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## Single Pole Response Linear Hall Sensor With Sleep Mode

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### 1. Features

- Proportional linear Hall-effect magnetic sensor
- Unipolar magnetic field response (S pole)
- Current consumption during sleep mode: < 3uA
- Fast power-on time: < 10us
- Supply voltage from 2.5 to 5.5 V
- Quiescent output voltage with 90%\*VCC
- High-speed 100 kHz detection bandwidth
- -40°C to 105°C wide ambient temperature range
- Packaging type
  - SOT23-3L
  - SOT23-5L

### 2. Applications

- Linear keyboard
- Position detection
- Trigger
- Game controllers and peripherals

### 3. Description

SC412X is a low-power linear Hall sensor IC that responds proportionally to magnetic flux density. The quiescent output voltage is 90%\*VCC. The device can enter an ultra-low-power shutdown mode by adding a user-selectable sleep mode. This makes these devices ideal for battery-powered applications such as robot vacuums, wireless power tools, and wireless game controllers and peripherals.

The device has a short start-up time (<10us) and is designed for low-power position sensing applications. The users can control the current consumption of the chip by applying a logic level signal to the SLEEP pin. During sleep mode, the output of the device is invalid (high impedance mode). The high-impedance output feature allows multiple SC412X Hall-effect devices to be connected to a single A/D converter input. Not to scale.

The SC412X family has a wide supply voltage range and can operate from a supply voltage range of 2.5V to 5.5V and a temperature range of -40°C to +105°C. The device is available in a 3-pin SOT23-3L package(SO) and a 5-pin SOT23-5Lpackage (S5). Both packages are lead (Pb) free, with 100% matte tin lead frame plating.

Not To Scale

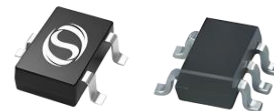


Fig.1 SOT23-3L(Left) &SOT23-5L(Right) Package Outline

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### 4. Terminal Configuration

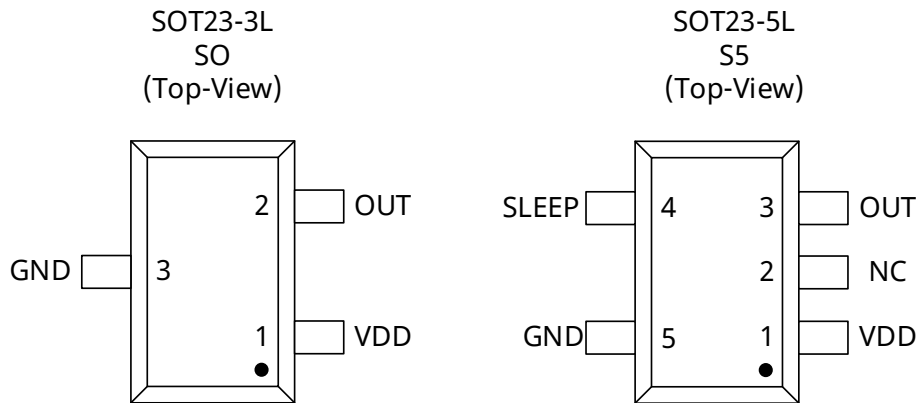


Fig.2 SOT23-3L(Left) and SOT23-5L(Right) Pin Description

Name	Number		Description
	SOT23-3L	SOT23-5L	
GND	3	5	Ground
SLEEP	-	4	Toggle sleep mode
OUT	2	3	Analog output
NC	-	2	No connect, recommend connect to ground
VDD	1	1	Power supply

