Two-Wire Programmable Hall Effect Switches IC

1. Features

- AEC-Q100 grade 0
- ISO26262 ASIL-B
- Two-wire current-type output interface
  - Provincial line
  - Open and short circuit diagnosis
- Programmable parameters：
  - Low current 3.3mA/6mA programmable
  - Unipolar or Omnipolar
  - Sensitivity range: -22mT to 22mT
  - Active Pole: North or South
  - Output: Direct or Inverted
- Wide voltage range: 4V to 24V
- Reverse battery protection: -28V
- CRC check protection
- High EMC/ESD immunity
- Wide operating temperature range:
  - -40℃ to 150℃
- Integrated cap+ TVS (PCB-less)
- Small package:
  - 3-pin TO-92S (TUA)
  - 3-pin TO-92S (UA)
  - 3-pin SOT23-3L (SO)

2. Applications

- Automotive and industrial applications
- Seat position detection
- Seat belt detection
- Protective cover / Luggage case / Door lock storage switch
- Window anti-pinch control
- Wiper motor switch

3. Description

SC2589X is manufactured using BCD technology and is a two-wire current-mode output programmable automotive-grade Hall effect sensor. It is developed in accordance with the ISO 26262 standard and supports the ASIL B functional safety level. Programmable is a key attribute of the SC2589X. Customer can select pre-programed units, or program at end of line to realize the system optimization across a range spanning -22mT to +22mT. And the low current state supports programming of 3.3mA and 6mA.

SC2589X is specifically designed according to the requirements of automotive applications, complies with the AEC-Q100 standard, supports operation with voltages ranging from 4V to 24V,

It has a functional safety function, which outputs a safe current in abnormal situations, and is equipped with a -28V reverse voltage protection function.

SC2589X device is available in either a TO-92S package (UA) and SOT23-3L package (SO).and provides options for capacitors and Transient Voltage Suppressor diodes (PCB-less) integrated in the TO-92S package (UA). All are lead (Pb) free, with 100% matte tin lead frame plating.

