S-57P1 S Series

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

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Rev.1.1_01

The S-57P1 S Series, developed by CMOS technology, is a high-accuracy Hall IC that operates with high temperature and high-withstand voltage.
The output voltage changes when the S-57P1 S Series detects the intensity level of magnetic flux density and a polarity change. Using the S-57P1 S Series with a magnet makes it possible to detect the rotation status in various devices.
The S-57P1 S Series 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, the S-57P1 S Series enables the user to reduce the operational variation in the system.

Caution **This product can be used in vehicle equipment and in-vehicle equipment. Before using the product in the purpose, contact to SII Semiconductor Corporation is indispensable.**

■ Features

- Pole detection: Bipolar latch
- Detection logic for magnetism*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.
- Operating cycle: t_{CYCLE} = 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 in process *2

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

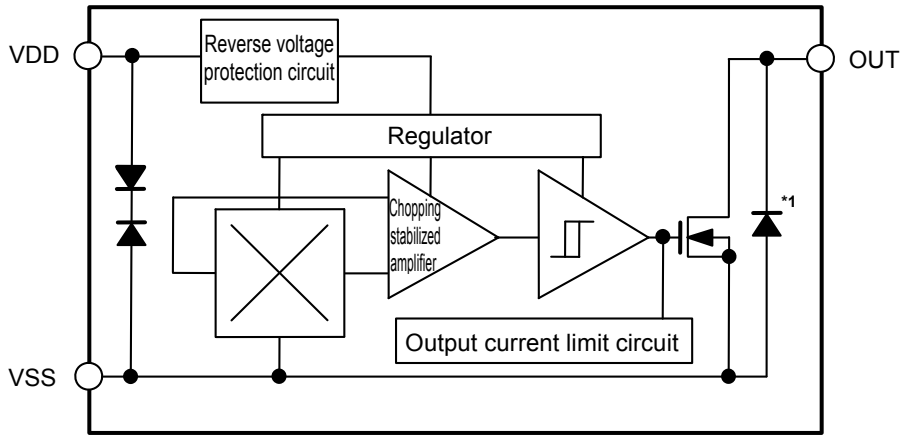
■ Applications

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

