S-57K1 A Series

FOR AUTOMOTIVE 125°C OPERATION HIGH-WITHSTAND VOLTAGE HIGH-SPEED BIPOLAR HALL EFFECT LATCH

www.sii-ic.com

The S-57K1 A 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-57K1 A Series detects the intensity level of magnetic flux density and a polarity change. Using the S-57K1 A Series with a magnet makes it possible to detect the rotation status in various devices.
The S-57K1 A Series includes a reverse voltage protection circuit and an output current limit circuit.
High-density mounting is possible by using the small SOT-23-3 package.
Due to its high-accuracy magnetic characteristics, the S-57K1 A Series can make operation's dispersion in the system combined with magnet smaller.

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*1: Nch open-drain output, Nch driver + built-in pull-up resistor
- Magnetic sensitivity*1: B_{OP} = 3.0 mT typ., B_{OP} = 6.0 mT typ.
- Operating cycle: t_{CYCLE} = 8.0 µs typ.
- Power supply voltage range: V_{DD} = 3.5 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 +125°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

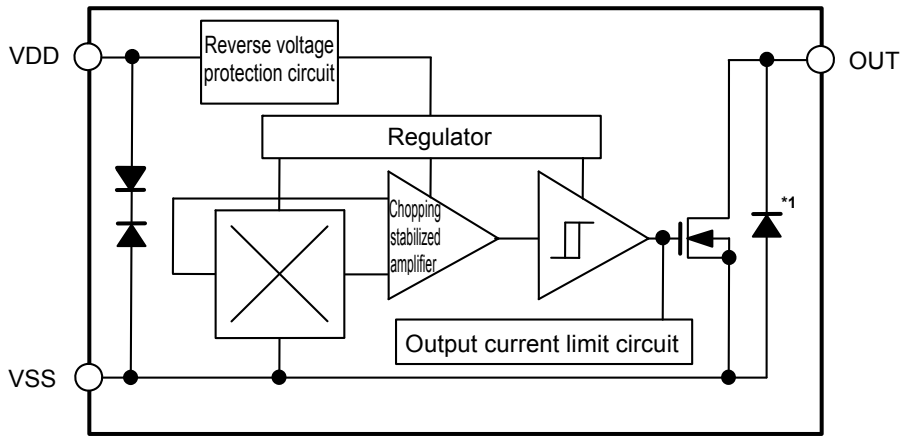
- Automobile equipment
- Home appliance
- DC brushless motor
- Housing equipment
- Industrial equipment