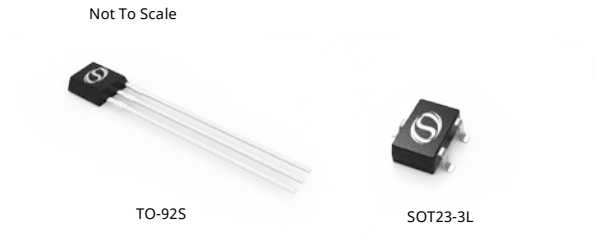

Fig.1 Package Outline

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4. Terminal Configuration

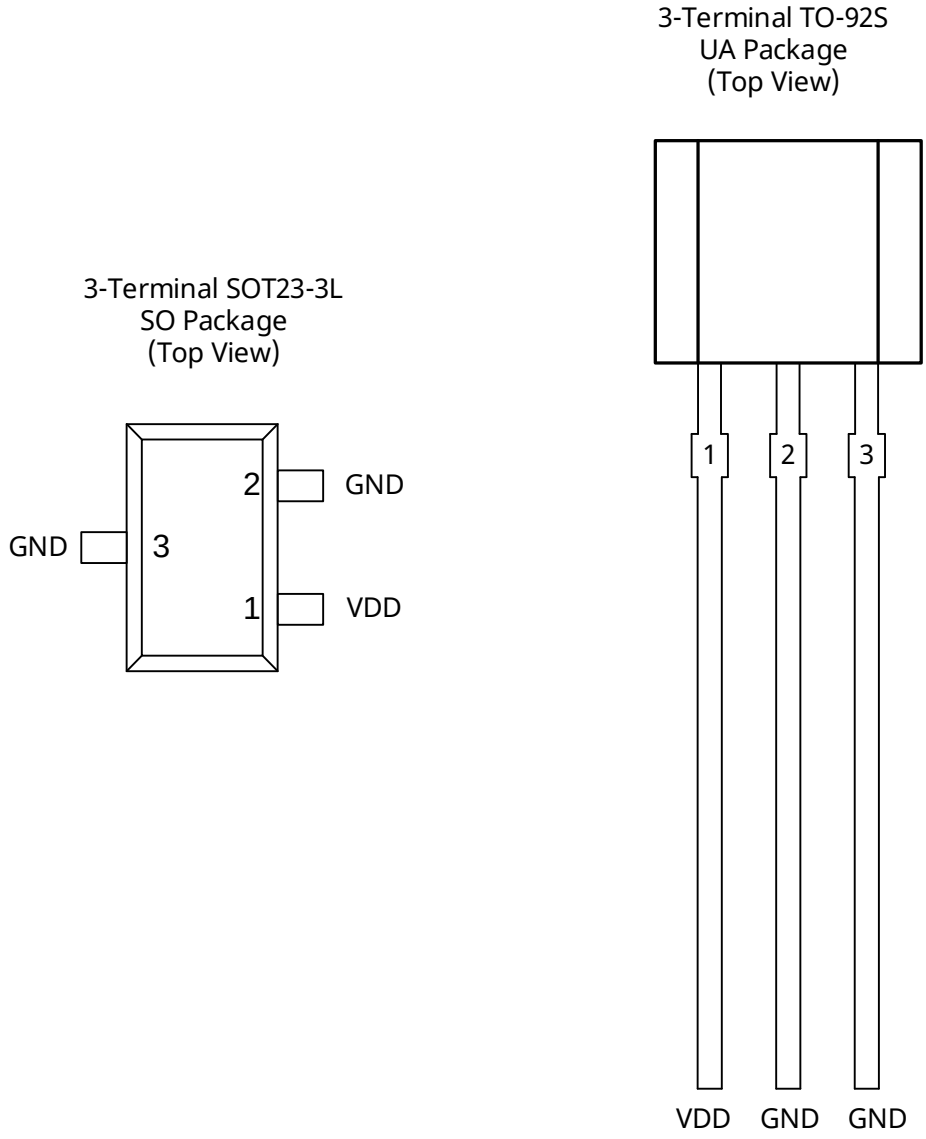


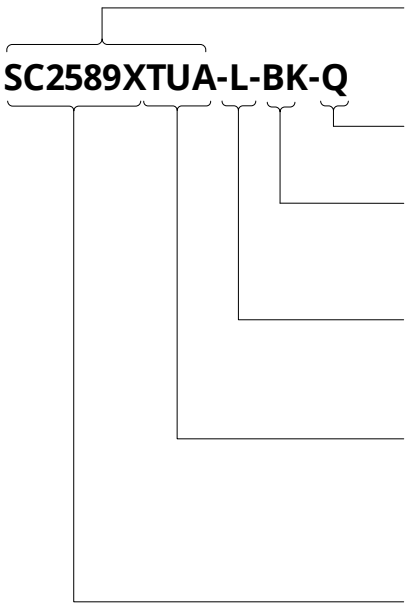
Fig.2 Pin Definition Diagram

Terminal			Type	Description
Name	SO	UA		
VDD	1	1	Power	4V to 24V power supply
GND	2	2	Ground	Ground terminal
GND	3	3	Ground	Ground terminal

5. Ordering Information

Ordering Information	Marking	I_{DDL}(mA)	I_{DDH}(mA)	B_{OP}(mT)	B_{RP}(mT)	Package	Packing	Quantity
SC25892SO-TR-Q	25892	6	14	8.6	7.6	SOT23-3L	Reel	3000/reel
SC25892UA-BK-Q	25892	6	14	8.6	7.6	TO-92S	Bulk	1000/bag
SC25893SO-TR-Q	25893	6	14	8.7	7.3	SOT23-3L	Reel	3000/reel
SC25893TUA-TR-Q	25893T	6	14	8.7	7.3	TO-92S	Reel	2000/reel
SC25893SO-L-TR-Q	25893	3.3	14	8.7	7.3	SOT23-3L	Reel	3000/reel
SC25893UA-L-BK-Q	25893	3.3	14	8.7	7.3	TO-92S	Bulk	1000/bag
SC25894SO-TR-Q	25894	6	14	9.2	7.2	SOT23-3L	Reel	3000/reel
SC25894UA-BK-Q	25894	6	14	9.2	7.2	TO-92S	Bulk	1000/bag
SC25894SO-L-TR-Q	25894	3.3	14	9.2	7.2	SOT23-3L	Reel	3000/reel
SC25894UA-L-BK-Q	25894	3.3	14	9.2	7.2	TO-92S	Bulk	1000/bag
SC25895SO-TR-Q	25895	6	14	12.2	10.9	SOT23-3L	Reel	3000/reel
SC25895UA-BK-Q	25895	6	14	12.2	10.9	TO-92S	Bulk	1000/bag
SC25899SO-TR-Q	25899	PROG	PROG	PROG	PROG	SOT23-3L	Reel	3000/reel
SC25899UA-BK-Q	25899	PROG	PROG	PROG	PROG	TO-92S	Bulk	1000/bag

