NSM1030

High Precision, Automotive 3-Wire Programmable Hall Switch/Latch

Datasheet (EN) 1.0

Product Overview

3-wire programmable Hall switch/latch NSM1030 is an automotive-grade magnetic sensor based on the planar Hall effect, developed according to ISO 26262:2011 and supports ASIL A functional safety level.

NSM1030 is designed in accordance with the requirement of automotive applications and meets AEC-Q100 requirements, which moisture sensitivity level (MSL) is one. The operating ambient temperature can reach 150°C. In addition, the product includes many special built-in designs to maximize the robustness of the system, such as reverse power supply protection, output current limiting, overvoltage protection and EMC protection, etc. With the built-in reverse voltage protection, NSM1030 can be applicated in harsh environments such as automotive 12V battery direct power supply.

NSM1030 has a full set of programmable parameters in order to provide extremely high application flexibility and system accuracy.

Typical Applications

- 3-phase BLDC motor commutation
- Wiper motor
- Window lifter
- Sunroof/Tailgate opener
- Brake light switch
- Seat motor adjuster

Packages

STD: SOT23-3L TO: TO-92s

Key Features

- AEC-Q100 grade 0
- ISO26262: ASIL A
- Programmable parameters:
    - Wide range switching point: ±1~±60 mT
    - Magnetic field polarity: South, North
    - Output polarity: High, Low
    - Temperature compensation: Flat, SmCo, NdFeB, Ferrite
    - Operation mode: General, Micropower
- Costumer ID: 16 bits
- Operating ambient temperature: -40°C ~ 150°C
- Operating voltage: 2.7~28V
- Protection: Undervoltage, Reverse voltage, Overvoltage, Output current limit, Thermal shutdown

Device Information

Part Number	Package	Body Size
NSM1030	SOT23-3L	2.926(mm)*2.80(mm)
	TO-92s	18.45(mm)*4.00(mm)

Functional Block Diagram

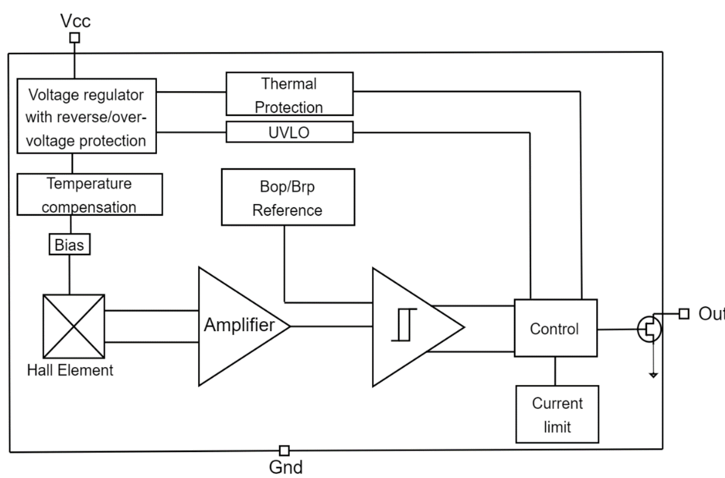


Figure 1 NSM1030 Block Diagram

Index

1. PIN CONFIGURATION AND FUNCTIONS ... 3
2. AXIS OF SENSITIVITY ... 4
3. ABSOLUTE MAXIMUM RATINGS ... 4
4. ESD RATINGS ... 5
5. RECOMMENDED OPERATING CONDITIONS ... 5
6. THERMAL CHARACTERISTICS ... 5
7. SPECIFICATIONS ... 6
   7.1. ELECTRICAL CHARACTERISTICS ... 6
   7.2. MAGNETIC CHARACTERISTICS ... 7
8. REGISTER TABLE ... 8
9. FUNCTION DESCRIPTION ... 9
   9.2. FEATURE DESCRIPTION ... 9
   9.3. POWER-ON BEHAVIOR ... 11
10. APPLICATION INFORMATION ... 11
   TYPICAL APPLICATION ... 11
11. PACKAGE INFORMATION ... 12
   11.1. STD PACKAGE ... 12
   11.2. TO PACKAGE ... 13
12. ORDERING INFORMATION ... 14
13. TAPE AND REEL INFORMATION ... 14

REVISION HISTORY ... 16

1. Pin Configuration and Functions

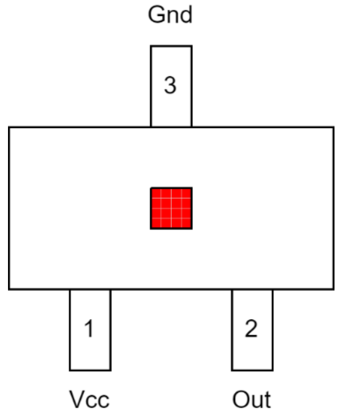


Figure 1.1 SOT23-3L package

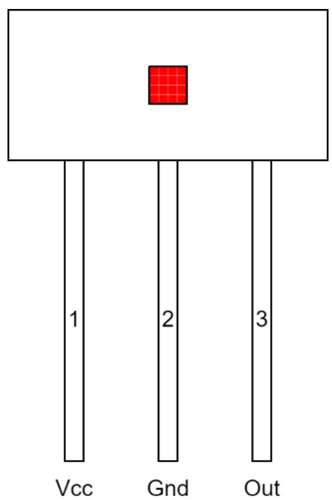


Figure 1.2 TO-92s Package

Table 1.1 NSM1030 Pin Configuration and Description

Symbol	***Pin No.***		***Function***
	SOT23-3L	***TO-92s***	
Vcc	1	1	Power supply
Gnd	3	2	Ground reference
Out	2	3	Output

