# 200 mA 36 V Input Ultra Low Supply Current VR for Automotive Applications

No. EC-332-250609

## 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 between −40°C to 125°C, and the maximum input voltage is 36 V. All these features allow this device to become an ideal power source for car accessories and ECUs.
The output voltages are internally fixed (refer to *SELECTION GUIDE*). The output voltage accuracy is ±0.6%. The packages for this device range from high-density mounting to ultra high wattage. The R1524x is offered in four packages; a 5-pin SOT-23-5, a 5-pin SOT-89-5, and a 6-pin HSOP-6J, 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°C to 125°C
- Supply Current ····· Typ. 2.2 µA
- Standby Current····· Typ. 0.1 µA
- Dropout Voltage····· Typ. 0.6 V ($I_{OUT}$ = 200 mA, $V_{OUT}$ = 5.0 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 / 7.5 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····· ±0.6% (Ta = 25°C)
- Output Voltage Temperature-Drift Coefficient ····· Typ. ±60 ppm/°C
- Line Regulation····· Typ. 0.01%/V ($V_{SET}$ + 1 V ≤ $V_{IN}$ ≤ 36 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°C
- Ceramic capacitors are recommended to be used with this device ····· $C_{OUT}$ = 0.1 µF or more
- Packages····· SOT-23-5, SOT-89-5, HSOP-6J, HSOP-8E

## APPLICATIONS

- Power source for accessories such as car audios, car navigation systems, and ETC systems
- Power source for ECUs such as EV inverter and battery charge control unit

# SELECTION GUIDE

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

**Selection Guide**

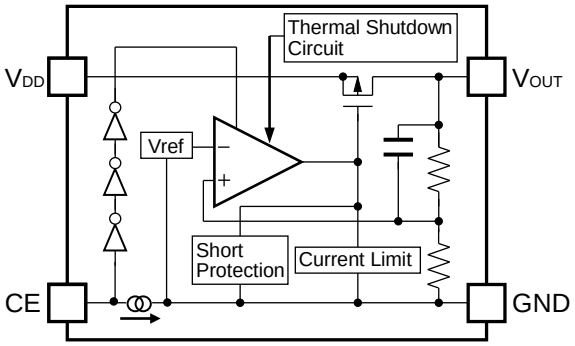
| Product Name | Package | Quantity per Reel | Pb Free | Halogen Free |
|---|---|---|---|---|
| R1524NxxxB-TR-#E | SOT-23-5 | 3,000 pcs | Yes | Yes |
| R1524HxxxB-T1-#E | SOT-89-5 | 1,000 pcs | Yes | Yes |
| R1524SxxxB-E2-#E | HSOP-6J | 1,000 pcs | Yes | Yes |
| R1524SxxxH-E2-#E | HSOP-8E | 1,000 pcs | 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) / 7.5 V (075) / 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.

# : Quality Class

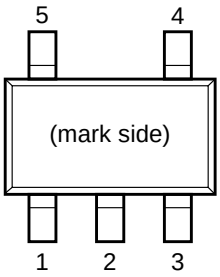
| # | Operating Temperature Range | Test Temperature |
|---|---|---|
| A | −40°C to 125°C | 25°C, High |
| K | −40°C to 125°C | Low, 25°C, High |

# BLOCK DIAGRAM

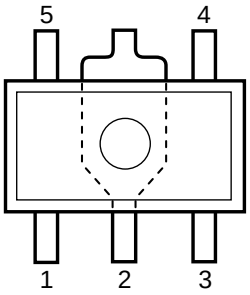



**R1524x Block Diagram**

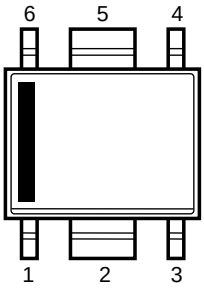
## PIN DESCRIPTIONS



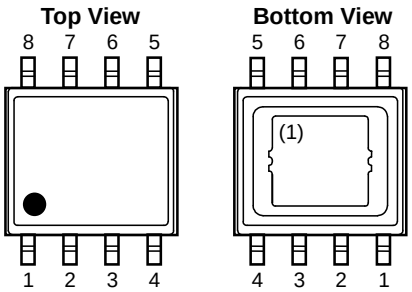

**SOT-23-5 Pin Configuration**




**SOT-89-5 Pin Configuration**




**HSOP-6J Pin Configuration**




**HSOP-8E Pin Configuration**

**SOT-23-5 Pin Descriptions**

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

**SOT-89-5 Pin Descriptions**

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

**HSOP-6J Pin Descriptions**

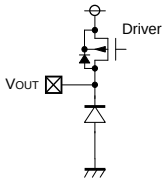
[1] The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). It is recommended that the tab be connected to the ground plane on the board, or otherwise be left open.
[2] The GND pin must be wired together when it is mounted on board.

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

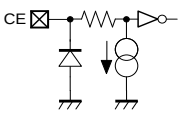
**HSOP-8E Pin Descriptions**

| 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**

(1) 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(1) | | 60 | V |
| $V_{CE}$ | Input Voltage (CE Pin) | | −0.3 to 50 | V |
| $V_{OUT}$ | Output Voltage | | −0.3 to $V_{IN}$ + 0.3 ≤ 50 | V |
| $I_{OUT}$ | Output Current | | 300 | mA |
| $P_D$ | Power Dissipation(2) (JEDEC STD.51-7 Test Land Pattern) | SOT-23-5 | 830 | mW |
| | | SOT-89-5 | 3200 | |
| | | HSOP-6J | 3400 | |
| | | HSOP-8E | 3600 | |
| Tj | Junction Temperature Range | | −40 to 150 | °C |
| Tstg | Storage Temperature Range | | −55 to 150 | °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 |
| Ta | Operating Temperature Range | −40 to 125 | °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.

(1) Duration time: 200 ms
(2) Refer to *POWER DISSIPATION* for detailed information.

# ELECTRICAL CHARACTERISTICS

$C_{IN}$ = $C_{OUT}$ = 0.1 µF, unless otherwise noted.

The specifications surrounded by ☐ are guaranteed by design engineering at -40°C ≤ Ta ≤ 125°C.

**R1524x (-AE) Electrical Characteristics** (Ta = 25°C)

| Symbol | Item | Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $I_{SS}$ | Supply Current | $V_{IN}$ = 14 V, $I_{OUT}$ = 0 mA | $V_{SET}$ ≤ 5.0 V | | 2.2 | 6.5 | µA |
| | | | 5.0 V < $V_{SET}$ | | 2.5 | 6.8 | |
| Istandby | Standby Current | $V_{IN}$ = 36 V, $V_{CE}$ = 0 V | | | 0.1 | 1.0 | µA |
| $V_{OUT}$ | Output Voltage | $V_{SET}$ + 1 V[1] ≤ $V_{IN}$ ≤ 36 V, $I_{OUT}$ = 1 mA | Ta = 25°C | ×0.994 | | ×1.006 | V |
| | | | −40°C ≤ Ta ≤ 125°C | ×0.984 | | ×1.016 | |
| $\Delta V_{OUT}$ /$\Delta I_{OUT}$ | Load Regulation | $V_{IN}$ = $V_{SET}$ + 3.0 V, 1 mA ≤ $I_{OUT}$ ≤ 200 mA | | Refer to the *Product-specific Electrical Characteristics* | | | |
| $\Delta V_{OUT}$ /$\Delta V_{IN}$ | Line Regulation | $V_{SET}$ + 1 V[1] ≤ $V_{IN}$ ≤ 36 V, $I_{OUT}$ = 1 mA | $V_{SET}$ < 3.3 V | -20 | 5 | 20 | mV |
| | | | 3.3 V ≤ $V_{SET}$ | -0.02 | 0.01 | 0.02 | %/V |
| $V_{DIF}$ | Dropout Voltage | $I_{OUT}$ = 200 mA | | Refer to the *Product-specific Electrical Characteristics* | | | |
| $I_{LIM}$ | Output Current Limit | $V_{IN}$ = $V_{SET}$ + 3.0 V | | 220 | 350 | 420 | mA |
| $I_{SC}$ | Short Current Limit | $V_{IN}$ = 3.5 V, $V_{OUT}$ = 0 V | | 60 | 80 | 110 | mA |
| $V_{CEH}$ | CE Pin Input Voltage, high | $V_{IN}$ = VSET + 1 V[1] | | 2.0 | | 36 | V |
| $V_{CEL}$ | CE Pin Input Voltage, low | $V_{IN}$ = 36 V | | 0 | | 1.0 | V |
| $I_{PD}$ | CE Pull-down Current | $V_{IN}$ = 36 V, $V_{CE}$ = 2 V | | | 0.2 | 0.6 | µA |
| $T_{TSD}$ | Thermal Shutdown Detection Temperature | Junction Temperature | | | 160 | | °C |
| $T_{TSR}$ | Thermal Shutdown Released Temperature | Junction Temperature | | | 135 | | °C |

All test items listed under Electrical Characteristics are done under the pulse load condition (Tj ≈ Ta = 25°C).

[1] $V_{SET}$ ≤ 2.5 V, $V_{IN}$ = 3.5 V

The specifications surrounded by ☐ are guaranteed by design engineering at -40°C ≤ Ta ≤ 125°C.

**R1524x (-AE) Product-specific Electrical Characteristics** (Ta = 25°C)

| Product Name | $V_{OUT}$ (V) (Ta = 25°C) | | | $V_{OUT}$ (V) (−40°C ≤ Ta ≤ 125°C) | | | $\Delta V_{OUT}/\Delta I_{OUT}$ (mV) | | | $V_{DIF}$ (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 | | | | 1.6 | 2.5 |
| R1524x025x | 2.4850 | 2.50 | 2.5150 | 2.4600 | 2.50 | 2.5400 | | | | | |
| R1524x028x | 2.7832 | 2.80 | 2.8168 | 2.7552 | 2.80 | 2.8448 | | | | 1.2 | 2.2 |
| R1524x030x | 2.9820 | 3.00 | 3.0180 | 2.9520 | 3.00 | 3.0480 | -10 | 10 | 40 | | |
| 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 | | | | 0.8 | 2.0 |
| R1524x050x | 4.9700 | 5.00 | 5.0300 | 4.9200 | 5.00 | 5.0800 | | | | | |
| 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 | | | | 0.6 | |
| R1524x070x | 6.9580 | 7.00 | 7.0420 | 6.8880 | 7.00 | 7.1120 | | | | | |
| R1524x075x | 7.4550 | 7.50 | 7.5450 | 7.3800 | 7.50 | 7.6200 | | | | | |
| R1524x080x | 7.9520 | 8.00 | 8.0480 | 7.8720 | 8.00 | 8.1280 | | | | | 1.2 |
| R1524x085x | 8.4490 | 8.50 | 8.5510 | 8.3640 | 8.50 | 8.6360 | -18 | 18 | 72 | | |
| 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 | | | | 0.5 | |
| 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 | | | | | |

$C_{IN}$ = $C_{OUT}$ = 0.1 µF, unless otherwise noted.