Ordering Information Format



Part Number

Product Grade
Q: Automotive Product

Pack Designation
TR: Tape & Reel
BK: Bulk

Function
Blank: 6.0mA/14mA
L: 3.3mA/14mA

Package Designation
SE: SOT23-3L
UA: TO-92S
TUA: TO-92S Add cap and TVS(PCB-less)

Device Family
SC2589X: Tow-Wire Programmable Hall Effect Switches IC

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	-	-	60	V
V_{DD}	Power supply voltage	PCB-less package (2)	-	40	V
I_{DD}	Supply current	-	-	40(3)	mA
$V_{DD\ REV}$	Output terminal current sink	-	-30	-	V
$I_{DD\ REV}$	Reverse supply current	-	-20	-	mA
T_A	Operating ambient temperature	-	-40	150	℃
T_J	Maximum junction temperature	For 168h max	-40	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) PCB-less package integrated 40V TVS
(3) For maximum 500ms

7. ESD Protection

Symbol	Parameter	Test Conditions	Min.	Max.	Units
V_{ESD_HBM}	HBM	According to: standard AEC-Q100-002 HBM	-8	+8	kV
V_{ESD_HBM}	HBM(PCB-less)	According to: standard AEC-Q100-002 HBM	-15	+15	kV
V_{ESD_CDM}	CDM	According to: standard AEC-Q100-011 CDM	-2	+2	kV

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
$R_{\Theta ja}$	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

over operating free-air temperature range V_{DD}=12V (unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.(1)	Max.	Units
V_{DD}	Operating voltage	$T_J < T_{J(Max.)}$	4.0	12	24	V
I_{Low}	Operating supply current	V_{DD}= 3.0 to 24V	2.0	3.3	5.0	mA
			5.0	6.0	6.9	mA
I_{High}	Operating supply current	V_{DD}= 3.0 to 24V	12	14	17	mA
I_{Rev}	Reverse Supply current	V_{DD}= -24V	-1	-	-	mA
I_{SAFE}	Safe Mode Supply Current		-	1.0	1.5	mA
$t_{(on)}$	Power-on time	V_{DD}= 12V, B＞B_{OP}	-	170	300	μs
$UVLO_H$	Under Voltage Lockout High	B>B_{OP}, V_{DD} Rising From 2V	-	1.95	-	V
$UVLO_L$	Under Voltage Lockout Low	B>B_{OP}, V_{DD} Decreasing From 4V	-	1.85	-	V
$UVLO_{HYS}$	Under Voltage Hysteresis	$UVLO_H$- $UVLO_L$	-	100	-	mV
t_{ON}	Power on time	V_{DD}= 5.0V	-	170	300	μs
t_d	Output delay time	V_{DD} =12V, R_{sense}=100Ω, C_{BYP}=100nF	-	-	25	μs
Sr	Output Slew Rate	V_{DD} =12V, R_{sense}=100Ω, C_{BYP}=100nF	1.0	3.0	5.0	μs
F_{sw}	Maximum switching frequency		10	-	-	kHz
C_{intg}	Integrated bypass capacitor		-	100	-	nF
TVS_{intg}	Integrated TVS BV voltage		-	40	-	V

9.2. Magnetic Characteristics

over operating free-air temperature range, V_{DD} = 12V (unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
SC25892 8.6(1)/7.6mT (2)						
B_{OP}	Operating point	T_A=25℃	7.1	8.6	10.1	mT
B_{RP}	Release point		6.0	7.6	9.2	mT
B_{HYS}	Hysteresis		-	1.0	-	mT
SC25893 8.7/7.3mT						
B_{OP}	Operating point	T_A=25℃	7.2	8.7	10.3	mT
B_{RP}	Release point		5.7	7.3	9.0	mT
B_{HYS}	Hysteresis		-	1.4	-	mT
SC25894 9.2/7.2mT						
B_{OP}	Operating point	T_A=25℃	6.0	9.2	12.0	mT
B_{RP}	Release point		5.0	7.2	10.5	mT
B_{HYS}	Hysteresis		-	2.0	-	mT
SC25895 12.2/10.9mT						
B_{OP}	Operating point	T_A=25℃	10.4	12.2	14.0	mT
B_{RP}	Release point		9.0	10.9	12.8	mT
B_{HYS}	Hysteresis		-	1.3	-	mT
SC25899 normal power mode programmable unipolar switch						
B_{OP}	Operating point	T_A=25℃	-22	-	22	mT
B_{HYS}	Hysteresis		0.5	-	10	mT
$B_{OP(STEP)}$ (3)	Average Magnetic Step Size		0.3	0.5	0.7	mT
$B_{HYS(STEP)}$ (4)	Average Hysteresis Step Size		0.3	0.5	0.7	mT
$B_{OP(INT)}$	Initial Operation Point		6	8.2	10	mT
$B_{HYS(INT)}$	Initial Hysteresis		1	2	3.5	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

