S-57P1 S Series

FOR AUTOMOTIVE 150°C OPERATION HIGH-WITHSTAND VOLTAGE HIGH-SPEED BIPOLAR HALL EFFECT LATCH IC

www.ablic.com

Rev.1.4_00

This IC, developed by CMOS technology, is a high-accuracy Hall effect latch IC that operates with high temperature and high-withstand voltage.
The output voltage changes when this IC detects the intensity level of magnetic flux density and a polarity change. Using this IC with a magnet makes it possible to detect the rotation status in various devices.
This IC includes a reverse voltage protection circuit and an output current limit circuit.
High-density mounting is possible by using the small SOT-23-3S package.
Due to its high-accuracy magnetic characteristics, this IC enables the user to reduce the operational variation in the system.

ABLIC Inc. offers a "magnetic simulation service" that provides the ideal combination of magnets and our Hall effect ICs for customer systems. Our magnetic simulation service will reduce prototype production, development period and development costs. In addition, it will contribute to optimization of parts to realize high cost performance.
For more information regarding our magnetic simulation service, contact our sales office.

Caution This product can be used in vehicle equipment and in-vehicle equipment. Before using the product in the purpose, contact to ABLIC Inc. is indispensable.

■ Features

- Pole detection: Bipolar latch
- Output logic*1: V_{OUT} = "L" at S pole detection
  V_{OUT} = "H" at S pole detection
- Output form: Nch open-drain output
- Magnetic sensitivity*1: B_{OP} = 0.5 mT typ.
  B_{OP} = 1.5 mT typ.
  B_{OP} = 2.2 mT typ.
  B_{OP} = 3.0 mT typ.
- Chopping frequency: f_C = 500 kHz typ.
- Output delay time: t_D = 8.0 µs typ.
- Power supply voltage range: V_{DD} = 2.7 V to 26.0 V
- Built-in regulator
- Built-in reverse voltage protection circuit
- Built-in output current limit circuit
- Operation temperature range: Ta = −40°C to +150°C
- Lead-free (Sn 100%), halogen-free
- AEC-Q100 qualified *2

***1.** The option can be selected.
***2.** Contact our sales office for details.

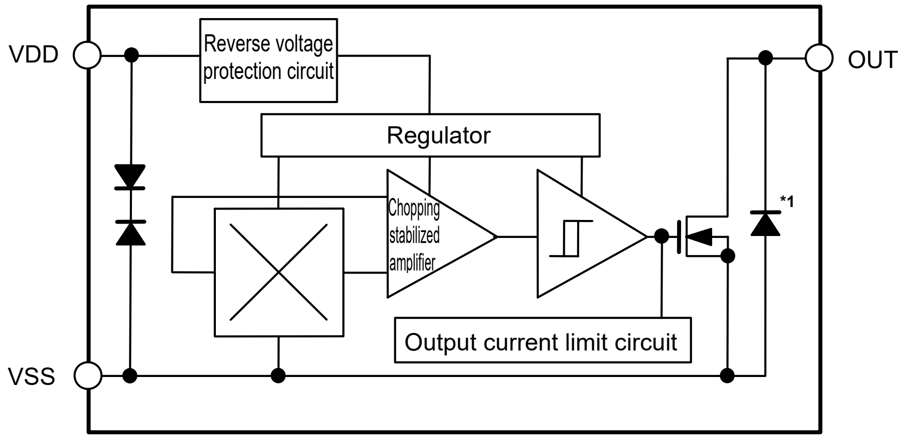
■ Applications

- Automobile equipment
- Home appliance
- DC brushless motor
- Housing equipment
- Industrial equipment

■ Package

- SOT-23-3S

■ Block Diagram



***1.** Parasitic diode

Figure 1

■ AEC-Q100 Qualified

This IC supports AEC-Q100 for operation temperature grade 0.
Contact our sales office for details of AEC-Q100 reliability specification.

■ Product Name Structure

1. Product name

S-57P1 N B x x S - M3T4 U

- U: Environmental code
  - U: Lead-free (Sn 100%), halogen-free
- M3T4: Package abbreviation and IC packing specifications*1
  - M3T4: SOT-23-3S, Tape
- S: Operation temperature
  - S: Ta = −40°C to +150°C
- x (second): Magnetic sensitivity
  - 9: B_{OP} = 0.5 mT typ.
  - 0: B_{OP} = 1.5 mT typ.
  - 8: B_{OP} = 2.2 mT typ.
  - 1: B_{OP} = 3.0 mT typ.
- x (first): Output logic
  - L: V_{OUT} = "L" at S pole detection
  - H: V_{OUT} = "H" at S pole detection
- B: Pole detection
  - B: Bipolar latch
- N: Output form
  - N: Nch open-drain output

***1.** Refer to the tape drawing.

2. Package

Table 1 Package Drawing Codes

Package Name	Dimension	Tape	Reel
SOT-23-3S	MP003-D-P-SD	MP003-D-C-SD	MP003-D-R-SD

3. Product name list

Table 2

Product Name	Output Form	Pole Detection	Output Logic	Magnetic Sensitivity (B_{OP})
S-57P1NBL9S-M3T4U	Nch open-drain output	Bipolar latch	V_{OUT} = "L" at S pole detection	0.5 mT typ.
S-57P1NBL0S-M3T4U	Nch open-drain output	Bipolar latch	V_{OUT} = "L" at S pole detection	1.5 mT typ.
S-57P1NBL8S-M3T4U	Nch open-drain output	Bipolar latch	V_{OUT} = "L" at S pole detection	2.2 mT typ.
S-57P1NBL1S-M3T4U	Nch open-drain output	Bipolar latch	V_{OUT} = "L" at S pole detection	3.0 mT typ.
S-57P1NBH9S-M3T4U	Nch open-drain output	Bipolar latch	V_{OUT} = "H" at S pole detection	0.5 mT typ.
S-57P1NBH0S-M3T4U	Nch open-drain output	Bipolar latch	V_{OUT} = "H" at S pole detection	1.5 mT typ.
S-57P1NBH1S-M3T4U	Nch open-drain output	Bipolar latch	V_{OUT} = "H" at S pole detection	3.0 mT typ.

Remark Please contact our sales office for products other than the above.