2. Axis of Sensitivity

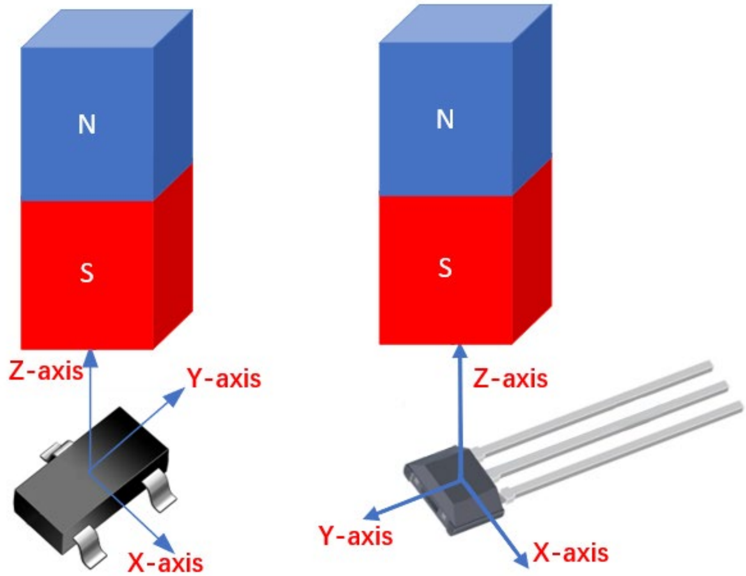


Figure 2.1 Axis of Sensitivity: Z axis (Operating Mode: South Pole)

3. Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)

Parameters	Symbol	Min	Typ.	Max	Unit
Power Supply Voltage	Vcc [1]			38	V
Reverse Supply Voltage	V_{RCC}			-20	V
Output Voltage	V_{OUT_OD} [2]			38	V
Reverse Output Voltage	V_{OUTREV}			-0.5	V
Magnetic Flux Density	B_{MAX}	Unlimited			mT
Operating Temperature Range	T_A	-40		150	°C
Junction Temperature	T_J			170	°C
Storage Temperature	$T_{STORAGE}$			175	°C
Lead Soldering Temperature, <10 seconds	$T_{SOLDRING}$			260	°C

[1]: Ambient temperature T_A =150°C for maximum 35h
[2]: The maximum junction temperature should not be exceeded

4. ESD Ratings

Characteristic	Symbol	Notes	Rating	Units
ESD Voltage	$V_{ESD(HBM)}$	Human body model (HBM), per AEC-Q100-002-RevE [1]	±8000	V
	$V_{ESD(CDM)}$	Charged-device model (CDM), per AEC-Q100-011-RevD [2]	±2000	V

[1]: AEC-Q100 document 002-RevE states that 500-V HBM allows safe manufacturing with a standard ESD control process.
[2]: AEC-Q100 document 011-RevD states that 250-V CDM allows safe manufacturing with a standard ESD control process.

5. Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

Parameters	Symbol	Min	Typ.	Max	Unit
Bypass Capacity	C_{BYP}		100		nF
Pull-up Resistance	$R_{PULL-UP}$		4.7		kΩ
Load Capacitor	C_{LOAD}		4.7		nF

6. Thermal Characteristics

Characteristic	Symbol	Test Conditions	Typ.	Units
Package Junction-to-Ambient Thermal Resistance	$R_{\theta JA}$	Package STD 1-layer PCB with copper limited to solder pads	290	°C/W
		Package TO 1-layer PCB with copper limited to solder pads	250	°C/W

7. Specifications

7.1. Electrical Characteristics

Valid over full operating voltage range Vcc =2.7 to 28V of general version and Vcc =3.1 to 28V of micropower version, ambient temperature range T_A = -40°C to 150°C, and with C_{BYP} = 0.1 µF (unless otherwise specified)

