High Sensitive Digital-Latch Hall Effect Sensor

1. Features

- Supports a wide operation voltage range: 2.8 to 40V
- Supply voltage transient up to 60V with 200Ω R_S resistor.
- Wide operating temperature range: -40℃-150℃
- Reverse battery protection: -28V
- Current limited open drain output: 40mA
- High EMC/ESD immunity
- AEC-Q100 qualified.
- Small package
  - 3-pin TO-92S (UA)
  - 3-pin SOT23-3L (SO)

2. Applications

- BLDC motor commutation
- Seat motor adjuster
- Window lifter
- Sunroof/Tailgate opener
- Tachometers

3. Description

The SC294X family, produced with advanced 60V BCD technology, is a chopper-stabilized Hall Effect Sensor that offers a magnetic sensing solution with superior sensitivity stability 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 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 2.8 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.

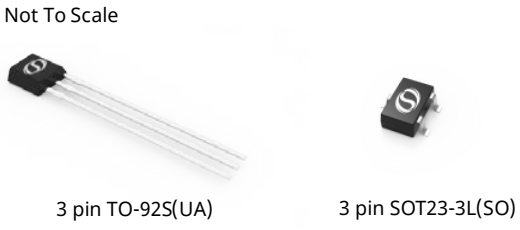

Fig.1 Package Outline

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4. Terminal Configuration

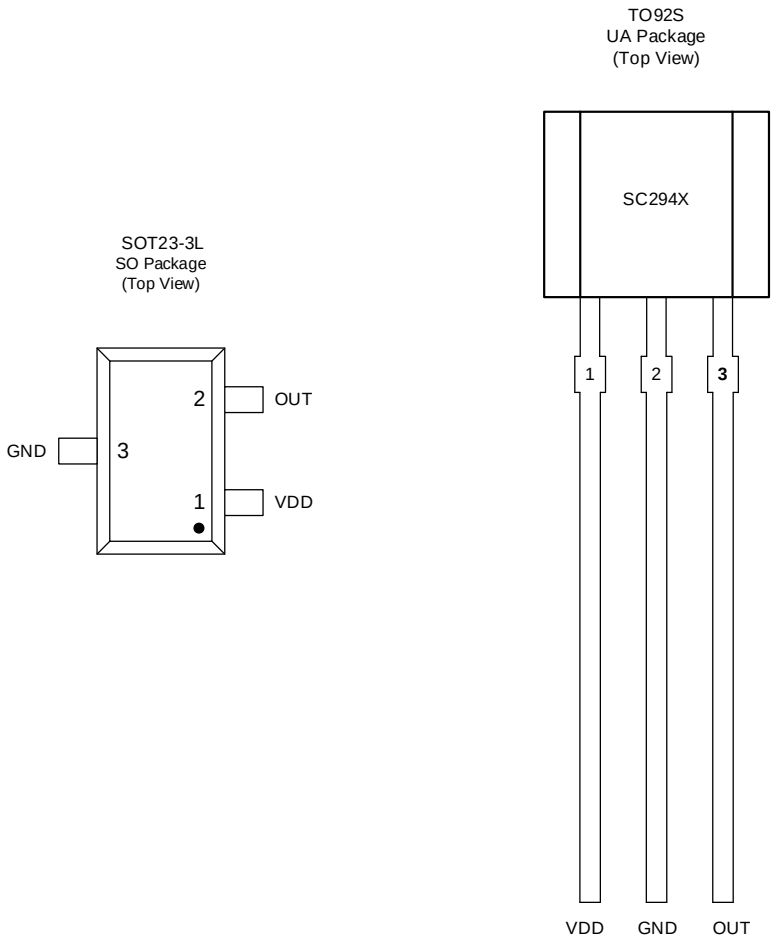


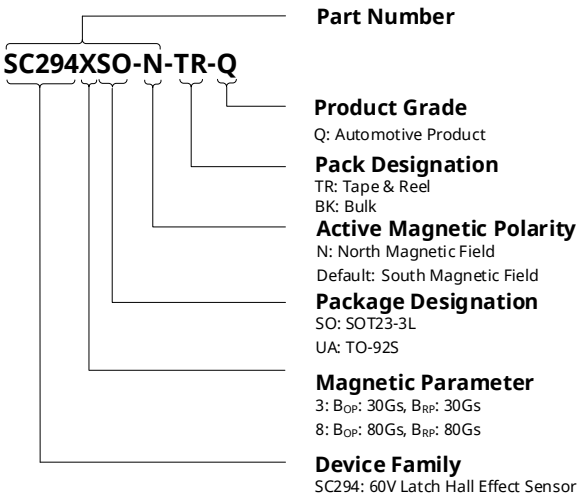
Fig. 2: Terminal Configuration

Terminal			Type	Description
Name	UA	SO		
VDD	1	1	Power	2.8V~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	B_{OP}(Gs)	B_{RP}(Gs)	Ambient, T_A(℃)	Package	Packing	Quantity
SC2943SO-TR-Q	2943	Q	-40~150	SOT23-3L	TR	3000 pieces/reel	3000/reel
SC2943UA-BK-Q	2943	Q	-40~150	TO92S	BK	1000 pieces/bag	3000/reel
SC2948SO-TR-Q	2948	Q	-40~150	SOT23-3L	TR	3000 pieces/reel	3000/reel
SC2948UA-BK-Q	2948	Q	-40~150	TO92S	BK	1000 pieces/bag	1000/bag

