# S-5733 B Series

## 125°C OPERATION, HIGH-WITHSTAND VOLTAGE, HIGH-SPEED, UNIPOLAR DETECTION TYPE HALL EFFECT SWITCH IC

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Rev.1.0_00

This IC, developed by CMOS technology, is a high-accuracy Hall effect switch IC that operates with high temperature and high-withstand 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 and position in various devices.

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 representatives.

## ■ Features

- Contributes to robust mechanism operation by magnetic sensitivity ($B_{OP}$ = 10.0 mT / 15.0 mT typ.) which reacts to strong magnetic field only
- Contributes to reduction of mechanism operation dispersion with high-accuracy magnetic characteristics (Refer to "■ **Magnetic Characteristics**" for details.)
- Contributes to device safe design with a built-in output current limit circuit

## ■ Specifications

- Pole detection: Detection of S pole
- Output logic*1: Active "L"
  Active "H"
- Output form*1: Nch open-drain output
  Nch driver + built-in pull-up resistor (1.2 kΩ typ.)
- Magnetic sensitivity*1: $B_{OP}$ = 10.0 mT typ.
  $B_{OP}$ = 15.0 mT typ.
- Chopping frequency: $f_C$ = 500 kHz typ.
- Output delay time: $t_D$ = 8.0 µs typ.
- Power supply voltage range*2: $V_{DD}$ = 2.7 V to 26.0 V
- Built-in regulator
- Built-in output current limit circuit
- Operation temperature range: Ta = −40°C to +125°C
- Lead-free (Sn 100%), halogen-free

***1.** The option can be selected.
***2.** $V_{DD}$ = 2.7 V to 5.5 V when output form is Nch driver + built-in pull-up resistor (1.2 kΩ typ.)

## ■ Applications

- Home appliance
- Housing equipment
- Industrial equipment

## ■ Packages

- TO-92S (Straight)
- TO-92S (Forming)

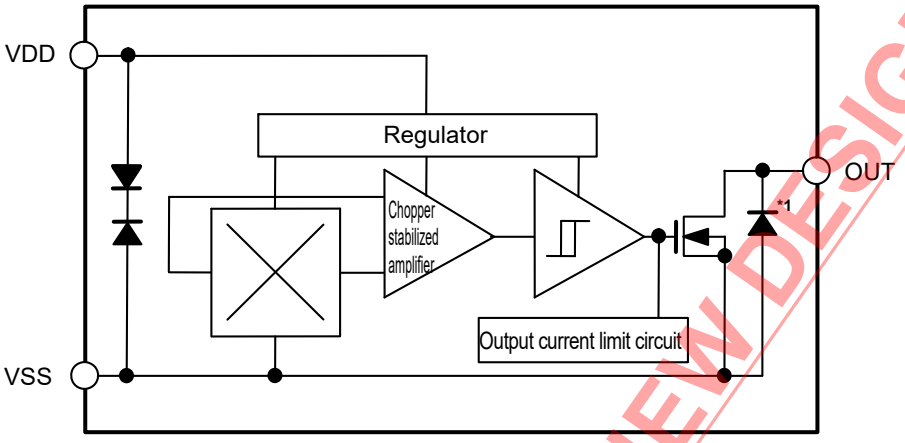
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## ■ Block Diagrams

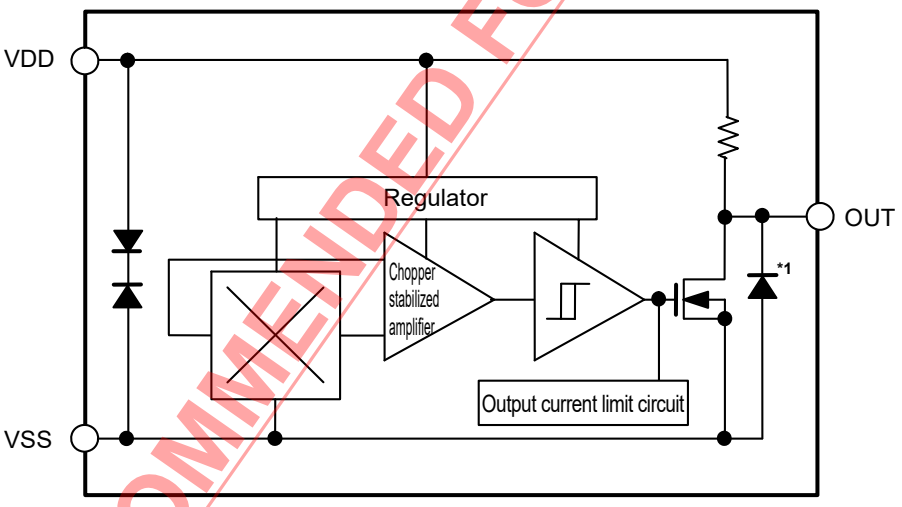
### 1. Nch open-drain output product




*1. Parasitic diode

**Figure 1**

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




*1. Parasitic diode

**Figure 2**

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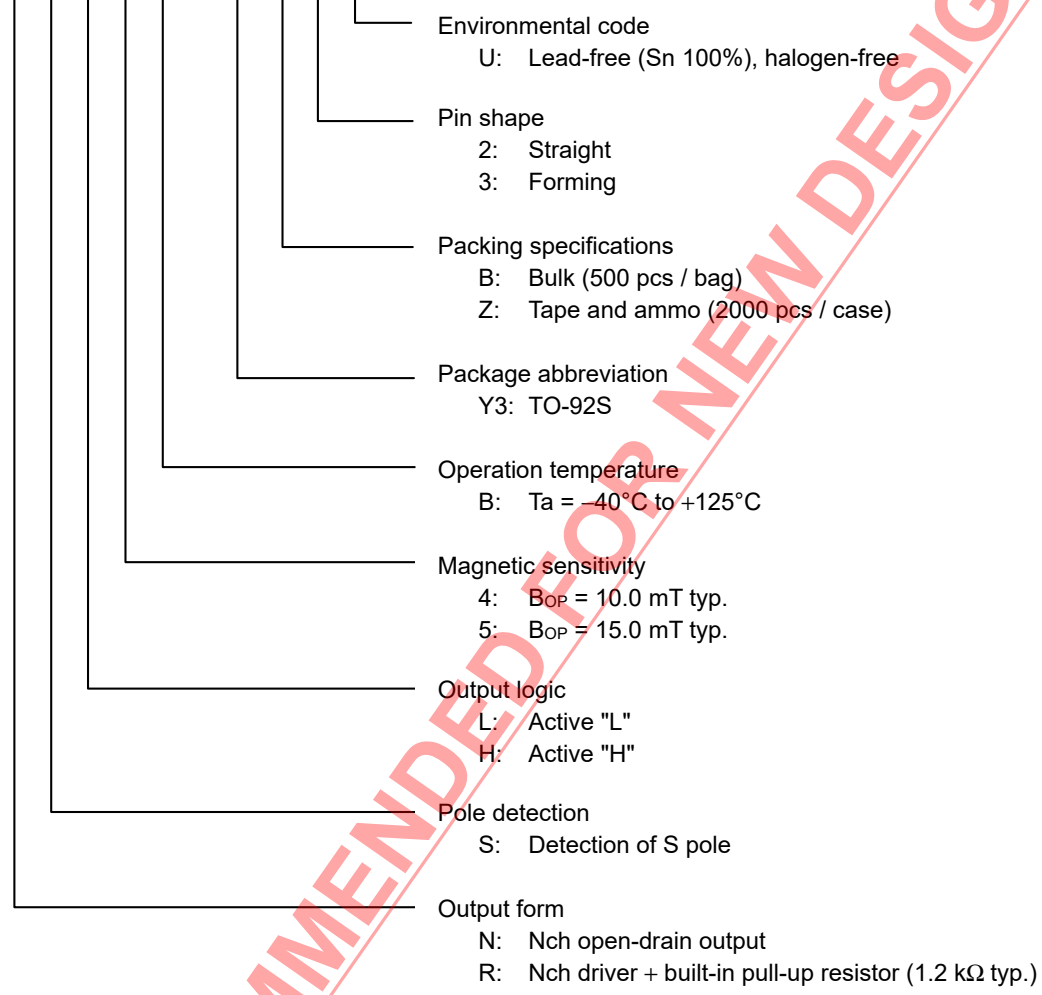