■ Pin Configuration

1. SOT-23-3S

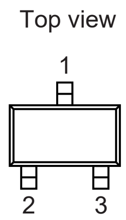


Figure 2

Table 3

Pin No.	Symbol	Description
1	VSS	GND pin
2	VDD	Power supply pin
3	OUT	Output pin

■ Absolute Maximum Ratings

Table 4

(Ta = +25°C unless otherwise specified)

Item	Symbol	Absolute Maximum Rating	Unit
Power supply voltage	V_{DD}	V_{SS} – 28.0 to V_{SS} + 28.0	V
Output current	I_{OUT}	20	mA
Output voltage	V_{OUT}	V_{SS} – 0.3 to V_{SS} + 28.0	V
Junction temperature	T_j	–40 to +170	°C
Operation ambient temperature	T_{opr}	–40 to +150	°C
Storage temperature	T_{stg}	–40 to +170	°C

Caution **The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.**

■ Thermal Resistance Value

Table 5

Item	Symbol	Condition		Min.	Typ.	Max.	Unit
Junction-to-ambient thermal resistance*1	θ_{ja}	SOT-23-3S	Board A	–	200	–	°C/W
			Board B	–	165	–	°C/W
			Board C	–	–	–	°C/W
			Board D	–	–	–	°C/W
			Board E	–	–	–	°C/W

***1.** Test environment: compliance with JEDEC STANDARD JESD51-2A

Remark Refer to "**■ Power Dissipation**" and "**Test Board**" for details.

■ Electrical Characteristics

Table 6

(Ta = +25°C, V_{DD} = 12.0 V, V_{SS} = 0 V unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit
Power supply voltage	V_{DD}	–	2.7	12.0	26.0	V	–
Current consumption	I_{DD}	Average value	–	3.0	4.0	mA	1
Current consumption during reverse connection	I_{DDREV}	V_{DD} = –26.0 V	–0.1	–	–	mA	1
Output voltage	V_{OUT}	I_{OUT} = 10 mA	–	–	0.4	V	2
Leakage current	I_{LEAK}	Output transistor Nch, V_{OUT} = 26.0 V	–	–	1	μA	3
Output limit current	I_{OM}	V_{OUT} = 12.0 V	22	–	70	mA	3
Output delay time	t_D	–	–	8.0	–	μs	–
Chopping frequency	f_C	–	–	500	–	kHz	–
Start up time	t_{PON}	–	–	20	–	μs	4
Output rise time	t_R	C = 20 pF, R = 820 Ω	–	–	2.0	μs	5
Output fall time	t_F	C = 20 pF, R = 820 Ω	–	–	2.0	μs	5

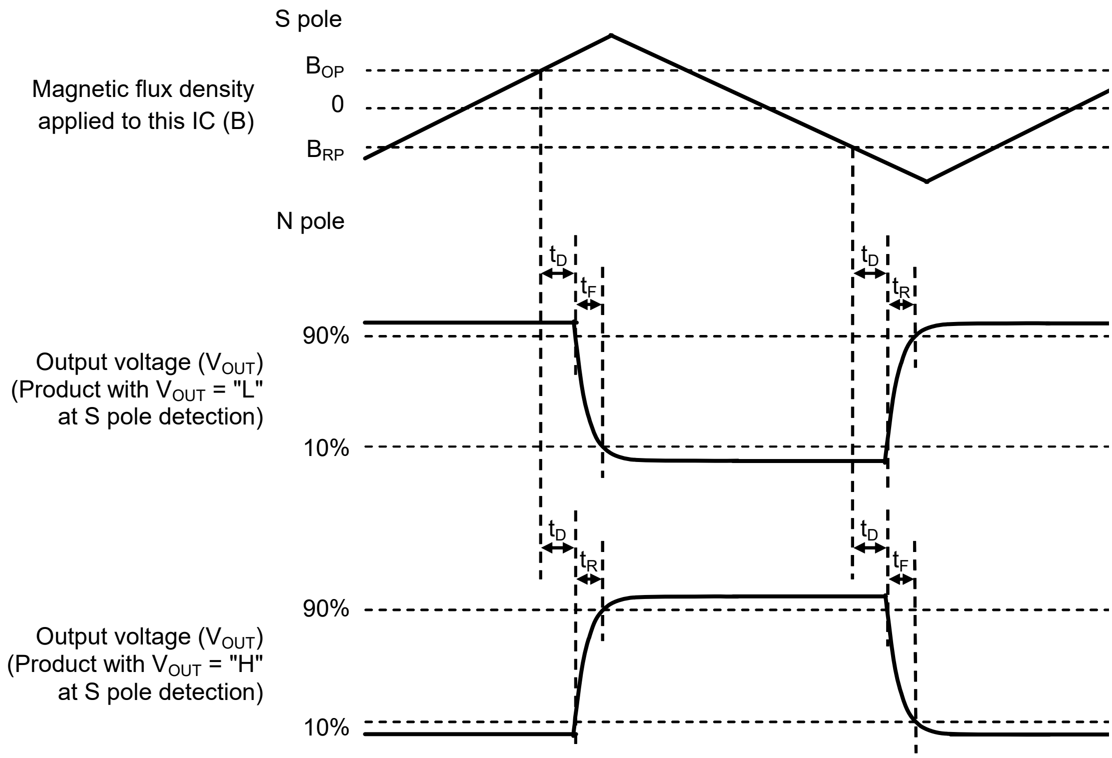


Figure 3 Operation Timing

■ Magnetic Characteristics

1. Product with B_{OP} = 0.5 mT typ.

Table 7

(Ta = +25°C, V_{DD} = 12.0 V, V_{SS} = 0 V unless otherwise specified)

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit
Operation point*1	S pole	B_{OP}	–	–0.5	0.5	1.5	mT	4
Release point*2	N pole	B_{RP}	–	–1.5	–0.5	0.5	mT	4
Hysteresis width*3		B_{HYS}	$B_{HYS} = B_{OP} - B_{RP}$	–	1.0	–	mT	4

2. Product with B_{OP} = 1.5 mT typ.

Table 8

(Ta = +25°C, V_{DD} = 12.0 V, V_{SS} = 0 V unless otherwise specified)

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit
Operation point*1	S pole	B_{OP}	–	0.5	1.5	2.5	mT	4
Release point*2	N pole	B_{RP}	–	–2.5	–1.5	–0.5	mT	4
Hysteresis width*3		B_{HYS}	$B_{HYS} = B_{OP} - B_{RP}$	–	3.0	–	mT	4