Parameters	Symbol		Min	Typ. [1]	Max	Unit	Comments
SUPPLY AND STARTUP							
Forward Supply Voltage	V_{cc}	General version	2.7		28	V	
		Micropower version	3.1		28	V	
Supply Current	I_{CC}	General version		2.5	4	mA	T≥10s, no load;
		Micropower version		63	250	µA	
Under-Voltage Lockout	V_{UVLO}	Vcc rising		2.6		V	
		Vcc falling		2.4		V	
UVLO Hysteresis	V_{UV_HYS}			200		mV	
Power-On Time	t_{PO} [2]	General version		0.3		ms	Vcc ≥ $Vcc_{(min)}$, Output low
		Micropower version			110	ms	Vcc ≥ $Vcc_{(min)}$, Output low; Typical awake period is 256ms
Power-On State	POS		High				Vcc ≥ $Vcc_{(min)}$, t < t_{PO}
MICROPOWER OPERATION							
Awake Time	t_{ACTIVE}			110		µs	
Programmable Awake Period	t_{AWAKE}		2		256	ms	
CHOPPER STABILIZATION AND OUTPUT MOSFET CHARACTERISTICS							
Chopping Frequency	f_C [2]			1000		kHz	
Output Leakage Current	I_{OUTOFF}	$V_{OUT(OFF)}$ = 12 V		0.6	2	µA	Vcc ≥ $Vcc_{(min)}$, t > t_{PO} Output high
	I_{OUTOFF}	$V_{OUT(OFF)}$ = 28 V		0.6	2	µA	Vcc ≥ $Vcc_{(min)}$, t > t_{PO} Output high
Output Voltage High	$V_{OUT(OFF)}$		Vcc-0.094		Vcc	V	Output high, $R_{PULL-UP}$ = 4.7 kΩ, no load
Output Saturation Voltage	$V_{OUT(SAT)}$			0.12	0.3	V	Vcc=12V, Output low, I_{OUT} =10 mA
Maximum Switching Frequency	f_{SW} [2]	General version		50		kHz	sine wave magnetic field with amplitude 5.5mT
		Micropower version		3.9		Hz	t_{AWAKE}=256ms

Parameters	*Symbol*		*Min*	*Typ.* [1]	*Max*	*Unit*	*Comments*
Output Jitter (p-p)	t_{JITTER} [2]	General version		5		μs	1 kHz square wave signal, square wave magnetic field with amplitude 15mT
Output Short-Circuit Current Limit	I_{SC}		25	32		mA	Output low, Vcc=12V
Output Rise Time	t_R			0.06		μs	C_{LOAD} [3] = 22 pF, $R_{PULL-UP}$ = 1 kΩ
Output Fall Time	t_F			0.1		μs	C_{LOAD} [3] = 22 pF, $R_{PULL-UP}$ = 1 kΩ
Thermal Protection Activation	T_{PORT} [4]			180		°C	
Thermal Protection Release	T_{REL} [4]			165		°C	

[1]: Typical values are defined at T_A=25°C and Vcc=12V.
[2]: Guaranteed by design and verified by characterization, not production tested.
[3]: C_{LOAD} – measurement probe capacitance
[4]: T_{PROT} and T_{REL} are the corresponding junction temperature values.

7.2. Magnetic Characteristics

Valid over full operating voltage range Vcc =2.7 to 28V of general version and Vcc =3.1 to 28V of micropower version, ambient temperature range T_A = -40°C to 150°C, and with C_{BYP} = 0.1 μF (unless otherwise specified)

Parameters	*Symbol*	*Min*	*Typ.* [1]	*Max*	*Unit*	*Comments*
Initial Operating Point	Bop(init)		±4.5	±8	mT	
Initial Release Point	Brp(init)	±0.3	±2		mT	Omnipolar switch(default)
Programmable Magnetic Operating Point	B_{op}	±1		±60	mT	Switch mode and latch mode, T_A = 25°C, 9 bits
Programmable Magnetic Releasing Point	B_{rp}	±1		±60	mT	Switch mode and latch mode, T_A = 25°C, 9 bits
Temperature Coefficient	TCSEL	-1100	-720	2500	ppm/°C	

[1]: Typical values are defined at T_A=25°C and Vcc=12V.

8. Register Table

Valid over full operating voltage range Vcc =2.7 to 28V of general version and Vcc =3.1 to 28V of micropower version, ambient temperature range T_A = -40°C to 150°C, and with C_{BYP} = 0.1 µF (unless otherwise specified)

Address	R/W	Register Name	Function	Default Value
0x10	RW	Config1	BIT<7,6>: Work Mode 00,01: Unipolar;10: Omnipolar; 11: Latch BIT<5>: Operating Mode 0: South; 1: North BIT<4>: Output Polarity 0: Output low; 1: Output high BIT<3:1>: Programmable Awake Period 000: 2ms 001:4ms 010: 8ms 011: 16ms 100: 32ms 101: 64ms 110: 128ms 111: 256ms BIT<0>: Power Mode 0: General mode 1: Programmable micropower mode	0x80
0x11	RW	Brpset	Bit<7:0>: BRPSEL [8:1]: 0.4Gs/LSB	0x21
0x12	RW	Bopset	Bit<7>: BRPSEL [0]: 0.4Gs/LSB Bit<6:0>: BOPSEL [8:2]: 0.4Gs/LSB	0x25
0x13	RW	Temperature Coefficient	Bit<7:6>: BOPSEL [1:0]: 0.4Gs/LSB Bit<5:0>: TSCEL [5:0] [1]: Temperature coefficient, 60ppm/°C/bit Flat(0ppm/°C): 0x0C SmCo(-300ppm/°C): 0x02 NdFeB(-1100ppm/°C): 0x27 Ferrite(-2000ppm/°C): 0x35	0xCC
0x14	RW	Config2	Bit<7>: Swap_input [2]: 0: Swap_input _Disable; 1: Swap_input _Enable; Bit<6:5>: Gain [1:0] [3] Gain selection 00: Magnetic field from 0.1 to 15mT 01: Magnetic field from 15.1 to 30mT 10: Magnetic field from 30.1 to 45mT 11: Magnetic field from 45.1 to 60mT Bit<4>: Thermal_shutdown 1: Enable 0: Disable Bit<3:0>: For NOVOSNS internal used	0x00
0x15	RW	ID1	Bit<7:0>: Costumer ID1	0x00

