INTRODUCTION

The SMH101 is an integrated hall-effect sensor designed specifically to meet the requirements of low-power devices as an On/Off switch in Cellular Flip-Phones, which battery operating voltages of 2.3V ~ 5.5V.
An onboard clock scheme is used to reduce the average operating current of IC SMH101 can be switched on with either the North or South pole of a magnet.

FEATURES

- 2.3V ~ 5.5V battery operation
- Omni-polar detection
- High sensitivity and high stability of the magnetic switching points
- CMOS output or NMOS Open drain output (SMH101)
- Micro power operation

APPLICATIONS

- Mobile Phones (Flip Type, Slide Type etc.)
- Laptop PCs, Notebook PCs
- Digital Still And Video, Cameras
- Playthings, Portable games
- Electronic Dictionaries
- Home Appliances

ORDER INFORMATION

Device No.	Feature Description	Package	Packaging
SMH101NM/SMH101NMR	Tp=50ms, NMOS Output	SOT-23-3/SOT-23-5	3000 parts per reel
SMH101CM/SMH101CMR	Tp=50ms, CMOS Output	SOT-23-3/SOT-23-5	3000 parts per reel
SMH101NTS	Tp=50ms, NMOS Output	TO-92S	1000 parts per reel
SMH101CTS	Tp=50ms, CMOS Output	TO-92S	1000 parts per reel

■ TYPICAL APPLICATION CIRCUIT

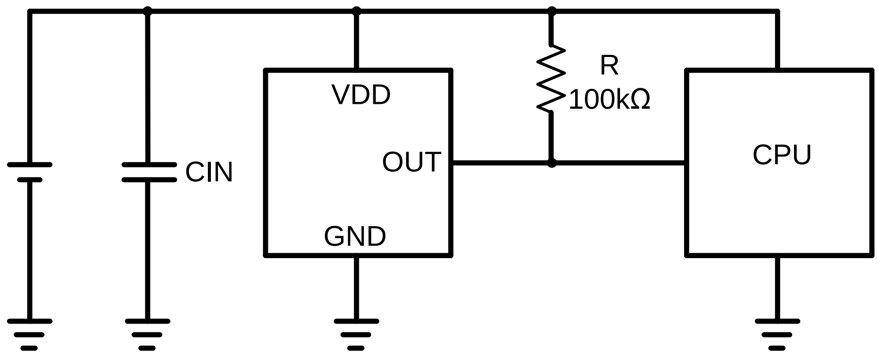


Figure 1. Standard Application Circuit（SMH101N）

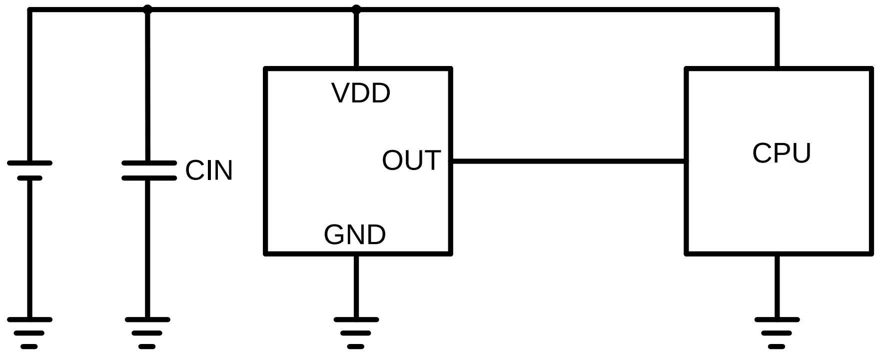
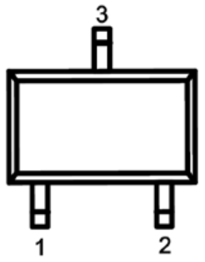
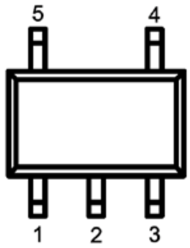


Figure 2. Standard Application Circuit（SMH101C）

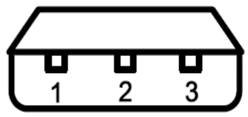
■ PIN CONFIGURATION



SOT-23-3 (Top View)



SOT-23-5 (Top View)



TO-92S (Bottom View)

SOT-23-3/SOT-23-5

PIN			TYPE(1)	DESCRIPTION AND REQUIRED COMPONENTS
M	MR	NAME		
SOT-23-3	SOT-23-5			
1	4	VDD	P	Supply Voltage Input.
2	5	OUT	I/O	NMOS Open Drain Output or CMOS Output.
3	2	GND	P	Ground Terminal.
	1/3	NC	I/O	Not Connected.

