Low Power with Sleep Mode Linear Hall Sensor

1. Features

- Proportional linear Hall-effect magnetic sensor

- Current consumption during sleep mode: < 3A

- Fast power-on time: < 10us

- Supply voltage from 2.5 to 5.5 V

- Quiescent output voltage with 50%*VCC

- High-speed 100 kHz detection bandwidth

- -40℃ to 105℃ wide ambient temperature range

- PKG Type
    - DFN1616
    - SOT23
    - SOT23-3L

2. Applications

- Motor control

- Keyboard

- Game controllers and peripherals

- Position sensing

3. Description

SC410X is a low-power linear Hall sensor IC that responds proportionally to magnetic flux density. The quiescent output voltage is 50%*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 SC410X Hall-effect devices to be connected to a single A/D converter input. Not to scale.

The SC410X 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 SOT-23 package(SO & SE) and a 6-pin DFN-1616 package (DN). Both packages are lead (Pb) free, with 100% matte tin lead frame plating.

Not To Scale

Fig.1 DFN1616(Left) & SOT23-3L(Mid) & SOT23(Right) Package Outline

CONTENTS

4. Terminal Configuration

SOT23 & SOT23-3L
(Top-View)
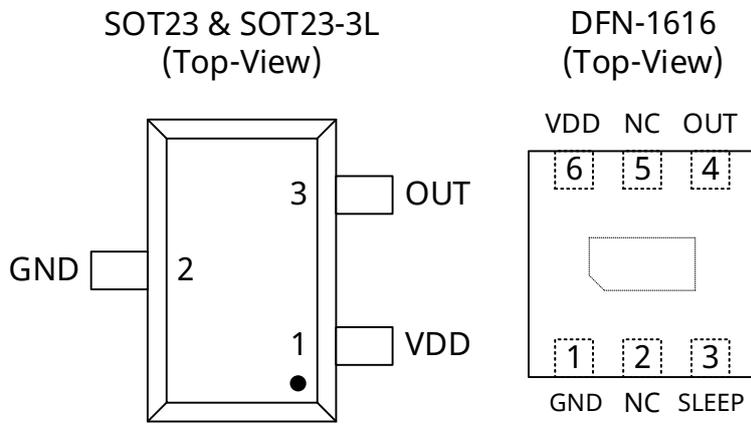
DFN-1616
(Top-View)

Fig.2 SOT23 & SOT23-3L(Left) and DFN1616(Right)Pin Description

Name	Number			Description
	DFN1616	SOT23-3L	SOT23	
GND	1	2	2	Ground
NC	2	--	--	No connect, recommend connect to ground
SLEEP	3	--	--	Toggle sleep mode
OUT	4	3	3	Analog output
NC	5	--	--	No connect, recommend connect to ground
VDD	6	1	1	Power supply

5. Ordering Information

Ordering Information	Sens(mV/Gs) [1]	Ambient, T_A(℃)	Package	Packing	Quantity
SC4101DN-TR	1	-40-105	DFN1616	T&R	4000/Reel
SC4102DN-TR	1.5	-40-105	DFN1616	T&R	4000/Reel
SC4103DN-TR	2.5	-40-105	DFN1616	T&R	4000/Reel
SC4104DN-TR	3.2	-40-105	DFN1616	T&R	4000/Reel
SC4101SO-N-TR	1	-40-105	SOT23-3L	T&R	3000/Reel
SC4102SO-N-TR	1.5	-40-105	SOT23-3L	T&R	3000/Reel
SC4103SO-N-TR	2.5	-40-105	SOT23-3L	T&R	3000/Reel
SC4104SO-N-TR	3.2	-40-105	SOT23-3L	T&R	3000/Reel
SC4101SE-TR	1	-40-105	SOT23	T&R	3000/Reel
SC4102SE-TR	1.5	-40-105	SOT23	T&R	3000/Reel
SC4103SE-TR	2.5	-40-105	SOT23	T&R	3000/Reel
SC4104SE-TR	3.2	-40-105	SOT23	T&R	3000/Reel

Note:

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

5.1. Order information format description

SC410XSO-N-TR

Part Number

Pack Designation
TR: Tape & Reel

Active Magnetic Polarity
N: North Magnetic Field
Default: South Magnetic Field

Package Designation
SO: SOT23-3L
SE: SOT23
DN:DFN1616

Magnetic Parameter
Different sensitivity

Device Family
SC410: Bipolar linear Hall
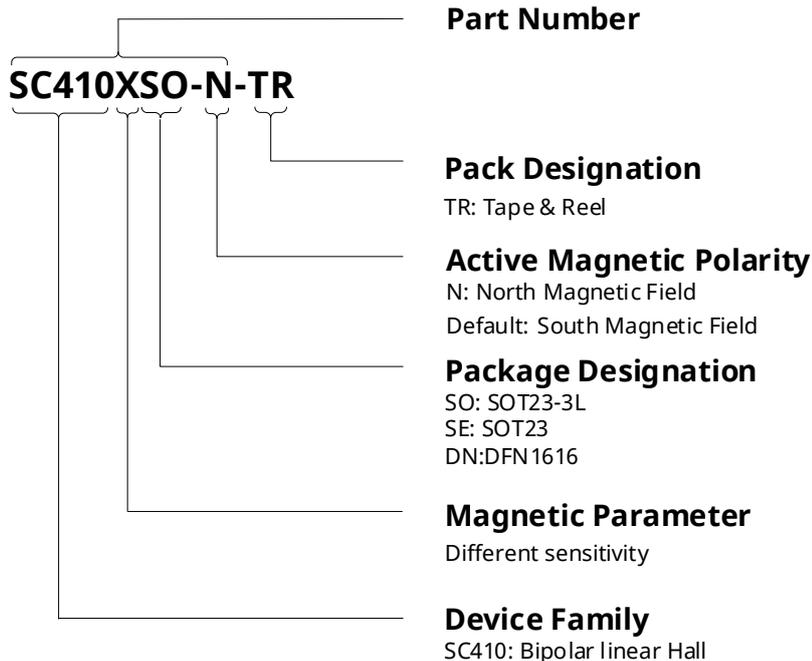
6. Absolute Maximum Ratings

Symbol	Parameter	Notes	Min.	Max.	Units
$V_{CC\,abs}$	Positive Supply Voltage(DC)	V_{CC}=0-->5.5V	--	5.5	V
$V_{ccr\,abs}$	Negative Supply Voltage	V_{CC}=0-->-1.0V	-0.3	--	V
$V_{OUT\,ABS}$	Positive V_{OUT} Voltage	V_{OUT}=0-->5.5V	--	5.5	V
$V_{OUTR\,ABS}$	Negative V_{OUT} Voltage	V_{CC}=0-->-1.0V	-0.3	--	V
T_A	Operating Temperature Range		-40	105	℃
T_{STG}	Storage Temperature Range		-55	165	℃
$T_{J(max)}$	Maximum Junction Temperature		--	165	℃

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[1]	-4	4	kV
V_{ESD_CDM}	CDM	Refer to ANSI/ESDA/JEDEC JS-002 standard[2]	-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[1]	Units
$R_{\theta JA}$	SOT23-3L	Single-layer PCBS, JEDEC 2s2p and 1s0p are defined in JESD 51-7 and JESD 51-3	313	℃/W
	SOT23-3		357	
	DFN1616		186	

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℃~105℃, VDD=2.5V~5.5V, unless otherwise noted）

Symbol	Parameter	Test Condition	Min	TYP	MAX	Unit
V_{CC}	Supply Voltage		2.5	3.3	3.6	V
			4.5	5	5.5	V
I_{CC}	Supply Current	V_{CC} = 3.3V, B = 0mT	--	3	--	mA
		V_{CC} = 5V, B = 0mT	--	4	--	mA
$I_{CC\text{-}SHDN}$	Shutdown Current	SLEEP-->3.3V	--	3	--	uA
t_{PO}	Power-on time	V_{CC} = 3.3V, B = 0mT, V_{OUT} = 90% of Full-Scale	--	10	--	us
t_{WK}	Awake time	SLEEP-->0V	--	10	--	us
I_{OUT}	OUT Load Current		--	--	2	mA
C_{OUT}	OUT Capacitive Load		--	--	1	nF
f_{BW}	Sensing bandwidth	(-3 dB)	--	100	--	kHz
t_{Pd}	Propagation delay time		--	10	--	us
fc	Chopping Frequency		--	500	--	kHz
V_{hsleep}	Sleep input High Voltage	SLEEP Enable	$0.7V_{CC}$	--	--	V
V_{LSLEEP}	Sleep input Low Voltage	SLEEP Disable	--	--	$0.3V_{CC}$	V