Address	R/W	Register Name	Function	Default Value
0x16	RW	ID2	Bit<7:0>: Costumer ID2	0x00
0x17	RW	ChainTrim	Bit<7>: OWI_disable [4] 1: Disable OWI Bit<6:0>: Signal Chain Trim For NOVOSNS internal used	0x00
0x20	RW	TrimFunction1	For NOVOSNS internal used	0x16
0x22	RW	TrimFunction3	Bit<3>: For NOVOSNS internal used Bit<2>: EN_SLP Bit<1:0>: For NOVOSNS internal used	0x08
0x24	R	Wafer Number	For NOVOSNS internal used	default
0x24	R	X_Location	For NOVOSNS internal used	default
0x24	R	Y_Location	For NOVOSNS internal used	default

[1]: The highest bit is sign bit, TSCEL [5] =0 is negative temperature coefficient; TSCEL [5] =1 is positive temperature coefficient.
[2]: Swap input needs to be set to 1 for TO-92s package.
[3]: The gain selection depends on the magnetic field range.
[4]: Once the OWI_disable is set to 1, the NSM1030 cannot be reprogrammed.

9. Function Description

9.1. Overview

NSM1030 integrates rotating current Hall plate, temperature sensor, Schmitt trigger and open drain output with short circuit protection, which can convert the changing external magnetic field signal into a digital voltage signal to achieve accurate position detection. The integrated temperature compensation function can match the temperature characteristics of different materials of the target and provide stable position detection in the full operating temperature range. NSM1030 supports online programming for users. The NOVOSENSE patented single-wire communication protocol (OWI protocol) can be used for single-wire programming through the output port under Vcc=10V. The NSM1030 is available in two packages: STD is a general-purpose 3-pin SOT23 package, and TO is a general-purpose TO-92s plug-in package. Both packages are lead (Pb) free and RoHS compliant with 100% tin plated lead frame.

9.2. Feature Description

The output state of NSM1030 changes when a magnetic field perpendicular to the Hall-effect sensor exceeds the operate point threshold (Bop). When the magnetic field is reduced below the release point (Brp), the device output changes to the alternate state. NSM1030 can be configured to respond to a north or south magnetic field, as well as the output polarity. The output state and magnetic field polarity depends on the EEPROM settings. For unipolar south, an increasing south field is required; likewise, for unipolar north, an increasing north field is required to exceed Bop. The output state is a configuration option. In omnipolar mode, the device will switch on and off with either magnetic polarity, while latching will require both polarities.