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## ■ Product Name Structure

### 1. Product name

S-5733 x S x x B - Y3 x x U




### 2. Packages

**Table 1 Package Drawing Codes**

| Package Name | | Dimension | Tape | Ammo Packing |
|---|---|---|---|---|
| TO-92S (Straight) | Bulk | YB003-A-P-SD | – | – |
| | Tape and ammo | | YC003-A-C-SD | YC003-A-Z-SD |
| TO-92S (Forming) | Bulk | YB003-B-P-SD | – | – |
| | Tape and ammo | | YC003-B-C-SD | YC003-B-Z-SD |

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## 3. Product name list

### 3. 1 TO-92S (Straight)

**Table 2**

| Product Name*1 | Output Form | Power Supply Voltage Range | Pole Detection | Output Logic | Magnetic Sensitivity ($B_{OP}$) |
|---|---|---|---|---|---|
| S-5733NSL4B-Y3n2U | Nch open-drain output | $V_{DD}$ = 2.7 V to 26.0 V | S pole | Active "L" | 10.0 mT typ. |
| S-5733NSL5B-Y3n2U | Nch open-drain output | $V_{DD}$ = 2.7 V to 26.0 V | S pole | Active "L" | 15.0 mT typ. |

***1.** "n" changes according to the packing specification as follows.
B: Bulk, Z: Tape and ammo

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

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## ■ Pin Configuration

### 1. TO-92S

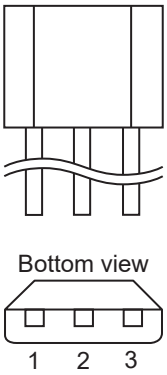



**Figure 3**

**Table 3**

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

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## ■ Absolute Maximum Ratings

**Table 4**

| Item | | Symbol | Absolute Maximum Rating | Unit |
|---|---|---|---|---|
| Power supply voltage | Nch open-drain output product | $V_{DD}$ | $V_{SS}$ – 0.3 to $V_{SS}$ + 28.0 | V |
| | Nch driver + built-in pull-up resistor (1.2 kΩ typ.) product | | $V_{SS}$ – 0.3 to $V_{SS}$ + 9.0 | V |
| Power supply current | | $I_{DD}$ | ±10 | mA |
| Output current | | $I_{OUT}$ | ±10 | 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 (1.2 kΩ typ.) product | | $V_{SS}$ – 0.3 to $V_{DD}$ + 0.3 | V |
| 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 | $\theta_{JA}$ | TO-92S | – | 153*1 | – | °C/W |

***1.** When not mounted on board

**Remark** Refer to "■ **Power Dissipation**" for details.

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## ■ Electrical Characteristics

### 1. Nch open-drain output product

**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 | $I_{DD}$ | – | – | 4.0 | 4.5 | mA | 1 |
| Low level output voltage | $V_{OL}$ | $I_{OUT}$ = 5 mA, $V_{OUT}$ = "L" | – | – | 0.4 | V | 2 |
| Leakage current | $I_{LEAK}$ | $V_{OUT}$ = "H" | – | – | 1.0 | µA | 3 |
| Output limit current | $I_{OM}$ | $V_{OUT}$ = 12.0 V | 11 | – | 35 | mA | 3 |
| Output delay time*1 | $t_D$ | – | – | 8 | 16 | µs | – |
| Chopping frequency*1 | $f_C$ | – | 250 | 500 | – | kHz | – |
| Start up time*1 | $t_{PON}$ | – | – | 25 | 40 | µs | 4 |
| Output rise time*1 | $t_R$ | C = 20 pF, R = 820 Ω | – | – | 1.0 | µs | 5 |
| Output fall time*1 | $t_F$ | C = 20 pF, R = 820 Ω | – | – | 1.0 | µs | 5 |

*1. This item is guaranteed by design.

### 2. Nch driver + built-in pull-up resistor (1.2 kΩ typ.) product

**Table 7**

(Ta = +25°C, $V_{DD}$ = 5.0 V, $V_{SS}$ = 0 V unless otherwise specified)

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit | Test Circuit |
|---|---|---|---|---|---|---|---|
| Power supply voltage | $V_{DD}$ | – | 2.7 | 5.0 | 5.5 | V | – |
| Current consumption | $I_{DD}$ | $V_{OUT}$ = "H" | – | 4.0 | 4.5 | mA | 1 |
| Low level output voltage | $V_{OL}$ | $I_{OUT}$ = 0 mA, $V_{OUT}$ = "L" | – | – | 0.4 | V | 2 |
| High level output voltage | $V_{OH}$ | $I_{OUT}$ = 0 mA, $V_{OUT}$ = "H" | $V_{DD}$ × 0.9 | – | – | V | 2 |
| Output limit current | $I_{OM}$ | $V_{DD}$ = $V_{OUT}$ = 5.0 V | 11 | – | 35 | mA | 3 |
| Output delay time*1 | $t_D$ | – | – | 8 | 16 | µs | – |
| Chopping frequency*1 | $f_C$ | – | 250 | 500 | – | kHz | – |
| Start up time*1 | $t_{PON}$ | – | – | 25 | 40 | µs | 4 |
| Output rise time*1 | $t_R$ | C = 20 pF | – | – | 1.0 | µs | 5 |
| Output fall time*1 | $t_F$ | C = 20 pF | – | – | 1.0 | µs | 5 |
| Pull-up resistor | $R_L$ | – | 0.9 | 1.2 | 1.5 | kΩ | – |

*1. This item is guaranteed by design.

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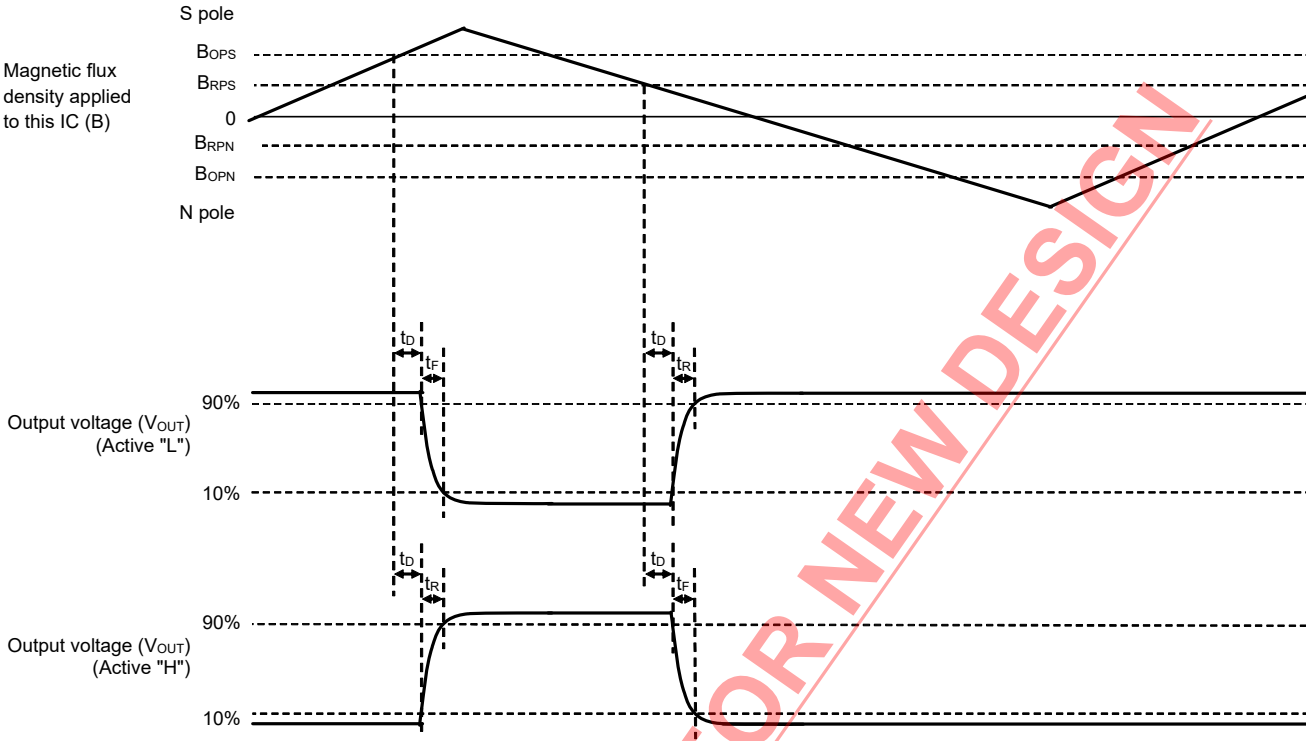



