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### Rectifier Switch IC for Battery Reverse Connection

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NO.EA-320-150630

#### OUTLINE

The R5590x is a CMOS-based rectifier switch IC for battery reverse connection. This device can output the voltage rectified in either positive or negative polarity regardless of the polarity of the input voltage. Therefore, this device allows the various applications without being limited by the battery loading directions or the connector insertion directions. This device also protect the device system from the accidental reverse connection of battery.

A small loss resistance of typically 0.6  $\Omega$  and a small supply current of typically 50 nA at 1.5 V input voltage make this device ideal for the applications using a battery.

For the applications using multiple batteries in series or in parallel, the output pin should also be connected in series or in parallel to rectify the power source and protect the device system.

This device is offered in a small 5-pin SOT-23-5 package or an ultra-small and thin 6-pin SON1612-6 (UD) package which achieves easy and the smallest possible footprint solutions on board where area is limited.

#### FEATURES

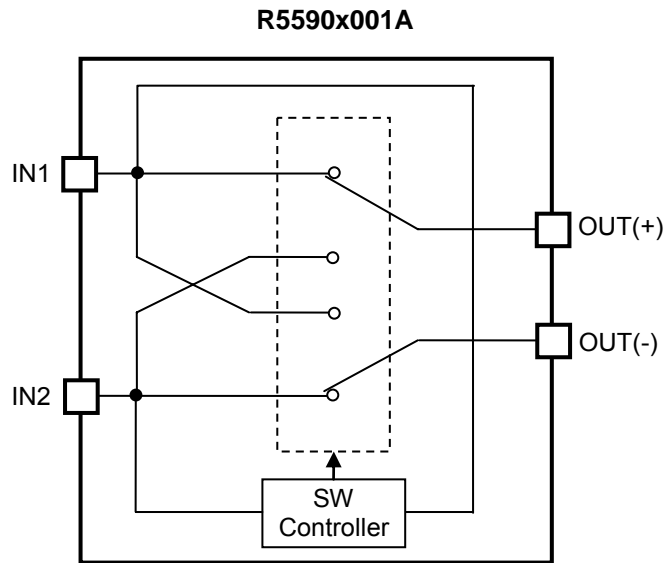
- Input Voltage Range (Maximum Rating) ..... 0.9 V to 5.25 V (6.0 V)
- Supply Current ..... Typ. 50 nA (Input Voltage 1.5 V)
- Loss Resistance ..... Typ. 0.52  $\Omega$  (Input Voltage 1.5 V, SON1612-6 (UD))  
Typ. 0.6  $\Omega$  (Input Voltage 1.5 V, SOT-23-5)
- Package ..... SON1612-6 (UD), SOT-23-5

UD: Under Development

#### APPLICATIONS

- Battery Driven Toys, Remote Controllers, Mouse
- Mobile Health Care Devices

## BLOCK DIAGRAMS



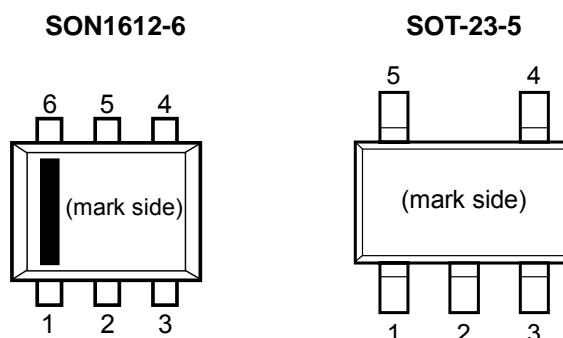
## SELECTION GUIDE

The package is a user-selectable option.

### Selection Guide

Product Name	Package	Quantity per Ree	Pb Free	Halogen Free
R5590D001A-TR-FE (UD)	SON1612-6	4,000 pcs	Yes	Yes
R5590N001A-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes

## PIN DESCRIPTION



### SON1612-6 Pin Description (UD)

Pin No.	Symbol	Description
1	IN2	Input Pin 2
2	OUT (-)	Negative Output Pin <sup>*1</sup>
3	NC	No Connection
4	IN1	Input Pin 1
5	OUT (-)	Negative Output Pin <sup>*1</sup>
6	OUT (+)	Positive Output Pin

<sup>\*1</sup> No. 2 pin and No. 5 pin must be wired together at mounting on a board.