■ Package

- SOT-23-3S

■ Block Diagrams



1. Parasitic diode

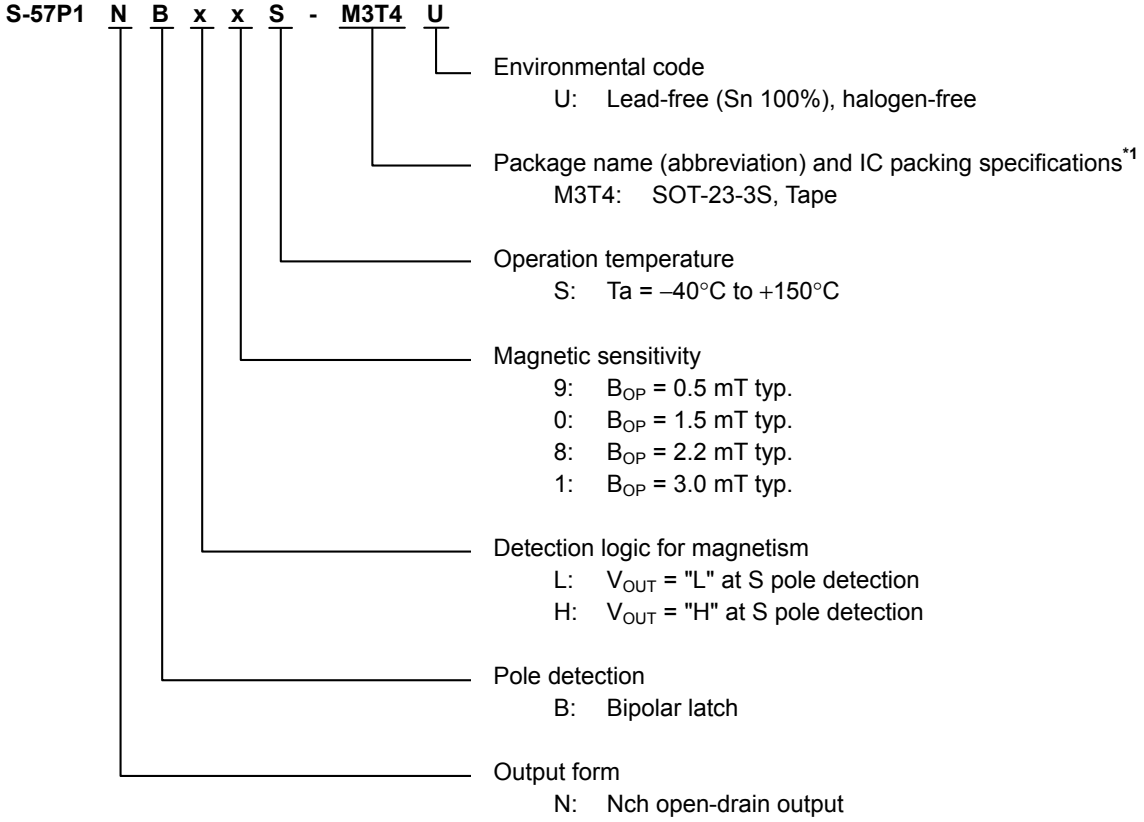
Figure 1

■ AEC-Q100 in Process

Contact our sales office for details of AEC-Q100 reliability specification.

■ Product Name Structure

1. Product name



***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	Detection Logic for Magnetism	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.

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

■ Pin Configuration

1. SOT-23-3S

Top view

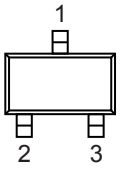


Figure 2

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 1	–	200	–	°C/W
			Board 2	–	165	–	°C/W

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

Remark Refer to "■ **Thermal Characteristics**" for details of power dissipation and test board.

■ 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
Operating cycle	t_{CYCLE}	–	–	8.0	–	µs	–
Operating frequency	f_{CYCLE}	–	–	125	–	kHz	–
Output limit current	I_{OM}	$V_{OUT} = 12.0$ V	22	–	70	mA	3
Start up time	t_{PON}	–	–	20	–	µs	–

■ 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 the S-57P1 S Series 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 the S-57P1 S Series 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