**Figure 4 Operation Timing**

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## ■ Magnetic Characteristics

### 1. $B_{OP}$ = 10.0 mT typ.

**Table 8**

($Ta$ = +25°C, $V_{DD}$ = 5.0 V, $V_{SS}$ = 0 V unless otherwise specified)

| Item | | Symbol | Condition | Min. | Typ. | Max. | Unit | Test Circuit |
|---|---|---|---|---|---|---|---|---|
| Operation point*1 | S pole | $B_{OPS}$ | – | 8.3 | 10.0 | 11.9 | mT | 4 |
| Release point*2 | S pole | $B_{RPS}$ | – | 6.1 | 7.5 | 8.8 | mT | 4 |
| Hysteresis width*3 | S pole | $B_{HYSS}$ | $B_{HYSS} = B_{OPS} - B_{RPS}$ | – | 2.5 | – | mT | 4 |

### 2. $B_{OP}$ = 15.0 mT typ.

**Table 9**

($Ta$ = +25°C, $V_{DD}$ = 5.0 V, $V_{SS}$ = 0 V unless otherwise specified)

| Item | | Symbol | Condition | Min. | Typ. | Max. | Unit | Test Circuit |
|---|---|---|---|---|---|---|---|---|
| Operation point*1 | S pole | $B_{OPS}$ | – | 12.8 | 15.0 | 17.8 | mT | 4 |
| Release point*2 | S pole | $B_{RPS}$ | – | 9.8 | 12.0 | 13.9 | mT | 4 |
| Hysteresis width*3 | S pole | $B_{HYSS}$ | $B_{HYSS} = B_{OPS} - B_{RPS}$ | – | 3.0 | – | mT | 4 |

***1.** $B_{OPS}$: Operation point
$B_{OPS}$ is the value of magnetic flux density when the output voltage ($V_{OUT}$) changes after the magnetic flux density (S pole) applied to this IC by the magnet is increased (by moving the magnet closer).
Even when the magnetic flux density exceeds $B_{OPS}$, $V_{OUT}$ retains the status.

***2.** $B_{RPS}$: Release point
$B_{RPS}$ is the value of magnetic flux density when the output voltage ($V_{OUT}$) changes after the magnetic flux density (S pole) applied to this IC by the magnet is decreased (the magnet is moved further away).
Even when the magnetic flux density falls below $B_{RPS}$, $V_{OUT}$ retains the status.

***3.** $B_{HYSS}$: Hysteresis widths
$B_{HYSS}$ is the difference between $B_{OPS}$ and $B_{RPS}$.

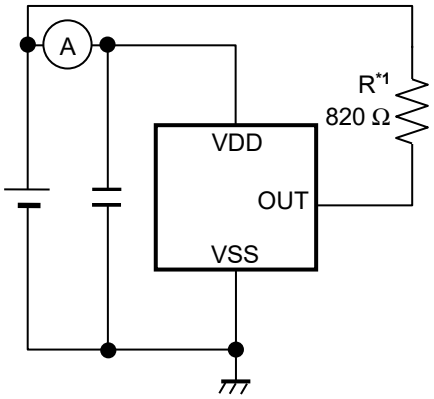
**Remark** The unit of magnetic density mT can be converted by using the formula 1 mT = 10 Gauss.

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## ■ Test Circuits




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

**Figure 5 Test Circuit 1**

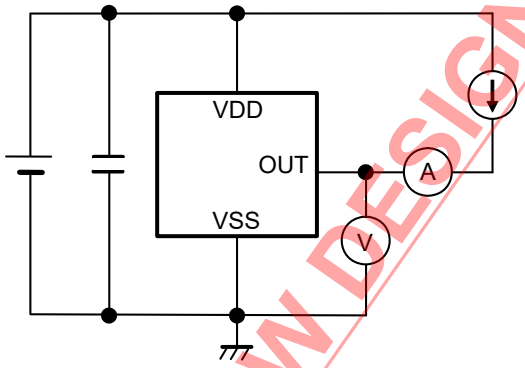



**Figure 6 Test Circuit 2**

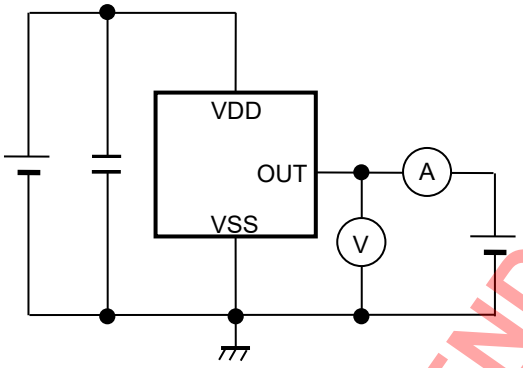
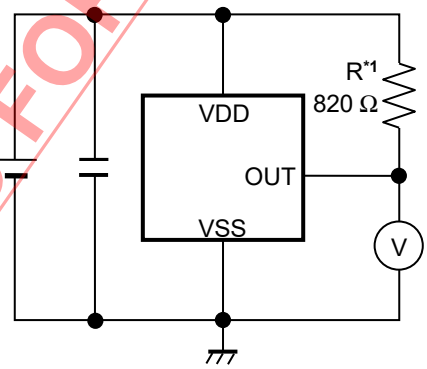
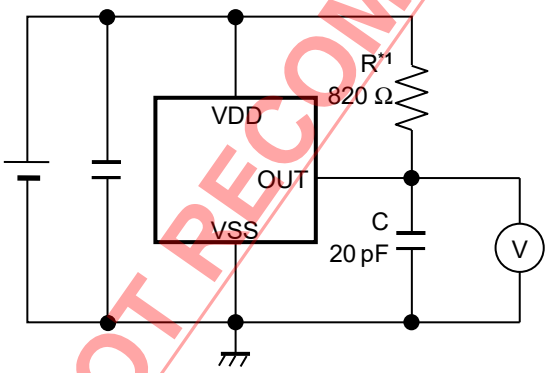



**Figure 7 Test Circuit 3**




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

**Figure 8 Test Circuit 4**




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

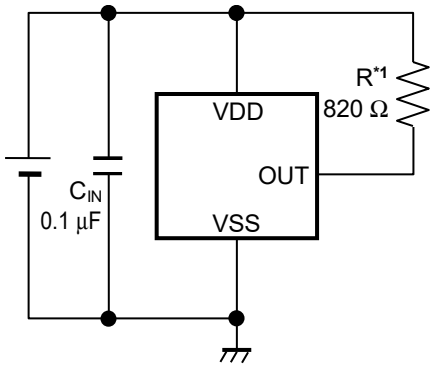
**Figure 9 Test Circuit 5**

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## ■ Standard Circuit




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

**Figure 10**

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

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## ■ Operation

### 1. Direction of applied magnetic flux

This IC detects the magnetic flux density which is perpendicular to the package marking surface. A magnetic field is defined as positive when marking side of the package is the S pole, and negative when it is the N pole.
**Figure 11** shows polarity in a magnetic field and direction in which magnetic flux is being applied.

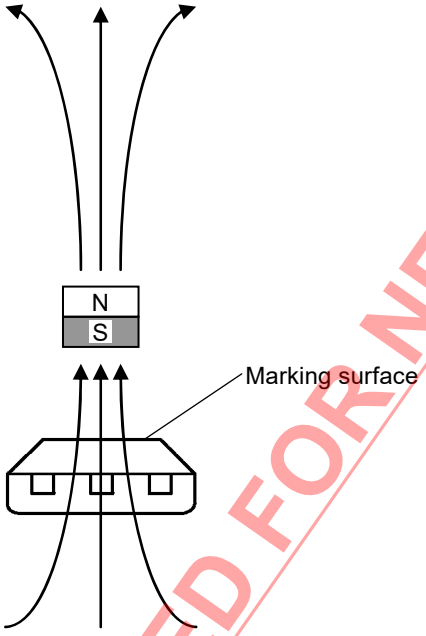



**Figure 11**

### 2. Position of Hall sensor

**Figure 12** 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.

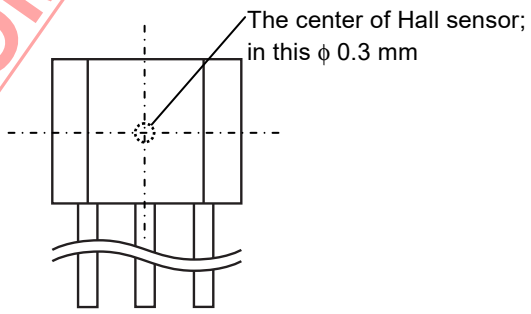



**Figure 12**

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## 3. Basic operation

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

### 3. 1 Active "L"

When the magnetic flux density of the S pole perpendicular to the marking surface exceeds the operation point ($B_{OPS}$) 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 S pole of a magnet is moved further away from the marking surface of this IC and the magnetic flux density is lower than the release point ($B_{RPS}$), $V_{OUT}$ changes from "L" to "H".

