2-Wire High Performance Programmable Hall effect sensor

1. Features

- Current output latching Hall - effect sensor.
  - 2-wire output interface
  - Interconnect open/short diagnostics
- AEC-Q100 qualified
- ISO26262 ASIL-B SEooC
- Up to 1MHz high chopping frequency
- Supports a wide operation voltage range:
  - 4 to 24V
- Wide operating temperature range:
  - -40℃ to 150℃
- Reverse battery protection: -28V
- Thermal shutdown protection
- High EMC/ESD immunity
- Multiple packaging forms are available
  - 3 pin TO92S(UA)
  - 3 pin SOT23-3L(SO)
  - 2 pin TO92S(CUB)–Integrate a 100nF capacitor

2. Applications

- Automotive and industrial safety system
- Seat Position detection
- Seat belt buckles
- Door latch switch
- Wiper motor switch Wiper motors

3. Description

The SC2589X family, designed and produced on high voltage BCD process, is a chopper-stabilized 2-wire Hall Effect Sensor with current interface that offers a magnetic sensing solution with superior sensitivity stability over temperature and integrated protection features.

The internal voltage regulator circuit of the chip can withstand a working voltage input voltage range of 4 to 24V, which is suitable for application in the industrial and automotive fields. At the same time, it makes the chip have strong electromagnetic interference (EMC) resistance and high reliability.

SC2589X adopts dynamic misalignment elimination and temperature compensation technology to reduce misalignment caused by process changes, packaging, and temperature stress, and has stable sensitivity. Internally integrated circuit modules include voltage stabilization module, Hall array, amplification circuit, low-pass filter, hysteresis comparator, and output current control.

This device is available in 3-pin SOT23-3L package (SO), 3-pin TO-92S package (UA), and 2-pin TO-92S package (CUB). The 2-wire current-type interface not only saves wires but also facilitates open and short circuit diagnosis.

All packages use 100% lead-free matte tin-plated lead packages.

