S-5701 B Series

**125°C OPERATION,
SUPER LOW CURRENT CONSUMPTION, LOW VOLTAGE OPERATION,
OMNIPOLAR DETECTION TYPE TMR MAGNETIC SENSOR IC**

www.ablic.com

Rev.1.0_00

This IC, developed by TMR (tunnel magneto resistance effect) technology and CMOS technology, is a magnetic sensor IC that operates with super low current consumption and low voltage.
The output voltage level changes when this IC detects the intensity level of magnetic flux density. Using this IC with a magnet makes it possible to detect the open / close in various devices.

ABLIC Inc. offers a "magnetic simulation service" that provides the ideal combination of magnets and our magnetic sensor IC 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 representatives.

■ Features

- Super low current consumption (I_{DD} = 160 nA typ.) contributes to device power saving and extended period operation of battery devices
- High sensitivity magnetic characteristics enable downsizing of magnets
- Contributes to accurate mechanism operation over a wide temperature range due to excellent thermal stability of magnetic characteristics (Refer to "**2. Magnetic characteristics**" in "**■ Characteristics (Typical Data)**" for details)
- Uses a thin (t0.80 mm max.) TSOT-23-3S package, contributing to the enhancement of the designs of devices

■ Specifications

- Detection direction: Horizontal direction (Refer to "**■ Operation**" for details)
- Pole detection: Omnipolar detection
- Output logic: Active "L"
- Output form: CMOS output
- Magnetic sensitivity*1: B_{OP} = 1.0 mT typ.
  B_{OP} = 3.0 mT typ.
- Operating cycle (current consumption): t_{CYCLE} = 100 ms (I_{DD} = 160 nA) typ.
- Power supply voltage range: V_{DD} = 1.7 V to 5.5 V
- Operation temperature range: Ta = −40°C to +125°C
- Lead-free (Sn 100%), halogen-free

***1.** The option can be selected.

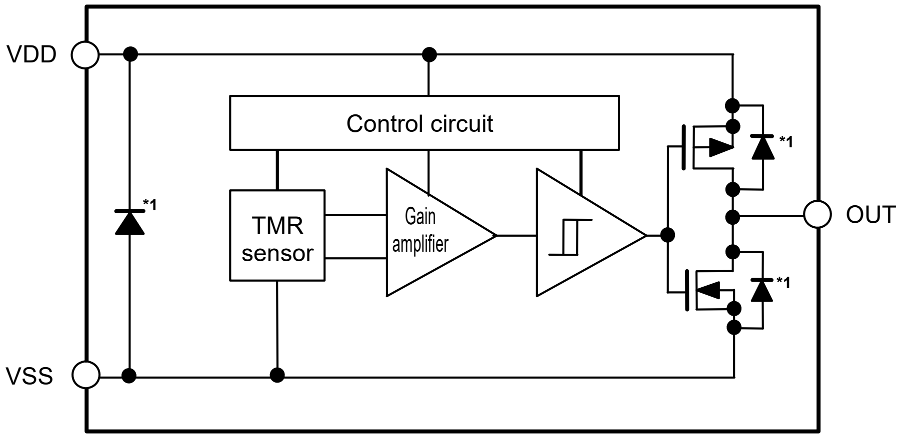
■ Applications

- Home security device
  (Window/door open/close detection)
- Utility meter
- Battery powered device
- Wearable device

■ Package

- TSOT-23-3S

■ Block Diagram



***1.** Parasitic diode

Figure 1

■ Product Name Structure

1. Product name

S-5701 B C 1 x B - L3T2 U 5

- Environmental code
  - U: Lead-free (Sn 100%), halogen-free
- Package abbreviation and IC packing specifications*1
  - L3T2: TSOT-23-3S, Tape
- Operation temperature
  - B: Ta = –40°C to +125°C
- Magnetic sensitivity
  - 0: B_{OP} = 1.0 mT typ.
  - 1: B_{OP} = 3.0 mT typ.
- Pole detection, output logic
  - 1: Omnipolar detection, active "L"
- Output form
  - C: CMOS output
- Operating cycle
  - B: t_{CYCLE} = 100 ms typ.

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

2. Package

Table 1 Package Drawing Codes

Package Name	Dimension	Tape	Reel
TSOT-23-3S	MP003-E-P-SD	MP003-E-C-SD	MP003-E-R-SD

3. Product name list

Table 2

Product Name	Operating Cycle (t_{CYCLE})	Output Form	Pole Detection	Output Logic	Magnetic Sensitivity (B_{OP})
S-5701BC10B-L3T2U5	100 ms typ.	CMOS output	Omnipolar	Active "L"	1.0 mT typ.
S-5701BC11B-L3T2U5	100 ms typ.	CMOS output	Omnipolar	Active "L"	3.0 mT typ.

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

■ Pin Configuraion

1. TSOT-23-3S

Top view

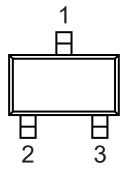


Figure 2

Table 3

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

Absolute Maximum Ratings

Table 4

Item	Symbol	Absolute Maximum Rating	Unit
Power supply voltage	V_{DD}	V_{SS} − 0.3 to V_{SS} + 6.0	V
Output current	I_{OUT}	±20	mA
Output voltage	V_{OUT}	V_{SS} − 0.3 to V_{DD} + 0.3	V
Maximum applied magnetic flux density	B_{MAX}	±50	mT
Junction temperature	T_{stg}	−40 to +150	°C
Operation ambient temperature	T_{opr}	−40 to +125	°C
Storage temperature	T_{stg}	−40 to +150	°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}	TSOT-23-3S	Board A	−	225	−	°C/W
			Board B	−	190	−	°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} = 3.3 V, V_{SS} = 0 V unless otherwise specified)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit
Power supply voltage	V_{DD}	–	1.7	3.3	5.5	V	–
Current consumption	I_{DD}	Average value, V_{DD} = 3.3 V	–	160	320	nA	1
		Average value, V_{DD} = 5.5 V	–	500	720	nA	1
Low level output voltage	V_{OL}	I_{OUT} = 2 mA	–	–	$V_{DD} \times 0.1$	V	2
High level output voltage	V_{OH}	I_{OUT} = –2 mA	$V_{DD} \times 0.9$	–	–	V	3
Awake mode time	t_{AW}	–	–	2.1	–	μs	–
Sleep mode time	t_{SL}	–	–	100	–	ms	–
Operating cycle	t_{CYCLE}	$t_{AW} + t_{SL}$	–	100	–	ms	–