**Figure 13** shows the relationship between the magnetic flux density and $V_{OUT}$.

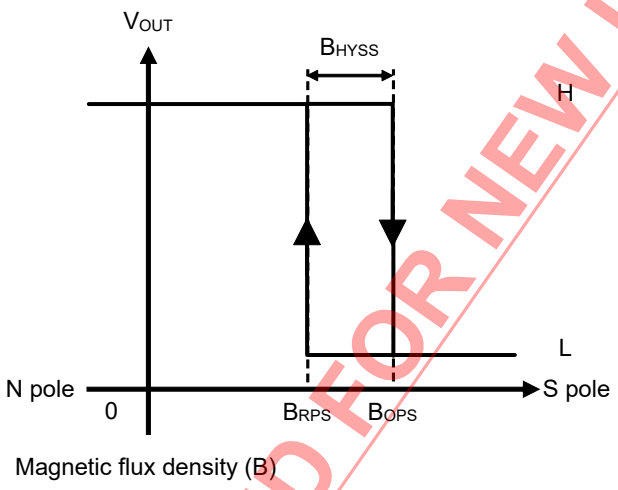



**Figure 13**

### 3. 2 Active "H"

When the magnetic flux density of the S pole perpendicular to the marking surface exceeds the operation point ($B_{OPS}$) 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 S pole of a magnet is moved further away from the marking surface of this IC and the magnetic flux density is lower than the release point ($B_{RPS}$), $V_{OUT}$ changes from "H" to "L".

**Figure 14** shows the relationship between the magnetic flux density and $V_{OUT}$.

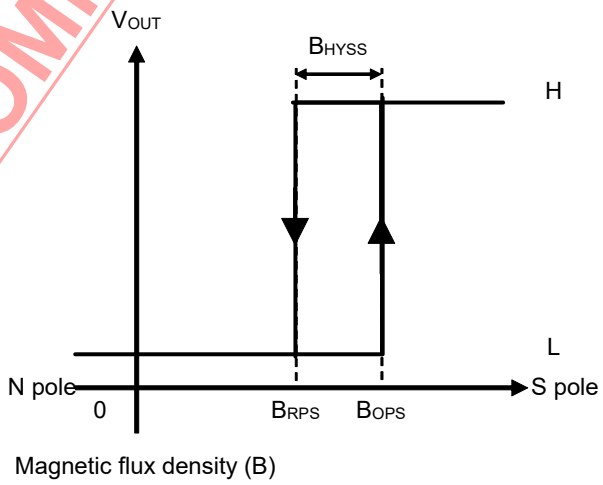



**Figure 14**

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## 4. Power-on operation

The output voltage ($V_{OUT}$) of this IC immediately after power-on is "H". After the start up time ($t_{PON}$) is passed, the IC changes $V_{OUT}$ according to the level of the magnetic flux density (S pole) applied by a magnet.

### 4. 1 Active "L"

**Figure 15** shows the timing chart at power-on for active "L" product.
The initial output voltage at rising of power supply voltage ($V_{DD}$) is "H".
In case of $B > B_{OPS}$ at the time when $t_{PON}$ is passed after rising of $V_{DD}$, $V_{OUT}$ changes from "H" to "L".
In case of $B < B_{OPS}$ at the time when $t_{PON}$ is passed after rising of $V_{DD}$, $V_{OUT}$ retains "H".

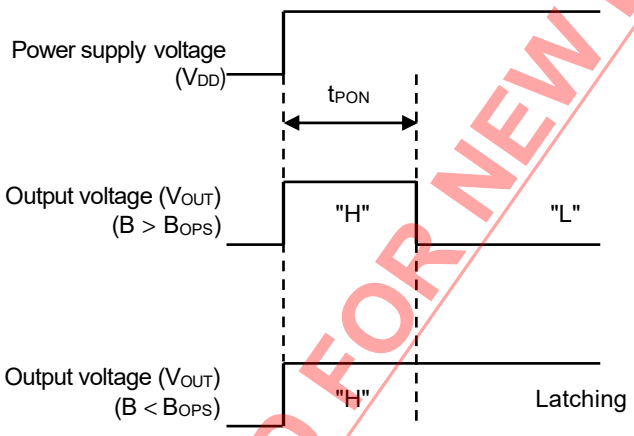



**Figure 15**

### 4. 2 Active "H"

**Figure 16** shows the timing chart at power-on for active "H" product.
The initial output voltage at rising of power supply voltage ($V_{DD}$) is "H".
In case of $B > B_{OPS}$ at the time when $t_{PON}$ is passed after rising of $V_{DD}$, $V_{OUT}$ retains "H".
In case of $B < B_{OPS}$ at the time when $t_{PON}$ is passed after rising of $V_{DD}$, $V_{OUT}$ changes from "H" to "L".

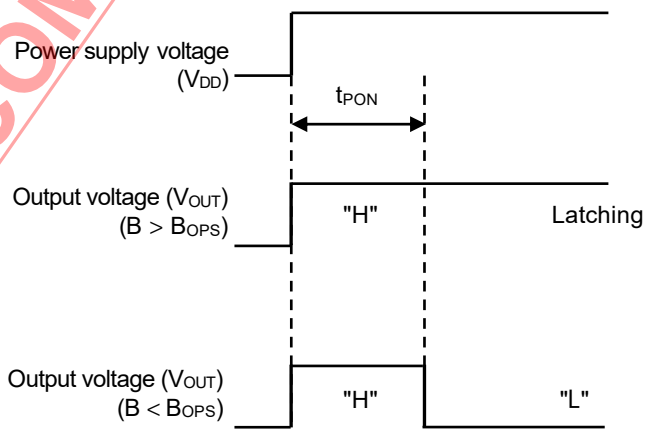



**Figure 16**

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## ■ 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.
- 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.
- 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.
- 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.
- Since the package heat radiation differs according to the conditions of the application, perform thorough evaluation with actual applications to confirm no problems occur.
- 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.

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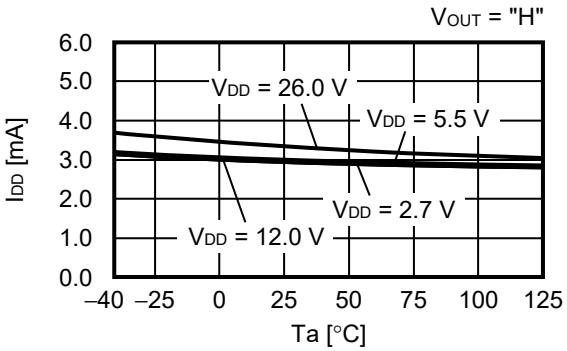
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## ■ Characteristics (Typical Data)