## 5. Ordering Information

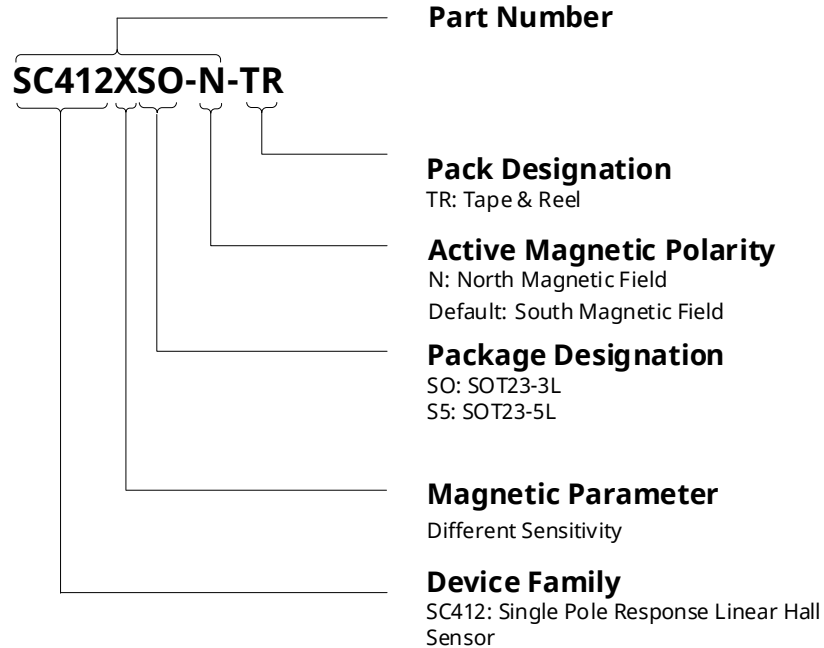
Ordering Information	Sens(mV/Gs) <sup>(1)</sup>	Ambient, T <sub>A</sub> (°C)	Package	Packing	Quantity
SC4123SO-N-TR <sup>(2)</sup>	3	-40-105	SOT23-3L	T&R	3000/Reel
SC4125SO-N-TR	5	-40-105	SOT23-3L	T&R	3000/Reel
SC4123S5-N-TR	3	-40-105	SOT23-5L	T&R	3000/Reel
SC4125S5-N-TR	5	-40-105	SOT23-5L	T&R	3000/Reel

Note:

(1) This sensitivity data is available under 3.3v application conditions

(2) TR: Tape & Reel

### 5.1. Order information format description



## 6. Absolute Maximum Ratings

Symbol	Parameter	Notes	Min.	Max.	Units
$V_{CC\ ABS}$	Positive Supply Voltage(DC)	$B = 0mT, T_A = 25^{\circ}C$	-	5.5	V
$V_{CCr\ ABS}$	Negative Supply Voltage	$B = 0mT, T_A = 25^{\circ}C$	-0.3	-	V
$V_{OUT\ ABS}$	Positive $V_{OUT}$ Voltage	$B = 0mT, T_A = 25^{\circ}C$	-	5.5	V
$V_{OUTr\ ABS}$	Negative $V_{OUT}$ Voltage	$B = 0mT, T_A = 25^{\circ}C$	-0.3	-	V
$T_A$	Operating Temperature Range		-40	105	$^{\circ}C$
$T_{STG}$	Storage Temperature Range		-55	165	$^{\circ}C$
$T_{J(max)}$	Maximum Junction Temperature		-	165	$^{\circ}C$

Note:

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 conditions	Min.	Max.	Units
$V_{ESD\_HBM}$	HBM	Refer to ANSI/ESDA/JEDEC JS-001 standard <sup>(1)</sup>	-4	+4	KV
$V_{ESD\_CDM}$	CDM	Refer to ANSI/ESDA/JEDEC JS-002 standard <sup>(2)</sup>	-750	+750	V

Note:

(1) JEDEC document JEP155 states that 4000V HBM allows safe manufacturing using standard ESD control processes.

(2) JEDEC document JEP157 states that 740V CDM allows safe manufacturing using standard ESD control processes.

## 8. Thermal characteristics

Symbol	Parameter	Test conditions	Value <sup>(1)</sup>	Units
$R_{\theta JA}$	SOT23-3L	Single-layer PCBs, JEDEC 2s2p and 1s0p are defined in JESD 51-7 and JESD 51-3	313	$^{\circ}C/W$
	SOT23-5L		300	

Note:

(1) The maximum operating voltage must meet the requirements of power consumption and junction temperature, refer to thermal characteristics

## 9. Operating Characteristics

### 9.1 Electrical Parameter

(TA=-40°C~105°C, VDD=2.5V~5.5V, unless otherwise noted)

