NSM101x

High Precision, Automotive 3-Wire Fixed-sensitivity Hall Switch/ Latch

Datasheet (EN) 1.0

Product Overview

3-wire fixed-sensitivity Hall switch/latch NSM101x 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.

NSM101x 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, NSM101x can be applicated in harsh environments such as automotive 12V battery direct power supply.

Typical Applications

- Automotive, Consumer and Industrial
- 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
- Optional parameters:
  - Multiple sensitivity options
  - Magnetic field polarity: South, North
  - Output phase: High, Low
  - Temperature compensation: Flat, SmCo, NdFeB, Ferrite
  - Operation mode: General version, Micropower version
- 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*
NSM1011	SOT23-3L	2.926(mm)*2.80(mm)
	TO-92s	18.45(mm)*4.00(mm)
NSM1012	SOT23-3L	2.926(mm)*2.80(mm)
	TO-92s	18.45(mm)*4.00(mm)
NSM1013	SOT23-3L	2.926(mm)*2.80(mm)
	TO-92s	18.45(mm)*4.00(mm)

Functional Block Diagram

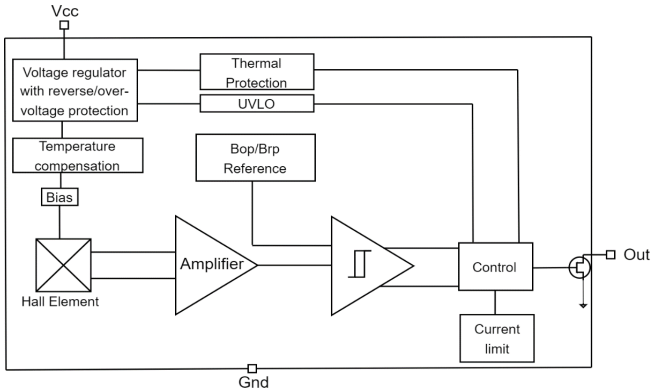

Figure 1 NSM101x Block Diagram

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1. Pin Configuration and Functions

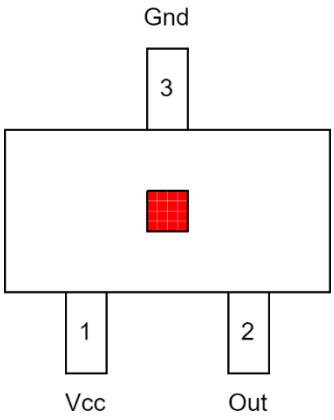


Figure 1.1 SOT23-3L Package

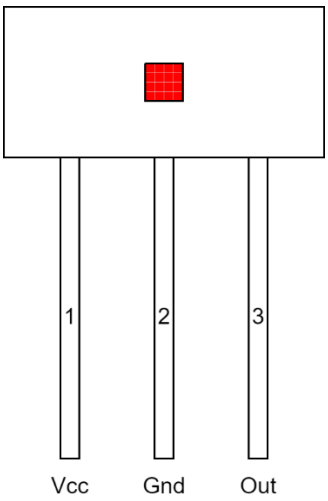


Figure 1.2 TO-92s Package

Table 1.1 NSM101x Pin Configuration and Functions

Symbol	***Pin No.***		***Function***
	SOT-23-3L	***TO-92s***	
Vcc	1	1	Power supply
Gnd	3	2	Ground reference
Out	2	3	Output

2. Axis of Sensitivity

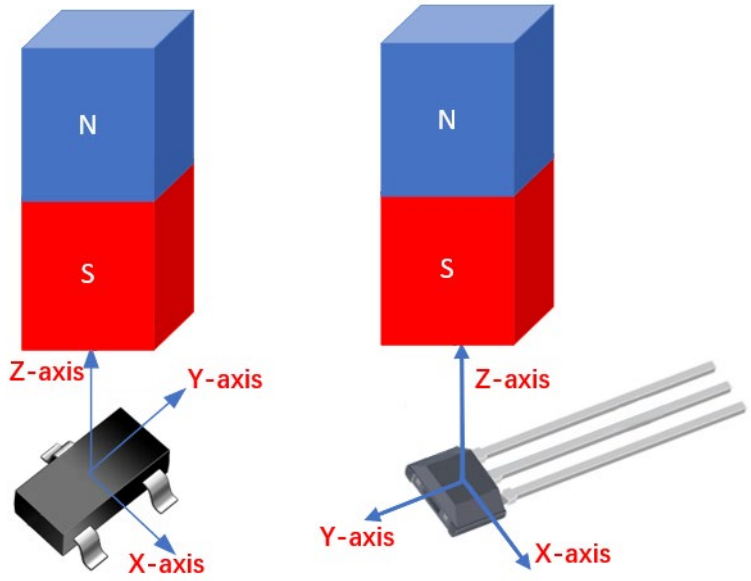


Figure 2.1 Axis Of Sensitivity: Z Axis (Operating Mode: South Pole)

3. 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.

4. Absolute Maximum Ratings

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

Parameters	*Symbol*	*Min*	*Typ.*	*Max*	*Unit*
Power Supply Voltage	V_{cc} [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	$T_{J\,(max)}$			170	°C

Storage Temperature	$T_{Storage}$			175	°C
Lead Soldering Temperature, <10 seconds	$T_{Soldering}$			260	°C

[1]: Ambient temperature T_A=150°C for maximum 35h.

[2]: The maximum junction temperature should not be exceeded.