■ Package

- SOT-23-3

■ Block Diagrams

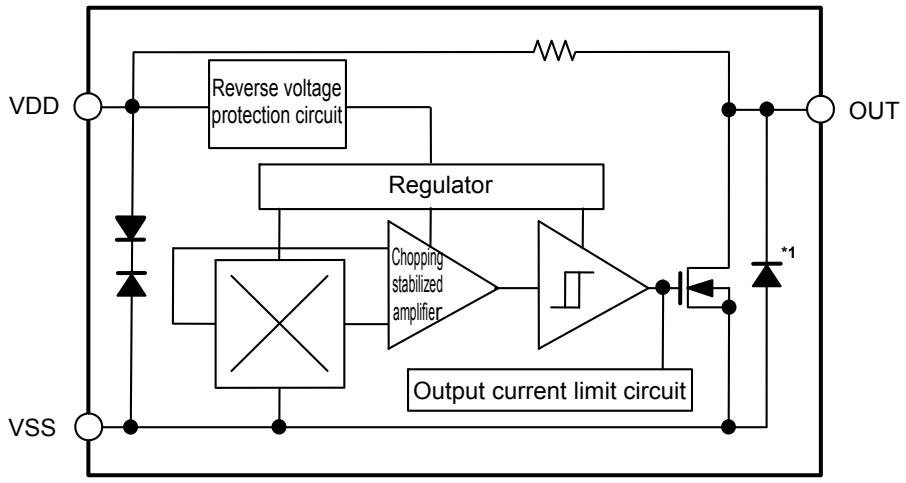
1. Nch open-drain output product



***1.** Parasitic diode

Figure 1

2. Nch driver + built-in pull-up resistor product



***1.** Parasitic diode

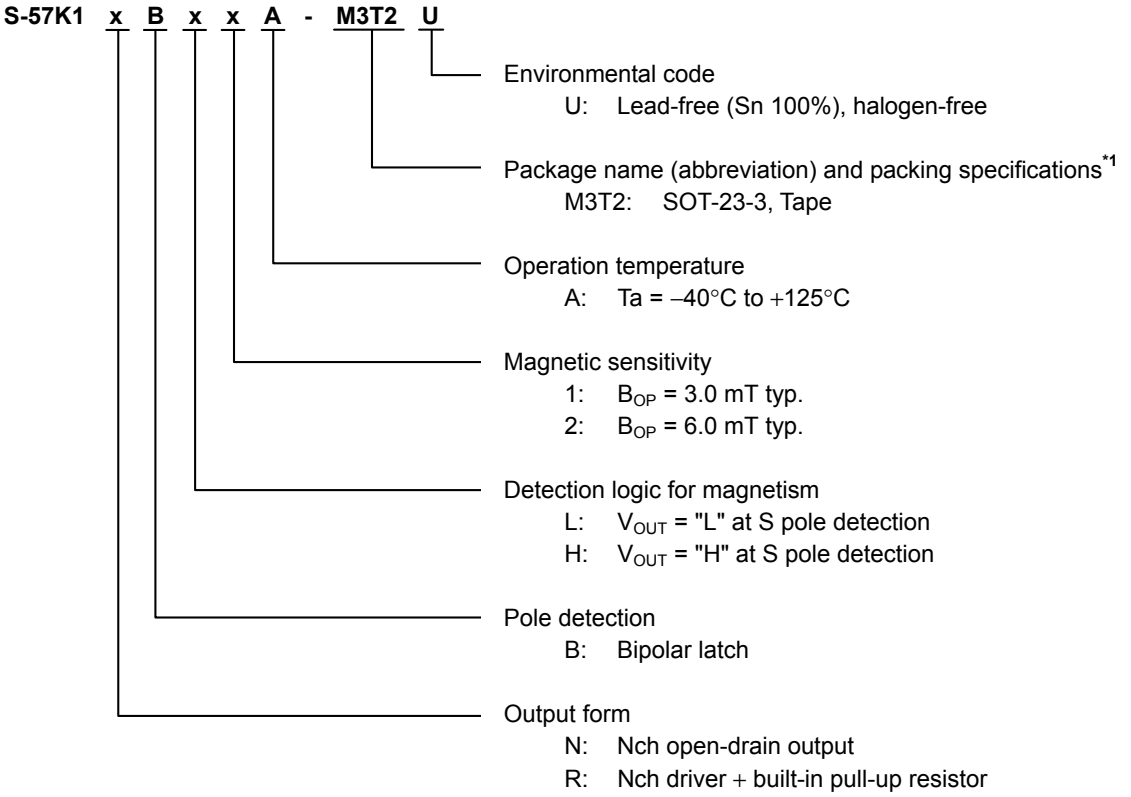
Figure 2

■ 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-23-3	MP003-C-P-SD	MP003-C-C-SD	MP003-Z-R-SD

3. Product name list

Table 2

Product Name	Output Form	Pole Detection	Detection Logic for Magnetism	Magnetic Sensitivity (B_{OP})
S-57K1NBL1A-M3T2U	Nch open-drain output	Bipolar latch	V_{OUT} = "L" at S pole detection	3.0 mT typ.
S-57K1NBL2A-M3T2U	Nch open-drain output	Bipolar latch	V_{OUT} = "L" at S pole detection	6.0 mT typ.
S-57K1NBH1A-M3T2U	Nch open-drain output	Bipolar latch	V_{OUT} = "H" at S pole detection	3.0 mT typ.
S-57K1RBL1A-M3T2U	Nch driver + built-in pull-up resistor	Bipolar latch	V_{OUT} = "L" at S pole detection	3.0 mT typ.

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

■ Pin Configuration

1. SOT-23-3

Top view

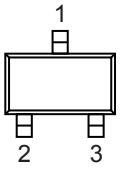


Figure 3

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	Nch open-drain output product	V_{OUT}	V_{SS} – 0.3 to V_{SS} + 28.0	V
	Nch driver + built-in pull-up resistor product		V_{SS} – 0.3 to V_{DD} + 0.3	V
Power dissipation		P_D	650*1	mW
Junction temperature		T_j	–40 to +150	°C
Operation ambient temperature		T_{opr}	–40 to +125	°C
Storage temperature		T_{stg}	–40 to +150	°C

***1.** When mounted on board
[Mounted board]
(1) Board size: 114.3 mm × 76.2 mm × t1.6 mm
(2) Board name: JEDEC STANDARD51-7

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.