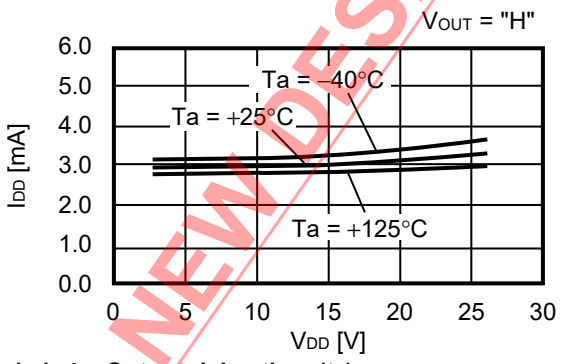
### 1. Electrical Characteristics

#### 1. 1 S-5733xSxxB

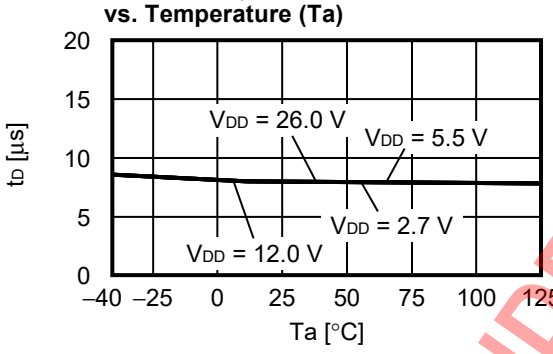
##### 1. 1. 1 Current consumption ($I_{DD}$) vs. Temperature (Ta)



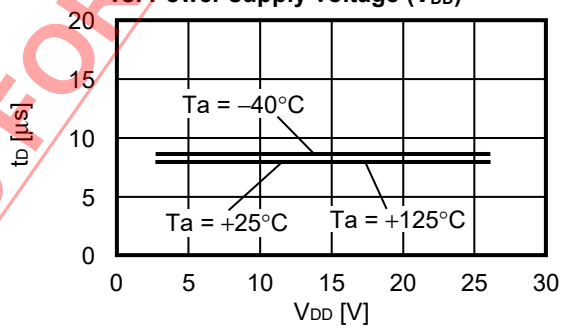

##### 1. 1. 2 Current consumption ($I_{DD}$) vs. Power supply voltage ($V_{DD}$)




##### 1. 1. 3 Output delay time ($t_D$) vs. Temperature (Ta)



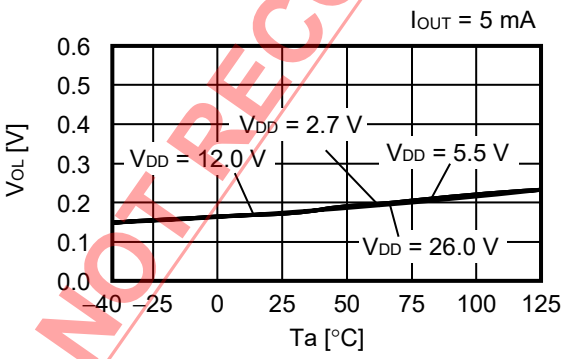

##### 1. 1. 4 Output delay time ($t_D$) vs. Power supply voltage ($V_{DD}$)



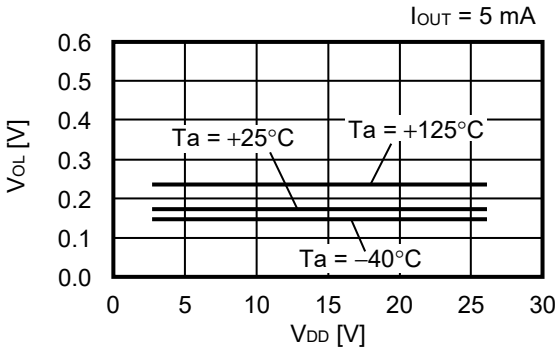

**Caution** **$V_{DD}$ = 2.7 V to 5.5 V when output form is Nch driver + built-in pull-up resistor (1.2 kΩ typ.). Comply with power supply voltage range and do not exceed absolute maximum ratings.**

#### 1. 2 S-5733NSxxB

##### 1. 2. 1 Low level output voltage ($V_{OL}$) vs. Temperature (Ta)




##### 1. 2. 2 Low level output voltage ($V_{OL}$) vs. Power supply voltage ($V_{DD}$)



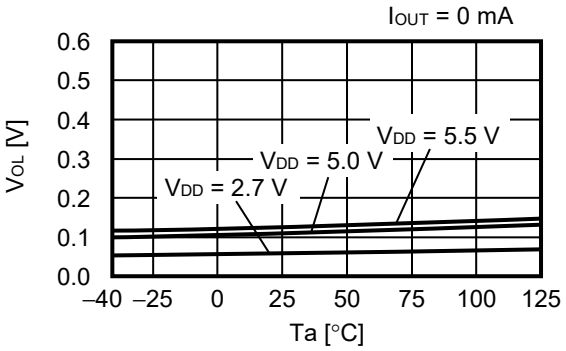

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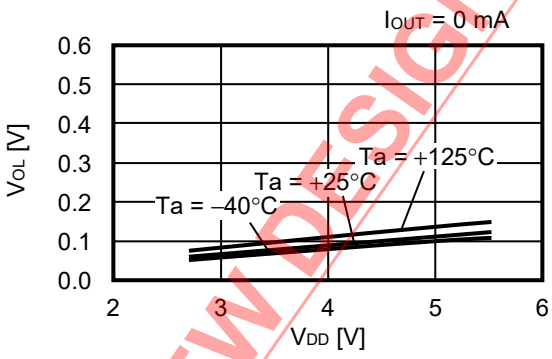
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### 1. 3 S-5733RSxxB

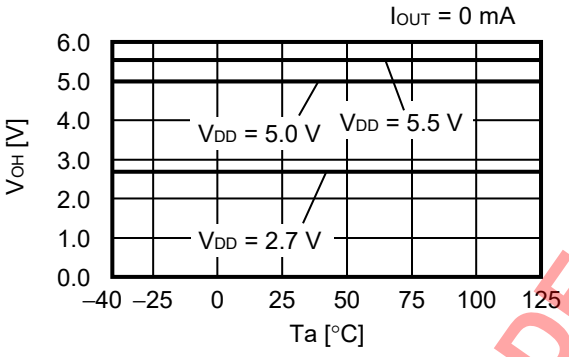
#### 1. 3. 1 Low level output voltage ($V_{OL}$) vs. Temperature (Ta)



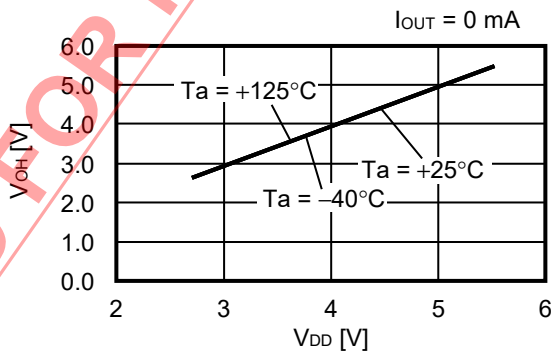

#### 1. 3. 2 Low level output voltage ($V_{OL}$) vs. Power supply voltage ($V_{DD}$)




#### 1. 3. 3 High level output voltage ($V_{OH}$) vs. Temperature (Ta)




#### 1. 3. 4 High level output voltage ($V_{OH}$) vs. Power supply voltage ($V_{DD}$)




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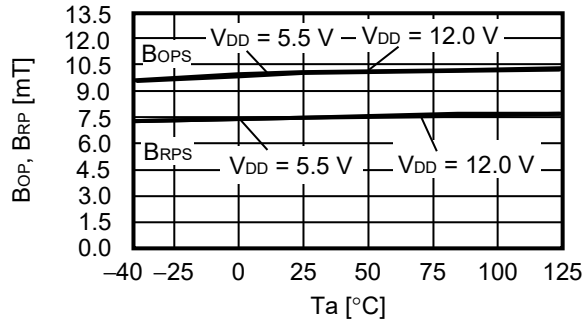


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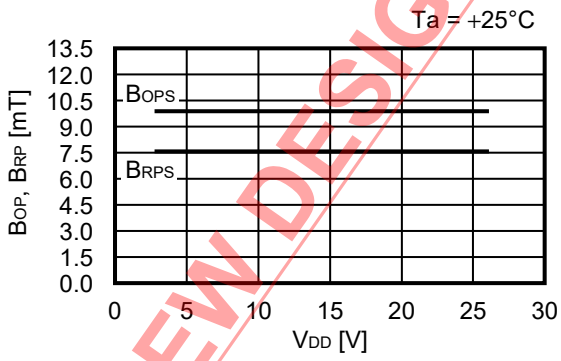
## 2. Magnetic Characteristics

