

## 200 mA 36 V Input Ultra Low Supply Current VR

No. EA-332-230703

### OUTLINE

The R1524x is an ultra-low supply current voltage regulator featuring 200 mA output current and 36 V input voltage. This device consists of an Output Short-circuit Protection Circuit, an Over-current Protection Circuit, and a Thermal Shutdown Circuit in addition to the basic regulator circuits. The operating temperature range is from  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$ , and the maximum input voltage is 36 V. All these features allow the R1524x to become an ideal power source of electric home appliances.

The output voltages are internally fixed (refer to *SELECTION GUIDE*). The output voltage accuracy is  $\pm 0.6\%$ . The packages for this device range from high-density mounting to ultra high wattage. The R1524x is offered in five packages; a 5-pin SOT-23-5, a 5-pin SOT-89-5, a 6-pin HSOP-6J, a 6-pin DFN(PL)1820-6, and an 8-pin HSOP-8E package.

### FEATURES

- Input Voltage Range (Maximum Rating) ..... 3.5 V to 36 V (50 V)
- Operating Temperature Range .....  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$
- Supply Current ..... Typ. 2.2  $\mu\text{A}$
- Standby Current ..... Typ. 0.1  $\mu\text{A}$
- Dropout Voltage ..... Typ. 0.6 V ( $I_{\text{OUT}} = 200 \text{ mA}$ ,  $V_{\text{OUT}} = 5.0 \text{ V}$ )
- Output Voltage Range ..... 1.8 V / 2.5 V / 2.8 V / 3.0 V / 3.3 V / 3.4 V / 5.0 V /  
5.5 V / 6.0 V / 6.4 V / 7.0 V / 8.0 V / 8.5 V / 9.0 V /  
10.0 V / 10.5 V / 11.0 V / 12.0 V  
\*Contact our sales representatives for other voltages.
- Output Voltage Accuracy .....  $\pm 0.6\%$  ( $T_a = 25^{\circ}\text{C}$ )
- Output Voltage Temperature-Drift Coefficient ..... Typ.  $\pm 60 \text{ ppm}/^{\circ}\text{C}$
- Line Regulation ..... Typ. 0.01%/V ( $V_{\text{SET}} + 1 \text{ V} \leq V_{\text{IN}} \leq 36 \text{ V}$ )
- Built-in Output Short-circuit Protection Circuit ..... Typ. 80 mA
- Built-in Over-current Protection Circuit ..... Typ. 350 mA
- Built-in Thermal Shutdown Circuit ..... Thermal Shutdown Temperature: Typ.  $160^{\circ}\text{C}$
- Ceramic capacitors are recommended  
to be used with this device .....  $C_{\text{OUT}} = 0.1 \mu\text{F}$  or more
- Packages ..... SOT-23-5, SOT-89-5, HSOP-6J,  
DFN(PL)1820-6, HSOP-8E

### APPLICATIONS

- Power source for home appliances such as refrigerators, rice cookers, and electric hot-water pot.
- Power source for notebook PCs, digital TVs, cordless phones, and private LAN system.
- Power source for office equipment machines such as copiers, printers, facsimiles, scanners, and projectors.

## SELECTION GUIDE

The set output voltage and the package type are user-selectable.

### Selection Guide

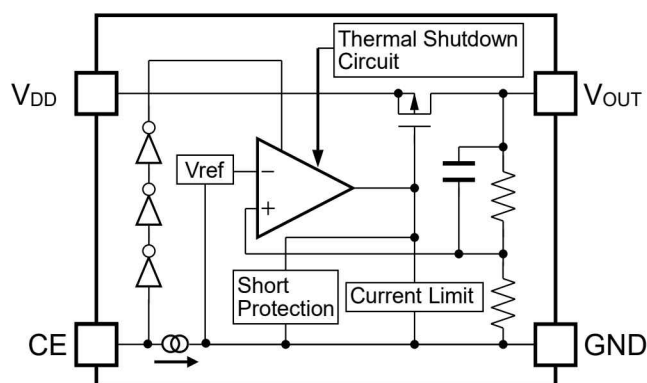
| Product Name     | Package       | Quantity per Reel | Pb Free | Halogen Free |
|------------------|---------------|-------------------|---------|--------------|
| R1524NxxxB-TR-FE | SOT-23-5      | 3,000 pcs         | Yes     | Yes          |
| R1524HxxxB-T1-FE | SOT-89-5      | 1,000 pcs         | Yes     | Yes          |
| R1524SxxxB-E2-FE | HSOP-6J       | 1,000 pcs         | Yes     | Yes          |
| R1524KxxxB-TR    | DFN(PL)1820-6 | 5,000 pcs         | Yes     | Yes          |
| R1524SxxxH-E2-FE | HSOP-8E       | 1,000 pcs         | Yes     | Yes          |

xxx: Specify the set output voltage ( $V_{SET}$ )

1.8 V (018) / 2.5 V (025) / 2.8 V (028) / 3.0 V (030) / 3.3 V (033) / 3.4 V (034) / 5.0 V (050) /  
5.5 V (055) / 6.0 V (060) / 6.4 V (064) / 7.0 V (070) / 8.0 V (080) / 8.5 V (085) / 9.0 V (090) /  
10.0 V (100) / 10.5 V (105) / 11.0 V (110) / 12.0 V (120)

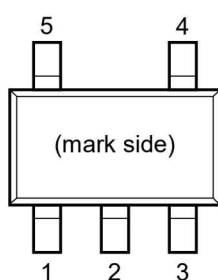
\*Contact our sales representatives for other voltages.

## BLOCK DIAGRAM

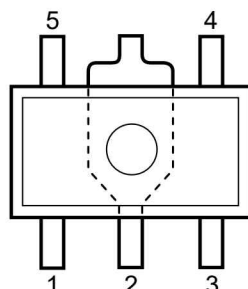


R1524x Block Diagram

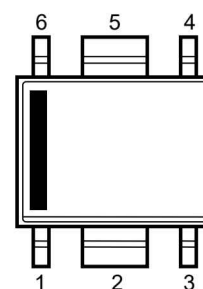
## PIN DESCRIPTIONS



SOT-23-5 Pin Configuration

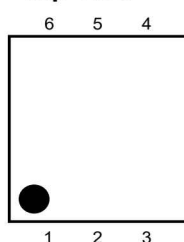


SOT-89-5 Pin Configuration

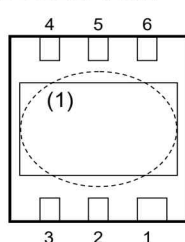


HSOP-6J Pin Configuration

Top View

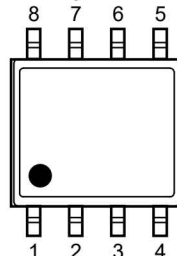


Bottom View

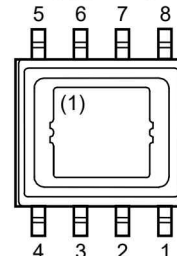


DFN(PL)1820-6 Pin Configuration

Top View



Bottom View



HSOP-8E Pin Configuration

### SOT-23-5 Pin Descriptions

| Pin No. | Symbol             | Description                   |
|---------|--------------------|-------------------------------|
| 1       | GND <sup>(2)</sup> | Ground Pin                    |
| 2       | GND <sup>(2)</sup> | Ground Pin                    |
| 3       | CE                 | Chip Enable Pin (Active-high) |
| 4       | V <sub>OUT</sub>   | Output Pin                    |
| 5       | V <sub>DD</sub>    | Input Pin                     |

### SOT-89-5 Pin Descriptions

| Pin No. | Symbol             | Description                   |
|---------|--------------------|-------------------------------|
| 1       | V <sub>OUT</sub>   | Output Pin                    |
| 2       | GND <sup>(3)</sup> | Ground Pin                    |
| 3       | CE                 | Chip Enable Pin (Active-high) |
| 4       | GND <sup>(3)</sup> | Ground Pin                    |
| 5       | V <sub>DD</sub>    | Input Pin                     |

(1) The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). It is recommended that the tab be connected to the ground plane on the board, or otherwise be left open.

(2) The GND pin must be wired together when it is mounted on board.

(3) The GND pin must be wired together when it is mounted on board.

## HSOP-6J Pin Descriptions

| Pin No. | Symbol             | Description                   |
|---------|--------------------|-------------------------------|
| 1       | $V_{OUT}$          | Output Pin                    |
| 2       | GND <sup>(1)</sup> | Ground Pin                    |
| 3       | CE                 | Chip Enable Pin (Active-high) |
| 4       | GND <sup>(1)</sup> | Ground Pin                    |
| 5       | GND <sup>(1)</sup> | Ground Pin                    |
| 6       | $V_{DD}$           | Input Pin                     |

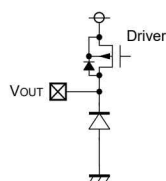
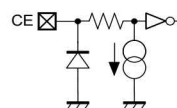
## DFN(PL)1820-6 Pin Descriptions

| Pin No. | Symbol    | Description                   |
|---------|-----------|-------------------------------|
| 1       | CE        | Chip Enable Pin (Active-high) |
| 2       | NC        | No Connection                 |
| 3       | GND       | Ground Pin                    |
| 4       | $V_{DD}$  | Input Pin                     |
| 5       | NC        | No Connection                 |
| 6       | $V_{OUT}$ | Output Pin                    |

## HSOP-8E Pin Descriptions

| Pin No. | Symbol    | Description                   |
|---------|-----------|-------------------------------|
| 1       | $V_{OUT}$ | Output Pin                    |
| 2       | NC        | No Connection                 |
| 3       | NC        | No Connection                 |
| 4       | CE        | Chip Enable Pin (Active-high) |
| 5       | GND       | Ground Pin                    |
| 6       | NC        | No Connection                 |
| 7       | NC        | No Connection                 |
| 8       | $V_{DD}$  | Input Pin                     |

## PIN EQUIVALENT CIRCUIT DIAGRAMS

 $V_{OUT}$  Pin

CE Pin

<sup>(1)</sup> The GND pin must be wired together when it is mounted on board.

## ABSOLUTE MAXIMUM RATINGS

### Absolute Maximum Ratings

| Symbol    | Item                                                                   |               | Rating                         | Unit |
|-----------|------------------------------------------------------------------------|---------------|--------------------------------|------|
| $V_{IN}$  | Input Voltage                                                          |               | -0.3 to 50                     | V    |
| $V_{IN}$  | Peak Input Voltage <sup>(1)</sup>                                      |               | 60                             | V    |
| $V_{CE}$  | Input Voltage (CE Pin)                                                 |               | -0.3 to 50                     | V    |
| $V_{OUT}$ | Output Voltage                                                         |               | -0.3 to $V_{IN} + 0.3 \leq 50$ | V    |
| $I_{OUT}$ | Output Current                                                         |               | 300                            | mA   |
| $P_D$     | Power Dissipation <sup>(2)</sup><br>(JEDEC STD.51-7 Test Land Pattern) | SOT-23-5      | 660                            | mW   |
|           |                                                                        | SOT-89-5      | 2600                           |      |
|           |                                                                        | HSOP-6J       | 2700                           |      |
|           |                                                                        | DFN(PL)1820-6 | 2200                           |      |
|           |                                                                        | HSOP-8E       | 2900                           |      |
| $T_j$     | Junction Temperature Range                                             |               | -40 to 125                     | °C   |
| $T_{stg}$ | Storage Temperature Range                                              |               | -55 to 125                     | °C   |

### ABSOLUTE MAXIMUM RATINGS

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

## RECOMMENDED OPERATING CONDITIONS

### Recommended Operating Conditions

| Symbol   | Item                        | Rating     | Unit |
|----------|-----------------------------|------------|------|
| $V_{IN}$ | Input Voltage               | 3.5 to 36  | V    |
| $T_a$    | Operating Temperature Range | -40 to 105 | °C   |

### RECOMMENDED OPERATING CONDITIONS

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 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.

<sup>(1)</sup> Duration time: 200 ms

<sup>(2)</sup> Refer to *POWER DISSIPATION* for detailed information.

## ELECTRICAL CHARACTERISTICS

$C_{IN} = C_{OUT} = 0.1 \mu F$ , unless otherwise noted.

The specifications surrounded by   are guaranteed by design engineering at  $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$ .

### R1524x Electrical Characteristics

( $T_a = 25^{\circ}\text{C}$ )

| Symbol                                | Item                                   | Conditions                                                                              |                                | Min.                                                            | Typ. | Max.   | Unit |
|---------------------------------------|----------------------------------------|-----------------------------------------------------------------------------------------|--------------------------------|-----------------------------------------------------------------|------|--------|------|
| I <sub>SS</sub>                       | Supply Current                         | V <sub>IN</sub> = 14 V<br>I <sub>OUT</sub> = 0 mA                                       | V <sub>SET</sub> ≤ 5.0 V       |                                                                 | 2.2  | 6.5    | μA   |
|                                       |                                        |                                                                                         | 5.0 V < V <sub>SET</sub>       |                                                                 | 2.5  | 6.8    |      |
| I <sub>standby</sub>                  | Standby Current                        | V <sub>IN</sub> = 36 V, V <sub>CE</sub> = 0 V                                           |                                |                                                                 | 0.1  | 1.0    | μA   |
| V <sub>OUT</sub>                      | Output Voltage                         | V <sub>SET</sub> + 1 V <sup>(1)</sup> ≤ V <sub>IN</sub> ≤ 36 V, I <sub>OUT</sub> = 1 mA | T <sub>a</sub> = 25°C          | ×0.994                                                          |      | ×1.006 | V    |
|                                       |                                        |                                                                                         | −40°C ≤ T <sub>a</sub> ≤ 105°C | ×0.984                                                          |      | ×1.016 |      |
| ΔV <sub>OUT</sub> / ΔI <sub>OUT</sub> | Load Regulation                        | V <sub>IN</sub> = V <sub>SET</sub> + 3.0 V<br>1 mA ≤ I <sub>OUT</sub> ≤ 200 mA          |                                | Refer to the <i>Product-specific Electrical Characteristics</i> |      |        |      |
| ΔV <sub>OUT</sub> / ΔV <sub>IN</sub>  | Line Regulation                        | V <sub>SET</sub> + 1 V <sup>(1)</sup> ≤ V <sub>IN</sub> ≤ 36 V, I <sub>OUT</sub> = 1 mA | V <sub>SET</sub> < 3.3 V       | −20                                                             | 5    | 20     | mV   |
|                                       |                                        |                                                                                         | 3.3 V ≤ V <sub>SET</sub>       | −0.02                                                           | 0.01 | 0.02   | %/V  |
| V <sub>DIF</sub>                      | Dropout Voltage                        | I <sub>OUT</sub> = 200 mA                                                               |                                | Refer to the <i>Product-specific Electrical Characteristics</i> |      |        |      |
| I <sub>LIM</sub>                      | Output Current Limit                   | V <sub>IN</sub> = V <sub>SET</sub> + 3.0 V                                              |                                | 220                                                             | 350  |        | mA   |
| I <sub>SC</sub>                       | Short Current Limit                    | V <sub>IN</sub> = 3.5 V, V <sub>OUT</sub> = 0 V                                         |                                | 60                                                              | 80   |        | mA   |
| V <sub>CEH</sub>                      | CE Pin Input Voltage, high             | V <sub>IN</sub> = V <sub>SET</sub> + 1 V <sup>(1)</sup>                                 |                                | 2.0                                                             |      | 36     | V    |
| V <sub>CEL</sub>                      | CE Pin Input Voltage, low              | V <sub>IN</sub> = 36 V                                                                  |                                | 0                                                               |      | 1.0    | V    |
| I <sub>PD</sub>                       | CE Pull-down Current                   | V <sub>IN</sub> = 36 V, V <sub>CE</sub> = 2 V                                           |                                |                                                                 | 0.2  | 0.6    | μA   |
| T <sub>TSD</sub>                      | Thermal Shutdown Detection Temperature | Junction Temperature                                                                    |                                |                                                                 | 160  |        | °C   |
| T <sub>TSR</sub>                      | Thermal Shutdown Released Temperature  | Junction Temperature                                                                    |                                |                                                                 | 135  |        | °C   |

All test items listed under Electrical Characteristics are done under the pulse load condition ( $T_J \approx T_a = 25^{\circ}\text{C}$ ).