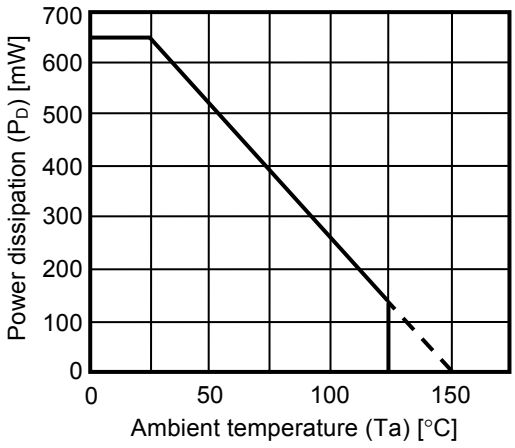


Figure 4 Power Dissipation of Package (When Mounted on Board)

■ Electrical Characteristics

Table 5

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

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit
Power supply voltage	V_{DD}	–	3.5	12.0	26.0	V	–
Current consumption	I_{DD}	Nch open-drain output product Average value	–	3.0	4.0	mA	1
		Nch driver + built-in pull-up resistor product Average value, V_{OUT} = "H"	–	3.0	4.0	mA	1
Current consumption during reverse connection	I_{DDREV}	Nch open-drain output product $V_{DD} = -26.0$ V	–1	–	–	mA	1
		Nch driver + built-in pull-up resistor product $V_{DD} = -26.0$ V	–5	–	–	mA	1
Output voltage	V_{OUT}	Nch open-drain output product Output transistor Nch, V_{OUT} = "L", I_{OUT} = 10 mA	–	–	0.4	V	2
		Nch driver + built-in pull-up resistor product Output transistor Nch, V_{OUT} = "L", I_{OUT} = 10 mA	–	–	0.5	V	2
Output drop voltage	V_D	Nch driver + built-in pull-up resistor product V_{OUT} = "H", $V_D = V_{DD} - V_{OUT}$	–	–	20	mV	2
Leakage current	I_{LEAK}	Nch open-drain output product Output transistor Nch, V_{OUT} = "H" = 26.0 V	–	–	10	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	4
Pull-up resistor	R_L	Nch driver + built-in pull-up resistor product	7	10	13	kΩ	–

■ Magnetic Characteristics

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

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
Operation point*1	S pole	B_{OP}	–	1.5	3.0	4.5	mT	4
Release point*2	N pole	B_{RP}	–	–4.5	–3.0	–1.5	mT	4
Hysteresis width*3		B_{HYS}	$B_{HYS} = B_{OP} - B_{RP}$	–	6.0	–	mT	4

2. Product with B_{OP} = 6.0 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}	–	3.0	6.0	9.0	mT	4
Release point*2	N pole	B_{RP}	–	–9.0	–6.0	–3.0	mT	4
Hysteresis width*3		B_{HYS}	$B_{HYS} = B_{OP} - B_{RP}$	–	12.0	–	mT	4

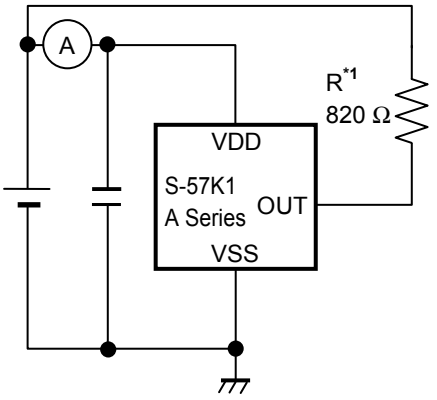
***1.** B_{OP}: Operation point
B_{OP} is the value of magnetic flux density when the output voltage (V_{OUT}) changes after the magnetic flux density applied to the S-57K1 A Series by the magnet (S pole) is increased (by moving the magnet closer).
V_{OUT} retains the status until a magnetic flux density 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-57K1 A 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