3. Product with B_{OP} = 2.2 mT typ.

Table 9

(Ta = +25°C, V_{DD} = 12.0 V, V_{SS} = 0 V unless otherwise specified)

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit
Operation point*1	S pole	B_{OP}	–	1.2	2.2	3.2	mT	4
Release point*2	N pole	B_{RP}	–	–3.2	–2.2	–1.2	mT	4
Hysteresis width*3		B_{HYS}	$B_{HYS} = B_{OP} - B_{RP}$	–	4.4	–	mT	4

4. Product with B_{OP} = 3.0 mT typ.

Table 10

(Ta = +25°C, V_{DD} = 12.0 V, V_{SS} = 0 V unless otherwise specified)

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit
Operation point*1	S pole	B_{OP}	–	2.0	3.0	4.0	mT	4
Release point*2	N pole	B_{RP}	–	–4.0	–3.0	–2.0	mT	4
Hysteresis width*3		B_{HYS}	$B_{HYS} = B_{OP} - B_{RP}$	–	6.0	–	mT	4

***1.** B_{OP}: Operation point
B_{OP} is the value of magnetic flux density when the output voltage (V_{OUT}) changes after the magnetic flux density applied to this IC by the magnet (S pole) is increased (by moving the magnet closer).
V_{OUT} retains the status until a magnetic flux density of the N pole higher than B_{RP} is applied.

***2.** B_{RP}: Release point
B_{RP} is the value of magnetic flux density when the output voltage (V_{OUT}) changes after the magnetic flux density applied to this IC by the magnet (N pole) is increased (by moving the magnet closer).
V_{OUT} retains the status until a magnetic flux density of the S pole higher than B_{OP} is applied.

***3.** B_{HYS}: Hysteresis width
B_{HYS} is the difference of magnetic flux density between B_{OP} and B_{RP}.

Remark The unit of magnetic density mT can be converted by using the formula 1 mT = 10 Gauss.

■ Test Circuits

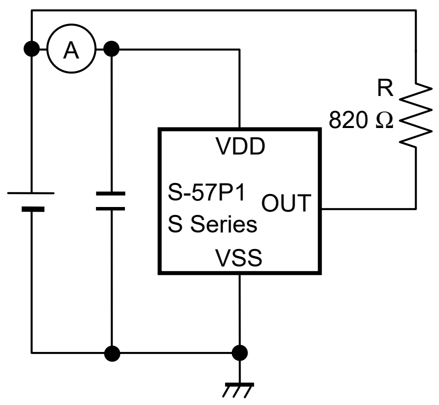


Figure 4 Test Circuit 1

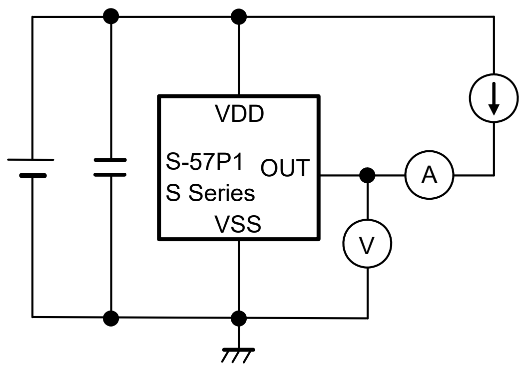


Figure 5 Test Circuit 2

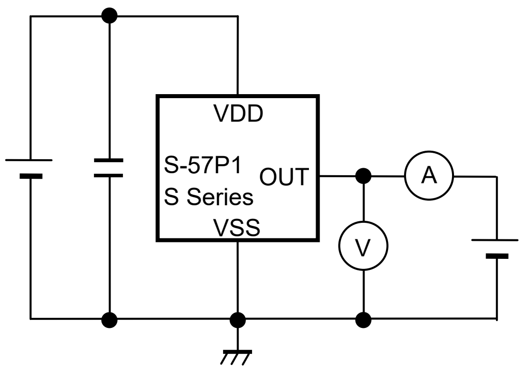


Figure 6 Test Circuit 3

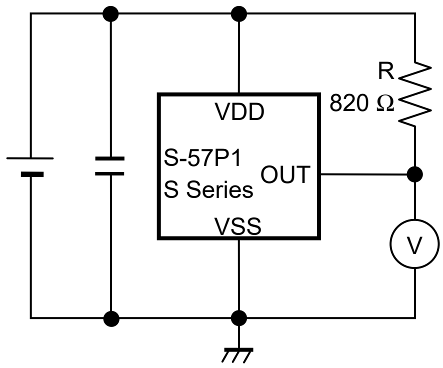


Figure 7 Test Circuit 4

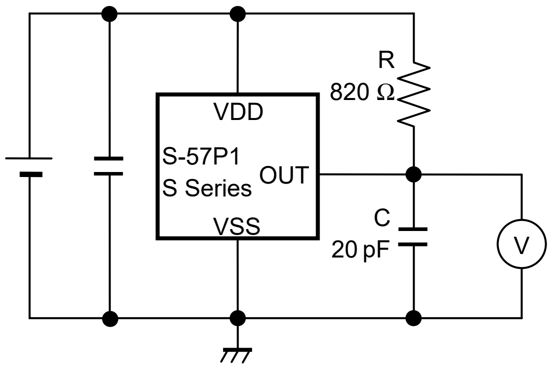


Figure 8 Test Circuit 5

■ Standard Circuit

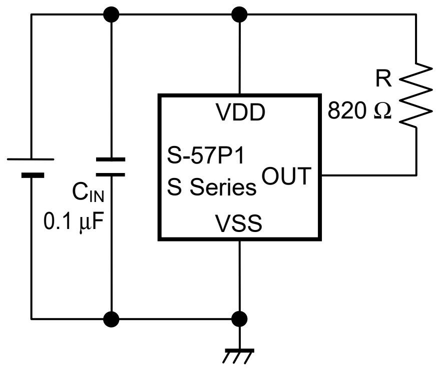


Figure 9

Caution The above connection diagram and constants will not guarantee successful operation. Perform thorough evaluation using the actual application to set the constants.

■ Operation

1. Direction of applied magnetic flux

This IC detects the magnetic flux density which is vertical to the marking surface.
Figure 10 shows the direction in which magnetic flux is being applied.