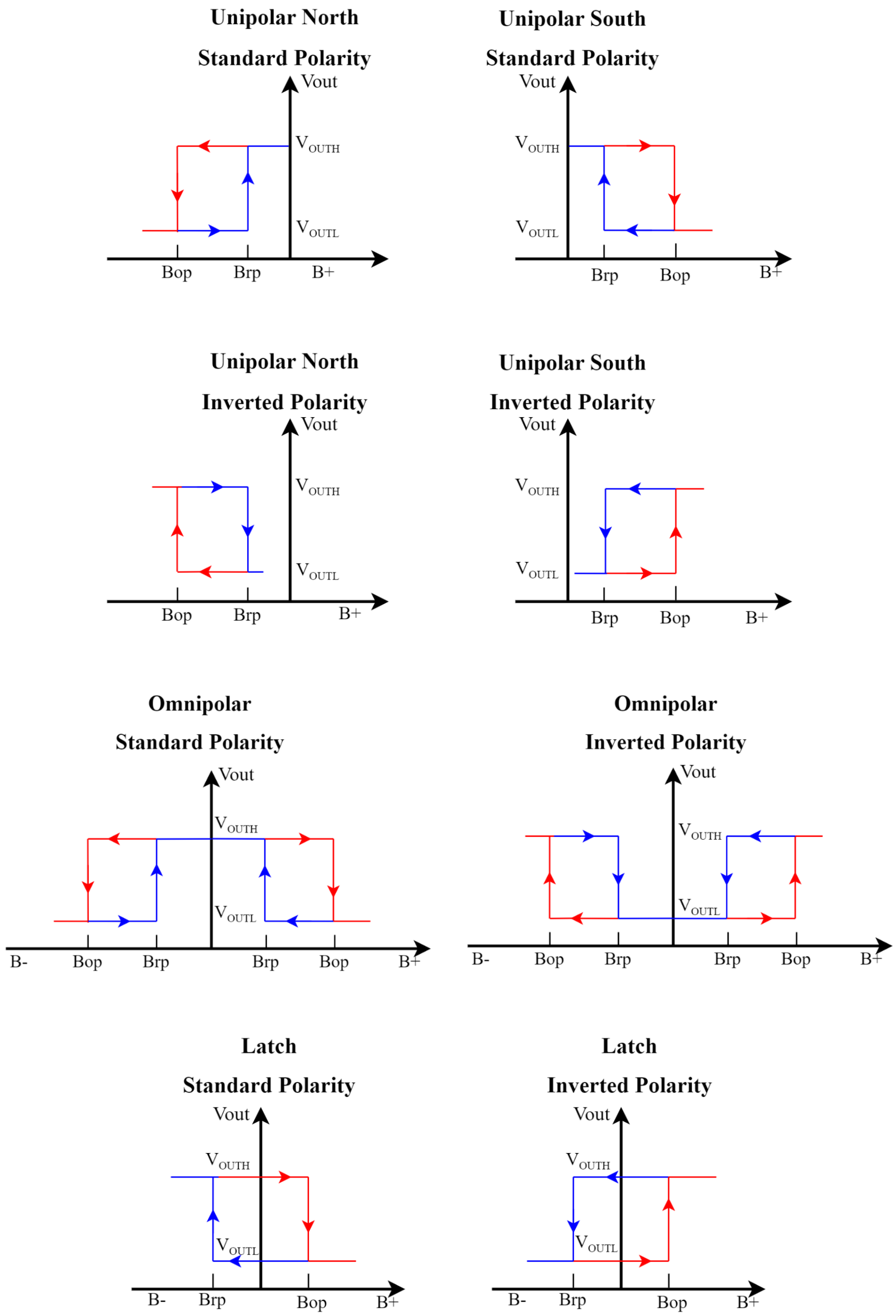


Figure 9.1 Magnetic and Output Polarity Options

Figure 9.1 shows the output switching behavior relative to increasing and decreasing magnetic field. On the horizontal axis, the B+ direction indicates increasing south polarity magnetic field strength.

NSM1030 has auto trim function. Users can activate auto trim at the desired mechanical position to find the corresponding desired magnetic switch point (Bop/ Brp). This method can realize high precision switching even in the presence of external mechanical vibration and electrical noise.

9.3. Power-On Behavior

The NSM1030 has an internal voltage regulator with undervoltage lockout. As the device powers up, it stays in the power-on state (POS) until the supply voltage exceeds $V_{cc\,(min)}$. Then the device reads the device configuration registers from EEPROM and checks that the EEPROM values are valid by comparing the calculated Error Correction Code (ECC) for each register against the stored ECC. After t_{po}, the output state depends on the magnetic field as shown in Figure 6. Similarly, when the supply voltage decreases, the device returns to the power on state (POS) when the supply voltage drops below V_{UVLO} falling. When the device powers on is in the hysteresis range (less than Bop and higher than Brp), the output corresponds to the power-on state. In this case, the correct state is attained after the first excursion beyond Bop or Brp

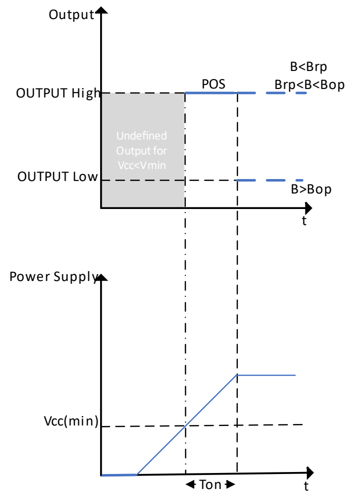


Figure 9.2 Power-On Sequence

10. Application Information

Typical Application

It is strongly recommended that an external bypass capacitor be connected between the supply and ground of the device to guarantee correct performance under harsh environmental conditions and to reduce noise from internal circuitry.