5. Thermal Information

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

6. Recommended Operating Conditions

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

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

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	90	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	$V_{CC} \geq V_{CC\ (min)}$, Output low
		Micropower version			110	ms	$V_{CC} \geq V_{CC\ (min)}$, Output low; Operating period is 256ms
Power-On State	POS		High				$V_{CC} \geq V_{CC\ (min)}$, t < t_{PO}
MICROPOWER OPERATION							
Awake Time	t_{ACTIVE}			110		µs	
Awake Period	t_{AWAKE}			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	$V_{CC} \geq V_{CC\ (min)}$, t > t_{PO}
	I_{OUTOFF}	$V_{OUT(OFF)}$ = 28 V		0.6	2	µA	$V_{CC} \geq V_{CC\ (min)}$, t > t_{PO}
Output Voltage High	V_{OUTH}		Vcc-0.094		Vcc	V	Output off, $R_{PULL-UP}$ = 4.7 kΩ, no load
Output Saturation Voltage	V_{OUTSAT}			0.12	0.3	V	Vcc=12V, Output on, I_{OUT} =10 mA
Maximum Switching Frequency	f_{SW} [2]	General version		50		kHz	B_{OP} = 2mT, B_{RP} = -2mT, sine wave magnetic field with amplitude 3.5mT

Parameters	Symbol		Min	Typ. [1]	Max	Unit	Comments
		Micropower version		3.9		Hz	
Output Jitter (p-p)	t_{JITTER} [2]	General version		5		μs	1 kHz square wave signal, B_{OP} = 2mT, B_{RP} = -2mT, square wave magnetic field with amplitude 10mT
Output Short-Circuit Current Limit	I_{SC}		25	32		mA	Output low, Vcc=12V
Short-Circuit Protection Time	t_{sc} [2]			2		min	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 from T_A = -40°C to 150°C, and with C_{BYP} = 0.1 μF (unless otherwise specified)

Parameters	Symbol	Min	Typ. [1]	Max	Unit
NSM1011A					
Operating Point	B_{op}	0.8	1.5	2.5	mT
Release Point	B_{rp}	0.1	0.5	1.2	mT
Hysteresis	B_{hys}	0.4	1	1.5	mT
NSM1011B					
Operating Point	B_{op}	2	3.5	5	mT
Release Point	B_{rp}	1.5	2.5	3.5	mT
Hysteresis	B_{hys}	0.4	1	2	mT
NSM1011C					
Operating Point	B_{op}	5.5	7.5	9.5	mT
Release Point	B_{rp}	5	6.5	8	mT

Parameters	Symbol	Min	Typ. [1]	Max	Unit
Hysteresis	B_{hys}	0.4	1	2	mT
NSM1011D					
Operating Point	B_{op}	7.5	10	12.5	mT
Release Point	B_{rp}	7	9	11	mT
Hysteresis	B_{hys}	0.4	1	2	mT
NSM1011E					
Operating Point	B_{op}	12.5	15	17.5	mT
Release Point	B_{rp}	11	13	15	mT
Hysteresis	B_{hys}	1	2	3	mT
NSM1012A					
Operating Point	B_{op}	±0.8	±1.5	±2.2	mT
Release Point	B_{rp}	±0.1	±0.5	±1	mT
Hysteresis	B_{hys}	0.4	1	1.5	mT
NSM1012B					
Operating Point	B_{op}	±2	±3.5	±5	mT
Release Point	B_{rp}	±1.5	±2.5	±3.5	mT
Hysteresis	B_{hys}	0.4	1	2	mT
NSM1012C					
Operating Point	B_{op}	±5.5	±7.5	±9.5	mT
Release Point	B_{rp}	±5	±6.5	±8	mT
Hysteresis	B_{hys}	0.4	1	2	mT
NSM1012D					
Operating Point	B_{op}	±7.5	±10	±12.5	mT
Release Point	B_{rp}	±7	±9	±11	mT
Hysteresis	B_{hys}	0.4	1	2	mT
NSM1012E					
Operating Point	B_{op}	±12.5	±15	±17.5	mT
Release Point	B_{rp}	±11	±13	±15	mT
Hysteresis	B_{hys}	1	2	3	mT
NSM1013A					
Operating Point	B_{op}	0.6	1.5	2.5	mT

Parameters	*Symbol*	*Min*	*Typ.* [1]	*Max*	*Unit*
Release Point	B_{rp}	-2.5	-1.5	-0.6	mT
Hysteresis	B_{hys}	1.2	3	5	mT
NSM1013B					
Operating Point	B_{op}	2	3.5	5	mT
Release Point	B_{rp}	-5	-3.5	-2	mT
Hysteresis	B_{hys}	4	7	10	mT
NSM1013C					
Operating Point	B_{op}	5.5	7.5	9.5	mT
Release Point	B_{rp}	-9.5	-7.5	-5.5	mT
Hysteresis	B_{hys}	11	15	19	mT
NSM1013D					
Operating Point	B_{op}	7.5	10	12.5	mT
Release Point	B_{rp}	-12.5	-10	-7.5	mT
Hysteresis	B_{hys}	15	20	25	mT
NSM1013E					
Operating Point	B_{op}	12.5	15	17.5	mT
Release Point	B_{rp}	-17.5	-15	-12.5	mT
Hysteresis	B_{hys}	25	30	35	mT