Fig. 1: Package Outline

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4. Terminal Configuration

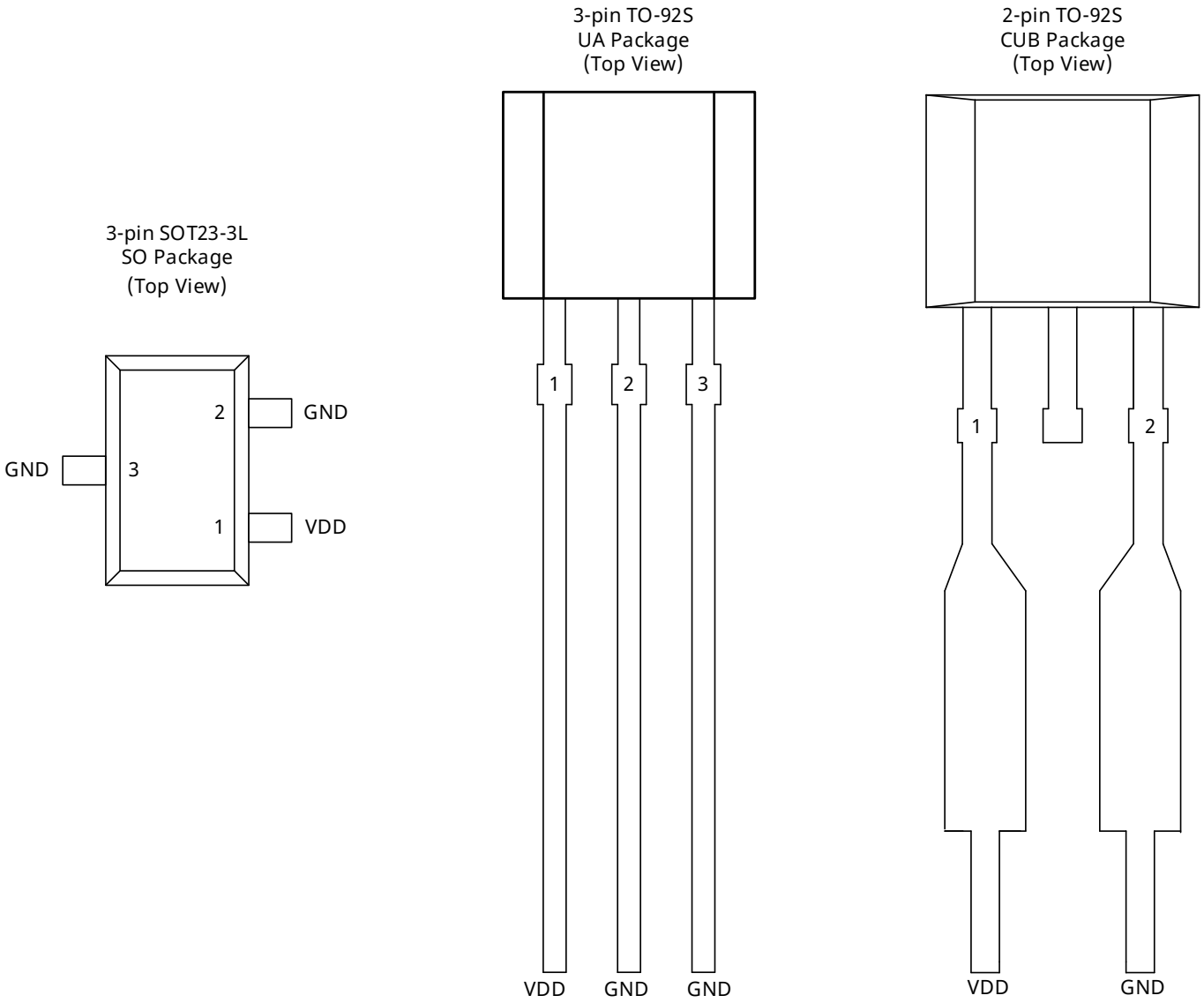


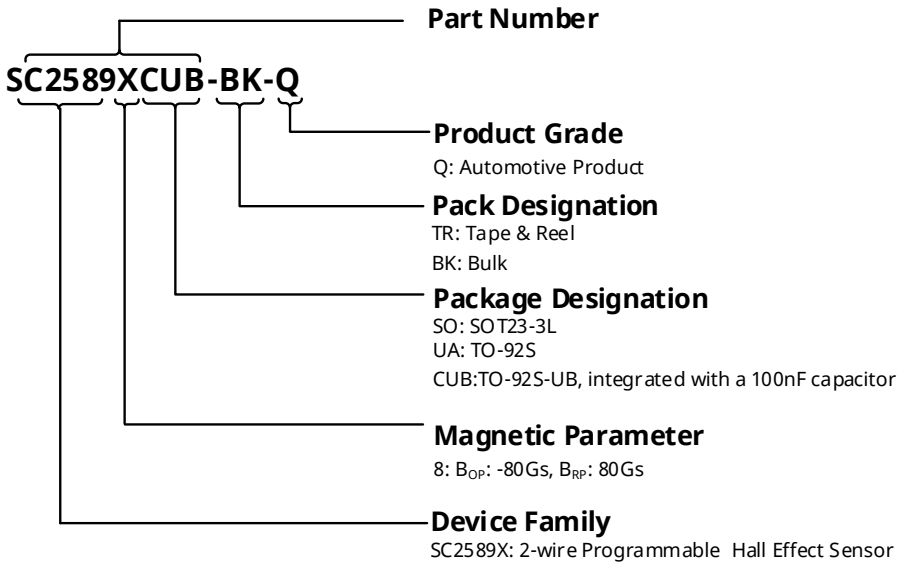
Fig. 2: Terminal Configuration Definition

Terminal				Type	Description
Name	UA	SO	CUB		
VDD	1	1	1	Power	4 to 24V Power Supply
GND	2	3	2	Ground	Ground Terminal
GND	3	2	-	Ground	Ground Terminal

5. Ordering Information

Part Number	Mark	B_{OP}(Gs)	B_{RP}(Gs)	Ambient, T_A	Package	Packing	Amount
SC25898SO-TR-Q	25898	80	-80	-40 to 150℃	SOT23-3L	Reel	3000 pieces/reel
SC25898UA-BK-Q	25898	-80	80	-40 to 150℃	TO92S	Bulk	1000 pieces/bag
SC25898CUB-BK-Q	25898	-80	80	-40 to 150℃	TO92S-UB(PCBLESS)	Bulk	1000 pieces/bag

Ordering Information Format



6. Absolute Maximum Ratings

Within the operating temperature range (unless otherwise specified) (1)

Symbol	Parameter	Test Conditon	Min.	Max.	Units
V_{DD}	Power supply voltage (2)	Rs≥200Ω, no more than 5 minutes	-28	60	V
T_A	Operating ambient temperature		-40	150(2)	℃
T_J	Maximum junction temperature	No more than 168 hours	-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.

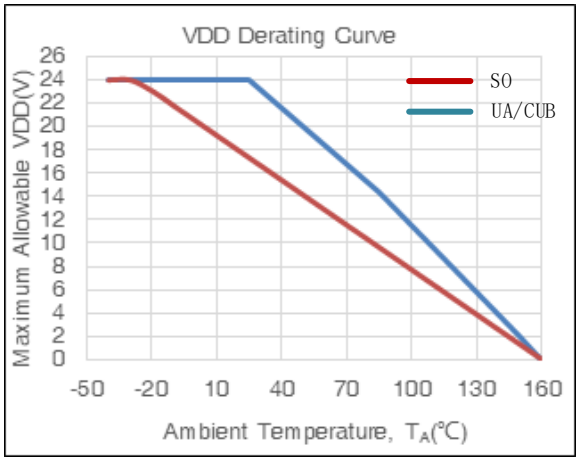
(2) Maximum voltage must be adjusted for power dissipation and junction temperature, see Thermal Characteristics.