<sup>(1)</sup>  $V_{SET} \leq 2.5 \text{ V}$ ,  $V_{IN} = 3.5 \text{ V}$

The specifications surrounded by   are guaranteed by design engineering at  $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$ .

**R1524x Product-specific Electrical Characteristics**

(Ta = 25°C)

| Product Name | V <sub>OUT</sub> (V)<br>(T <sub>a</sub> = 25°C) |      |         | V <sub>OUT</sub> (V)<br>(-40°C ≤ T <sub>a</sub> ≤ 105°C) |      |         | ΔV <sub>OUT</sub> /ΔI <sub>OUT</sub> (mV) |      |      | V <sub>DIF</sub> (V) |      |
|--------------|-------------------------------------------------|------|---------|----------------------------------------------------------|------|---------|-------------------------------------------|------|------|----------------------|------|
|              | MIN.                                            | TYP. | MAX.    | MIN.                                                     | TYP. | MAX.    | MIN.                                      | TYP. | MAX. | TYP.                 | MAX. |
| R1524x018x   | 1.7892                                          | 1.80 | 1.8108  | 1.7712                                                   | 1.80 | 1.8288  | -10                                       | 10   | 40   | 1.6                  | 2.5  |
| R1524x025x   | 2.4850                                          | 2.50 | 2.5150  | 2.4600                                                   | 2.50 | 2.5400  |                                           |      |      | 1.2                  | 2.2  |
| R1524x028x   | 2.7832                                          | 2.80 | 2.8168  | 2.7552                                                   | 2.80 | 2.8448  |                                           |      |      |                      |      |
| R1524x030x   | 2.9820                                          | 3.00 | 3.0180  | 2.9520                                                   | 3.00 | 3.0480  |                                           |      |      |                      |      |
| R1524x033x   | 3.2802                                          | 3.30 | 3.3198  | 3.2472                                                   | 3.30 | 3.3528  |                                           |      |      |                      |      |
| R1524x034x   | 3.3796                                          | 3.40 | 3.4204  | 3.3456                                                   | 3.40 | 3.4544  |                                           |      |      |                      |      |
| R1524x050x   | 4.9700                                          | 5.00 | 5.0300  | 4.9200                                                   | 5.00 | 5.0800  | -18                                       | 18   | 72   | 0.6                  | 1.2  |
| R1524x055x   | 5.4670                                          | 5.50 | 5.5330  | 5.4120                                                   | 5.50 | 5.5880  |                                           |      |      |                      |      |
| R1524x060x   | 5.9640                                          | 6.00 | 6.0360  | 5.9040                                                   | 6.00 | 6.0960  |                                           |      |      |                      |      |
| R1524x064x   | 6.3616                                          | 6.40 | 6.4384  | 6.2976                                                   | 6.40 | 6.5024  |                                           |      |      |                      |      |
| R1524x070x   | 6.9580                                          | 7.00 | 7.0420  | 6.8880                                                   | 7.00 | 7.1120  |                                           |      |      |                      |      |
| R1524x080x   | 7.9520                                          | 8.00 | 8.0480  | 7.8720                                                   | 8.00 | 8.1280  |                                           |      |      |                      |      |
| R1524x085x   | 8.4490                                          | 8.50 | 8.5510  | 8.3640                                                   | 8.50 | 8.6360  |                                           |      |      | 0.5                  |      |
| R1524x090x   | 8.9460                                          | 9.00 | 9.0540  | 8.8560                                                   | 9.00 | 9.1440  |                                           |      |      |                      |      |
| R1524x100x   | 9.9400                                          | 10.0 | 10.0600 | 9.8400                                                   | 10.0 | 10.1600 |                                           |      |      |                      |      |
| R1524x105x   | 10.4370                                         | 10.5 | 10.5630 | 10.3320                                                  | 10.5 | 10.6680 |                                           |      |      |                      |      |
| R1524x110x   | 10.9340                                         | 11.0 | 11.0660 | 10.8240                                                  | 11.0 | 11.1760 |                                           |      |      |                      |      |
| R1524x120x   | 11.9280                                         | 12.0 | 12.0720 | 11.8080                                                  | 12.0 | 12.1920 |                                           |      |      |                      |      |

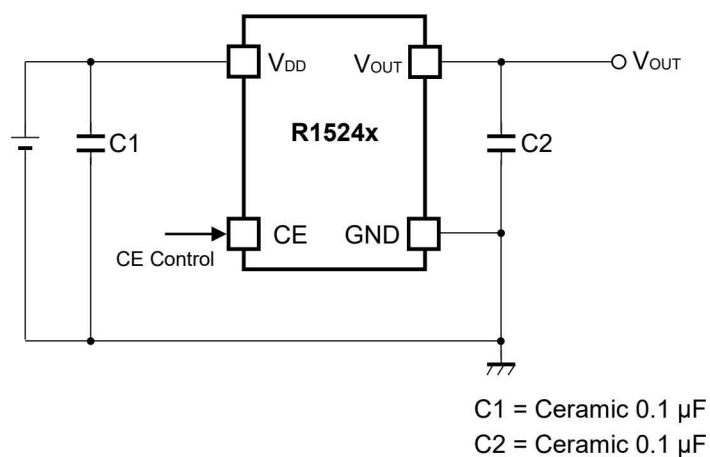
## THEORY OF OPERATION

### Thermal Shutdown

R1524x has a built-in thermal shutdown circuit, which stops the regulator operation if the junction temperature of this device increases to 160°C (Typ.) or higher. If the temperature drops to 135°C (Typ.) or lower, the regulator restarts the operation. Unless eliminating the overheating problem, the regulator turns on and off repeatedly and as a result, a pulse shaped output voltage is generated.

## APPLICATION INFORMATION

### TYPICAL APPLICATIONS



**R1524x Typical Applications**

## TECHNICAL NOTES

### Phase Compensation

In the R1524x, phase compensation is provided to secure stable operation even when the load current is varied. For this purpose, make sure to use 0.1  $\mu$ F or more of a capacitor (C2).

In case of using a tantalum type capacitor and the ESR (Equivalent Series Resistance) value of the capacitor is large, the output might be unstable. Evaluate the circuit including consideration of frequency characteristics. Connect 0.1  $\mu$ F or more of a capacitor (C1) between  $V_{DD}$  and GND, and as close as possible to the pins.

### PCB Layout

For SOT-23-5 package type, wire the following GND pins together: No. 1 and No. 2

For SOT-89-5 package type, wire the following GND pins together: No. 2 and No. 4.

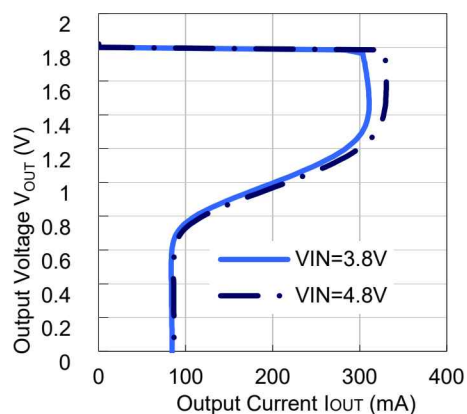
For HSOP-6J package type, wire the following GND pins together: No. 2, No. 4, and No. 5.

## TYPICAL CHARACTERISTICS

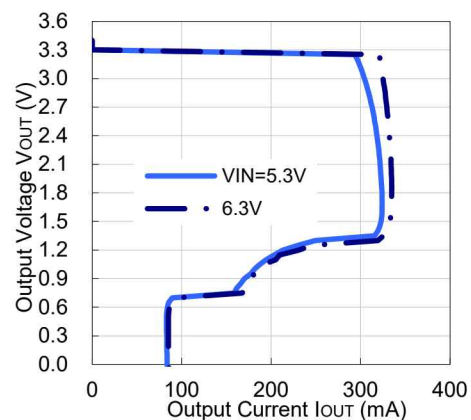
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

### 1) Output Voltage vs. Output Current (Ta = 25°C)

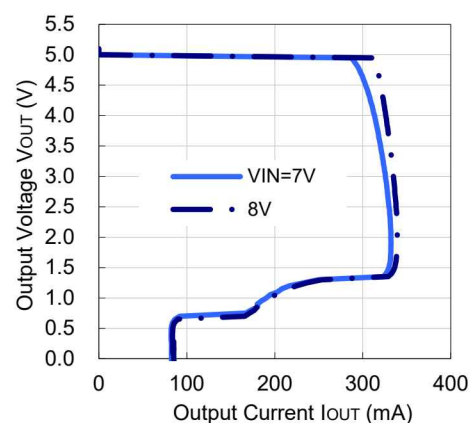
**R1524x018B**



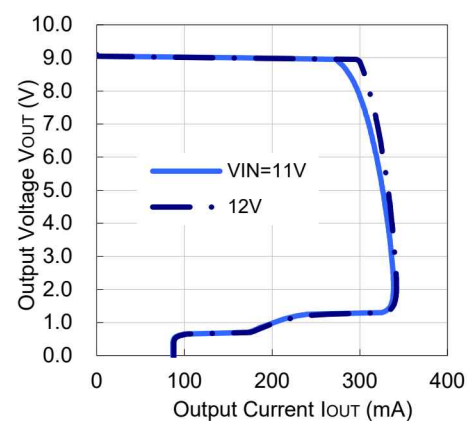
**R1524x033B**



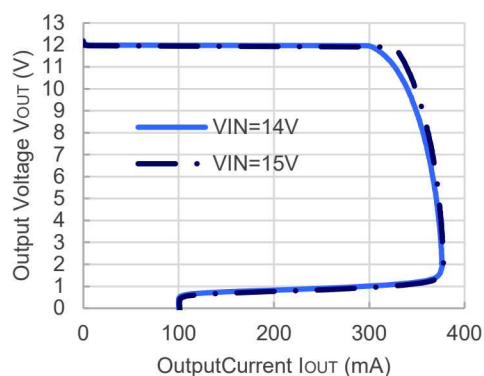
**R1524x050B**



**R1524x090B**

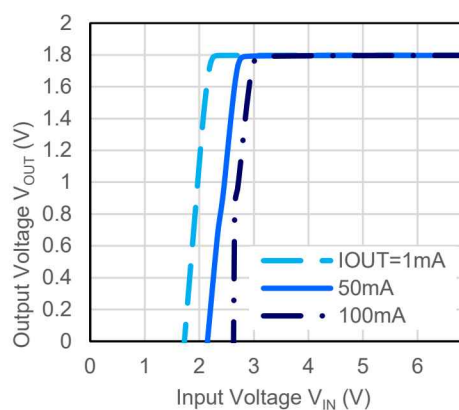


**R1524x120B**

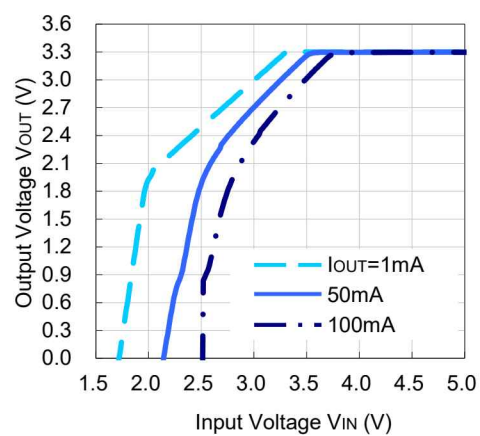


2) Output Voltage vs. Input Voltage ( $T_a = 25^\circ\text{C}$ )