***1.** Resistor (R) is unnecessary for the pull-up resistor built-in product.

Figure 5 Test Circuit 1

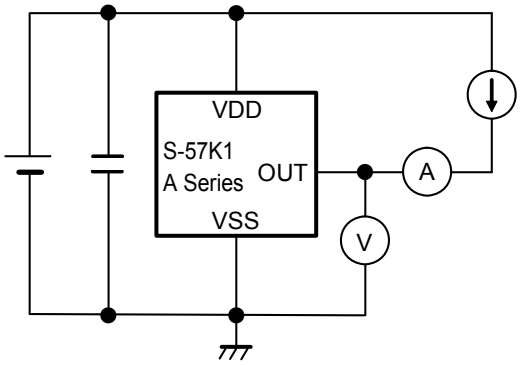


Figure 6 Test Circuit 2

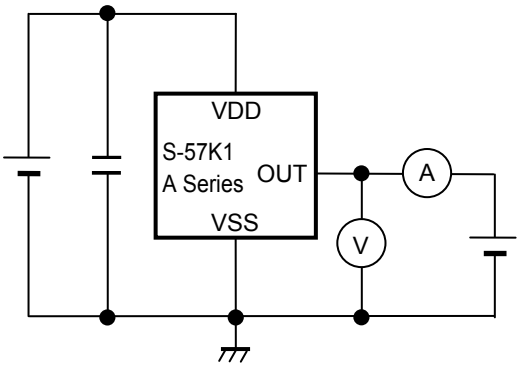
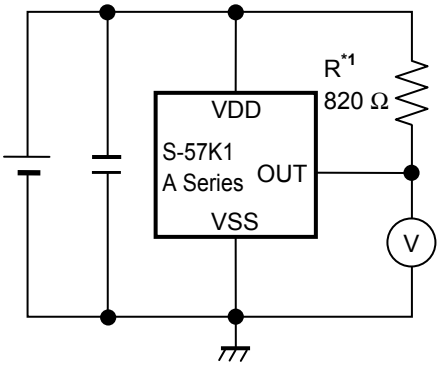


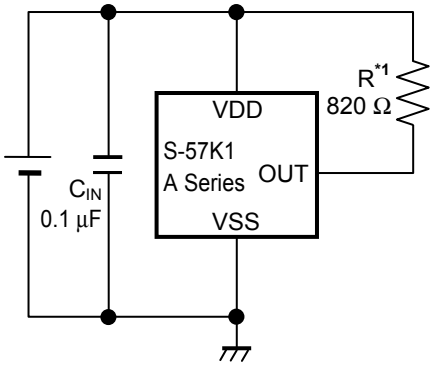
Figure 7 Test Circuit 3



***1.** Resistor (R) is unnecessary for the pull-up resistor built-in product.

Figure 8 Test Circuit 4

■ Standard Circuit



***1.** Resistor (R) is unnecessary for the pull-up resistor built-in product.

Figure 9

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-57K1 A Series detects the magnetic flux density which is vertical to the marking surface.
Figure 10 shows the direction in which magnetic flux is being applied.

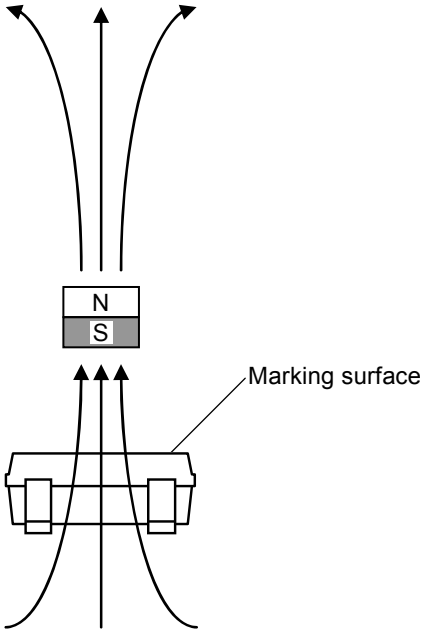


Figure 10

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.

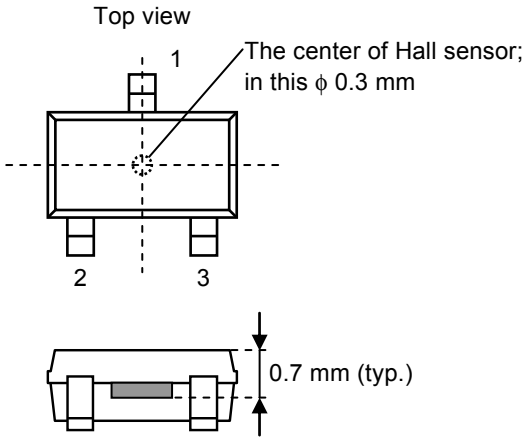


Figure 11

3. Basic operation

The S-57K1 A Series changes the output voltage (V_{OUT}) according to the level of the magnetic flux density and a polarity change (N pole or S pole) 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-57K1 A 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-57K1 A 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 12** shows the relationship between the magnetic flux density and V_{OUT}.