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

7.3. Typical Performance Characteristics

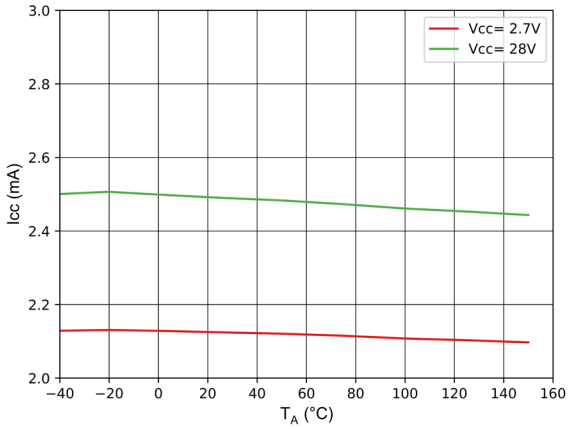


Figure 7.1 Supply Current Versus Temperature

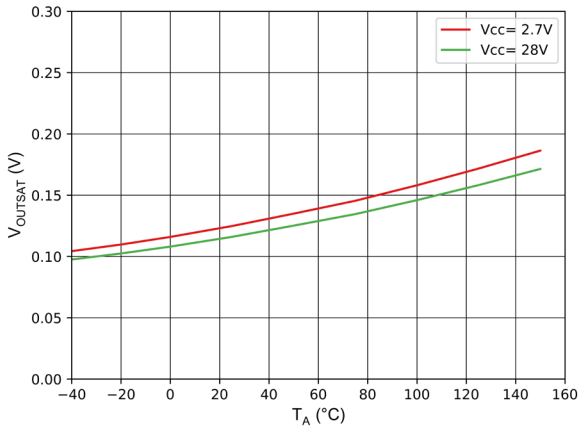


Figure 7.2 Output Saturation Voltage Versus Temperature

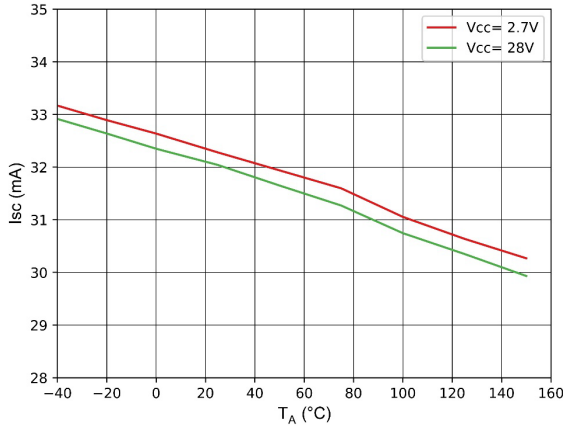


Figure 7.3 Output Short-Circuit Current Limit Versus Temperature

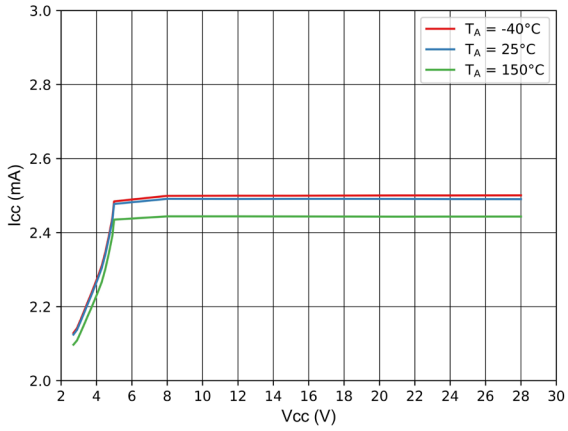


Figure 7.4 Supply Current Versus Power Supply

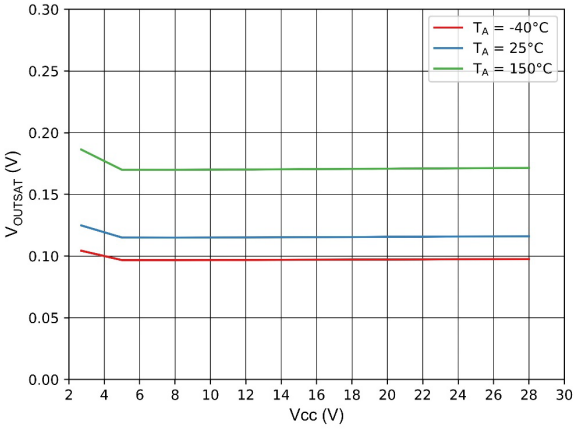


Figure 7.5 Output Saturation Voltage Versus Power Supply

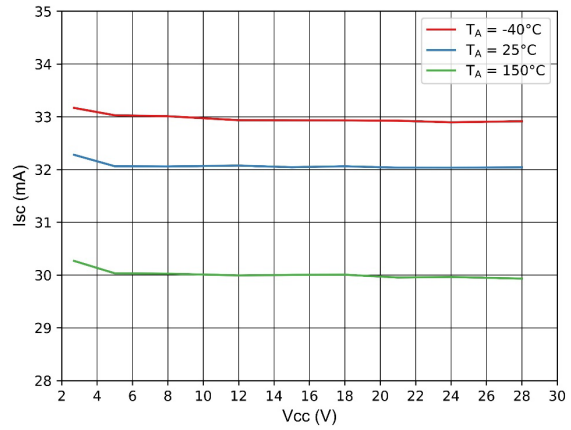


Figure 7.6 Output Short-Circuit Current Limit Versus Power Supply

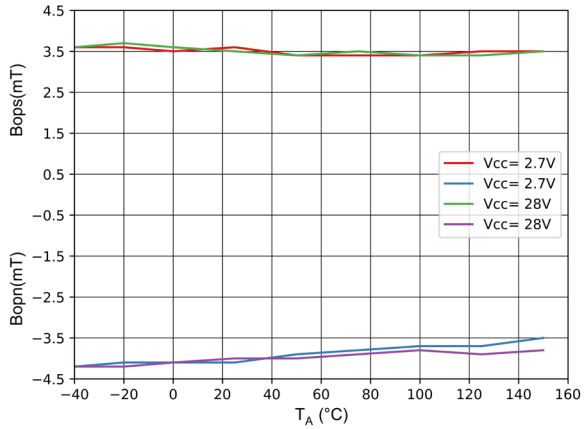


Figure 7.7 Operating Points Versus Temperature (-A: Flat)