7. ESD Protection

Symbol	Parameter	Test Condition	Min.	Max.	Units
V_{ESD_HBM}	HBM	according to standard AEC-Q100-002	-8	8	kV
V_{ESD_HBM}	CDM	according to standard AEC-Q100-011	-750	750	V

8. Thermal Characteristics

Symbol	Parameter	Test Conditions	Rating	Units
$R_{\theta JA}$	UA/CUB Package thermal resistance	Single-layer PCB, with copper limited to solder pads	200(1)	℃/W
$R_{\theta JA}$	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

Within the operating temperature range, VDD = 12 V (unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.(1)	Max.	Units
V_{DD}	Operating Voltage (2)	$T_J < T_{J(Max.)}$	4	12	24	V
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	-	2.5	-	V
$UVLO_L$	Under Voltage Lockout Low	B>B_{OP}+2.0mT, VDD Decreasing From 2.5V	-	2.1	-	V
$UVLO_{HYS}$	Under Voltage Hysteresis	$UVLO_H$- $UVLO_L$	-	400	-	mV
I_{DDL}	Low Supply Current	V_{DD}=4 to 24 V, T_A=25℃	-	4	-	mA
I_{DDH}	High Supply Current	V_{DD}=4 to 24 V, T_A=25℃	-	26	-	mA
t_{on}	Power-on time	V_{DD}>2.5V	-	50	60	μs
t_d	Output delay time	B=B_{RP} to B_{OP}	-	15	40	μs

Note:

(1) Typical values are defined at T_A = +25°C and V_{DD} = 12V

(2) The maximum operating voltage must meet the requirements of power consumption and junction temperature, See Thermal Characteristics.

9.2. Magnetic Characteristics

Within the operating temperature range, VDD = 12 V (unless otherwise specified)

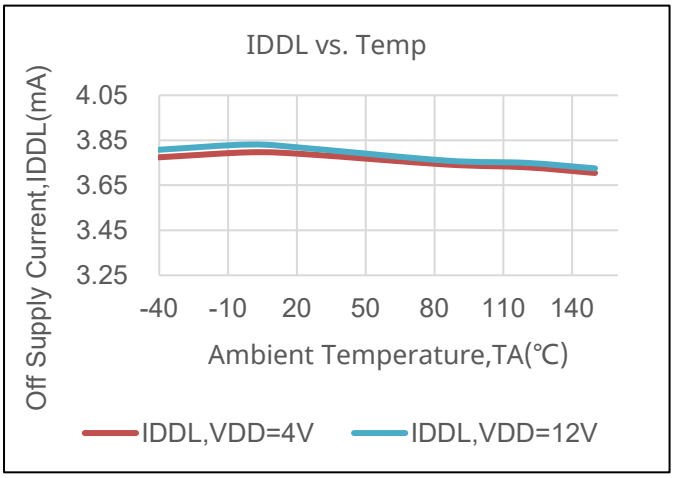
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
f_{BW}	Bandwidth		20			kHz
SC25898SO 8.0 / -8.0 mT						
B_{OP}	Operated point	T_A=25℃	6.0	8.0	10.0	mT
B_{RP}	Release point		-10.0	-8.0	-6.0	mT
B_{HYS}	Hysteresis		12.0	16.0	20.0	mT
B_O	Magnetic offset	$B_O=(B_{OP}+B_{RP})/2$	-2.0	0	+2.0	mT
SC25898UA/CUB -8.0 / +8.0 mT						
B_{OP}	Operated point	T_A=25℃	-10.0	-8.0	-6.0	mT
B_{RP}	Release point		6.0	8.0	10.0	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

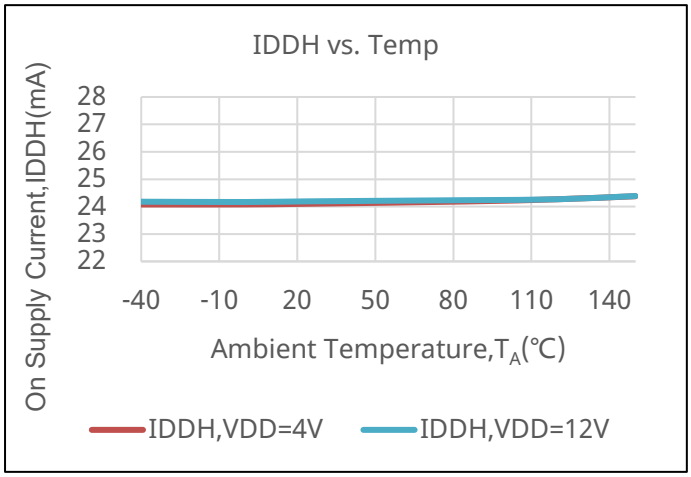
Note:

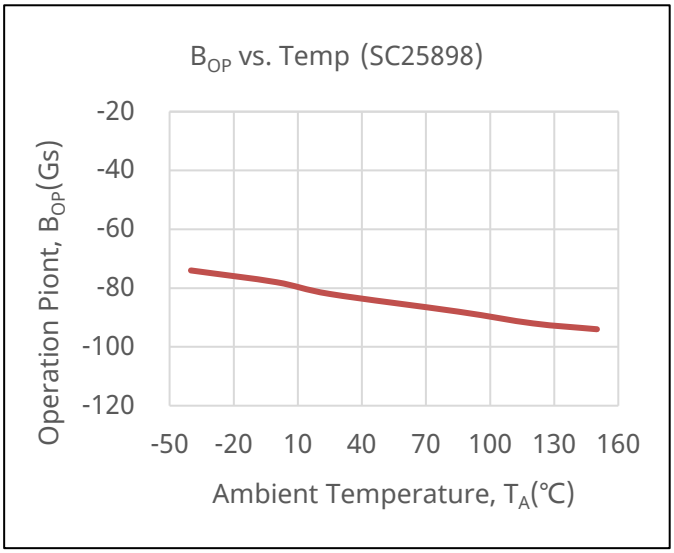
(1)1mT=10Gs

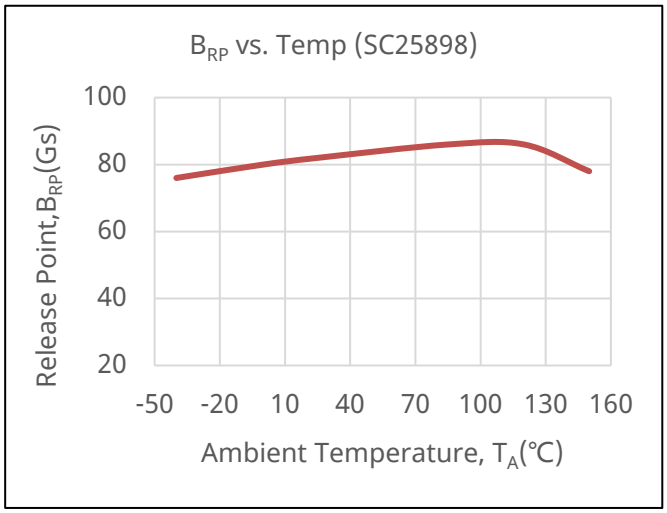
(2) Magnetic flux density, B is indicated as a negative value for North-polarity magnetic fields, and as a positive value for South-polarity magnetic fields.