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	60	V
V_{OUT}	Output terminal voltage	*For 5 min @ 1.2 kΩ pull up resistor.*	-0.5	60	V
I_{SINK}	Output terminal current sink		0	60	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.

(2) For 5 min @ Rs≥200Ω

(3) For 5 min @ 1.2 kΩ pull up resistor.

(4) For 168 h max.

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	166 (1)	℃/W
$R_{\theta JA}$	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.(2)	Max.	Units
V_{DD}	Operating Voltage (1)	$T_J < T_{J(Max.)}$, IDD=1.2mA	2.8	5	40	V
		$T_J < T_{J(Max.)}$, IDD=4.1mA	3.0		40	
V_{DDR}	Reverse Supply Voltage	I_{DD} < -10mA, T_A=25℃	-28	--	--	V
$UVLO_H$	Under Voltage Lockout High	B>B_{OP}+2.0mT, VDD Rising From 1.5V, IDD=1.2mA		1.75		V
		B>B_{OP}+2.0mT, VDD Rising From 1.5V, IDD=4.1mA		1.95		
$UVLO_L$	Under Voltage Lockout Low	B>B_{OP}+2.0mT, VDD Decreasing From 2.5V, IDD=1.2mA		1.5		V
		B>B_{OP}+2.0mT, VDD Decreasing From 2.5V, IDD=4.1mA		1.7		
$UVLO_{HYS}$	Under Voltage Hysteresis	$UVLO_H$- $UVLO_L$		250		mV
$I_{DD\ (off)}$	Off Stage Operating Current	VDD=3 to 40 V, TA=25℃, SC2943SO-N/SC2943UA		1.2		mA
		VDD=3 to 40 V, TA=25℃ SC2948SO/SC2948UA		4.1		
t_{on}	Power-on time		--	25	40	μS
I_{QL}	Off-state leakage current	Output Hi-Z	--	--	3	μA
V_{SAT}	Output Low Voltage	V_{DD}=5V/12V/40V, I_O=20mA, T_A=25℃	--	0.14	0.4	V
		V_{DD}=5V/12V/40V, I_O=30mA, T_A=125℃	--		0.5	V
I_O	Output Sink Current	V_{DD}=5V/12V/40V, 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%)	R_{PU}(3)=1Kohm C_L=50pF	--	0.2	1	μS
t_f	Output fall time (90% to 10%)	R_{PU}=1Kohm C_L=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)