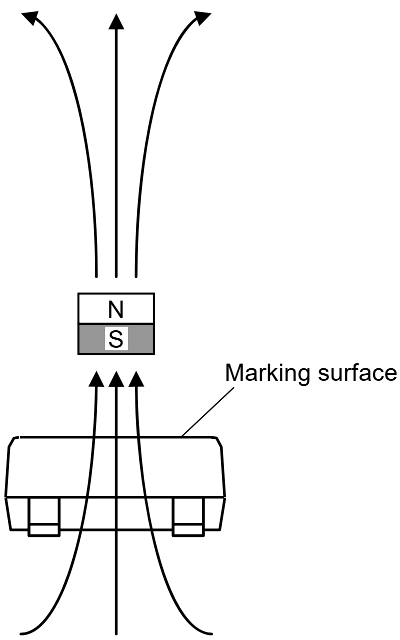


Figure 10

2. Position of Hall sensor

Figure 11 shows the position of Hall sensor.
The center of this Hall sensor is located in the area indicated by a circle, which is in the center of a package as described below.
The following also shows the distance (typ. value) between the marking surface and the chip surface of a package.

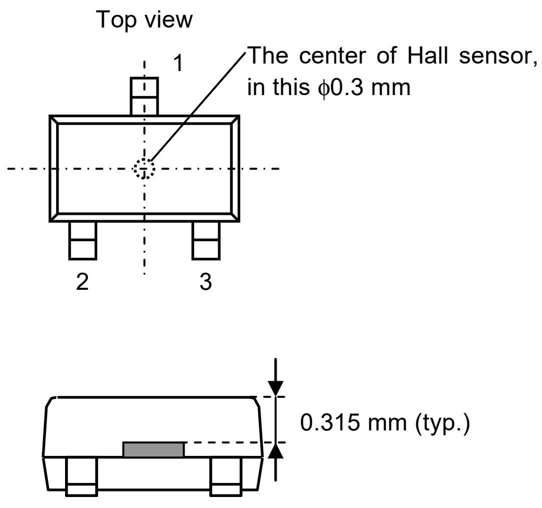


Figure 11

3. Basic operation

This IC changes the output voltage (V_{OUT}) according to the level of the magnetic flux density (N pole or S pole) and a polarity change applied by a magnet.

3. 1 Product with V_{OUT} = "L" at S pole detection

When the magnetic flux density of the S pole perpendicular to the marking surface exceeds the operation point (B_{OP}) after the S pole of a magnet is moved closer to the marking surface of this IC, V_{OUT} changes from "H" to "L". When the N pole of a magnet is moved closer to the marking surface of this IC and the magnetic flux density of the N pole is higher than the release point (B_{RP}), V_{OUT} changes from "L" to "H". In case of $B_{RP} < B < B_{OP}$, V_{OUT} retains the status. **Figure 12** shows the relationship between the magnetic flux density and V_{OUT}.

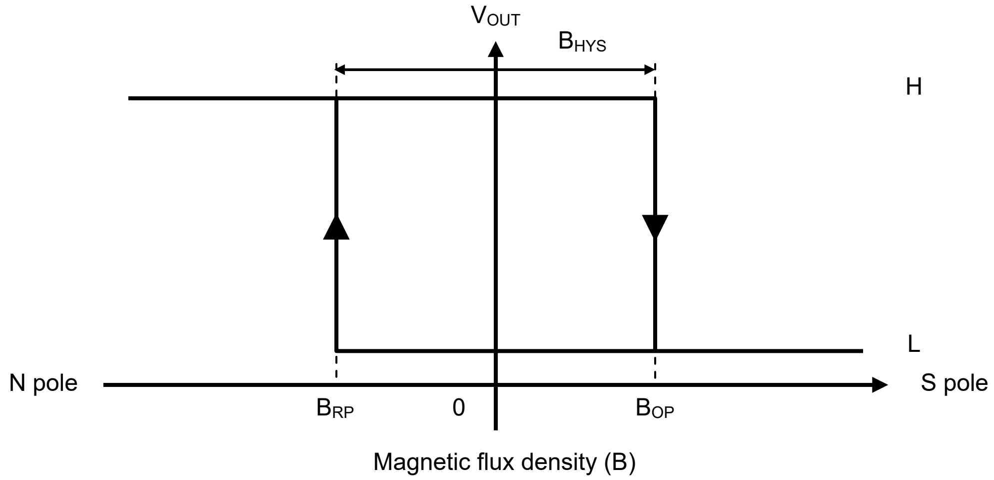


Figure 12

3. 2 Product with V_{OUT} = "H" at S pole detection

When the magnetic flux density of the S pole perpendicular to the marking surface exceeds B_{OP} after the S pole of a magnet is moved closer to the marking surface of this IC, V_{OUT} changes from "L" to "H". When the N pole of a magnet is moved closer to the marking surface of this IC and the magnetic flux density of the N pole is higher than B_{RP}, V_{OUT} changes from "H" to "L". In case of $B_{RP} < B < B_{OP}$, V_{OUT} retains the status.
Figure 13 shows the relationship between the magnetic flux density and V_{OUT}.

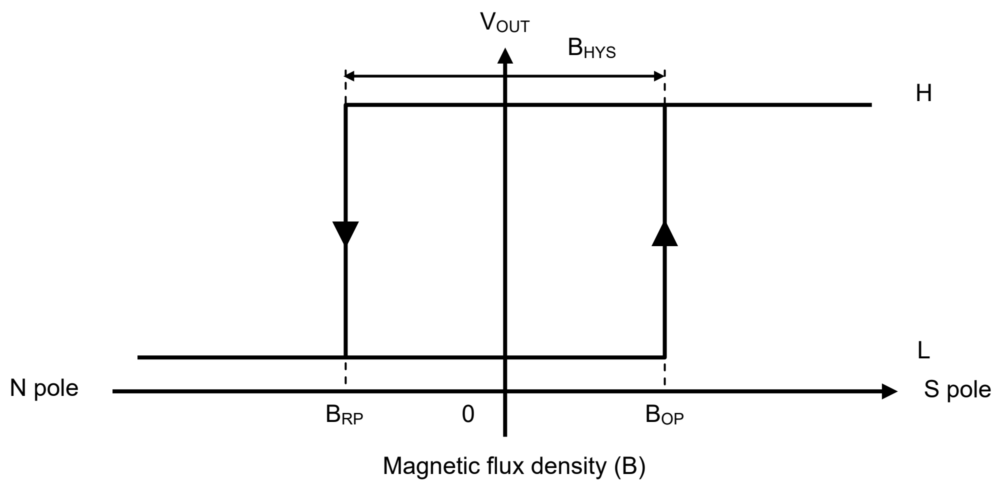


Figure 13

4. Timing chart

Figure 14 shows the timing chart at power-on for product with V_{OUT} = "L" at S pole detection.
The initial output voltage at rising of power supply voltage (V_{DD}) is "H".
In case of $B > B_{OP}$ at the time when the start up time (t_{PON}) is passed after rising of V_{DD}, this IC outputs "L".
In case of $B < B_{OP}$ at the time when t_{PON} is passed after rising of V_{DD}, this IC maintains "H".