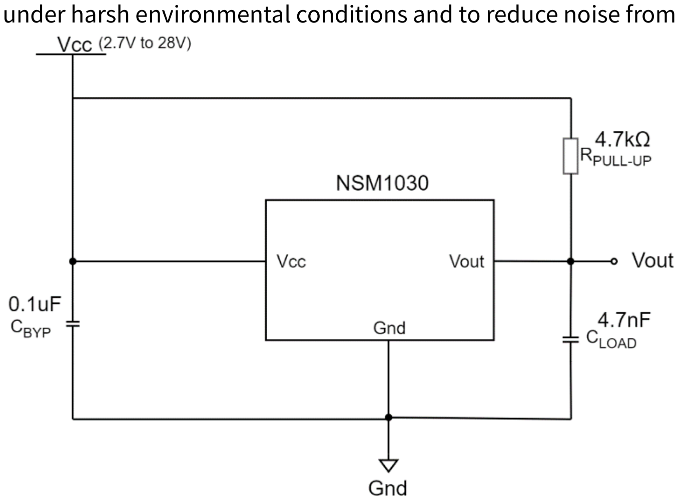
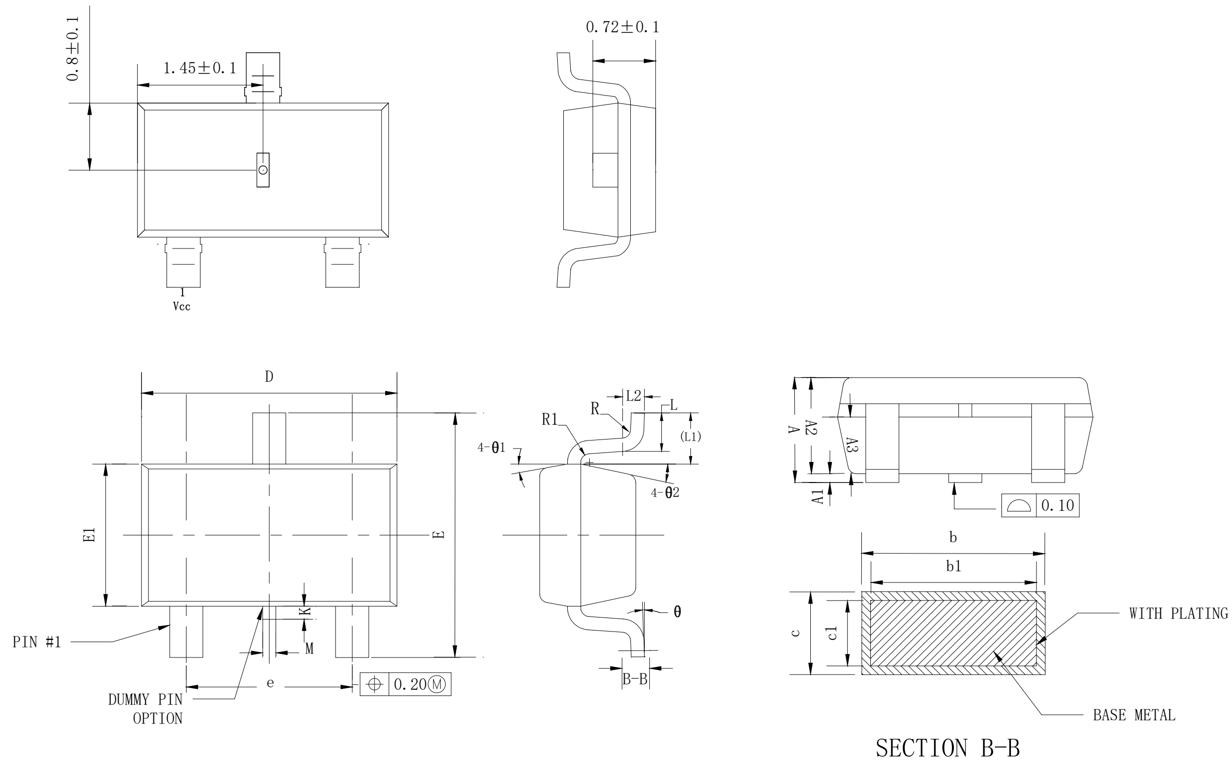


Figure 10.1 Typical Application Circuit

11. Package Information

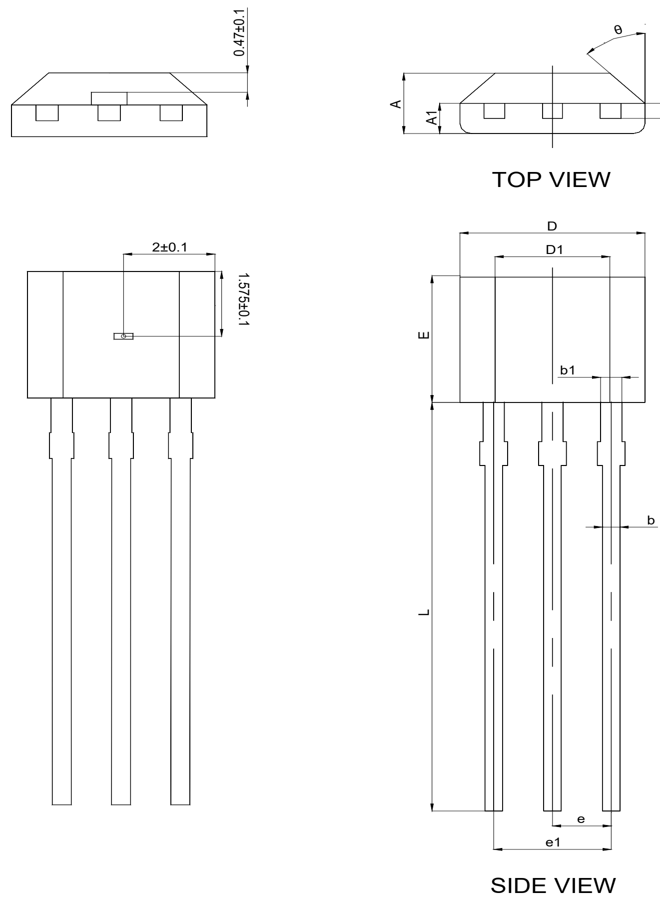
11.1. STD package



Symbol	Dimensions In Millimeters		
	Min.	Typ.	Max.
A	-	-	1.200
A1	0.000	-	0.150
A2	1.000	1.100	1.200
A3	0.600	0.650	0.700
b	0.340	-	0.450
b1	0.340	0.380	0.410
c	0.120	-	0.200
c1	0.120	0.150	0.160
D	2.826	2.926	3.026
E	2.600	2.800	3.000
E1	1.526	1.626	1.700
e	1.800	1.900	2.000
K	0.000	-	0.200
L	0.300	0.400	0.600
L1	0.590REF		
L2	0.250BSC		
M	0.100	0.150	0.200
R	0.050	-	0.200
R1	0.050	-	0.200
θ	0°	-	8°
θ1	8°	10°	12°
θ2	10°	12°	14°