9.2 Magnetic Parameter

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

| Symbol	Parameter	Test Condition	Min	TYP	MAX	Unit
V_{QT}	Quiescent voltage	B = 0 Gs, T_A = 25°C, V_{CC} = 3.3 V	1.58	1.65	1.72	V
		B = 0 Gs, T_A = 25°C, V_{CC} = 5 V	2.43	2.5	2.57	V
$V_{Q\Delta T}$	Quiescent voltage temperature drift	B = 0 Gs, V_{CC} = 3.3 V, T_A = -40°C to 105°C versus 25°C	--	±1% ×VCC	--	V
		B = 0 Gs, V_{CC} = 5 V, T_A = -40°C to 105°C versus 25°C	--	±1% ×VCC	--	V
V_{QRE}	Quiescent voltage ratio metric error		--	±0.2	--	%
S	Sensitivity	SC4101, V_{CC} = 3.3 V, T_A = 25°C	--	1.0	--	mV/Gs
		SC4102, V_{CC} = 3.3 V, T_A = 25°C	--	1.5	--	
		SC4103, V_{CC} = 3.3 V, T_A = 25°C	--	2.5	--	
		SC4104, V_{CC} = 3.3 V, T_A = 25°C	--	3.2	--	
		SC4101, V_{CC} = 5 V, T_A = 25°C	--	1.5	--	
		SC4102, V_{CC} = 5 V, T_A = 25°C	--	2.5	--	
		SC4103, V_{CC} = 5 V, T_A = 25°C	--	4.0	--	
		SC4104, V_{CC} = 5 V, T_A = 25°C	--	5.0	--	
BL	Linear magnetic sensing range	SC4101, V_{CC} = 3.3 V, T_A = 25°C	--	±1200	--	Gs
		SC4102, V_{CC} = 3.3 V, T_A = 25°C	--	±800	--	
		SC4103, V_{CC} = 3.3 V, T_A = 25°C	--	±480	--	
		SC4104, V_{CC} = 3.3 V, T_A = 25°C	--	±400	--	
		SC4101, V_{CC} = 5 V, T_A = 25°C	--	±1200	--	
		SC4102, V_{CC} = 5 V, T_A = 25°C	--	±800	--	
		SC4103, V_{CC} = 5 V, T_A = 25°C	--	±480	--	
		SC4104, V_{CC} = 5 V, T_A = 25°C	--	±400	--	
V_L	Linear range of output voltage		0.2	-	VCC−0.2	V
S_{TC}	Sens temperature coefficient	T_A = -40°C to 105°C versus 25°C	0.04	0.12	0.2	%/℃
S_{LE}	Sensitivity linearity error		--	±1	--	%
S_{SE}	Sensitivity symmetry error		--	±1	--	%
S_{RE}	Sensitivity ratio metric error	T_A = 25°C, V_{CC} = 3 V - 3.6 V, with respect to V_{CC} =3.3 V	-3	-	+3	%
V_N	Output-referred peak-to-peak noise	SC4101, B_N × S, OUT with RC filter	--	8	--	mVpp
		SC4102, B_N × S, OUT with RC filter	--	12	--	
		SC4103, B_N × S, OUT with RC filter	--	16	--	
		SC4104, B_N × S, OUT with RC filter	--	24	--	