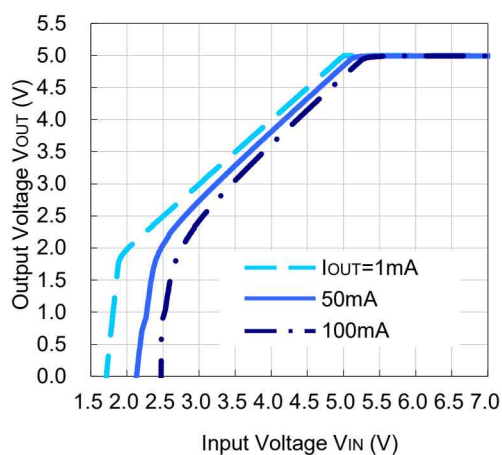
R1524x018B



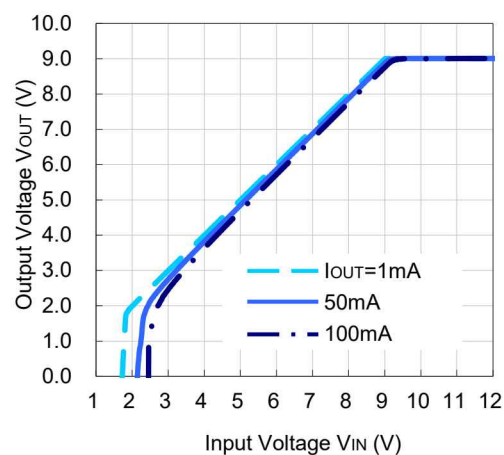
R1524x033B



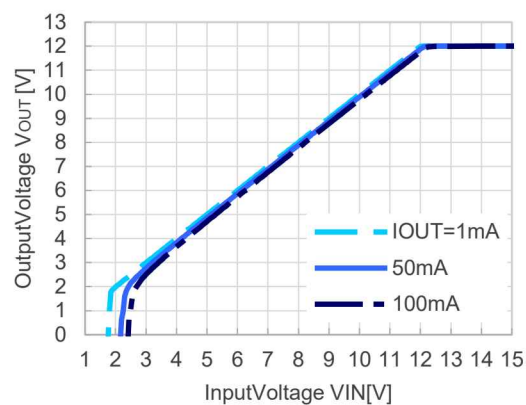
R1524x050B



R1524x090B

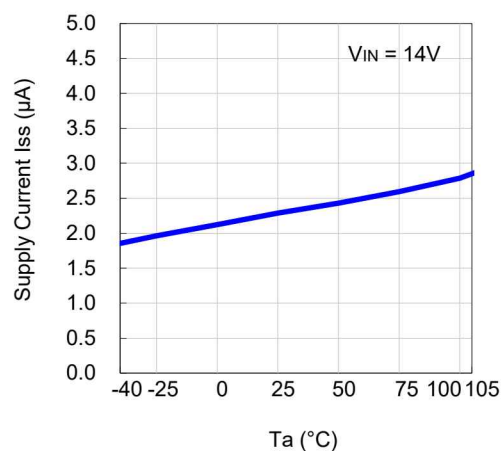


R1524x120B

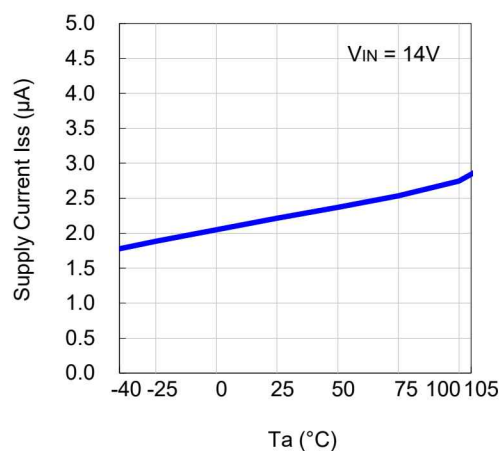


## 3) Supply Current vs. Temperature

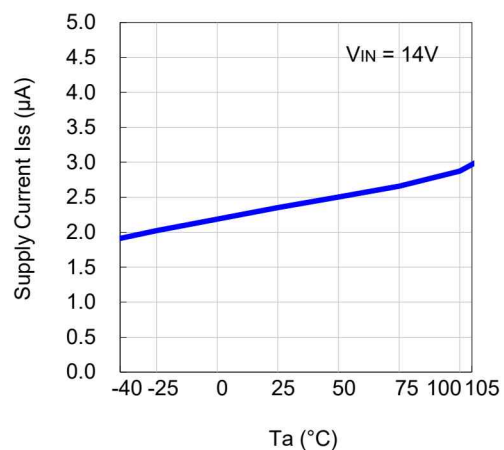
R1524x018B



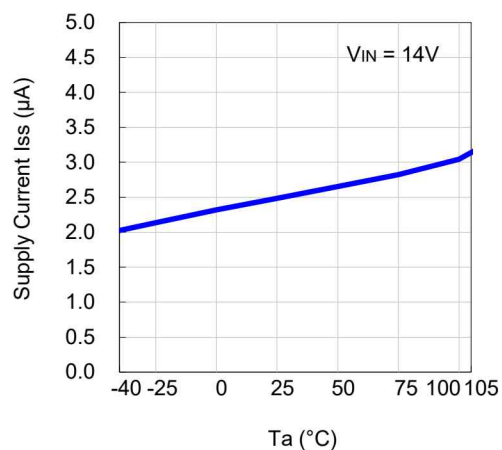
R1524x033B



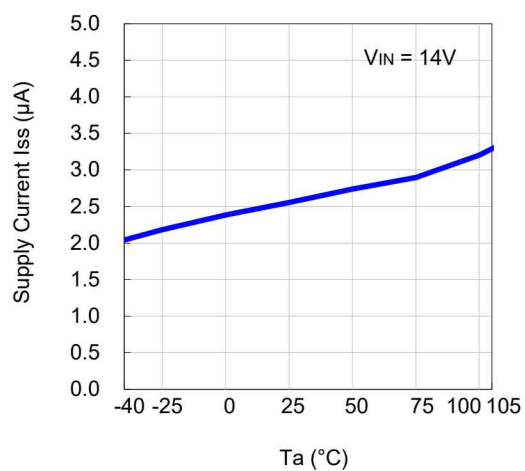
R1524x050B



R1524x090B

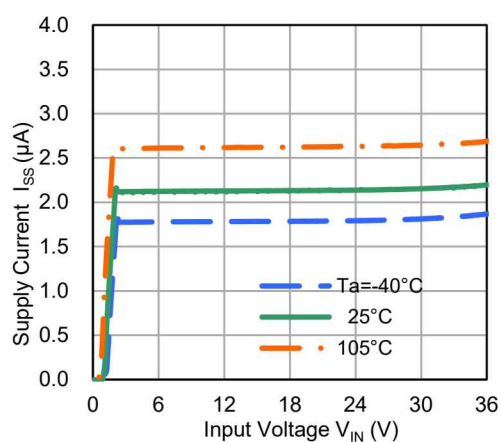


R1524x120B

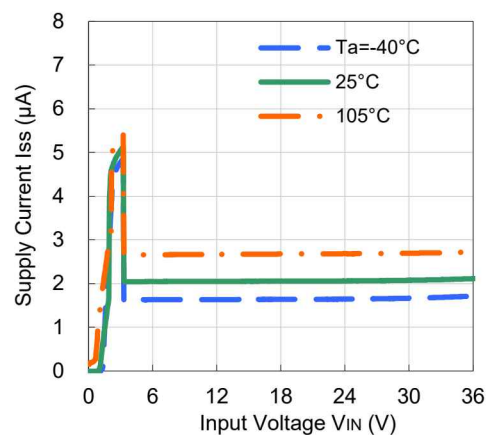


## 4) Supply Current vs. Input Voltage

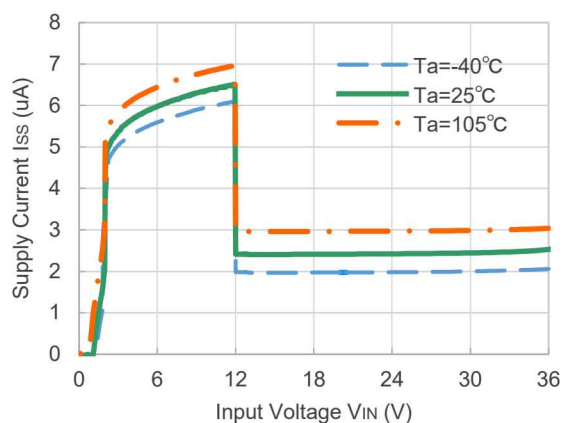
R1524x018B



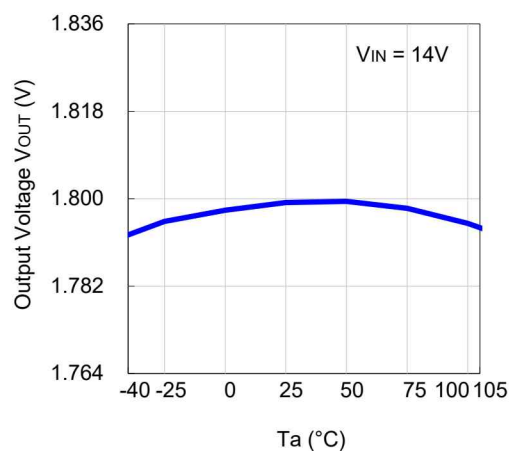
R1524x033B



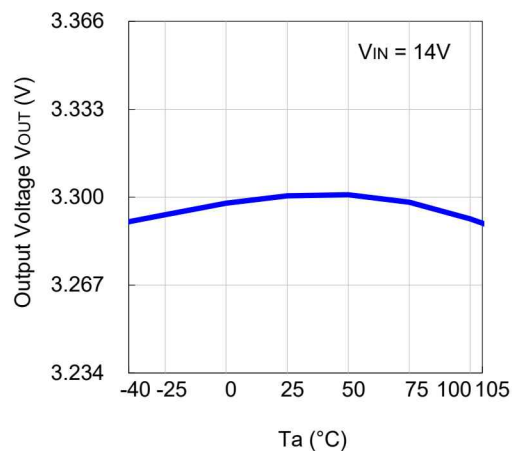
R1524x120B

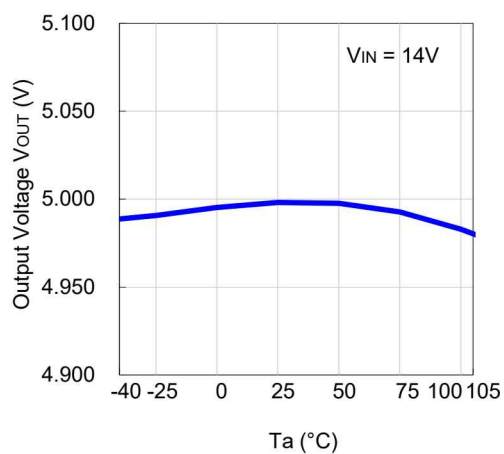
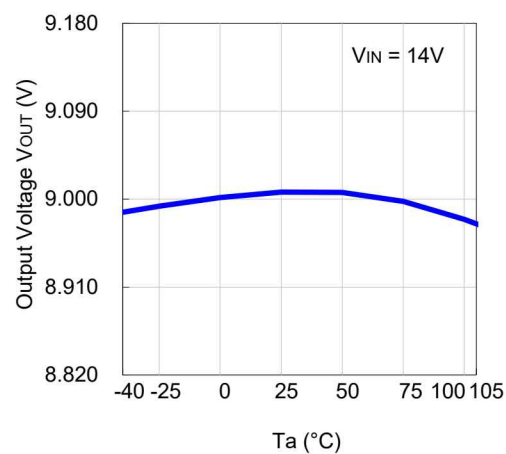
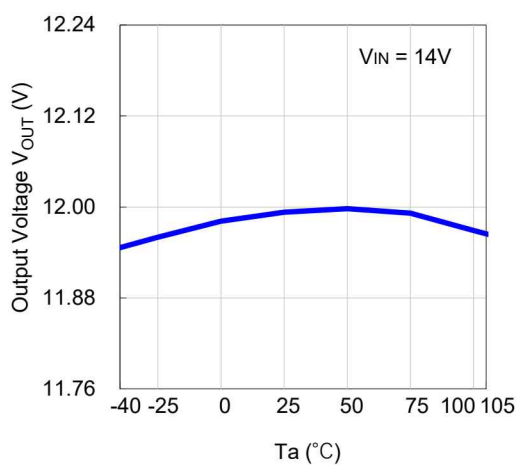
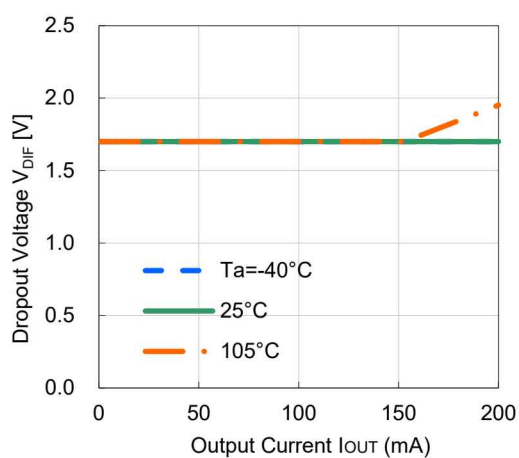
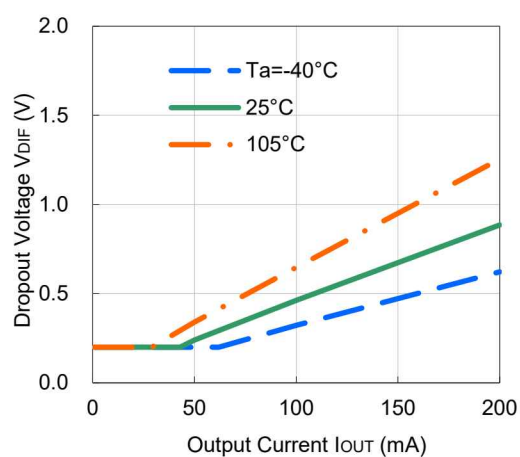
5) Output Voltage vs. Temperature ( $I_{OUT} = 1\text{ mA}$ )

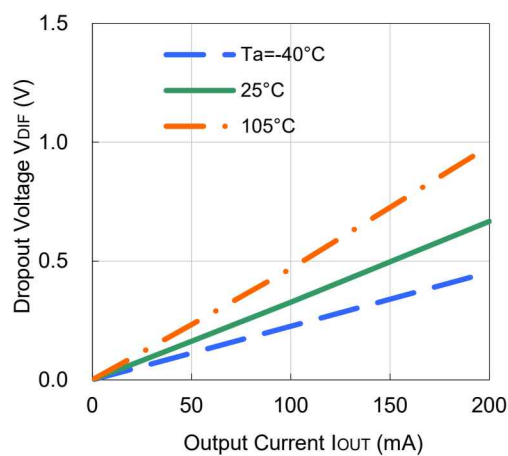
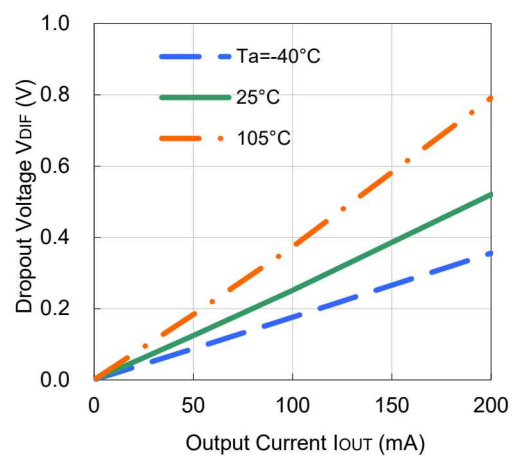
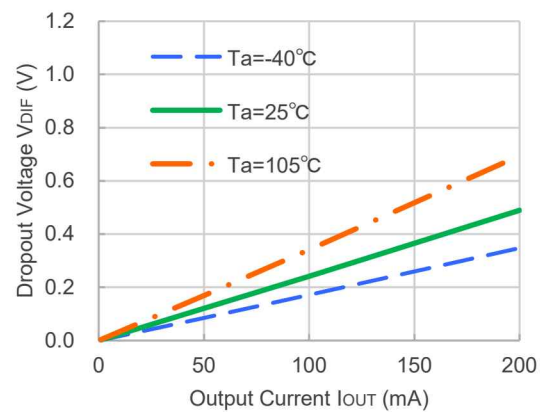
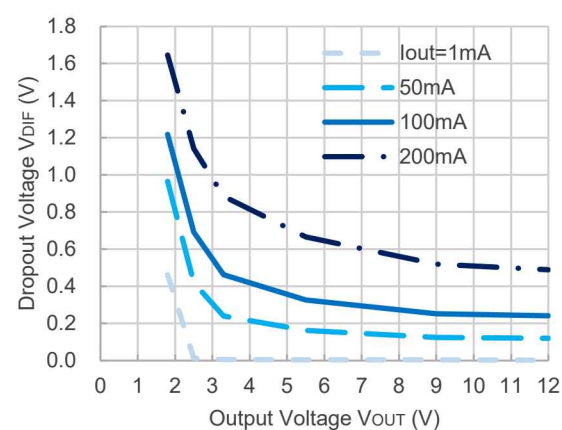
R1524x018B