■ Magnetic Characteristics

1. Product with B_{OP} = 1.0 mT typ.

Table 7

(Ta = +25°C, V_{DD} = 3.3 V, V_{SS} = 0 V unless otherwise specified)

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit
Operation point*1	S pole	B_{OPS}	–	0.4	1.0	1.5	mT	4
	N pole	B_{OPN}	–	–1.5	–1.0	–0.4	mT	4
Release point*2	S pole	B_{RPS}	–	0.1	0.5	0.9	mT	4
	N pole	B_{RPN}	–	–0.9	–0.5	–0.1	mT	4
Hysteresis width*3	S pole	B_{HYSS}	$B_{HYSS} = B_{OPS} - B_{RPS}$	–	0.5	–	mT	4
	N pole	B_{HYSN}	$B_{HYSN} = \|B_{OPN} - B_{RPN}\|$	–	0.5	–	mT	4

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

Table 8

(Ta = +25°C, V_{DD} = 3.3 V, V_{SS} = 0 V unless otherwise specified)

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Test Circuit
Operation point*1	S pole	B_{OPS}	–	2.0	3.0	4.0	mT	4
	N pole	B_{OPN}	–	–4.0	–3.0	–2.0	mT	4
Release point*2	S pole	B_{RPS}	–	1.0	2.0	3.0	mT	4
	N pole	B_{RPN}	–	–3.0	–2.0	–1.0	mT	4
Hysteresis width*3	S pole	B_{HYSS}	$B_{HYSS} = B_{OPS} - B_{RPS}$	–	1.0	–	mT	4
	N pole	B_{HYSN}	$B_{HYSN} = \|B_{OPN} - B_{RPN}\|$	–	1.0	–	mT	4

***1.** B_{OPN}, B_{OPS}: Operation points
B_{OPN} and B_{OPS} are the values 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 or S pole) is increased (by moving the magnet closer).
Even when the magnetic flux density exceeds B_{OPN} or B_{OPS}, V_{OUT} retains the status.

***2.** B_{RPN}, B_{RPS}: Release points
B_{RPN} and B_{RPS} are the values 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 or S pole) is decreased (the magnet is moved further away).
Even when the magnetic flux density falls below B_{RPN} or B_{RPS}, V_{OUT} retains the status.

***3.** B_{HYSN}, B_{HYSS}: Hysteresis widths
B_{HYSN} and B_{HYSS} are the difference between B_{OPN} and B_{RPN}, and B_{OPS} and B_{RPS}, respectively.