Figure 11.1 SOT23-3L Package Shape and Dimension in Millimeters

11.2. TO package



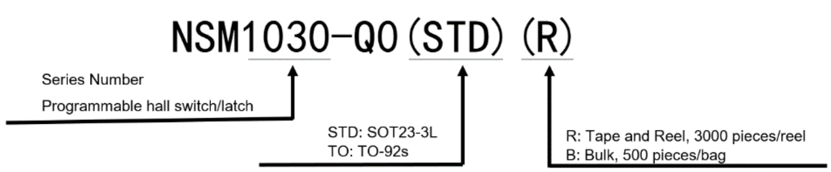
Symbol	Dimensions In Millimeters	
	Min.	Max.
A	1.420	1.620
A1	0.660	0.860
b	0.330	0.480
b1	0.400	0.510
c	0.330	0.510
D	3.900	4.100
D1	2.280	2.680
E	3.050	3.250
e	1.270 TYP.	
e1	2.440	2.640
L	15.100	15.500
θ	45° TYP.	

Figure 11.2 TO-92s Package Shape and Dimension in Millimeters

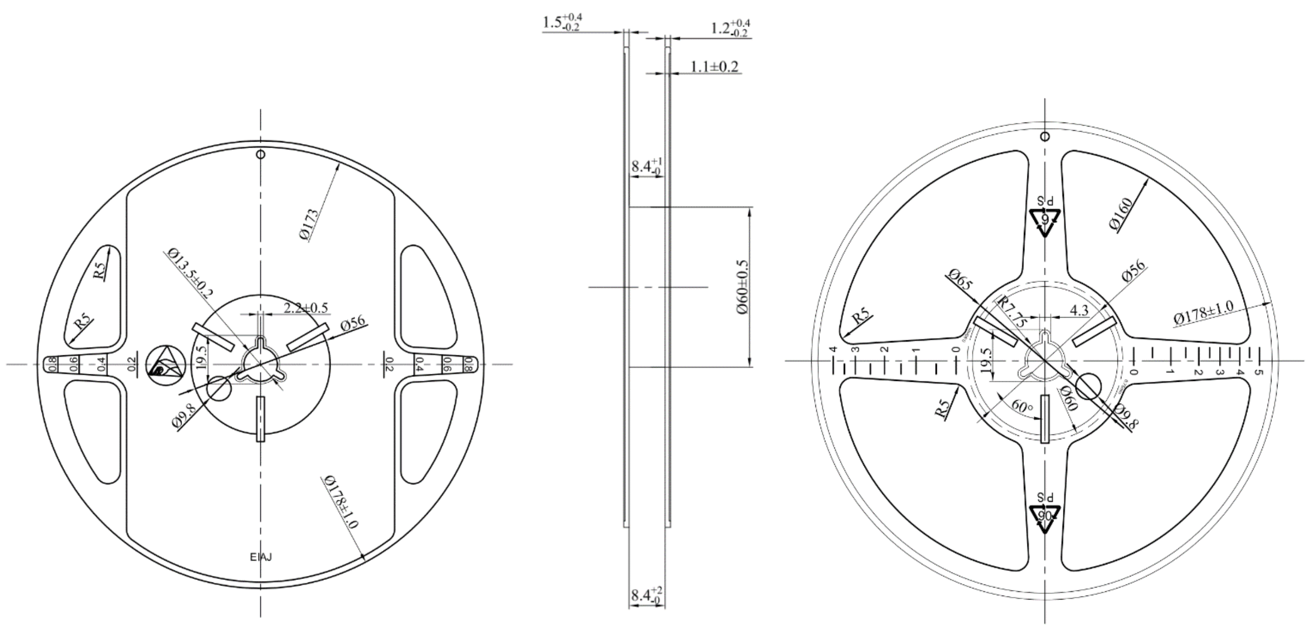
12. Ordering Information

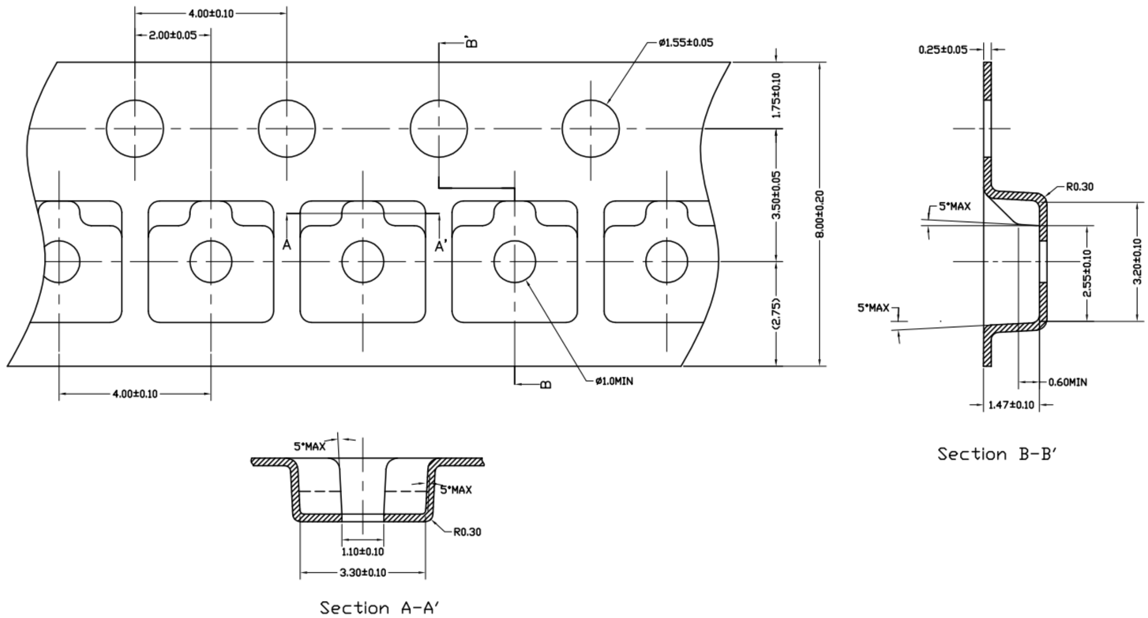
Part Number	Default Work Mode	Operating Mode	Default Output Polarity	Default Device Switch Threshold Magnitude	Power Mode	Package	Packing
NSM1030-Q0STDR	Omnipolar	South	Output Low	Bop: ±4.5mT Brp: ±2mT	General Mode	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1030-Q0TOB	Omnipolar	South	Output Low	Bop: ±4.5mT Brp: ±2mT	General Mode	TO-92s	Bulk, 500 pieces/bag

Part Number Rule:



13. Tape and Reel Information





NOTES:
1.MATERIAL:CONDUCTIVE PS
2.ALL DIMS IN MM
3.There must not be foreign body adhesion and the state of the surface must be excellent
4.A permissible difference of the accumulation pitch of the sending hole is assumed to be ±0.2 up to 10 pitches
5.17” PAPER—Reel, 125000pockets
6.Surface resistance 1X10E5～1X10E9 OHMS/SQ

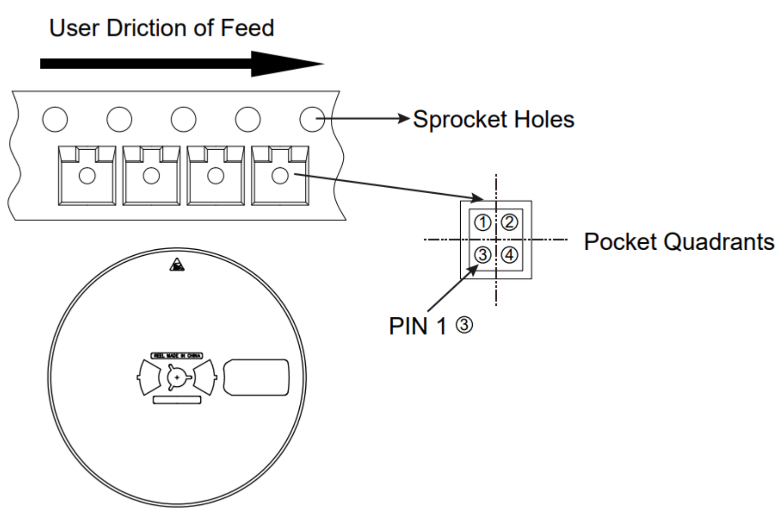


Figure 13.1 Tape and Reel Information of SOT23-3L

Revision History

Revision	Description	Date
1.0	Initial Version	2024/05/31

IMPORTANT NOTICE