(1) I = input; O = output; P = power

TO-92S

PIN NO	NAME	DESCRIPTION AND REQUIRED COMPONENTS
1	VDD	Supply Voltage Input.
2	GND	Ground Terminal.
3	OUT	NMOS Open Drain Output or CMOS Output.

ABSOLUTE MAXIMUM RATINGS[1]

(unless otherwise specified , T_A=25°C)

PARAMETER		SYMBOL	RATINGS	UNITS
Input Supply Voltage[2]		V_{DD}	-0.3~7	V
OUT Pin Voltage[2]		V_{OUT}	-0.3~7	
Supply Pin Current		I_{DD}	-1~2.5	mA
OUT Pin Current		I_{OUT}	-1~2.5	mA
Power dissipation	SOT-23-3	P_D	400	mW
	SOT-23-5	P_D	400	mW
	TO-92S	P_D	500	mW
Operating Ambient Temperature Range[3]		T_A	-40~85	°C
Junction Temperature		T_J	-40~125	°C
Storage Temperature		T_{stg}	-65~125	°C
Lead Temperature (Soldering, 10s)		T_{solder}	260	°C
ESD rating[4]		HBM	4000	V
		MM	200	V

(1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods my affect device reliability.

(2) All voltages are with respect to network ground terminal.

(3) The SMH101 are guaranteed to meet performance specifications from 0°C to 70°C. Specifications over the －40°C to 85°C operating temperature range are assured by design, characterization and correlation with statistical process controls.

(4) ESD testing is performed according to the respective JESD22 JEDEC standard.

The human body model is a 100 pF capacitor discharged through a 1.5kΩ resistor into each pin. The machine model is a 200pF capacitor discharged directly into each pin.

RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	MIN	MAX	UNITS
Input voltage range	V_{DD}	2.3	5.5	V
Output Pin voltage range	V_{OUT}	-0.3	5.5	V
Operating junction temperature range	T_J	0	70	°C

■ ELECTRICAL CHARACTERISTICS

(V_{DD}=3V and T_A=25°C)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Average Supply Current	I_{DDAVG}			6	15	μA
Average Supply Current During Operating Time	V_{DDEN}(1)			5		mA
Supply Current During Standby Time	V_{DDDIS}(1)			3	8	μA
Output High Voltage	V_{OH}	I_{OUT}=-1.0mA	V_{DD}-0.4			V
Output Low Voltage	V_{OL}	I_{OUT}=1.0mA			0.4	V
Output Leakage Current	I_{QLEAK}				1	μA
Period	T_P			50	100	ms
Operating Time	t_{EN}			50		μs

(1) Specified by design, not production tested.

■ MAGNETIC CHARACTERISTICS

(V_{DD}=3V and T_A=25°C)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNITS
Operate Point	B_{OPS}		3.7	5.0	mT
	B_{OPN}	-5.0	-3.7		mT
Release Point	B_{RPS}	1.3	2.9		mT
	B_{RPN}		-2.9	-1.3	mT
Hysteresis Point	B_{HYS}		1.5		mT