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

■ Test Circuits

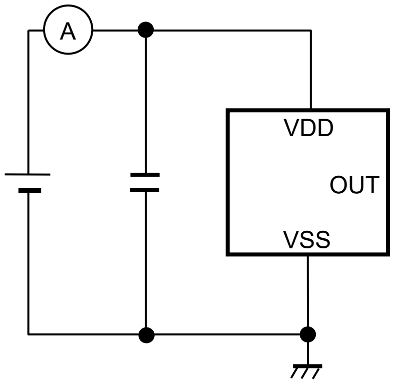


Figure 3 Test Circuit 1

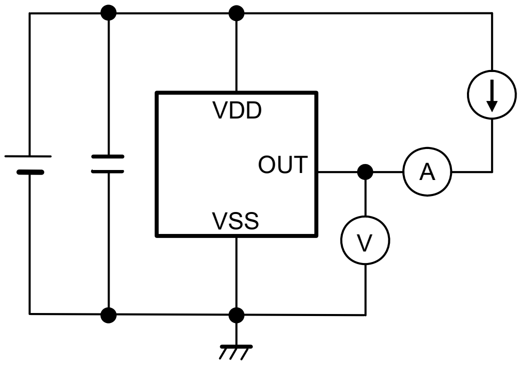


Figure 4 Test Circuit 2

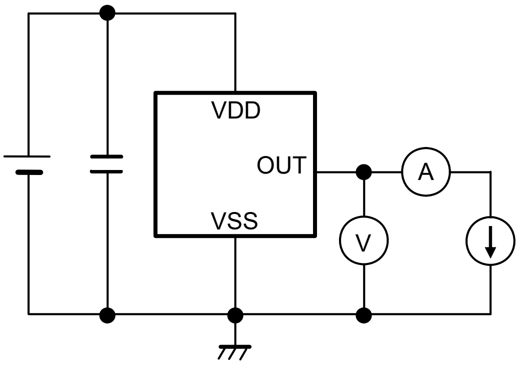


Figure 5 Test Circuit 3

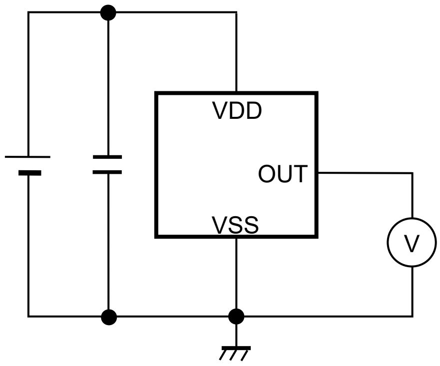


Figure 6 Test Circuit 4

■ Standard Circuit

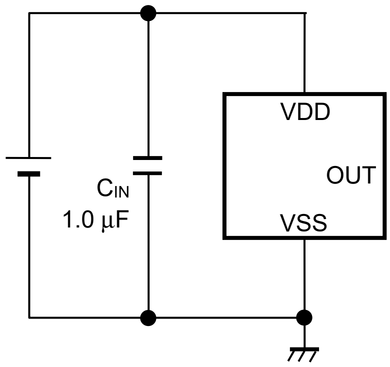


Figure 7

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

■ Operation

1. Direction of applied magnetic flux

This IC detects the magnetic flux density which is horizontal to the package marking surface. A magnetic field is defined as positive when No.3 pin side of the package is the S pole, and negative when it is the N pole.
Figure 8 shows polarity in a magnetic field and direction in which magnetic flux is being applied.

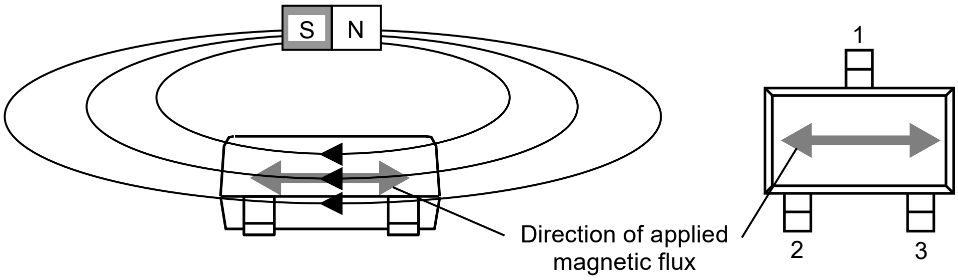


Figure 8

2. Position of magnetic sensor

Figure 9 shows the position of a magnetic sensor.
The center of this magnetic 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.

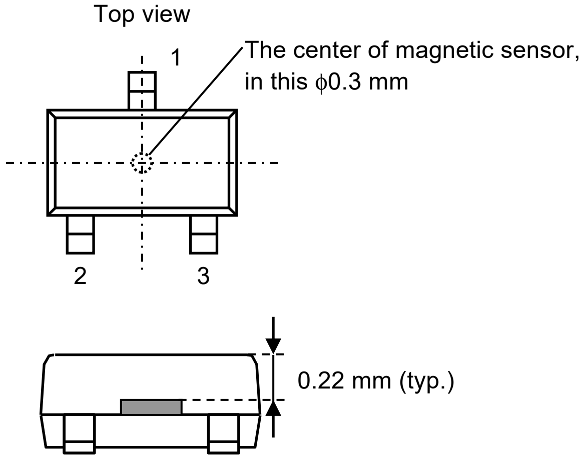


Figure 9

3. Basic operation

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

When the detected magnetic flux density exceeds the operation point (B_{OPN} or B_{OPS}), V_{OUT} changes from "H" to "L".

When the detected magnetic flux density becomes lower than the release point (B_{RPN} or B_{RPS}), V_{OUT} changes from "L" to "H".

Figure 10 shows the relationship between the magnetic flux density and V_{OUT}.

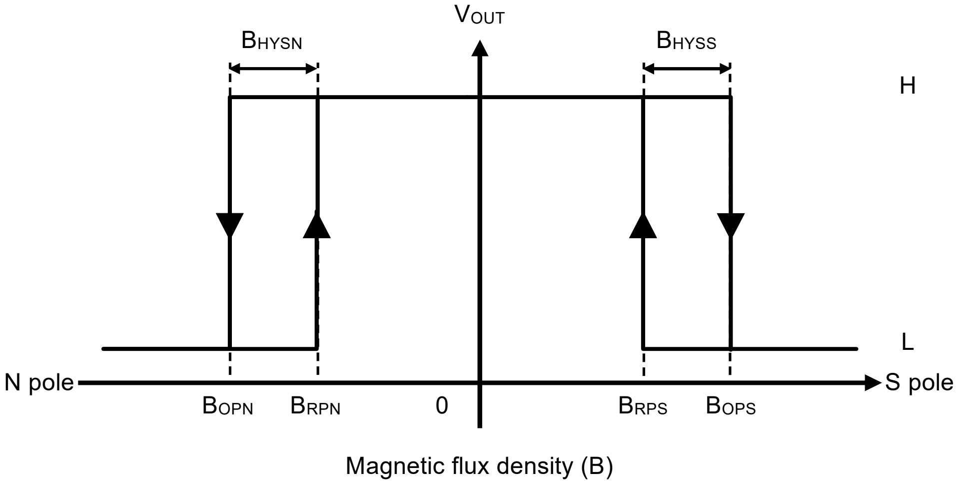


Figure 10

4. Time dependency in the current consumption

This IC performs the intermittent operation, and operates at low current consumption due to repeating the sleep mode and the awake mode.
Figure 11 shows the time dependency in the current consumption.