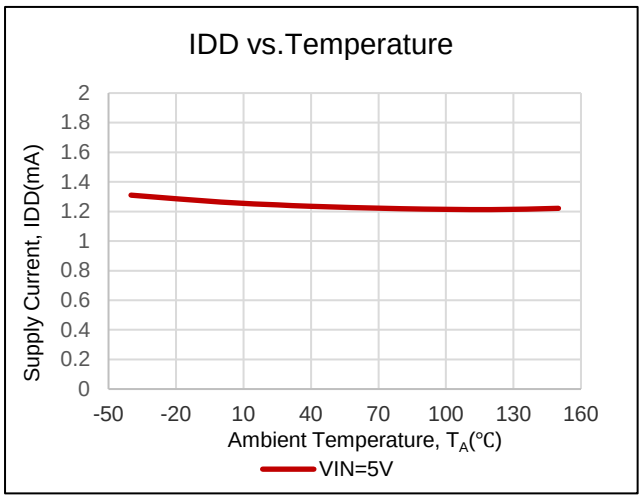
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
f_{BW}	BW		20	--	--	kHz
SC2943SO-TR-Q +3.0 / -3.0 mT						
B_{OP}	Operated point	T_A=-40℃ to 150℃	+1.5	+3.0(2)	+4.5	mT(1)
B_{RP}	Release point		-4.5	-3.0(2)	-1.5	mT
B_{HYS}	Hysteresis		3.0	6.0	9.0	mT
B_O	Magnetic offset	$B_O=(B_{OP}+B_{RP})/2$	-1.5	0	+1.5	mT
IDD	The Supply Current			1.2		mA
SC2943UA-BK-Q +3.0 / -3.0 mT						
B_{OP}	Operated point	T_A=-40℃ to 150℃	+1.5	+3.0	+4.5	mT
B_{RP}	Release point		-4.5	-3.0	-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
IDD	The Supply Current			1.2		mA
SC2948SO-TR-Q +8.0 / -8.0 mT						
B_{OP}	Operated point	T_A=-40℃ to 150℃	+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
IDD	The Supply Current			4.1		mA
SC2948UA-BK-Q +8.0 / -8.0 mT						
B_{OP}	Operated point	T_A=-40℃ to 150℃	+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
IDD	The Supply Current			4.1		mA

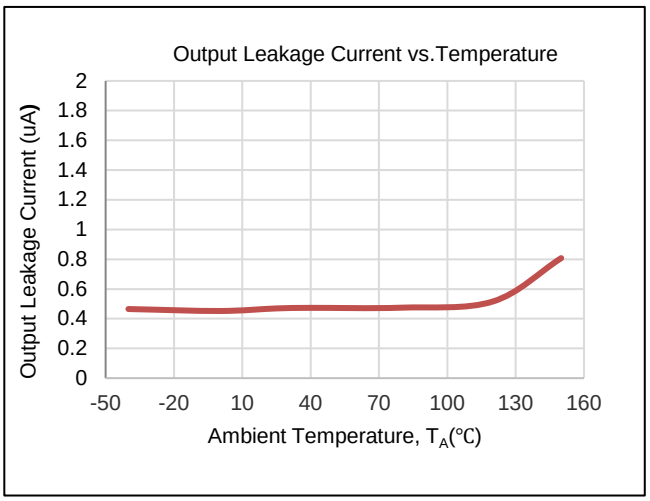
Note:

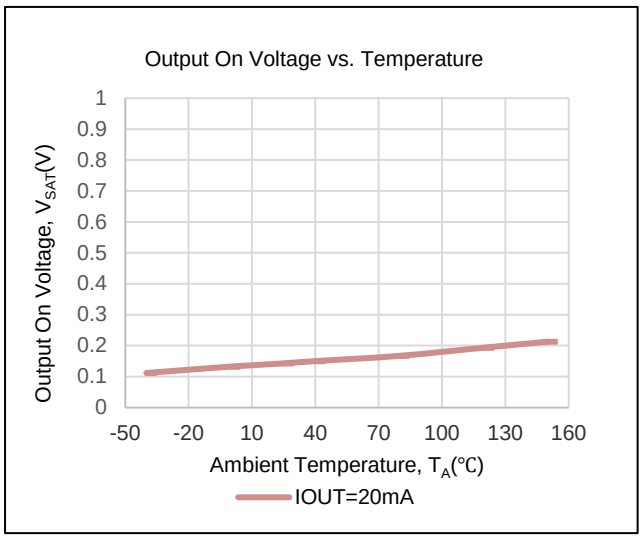
(1) 1mT=10Gs

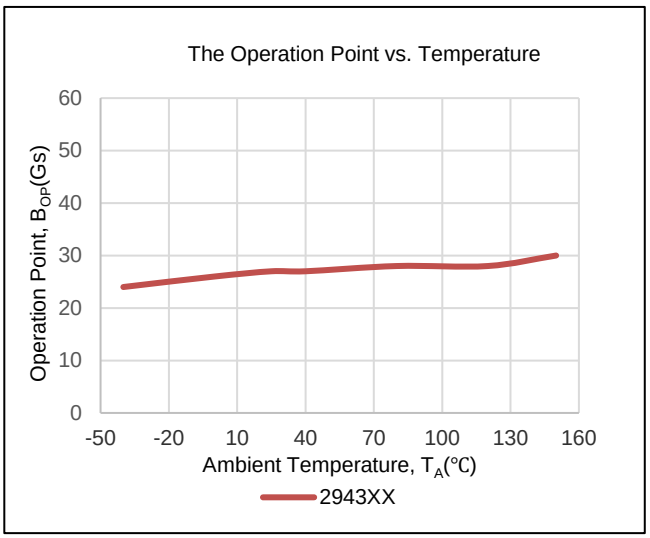
(2) Magnetic flux density, B, is indicated as a negative value for North-polarity magnetic fields, and as a positive value for South-polarity magnetic fields.