R1524x033B

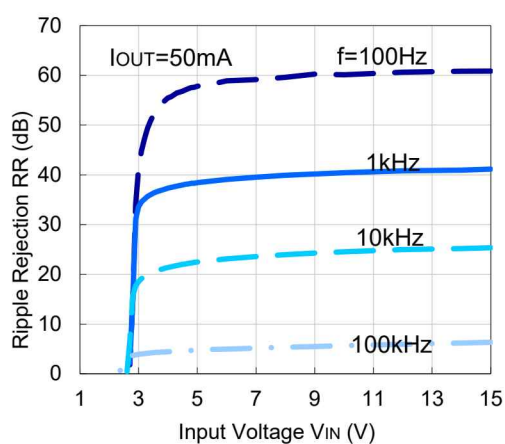


**R1524x050B****R1524x090B****R1524x120B****6) Dropout Voltage vs. Output Current****R1524x018B****R1524x033B**

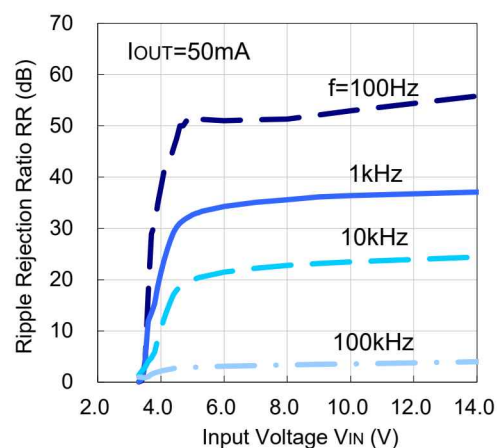
**R1524x050B****R1524x090B****R1524x120B****7) Dropout Voltage vs. Output Voltage ( $T_a = 25^\circ\text{C}$ )**

8) Ripple Rejection vs. Input Voltage ( $T_a = 25^\circ\text{C}$ , Ripple = 0.2 Vpp)

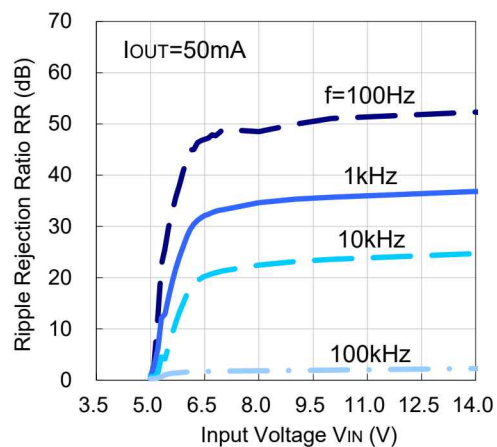
R1524x018B



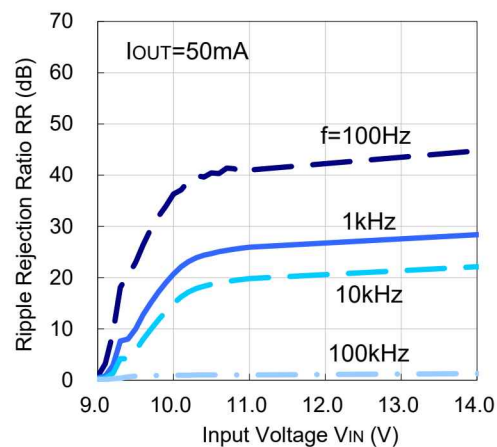
R1524x033B



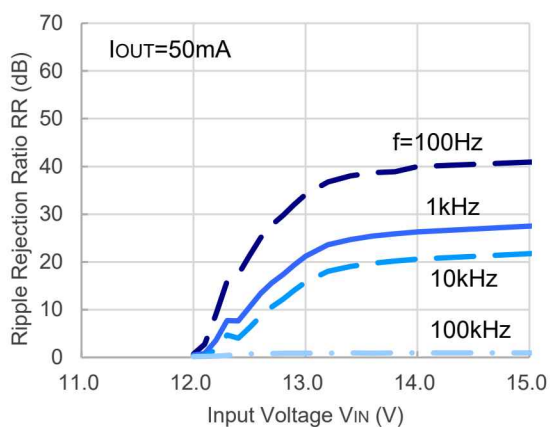
R1524x050B



R1524x090B

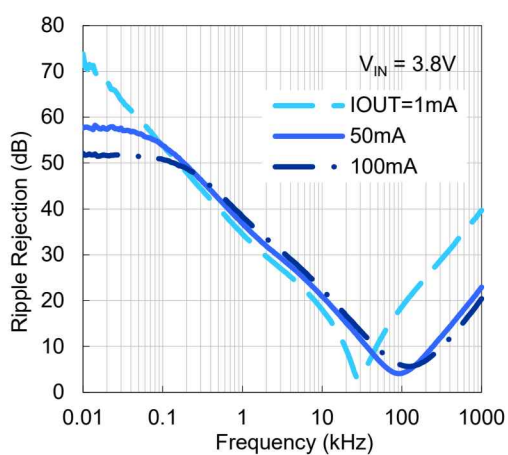


R1524x120B

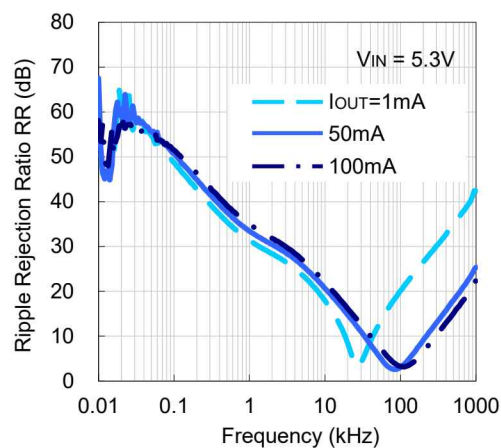


9) Ripple Rejection vs. Frequency ( $T_a = 25^\circ\text{C}$ , Ripple = 0.2 Vpp)

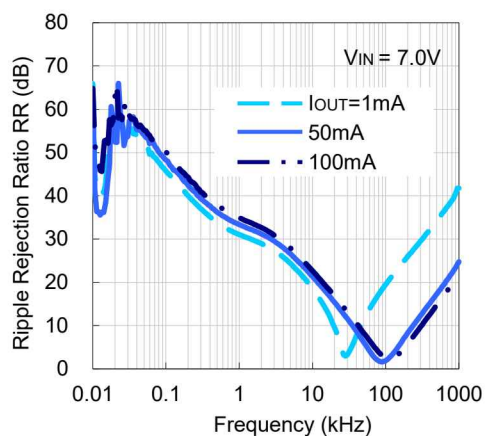
R1524x018B



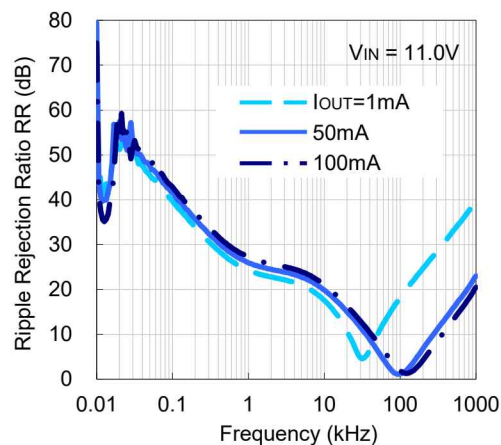
R1524x033B



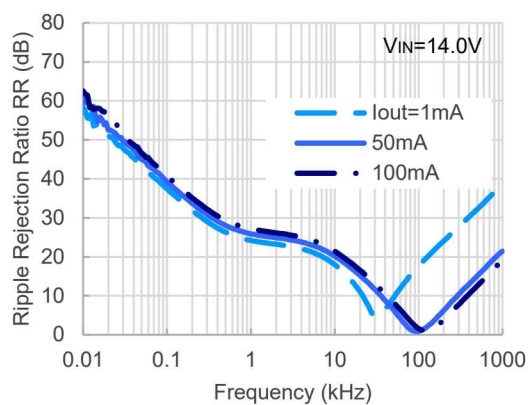
R1524x050B



R1524x090B

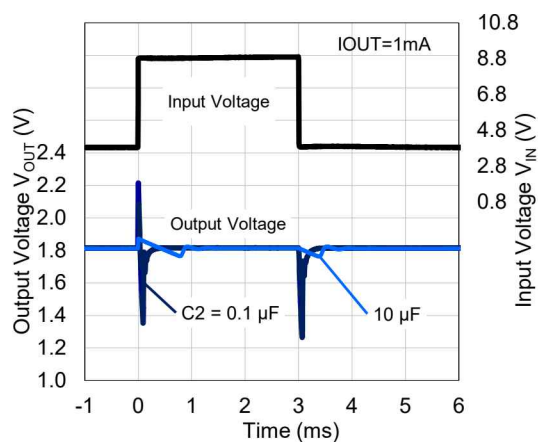


R1524x120B

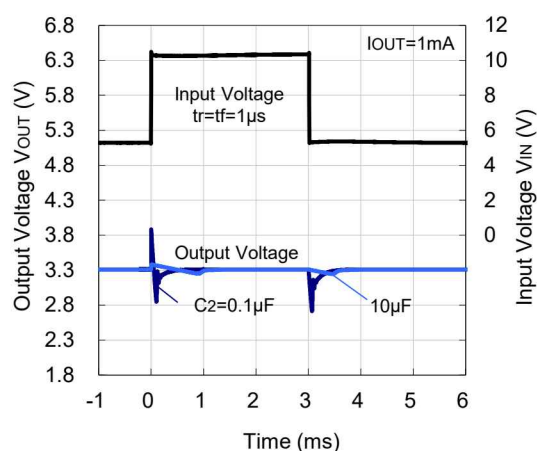


10) Input Transient Response ( $T_a = 25^\circ\text{C}$ )

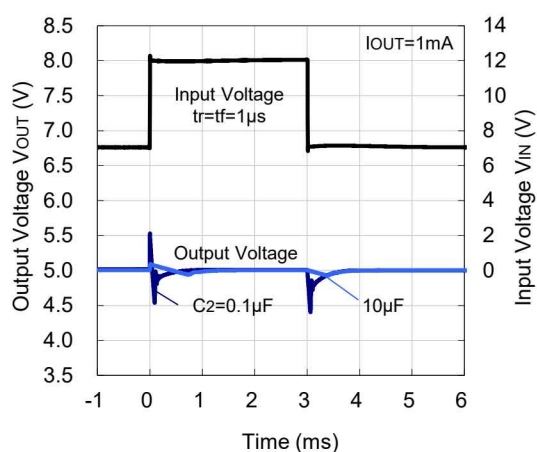
R1524x018B



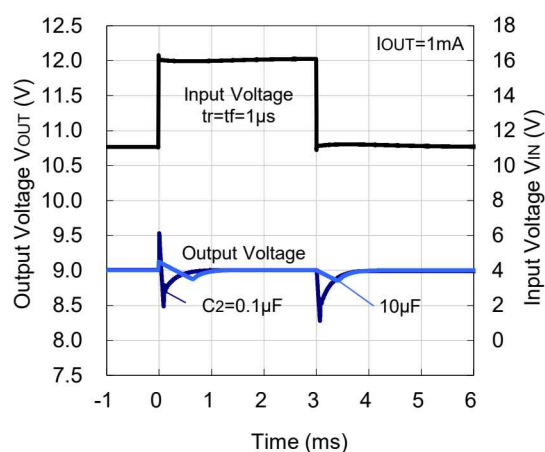
R1524x033B



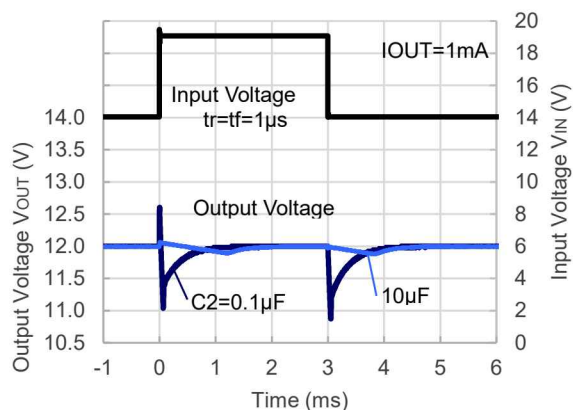
R1524x050B



R1524x090B

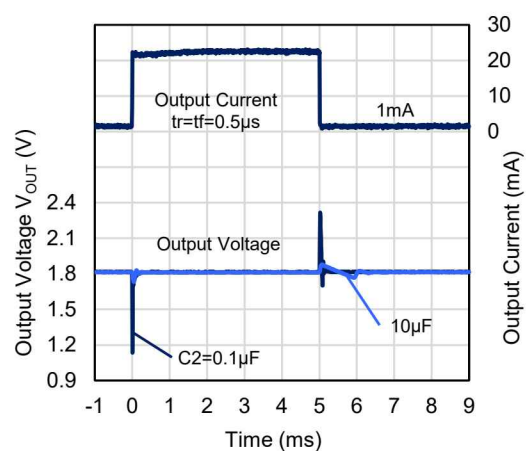


R1524x120B

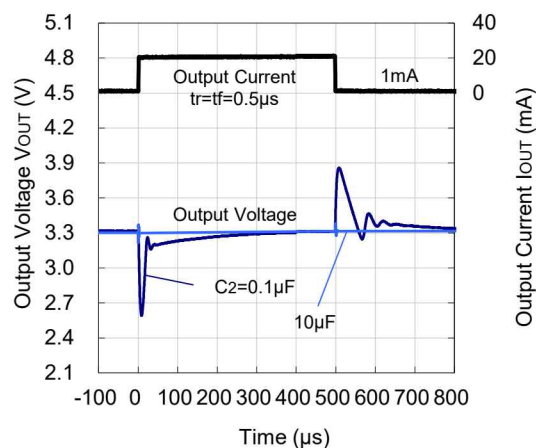


11) Load Transient Response ( $T_a = 25^\circ\text{C}$ )