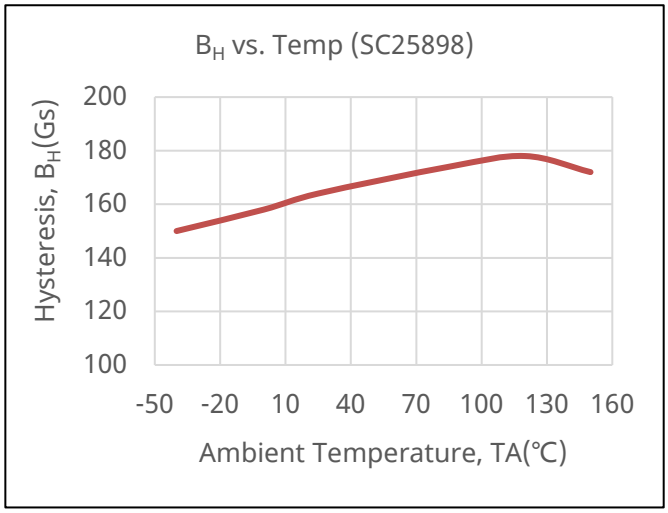
10. Typical Characteristics











11. Block Diagram

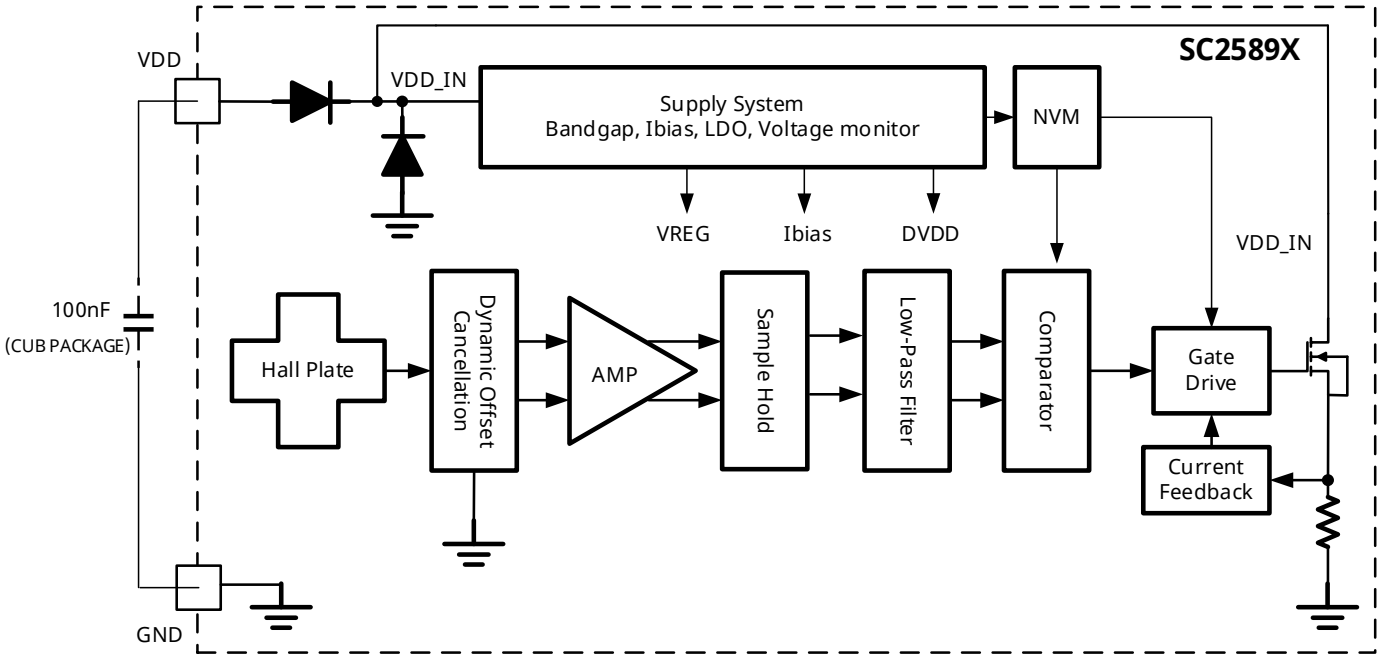


Fig.3: Function Block Diagram

12. Function Description

The SC2589X device is a chopper-stabilized 2-wire Hall sensor with current interface output for magnetic sensing applications. The device can be powered with a supply voltage between 4 to 24V, and continuously survives continuous -28V reverse-battery conditions.

The output of SC2589X series switches to I_{DDH} (turns on) when the absolute value of a magnetic field perpendicular to the Hall element exceeds the absolute value of the operate point threshold, B_{OP}. When the magnetic field is reduced below the absolute value of the release point, B_{RP}, the supply current of the device goes I_{DDL} (turns off). The difference between 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.

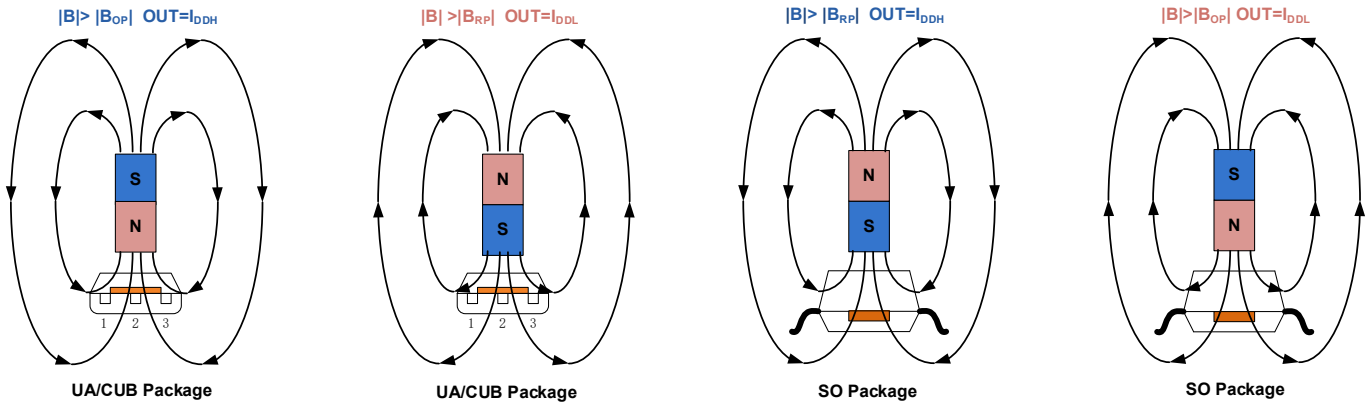


Fig. 4: Magnetic Field Direction Definition

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}. For UA-N package, if the absolute value of the field strength is greater than the absolute value of B_{OP}, then the supply current is high (I_{DDH}). If the absolute value of the field strength is greater than the absolute value of B_{RP}, the output is released, the supply current is low (I_{DDL}). Conversely, for SO package if the absolute value of the field strength is greater than the absolute value of B_{OP}, then the supply current is low (I_{DDL}). If the absolute value of the field strength is greater than the absolute value of B_{RP}, the output is released, the supply current is high (I_{DDH}).

B_{OP}—magnetic threshold for activation of the device output, turning in ON (I_{DDH} for UA-N, I_{DDL} for SO) state

B_{RP}—magnetic threshold for release of the device output, turning in OFF (I_{DDL} for UA-N, I_{DDH} for SO) state.