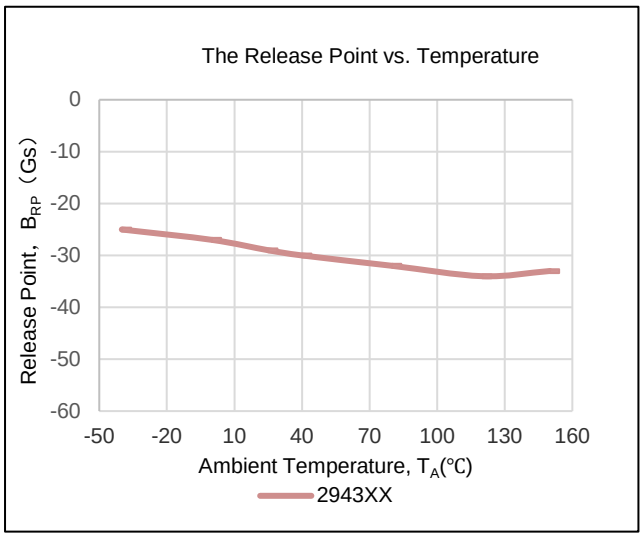
10. Typical Characteristics

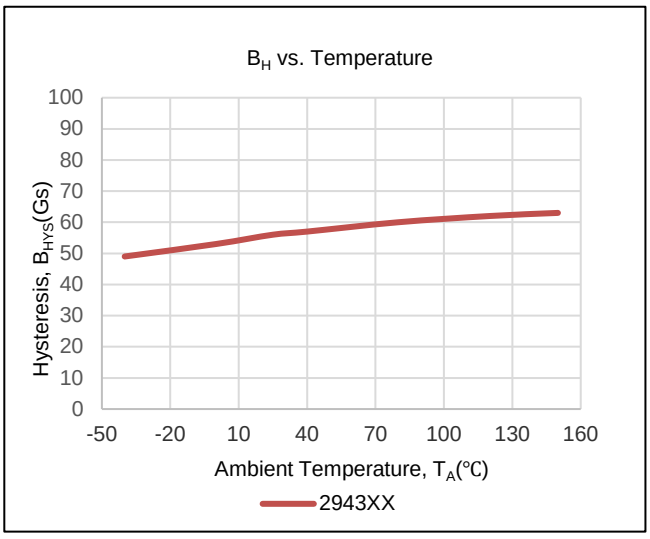


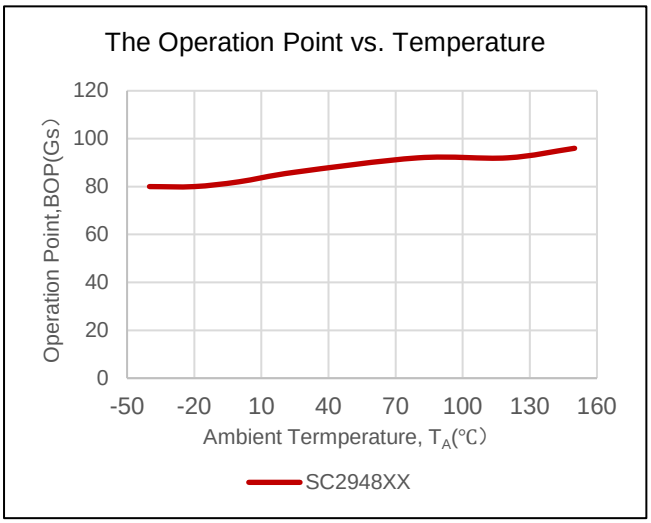


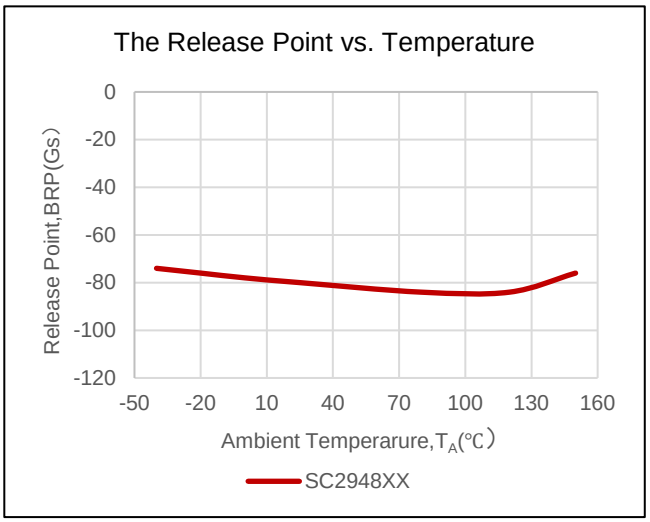


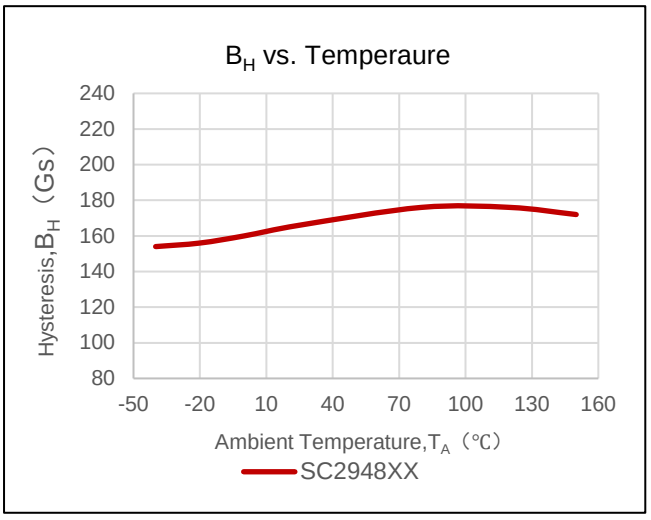







The Operation Point vs. Temperature
Operation Point,BOP(Gs)
120
100
80
60
40
20
0
-50 -20 10 40 70 100 130 160
Ambient Termperature, T_A(℃)
SC2948XX