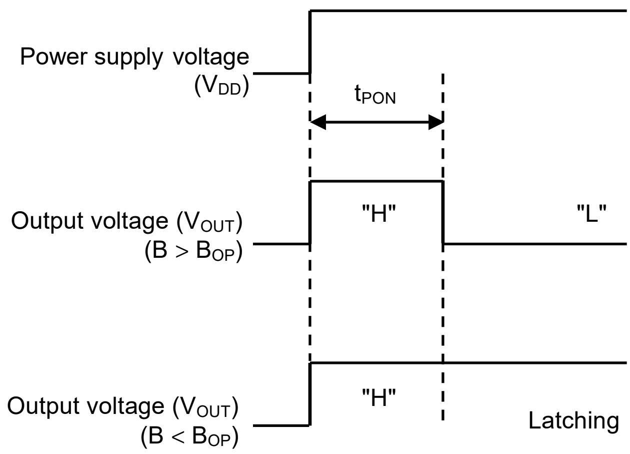


Figure 14

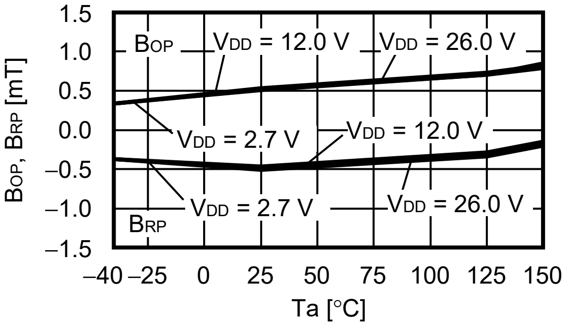
■ Precautions

- If the impedance of the power supply is high, the IC may malfunction due to a supply voltage drop caused by feed-through current. Take care with the pattern wiring to ensure that the impedance of the power supply is low.
- Note that the IC may malfunction if the power supply voltage rapidly changes. When the IC is used under the environment where the power supply voltage rapidly changes, it is recommended to judge the output voltage of the IC by reading it multiple times.
- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.
- Although this IC has a built-in output current limit circuit, it may suffer physical damage such as product deterioration under the environment where the absolute maximum ratings are exceeded.
- Although this IC has a built-in reverse voltage protection circuit, it may suffer physical damage such as product deterioration under the environment where the absolute maximum ratings are exceeded.
- The application conditions for the power supply voltage, the pull-up voltage, and the pull-up resistor should not exceed the power dissipation.
- Large stress on this IC may affect the magnetic characteristics. Avoid large stress which is caused by the handling during or after mounting the IC on a board.
- ABLIC Inc. claims no responsibility for any disputes arising out of or in connection with any infringement by products including this IC of patents owned by a third party.

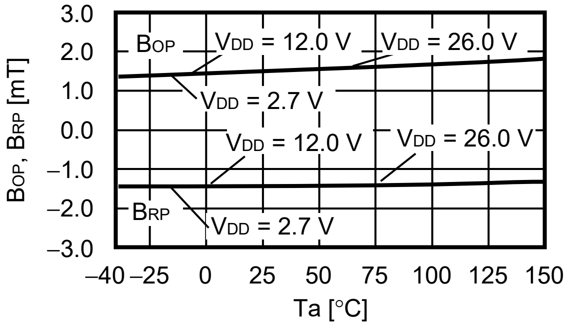
■ Characteristics (Typical Data)