■ BLOCK DIAGRAM

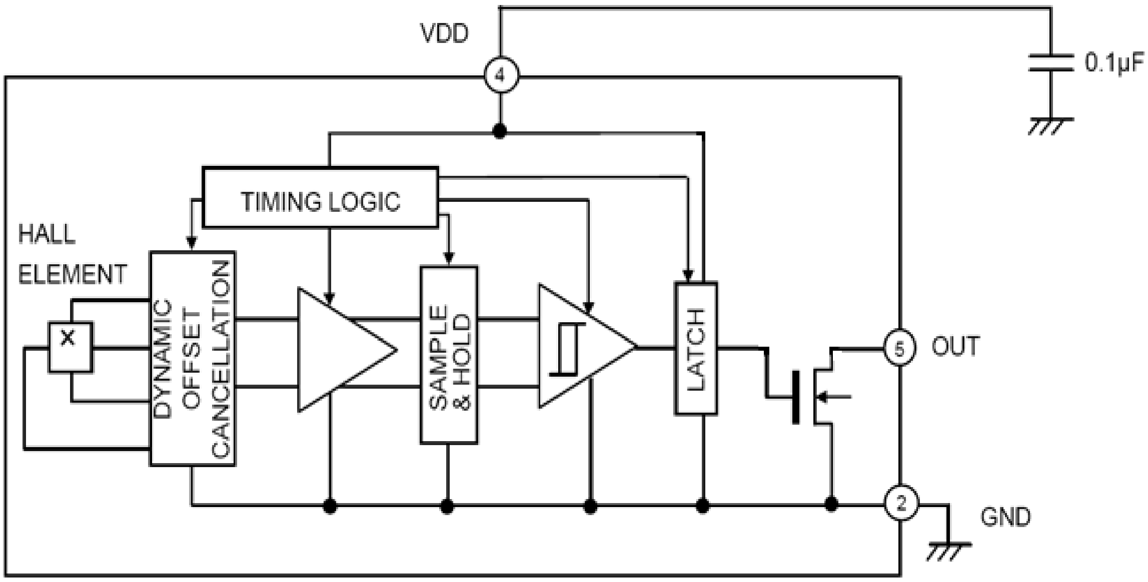


Figure 3. SMH101N Functional Block Diagram

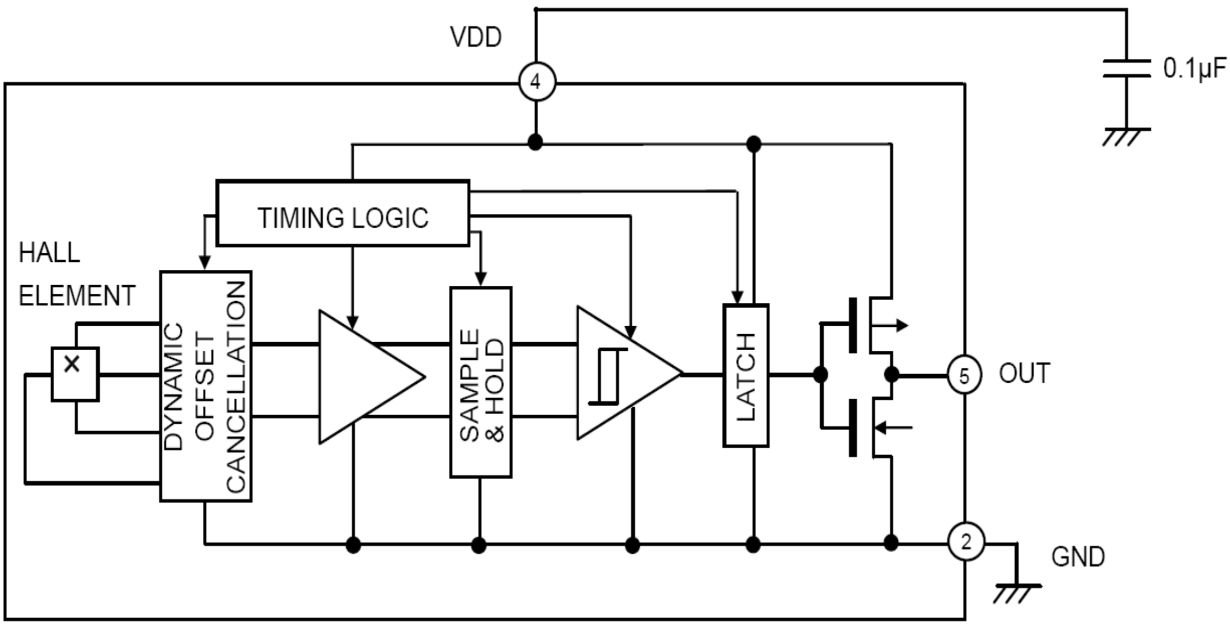


Figure 4. SMH101C Functional Block Diagram

■ FUNCTIONAL DESCRIPTION

Micropower Operation

The bipolar detection Hall IC adopts an intermittent operation method to save energy (shown in the Figure 4). At startup, the Hall elements, amp, comparator and other detection circuits power ON and magnetic detection begins. During standby, the detection circuits power OFF, thereby reducing current consumption. The detection results are held while standby is active, and then output.