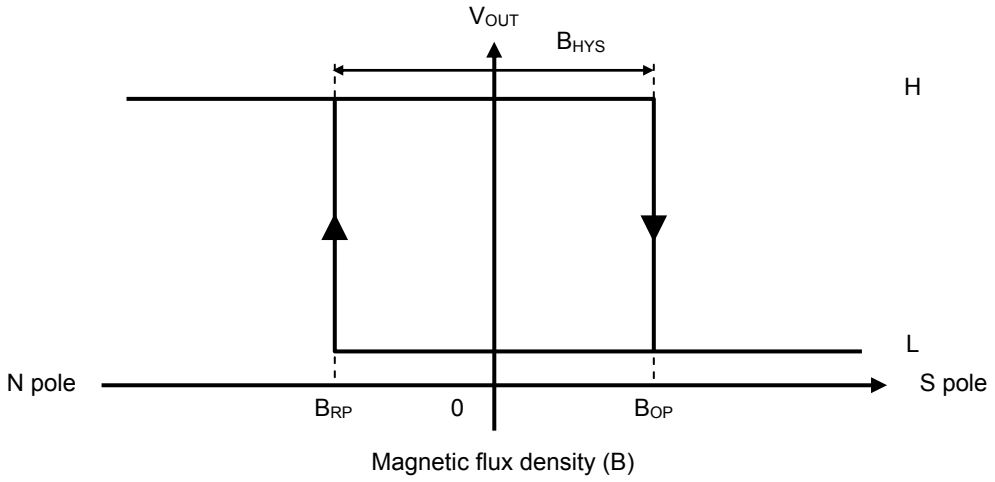


Figure 12

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 the S-57K1 A 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-57K1 A 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 13 shows the relationship between the magnetic flux density and V_{OUT}.

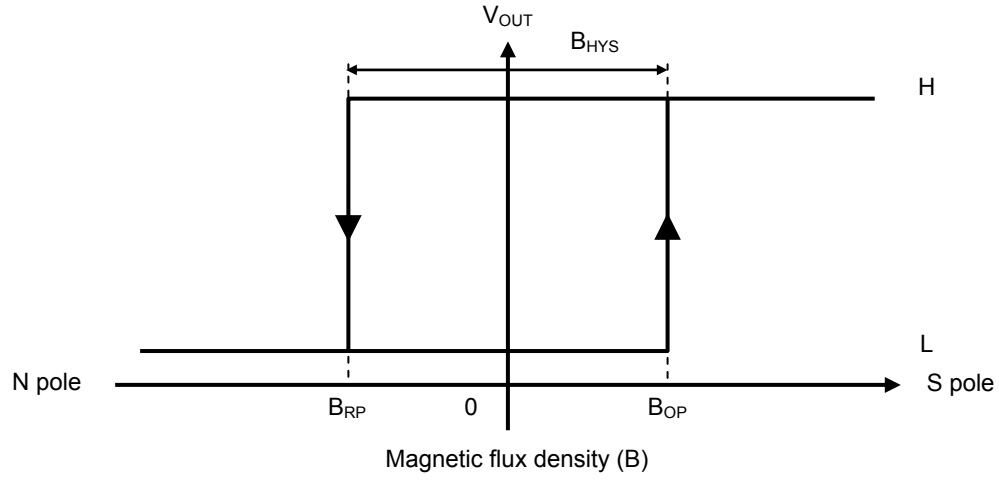
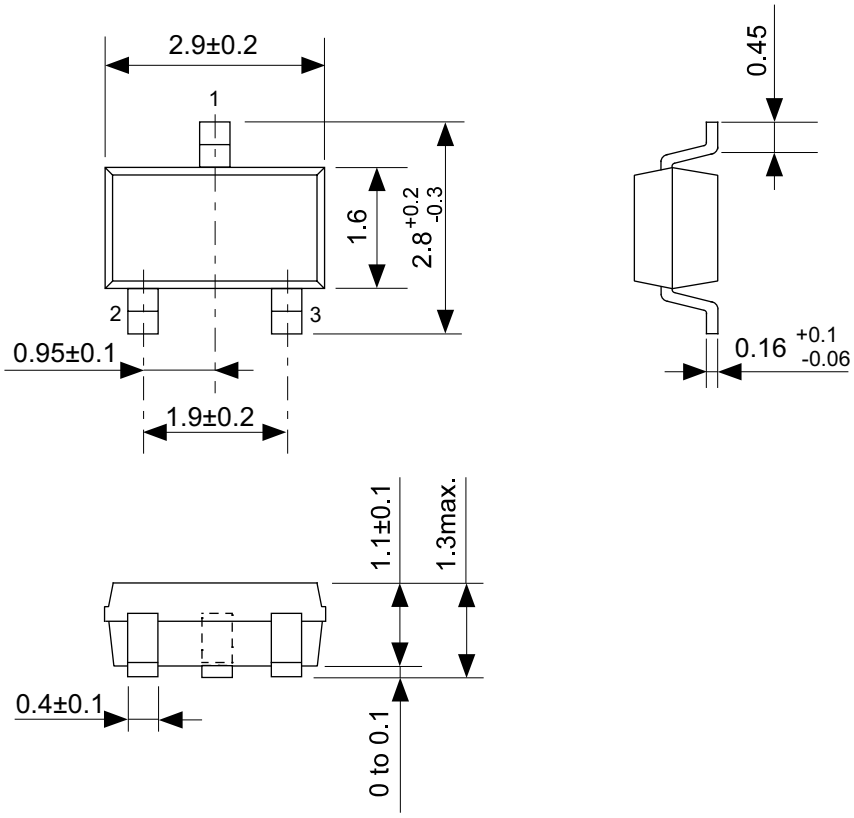