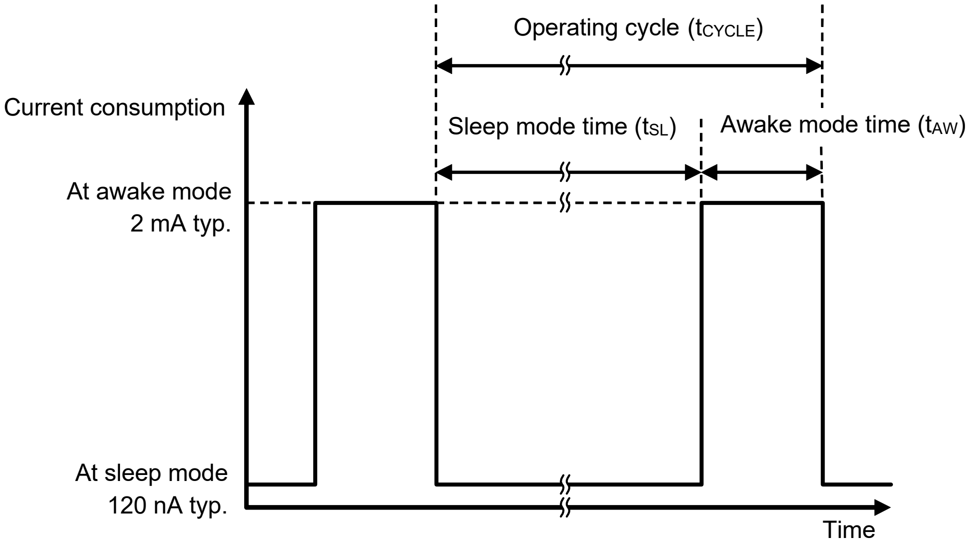


Figure 11

5. Timing chart

Figure 12 shows the operation timing of this IC.

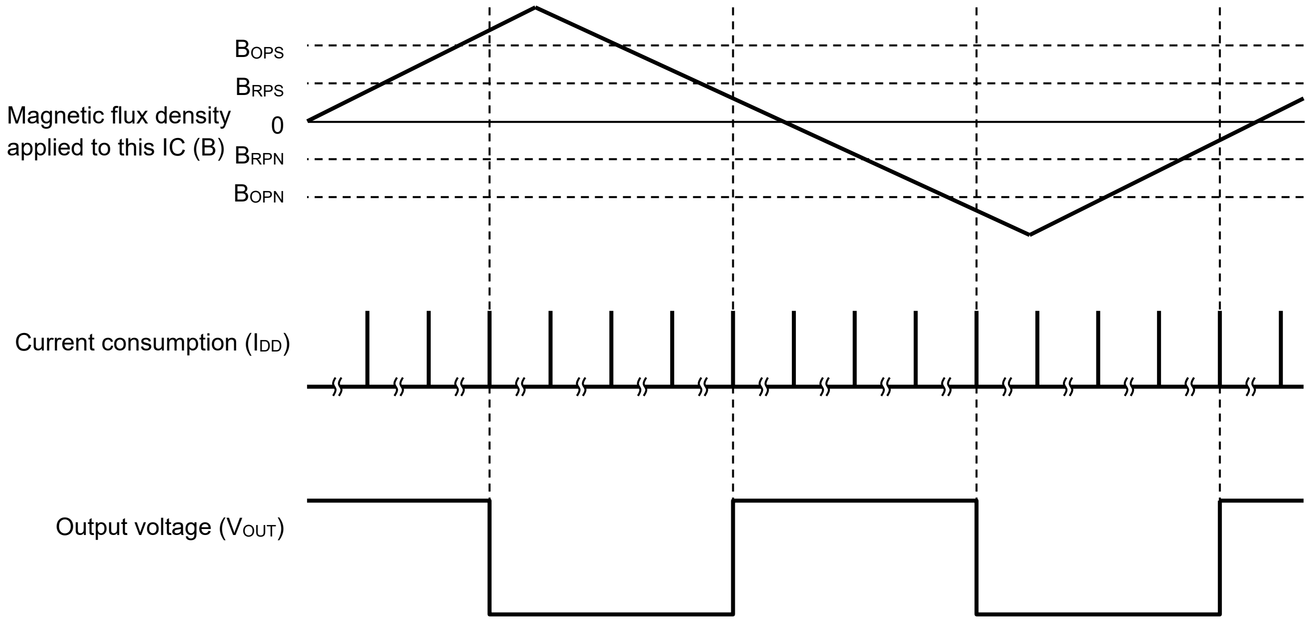


Figure 12

■ 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.

- Note that the IC may take longer to change the output voltage according to the level of the magnetic flux density when power is supplied again just after power shutdown.

- Do not apply an electrostatic discharge to this IC that exceeds the performance ratings of the built-in electrostatic protection circuit.

- Note that the output voltage may rarely change if the magnetic flux density between the operation point and the release point is applied to this IC continuously for a long time.

- The application conditions for the power supply voltage 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.

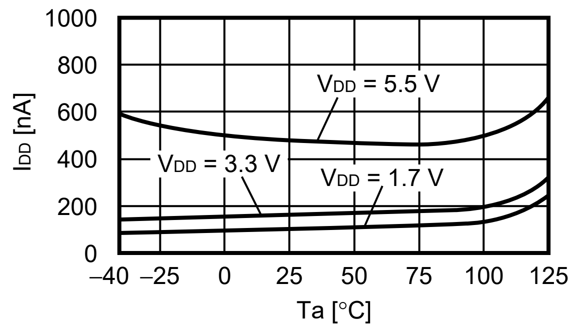
- ABLIC Inc. claims no responsibility for any disputes arising out of or in connection with any infringement by products including this IC of patents owned by a third party.