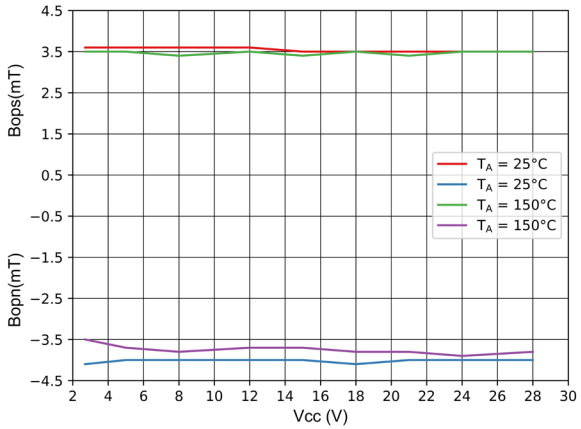


Figure 7.8 Operating Points Versus Power Supply (-A: Flat)

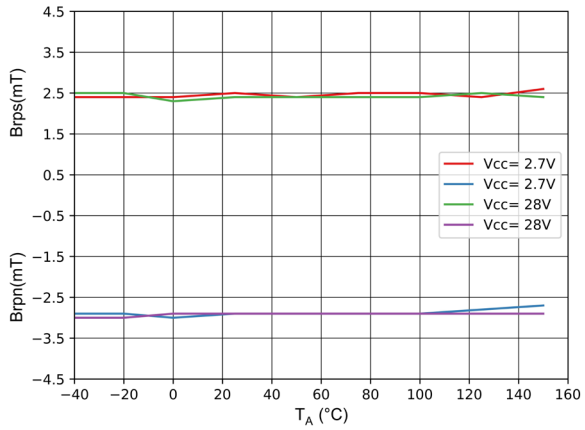


Figure 7.9 Release Points Versus Temperature (-A: Flat)

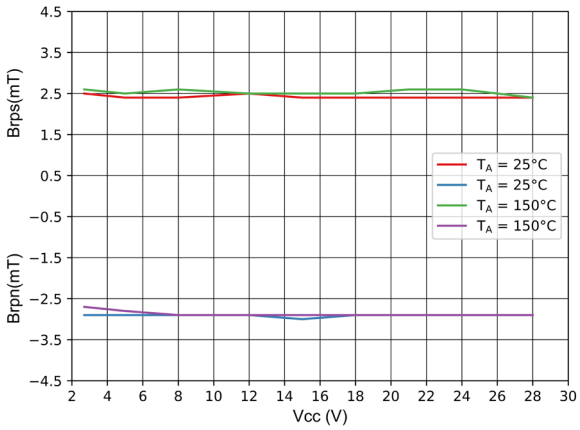


Figure 7.10 Release Points Versus Power Supply (-A: Flat)

8. Function Description

8.1. Overview

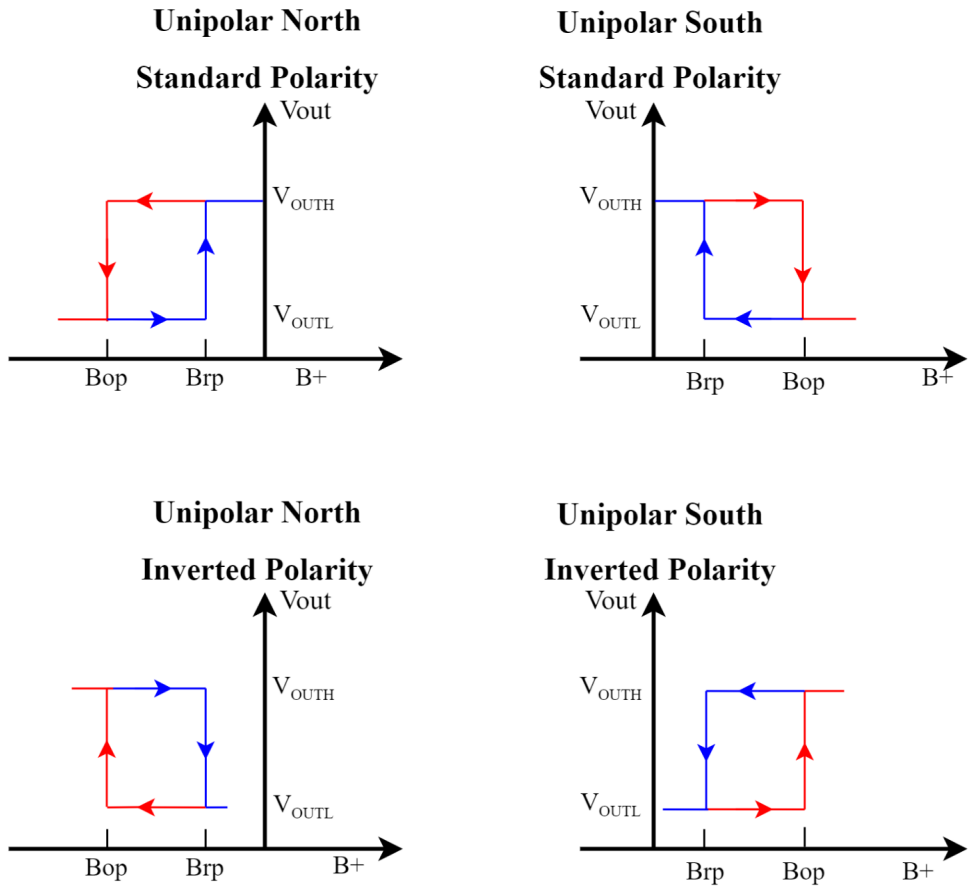
NSM101x integrates rotating current Hall plate, temperature sensor, Schmitt trigger and open drain output with short circuit protection, which can convert the changing external magnetic field signal into a digital voltage signal to achieve accurate position detection. The integrated temperature compensation function can match the temperature characteristics of different materials of the target and provide stable position detection in the full operating temperature range.

The NSM101x is available in two packages: STD is a general-purpose 3-pin SOT-23 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.

8.2. Feature Description

The output state of NSM101x 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. For unipolar south, an increasing south field is required; likewise, for unipolar north, an increasing north field is required to exceed Bop. In omnipolar mode, the device will switch on and off with either magnetic polarity, while latching will require both polarities.