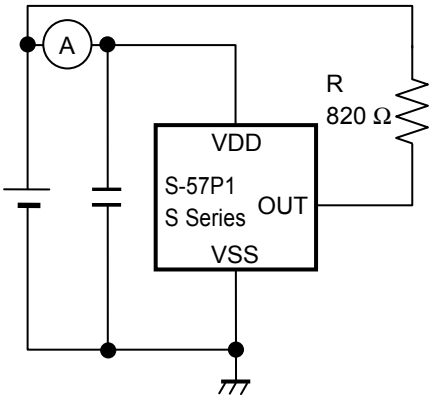


Figure 3 Test Circuit 1

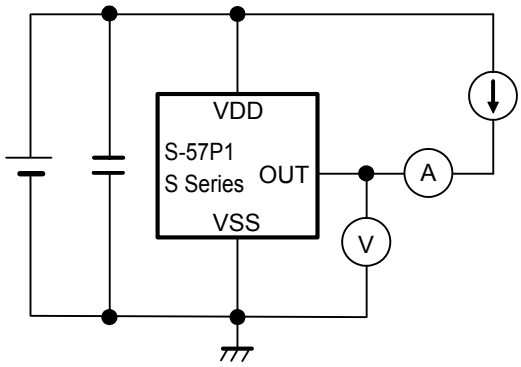


Figure 4 Test Circuit 2

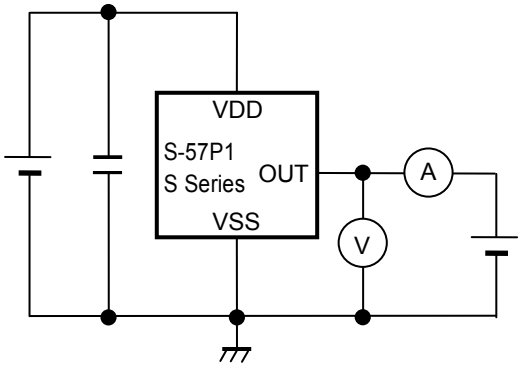


Figure 5 Test Circuit 3

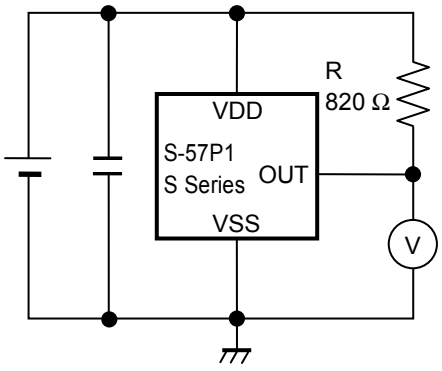


Figure 6 Test Circuit 4

■ Standard Circuit

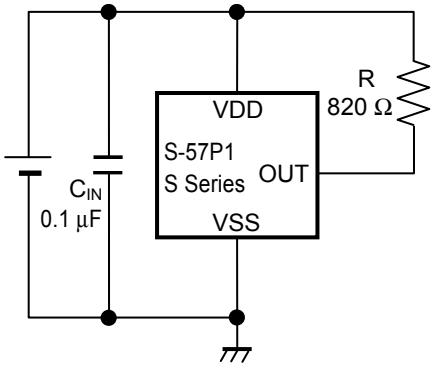


Figure 7

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

■ Operation

1. Direction of applied magnetic flux

The S-57P1 S Series detects the magnetic flux density which is vertical to the marking surface.
Figure 8 shows the direction in which magnetic flux is being applied.

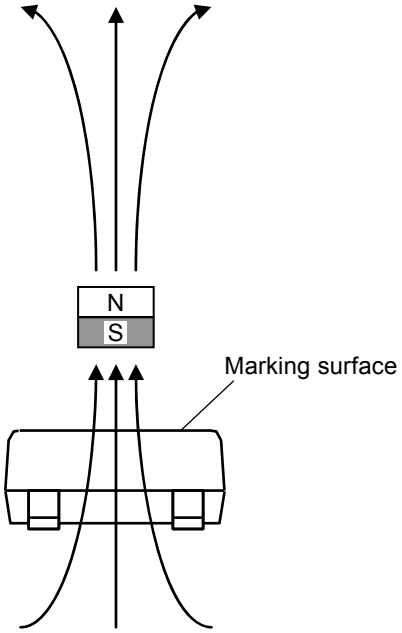


Figure 8

2. Position of Hall sensor

Figure 9 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.

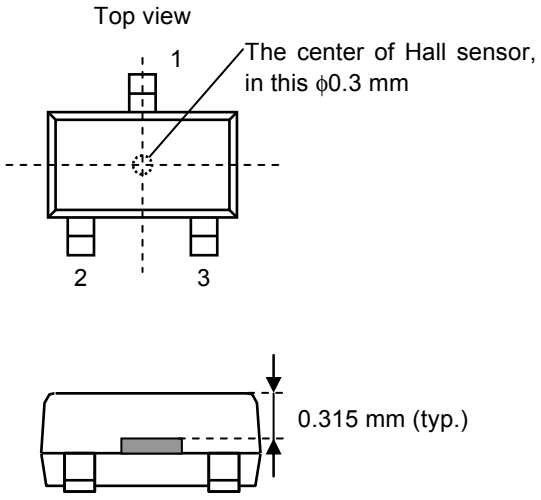


Figure 9

3. Basic operation

The S-57P1 S Series 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.
Definition of the magnetic field is performed every operating cycle indicated in "■ **Electrical Characteristics**".

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 the S-57P1 S Series, V_{OUT} changes from "H" to "L". When the N pole of a magnet is moved closer to the marking surface of the S-57P1 S Series 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 10** shows the relationship between the magnetic flux density and V_{OUT}.