(3) $B_{OP(STEP)}$ is a calculated average from the cumulative programmed bits

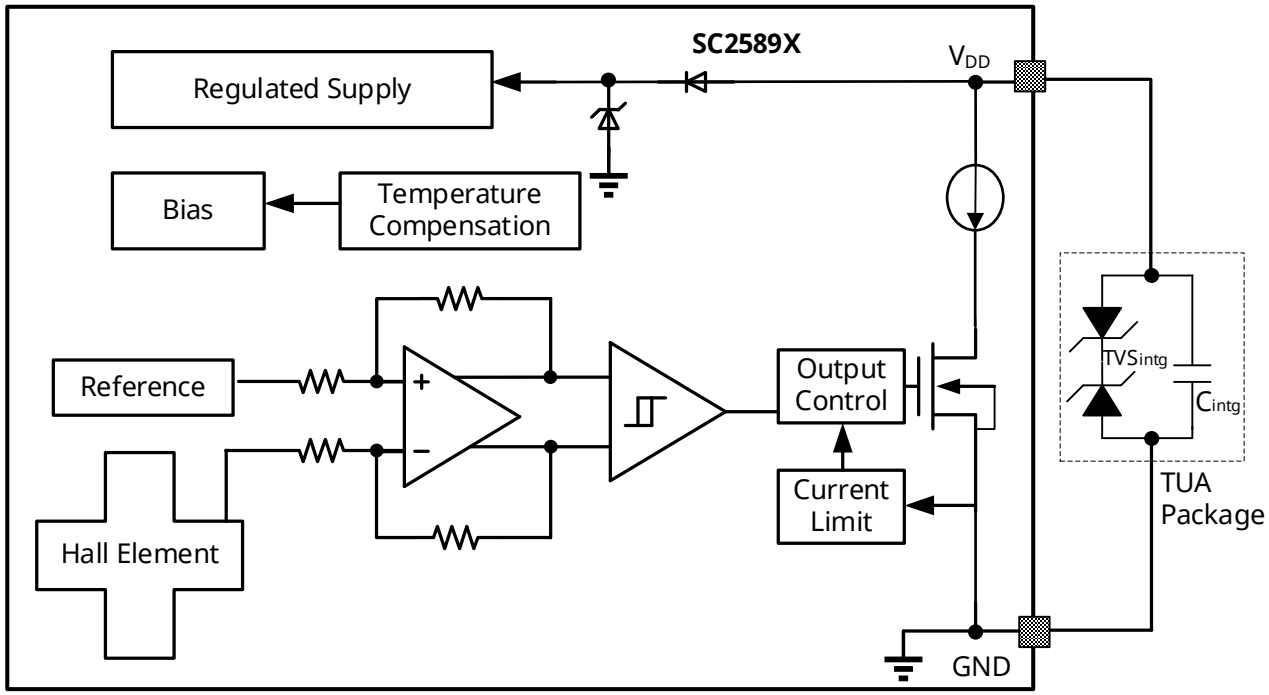
(4) $B_{HYS(STEP)}$ is a calculated average from the cumulative programmed bits

9.3. Program Related Specification

V_{DD} = 12.0V, T_A=-40℃ to 150℃ (unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Units
BOPSEL	Operation Point Magnitude Programming		-	6	-	BIT
HYSSEL	Magnitude Hysteresis Programming		-	6	-	BIT
MAG_POL	Magnetic Polarity Selection	The default value is 0.	-	1	-	BIT
OMNI	Unipolar/Omnipolar/Latch Selection	The default value is 0.	-	1	-	BIT
LTH	Unipolar/Omnipolar/Latch Selection	The default value is 0.	-	1	-	BIT
OUT_POL	Output Polarity Selection	The default value is 0.	-	1	-	BIT
IDDL	Low current level selection	The default value is 1.	-	1	-	BIT