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(℃)
SC2948XX


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（℃）
SC2948XX

11. Block Diagram

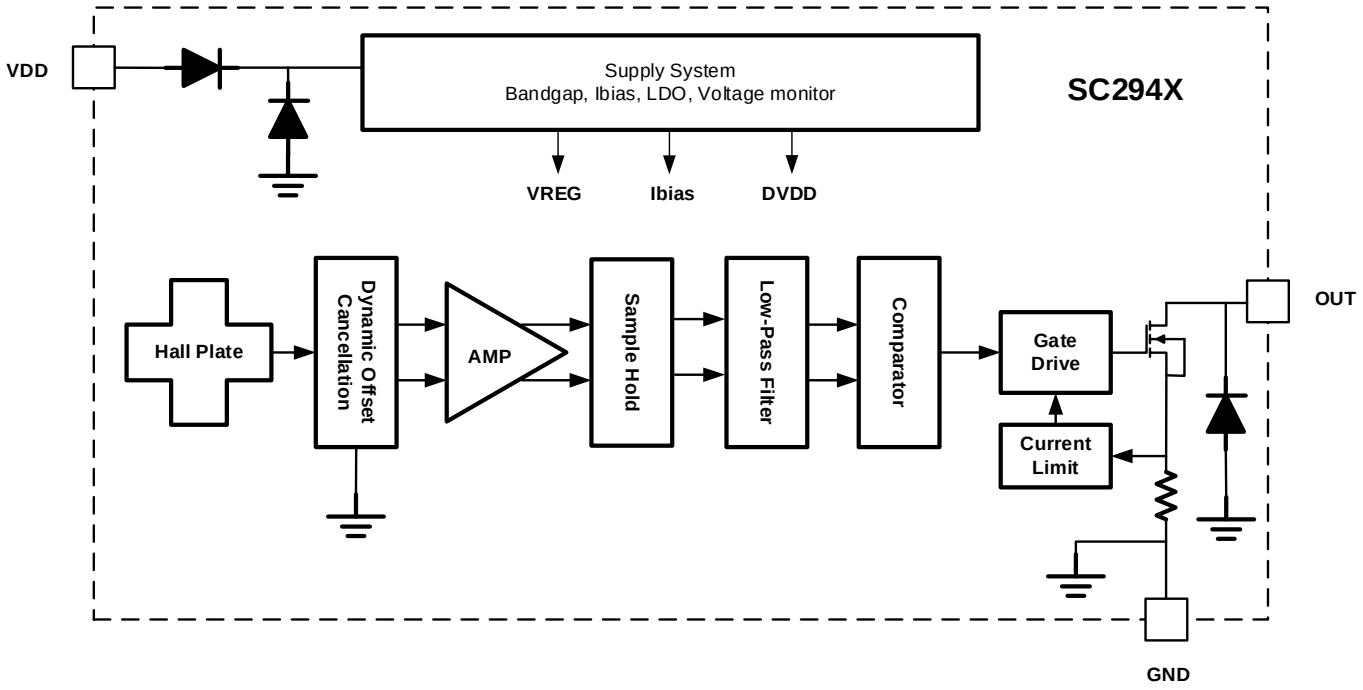


Fig. 3: Function Block Diagram

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 2.8V and 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 20mA 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.

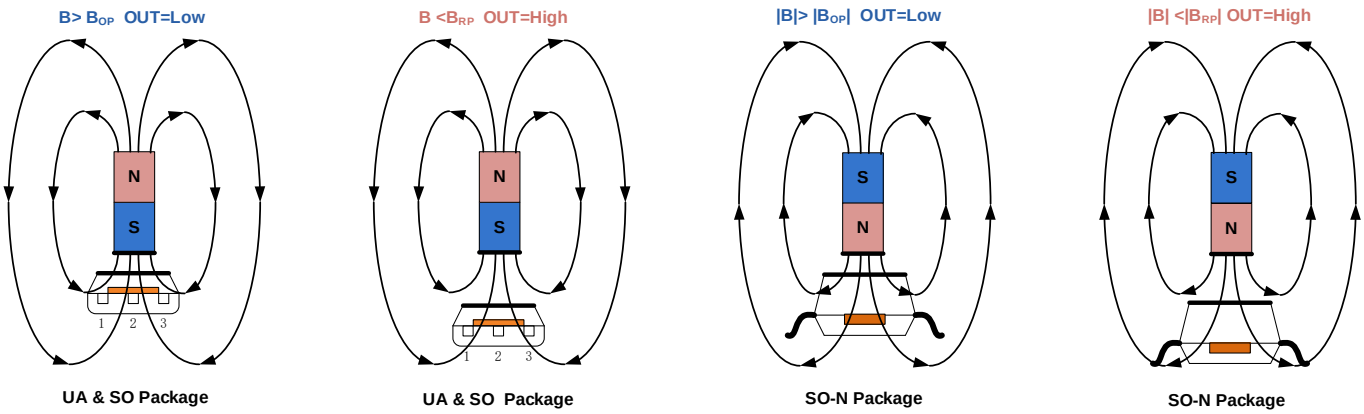


Fig. 4: Magnetic Field Direction Definition

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.