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

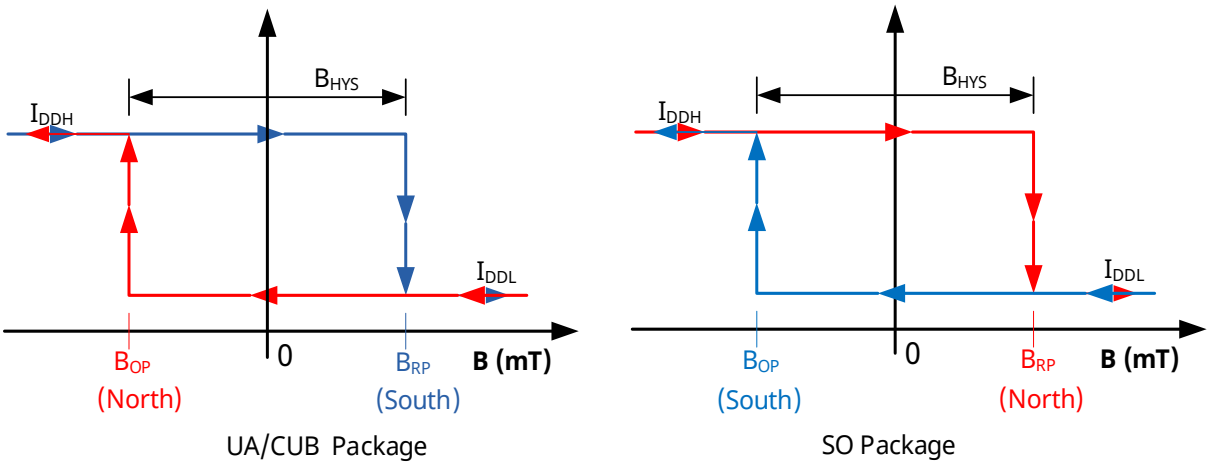


Fig. 5: Magnetic Transfer Function

12.3. Diagnostic Features

When properly supplied, SC2589X always has current flowing at a specified level: either I_{DDH} or I_{DDL}. Any current outside of these narrow ranges is a fault condition. If there is a short, current increases so that IDD > I_{DDH} (max), outside the valid I_{DDH} range. If there is an open, the current lowers below the $_{IDDL}$ (min), outside the valid output current range. In this way, connectivity issues between the ECU and the sensor can easily be detected.