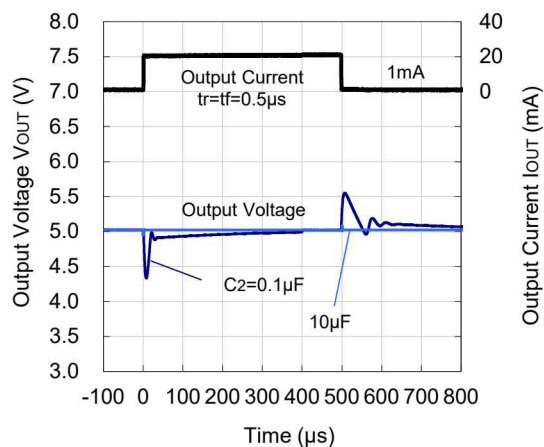
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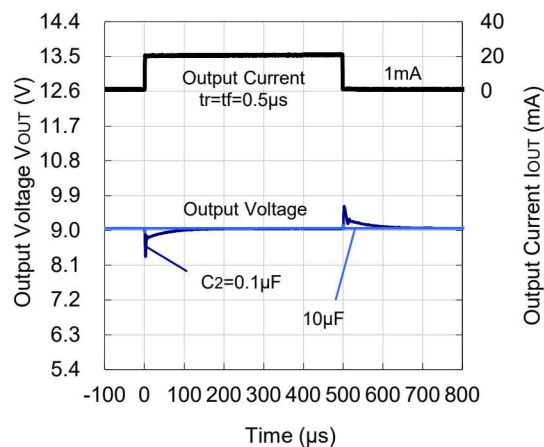
R1524x033B



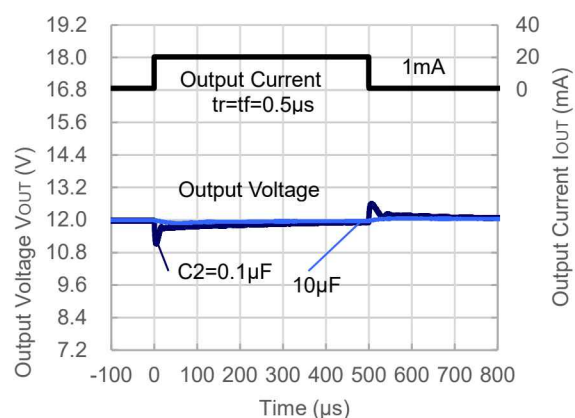
R1524x050B



R1524x090B

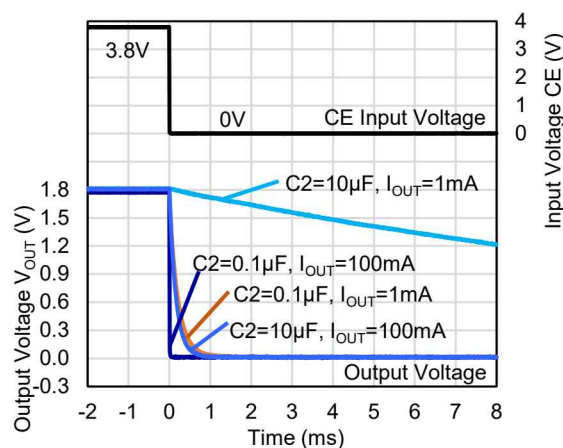
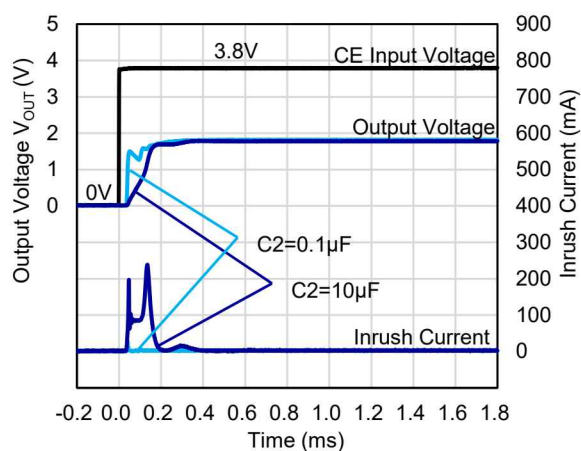


R1524x120B

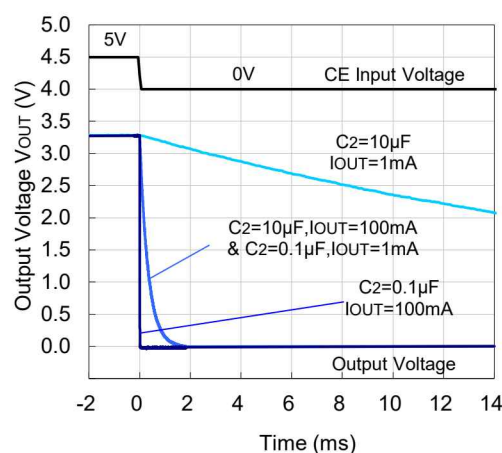
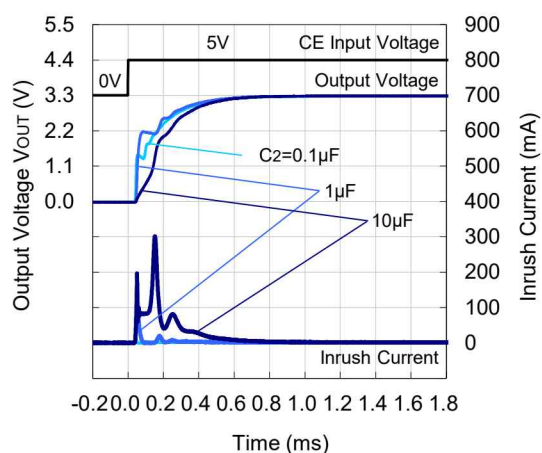


12) CE Transient Response ( $T_a = 25^\circ\text{C}$ )

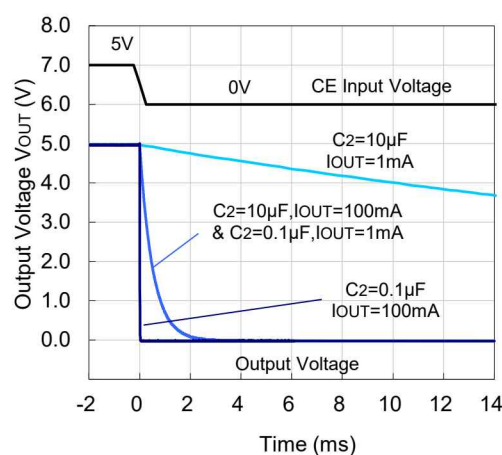
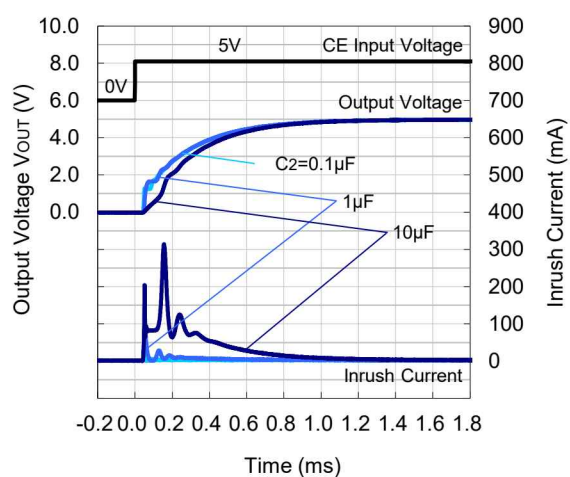
## R1524x018B

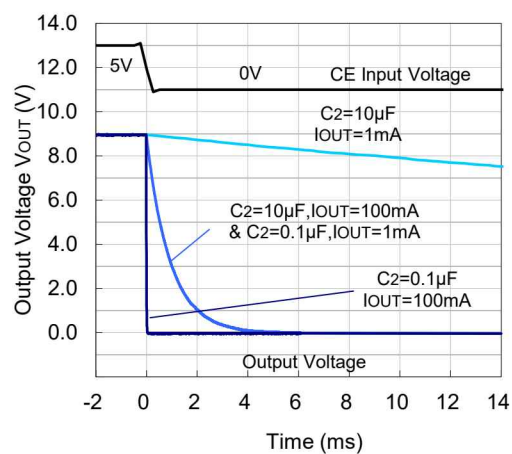
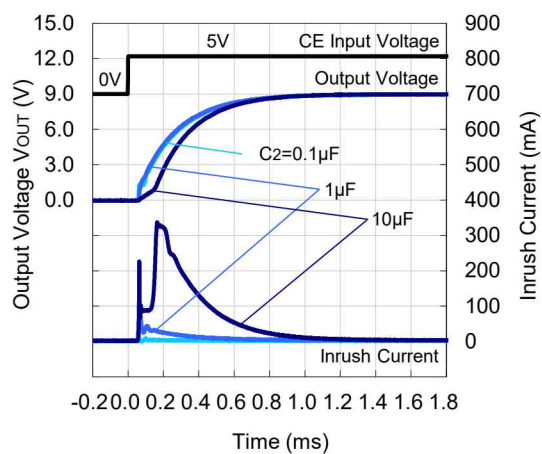
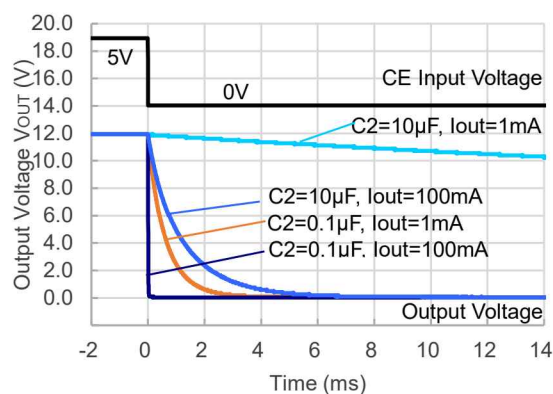
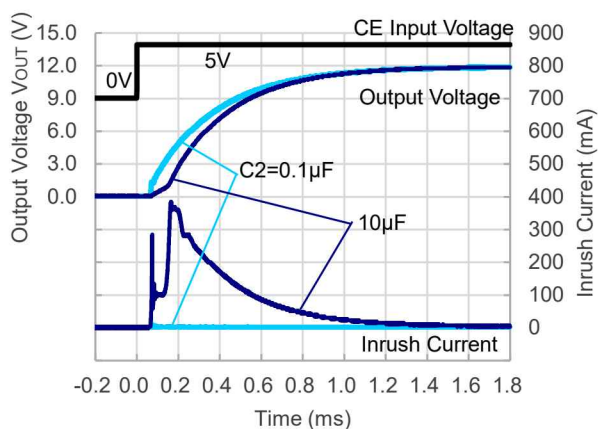
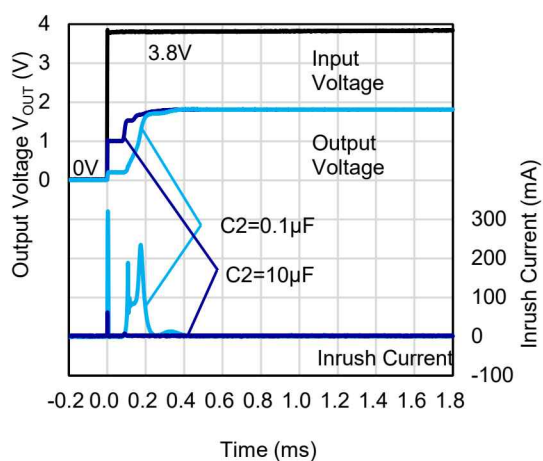
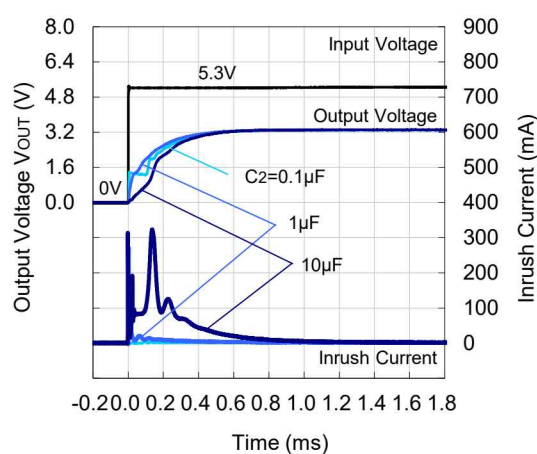


## R1524x033B

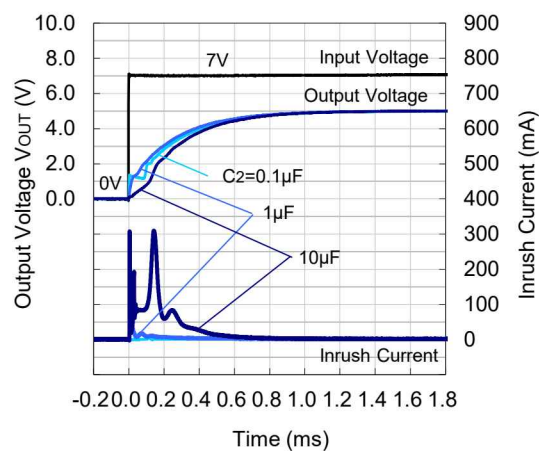


## R1524x050B

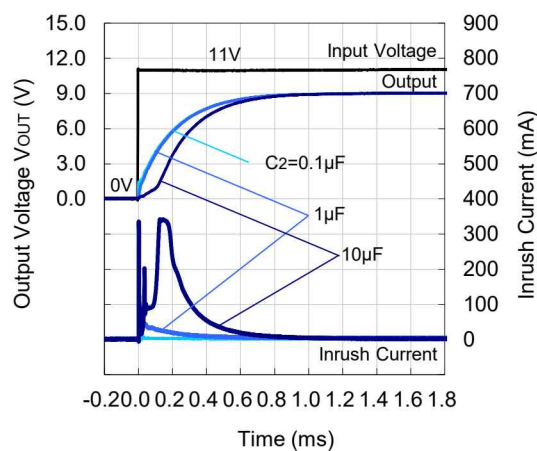


**R1524x090B****R1524x120B****13) Power-on Transient Response ( $T_a = 25^\circ\text{C}$ ,  $V_{CE} = 5\text{V}$ )****R1524x018B****R1524x033B**