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

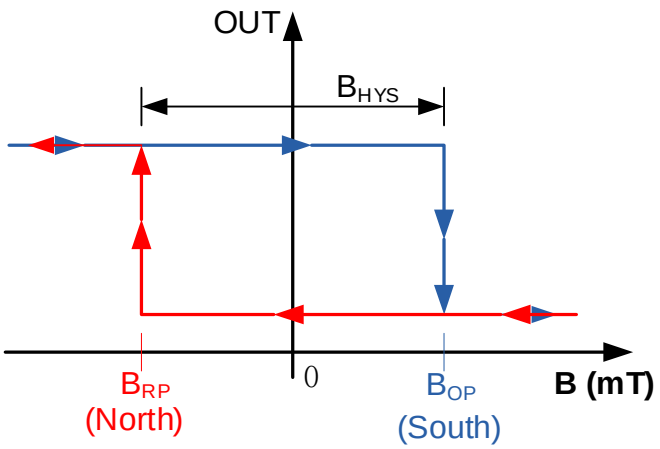


Fig. 5: Magnetic Transfer Function

13. Typical Application

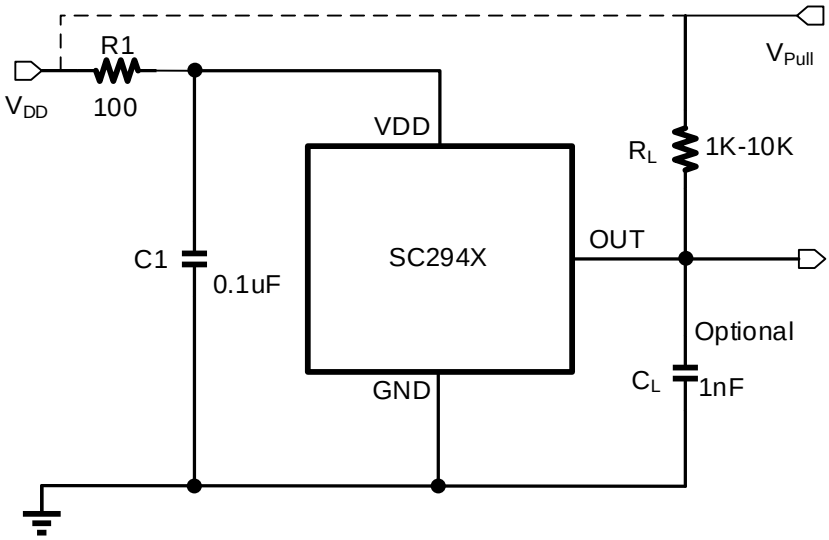


Fig. 6: Typical Application Circuit

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：

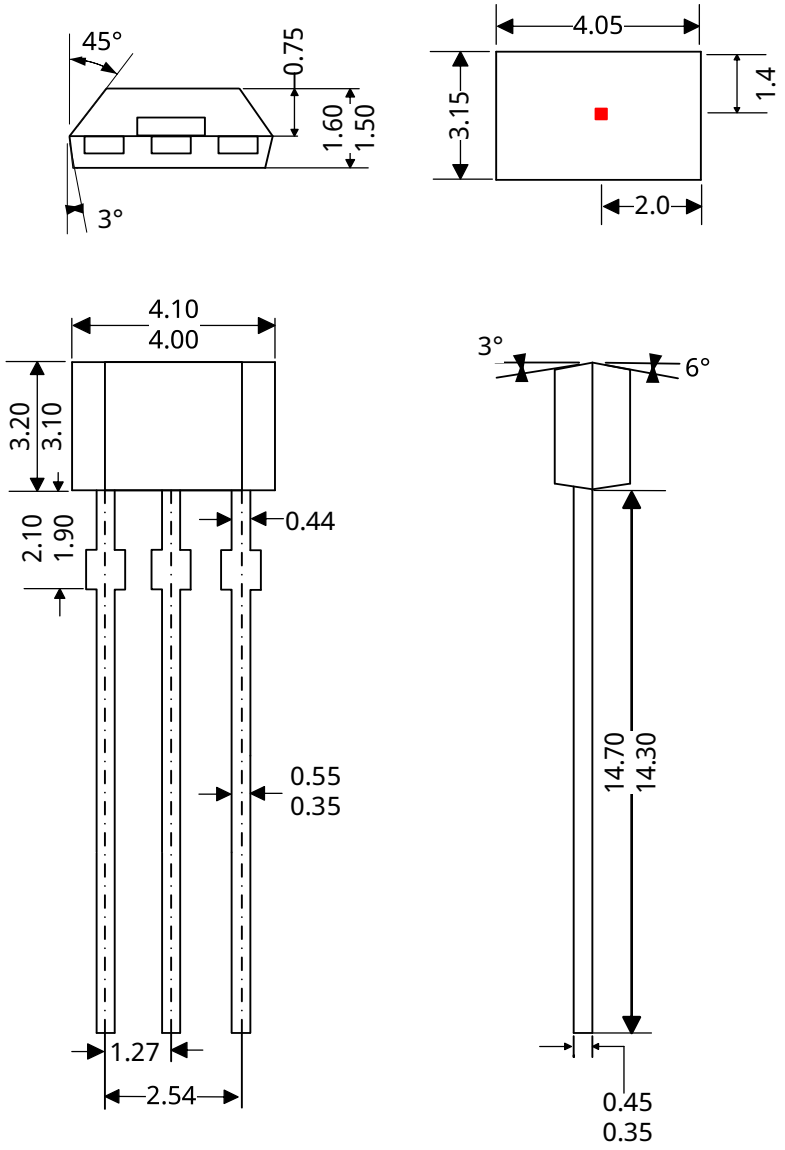
$$C_L < \frac{1}{2\pi \times R_L \times 2 \times f_{BW}(Hz)}$$