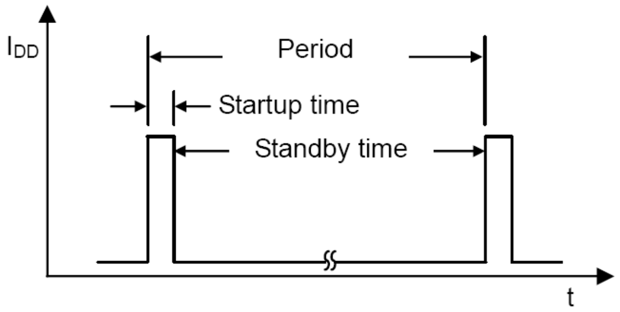


Figure 4. Intermittent Operation Method

Offset Cancelation

The Hall elements form an equivalent Wheatstone (resistor) bridge circuit. Offset voltage may be generated by a differential in this bridge resistance, or can arise from changes in resistance due to package or bonding stress. A dynamic offset cancellation circuit is employed to cancel this offset voltage.

When Hall elements are connected as shown in Figure 5 and a magnetic field is applied perpendicular to the Hall elements, voltage is generated at the mid-point terminal of the bridge. This is known as Hall voltage.

Dynamic cancellation switches the wiring to redirect the current flow to a 90° angle from its original path, and thereby cancels the Hall voltage. The magnetic signal is maintained in the sample/hold circuit during the offset cancellation process and then released.

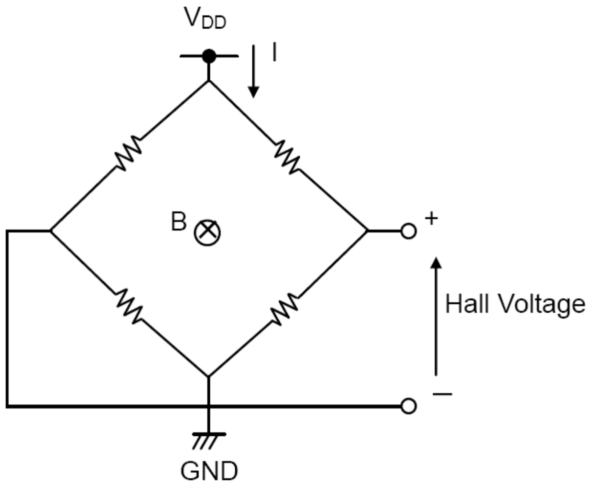


Figure 5. Equivalent Wheatstone Bridge Circuit

Magnetic Field Detection Mechanism

The Hall IC cannot detect magnetic fields that run horizontal to the package top layer. Be certain

to configure the Hall IC so that the magnetic field is perpendicular to the top layer, as shown in Figure 6.
The bipolar detection Hall IC detects magnetic fields running perpendicular to the top surface of the package. There is an inverse relationship between magnetic flux density and the distance separating the magnet and the Hall IC: when distance decrease magnetic density falls. When it drops below the operate point (Brp), output goes HIGH. When the magnet gets closer to the IC and magnetic density rises, to the operate point (Bop), the output switches LOW. In LOW output mode, the distance from the magnet to the IC decrease again until the magnetic density falls to a point just below Bop, and output returns HIGH. (This point, where magnetic flux density restores HIGH output, is known as the release point, Brp.) This detection and adjustment mechanism is designed to prevent noise, oscillation and other erratic system operation.