Figure 8.1 Magnetic and output polarity options 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.



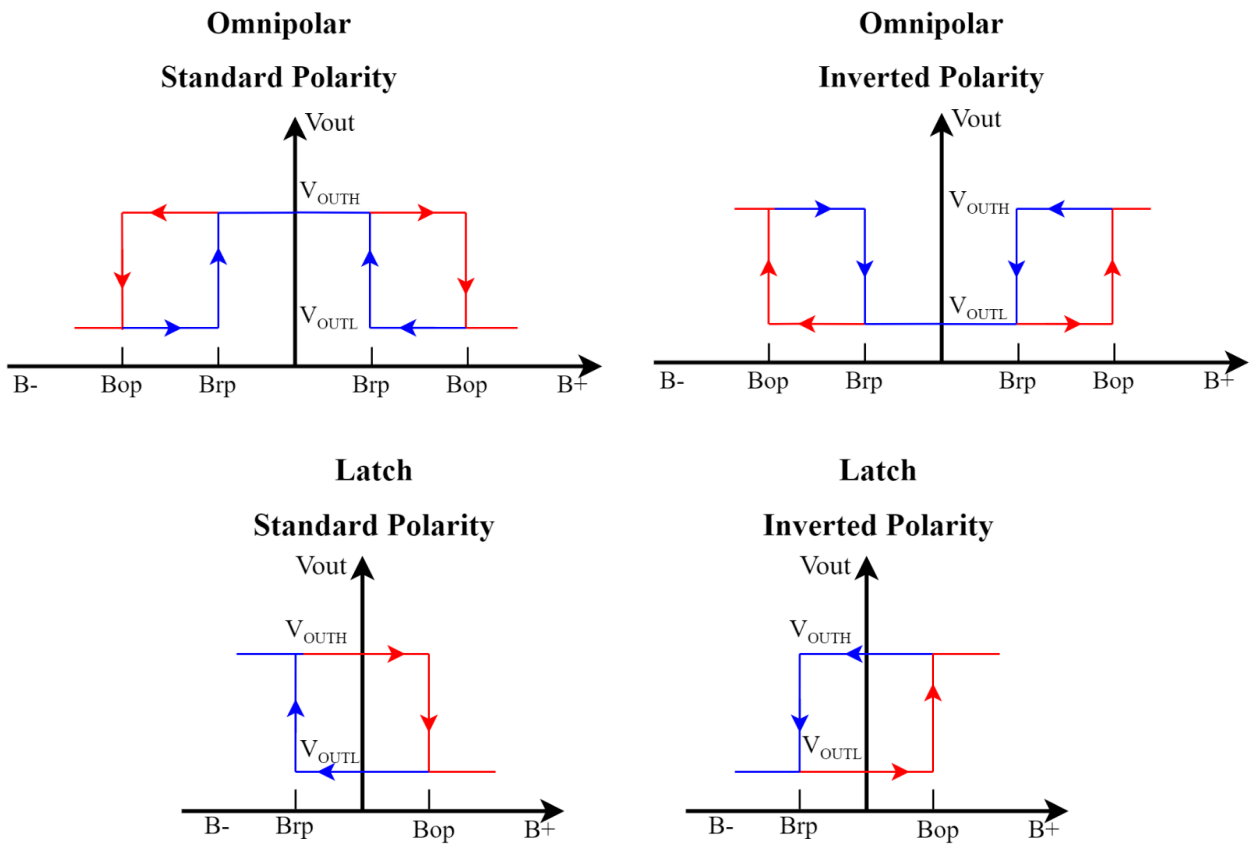


Figure 8.1 Magnetic and Output Polarity Options

8.3. Power-On Behavior

The NSM101x 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 $V_{cc\ (min)}$. After t_{PO}, the output state depends on the magnetic field as shown in Figure 8.2 Power-on sequence. 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.

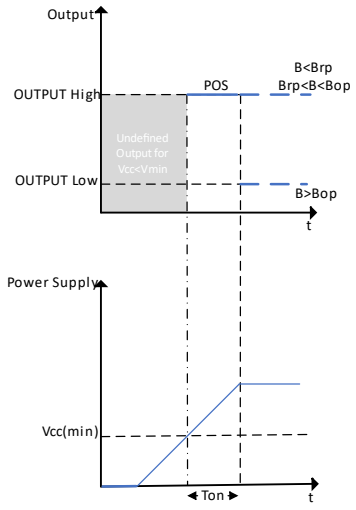


Figure 8.2 Power-on Sequence

9. 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.