Symbol	Parameter	Test Condition	Min	TYP	MAX	Unit
V <sub>CC</sub>	Supply Voltage		2.5	3.3	3.6	V
			4.5	5	5.5	V
I <sub>CC</sub>	Supply Current	V <sub>CC</sub> = 3.3V, B = 0mT	-	3	-	mA
		V <sub>CC</sub> = 5V, B = 0mT	-	4	-	mA
I <sub>CC-SHDN</sub>	Shutdown Current	SLEEP-->3.3V	-	3	-	uA
T <sub>PO</sub>	Power-on time	V <sub>CC</sub> = 3.3V, B = 0mT, V <sub>OUT</sub> = 90% of Full-Scale	-	10	-	us
T <sub>WK</sub>	Awake time	SLEEP-->0V	-	10	-	us
I <sub>OUT</sub>	OUT Load Current		-	-	2	mA
C <sub>OUT</sub>	OUT Capacitive Load		-	-	1	nF
F <sub>BW</sub>	Sensing bandwidth	(-3 dB)	-	100	-	kHz
T <sub>PD</sub>	Propagation delay time		-	10	-	us
F <sub>C</sub>	Chopping Frequency		-	500	-	kHz
V <sub>HSLEEP</sub>	Sleep input High Voltage	SLEEP Enable	0.7V <sub>CC</sub>	-	-	V
V <sub>LSLEEP</sub>	Sleep input Low Voltage	SLEEP Disable	-	-	0.3V <sub>CC</sub>	V

## 9.2 Magnetic Parameter

( $T_A = -40^{\circ}\text{C} \sim 105^{\circ}\text{C}$ ,  $V_{DD} = 2.5\text{V} \sim 5.5\text{V}$ , unless otherwise noted)

Symbol	Parameter	Test Condition	Min	TYP	MAX	Unit
$V_{QT}$	Quiescent voltage	$B = 0\text{Gs}$ , $T_A = 25^{\circ}\text{C}$ , $V_{CC} = 3.3\text{V}$	2.8	2.97	3.14	V
		$B = 0\text{Gs}$ , $T_A = 25^{\circ}\text{C}$ , $V_{CC} = 5\text{V}$	4.3	4.5	4.7	V
$V_{Q\Delta T}$	Quiescent voltage temperature drift	$B = 0\text{Gs}$ , $V_{CC} = 3.3\text{V}$ , $T_A = -40^{\circ}\text{C}$ to $105^{\circ}\text{C}$ versus $25^{\circ}\text{C}$	-	$\pm 1\%$ $\times V_{CC}$	-	V
		$B = 0\text{Gs}$ , $V_{CC} = 5\text{V}$ , $T_A = -40^{\circ}\text{C}$ to $105^{\circ}\text{C}$ versus $25^{\circ}\text{C}$	-	$\pm 1\%$ $\times V_{CC}$	-	V
$V_{QRE}$	Quiescent voltage ratio metric error		-	$\pm 0.2$	-	%
S	Sensitivity	SC4123, $V_{CC} = 3.3\text{V}$ , $T_A = 25^{\circ}\text{C}$	-	3	-	mV/Gs
		SC4125, $V_{CC} = 3.3\text{V}$ , $T_A = 25^{\circ}\text{C}$	-	5	-	
		SC4123, $V_{CC} = 5\text{V}$ , $T_A = 25^{\circ}\text{C}$	-	4.5	-	
		SC4125, $V_{CC} = 5\text{V}$ , $T_A = 25^{\circ}\text{C}$	-	7.6	-	
BL	Linear magnetic sensing range	SC4123, $V_{CC} = 3.3\text{V}$ , $T_A = 25^{\circ}\text{C}$	-	920	-	Gs
		SC4125, $V_{CC} = 3.3\text{V}$ , $T_A = 25^{\circ}\text{C}$	-	550	-	
		SC4123, $V_{CC} = 5\text{V}$ , $T_A = 25^{\circ}\text{C}$	-	920	-	
		SC4125, $V_{CC} = 5\text{V}$ , $T_A = 25^{\circ}\text{C}$	-	550	-	
$V_L$	Linear range of output voltage		0.2	-	$V_{CC} - 0.2$	V
$S_{TC}$	Sens temperature coefficient	$T_A = -40^{\circ}\text{C}$ to $105^{\circ}\text{C}$ versus $25^{\circ}\text{C}$	0.04	0.12	0.2	%/ $^{\circ}\text{C}$
$S_{LE}$	Sensitivity linearity error		-	$\pm 1$	-	%
$S_{SE}$	Sensitivity symmetry error		-	$\pm 1$	-	%
$S_{RE}$	Sensitivity ratio metric error	$T_A = 25^{\circ}\text{C}$ , $V_{CC} = 3\text{V} - 3.6\text{V}$ , with respect to $V_{CC} = 3.3\text{V}$	-3	-	+3	%
$V_N$	Output-referred peak-to-peak noise	SC4123, $B_N \times S$ , OUT with RC filter	-	24	-	mVpp
		SC4125, $B_N \times S$ , OUT with RC filter	-	40	-	