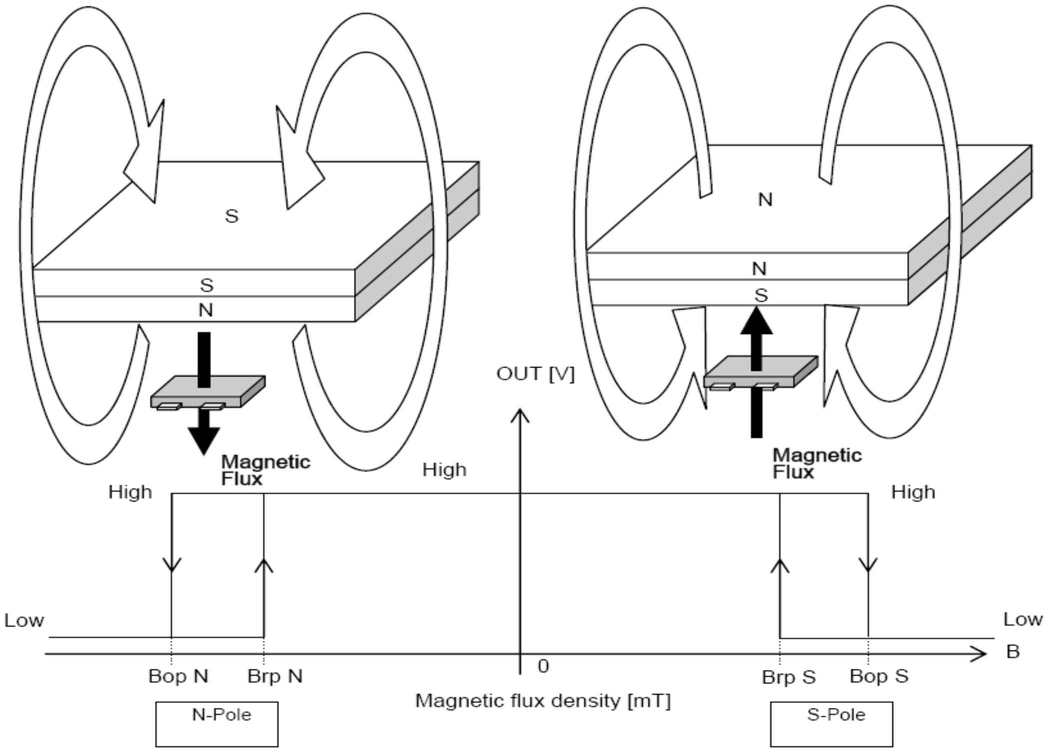


Figure 6. Operate Magnetic Field

Intermittent Operation at Power ON

The bipolar detection Hall IC adopts an intermittent operation method in detecting the magnetic field during startup, as shown in Figure 7. It outputs to the appropriate terminal based on the detection result and maintains the output condition during the standby period. The time from power ON until the end of the initial startup period is an indefinite interval, but it cannot exceed the maximum period, 100ms. To accommodate the system design, the Hall IC output read should be programmed within 100ms of power ON, but after the time allowed for the period ambient temperature and supply voltage.

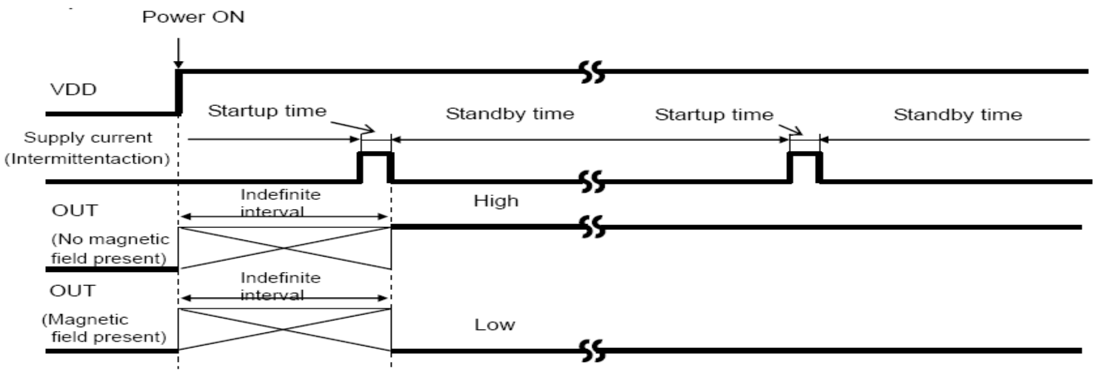


Figure 7. Detail Intermittent Operation Method

■ APPLICATION INFORMATIONS

Magnet Selection

Of the two representative varieties of permanent magnet, neodymium generally offers greater magnetic power per volume than ferrite, thereby enabling the highest degree of miniaturization. Thus, neodymium is best suited for small equipment applications. Figure 8 shows the relation between the size (volume) of a neodymium magnet and magnetic flux density. The graph plots the correlation between the distance (L) from three versions of a 4mm X 4mm cross-section neodymium magnet (1mm, 2mm, and 3mm thick) and magnetic flux density. Figure 9 shows Hall IC detection distance – a good guide for determining the proper size and detection distance of the magnet. Based on the operating point max 5.0 mT, the minimum detection distance for the 1mm, 2mm and 3mm magnets would be 7.6mm, 9.22mm, and 10.4mm, respectively. To increase the magnet's detection distance, either increase its thickness or sectional area.