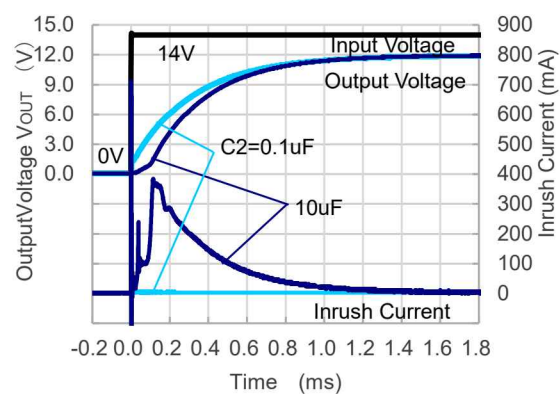
R1524x050B



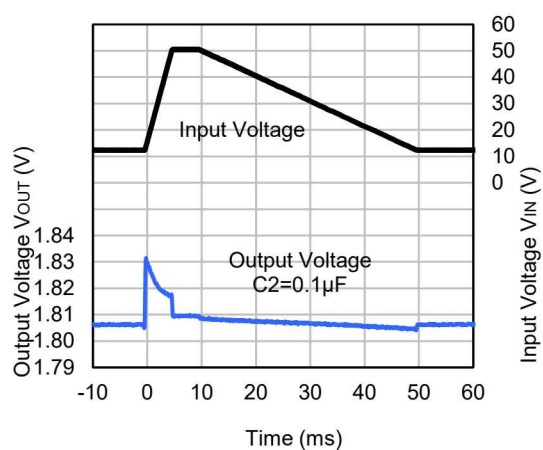
R1524x090B



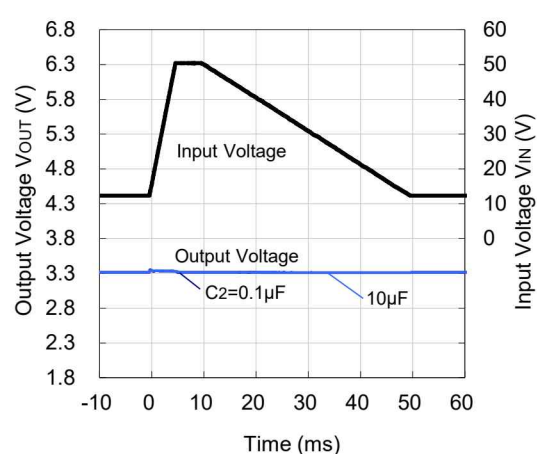
R1524x120B

14) Load Dump ( $T_a = 25^\circ C$ )

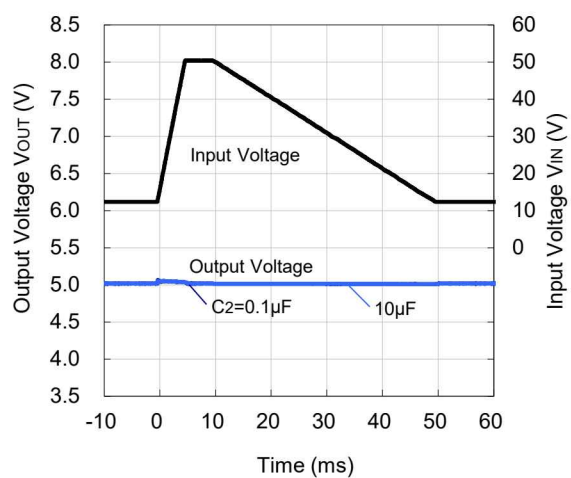
R1524x018B



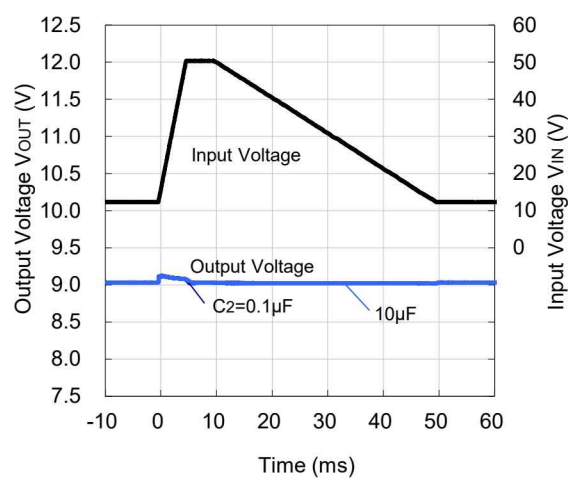
R1524x033B



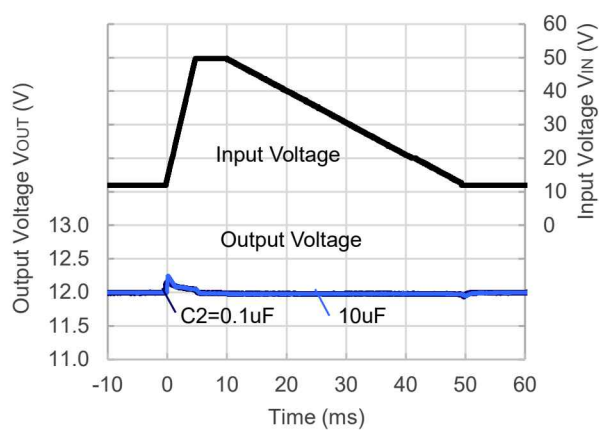
R1524x050B



R1524x090B

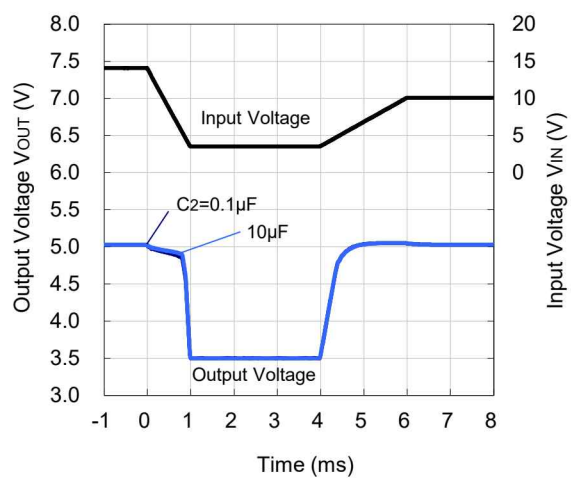


R1524x120B

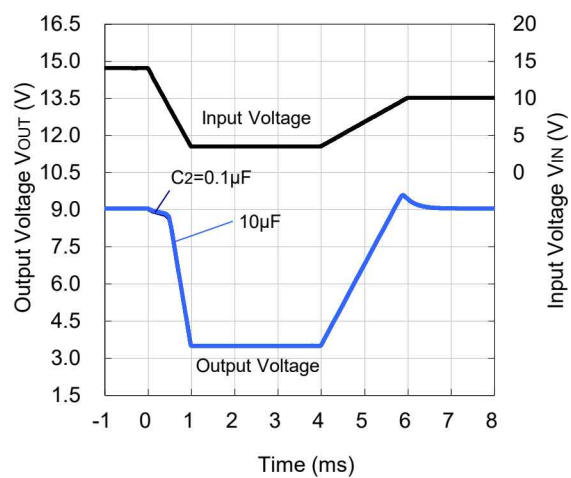


## 15) Cranking (Ta = 25°C)

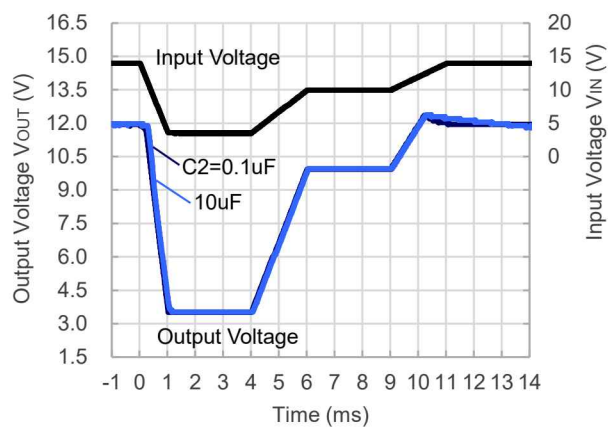
R1524x050B



R1524x090B

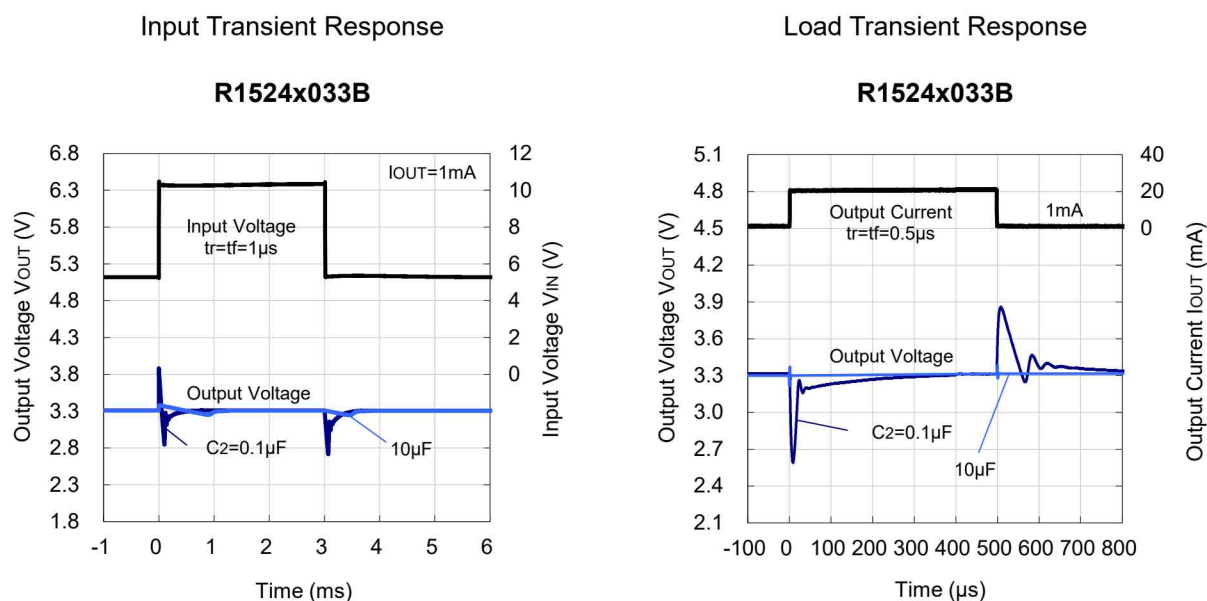


R1524x120B



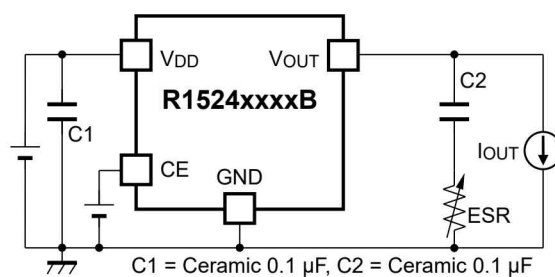
## Input Transient/Load Transient vs. Output Capacity (C2)

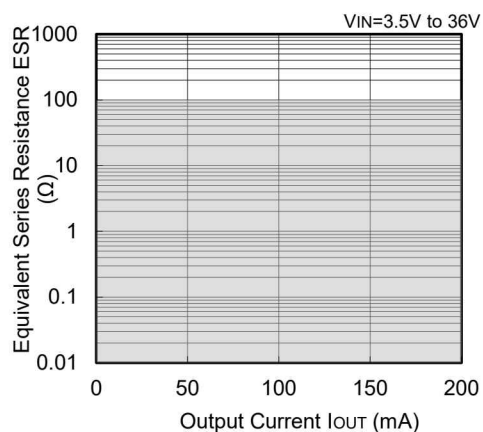
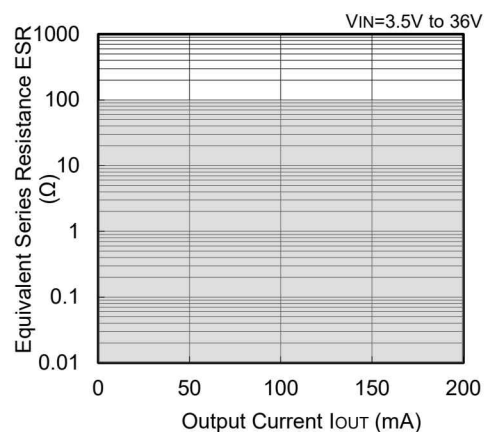
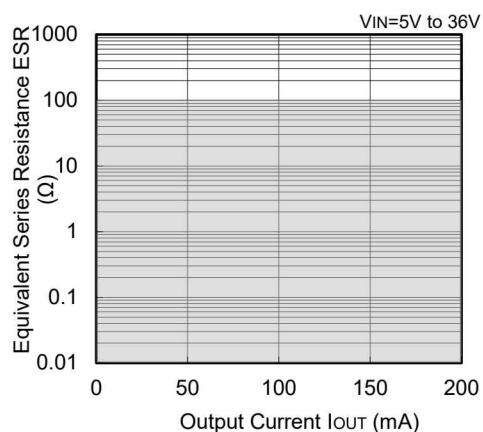
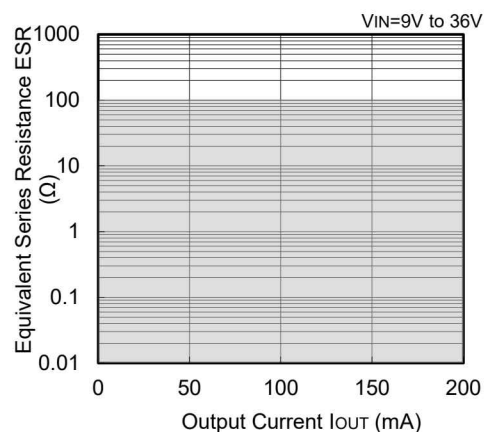
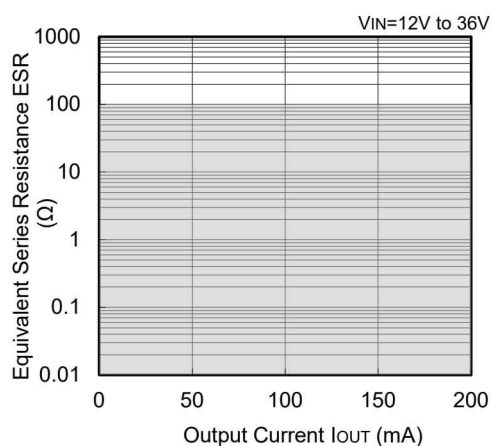
R1524 performs a stable operation by using 0.1  $\mu\text{F}$  of ceramic capacitor as the output capacitor. However, the variation of output voltage may not meet the demand of the system when input voltage and load current vary. In such cases, the variation of output voltage can be minimized significantly by using 10  $\mu\text{F}$  or higher ceramic capacitor. When using an electrolytic capacitor for the output line, place the electrolytic capacitor outer side of the ceramic capacitor arranged close to the IC.