## 10. Block Diagram

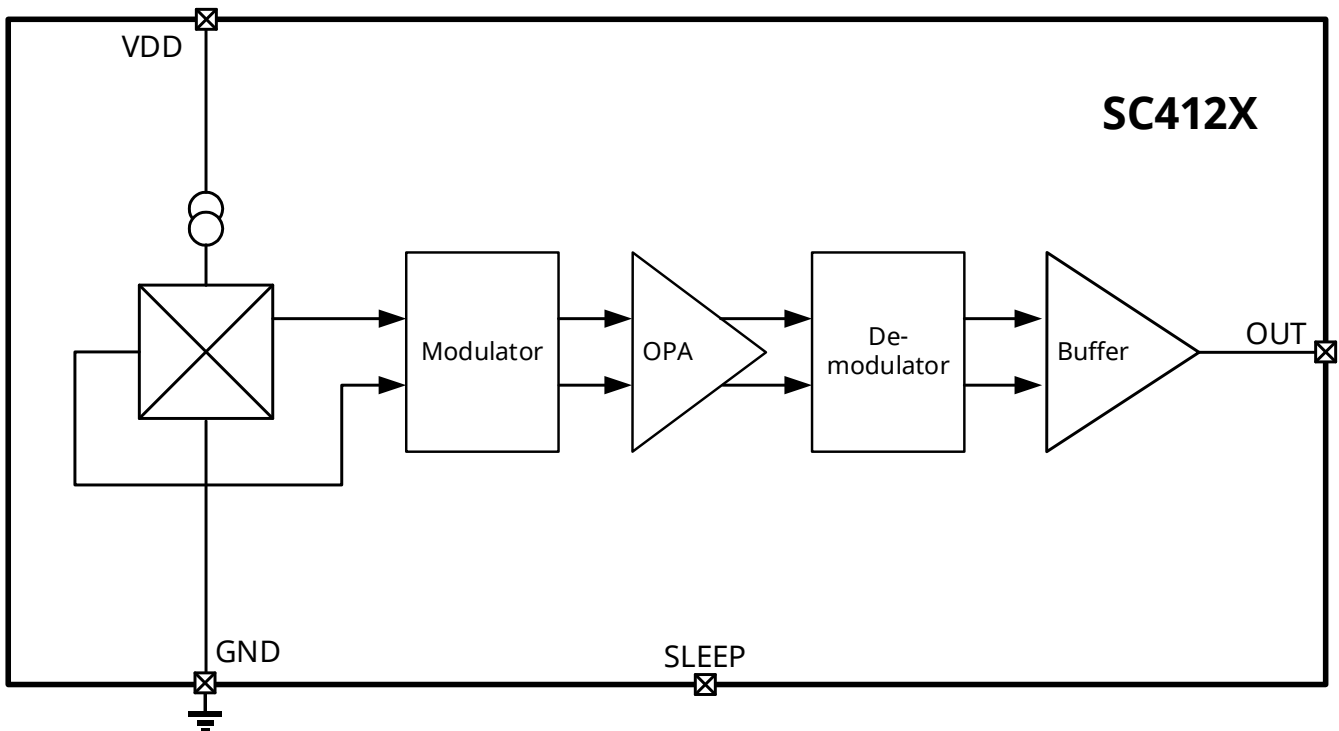


Fig.3 Block Diagram

## 11. Function Description

**Magnetic Field Direction Definition:** The S-pole magnetic field is defined as a negative magnetic field on the PKG marking surface for SOT23-3L(SO)&SOT23-5L.