10. Block Diagram



Comments: Only TO-92 TUA Package integrated a capacitor and a TVS between V_{DD} and GND

Fig. 3 Functional block diagram

11. Function Description

The SC2589X device is a two-wire current-mode programmable Hall effect sensor that provides an indication when the magnetic flux density exceeds a threshold. Programming can be performed at the end of the line to optimize the sensor on a per unit or per module basis. The user can select the magnetic operating points across a range spanning -22 mT to 22 mT, the magnitude hysteresis across a range spanning 0.5 mT to 10 mT, and whether the device responds to north or south magnetic fields (unipolar switch) or both (omnipolar switch), and output polarity (direct or inverted). In addition, the low current state supports programming at 3.3 mA and 6 mA.

The output of SC2589X switches I_{DD} is I_{Low}, when a magnetic field (South polarity) perpendicular to the Hall element exceeds the operating point threshold, B_{OP}. When the magnetic field is reduced below the release point, B_{RP}, the device I_{DD} is I_{High}. The difference in the magnetic operation 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.

11.1. Magnetic Field Direction Definition

A positive magnetic field is defined as the magnetic South pole facing the marked side of the package.

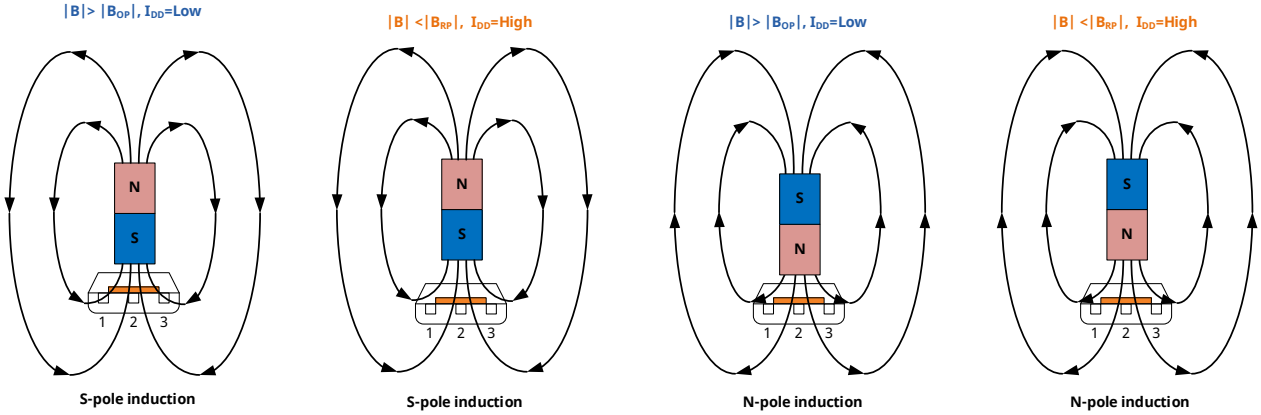


Fig.4 Magnetic Field Direction Definition

11.2. Transfer Function

"Omnipolar" 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.