Figure 13

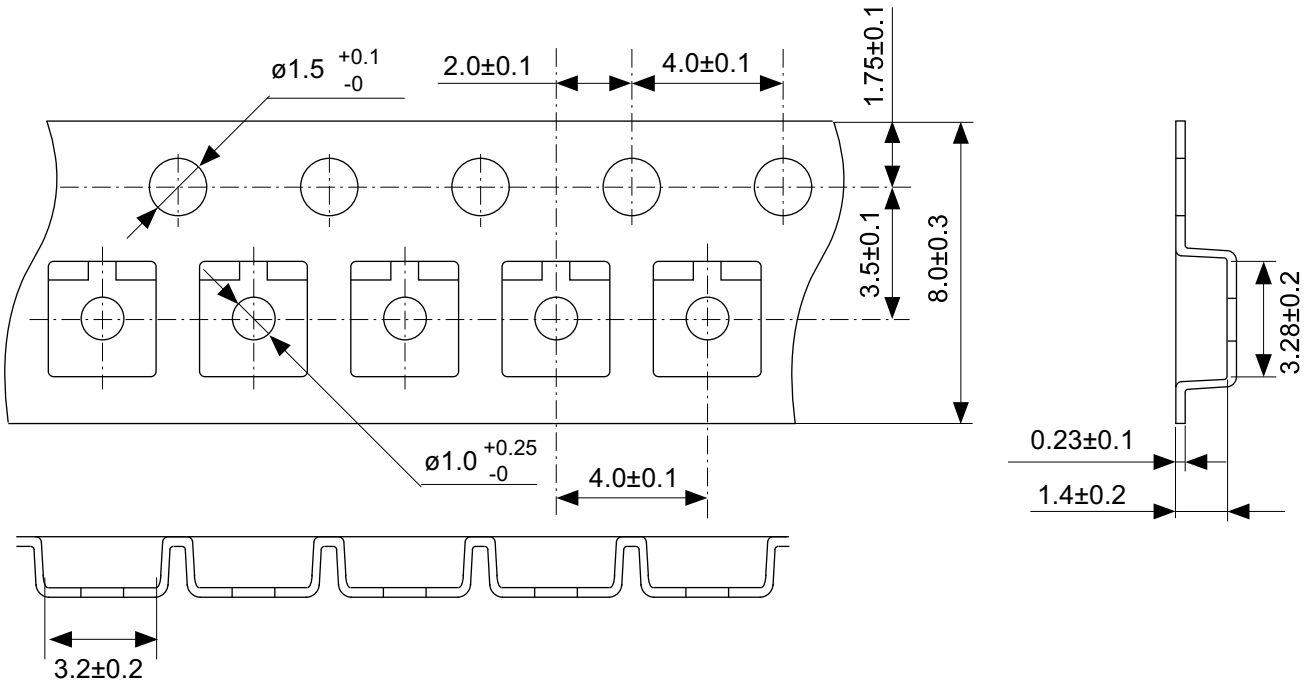
■ Precautions

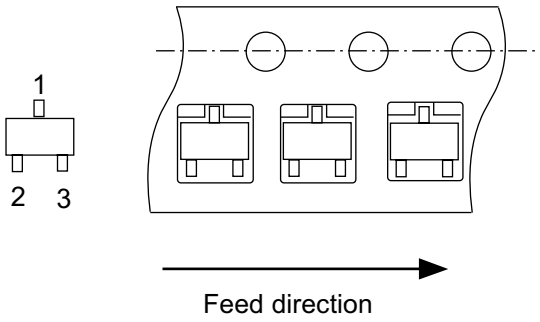
- If the impedance of the power supply is high, the IC may malfunction due to a supply voltage drop caused by feed-through current. Take care with the pattern wiring to ensure that the impedance of the power supply is low.