13. Typical Application

The typical application circuit is as follow, RS=100Ω，CP=100nF

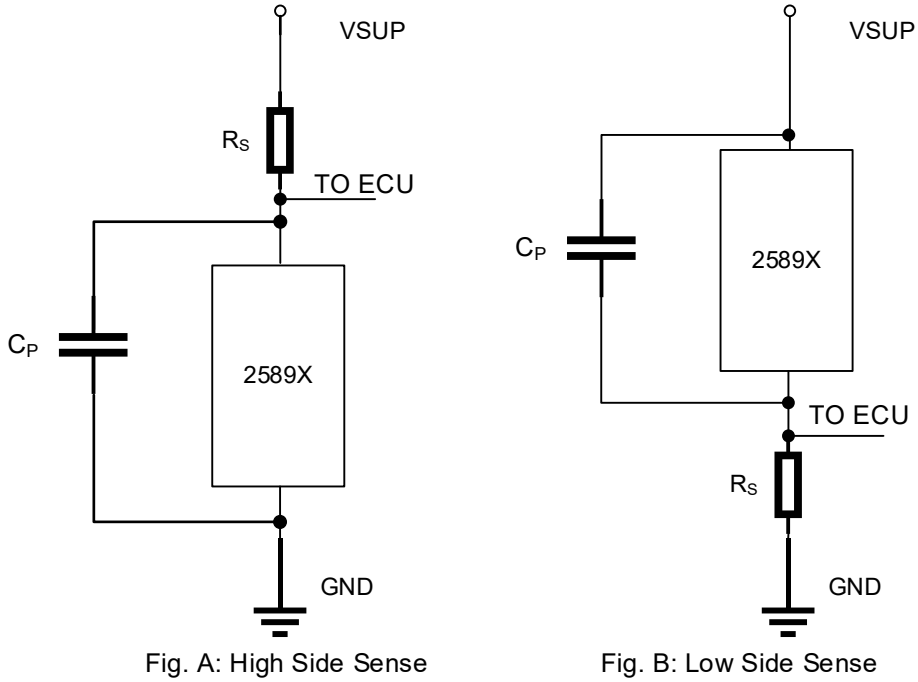


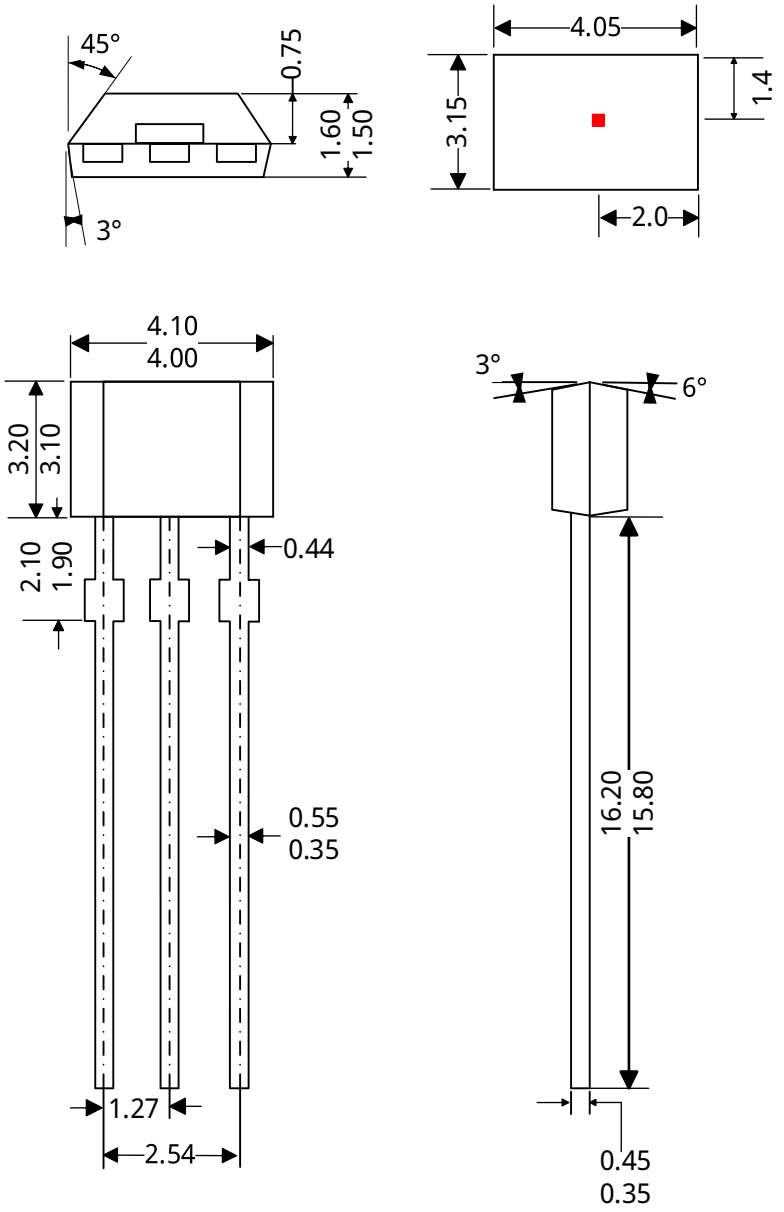
Fig. 6: The Typical Application Circuit

The SC2589X 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 shunt capacitor C_P (From 10nF to 100nF) to the ground as close as possible to V_{DD} power supply, a typical value is 100nF. At the same time, the external series resistor R_S is needed, the typical value is 100Ω. In addition, when using CUB packaging, since the CUB packaging chip already integrates a 100nF capacitor internally, the external Cp capacitor can be omitted when designing the overall sensor scheme, thus achieving a PCBLESS solution without PCBA requirements.

14. Package Information "UA"

3-Terminal
UA Package

Uint:mm



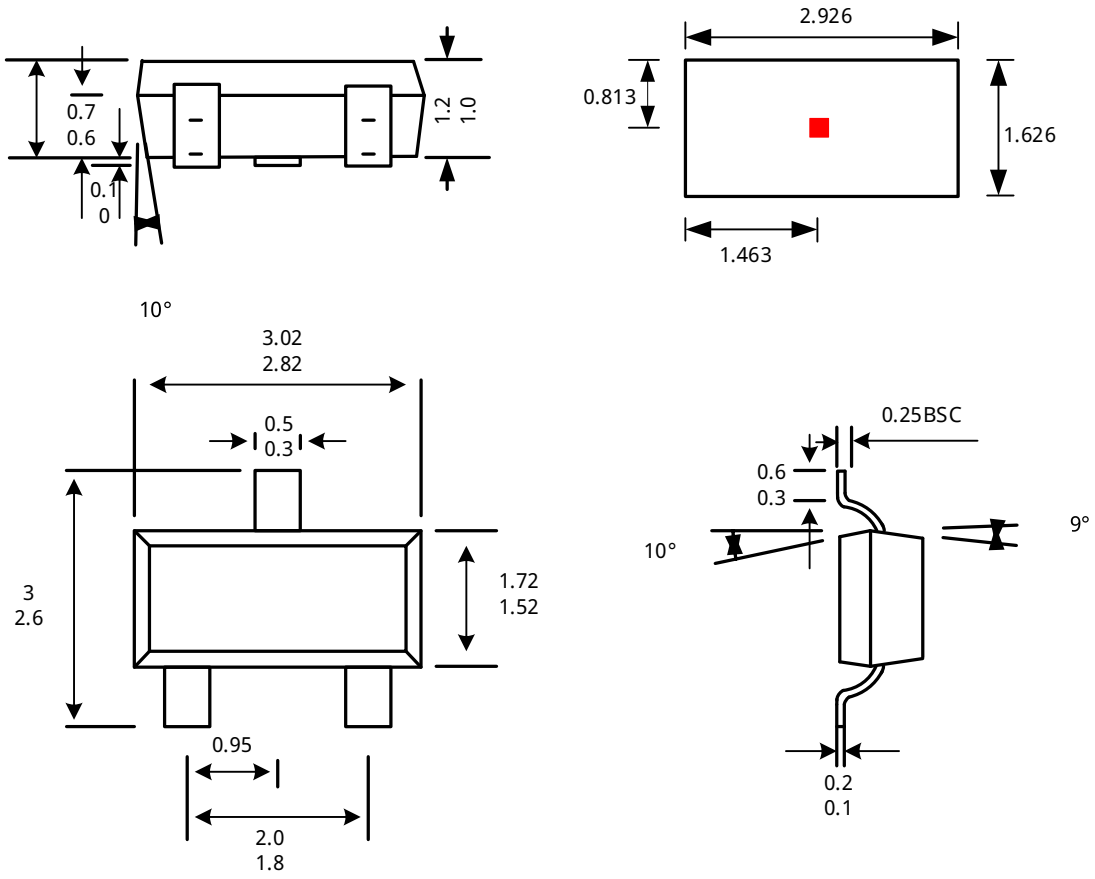
Notes:
1. Exact body and lead configuration at vendor's option within limits shown.
2. Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.