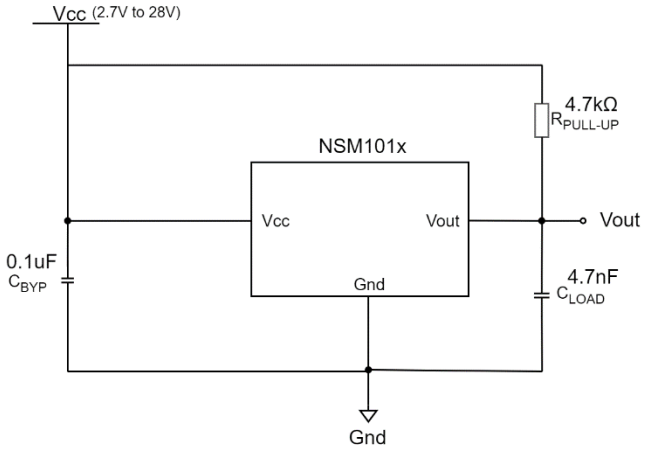
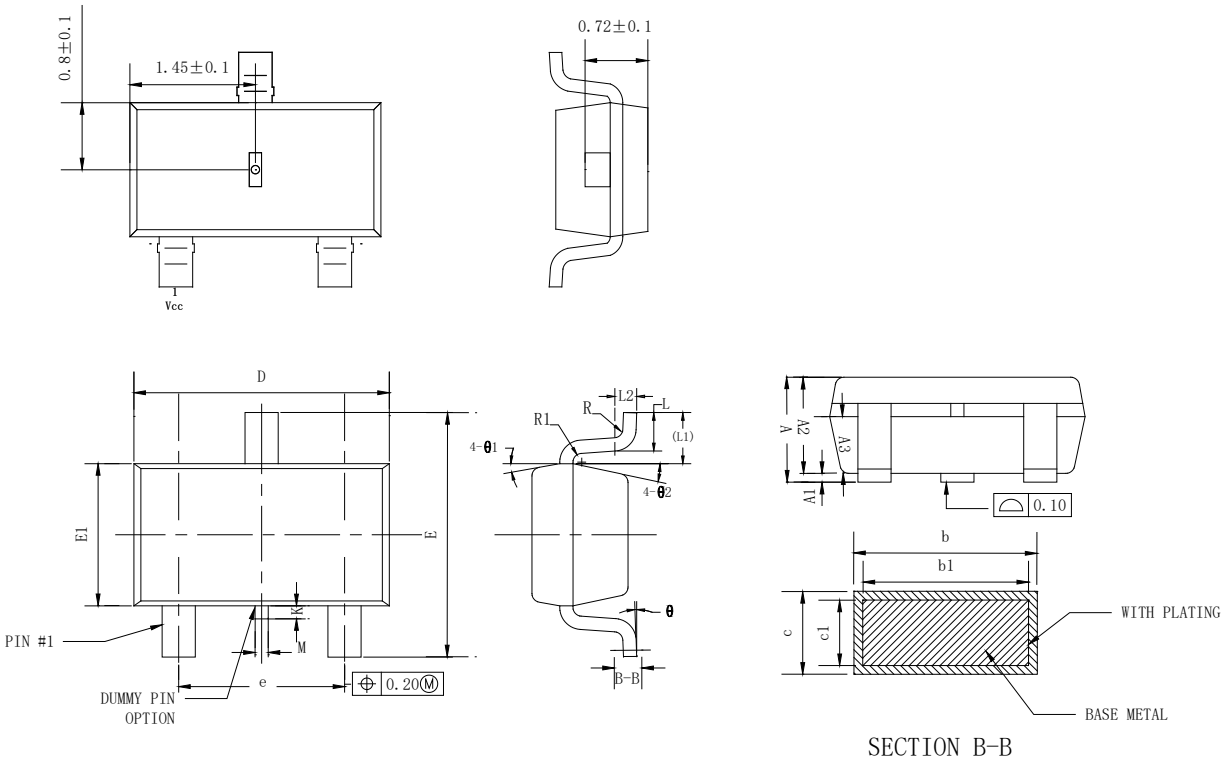


Figure 9.1 Typical Application Circuit

10. Package Information

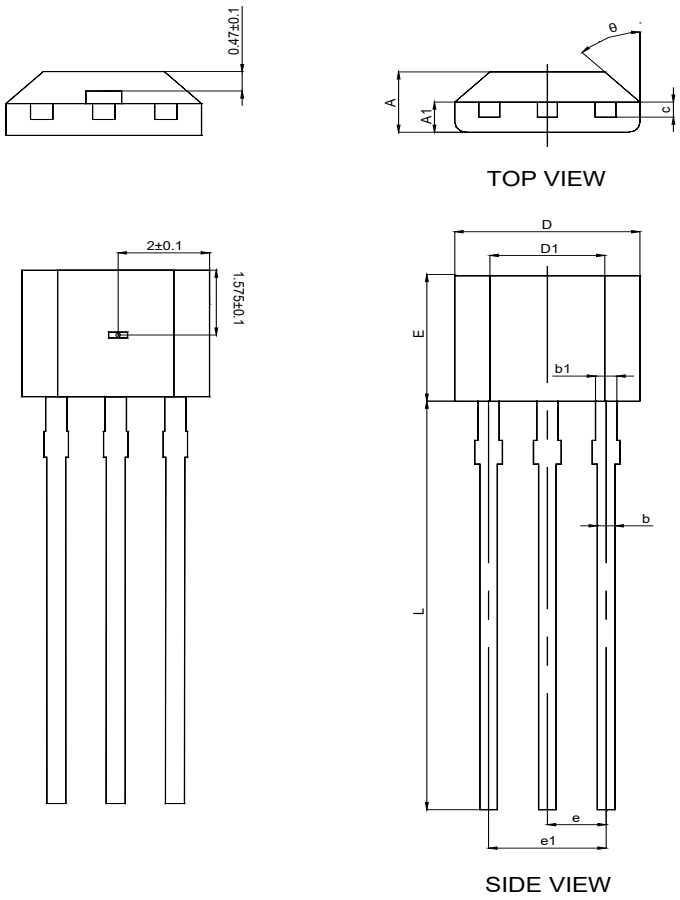
10.1. STD Package



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 10.1 SOT23-3L package shape and dimension in millimeters

10.2. 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 10.2 TO-92s package shape and dimension in millimeters