**R1524x (-KE) Electrical Characteristics** (−40°C ≤ Ta ≤ 125°C)

| Symbol | Item | Conditions | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| $I_{SS}$ | Supply Current | $V_{IN}$ = 14 V<br>$I_{OUT}$ = 0 mA | $V_{SET}$ ≤ 5.0 V | | 2.2 | 6.5 | µA |
| | | | 5.0 V < $V_{SET}$ | | 2.5 | 6.8 | |
| Istandby | Standby Current | $V_{IN}$ = 36 V, $V_{CE}$ = 0 V | | | 0.1 | 1.0 | µA |
| $V_{OUT}$ | Output Voltage | $V_{SET}$ + 1 V[(1)] ≤ $V_{IN}$ ≤ 36 V, $I_{OUT}$ = 1 mA | Ta = 25°C | ×0.994 | | ×1.006 | V |
| | | | −40°C ≤ Ta ≤ 125°C | ×0.984 | | ×1.016 | |
| $\Delta V_{OUT}$ /$\Delta I_{OUT}$ | Load Regulation | $V_{IN}$ = $V_{SET}$ + 3.0 V<br>1 mA ≤ $I_{OUT}$ ≤ 200 mA | | Refer to the *Product-specific Electrical Characteristics* | | | |
| $\Delta V_{OUT}$ /$\Delta V_{IN}$ | Line Regulation | $V_{SET}$ + 1 V[(1)] ≤ $V_{IN}$ ≤ 36 V, $I_{OUT}$ = 1 mA | $V_{SET}$ < 3.3 V | -20 | 5 | 20 | mV |
| | | | 3.3 V ≤ $V_{SET}$ | -0.02 | 0.01 | 0.02 | %/V |
| $V_{DIF}$ | Dropout Voltage | $I_{OUT}$ = 200 mA | | Refer to the *Product-specific Electrical Characteristics* | | | |
| $I_{LIM}$ | Output Current Limit | $V_{IN}$ = $V_{SET}$ + 3.0 V | | 220 | 350 | 420 | mA |
| $I_{SC}$ | Short Current Limit | $V_{IN}$ = 3.5 V, $V_{OUT}$ = 0 V | | 60 | 80 | 110 | mA |
| $V_{CEH}$ | CE Pin Input Voltage, high | $V_{IN}$ = VSET + 1 V[(1)] | | 2.0 | | 36 | V |
| $V_{CEL}$ | CE Pin Input Voltage, low | $V_{IN}$ = 36 V | | 0 | | 1.0 | V |
| $I_{PD}$ | CE Pull-down Current | $V_{IN}$ = 36 V, $V_{CE}$ = 2 V | | | 0.2 | 0.6 | µA |
| $T_{TSD}$ | Thermal Shutdown Detection Temparature | Junction Temperature | | 150 | 160 | | °C |
| $T_{TSR}$ | Thermal Shutdown Released Temperature | Junction Temperature | | 125 | 135 | | °C |

[(1)] $V_{SET}$ ≤ 2.5 V, $V_{IN}$ = 3.5 V

**R1524x (-KE) Product-specific Electrical Characteristics** (−40°C ≤ Ta ≤ 125°C)

| Product Name | $V_{OUT}$ (V) (Ta = 25°C) | | | $V_{OUT}$ (V) (−40°C ≤ Ta ≤ 125°C) | | | $\Delta V_{OUT}/\Delta I_{OUT}$ (mV) | | | $V_{DIF}$ (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 | | | | 0.8 | 2.0 |
| 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 | | | | 0.6 | 1.2 |
| R1524x055x | 5.4670 | 5.50 | 5.5330 | 5.4120 | 5.50 | 5.5880 | -18 | 18 | 72 | | |
| 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 | | | | | |
| R1524x075x | 7.4550 | 7.50 | 7.5450 | 7.3800 | 7.50 | 7.6200 | | | | | |
| R1524x080x | 7.9520 | 8.00 | 8.0480 | 7.8720 | 8.00 | 8.1280 | | | | 0.5 | |
| R1524x085x | 8.4490 | 8.50 | 8.5510 | 8.3640 | 8.50 | 8.6360 | | | | | |
| 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 | | | | | |

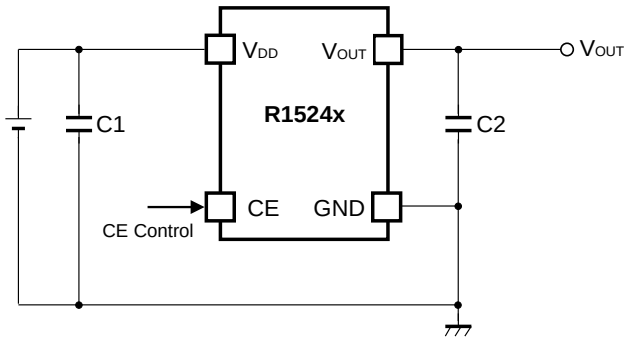
# THEORY OF OPERATION

### 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

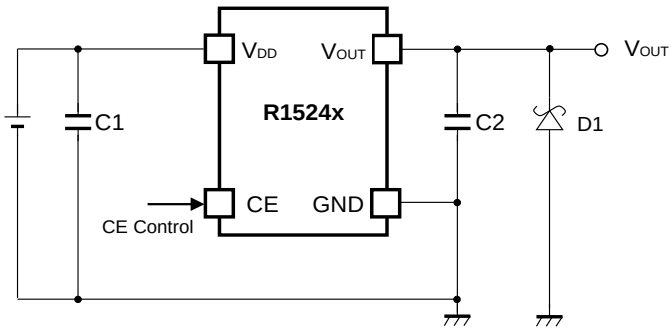
### TYPICAL APPLICATIONS




C1 = Ceramic 0.1 µF
C2 = Ceramic 0.1 µF

**R1524x Typical Applications**

### TYPICAL APPLICATION FOR IC CHIP BREAKDOWN PREVENTION




C1 = Ceramic 0.1 µF
C2 = Ceramic 0.1 µF

**R1524x Typical Application for IC Chip Breakdown Prevention**

When a sudden surge of electrical current travels along the $V_{OUT}$ pin and GND due to a short-circuit, electrical resonance of a circuit involving an output capacitor (C2) and a short circuit inductor generates a negative voltage and may damage the device or the load devices. Connecting a schottky diode (D1) between the $V_{OUT}$ pin and GND has the effect of preventing damage to them.

# 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 µF 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 µF 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.

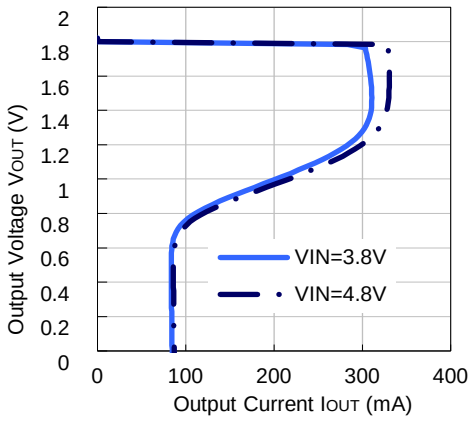
For HSOP-6J package type, wire the following GND pins together: No. 2, No. 4, and No. 5.

# TYPICAL CHARACTERISTICS

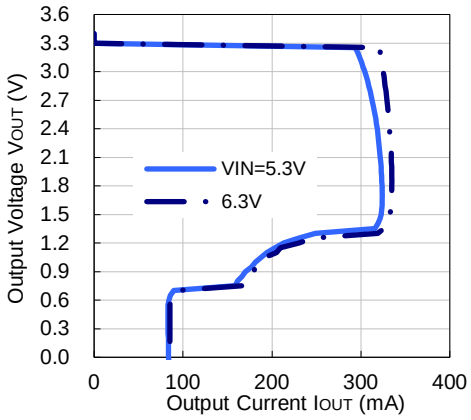
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