15. Package Information “SO”

3-Terminal
SO Package

Unit:mm



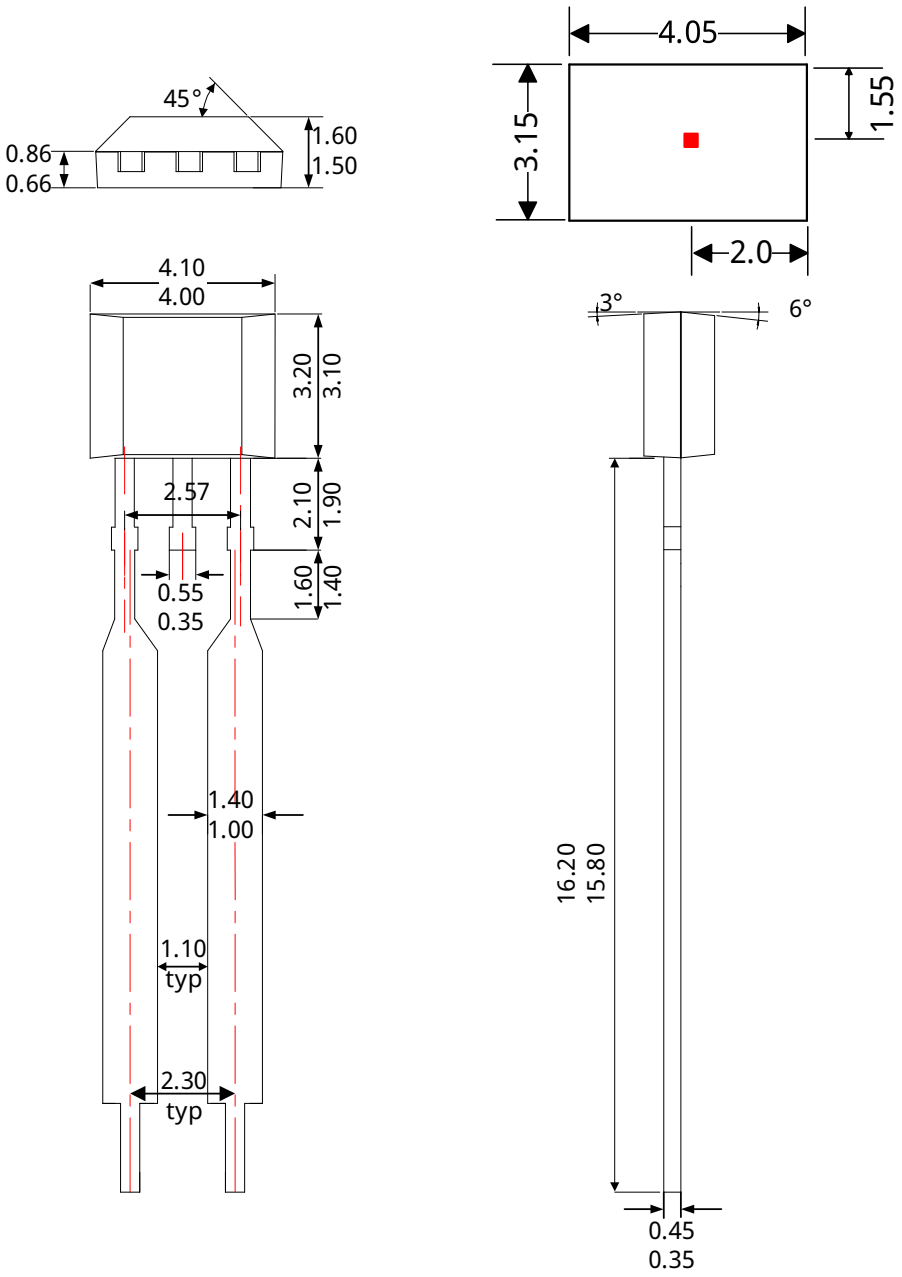
Notes:
1. Exact body and lead configuration at vendor’s option within limits shown.
2. Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.

16. Package Information "CUB"

3-Terminal
TO-92S 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.

17 . Revision History

Revision	Date	Description
Rev.E0.1	2024-12-22	Preliminary datasheet
Rev.A1.0	2025-07-14	Initial Release