■ Characteristics (Typical Data)

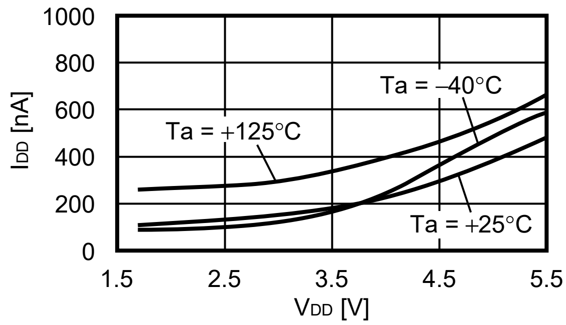
1. Electrical characteristics

1. 1 S-5701BC1xB

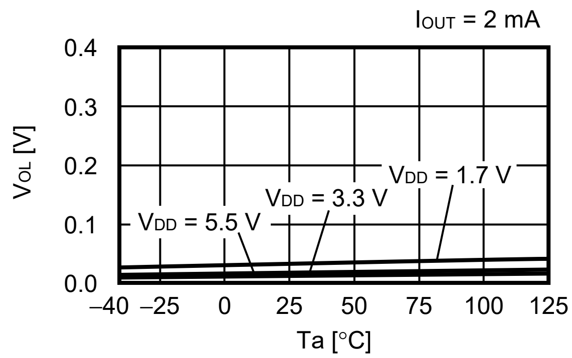
1. 1. 1 Current consumption (I_{DD}) vs. Temperature (Ta)



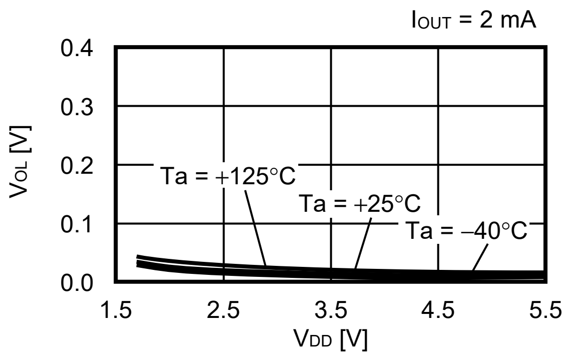
1. 1. 2 Current consumption (I_{DD}) vs. Power supply voltage (V_{DD})



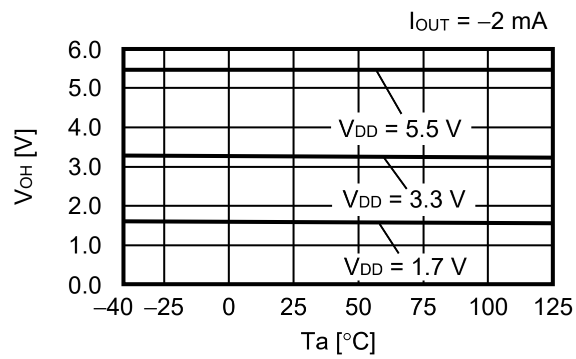
1. 1. 3 Low level output voltage (V_{OL}) vs. Temperature (Ta)



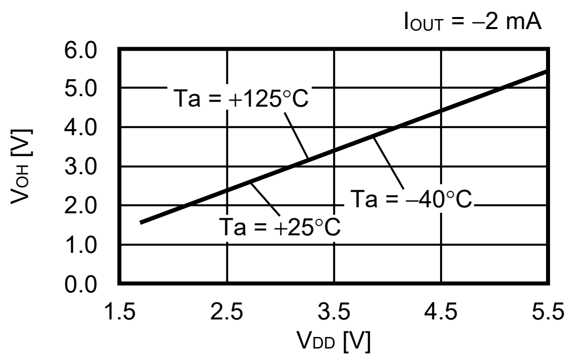
1. 1. 4 Low level output voltage (V_{OL}) vs. Power supply voltage (V_{DD})



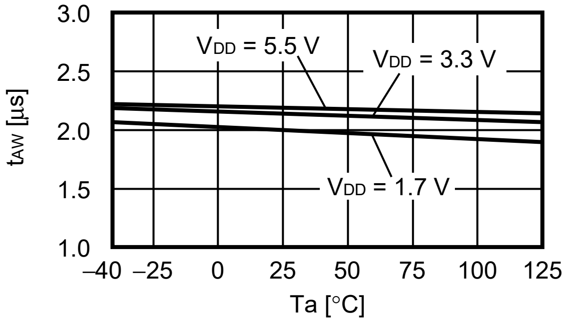
1. 1. 5 High level output voltage (V_{OH}) vs. Temperature (Ta)



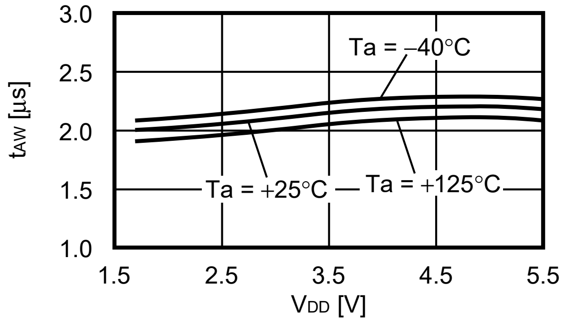
1. 1. 6 High level output voltage (V_{OH}) vs. Power supply voltage (V_{DD})



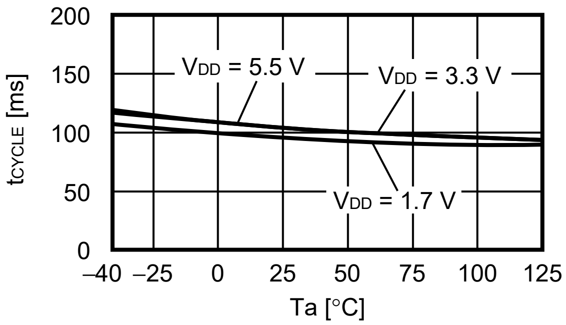
1. 1. 7 Awake mode time (t_{AW}) vs. Temperature (Ta)