1. Operation point, release point (B_{OP}, B_{RP}) vs. Temperature (Ta)

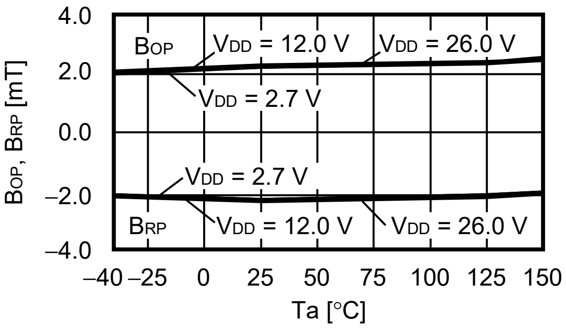
1. 1 S-57P1NBx9S



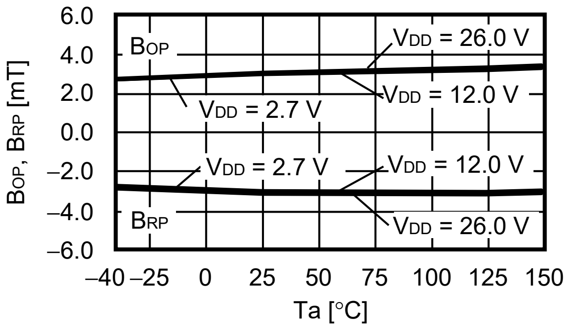
1. 2 S-57P1NBx0S



1. 3 S-57P1NBx8S

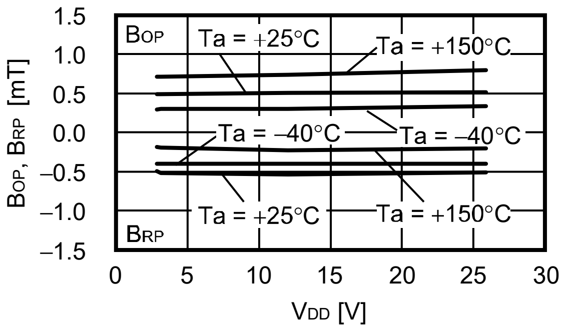


1. 4 S-57P1NBx1S

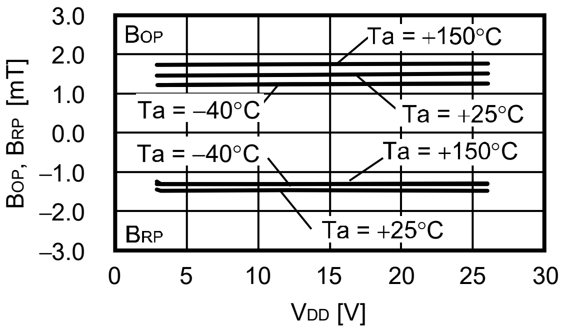


2. Operation point, release point (B_{OP}, B_{RP}) vs. Power supply voltage (V_{DD})

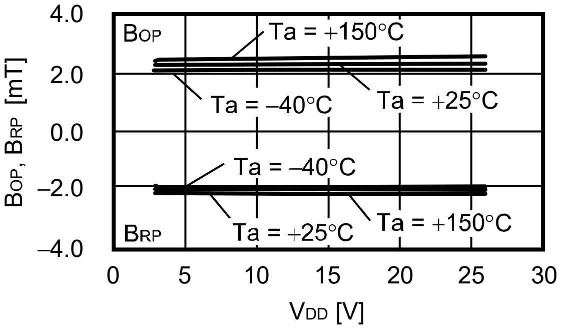
2. 1 S-57P1NBx9S



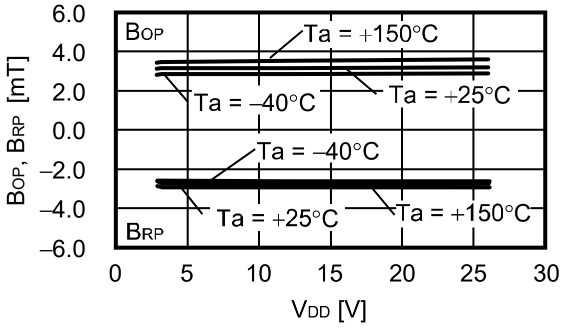
2. 2 S-57P1NBx0S



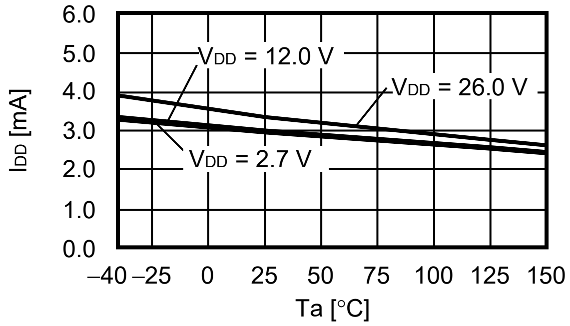
2. 3 S-57P1NBx8S



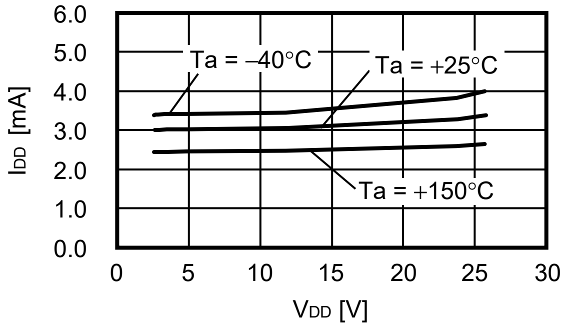
2. 4 S-57P1NBx1S



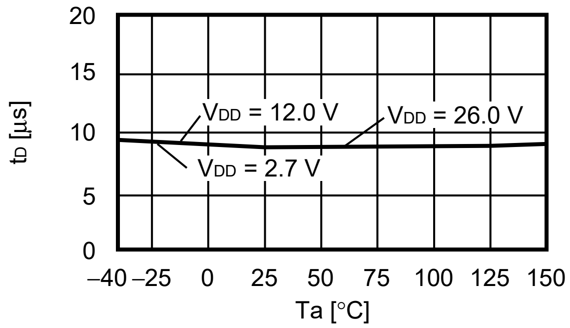
3. **Current consumption (I_{DD}) vs. Temperature (Ta)**



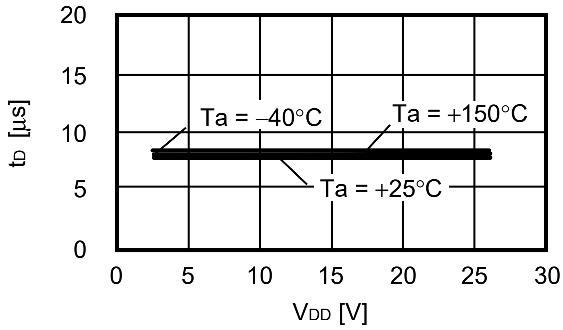
4. **Current consumption (I_{DD}) vs. Power supply voltage (V_{DD})**



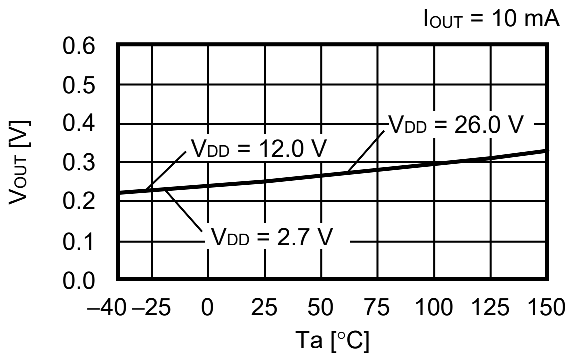
5. **Output delay time (t_D) vs. Temperature (Ta)**



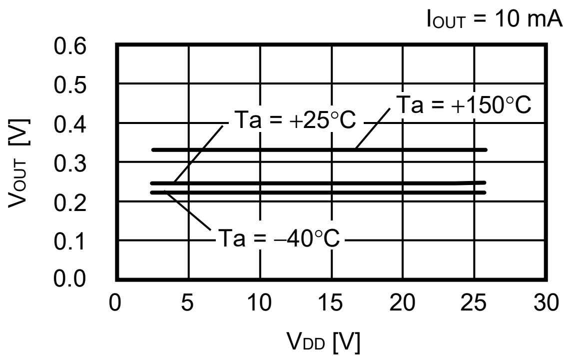
6. **Output delay time (t_D) vs. Power supply voltage (V_{DD})**