### SOT-23-5 Pin Description

Pin No.	Symbol	Description
1	IN1	Input Pin 1
2	OUT (-)	Negative Output Pin
3	NC	No Connection
4	IN2	Input Pin 2
5	OUT (+)	Positive Output Pin

## ABSOLUTE MAXIMUM RATINGS

### Absolute Maximum Ratings

Symbol	Item	Rating	Unit	
$\Delta V_{IN}$	Input Pin Voltage Difference ( $ IN1 - IN2 $ )	6.0	V	
$\Delta V_{OUT}$	Output Pin Voltage ( $OUT(+) - OUT(-)$ )	0 to $\Delta V_{IN}$	V	
$I_{OUT}$	Output Current	400	mA	
$P_D$	Power Dissipation (Standard Land Pattern)*1	SON1612-6 (UD)	500	mW
		SOT-23-5	420	
$T_a$	Operating Temperature Range	-40 to +85	°C	
$T_{stg}$	Storage Temperature Range	-55 to +125	°C	

\*1 Refer to *PACKAGE INFORMATION* for detailed information.

### ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

## ELECTRICAL CHARACTERISTICS

The specifications surrounded by   are guaranteed by design engineering at  $-40^{\circ}\text{C} \leq T_a \leq 85^{\circ}\text{C}$ .

### R5590D001A Electrical Characteristics (UD)

(Ta = 25°C)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
$\Delta V_{\text{IN}}$	Input Pin Voltage Difference		<span style="border: 1px solid black; padding: 0 2px;">0.9</span>		5.25	V	
$R_{\text{ON}}$	Switch On Resistance	$V_{\text{IN}} = 1 \text{ V}, I_{\text{OUT}} = 100 \text{ mA}$		0.82	<span style="border: 1px solid black; padding: 0 2px;">TBD</span>	$\Omega$	
		$V_{\text{IN}} = 1.5 \text{ V}, I_{\text{OUT}} = 100 \text{ mA}$		0.52	<span style="border: 1px solid black; padding: 0 2px;">TBD</span>		
		$V_{\text{IN}} = 5.25 \text{ V}, I_{\text{OUT}} = 100 \text{ mA}$		0.37	<span style="border: 1px solid black; padding: 0 2px;">TBD</span>		
$I_{\text{SS}}$	Supply Current	$V_{\text{IN}} = 1.5 \text{ V}, I_{\text{OUT}} = 0 \text{ mA}$	$T_a = 25^{\circ}\text{C}$		0.05	$\mu\text{A}$	
		$V_{\text{IN}} = 5.25 \text{ V}, I_{\text{OUT}} = 0 \text{ mA}$	$T_a = 25^{\circ}\text{C}$		0.15		4.5
			$-40^{\circ}\text{C} \leq T_a \leq 85^{\circ}\text{C}$				<span style="border: 1px solid black; padding: 0 2px;">55</span>

All test items listed under *ELECTRICAL CHARACTERISTICS* are done under the pulse load condition ( $T_j \approx T_a = 25^{\circ}\text{C}$ ).

### R5590N001A Electrical Characteristics

(Ta = 25°C)