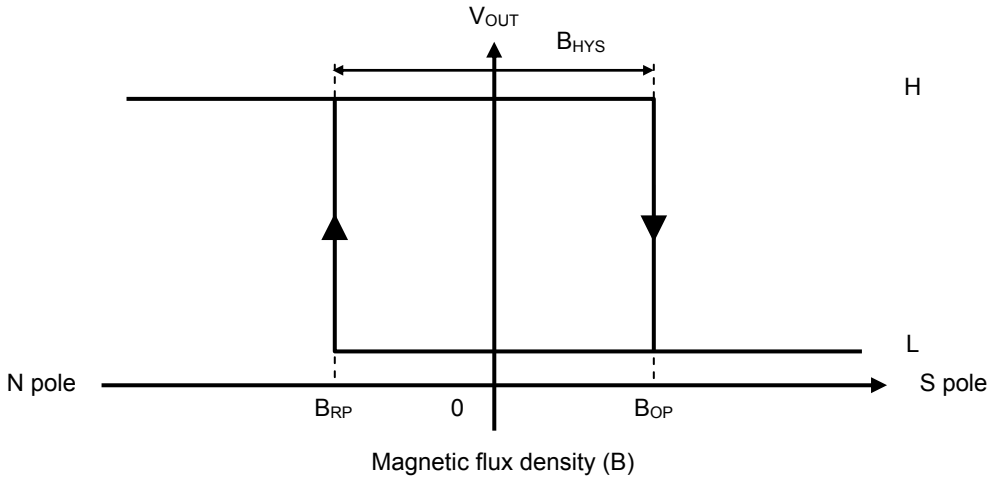


Figure 10

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 the S-57P1 S Series, V_{OUT} changes from "L" to "H". When the N pole of a magnet is moved closer to the marking surface of the S-57P1 S Series 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 11 shows the relationship between the magnetic flux density and V_{OUT}.

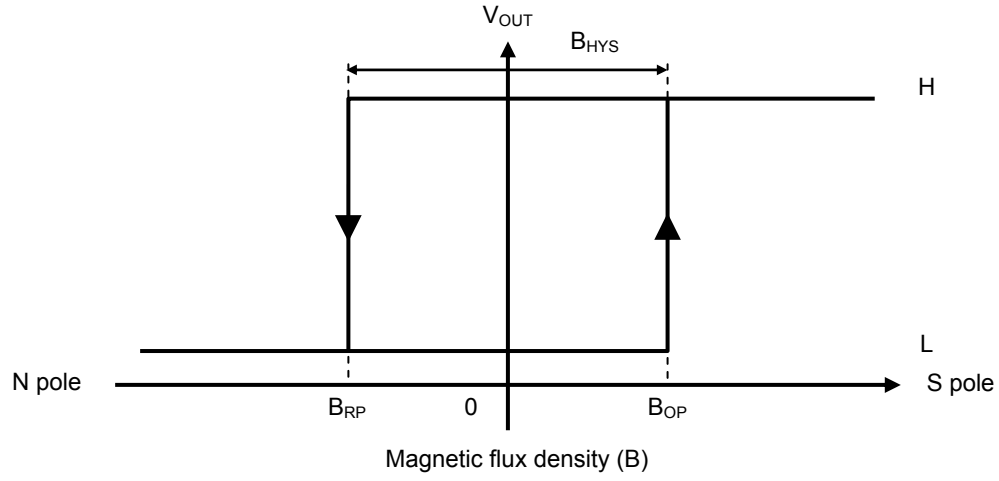


Figure 11

■ 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 package power dissipation.
- Large stress on this IC may affect on the magnetic characteristics. Avoid large stress which is caused by bend and distortion during mounting the IC on a board or handle after mounting.
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■ Thermal Characteristics

1. SOT-23-3S

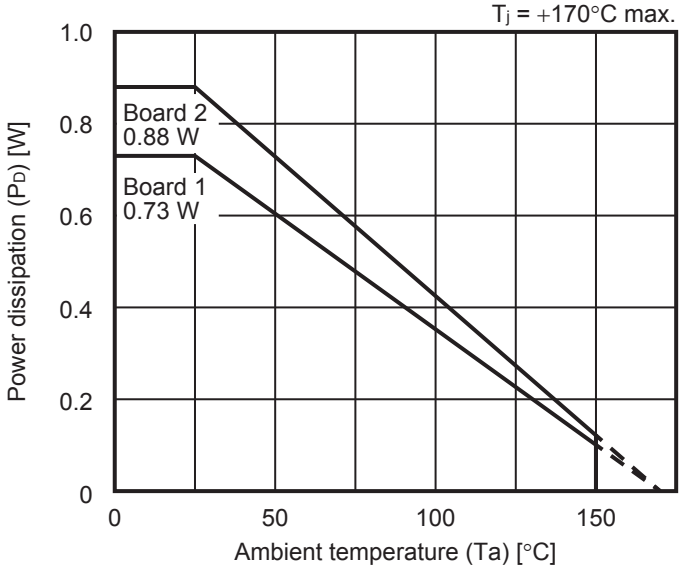


Figure 12 Power Dissipation of Package (When Mounted on Board)