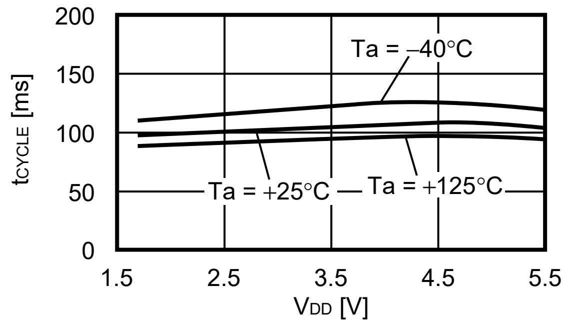
1. 1. 8 Awake mode time (t_{AW}) vs. Power supply voltage (V_{DD})



1. 1. 9 Operating cycle (t_{CYCLE}) vs. Temperature (Ta)



1. 1. 10 Operating cycle (t_{CYCLE}) vs. Power supply voltage (V_{DD})

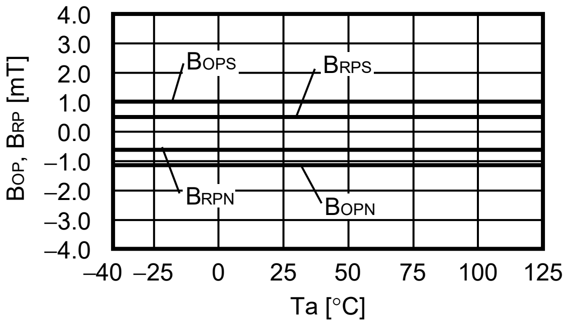


2. Magnetic characteristics

2. 1 S-5701BC10B

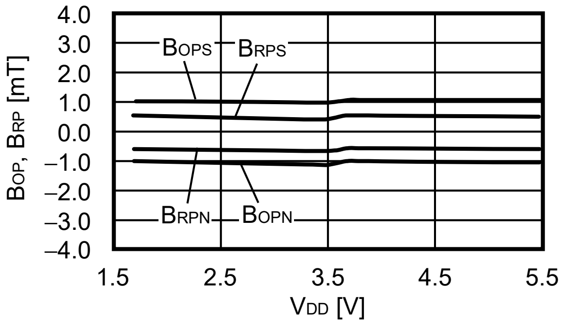
2. 1. 1 Operation point, release point (B_{OP}, B_{RP}) vs. Temperature (Ta)

V_{DD} = 3.3 V



2. 1. 2 Operation point, release point (B_{OP}, B_{RP}) vs. Power supply voltage (V_{DD})

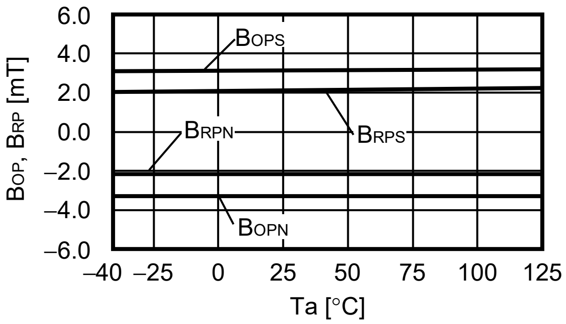
Ta = +25°C



2. 2 S-5701BC11B

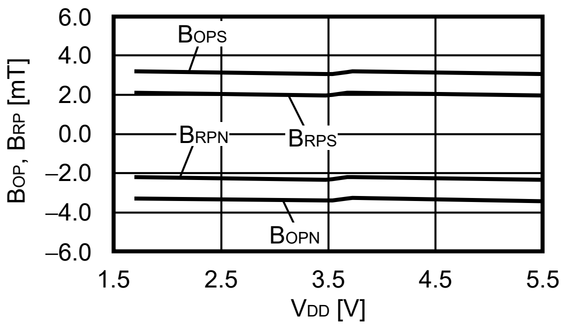
2. 2. 1 Operation point, release point (B_{OP}, B_{RP}) vs. Temperature (Ta)

V_{DD} = 3.3 V



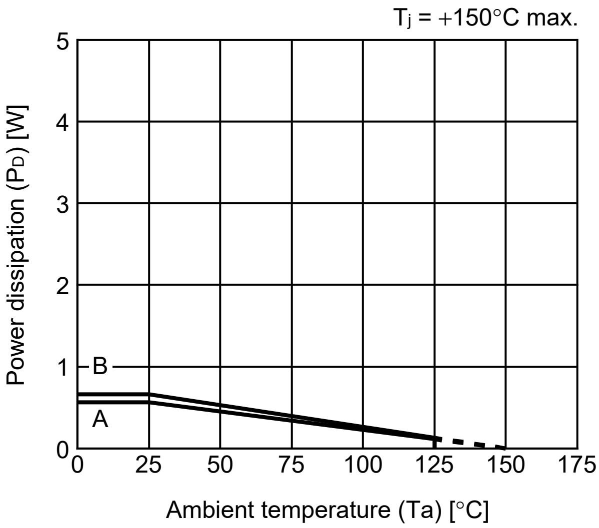
2. 2. 2 Operation point, release point (B_{OP}, B_{RP}) vs. Power supply voltage (V_{DD})

