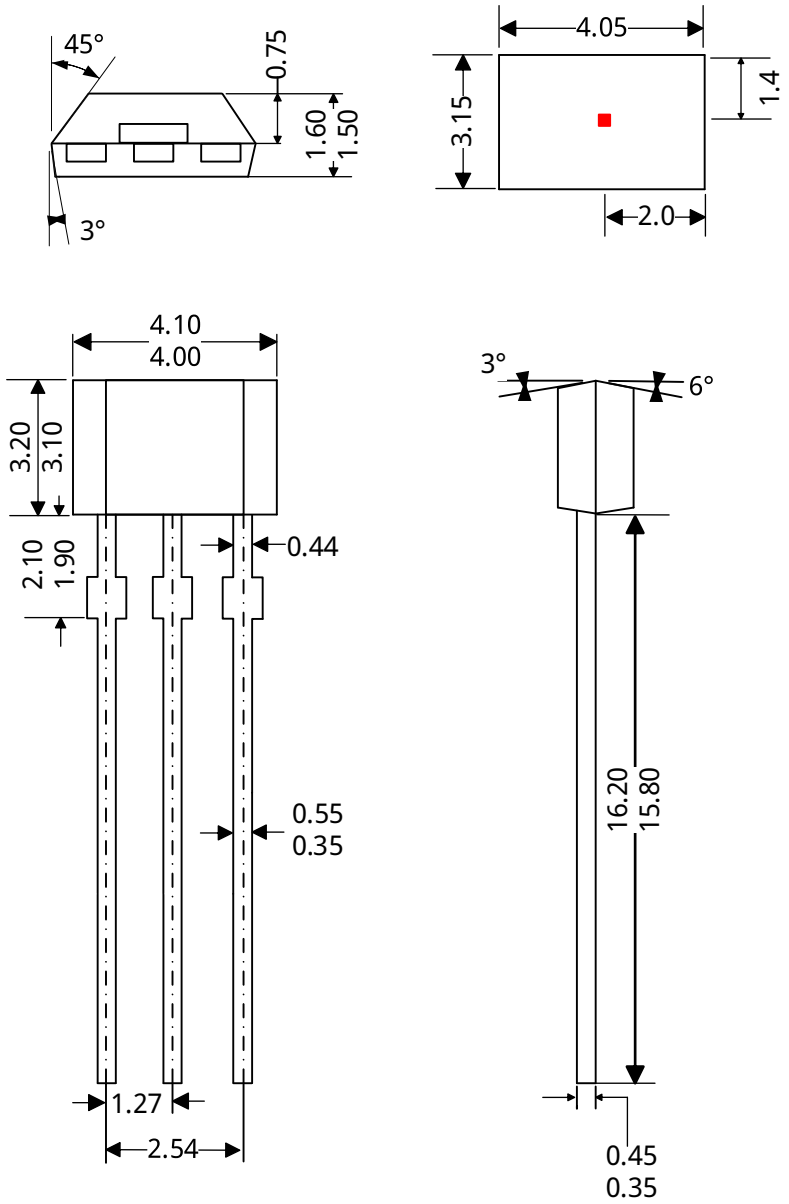
$$C_L < \frac{1}{2\pi \times R_L \times 2 \times f_{BW}(Hz)}$$

V_{PULL} is not restricted to V_{DD} and could be connected to other voltage 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



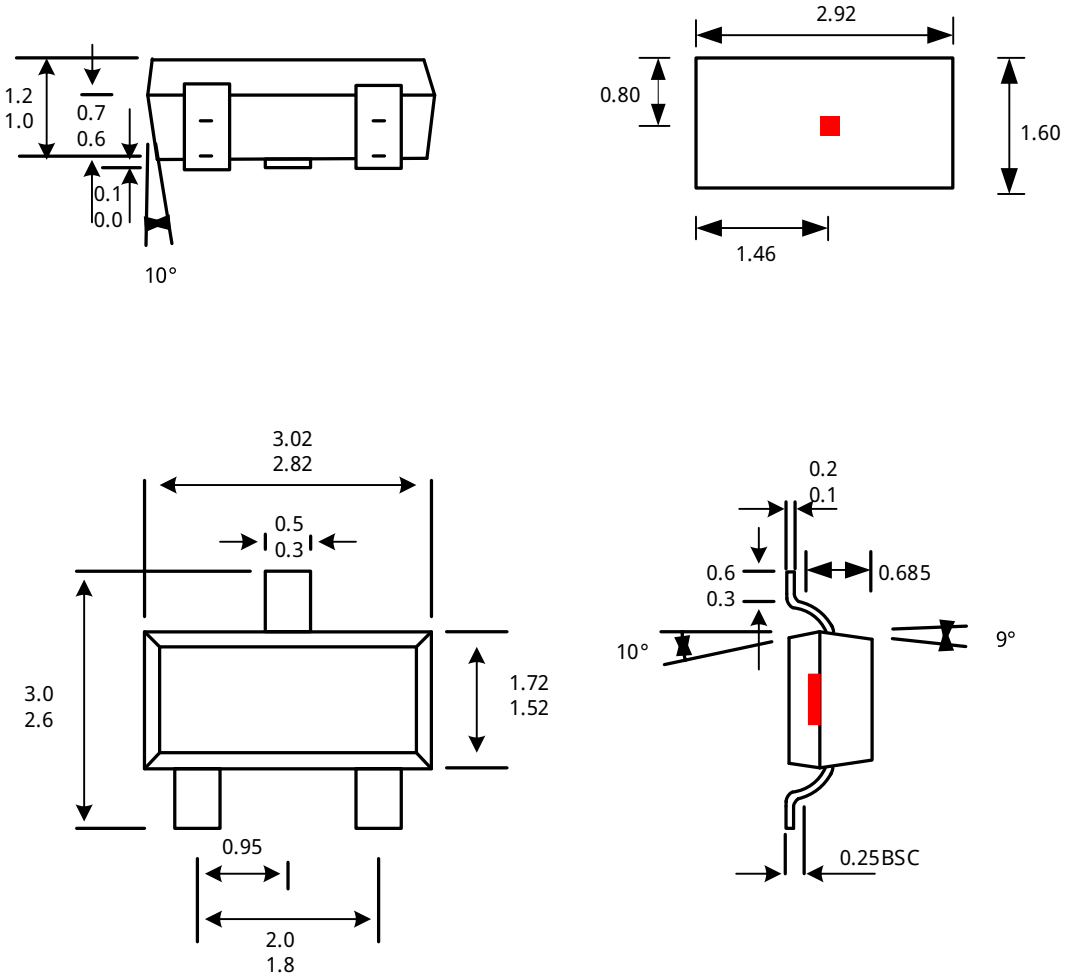
Notes:
(1)Exact body and lead configuration at vendor's option within limits shown.
(2)Height does not include mold gate flash.

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 Hale 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