1. 1 Board 1*1

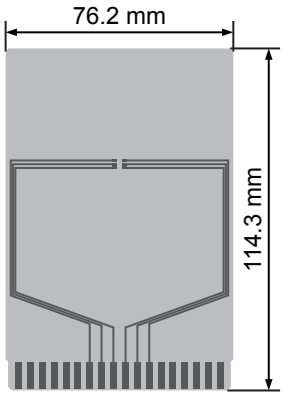


Figure 13

Table 11

Item		Specification
Thermal resistance value (θ_{ja})		200°C/W
Size		114.3 mm × 76.2 mm × t1.6 mm
Material		FR-4
Number of copper foil layer		2
Copper foil layer	1	Land pattern and wiring for testing: t0.070 mm
	2	–
	3	–
	4	74.2 mm × 74.2 mm × t0.070 mm
Thermal via		–

1. 2 Board 2*1

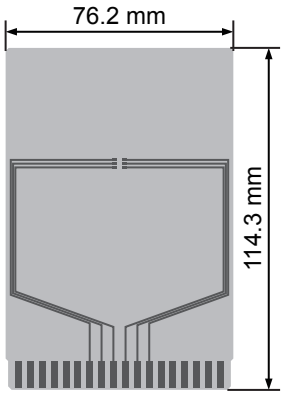
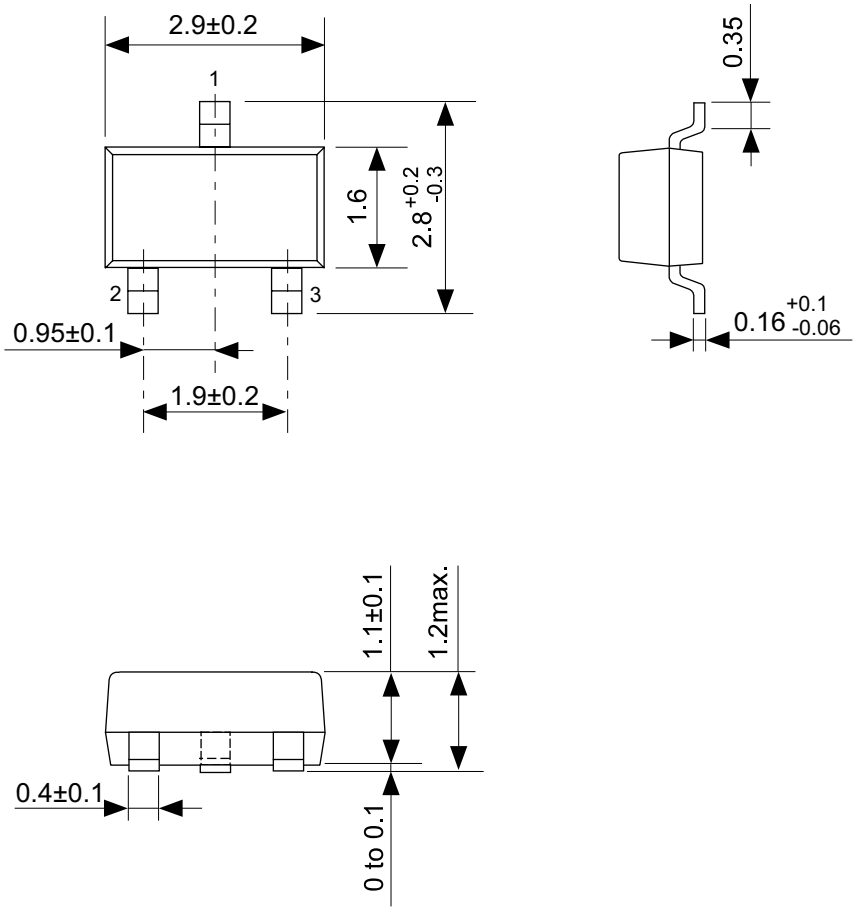