**Quiescent Output Voltage ( $V_{OUT(Q)}$ ):** Quiescent Output Voltage indicates the output voltage of the IC when there is no magnetic field. Theoretically, the output voltage of SC412X equals 90%, but interfered by the offset voltage, sensitivity, packaging stress, and other factors, the Quiescent output Voltage does have some deviation from the Theoretic figure. Quiescent output Voltage is influenced by temperature coefficient to an extent, which referred to in statistics is with the variation of the temperature, the Quiescent Output Voltage also changes (the higher the sensitivity is the more evident it will be).

### Sensitivity

$$Sens = [VOUT(B1) - VOUT(B2)] / (B1 - B2)$$

When the positive electrode magnetic field perpendicular to the chip tagged side approaches, the output voltage increases proportionally, until it reaches supply voltage. Conversely, when the negative electrode magnetic field perpendicular to the chip tagged side approaches, the output voltage decreases proportionally, until it reaches ground level. Sensitivity is defined as the specific value of the output voltage variation and the magnetic field variation, commonly in mV/Gs or mV/mT.

**Power-On Time ( $t_{PO}$ ):** Power-On Time ( $t_{PO}$ ) is defined as the time it takes for the output voltage to settle within  $\pm 10\%$  of its steady-state value under an applied magnetic field after the power supply has reached its minimum specified operating voltage ( $VCC(\min)$ ) as shown in Figure 4.

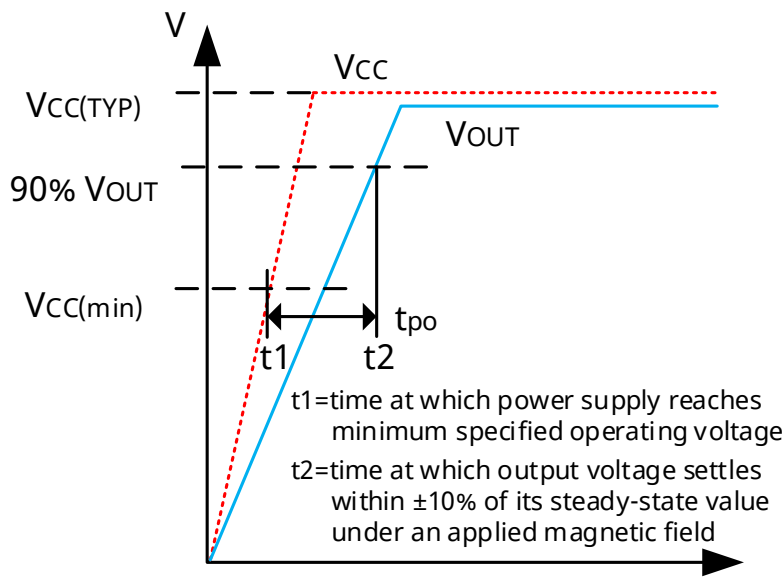


Fig.4 Power-On Time Definition

**Propagation Delay ( $t_{pd}$ ):** The time interval between a) when the applied magnetic field reaches 20% of its final value, and b) when the output reaches 20% of its final value (see Figure 5).

**Rise Time ( $t_r$ ):** The time interval between a) when the sensor IC reaches 10% of its final value, and b) when it reaches 90% of its final value (see Figure 5).  $t_r$  is detrimentally affected by eddy current losses observed in the conductive IC ground plane.