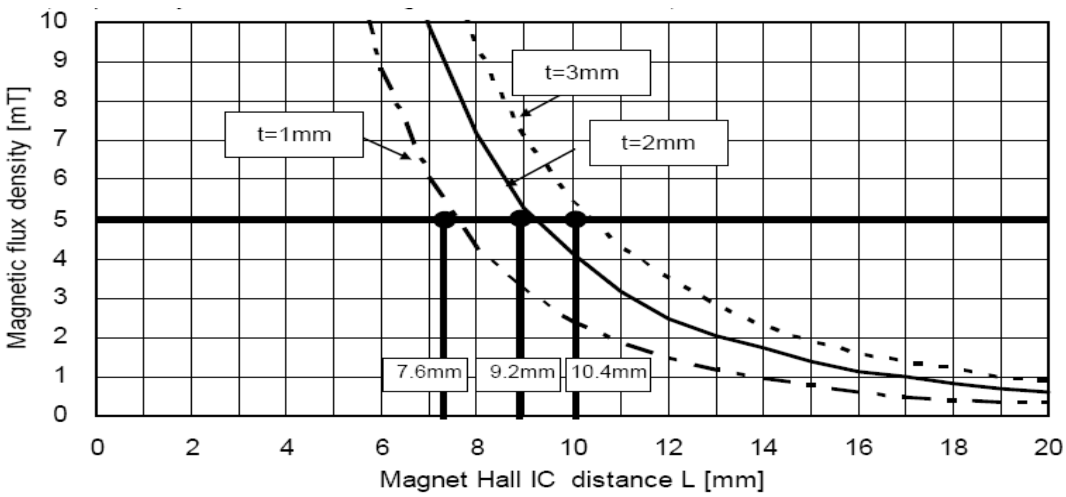


Figure 8. Magnet Hall IC Distance

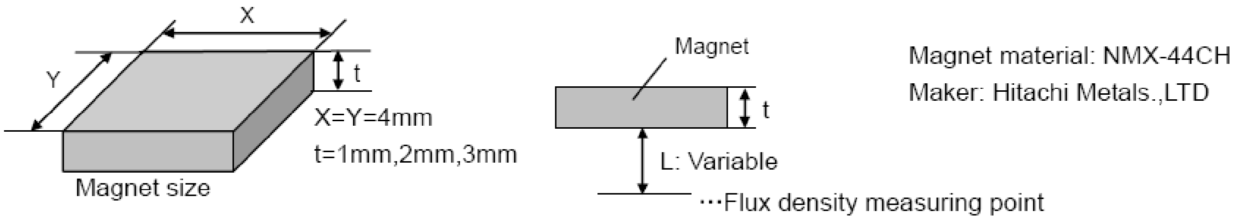


Figure 9. Magnet Dimensions and Flux Density Measuring Point

NOTES FOR USE

1) Positioning components in proximity to the Hall IC and magnet

   Positioning magnetic components in close proximity to the Hall IC or magnet may alter the magnetic field, and therefore the magnetic detection operation. Thus, placing magnetic components near the Hall IC and magnet should be avoided in the design if possible. However, where there is no alternative to employing such a design, be sure to thoroughly test and evaluate performance with the magnetic component(s) in place to verify normal operation before implementing the design.

2) Slide-by position sensing

   Figure 10 depicts the slide-by configuration employed for position sensing. Note that when the gap (d) between the magnet and the Hall IC is narrowed, the reverse magnetic field generated by the magnet can cause the IC to malfunction. As seen in Figure 10, the magnetic field runs in opposite directions at Point A and Point B. Since the bipolar detection Hall IC can detect the S-pole at Point A and the N-pole at Point B, it can wind up switching output ON as the magnet slides by in the process of position detection. Figure 10 plots magnetic flux density during the magnet slide-by. Although a reverse magnetic field was generated in the process, the magnetic flux density decreased compared with the center of the magnet. This demonstrates that slightly widening the gap (d) between the magnet and Hall IC reduces the reverse magnetic field and prevents malfunctions.