Ta = +25°C



■ Power Dissipation

TSOT-23-3S

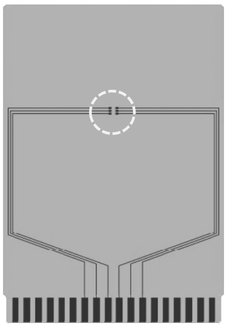


Board	Power Dissipation (P_D)
A	0.56 W
B	0.66 W
C	−
D	−
E	−

TSOT-23-3S Test Board

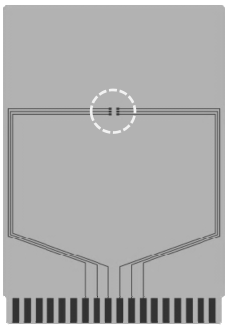
IC Mount Area

(1) Board A



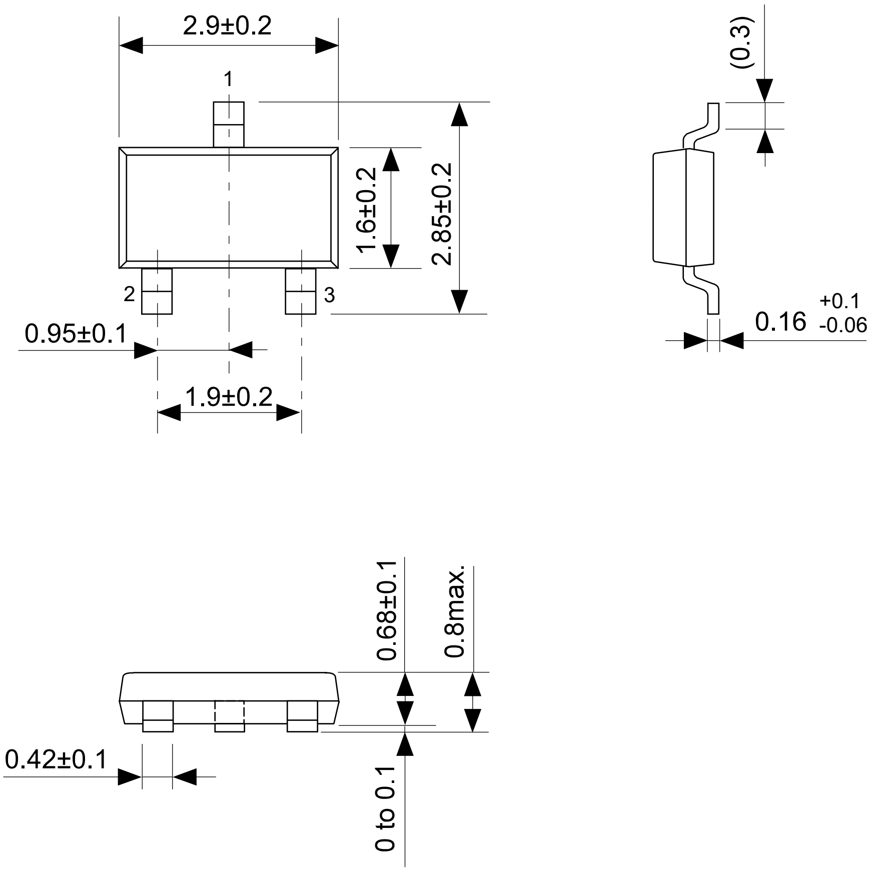
Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		2
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	-
	3	-
	4	74.2 x 74.2 x t0.070
Thermal via		-

(2) Board B



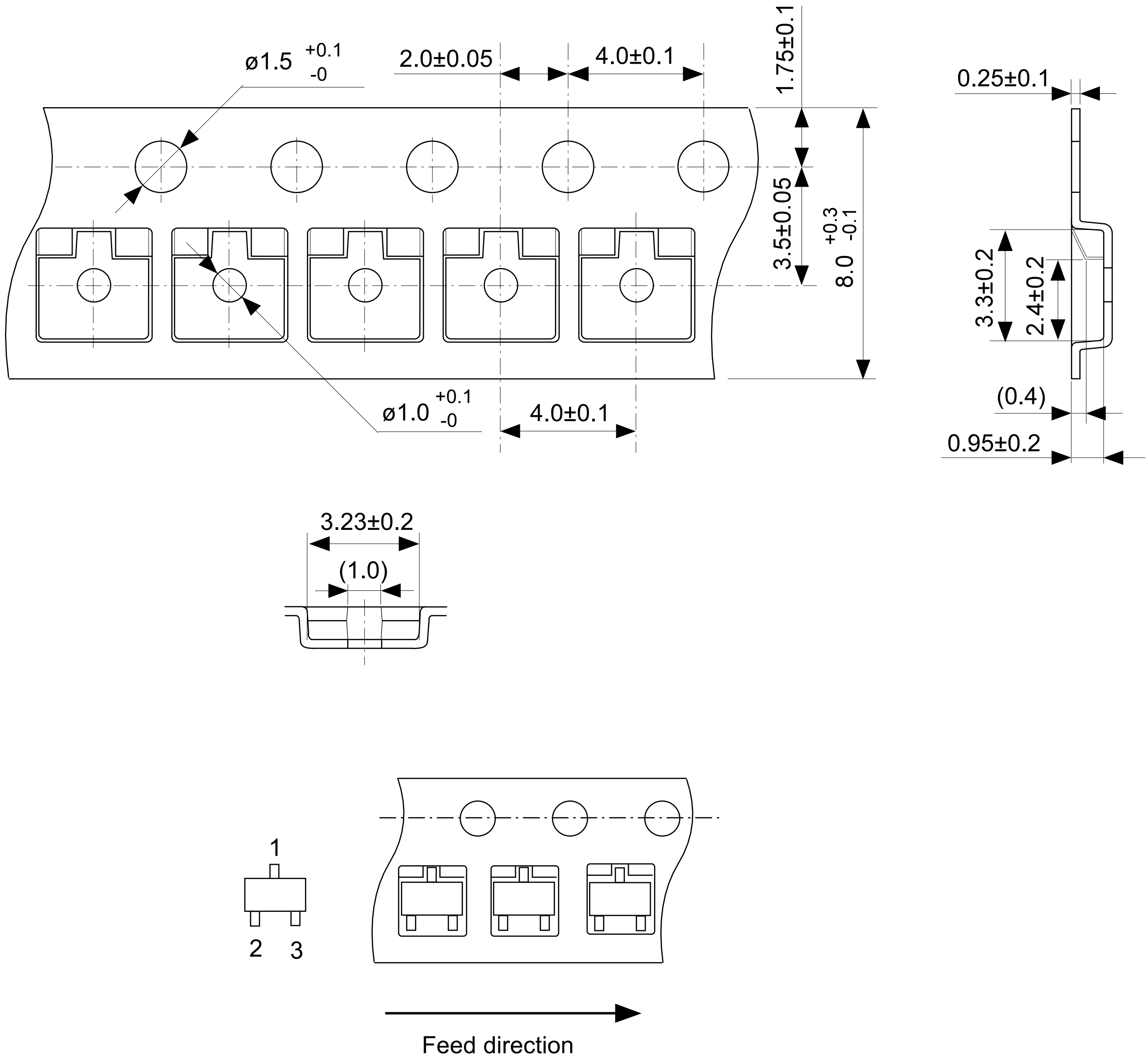
Item		Specification
Size [mm]		114.3 x 76.2 x t1.6
Material		FR-4
Number of copper foil layer		4
Copper foil layer [mm]	1	Land pattern and wiring for testing: t0.070
	2	74.2 x 74.2 x t0.035
	3	74.2 x 74.2 x t0.035
	4	74.2 x 74.2 x t0.070
Thermal via		-