7. **Output voltage (V_{OUT}) vs. Temperature (Ta)**

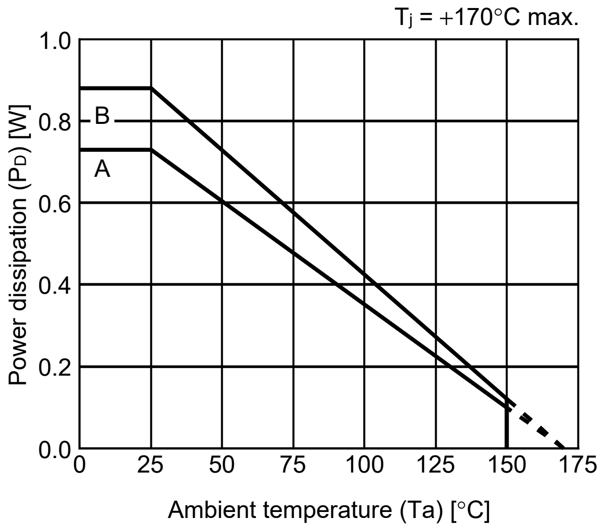


8. **Output voltage (V_{OUT}) vs. Power supply voltage (V_{DD})**



■ Power Dissipation

SOT-23-3S

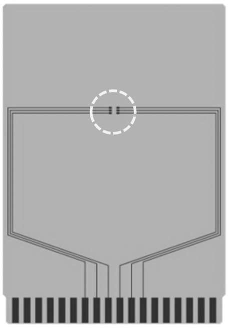


Board	Power Dissipation (P_D)
A	0.73 W
B	0.88 W
C	–
D	–
E	–

SOT-23-3/3S/5/6 Test Board

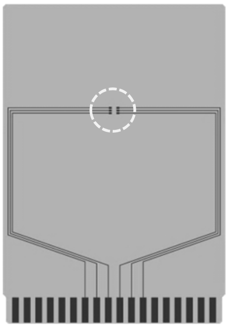
IC Mount Area

(1) Board A



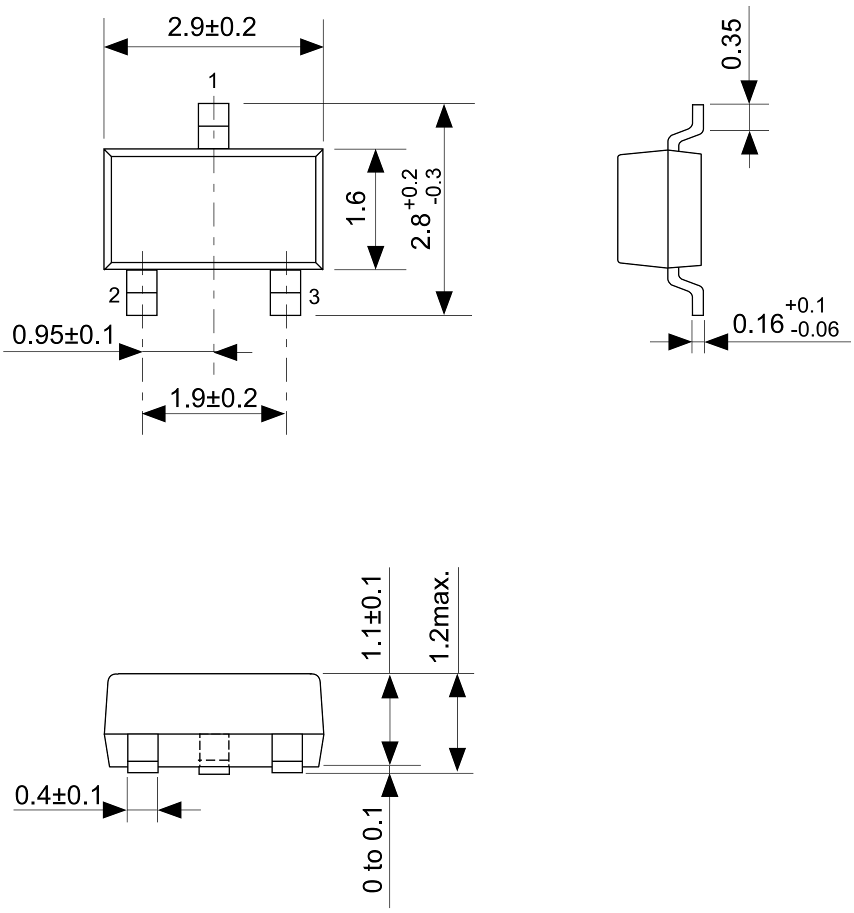
Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		2
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	-
	3	-
	4	74.2 x 74.2 x t0.070
Thermal via		-

(2) Board B



Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		4
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	74.2 x 74.2 x t0.035
	3	74.2 x 74.2 x t0.035
	4	74.2 x 74.2 x t0.070
Thermal via		-