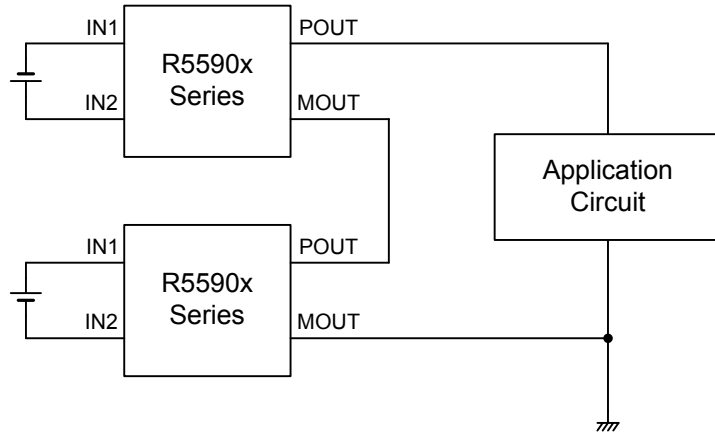
Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
$\Delta V_{\text{IN}}$	Input Pin Voltage Difference		<span style="border: 1px solid black; padding: 0 2px;">0.9</span>		5.25	V	
$R_{\text{ON}}$	Switch On Resistance	$V_{\text{IN}} = 1 \text{ V}, I_{\text{OUT}} = 100 \text{ mA}$		0.9	<span style="border: 1px solid black; padding: 0 2px;">1.45</span>	$\Omega$	
		$V_{\text{IN}} = 1.5 \text{ V}, I_{\text{OUT}} = 100 \text{ mA}$		0.6	<span style="border: 1px solid black; padding: 0 2px;">0.88</span>		
		$V_{\text{IN}} = 5.25 \text{ V}, I_{\text{OUT}} = 100 \text{ mA}$		0.45	<span style="border: 1px solid black; padding: 0 2px;">0.65</span>		
$I_{\text{SS}}$	Supply Current	$V_{\text{IN}} = 1.5 \text{ V}, I_{\text{OUT}} = 0 \text{ mA}$	$T_a = 25^{\circ}\text{C}$		0.05	$\mu\text{A}$	
		$V_{\text{IN}} = 5.25 \text{ V}, I_{\text{OUT}} = 0 \text{ mA}$	$T_a = 25^{\circ}\text{C}$		0.15		4.5
			$-40^{\circ}\text{C} \leq T_a \leq 85^{\circ}\text{C}$				<span style="border: 1px solid black; padding: 0 2px;">55</span>

All test items listed under *ELECTRICAL CHARACTERISTICS* are done under the pulse load condition ( $T_j \approx T_a = 25^{\circ}\text{C}$ ).

#### RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

## TYPICAL APPLICATIONS



**Typical Rectification Circuit with 2 Serial Batteries**

## TECHNICAL NOTES

If the input voltage difference becomes less than output voltage difference, which could happen when the AC power source is rectified or the DC power source having different voltage is used in parallel, the current flows from the output side to the input side. To prevent this, use a reverse current prevention diode.

The short circuit current flows when the output pin is shorted while bias voltage is applied to the input pin. The R5590x should be operated within the absolute maximum ratings of each package.

## PACKAGE INFORMATION

### POWER DISSIPATION (SON1612-6) (UD)

Power Dissipation (PD) of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

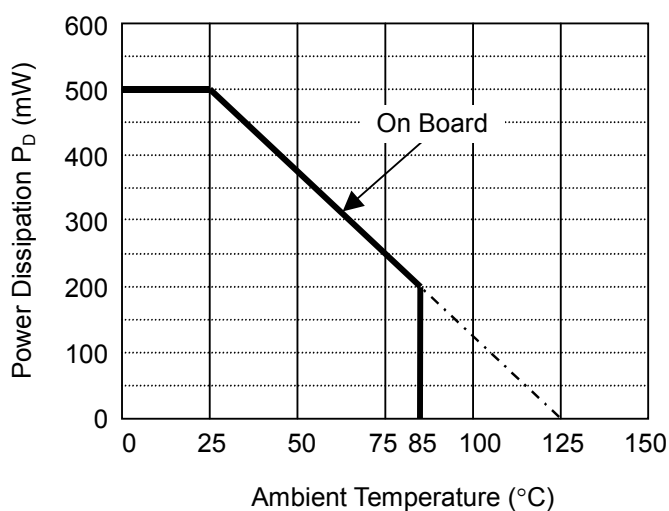
#### Measurement Conditions

	Standard Land Pattern
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Double-sided)
Board Dimensions	40 mm x 40 mm x 1.6 mm
Copper Ratio	Topside: Approx. 50%, Backside: Approx. 50%
Through-holes	$\phi$ : 0.5 mm x 24 pcs