No. TSOT23x-A-Board-SD-1.0



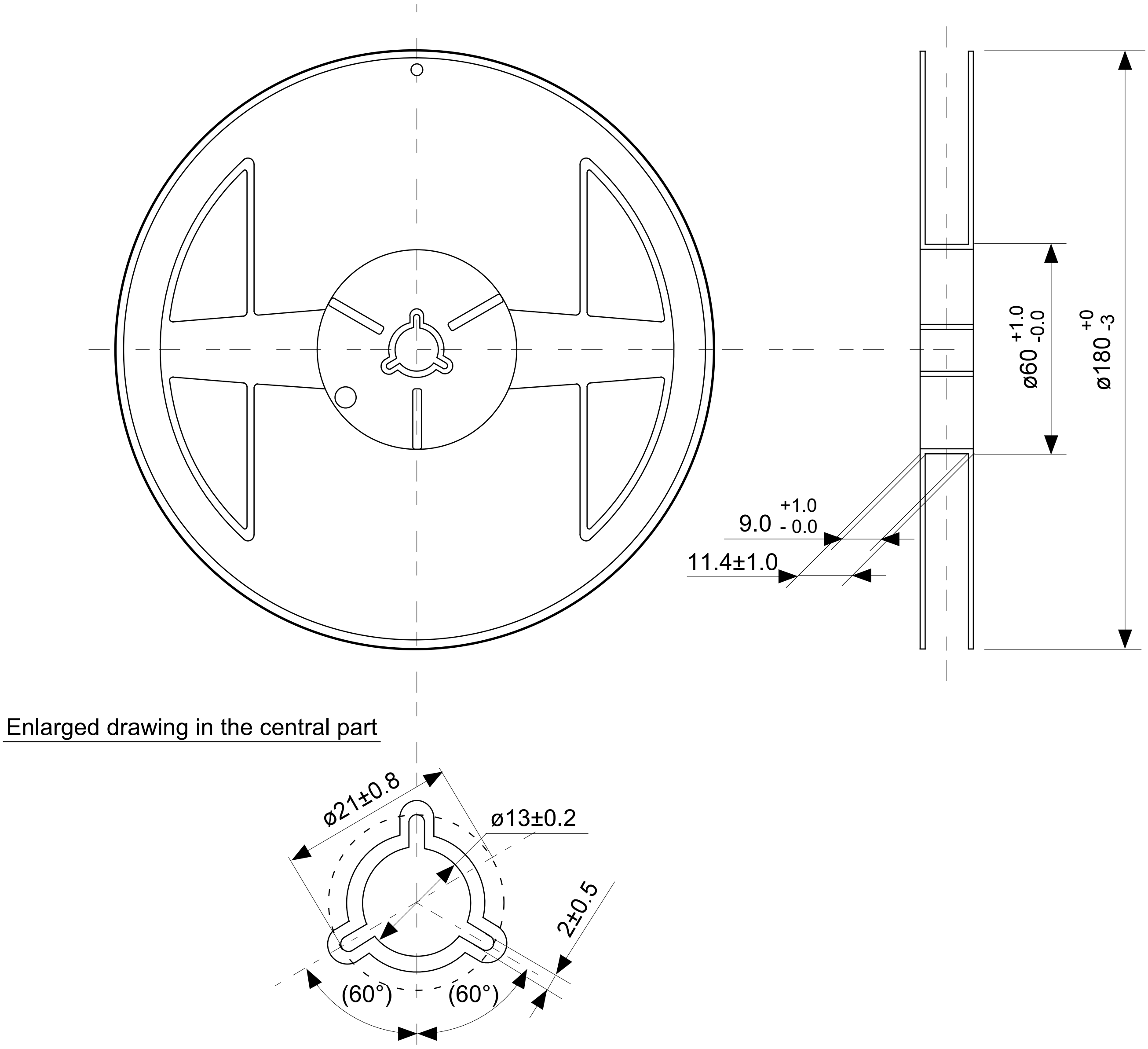
No. MP003-E-P-SD-1.0

TITLE	TSOT233S-A-PKG Dimensions
No.	MP003-E-P-SD-1.0
ANGLE	
UNIT	mm
ABLIC Inc.	



No. MP003-E-C-SD-1.0

TITLE	TSOT233S-A-Carrier Tape
No.	MP003-E-C-SD-1.0
ANGLE	
UNIT	mm
ABLIC Inc.	



No. MP003-E-R-SD-1.0

TITLE	TSOT233S-A-Reel		
No.	MP003-E-R-SD-1.0		
ANGLE		QTY.	3,000
UNIT	mm		

ABLIC Inc.

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