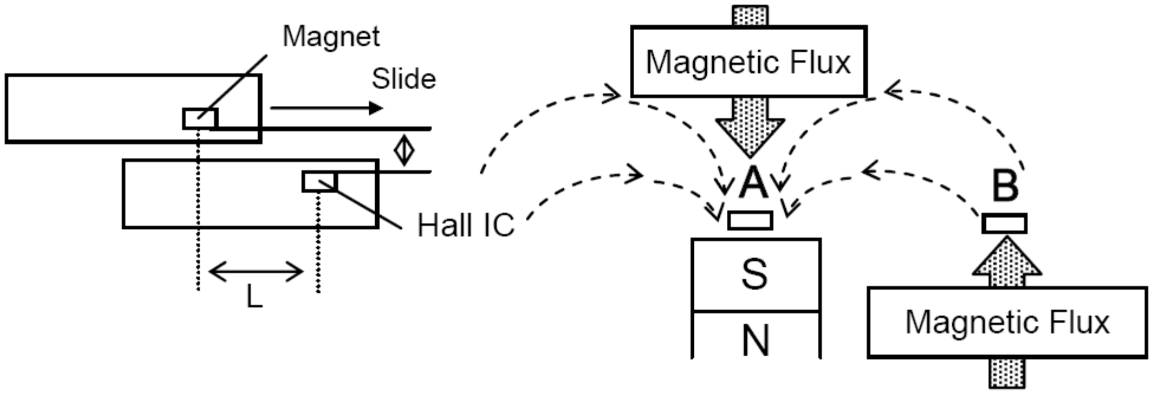
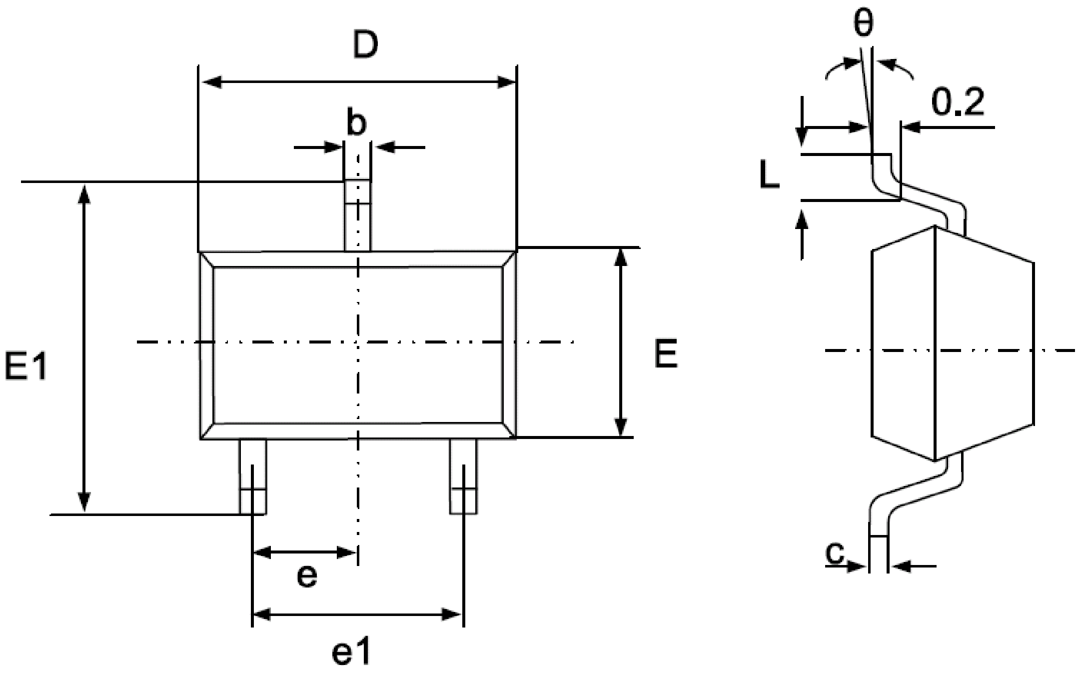
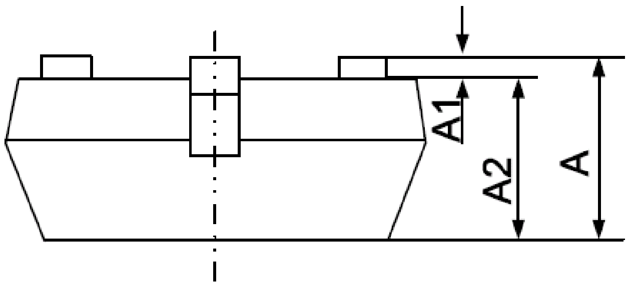