10. Block Diagram
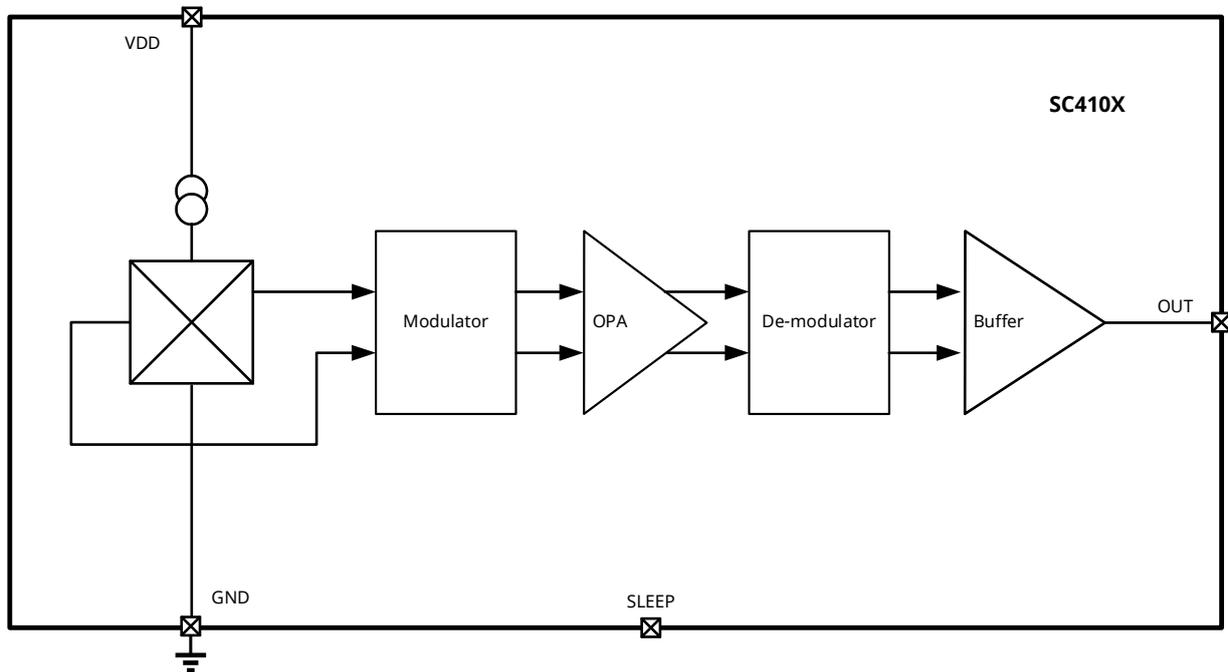
Fig.3 Block Diagram

11. Function Description

Magnetic Field Direction Definition: The S-pole magnetic field is defined as a positive magnetic field on the PKG marking surface for DFN1616(DN) & SOT23(SE), the S-pole magnetic field is defined as a negative magnetic field on the PKG marking surface for SOT23-3L(SO).

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 SC410X equals VCC/2, but interfered by the offset voltage, sensitivity, packaging stress, and other factors, the Quiescent output Voltage does have some deviation from the Theoretic figure. During the factory, the actual Quiescent Voltage can be modified to the theoretical value of ±70mV. 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 South Pole magnetic field perpendicular to the chip tagged side approaches, the output voltage increases proportionally, until it reaches supply voltage. Conversely, when the North Pole 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 ±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.
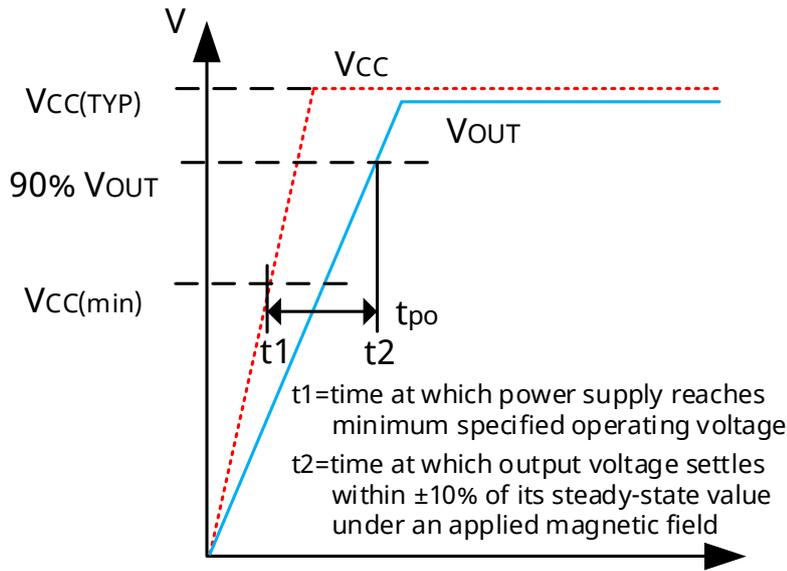

Fig.4 Power-On Time Definition

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.
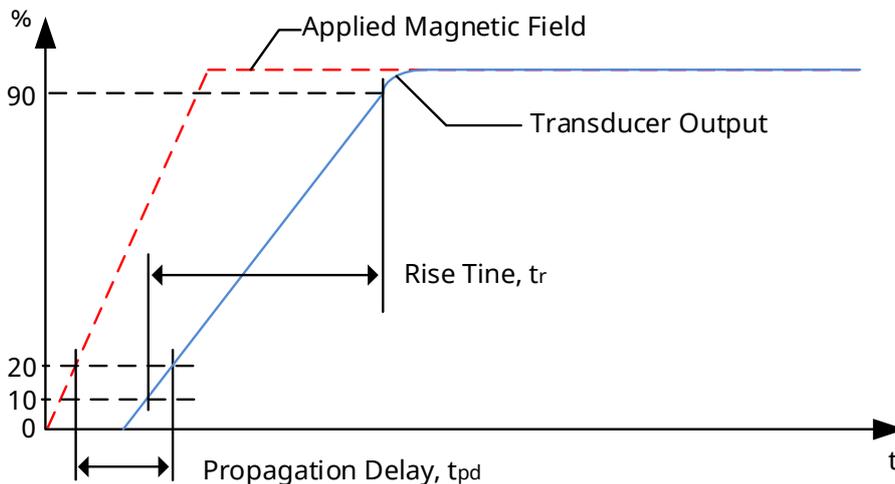