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

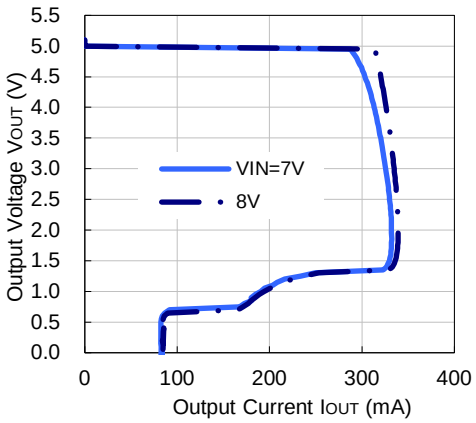
**R1524x018B**



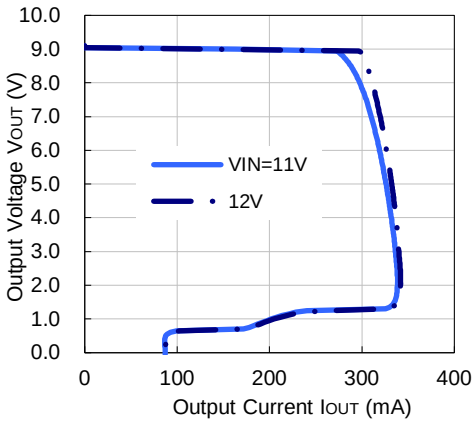

**R1524x033B**



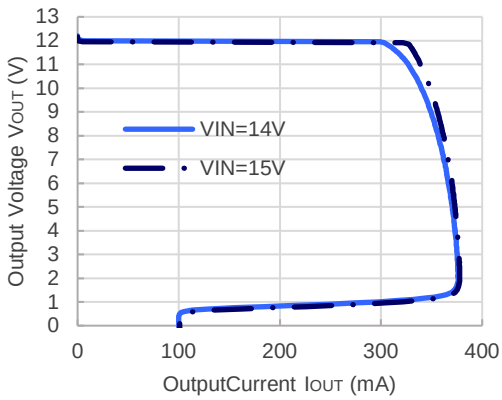

**R1524x050B**




**R1524x090B**

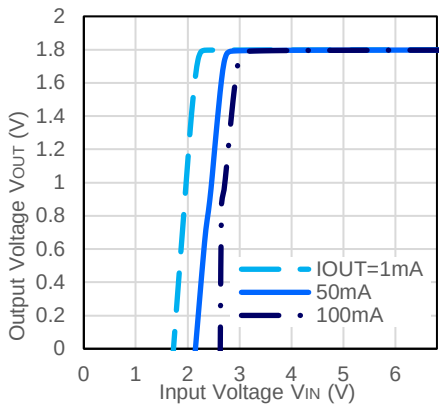



**R1524x120B**

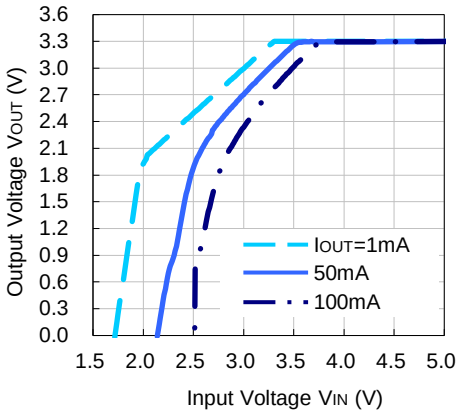


**2) Output Voltage vs. Input Voltage (Ta = 25°C)**

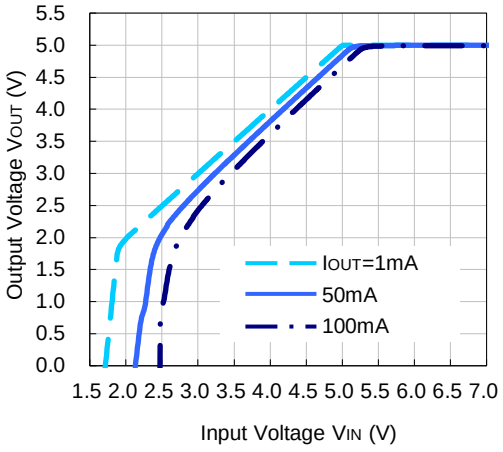
**R1524x018B**



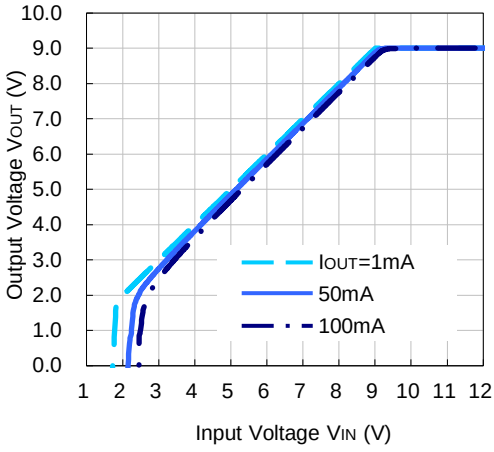

**R1524x033B**



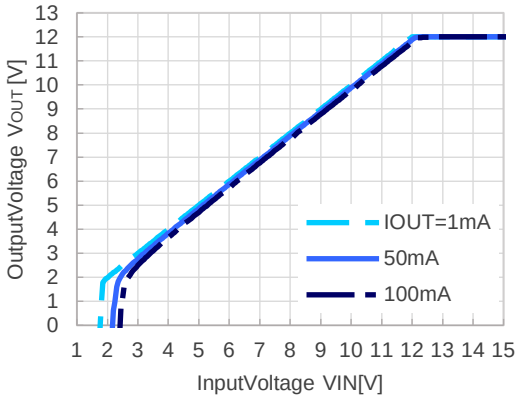

**R1524x050B**




**R1524x090B**

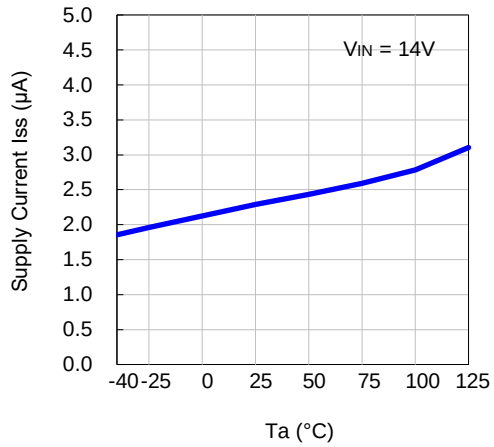



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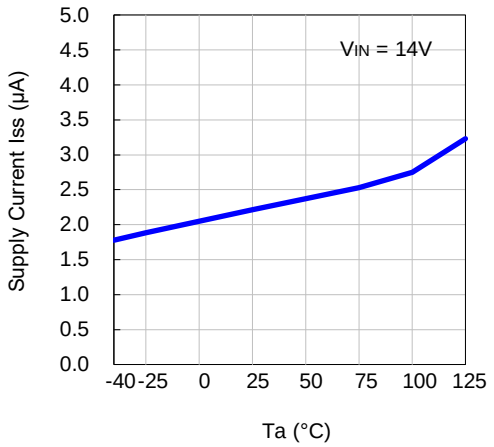