No. SOT23x-A-Board-SD-2.0



No. MP003-D-P-SD-1.1

TITLE	SOT233S-A-PKG Dimensions
No.	MP003-D-P-SD-1.1
ANGLE	
UNIT	mm
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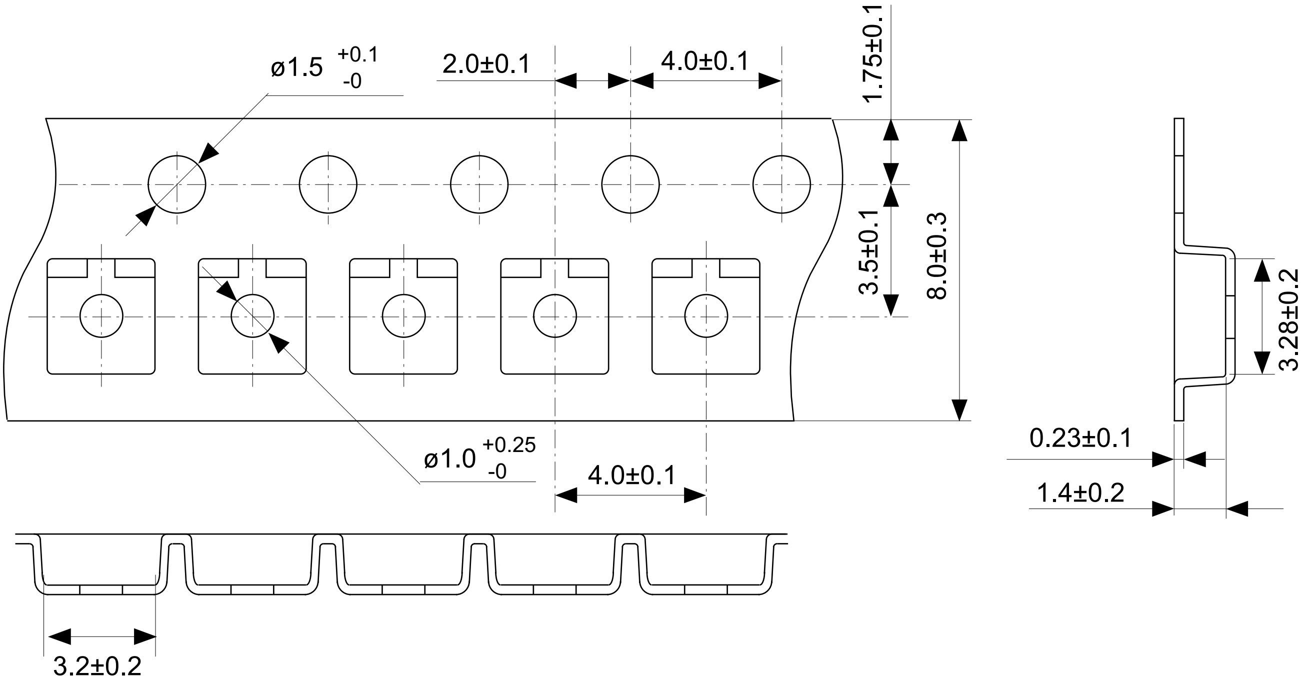

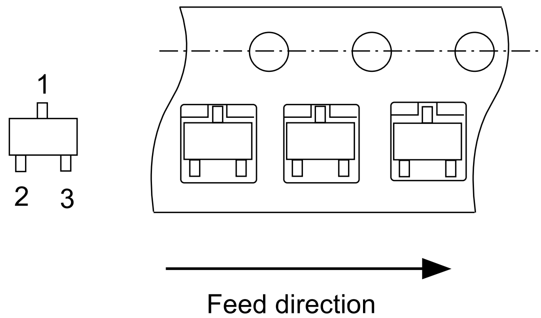

No. MP003-D-C-SD-1.0

TITLE	SOT233S-A-Carrier Tape
No.	MP003-D-C-SD-1.0
ANGLE	
UNIT	mm

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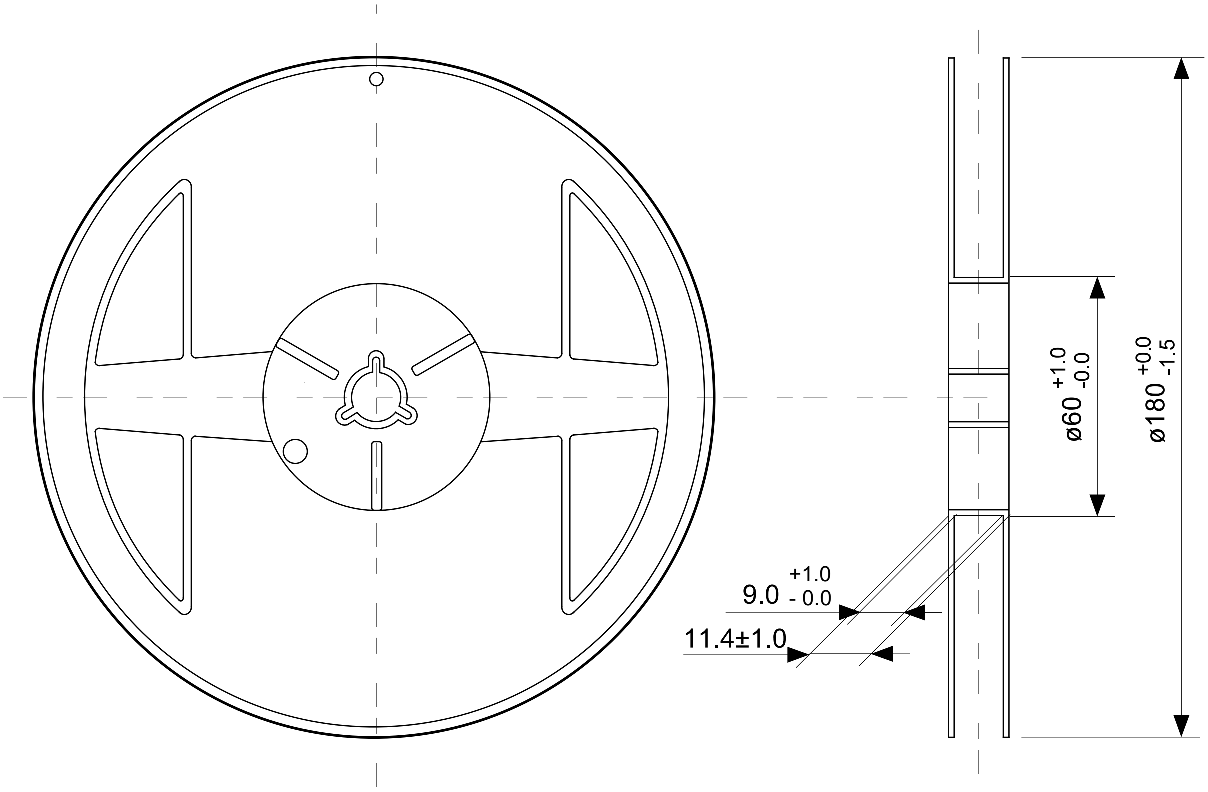
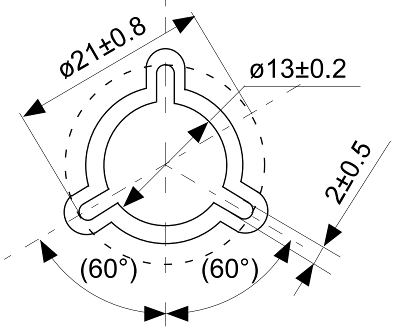


Enlarged drawing in the central part



No. MP003-D-R-SD-1.0

TITLE	SOT233S-A-Reel		
No.	MP003-D-R-SD-1.0		
ANGLE		QTY.	3,000
UNIT	mm		

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