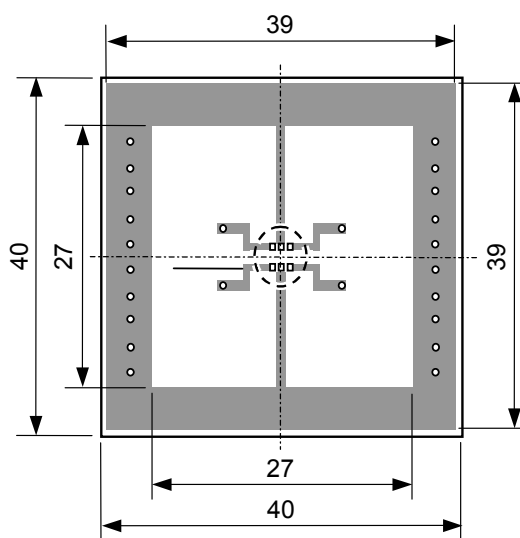
#### Measurement Result

( $T_a = 25^\circ\text{C}$ ,  $T_{j\text{max}} = 125^\circ\text{C}$ )


	Standard Land Pattern
Power Dissipation	500 mW
Thermal Resistance	$\theta_{ja} = (125 - 25^\circ\text{C}) / 0.5 \text{ W} = 200^\circ\text{C/W}$



Power Dissipation



Measurement Board Pattern

 IC Mount Area (Unit: mm)





## POWER DISSIPATION (SOT-23-5)

Power Dissipation (PD) of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement. This data is taken from a 6-pin SOT-23-6 package.

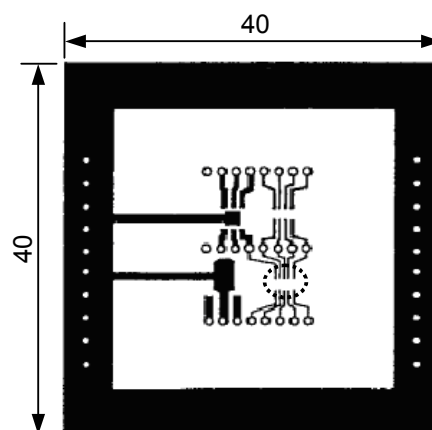
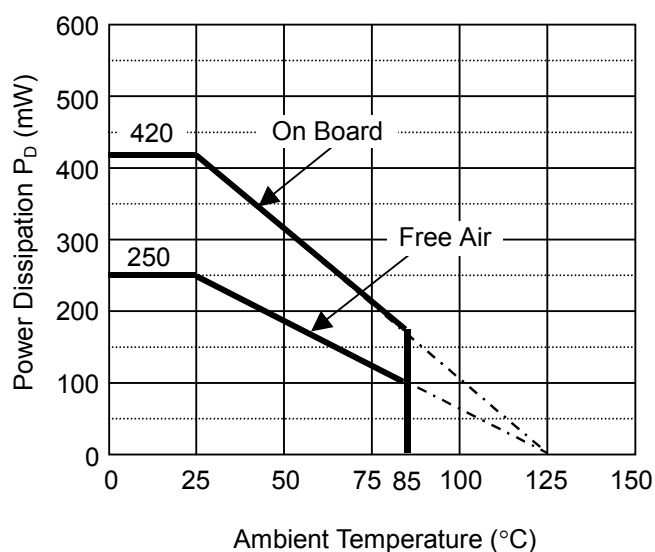
### Measurement Conditions

	Standard Land Pattern
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Double-sided)
Board Dimensions	40 mm x 40 mm x 1.6 mm
Copper Ratio	Topside: Approx. 50%, Backside: Approx. 50%
Through-holes	$\phi$ : 0.5 mm x 44 pcs

### Measurement Result

( $T_a = 25^\circ\text{C}$ ,  $T_{j\text{max}} = 125^\circ\text{C}$ )

	Standard Land Pattern	Free Air
Power Dissipation	420 mW	250 mW
Thermal Resistance	$\theta_{ja} = (125 - 25^\circ\text{C}) / 0.42 \text{ W} = 238^\circ\text{C/W}$	$400^\circ\text{C/W}$