### 3) Supply Current vs. Temperature

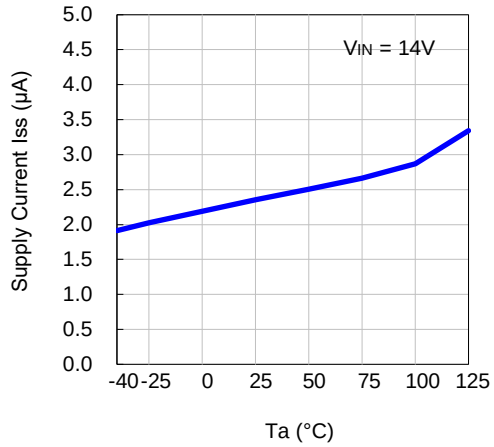
**R1524x018B**



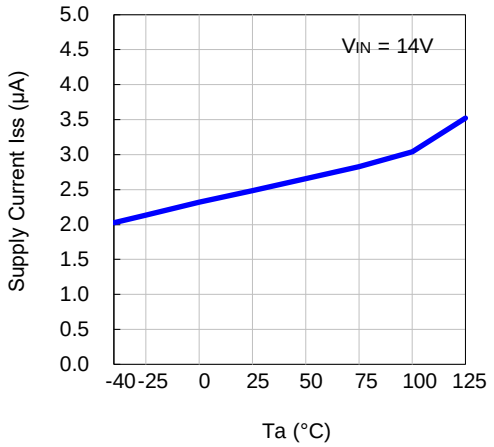

**R1524x033B**



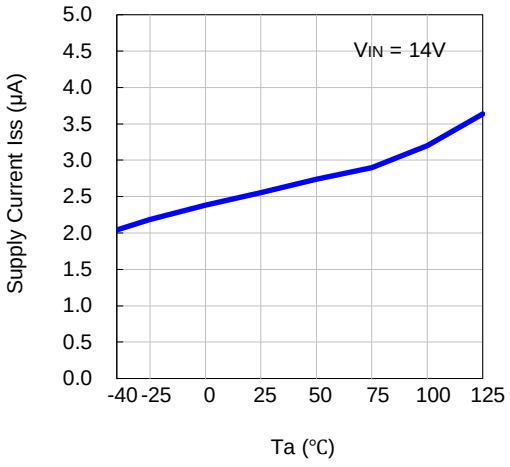

**R1524x050B**




**R1524x090B**

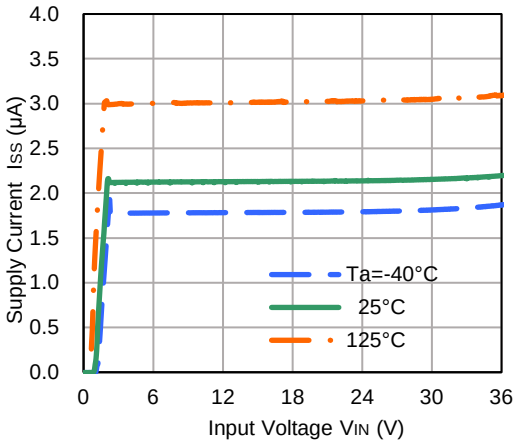



**R1524x120B**

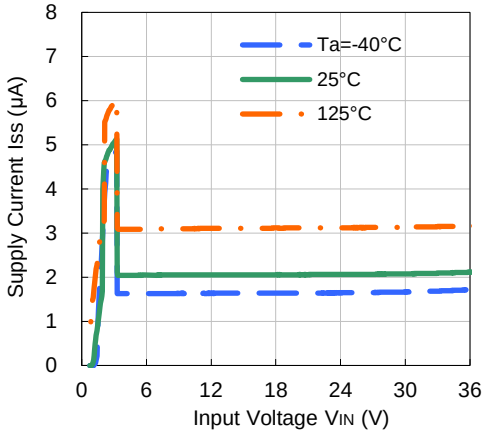


### 4) Supply Current vs. Input Voltage

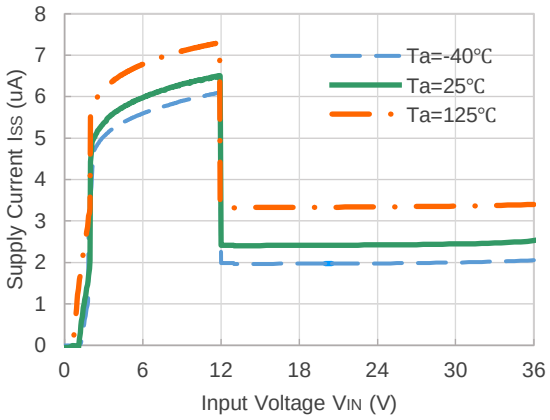
**R1524x018B**




**R1524x033B**

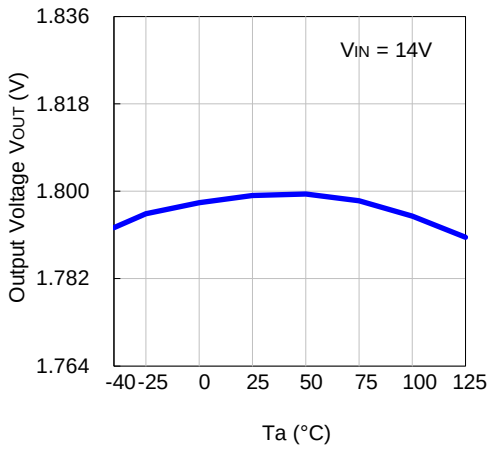



**R1524x120B**

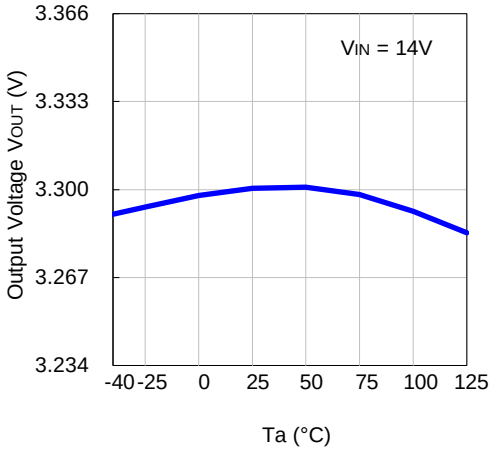



### 5) Output Voltage vs. Temperature ($I_{OUT}$ = 1mA)

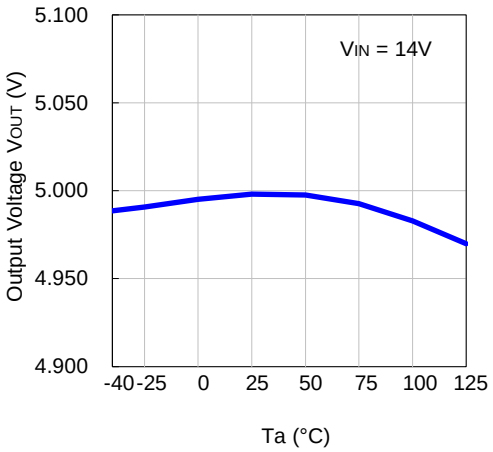
**R1524x018B**



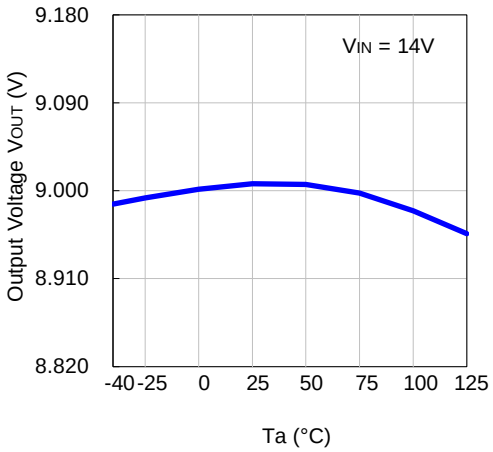

**R1524x033B**



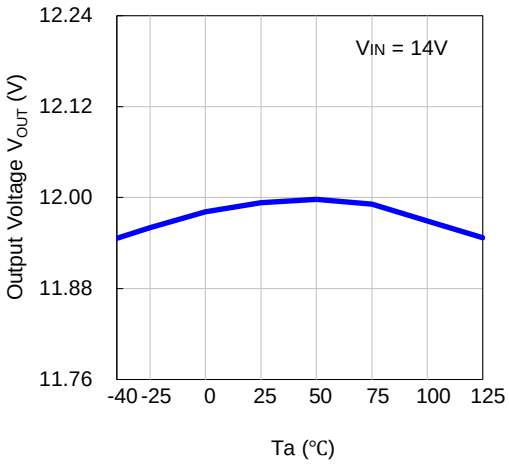
**R1524x050B**




**R1524x090B**

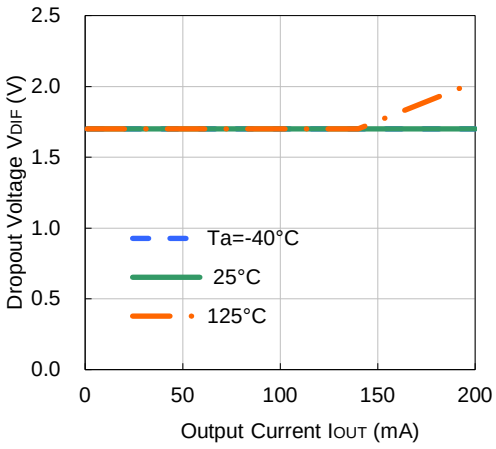



**R1524x120B**

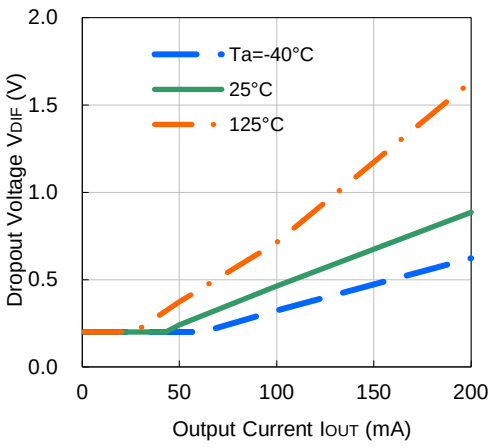