Figure 10. Slide-by Position Sensing

■ PACKAGING INFORMATION

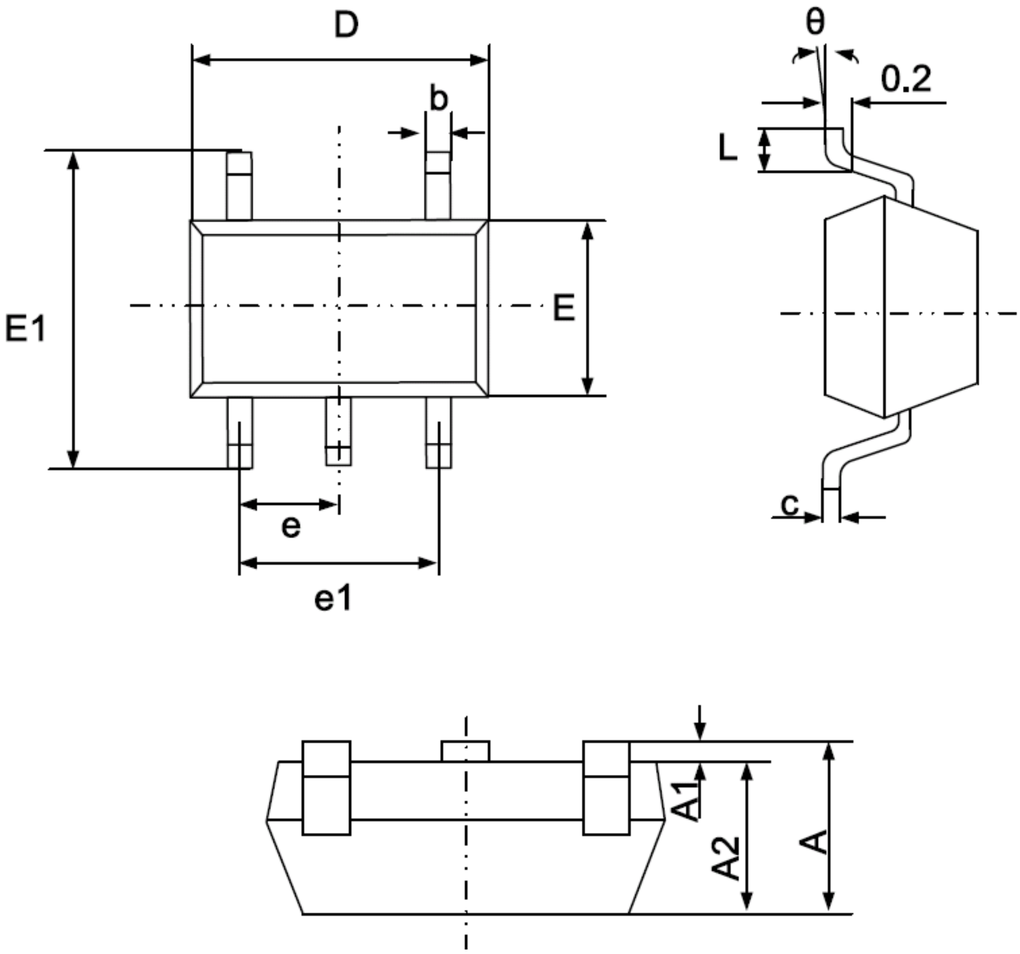
● SOT-23-3 PACKAGE OUTLINE DIMENSIONS





Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

- **SOT-23-5 PACKAGE OUTLINE DIMENSIONS**



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°