The information given in this document (the “Document”) shall in no event be regarded as any warranty or authorization of, express or implied, including but not limited to accuracy, completeness, merchantability, fitness for a particular purpose or infringement of any third party’s intellectual property rights.

Users of this Document shall be solely responsible for the use of NOVOSENSE’s products and applications, and for the safety thereof. Users shall comply with all laws, regulations and requirements related to NOVOSENSE’s products and applications, although information or support related to any application may still be provided by NOVOSENSE.

This Document is provided on an “AS IS” basis, and is intended only for skilled developers designing with NOVOSENSE’ products. NOVOSENSE reserves the rights to make corrections, modifications, enhancements, improvements or other changes to the products and services provided without notice. NOVOSENSE authorizes users to use this Document exclusively for the development of relevant applications or systems designed to integrate NOVOSENSE’s products. No license to any intellectual property rights of NOVOSENSE is granted by implication or otherwise. Using this Document for any other purpose, or any unauthorized reproduction or display of this Document is strictly prohibited. In no event shall NOVOSENSE be liable for any claims, damages, costs, losses or liabilities arising out of or in connection with this Document or the use of this Document.

For further information on applications, products and technologies, please contact NOVOSENSE (www.novosns.com).

Suzhou NOVOSENSE Microelectronics Co., Ltd