## 6) Dropout Voltage vs. Output Current

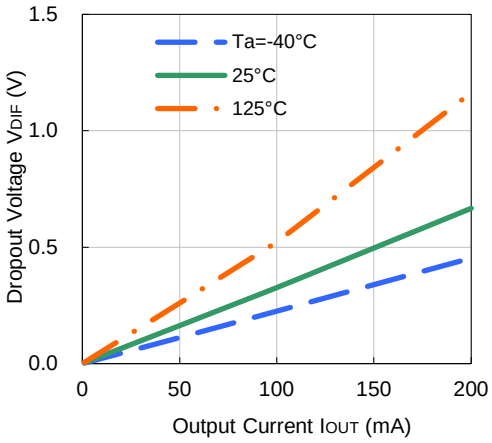
**R1524x018B**



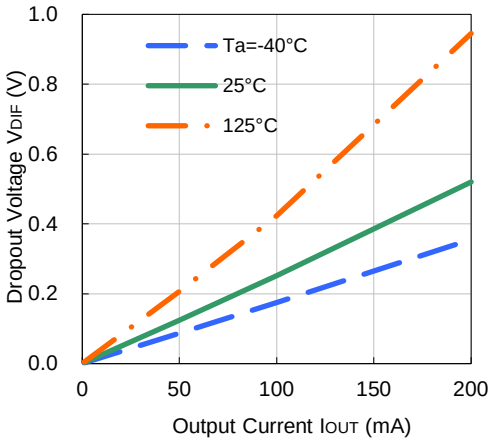

**R1524x033B**



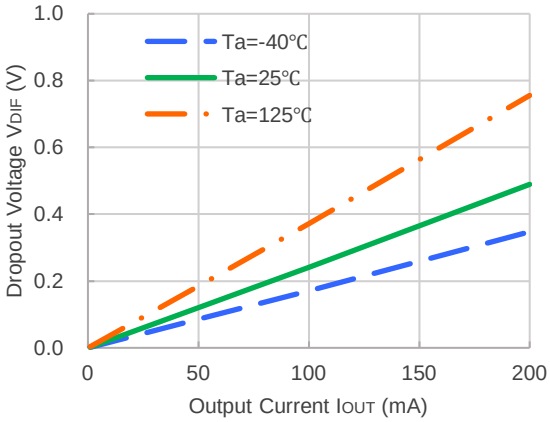
**R1524x050B**



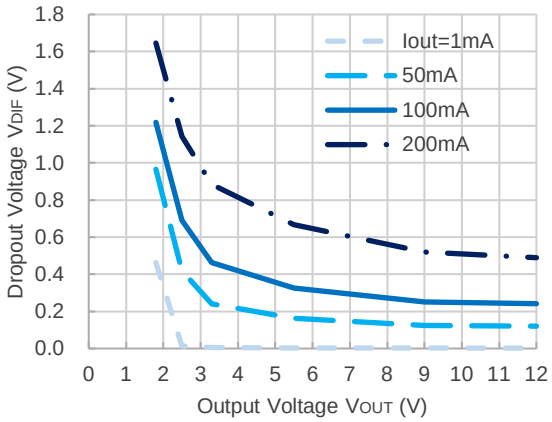

**R1524x090B**




**R1524x120B**

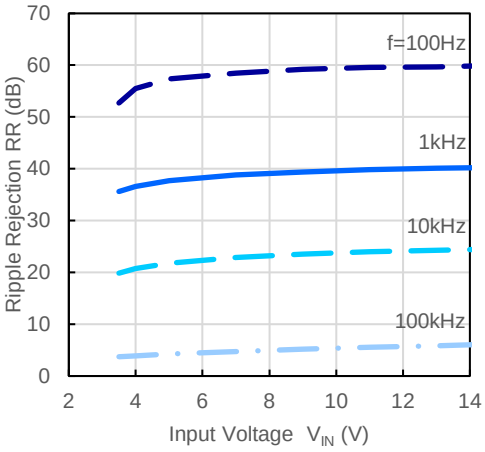



**7) Dropout Voltage vs. Output Voltage (Ta = 25°C)**

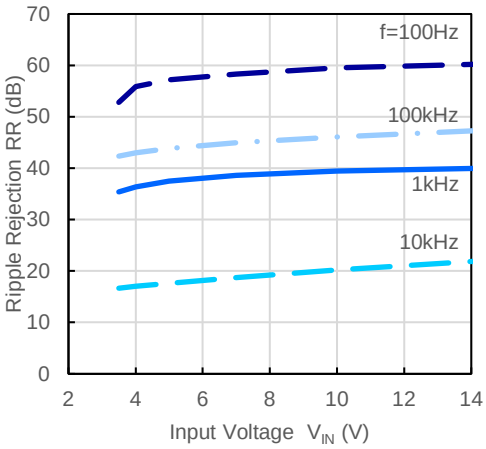


**8) Ripple Rejection vs. Input Voltage (Ta = 25°C, Ripple = 0.2Vpp, $I_{out}$ = 50mA)**

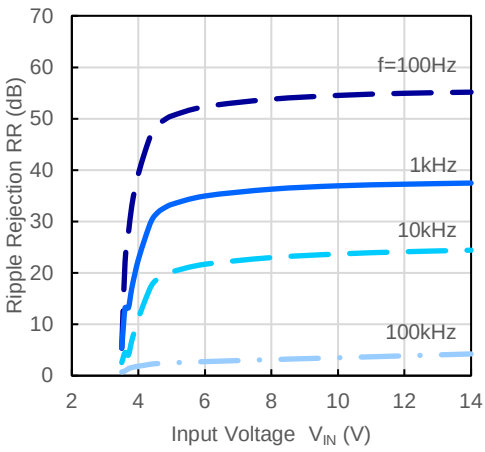
**R1524x018B ($C_2$ = 0.1µF)**



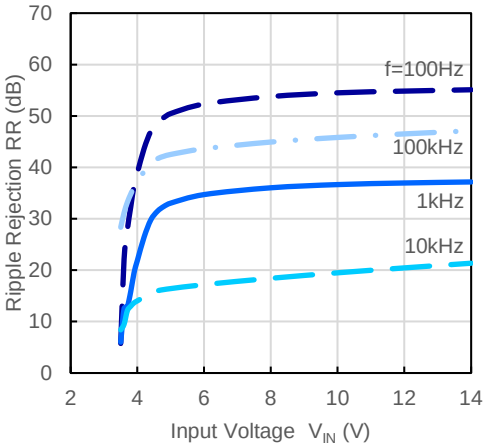

**R1524x018B ($C_2$ = 10µF)**



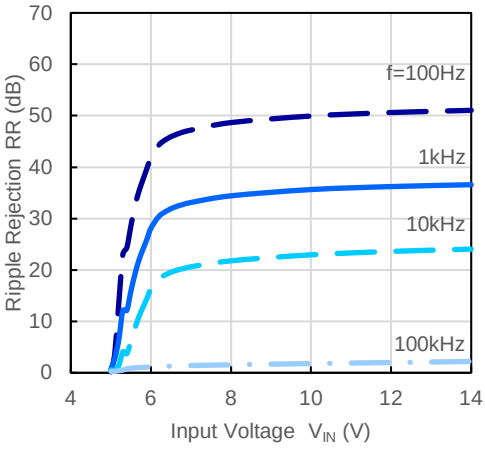

**R1524x033B ($C_2$ = 0.1µF)**



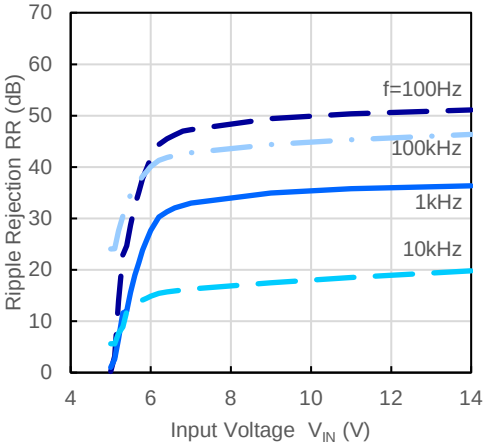

**R1524x033B ($C_2$ = 10µF)**



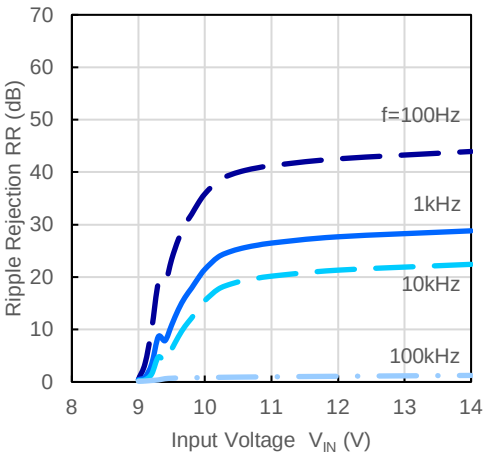

**R1524x050B ($C_2$ = 0.1µF)**



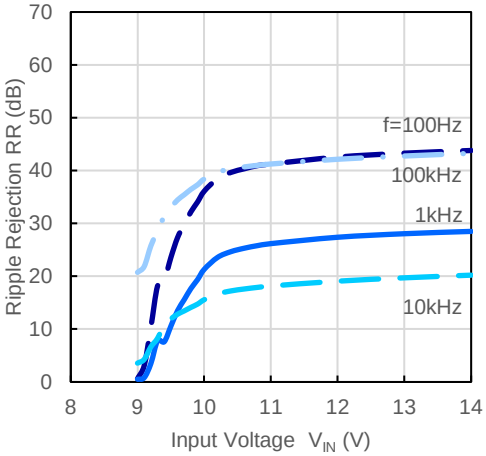