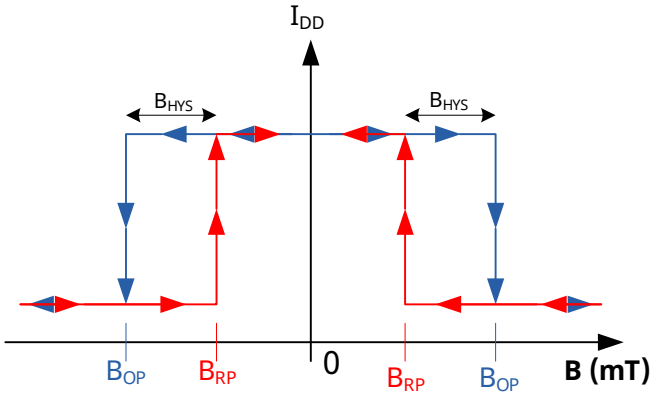


Fig.5 Omnipolar Transfer Function diagram

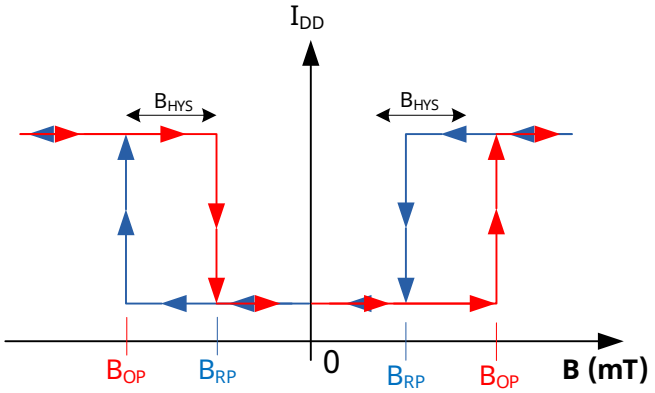


Fig.6 Omnipolar and Unipolar Inverted output Transfer Function diagram

"Unipolar" magnetic characteristics, it means the device only reacts to North or South magnetic pole.

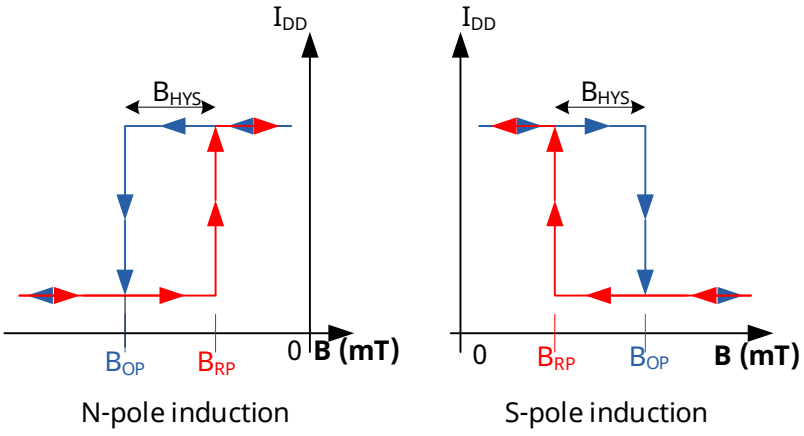


Fig.7 Unipolar Transfer Function diagram

12. Typical Application

It is strongly recommended that an external bypass capacitor, C_{BYP}, be connected (in close proximity to the Hall sensor) between the supply and ground of the device to guarantee correct performance under harsh environmental conditions and to reduce noise from internal circuitry. As is shown in Figure Below, a 0.01 μF capacitor is typical. Use of a larger bypass capacitor may result in a slower output slew rate and should be evaluated according to the requirements set forth by the application. Additionally, an optional output load capacitor may be added in parallel with the sense resistor for increased signal filtering and EMC immunity.

In addition, when using TUA packaging, since the TUA packaging chip already integrates a capacitor and a TVS diode internally, the external C_{BYP} capacitor can be omitted when designing the overall sensor scheme, thus achieving a PCB-less solution without PCBA requirements.