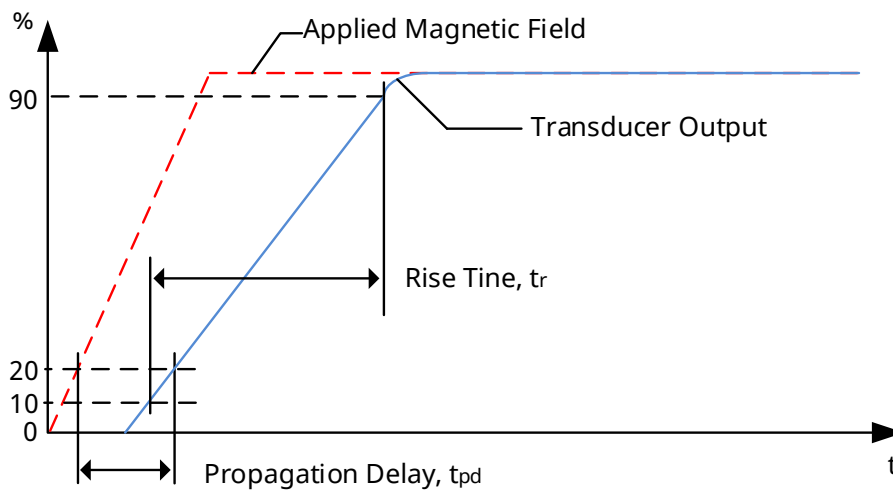


Fig.5 Propagation Delay and Rise Time Definitions

**Low-Power SLEEP Mode Design:** For battery-powered applications where power is critical, the sensor can be duty-cycled using the SLEEP pin. This will ensure the average current consumption remains low to meet the system level power targets. In duty-cycled applications, the start-up time must be very fast so the external ADC can sample the signal faster and shutdown the device quickly to minimize average power. With very fast start-up and power-off times, the SC410X enables low average power consumption for the system.

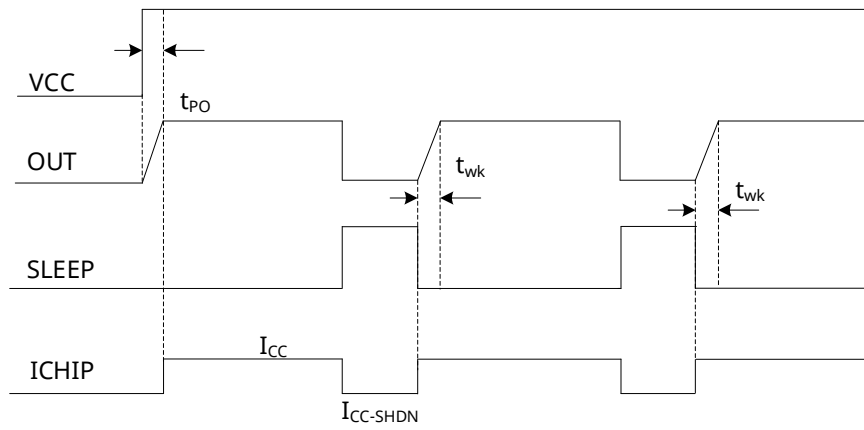


Fig.6 SLEEP Mode Description

## 12. Typical Application

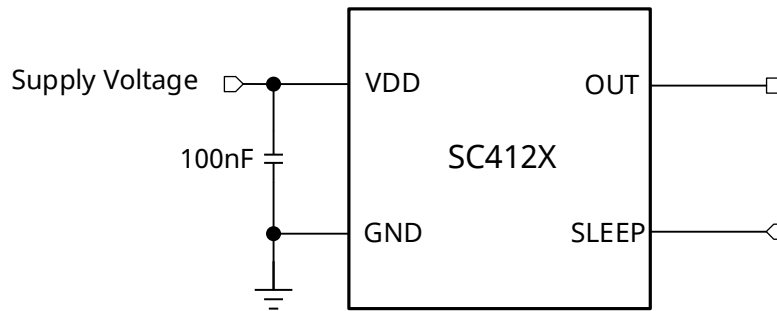


Fig.7 Typical Application Circuit

In the quiescent state (that is, with no significant magnetic field:  $B=0$ ), the output,  $V_{OUT}(Q)$ , equals to  $90\% \cdot V_{CC}$ . The presence of a North-polarity magnetic field perpendicular to the branded surface of the package increases the output voltage from its quiescent value toward the supply voltage rail. The amount of the output voltage increase is proportional to the magnitude of the magnetic field applied. Conversely, the application of a South polarity field will decrease the output voltage from its quiescent value. This proportionality is specified as the magnetic sensitivity,  $Sens$  (mV/Gs), of the device.