**R1524x050B ($C_2$ = 10µF)**



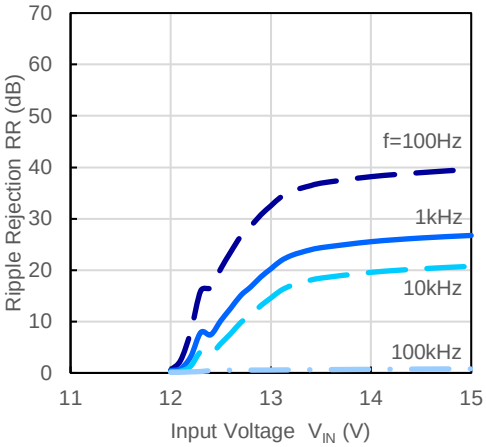
**R1524x090B ($C_2$ = 0.1µF)**



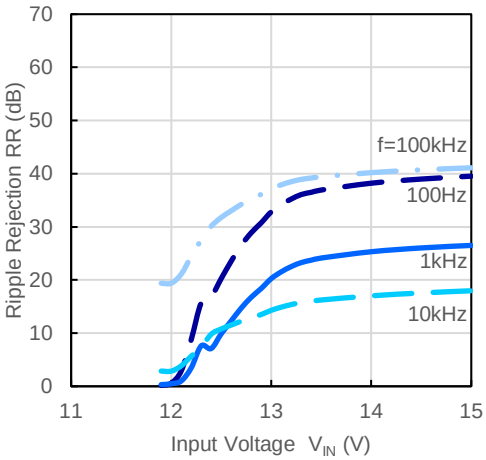

**R1524x090B ($C_2$ = 10µF)**




**R1524x120B ($C_2$ = 0.1µF)**

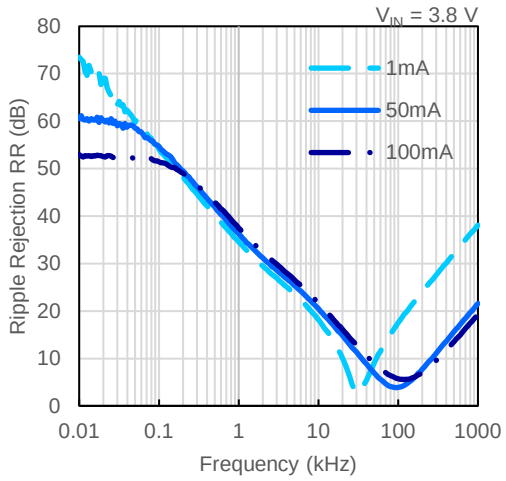



**R1524x120B ($C_2$ = 10µF)**

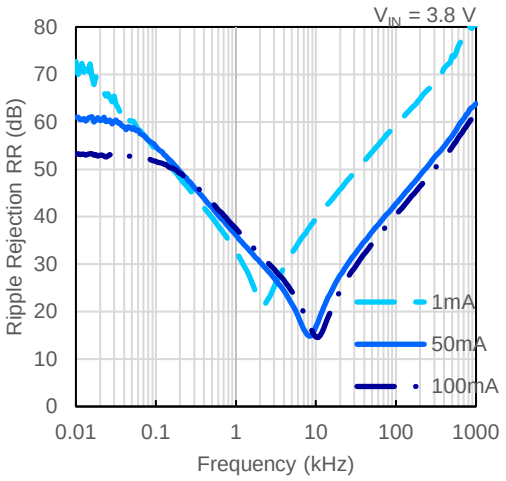


**9) Ripple Rejection vs. Frequency (Ta = 25°C, Ripple = 0.2Vpp)**

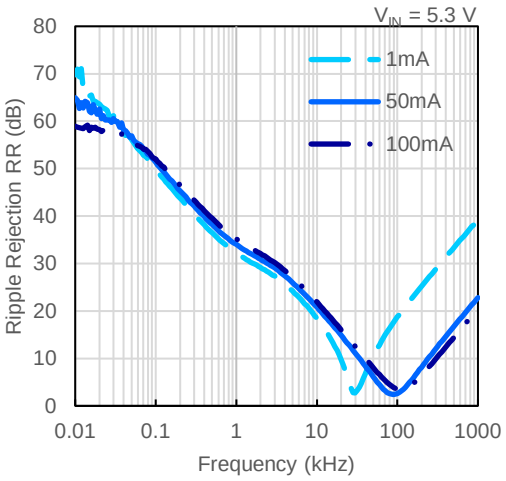
**R1524x018B ($C_2$ = 0.1µF)**



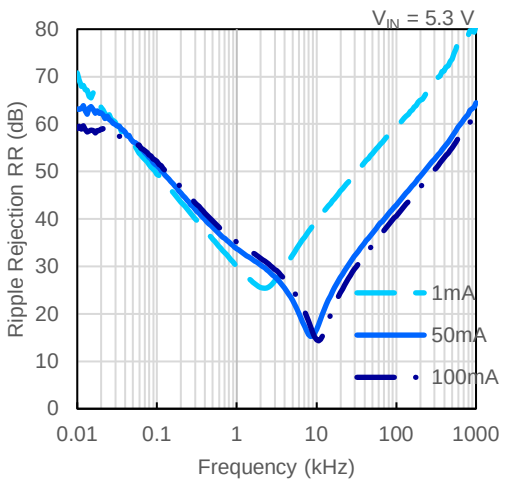

**R1524x018B ($C_2$ = 10µF)**



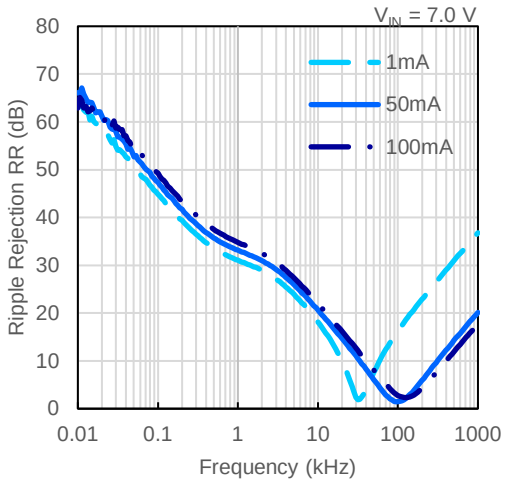

**R1524x033B ($C_2$ = 0.1µF)**



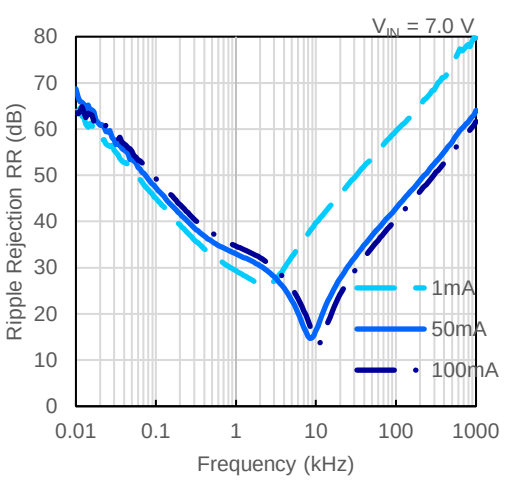

**R1524x033B ($C_2$ = 10µF)**



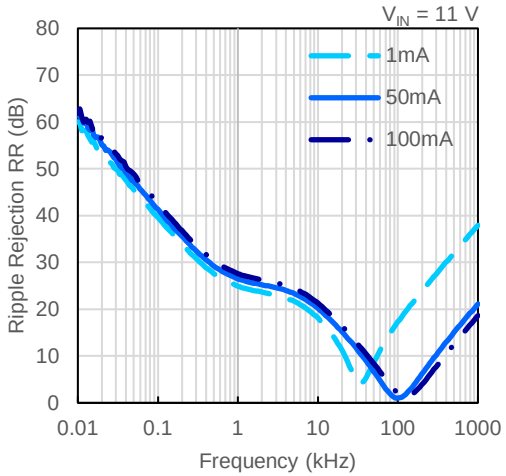

**R1524x050B ($C_2$ = 0.1µF)**



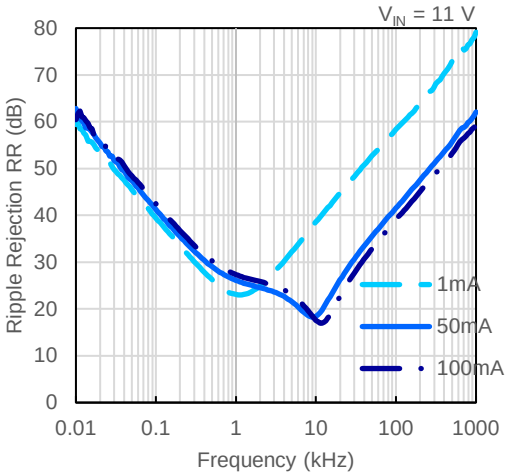

**R1524x050B ($C_2$ = 10µF)**



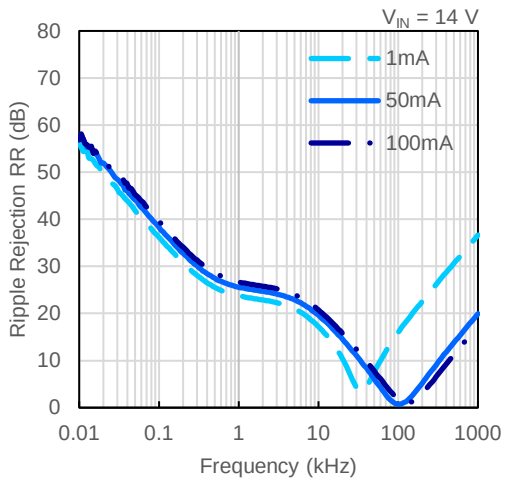
**R1524x090B ($C_2$ = 0.1µF)**



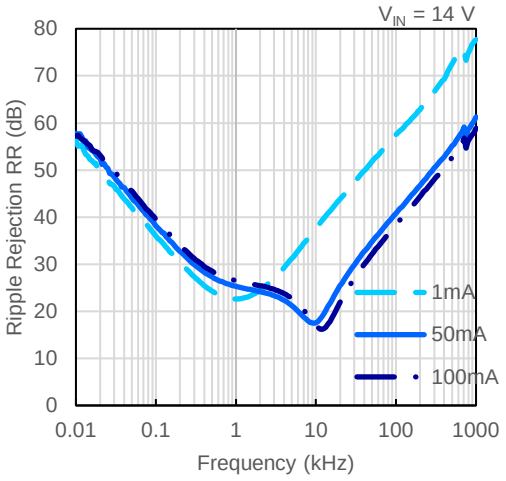