### 2. 1 S-5733xSx4B

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

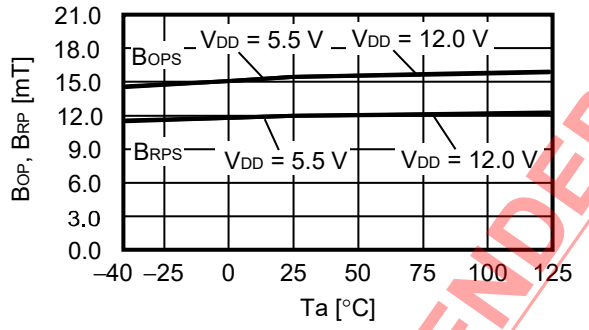



#### 2. 1. 2 Operation point, release point ($B_{OP}$, $B_{RP}$) vs. Power supply voltage ($V_{DD}$)

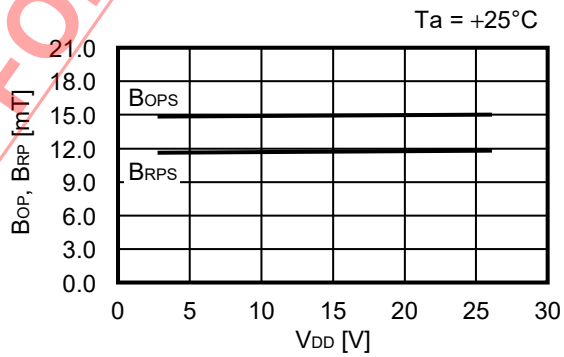



### 2. 2 S-5733xSx5B

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




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




**Caution** $V_{DD}$ = 2.7 V to 5.5 V when output form is Nch driver + built-in pull-up resistor (1.2 kΩ typ.). Comply with power supply voltage range and do not exceed absolute maximum ratings.

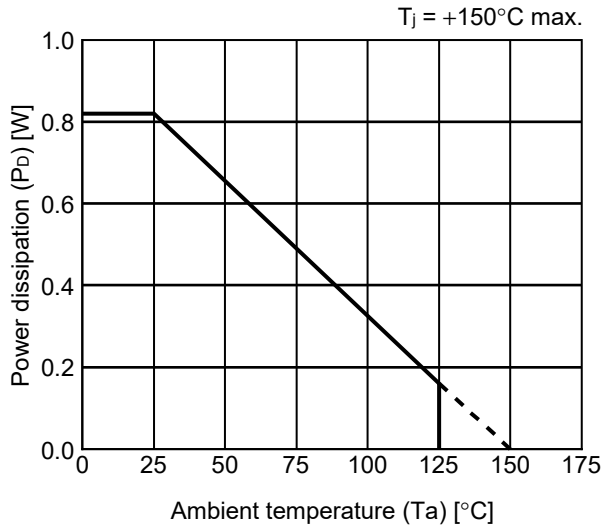
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## ■ Power Dissipation