- Note that the IC may malfunction if the power supply voltage rapidly changes. 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.
- SII Semiconductor Corporation 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.



No. MP003-C-P-SD-1.1

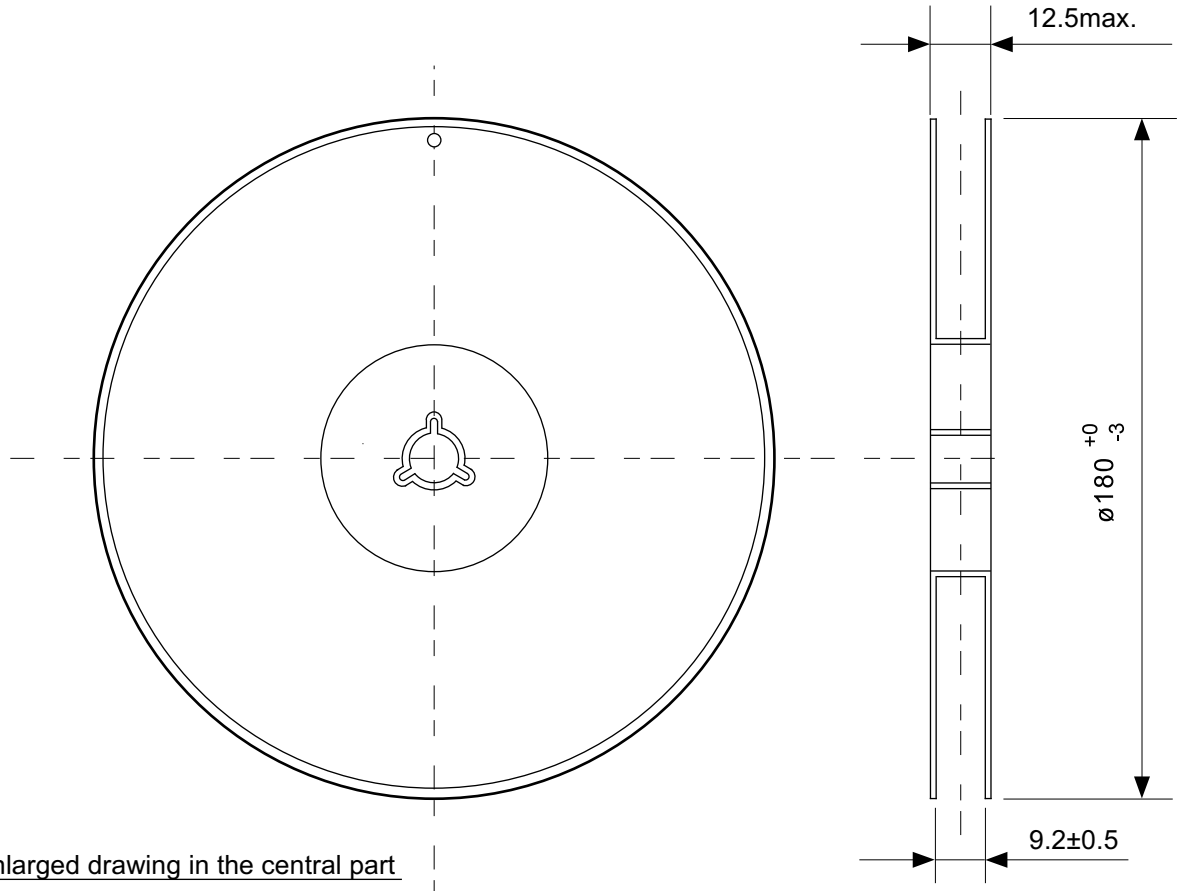
TITLE	SOT233-C-PKG Dimensions
No.	MP003-C-P-SD-1.1
ANGLE	
UNIT	mm
SII Semiconductor Corporation	