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
S1 Package

Dimension:mm



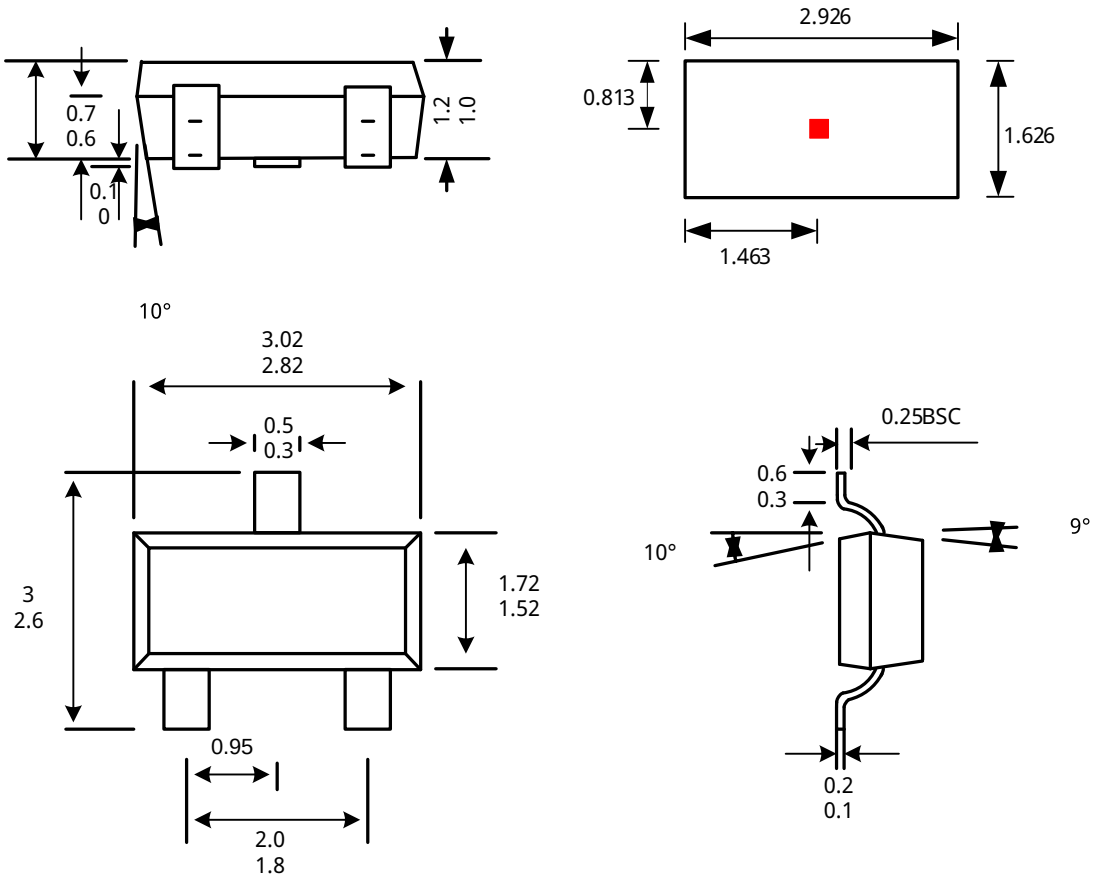
Notes:
1. Exact body and lead configuration at vendor's option within limits shown.
2. Height does not include mold gate flash.

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.

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