11. Ordering Information

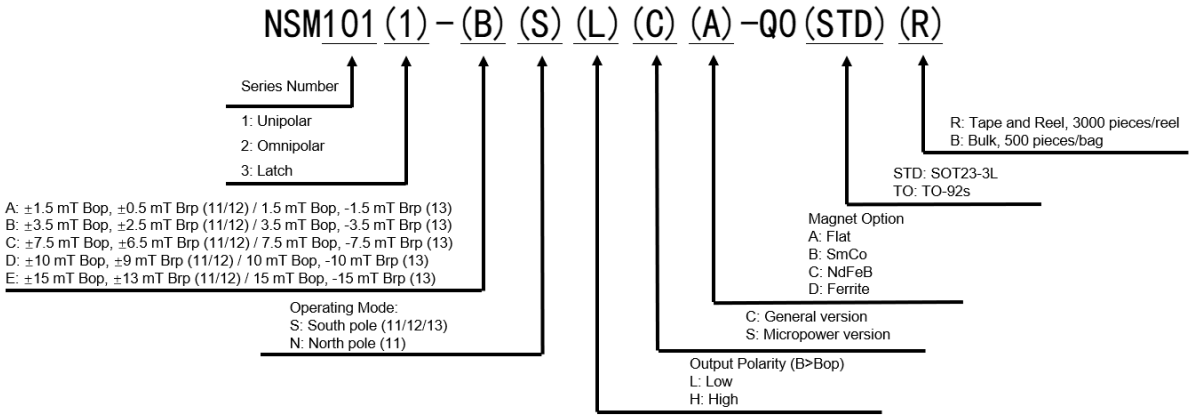
Part Number	Device Switch Threshold Magnitude	Operating Mode	Output Polarity	Power Mode	Package	Packing
NSM1011-BSLCA-Q0STDR	Bop: 3.5mT Brp: 2.5mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1011-BNLCA-Q0STDR	Bop: -3.5mT Brp: -2.5mT	North	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1011-BSLCA-Q0TOB	Bop: 3.5mT Brp: 2.5mT	South	Low	General power	TO-92s	Bulk, 500 pieces/bag
NSM1011-BSHCA-Q0STDR	Bop: 3.5mT Brp: 2.5mT	South	High	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1011-CSLCA-Q0STDR	Bop: 7.5mT Brp: 6.5mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1011-CNLCA-Q0STDR	Bop: 7.5mT Brp: 6.5mT	North	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1011-CSLCA-Q0TOB	Bop: 7.5mT Brp: 6.5mT	South	Low	General power	TO-92s	Bulk, 500 pieces/bag
NSM1011-DSLCA-Q0STDR	Bop: 10mT Brp: 9mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1011-DSLCC-Q0STDR	Bop: 10mT Brp: 9mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1011-DNLCA-Q0STDR	Bop: 10mT Brp: 9mT	North	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1011-DSLCA-Q0TOB	Bop: 10mT Brp: 9mT	South	Low	General power	TO-92s	Bulk, 500 pieces/bag
NSM1011-ESLCA-Q0STDR	Bop: 15mT Brp: 13mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1011-ENLCA-Q0STDR	Bop: 15mT Brp: 13mT	North	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1011-ESLCA-Q0TOB	Bop: 15mT Brp: 13mT	South	Low	General power	TO-92s	Bulk, 500 pieces/bag
NSM1011-BSLSA-Q0STDR	Bop: 3.5mT Brp: 2.5mT	South	Low	Micropower	SOT23-3L	Tape and Reel, 3000 pieces/reel

NSM1011-BSLSA-Q0TOB	Bop: 3.5mT Brp: 2.5mT	South	Low	Micropower	TO-92s	Bulk, 500 pieces/bag
NSM1012-BSLCA-Q0STDR	Bop: ±3.5mT Brp: ±2.5mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1012-BSLCA-Q0TOB	Bop: ±3.5mT Brp: ±2.5mT	South	Low	General power	TO-92s	Bulk, 500 pieces/bag
NSM1012-DSLCA-Q0STDR	Bop: ±10mT Brp: ±9mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1012-DSLCA-Q0TOB	Bop: ±10mT Brp: ±9mT	South	Low	General power	TO-92s	Bulk, 500 pieces/bag
NSM1012-ASLSA-Q0STDR	Bop: ±1.5mT Brp: ±0.5mT	South	Low	Micropower	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1012-ASLSA-Q0TOB	Bop: ±1.5mT Brp: ±0.5mT	South	Low	Micropower	TO-92s	Bulk, 500 pieces/bag
NSM1012-BSLSA-Q0STDR	Bop: ±3.5mT Brp: ±2.5mT	South	Low	Micropower	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1012-BSLSA-Q0TOB	Bop: ±3.5mT Brp: ±2.5mT	South	Low	Micropower	TO-92s	Bulk, 500 pieces/bag
NSM1013-ASLCA-Q0STDR	Bop: 1.5mT Brp: -1.5mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1013-ASLCC-Q0STDR	Bop: 1.5mT Brp: -1.5mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1013-ASHCA-Q0STDR	Bop: 1.5mT Brp: -1.5mT	South	High	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1013-ASLCA-Q0TOB	Bop: 1.5mT Brp: -1.5mT	South	Low	General power	TO-92s	Bulk, 500 pieces/bag
NSM1013-BSLCA-Q0STDR	Bop: 3.5mT Brp: -3.5mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1013-BSLCA-Q0TOB	Bop: 3.5mT Brp: -3.5mT	South	Low	General power	TO-92s	Bulk, 500 pieces/bag
NSM1013-CSLCA-Q0STDR	Bop: 7.5mT Brp: -7.5mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1013-CSLCA-Q0TOB	Bop: 7.5mT Brp: -7.5mT	South	Low	General power	TO-92s	Bulk, 500 pieces/bag