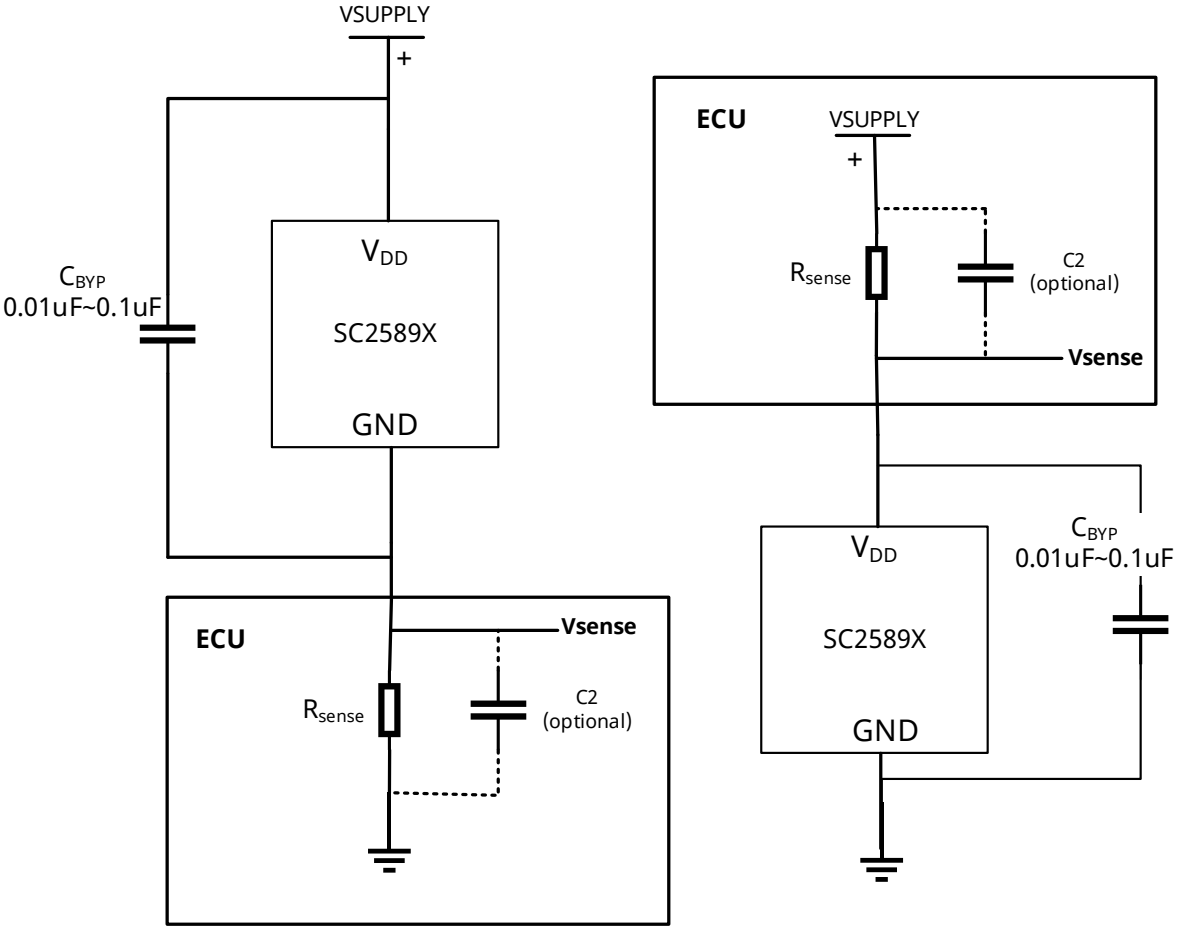
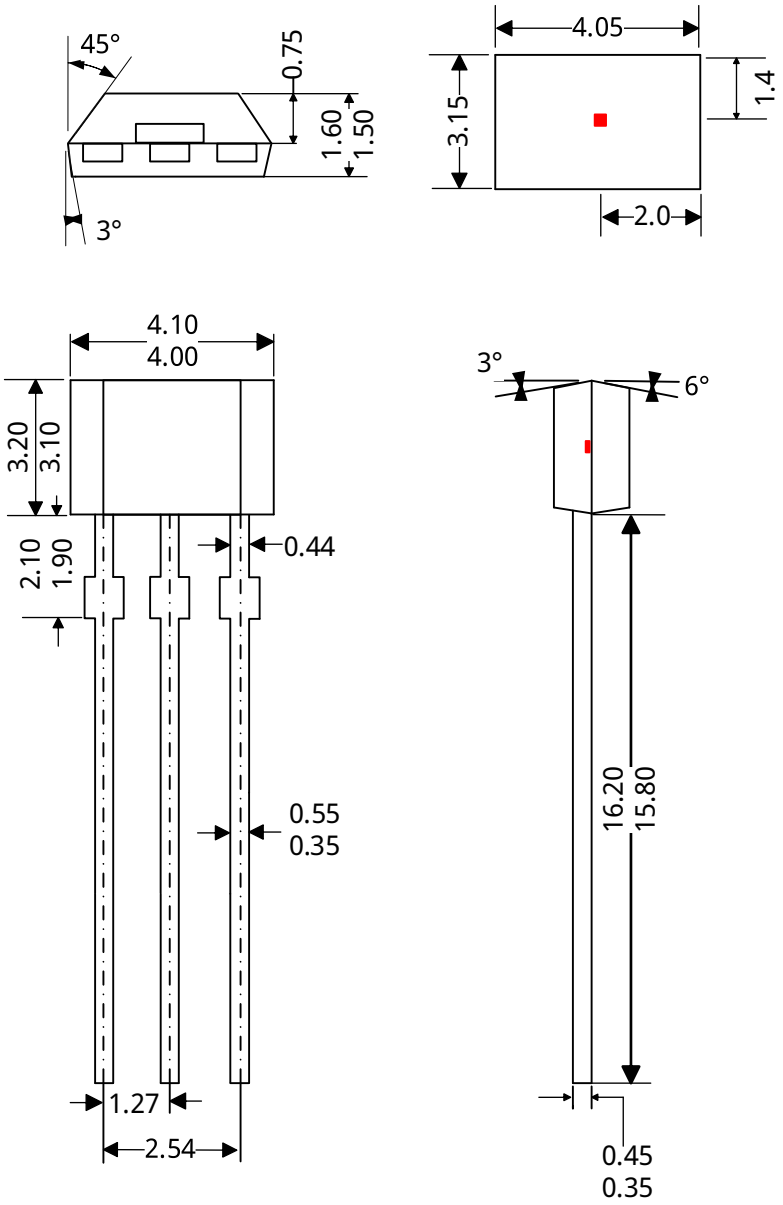