## ESR vs. Output Current

It is recommended that a ceramic type capacitor be used for this device. However, other types of capacitors having lower ESR can also be used. The relation between the output current ( $I_{OUT}$ ) and the ESR of output capacitor is shown below.



**R1524x018B****R1524x033B****R1524x050B****R1524x090B****R1524x120B****Measurement Conditions**

Frequency Band: 10 Hz to 2 MHz

Measurement Temperature:  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$ Hatched area: Noise level is 40  $\mu\text{V}$  (average) or below

Ceramic Capacitors:

 $C_{IN}$  = 0.1  $\mu\text{F}$ , Murata, GRM188R71H104JA93D $C_{OUT}$  = 0.1  $\mu\text{F}$ , TDK, CGA3E2X7R1E104K

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

Measurement Conditions

| Item             | Measurement Conditions                                                                                                                                                                       |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environment      | Mounting on Board (Wind Velocity = 0 m/s)                                                                                                                                                    |
| Board Material   | Glass Cloth Epoxy Plastic (Four-Layer Board)                                                                                                                                                 |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm                                                                                                                                                                  |
| Copper Ratio     | Outer Layer (First Layer): Less than 95% of 50 mm Square<br>Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square<br>Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square |
| Through-holes    | φ 0.3 mm × 7 pcs                                                                                                                                                                             |

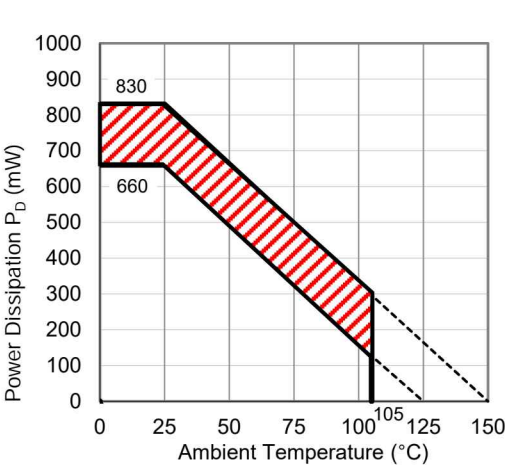
Measurement Result

(Ta = 25°C, Tjmax = 125°C)

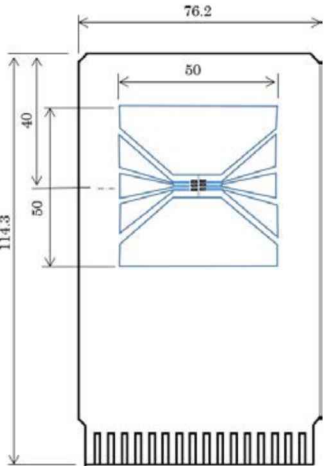
| Item                                     | Measurement Result |
|------------------------------------------|--------------------|
| Power Dissipation                        | 660 mW             |
| Thermal Resistance (θja)                 | θja = 150°C/W      |
| Thermal Characterization Parameter (ψjt) | ψjt = 51°C/W       |

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



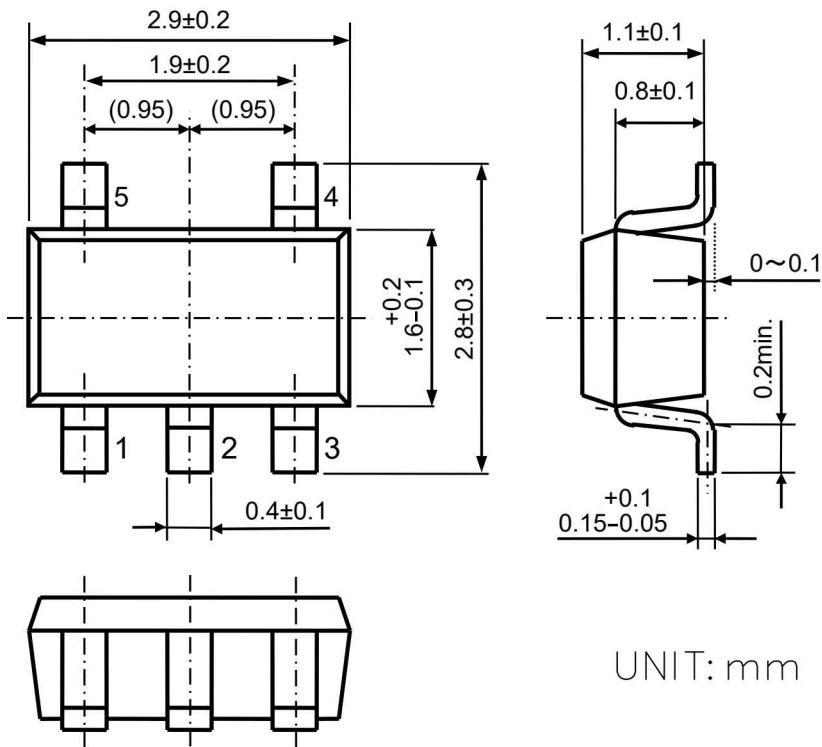
Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

| Total Hours of Use | Total Years of Use (4 hours/day) |
|--------------------|----------------------------------|
| 13,000 hours       | 9 years                          |



SOT-23-5 Package Dimensions

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

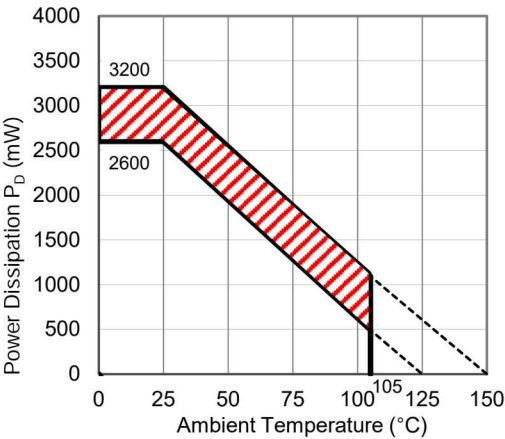
Measurement Conditions

| Item             | Measurement Conditions                                                                                                                                                                       |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environment      | Mounting on Board (Wind Velocity = 0 m/s)                                                                                                                                                    |
| Board Material   | Glass Cloth Epoxy Plastic (Four-Layer Board)                                                                                                                                                 |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm                                                                                                                                                                  |
| Copper Ratio     | Outer Layer (First Layer): Less than 95% of 50 mm Square<br>Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square<br>Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square |
| Through-holes    | φ 0.3 mm × 13 pcs                                                                                                                                                                            |

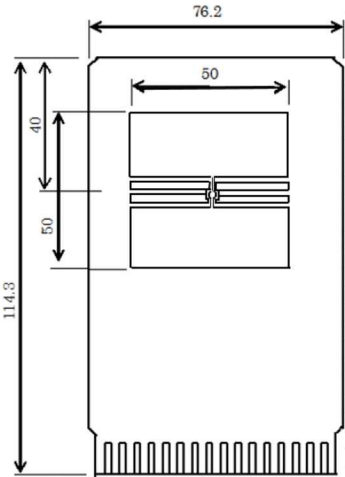
Measurement Result (Ta = 25°C, Tjmax = 125°C)

| Item                                     | Measurement Result |
|------------------------------------------|--------------------|
| Power Dissipation                        | 2600 mW            |
| Thermal Resistance (θja)                 | θja = 38°C/W       |
| Thermal Characterization Parameter (ψjt) | ψjt = 13°C/W       |

θja: Junction-to-Ambient Thermal Resistance  
ψjt: Junction-to-Top Thermal Characterization Parameter



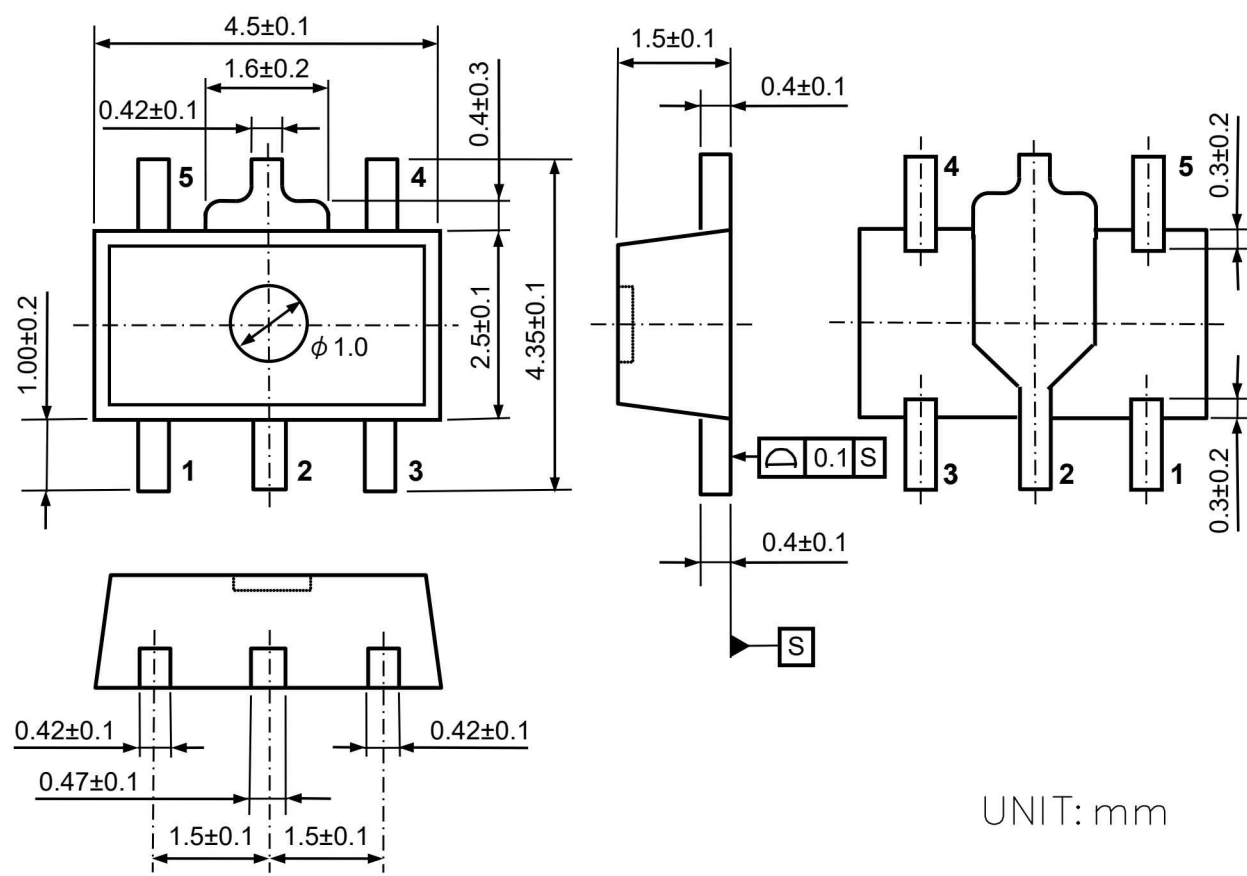
Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

| Total Hours of Use | Total Years of Use (4 hours/day) |
|--------------------|----------------------------------|
| 13,000 hours       | 9 years                          |



UNIT: mm

SOT-89-5 Package Dimensions

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

Measurement Conditions

| Item             | Measurement Conditions                                                                                                                                                                       |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environment      | Mounting on Board (Wind Velocity = 0 m/s)                                                                                                                                                    |
| Board Material   | Glass Cloth Epoxy Plastic (Four-Layer Board)                                                                                                                                                 |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm                                                                                                                                                                  |
| Copper Ratio     | Outer Layer (First Layer): Less than 95% of 50 mm Square<br>Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square<br>Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square |
| Through-holes    | φ 0.3 mm × 28 pcs                                                                                                                                                                            |

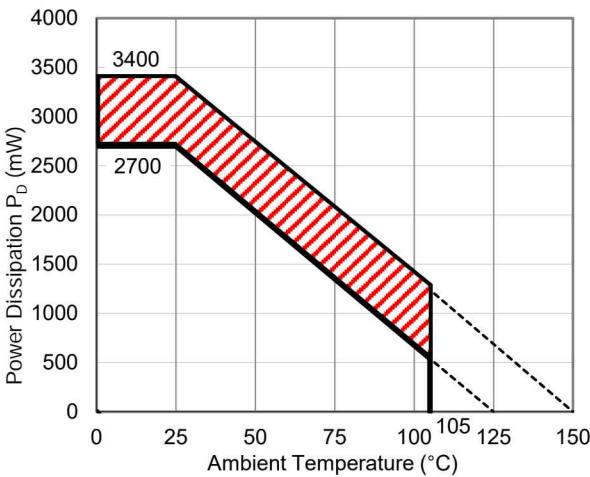
Measurement Result

(Ta = 25°C, Tjmax = 125°C)

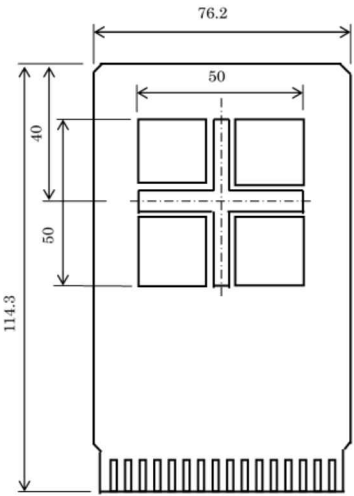
| Item                                     | Measurement Result |
|------------------------------------------|--------------------|
| Power Dissipation                        | 2700 mW            |
| Thermal Resistance (θja)                 | θja = 37°C/W       |
| Thermal Characterization Parameter (ψjt) | ψjt = 7°C/W        |