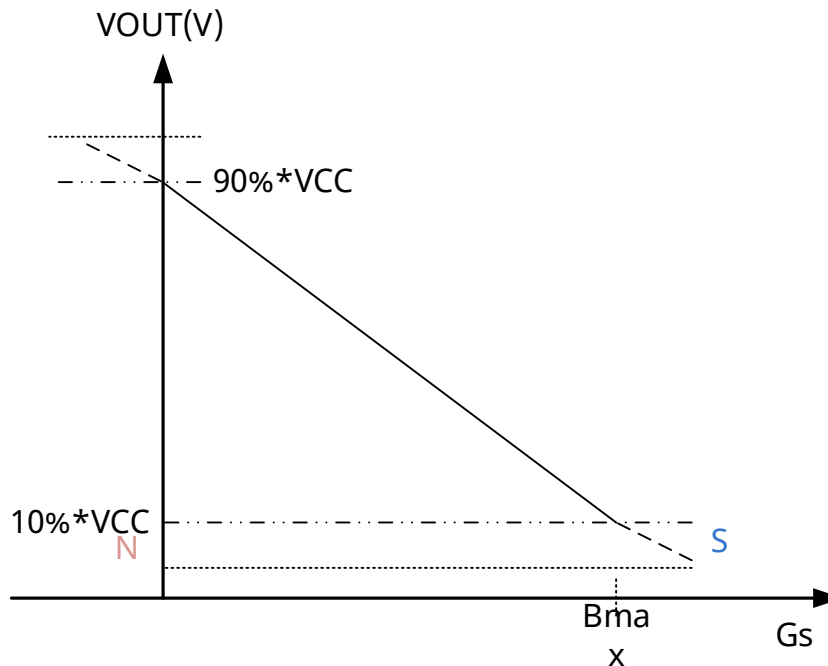
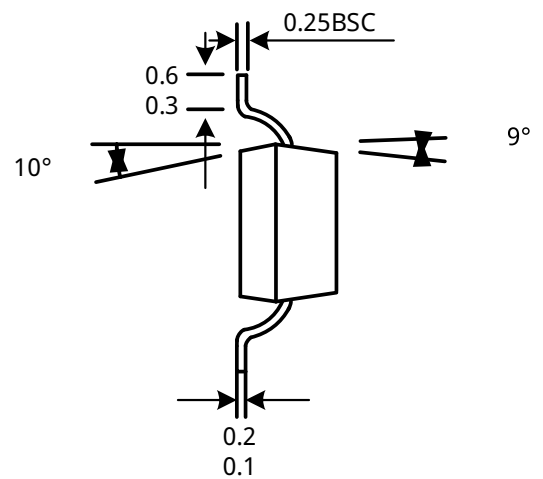
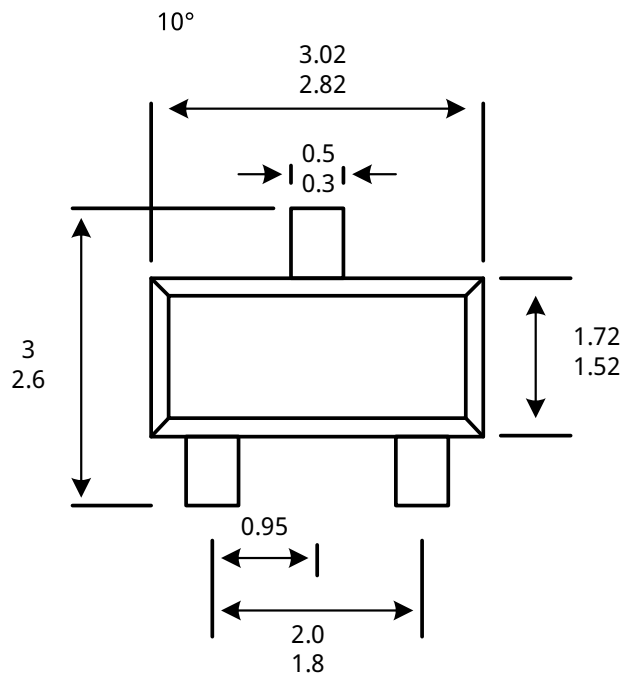
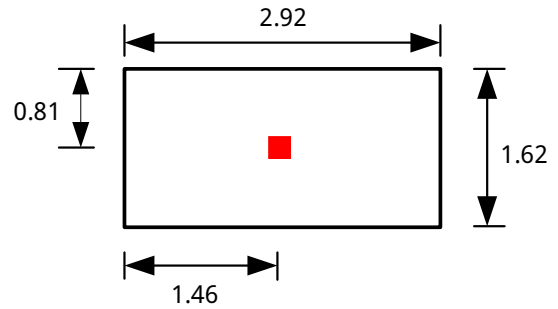
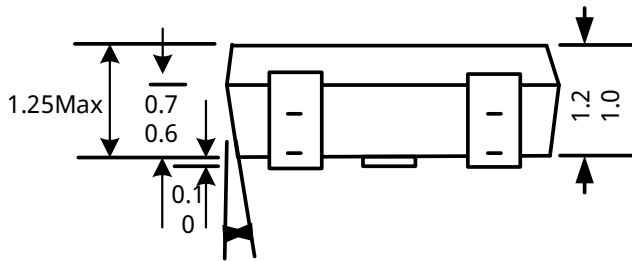