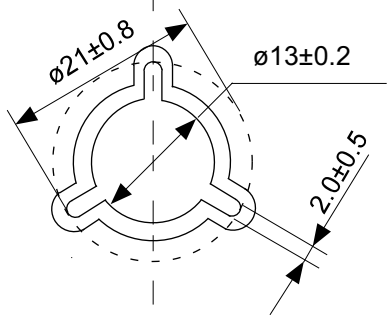


No. MP003-C-C-SD-2.0

TITLE	SOT233-C-Carrier Tape
No.	MP003-C-C-SD-2.0
ANGLE	
UNIT	mm
SII Semiconductor Corporation	



Enlarged drawing in the central part



No. MP003-Z-R-SD-1.0

TITLE	SOT233-C-Reel		
No.	MP003-Z-R-SD-1.0		
ANGLE		QTY.	3,000
UNIT	mm		
SII Semiconductor Corporation			

Disclaimers (Handling Precautions)

1. All the information described herein (product data, specifications, figures, tables, programs, algorithms and application circuit examples, etc.) is current as of publishing date of this document and is subject to change without notice.
2. The circuit examples and the usages described herein are for reference only, and do not guarantee the success of any specific mass-production design.
   SII Semiconductor Corporation is not responsible for damages caused by the reasons other than the products or infringement of third-party intellectual property rights and any other rights due to the use of the information described herein.
3. SII Semiconductor Corporation is not responsible for damages caused by the incorrect information described herein.
4. Take care to use the products described herein within their specified ranges. Pay special attention to the absolute maximum ratings, operation voltage range and electrical characteristics, etc.
   SII Semiconductor Corporation is not responsible for damages caused by failures and/or accidents, etc. that occur due to the use of products outside their specified ranges.
5. When using the products described herein, confirm their applications, and the laws and regulations of the region or country where they are used and verify suitability, safety and other factors for the intended use.
6. When exporting the products described herein, comply with the Foreign Exchange and Foreign Trade Act and all other export-related laws, and follow the required procedures.
7. The products described herein must not be used or provided (exported) for the purposes of the development of weapons of mass destruction or military use. SII Semiconductor Corporation is not responsible for any provision (export) to those whose purpose is to develop, manufacture, use or store nuclear, biological or chemical weapons, missiles, or other military use.
8. The products described herein are not designed to be used as part of any device or equipment that may affect the human body, human life, or assets (such as medical equipment, disaster prevention systems, security systems, combustion control systems, infrastructure control systems, vehicle equipment, traffic systems, in-vehicle equipment, aviation equipment, aerospace equipment, and nuclear-related equipment), excluding when specified for in-vehicle use or other uses. Do not use those products without the prior written permission of SII Semiconductor Corporation.
   Especially, the products described herein cannot be used for life support devices, devices implanted in the human body and devices that directly affect human life, etc.
   Prior consultation with our sales office is required when considering the above uses.
   SII Semiconductor Corporation is not responsible for damages caused by unauthorized or unspecified use of our products.
9. Semiconductor products may fail or malfunction with some probability.
   The user of these products should therefore take responsibility to give thorough consideration to safety design including redundancy, fire spread prevention measures, and malfunction prevention to prevent accidents causing injury or death, fires and social damage, etc. that may ensue from the products' failure or malfunction.
   The entire system must be sufficiently evaluated and applied on customer's own responsibility.
10. The products described herein are not designed to be radiation-proof. The necessary radiation measures should be taken in the product design by the customer depending on the intended use.
11. The products described herein do not affect human health under normal use. However, they contain chemical substances and heavy metals and should therefore not be put in the mouth. The fracture surfaces of wafers and chips may be sharp. Take care when handling these with the bare hands to prevent injuries, etc.
12. When disposing of the products described herein, comply with the laws and ordinances of the country or region where they are used.
13. The information described herein contains copyright information and know-how of SII Semiconductor Corporation.
    The information described herein does not convey any license under any intellectual property rights or any other rights belonging to SII Semiconductor Corporation or a third party. Reproduction or copying of the information described herein for the purpose of disclosing it to a third-party without the express permission of SII Semiconductor Corporation is strictly prohibited.
14. For more details on the information described herein, contact our sales office.

1.0-2016.01