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



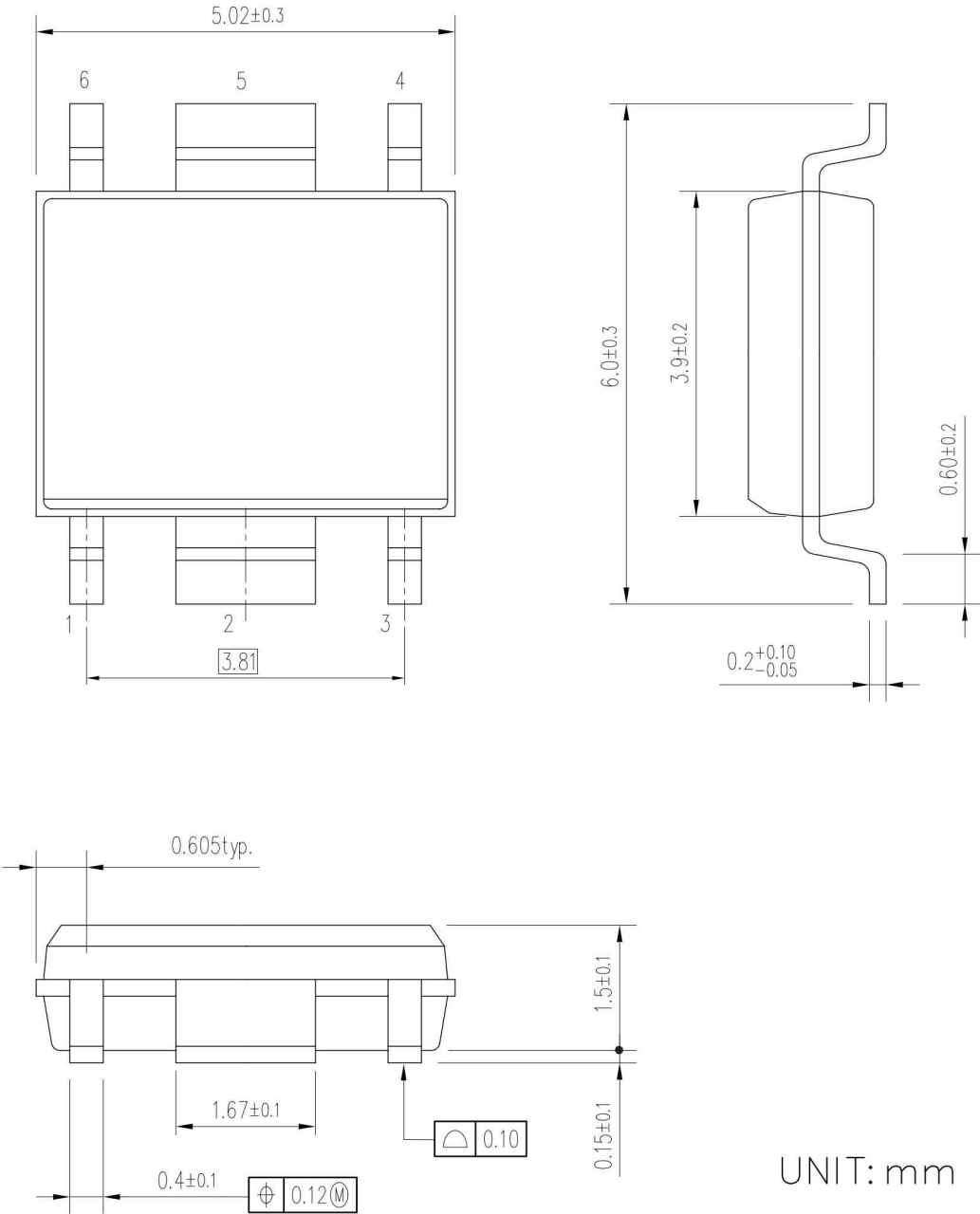
Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

The above graph shows the power dissipation of the package at Tjmax = 125°C and Tjmax = 150°C. Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

| Total Hours of Use | Total Years of Use (4 hours/day) |
|--------------------|----------------------------------|
| 13,000 hours       | 9 years                          |



HSOP-6J Package Dimensions

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51.

**Measurement Conditions**

| Item             | Measurement Conditions                                                                                                                                                                       |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environment      | Mounting on Board (Wind Velocity = 0 m/s)                                                                                                                                                    |
| Board Material   | Glass Cloth Epoxy Plastic (Four-Layer Board)                                                                                                                                                 |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm                                                                                                                                                                  |
| Copper Ratio     | Outer Layer (First Layer): Less than 95% of 50 mm Square<br>Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square<br>Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square |
| Through-holes    | φ 0.2 mm × 36 pcs                                                                                                                                                                            |

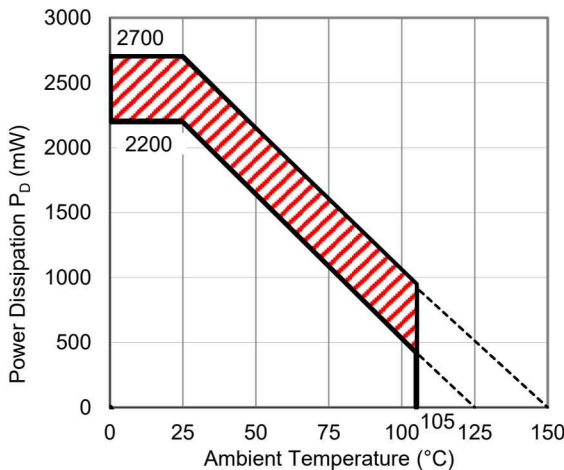
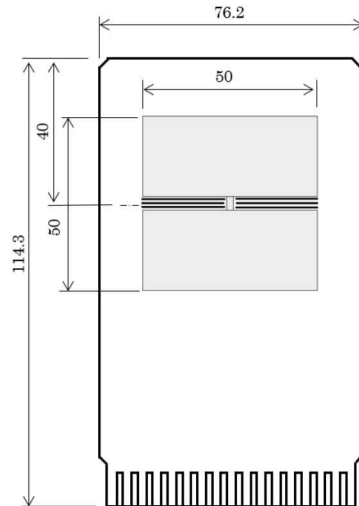
**Measurement Result**

(Ta = 25°C, Tjmax = 125°C)

| Item                                               | Measurement Result                   |
|----------------------------------------------------|--------------------------------------|
| Power Dissipation                                  | 2200 mW                              |
| Thermal Resistance ( $\theta_{ja}$ )               | $\theta_{ja} = 45^{\circ}\text{C/W}$ |
| Thermal Characterization Parameter ( $\psi_{jt}$ ) | $\psi_{jt} = 18^{\circ}\text{C/W}$   |

$\theta_{ja}$ : Junction-to-ambient thermal resistance.

$\psi_{jt}$ : Junction-to-top of package thermal characterization parameter.

**Power Dissipation vs. Ambient Temperature****Measurement Board Pattern**

The above graph shows the power dissipation of the package at  $T_{jmax} = 125^{\circ}\text{C}$  and  $T_{jmax} = 150^{\circ}\text{C}$ . Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

| Total Hours of Use | Total Years of Use (4 hours/day) |
|--------------------|----------------------------------|
| 13,000 hours       | 9 years                          |

UNIT: mm

### DFN(PL)1820-6 Package Dimensions

**Nisshinbo Micro Devices Inc.**

# POWER DISSIPATION

# HSOP-8E

PD-HSOP-8E-(105125150)-JE-B

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions.  
The following measurement conditions are based on JEDEC STD. 51-7.

## Measurement Conditions

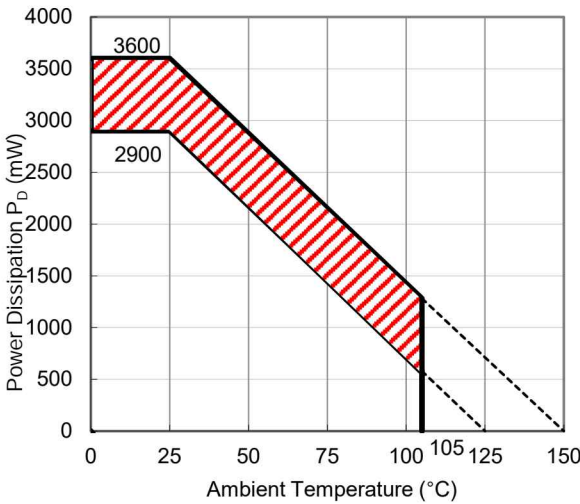
| Item             | Measurement Conditions                                                                                                                                                                       |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Environment      | Mounting on Board (Wind Velocity = 0 m/s)                                                                                                                                                    |
| Board Material   | Glass Cloth Epoxy Plastic (Four-Layer Board)                                                                                                                                                 |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm                                                                                                                                                                  |
| Copper Ratio     | Outer Layer (First Layer): Less than 95% of 50 mm Square<br>Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square<br>Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square |
| Through-holes    | φ 0.3 mm × 21 pcs                                                                                                                                                                            |

## Measurement Result (Ta = 25°C, Tjmax = 125°C)

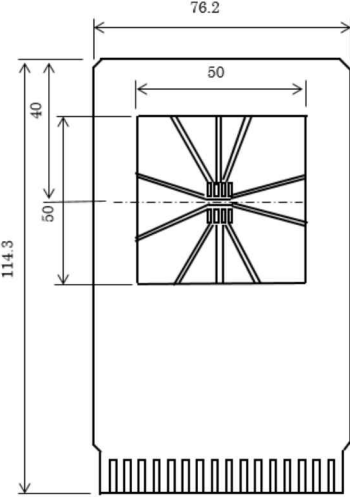
| Item                                               | Measurement Result                     |
|----------------------------------------------------|----------------------------------------|
| Power Dissipation                                  | 2900 mW                                |
| Thermal Resistance ( $\theta_{ja}$ )               | $\theta_{ja} = 34.5^{\circ}\text{C/W}$ |
| Thermal Characterization Parameter ( $\psi_{jt}$ ) | $\psi_{jt} = 10^{\circ}\text{C/W}$     |

$\theta_{ja}$ : Junction-to-ambient thermal resistance.

$\psi_{jt}$ : Junction-to-top of package thermal characterization parameter.



Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

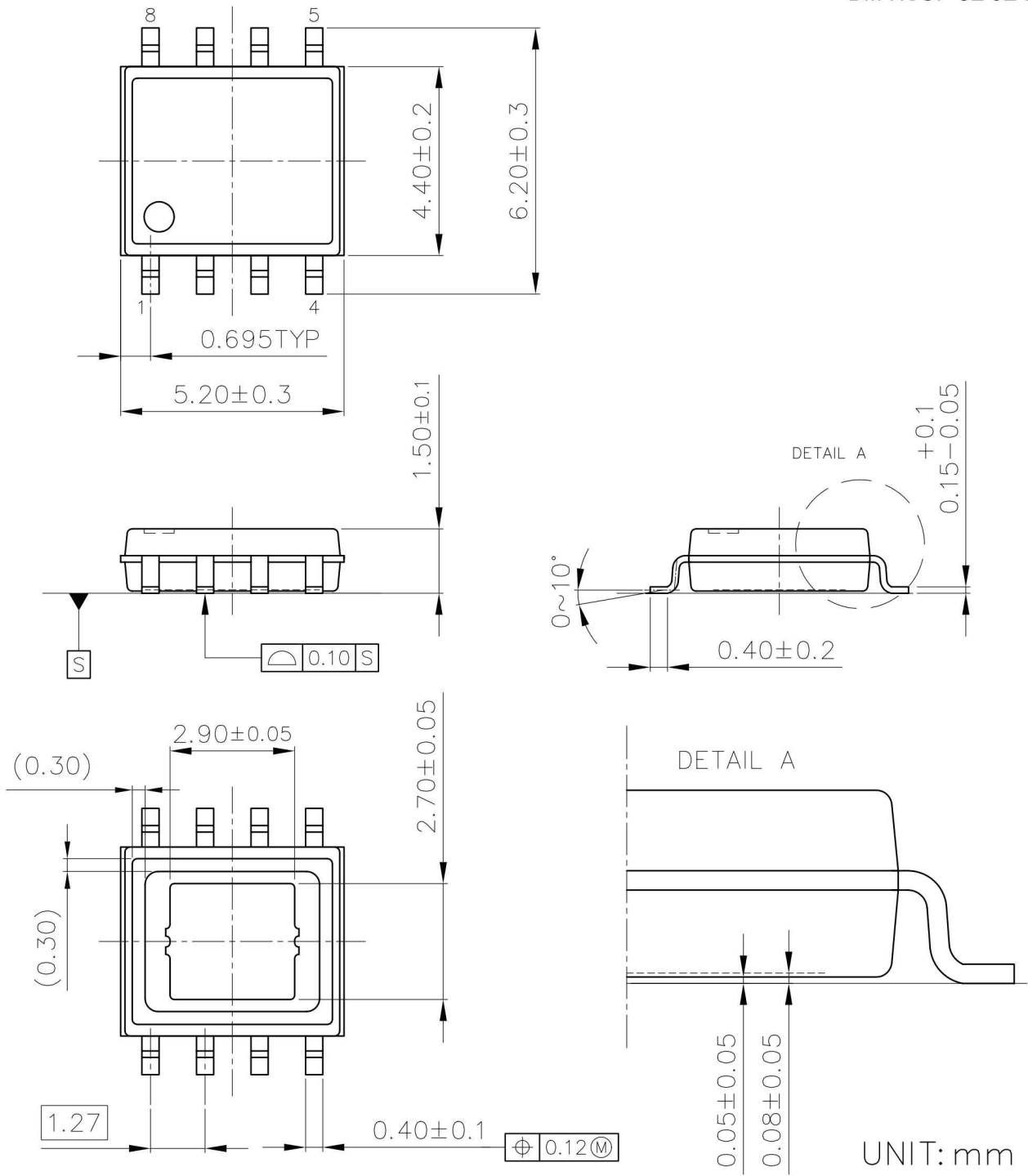
The above graph shows the power dissipation of the package at  $T_{jmax} = 125^{\circ}\text{C}$  and  $T_{jmax} = 150^{\circ}\text{C}$ .  
Operating the device in the hatched range might have a negative influence on its lifetime. The total hours of use and the total years of use must be limited as follows:

| Total Hours of Use | Total Years of Use (4 hours/day) |
|--------------------|----------------------------------|
| 13,000 hours       | 9 years                          |

PACKAGE DIMENSIONS

HSOP-8E

DM-HSOP-8E-JE-B



HSOP-8E Package Dimensions

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  - 8-1. **Quality Warranty Period**

In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
  - 8-2. **Quality Warranty Remedies**

When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.

Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
  - 8-3. **Remedies after Quality Warranty Period**

With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
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10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
12. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.
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