Figure 14

Table 12

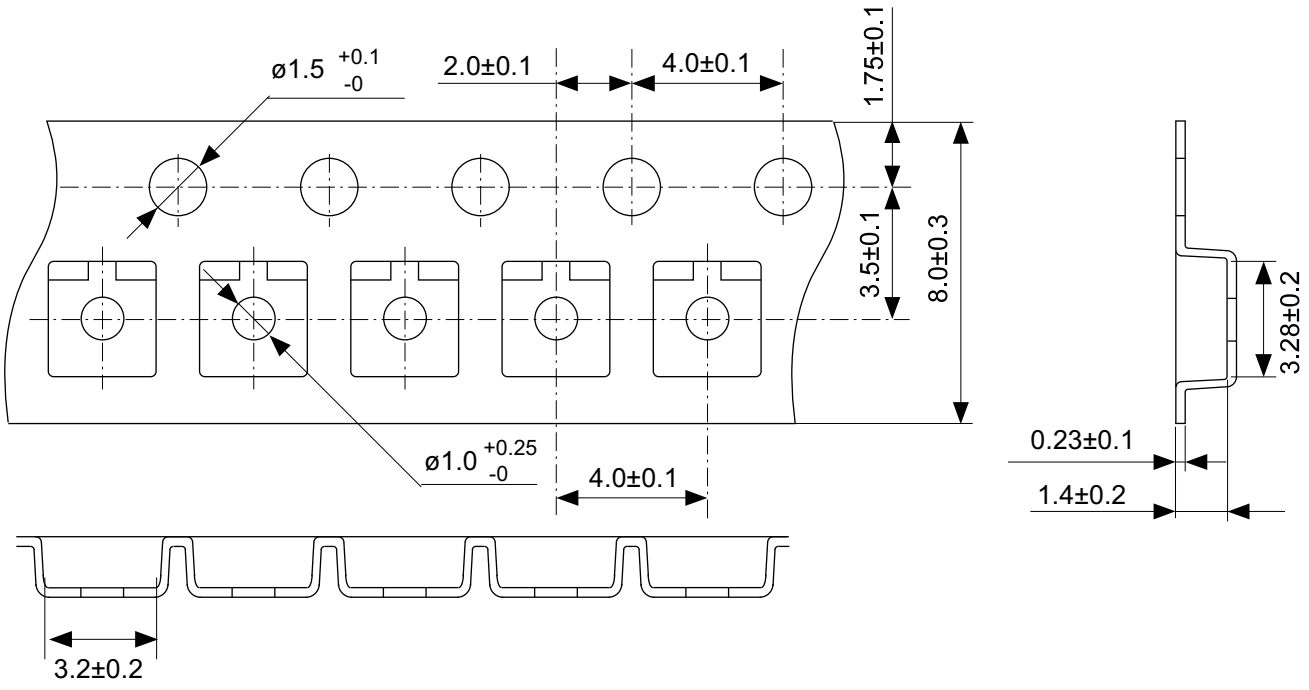
Item		Specification
Thermal resistance value (θ_{ja})		165°C/W
Size		114.3 mm × 76.2 mm × t1.6 mm
Material		FR-4
Number of copper foil layer		4
Copper foil layer	1	Land pattern and wiring for testing: t0.070 mm
	2	74.2 mm × 74.2 mm × t0.035 mm
	3	74.2 mm × 74.2 mm × t0.035 mm
	4	74.2 mm × 74.2 mm × t0.070 mm
Thermal via		–

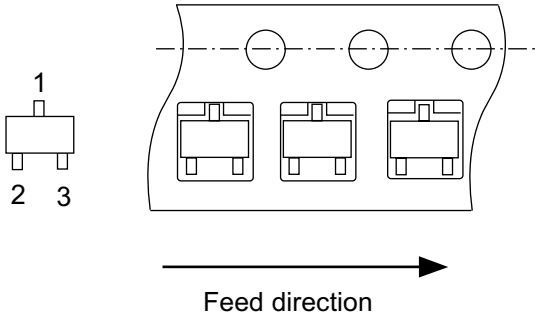
***1.** The board is same in SOT-23-3, SOT-23-5 and SOT-23-6.