### TO-92S

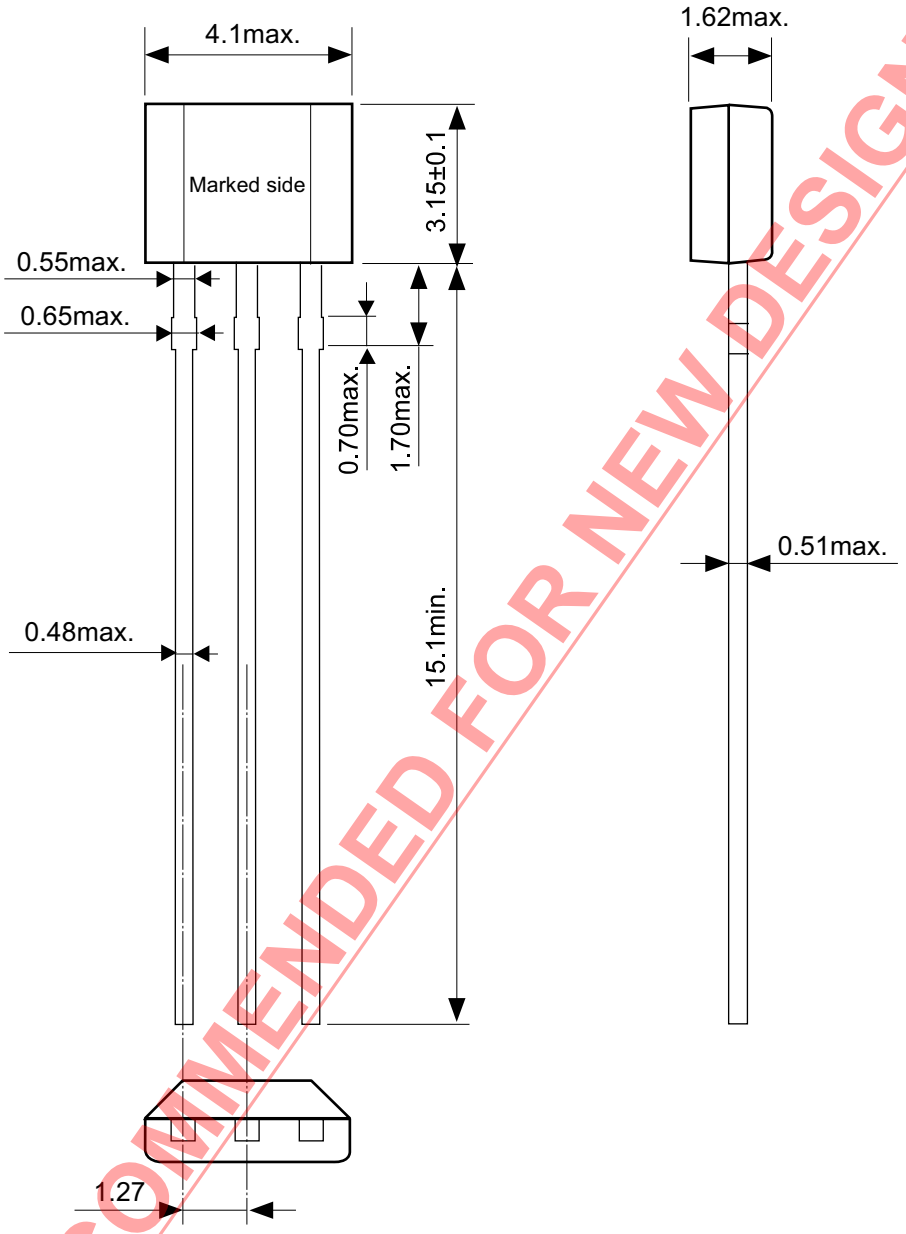



| Power Dissipation ($P_D$) |
|---|
| 0.82 W (when not mounted on board) |

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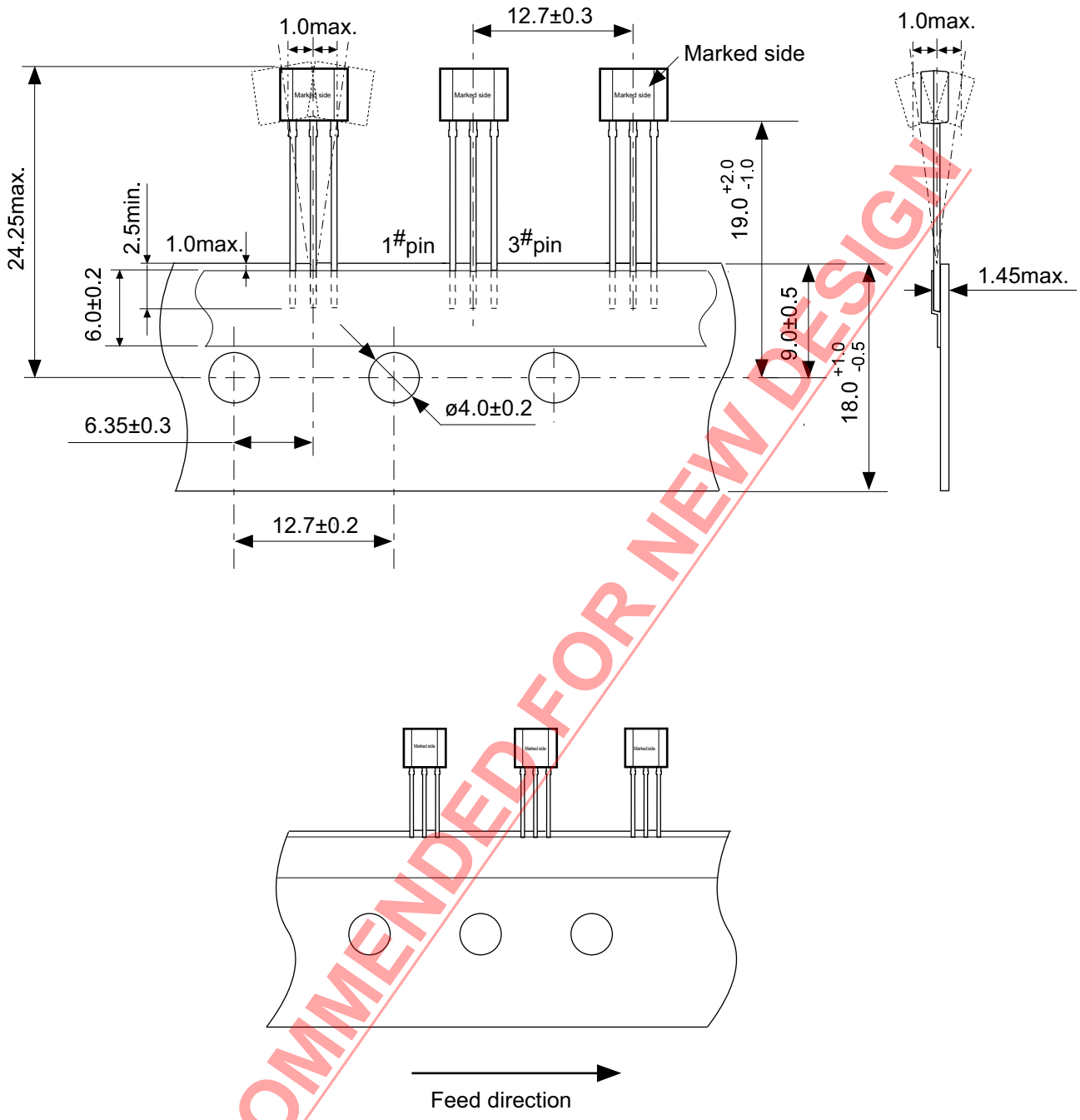

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No. YB003-A-P-SD-1.0

| | |
|---|---|
| TITLE | TO92S-C-PKG Dimensions |
| No. | YB003-A-P-SD-1.0 |
| ANGLE | |
| UNIT | mm |
| | |

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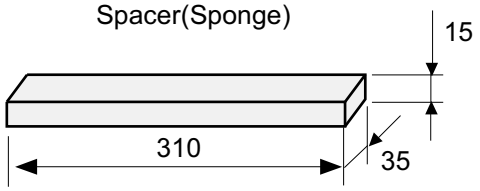
No. YC003-A-C-SD-1.1

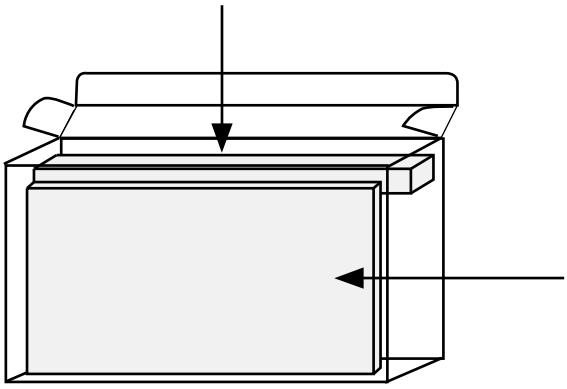
| | |
|---|---|
| TITLE | TO92S-E-Radial Tape |
| No. | YC003-A-C-SD-1.1 |
| ANGLE | |
| UNIT | mm |
| | |

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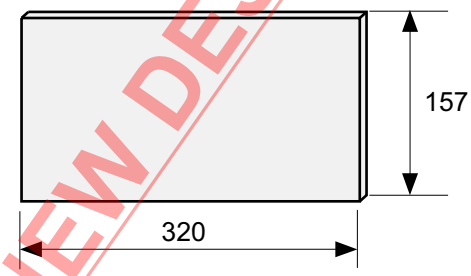
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Spacer(Sponge)

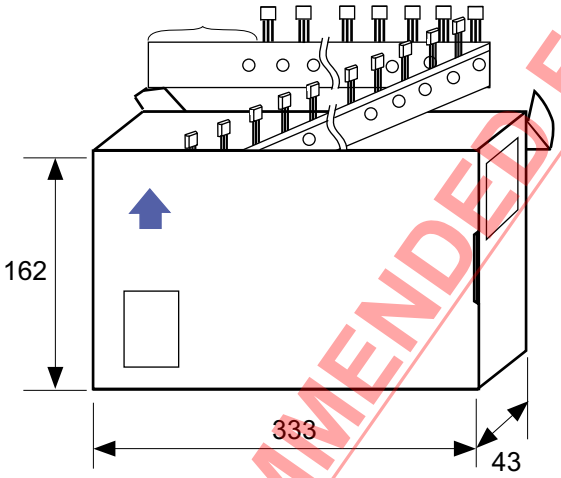


Side spacer placed in front side




Space more than 4 strokes

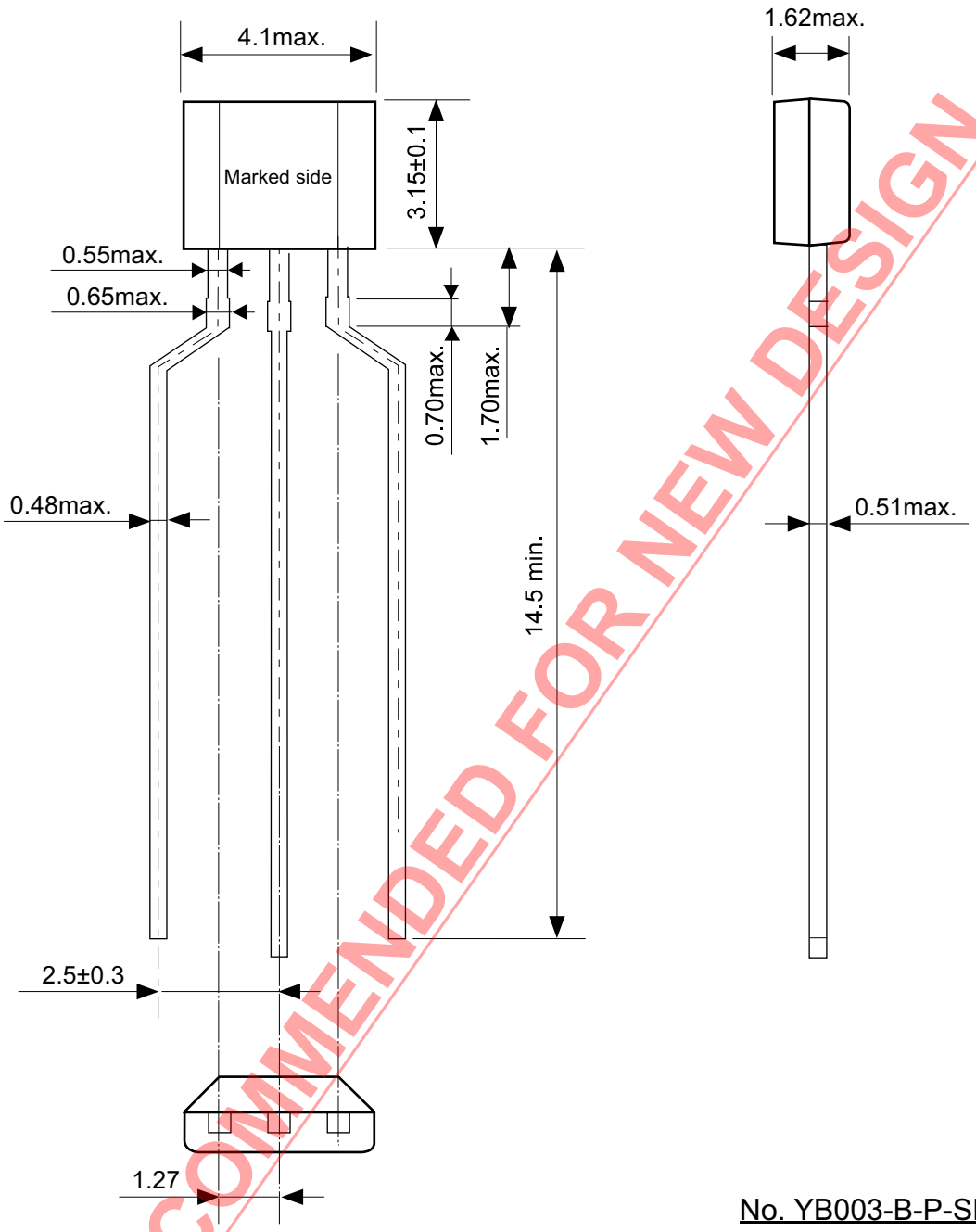



NOT RECOMMENDED FOR NEW DESIGN

No. YC003-A-Z-SD-1.0

| | | | |
|---|---|---|---|
| TITLE | TO92S-E-Ammo Packing | | |
| No. | YC003-A-Z-SD-1.0 | | |
| ANGLE | | QTY. | 2,000 |
| UNIT | mm | | |
| | | | |
| ABLIC Inc. | | | |