Measurement Board Pattern

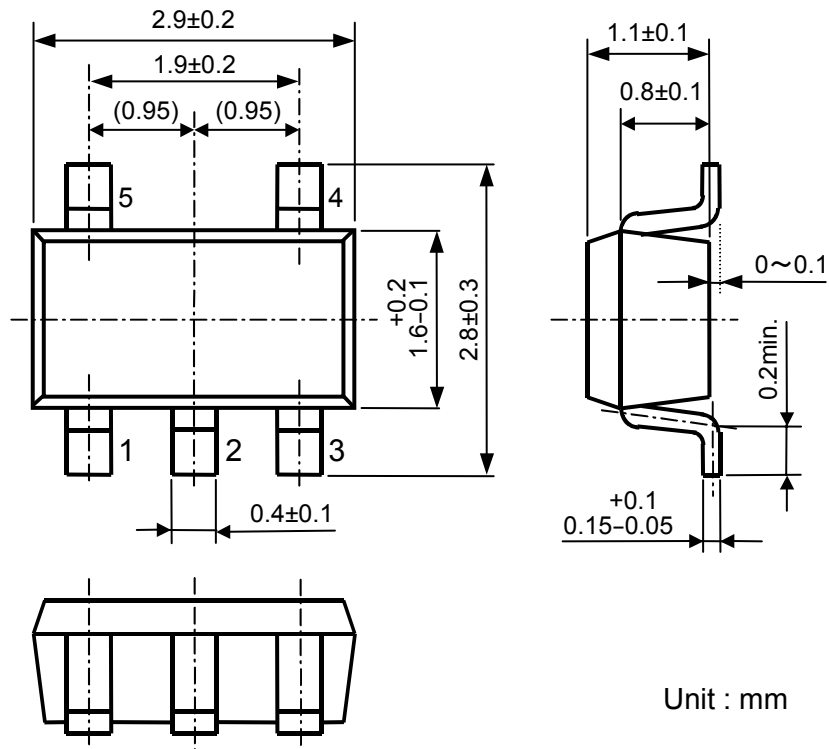
 IC Mount Area (Unit: mm)

Power Dissipation

**R5590x**

NO.EA-320-150630

**PACKAGE DIMENSIONS (SOT-23-5)**

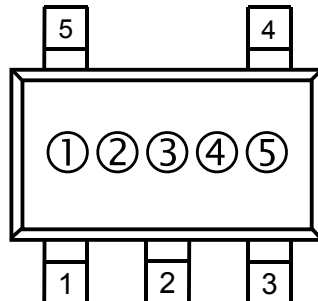


Unit : mm

**MARK SPECIFICATION (SOT-23-5)**

①②③: Product Code ... **AA0**

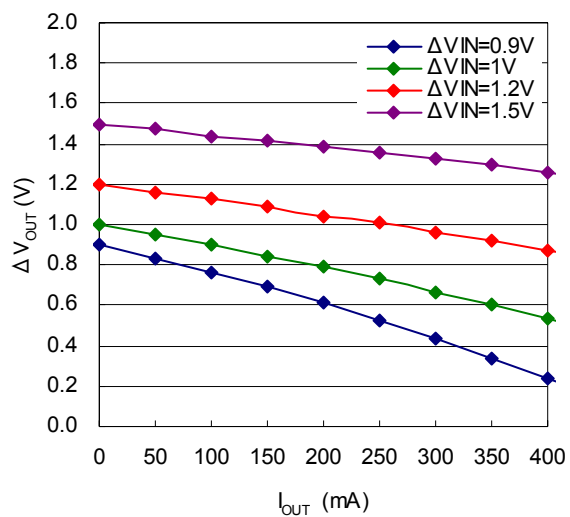
④⑤: Lot Number ... Alphanumeric Serial Number



## TYPICAL CHARACTERISTICS

Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

### 1) Output Current vs. Output Pin Voltage ( $T_a = 85^\circ\text{C}$ )





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