No. MP003-D-P-SD-1.1

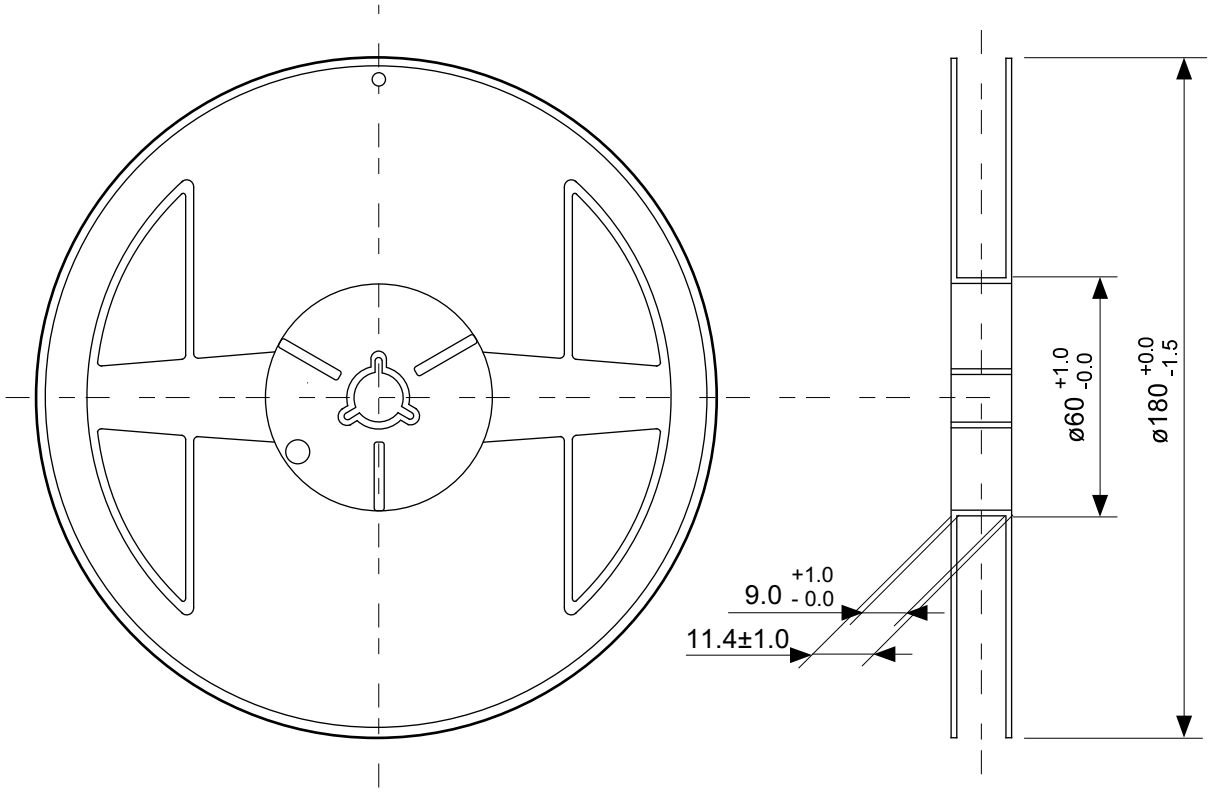
TITLE	SOT233S-A-PKG Dimensions
No.	MP003-D-P-SD-1.1
ANGLE	
UNIT	mm
SII Semiconductor Corporation	



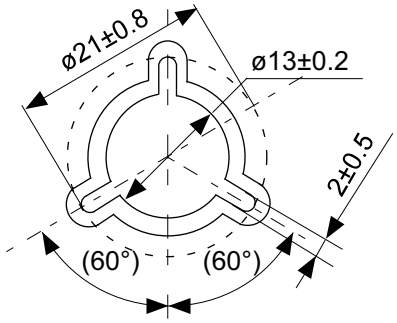


No. MP003-D-C-SD-1.0

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



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		
SII Semiconductor Corporation			

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