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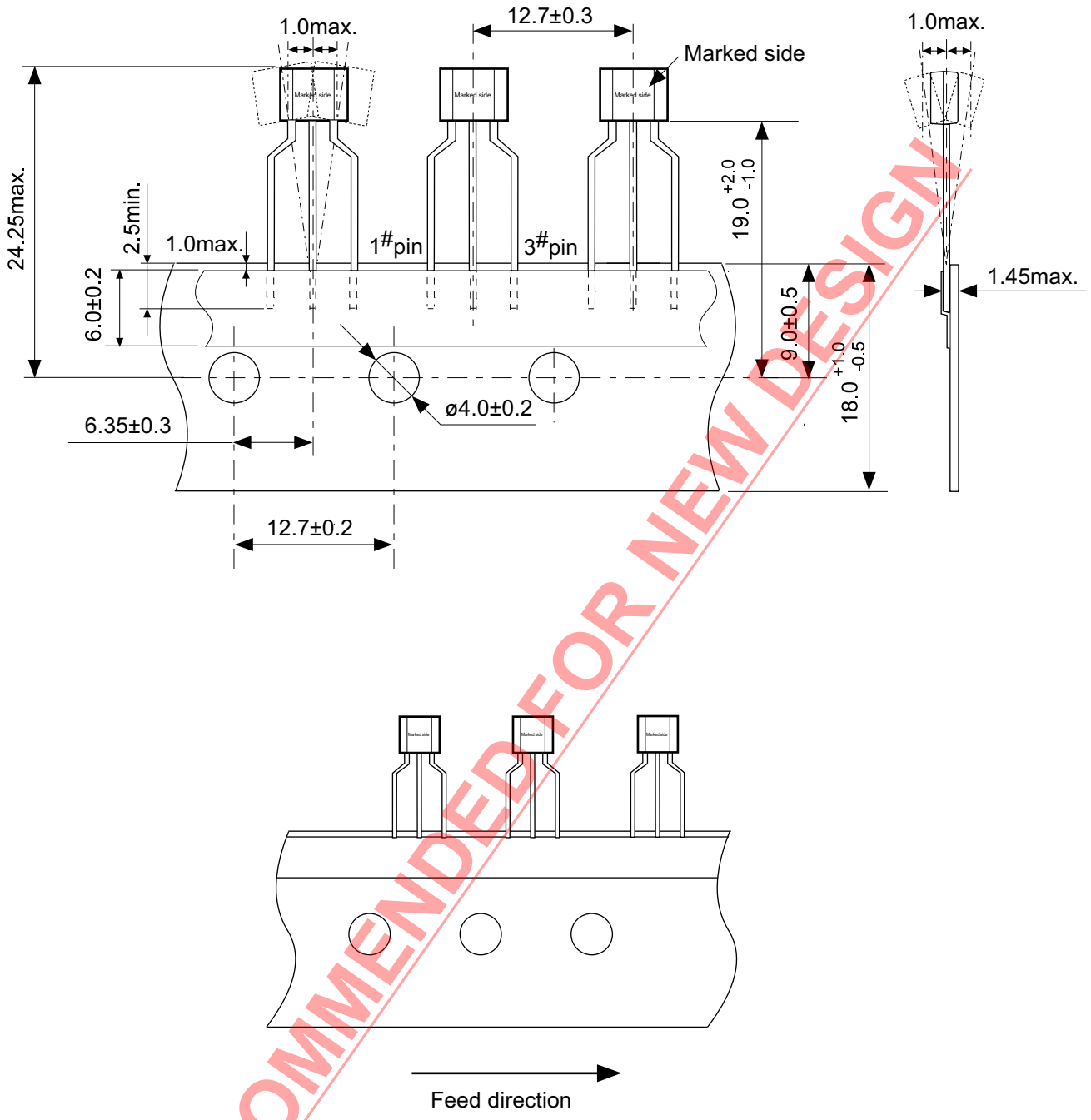

No. YB003-B-P-SD-1.0

NOT RECOMMENDED FOR NEW DESIGN

| | |
|---|---|
| TITLE | TO92S-D-PKG Dimensions |
| No. | YB003-B-P-SD-1.0 |
| ANGLE | |
| UNIT | mm |
| | |

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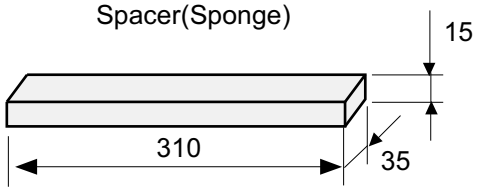
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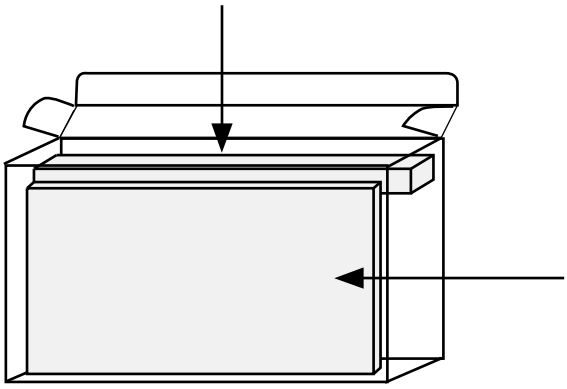
No. YC003-B-C-SD-1.1

| | |
|---|---|
| TITLE | TO92S-F-Radial Tape |
| No. | YC003-B-C-SD-1.1 |
| ANGLE | |
| UNIT | mm |
| | |
| ABLIC Inc. | |

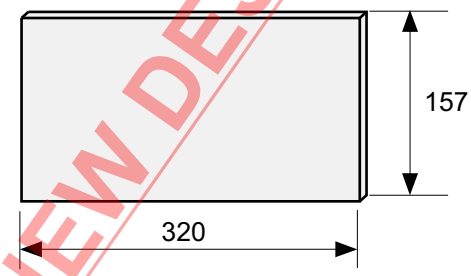
Downloaded from Arrow.com.

Spacer(Sponge)

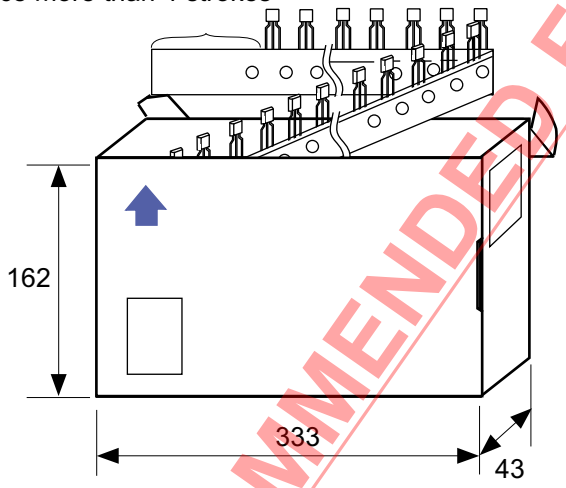


Side spacer placed in front side




Space more than 4 strokes




NOT RECOMMENDED FOR NEW DESIGN

No. YC003-B-Z-SD-1.0

| | | | |
|---|---|---|---|
| TITLE | TO92S-F-Ammo Packing | | |
| No. | YC003-B-Z-SD-1.0 | | |
| ANGLE | | QTY. | 2,000 |
| UNIT | mm | | |
| | | | |
| ABLIC Inc. | | | |

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