Fig.8 SC2589X Typical Application Circuit

13. Package Information UA

3-Terminal UA Package

Unit: mm



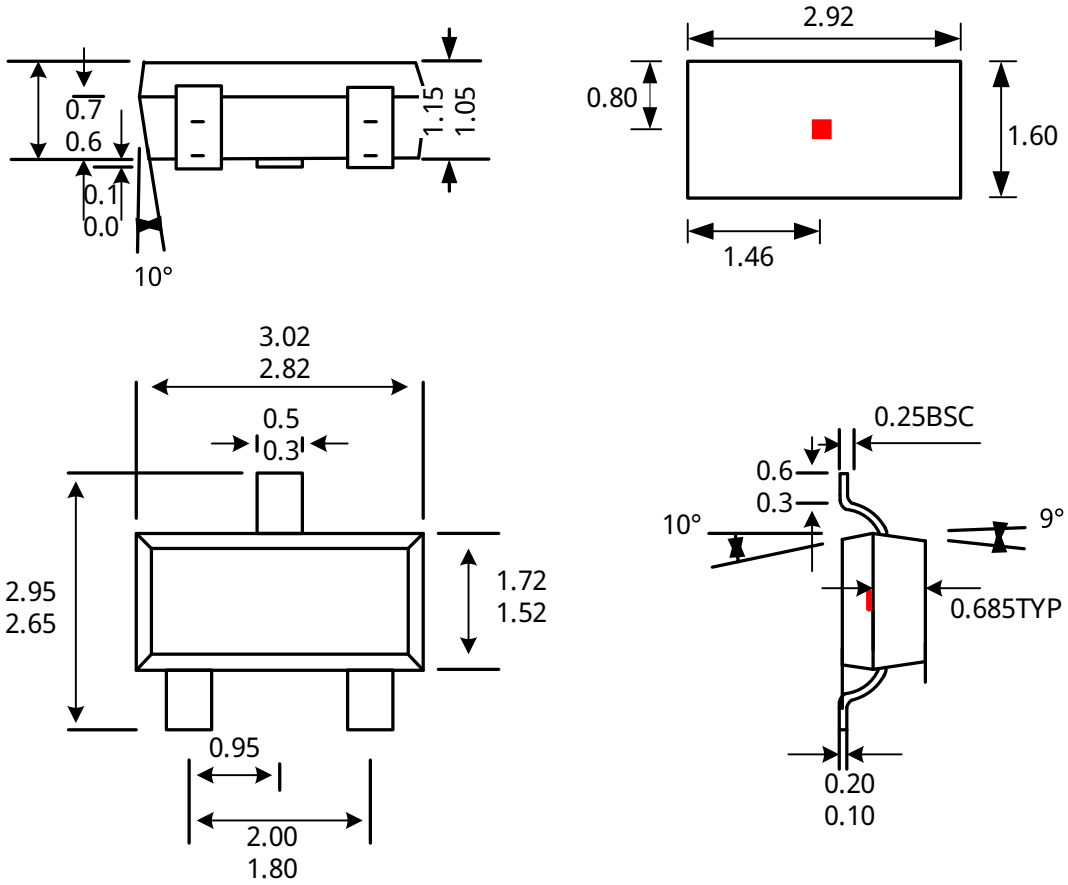
Notes:
(1) Exact body and lead configuration at vendor's option within limits shown.
(2) Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.

14. 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.

15. Revision History

Revision	Date	Description
Rev.E0.1	2025-03-10	Preliminary Datasheet
Rev.A1.0	2025-07-18	Official version release