Fig.5 Propagation Delay and Rise Time Definitions

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.
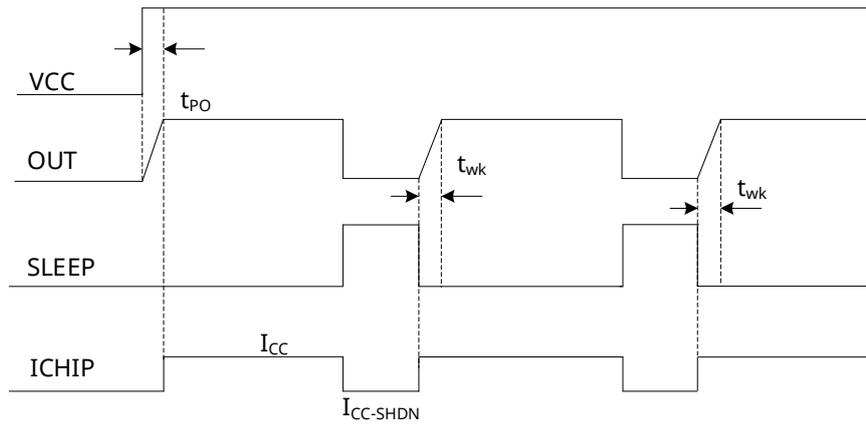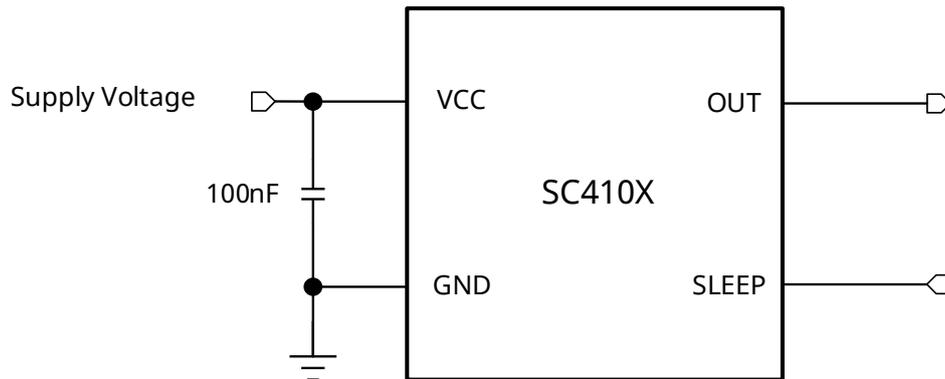
Fig.6 SLEEP Mode Description