Fig.8 Output function

### 13. Package Information “SOT23-3L(SO)”

**3-PIN  
SOT23-3L  
Package**

Unit: mm



**Notes:**

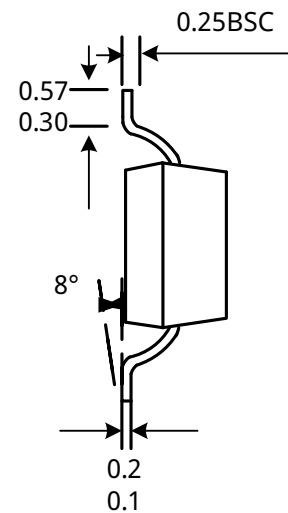
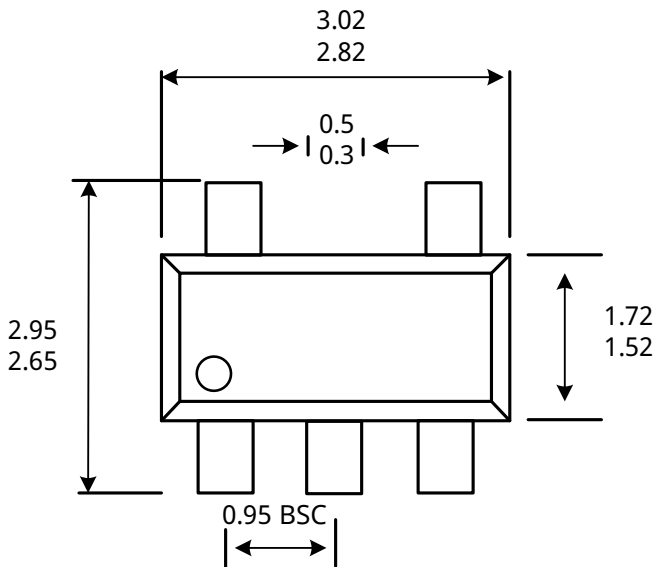
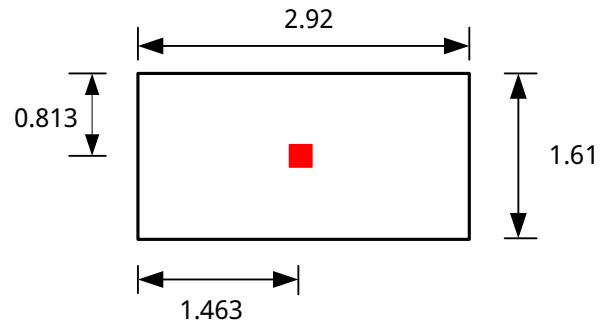
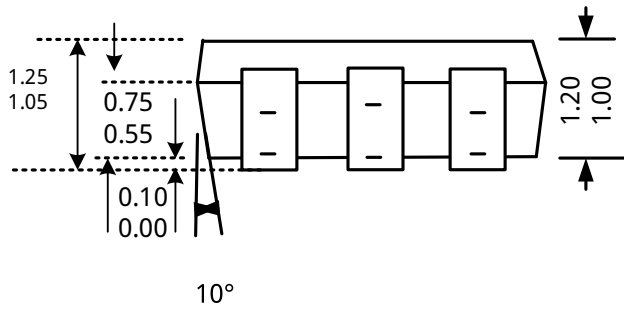
1. Exact body and lead configuration at vendor’s option within limits shown.
2. Height does not include mold gate flash.

Where no tolerance is specified, dimension is nominal.

### 14. Package Information “SOT23-5L(S5)”

5-PIN  
S5  
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.0.1	2024-05-07	Preliminary datasheet
Rev.A1.0	2024-11-27	Unified datasheet format