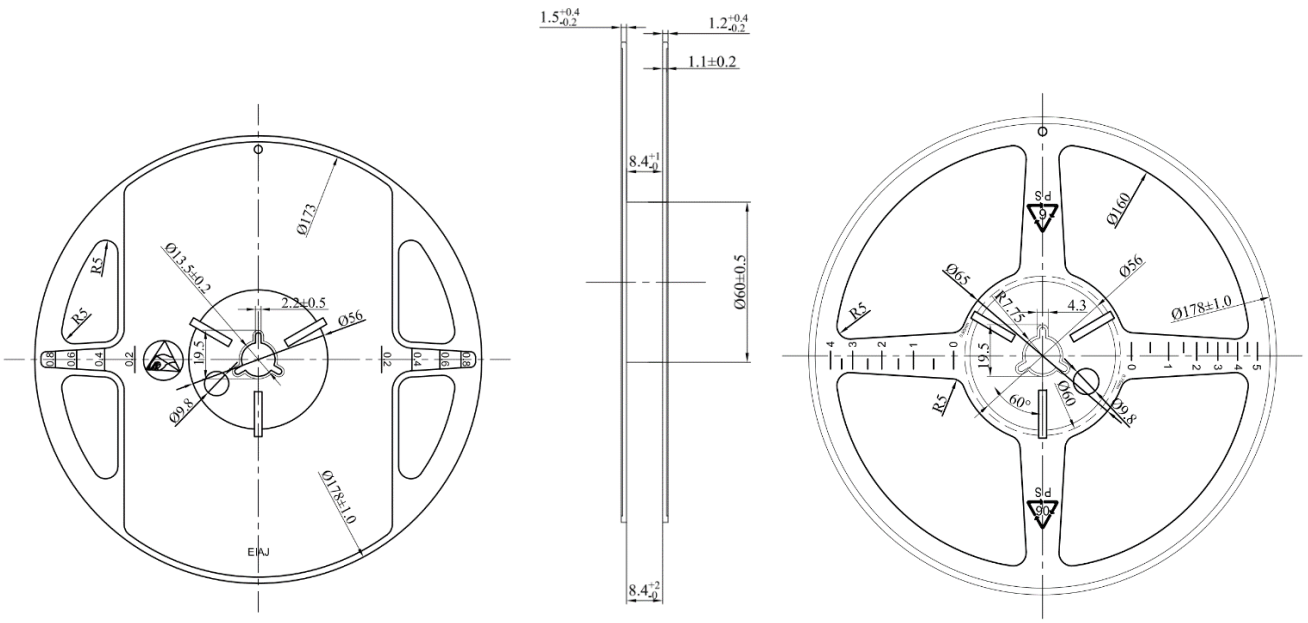
NSM1013-DSLCA-Q0STDR	Bop: 10mT Brp: -10mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1013-DSLCA-Q0TOB	Bop: 10mT Brp: -10mT	South	Low	General power	TO-92s	Bulk, 500 pieces/bag
NSM1013-ESLCA-Q0STDR	Bop: 15mT Brp: -15mT	South	Low	General power	SOT23-3L	Tape and Reel, 3000 pieces/reel
NSM1013-ESLCA-Q0TOB	Bop: 15mT Brp: -15mT	South	Low	General power	TO-92s	Bulk, 500 pieces/bag

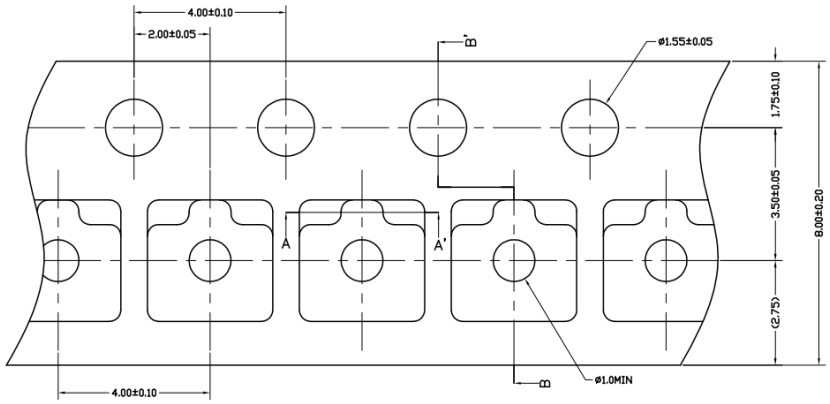
*If you need other part numbers, please contact NOVOSENSE's FAE.

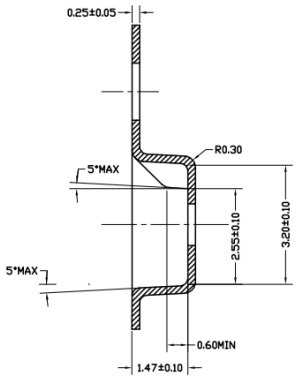
Part Number Rule:



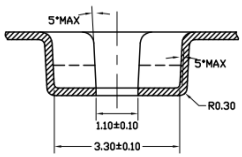
12. Tape and Reel Information







Section B-B'



Section A-A'

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

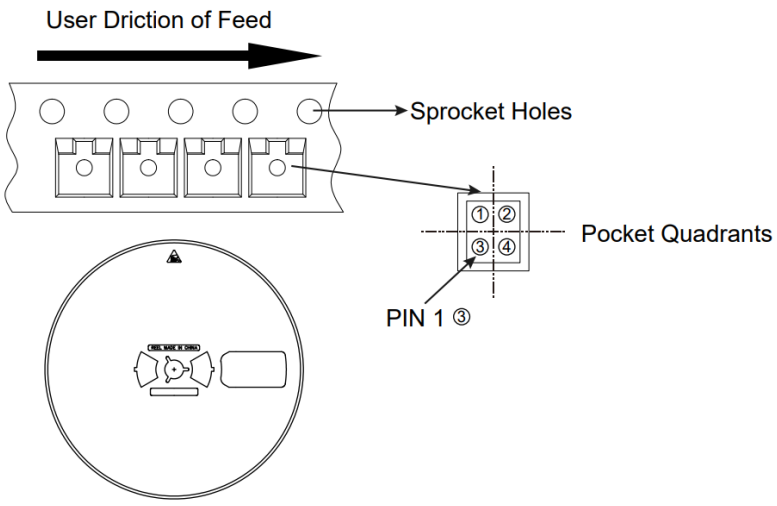


Figure 2 Tape and reel information of SOT23-3L

Revision History

Revision	Description	Date
1.0	Initial Version	2024/05/30

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