12. Typical Application

Fig.7 Typical Application Circuit

In the quiescent state (that is, with no significant magnetic field: B=0), the output, VOUT(Q), equals to 50%*VCC. The presence of a South-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 North 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.
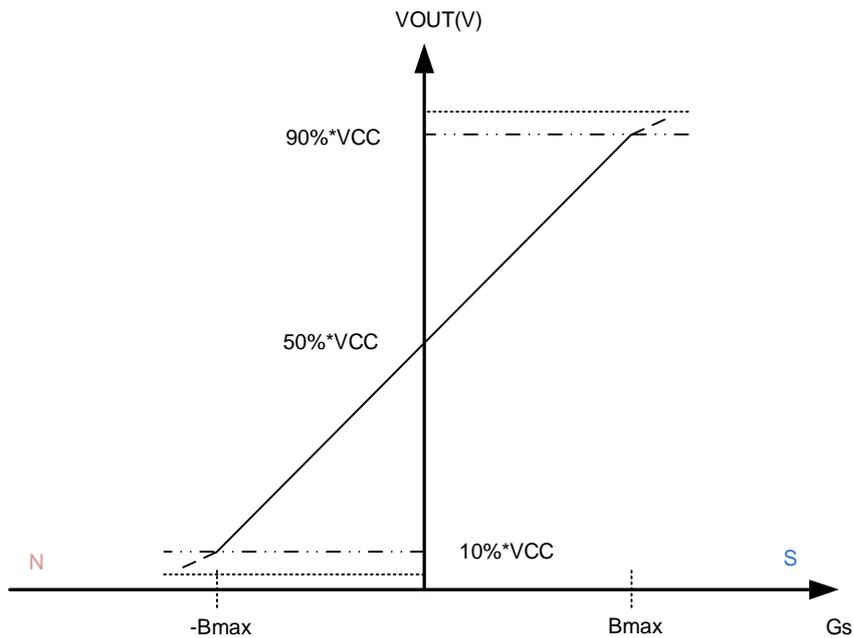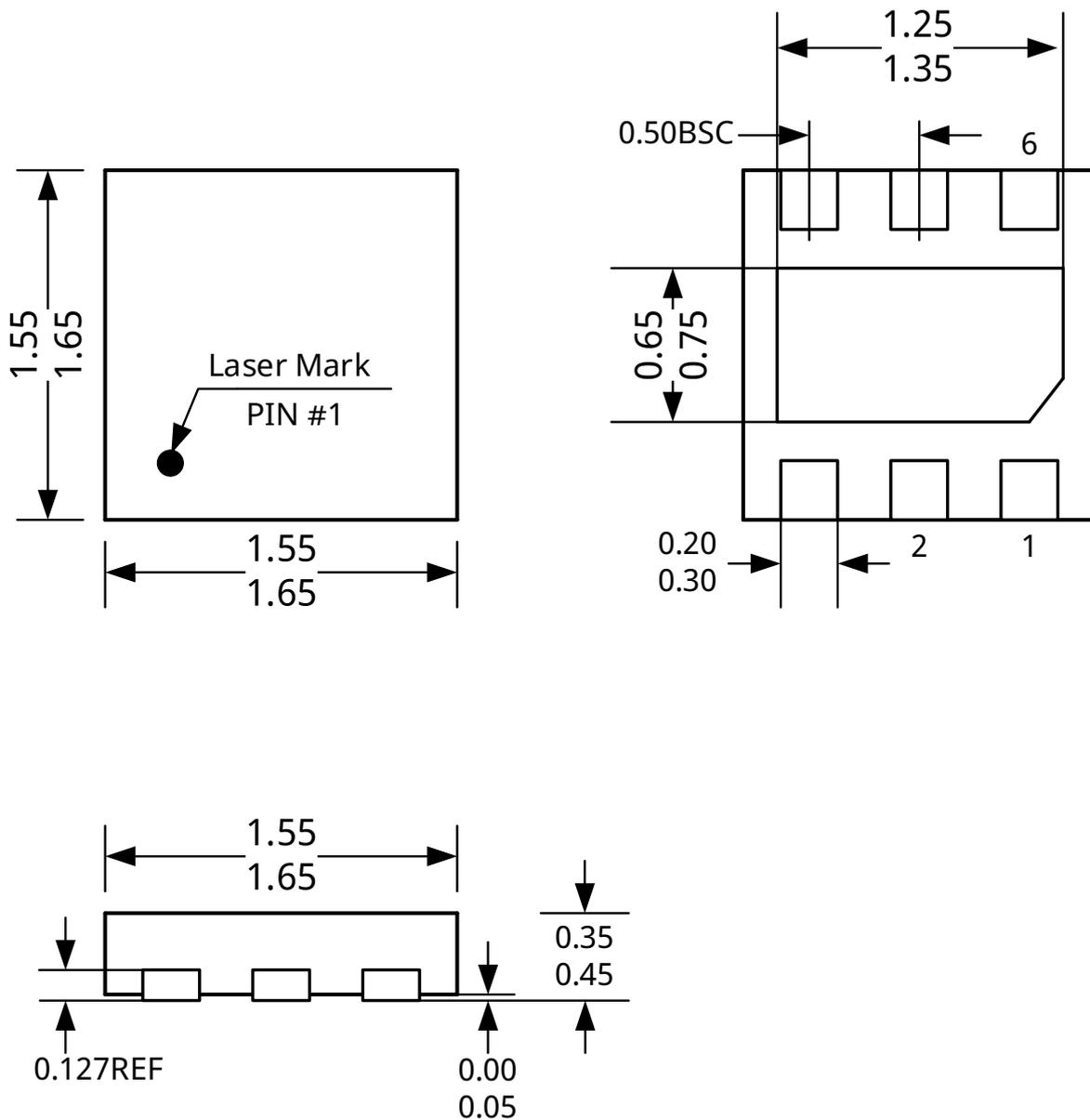