**R1524x090B ($C_2$ = 10µF)**




**R1524x120B ($C_2$ = 0.1µF)**

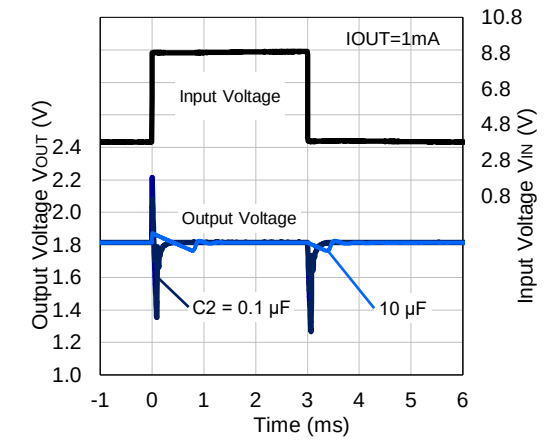



**R1524x120B ($C_2$ = 10µF)**

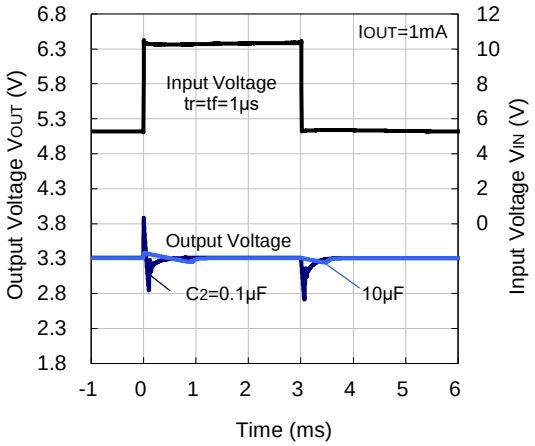


### 10) Input Transient Response (Ta = 25°C)

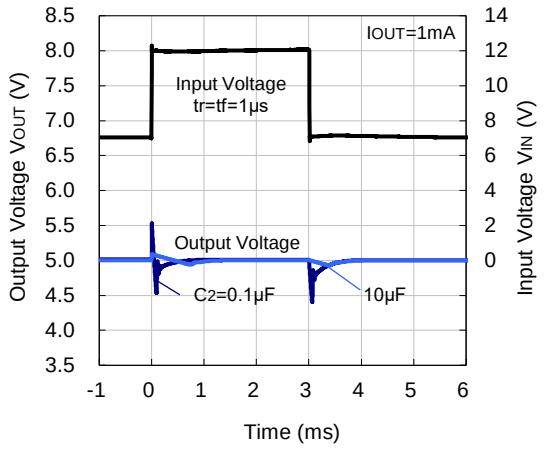
**R1524x018B**



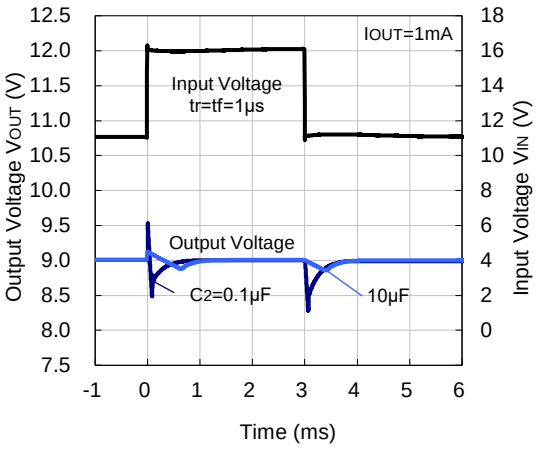

**R1524x033B**



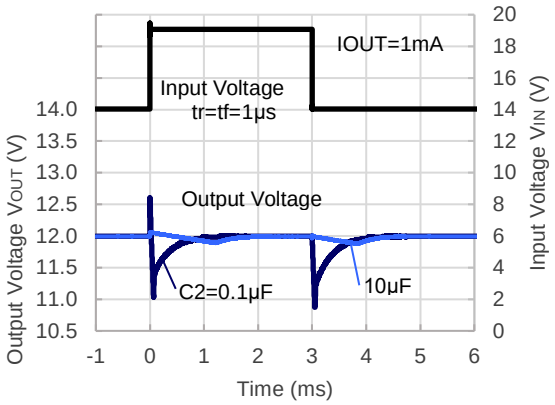

**R1524x050B**




**R1524x090B**

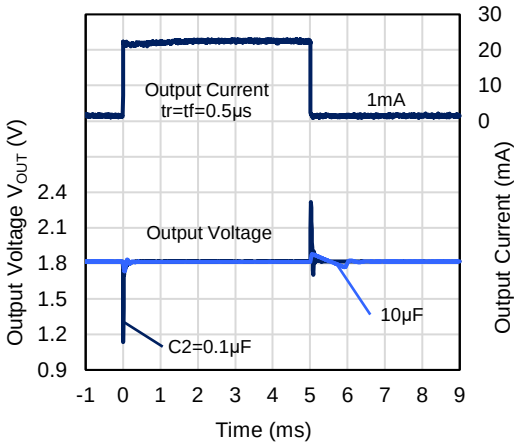



**R1524x120B**

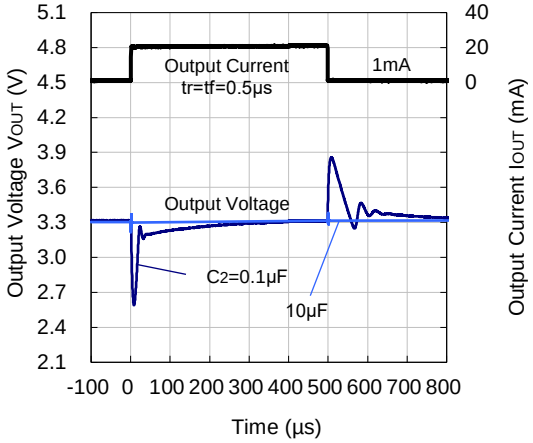


### 11) Load Transient Response (Ta = 25°C)

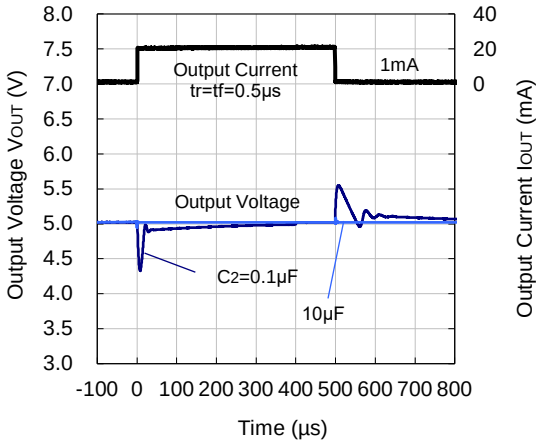
**R1524x018B**



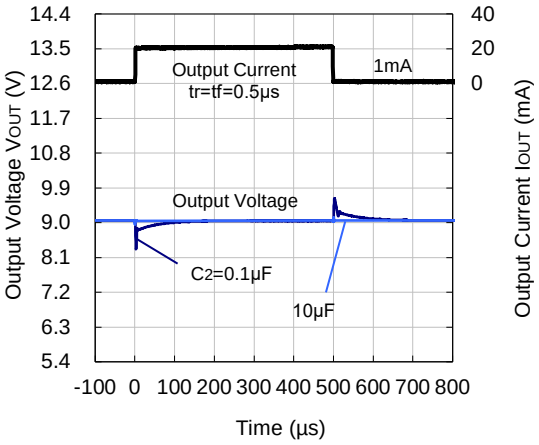

**R1524x033B**



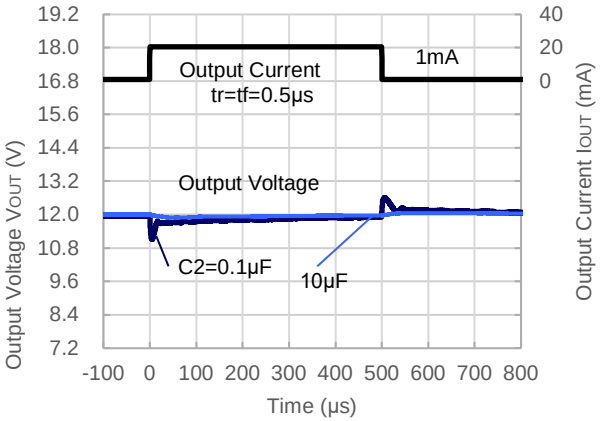

**R1524x050B**




**R1524x090B**

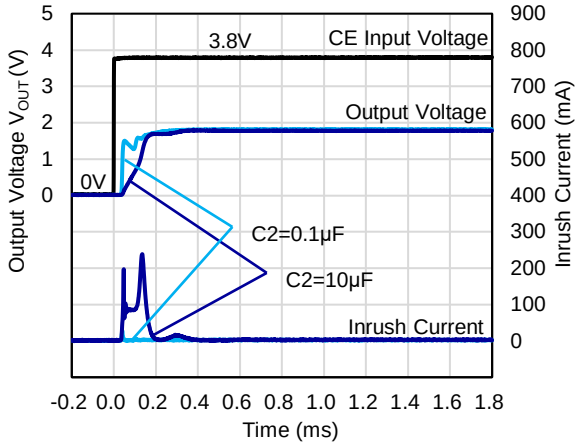


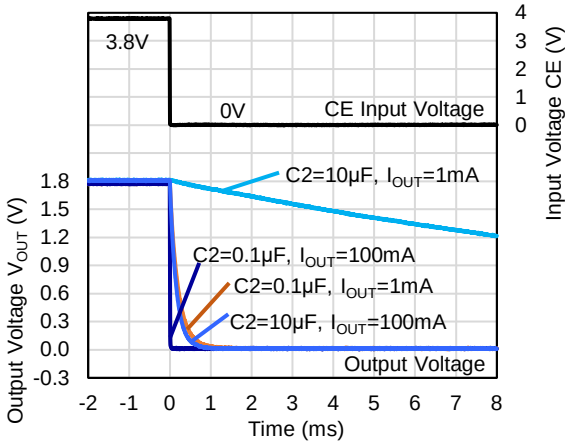

**R1524x120B**



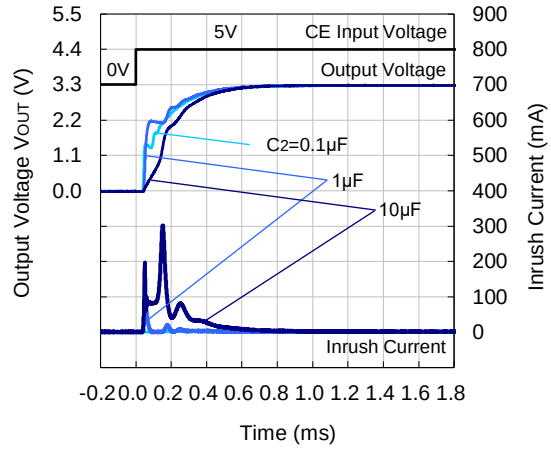
## 12) CE Transient Response (Ta = 25°C)