Fig.8 Output function

13. Package Information "DFN1616(DN)"

**6-Pin
DFN1616
Package**

Dimension:mm

Laser Mark

PIN #1

1.55
1.65

1.55
1.65

1.25
1.35

0.50BSC

6

0.65
0.75

0.20
0.30

2

1

1.55
1.65

0.35
0.45
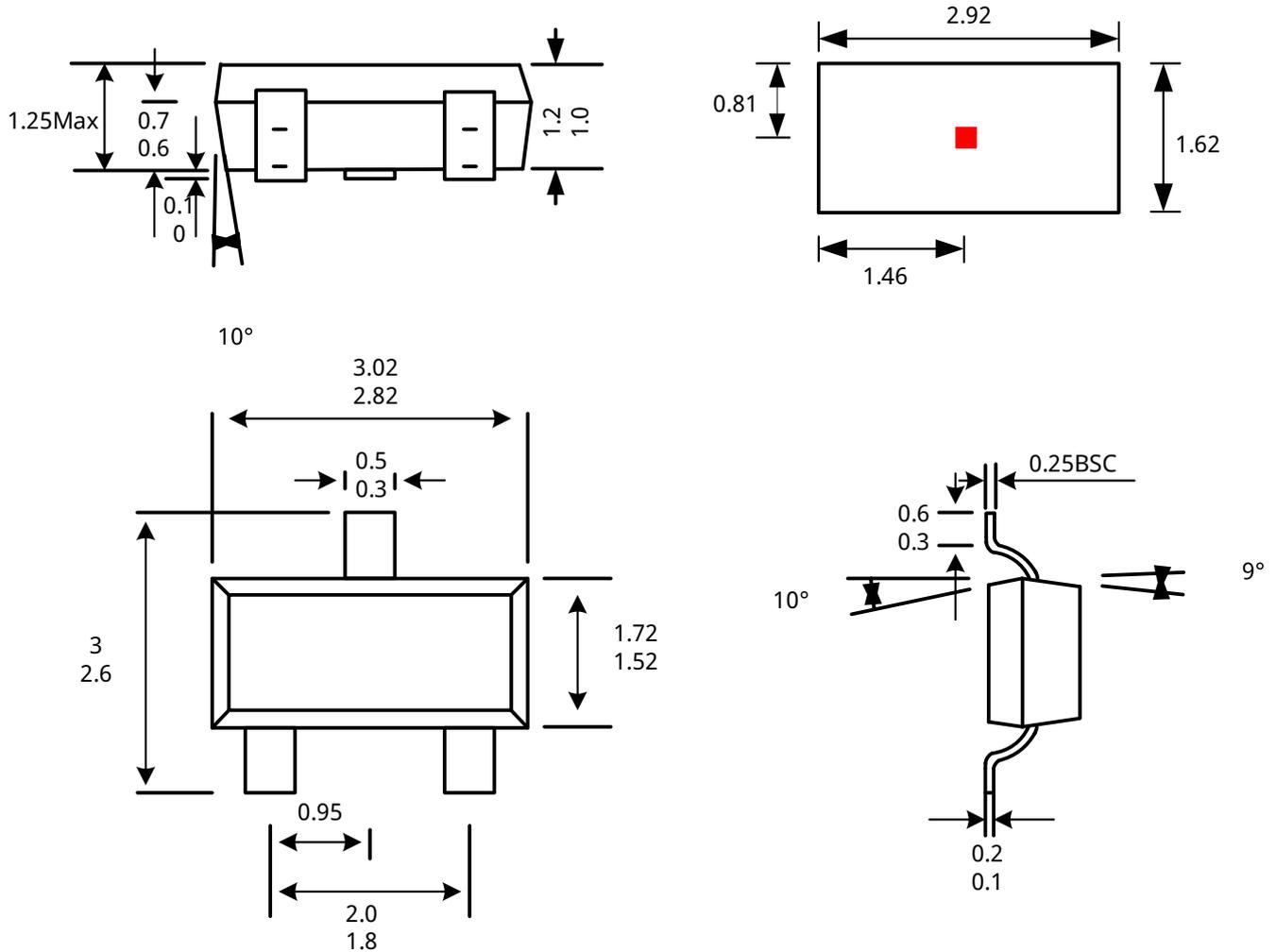
0.127REF

0.00
0.05

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 "SOT23-3L(SO)"

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

Unit：mm

1.25Max
0.7
0.6
0.1
0
10°
1.2
1.0

2.92
0.81
1.62
1.46

3.02
2.82
0.5
0.3
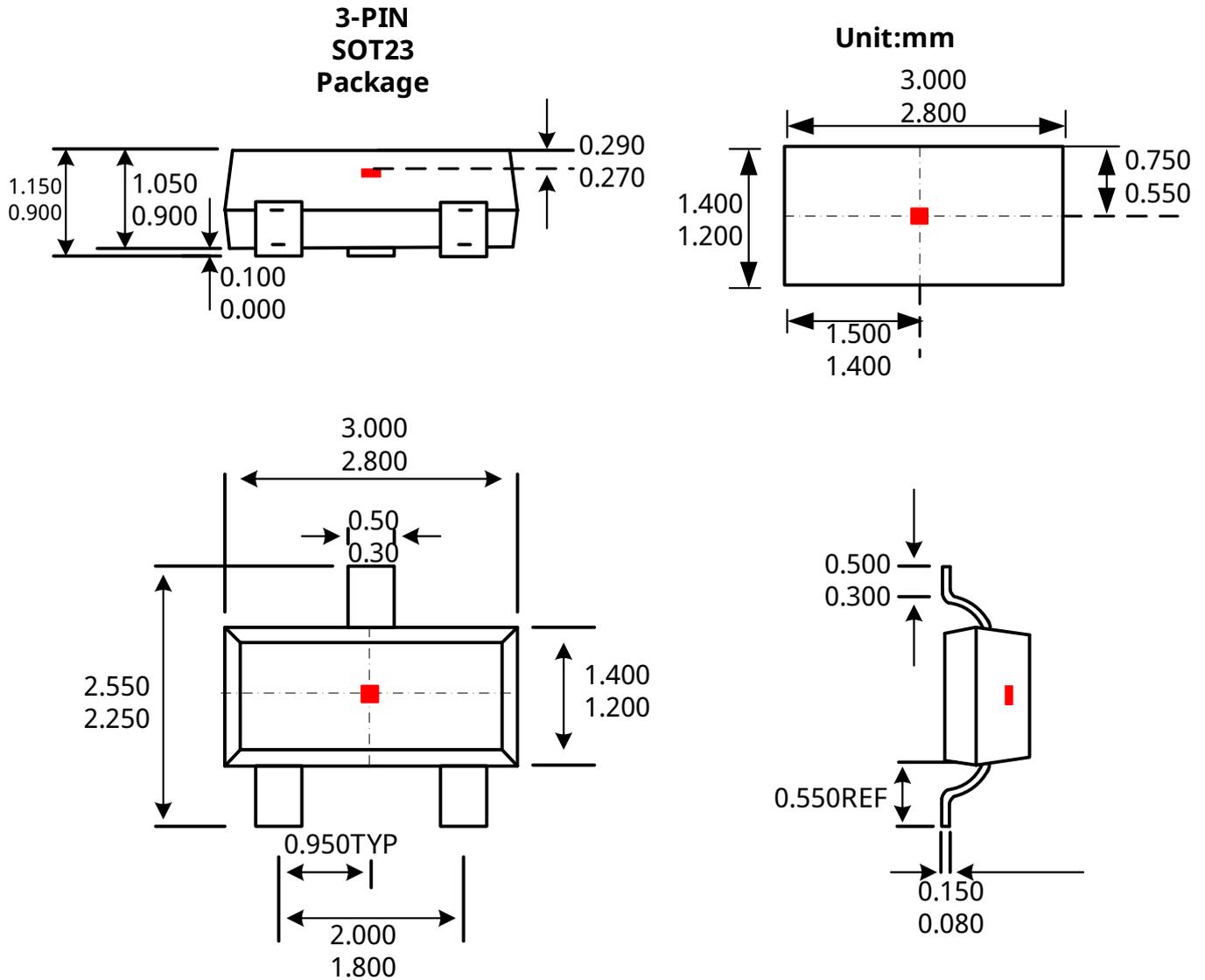3
2.6
1.72
1.52
0.95
2.0
1.8

0.25BSC
0.6
0.3
10°
9°
0.2
0.1

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 "SOT23(SE)"

**3-PIN
SOT23
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. Red mark is Hall element

Where no tolerance is specified, dimension is nominal.

16. Revision History

Revision	Date	Description
Rev.0.1	2016-05-07	Preliminary datasheet
Rev.A1.0	2024-11-27	Unified datasheet format