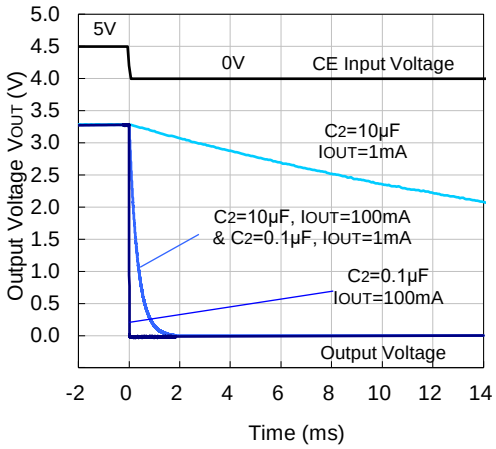
### R1524x018B



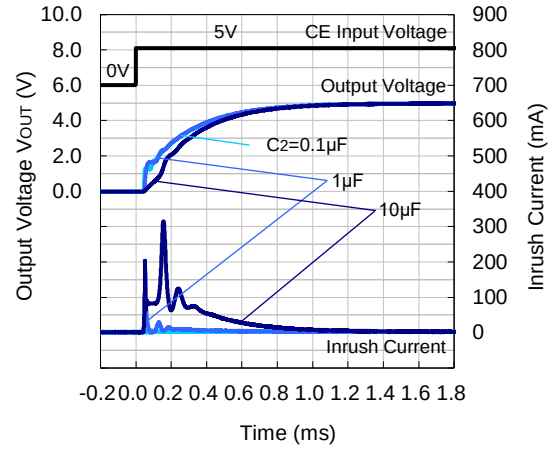



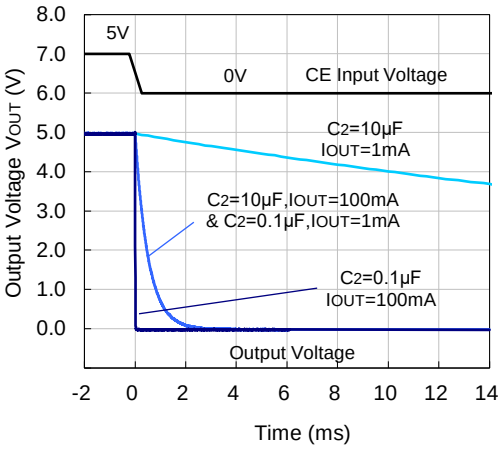

### R1524x033B



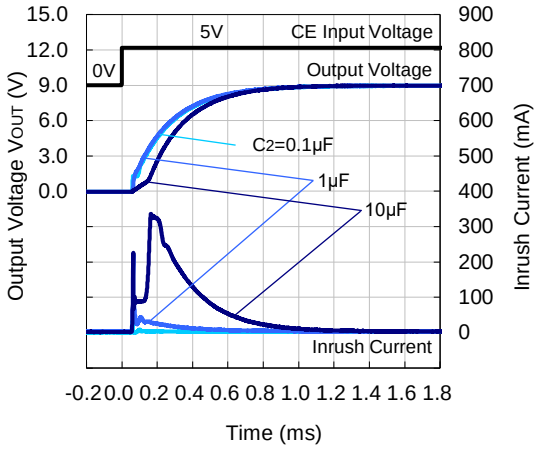



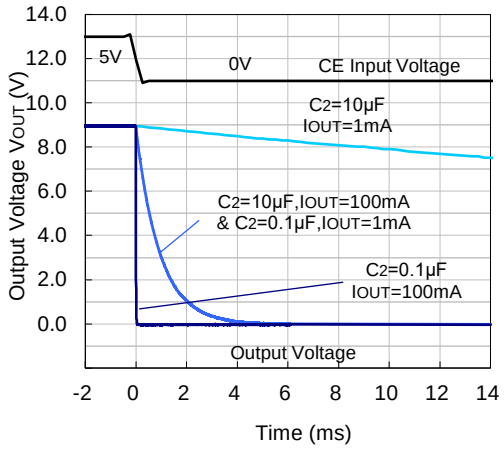

### R1524x050B



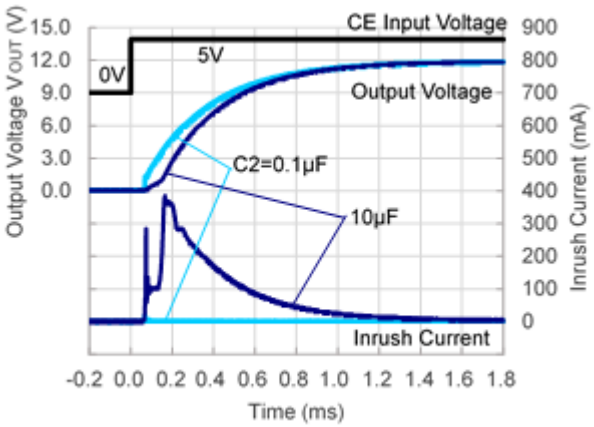



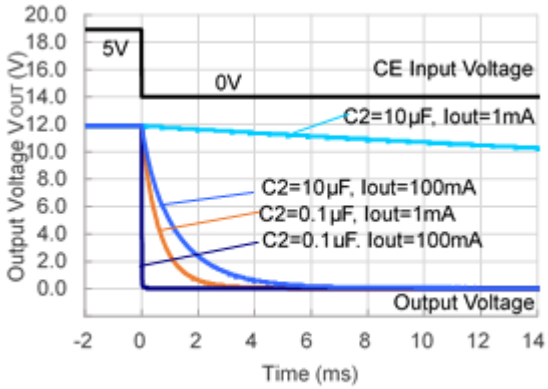

### R1524x090B



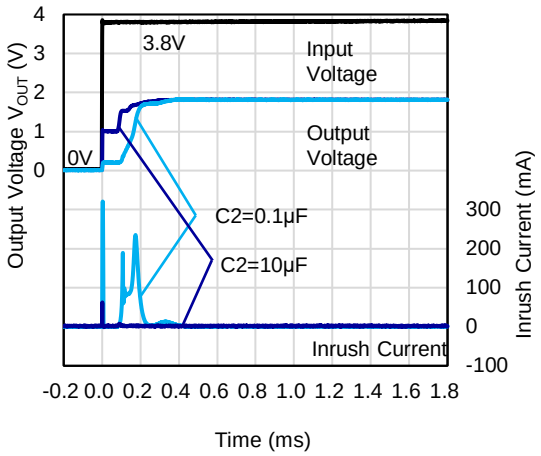

**R1524x120B**



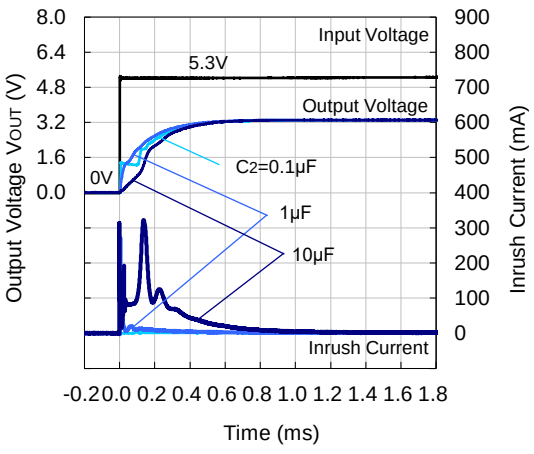




## 13) Power-on Transient Response (Ta = 25°C, $V_{CE}$ = 5 V)

**R1524x018B**

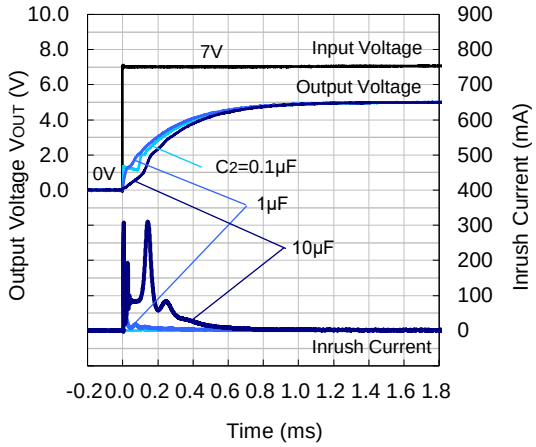


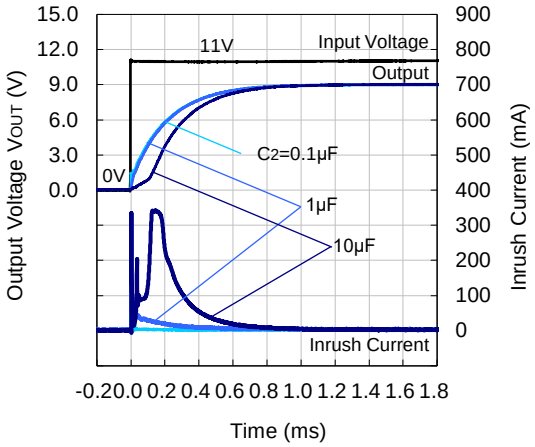

**R1524x033B**



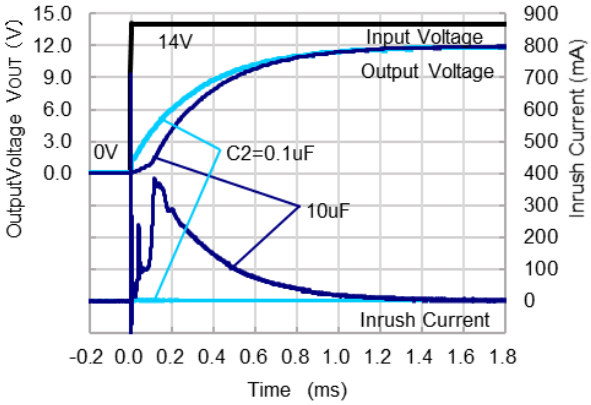

**R1524x050B**

**R1524x090B**



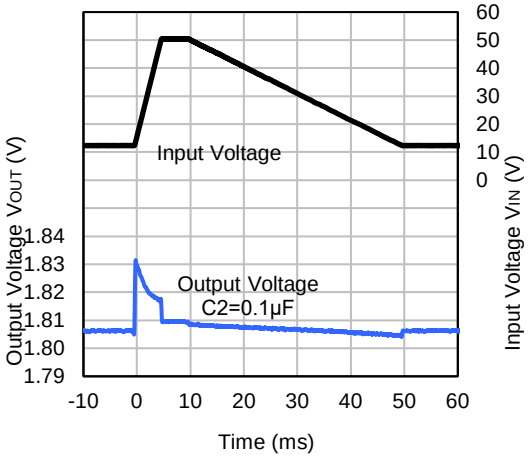




**R1524x120B**

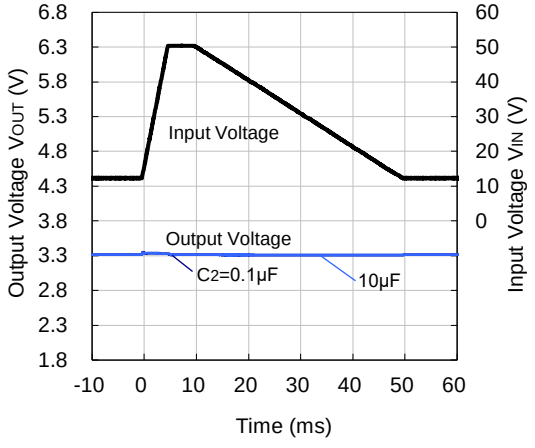



**14) Load Dump (Ta = 25°C)**

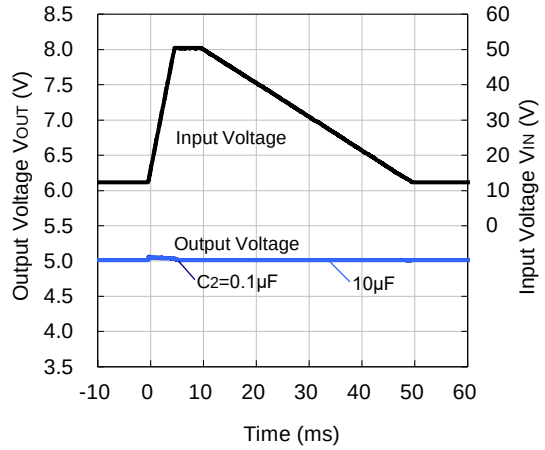
**R1524x018B**



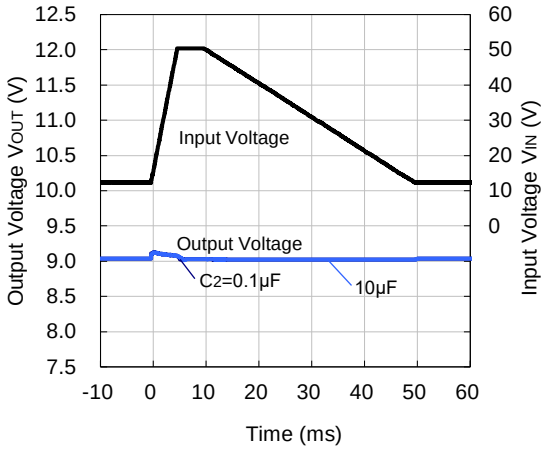

**R1524x033B**



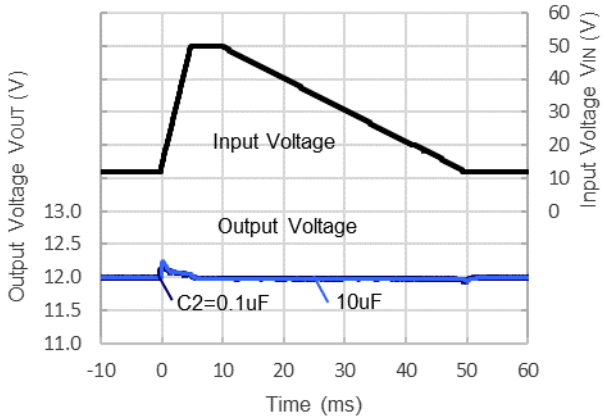
**R1524x050B**




**R1524x090B**

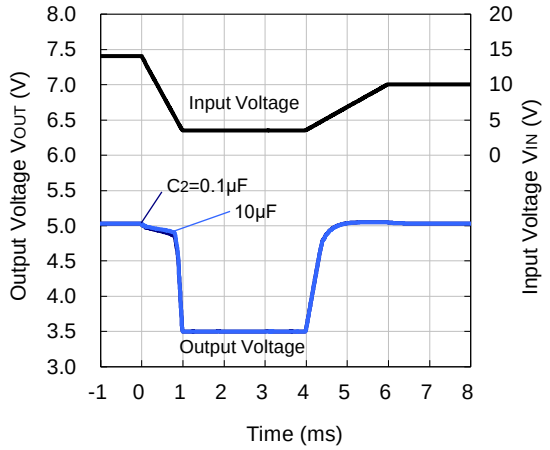



**R1524x120B**

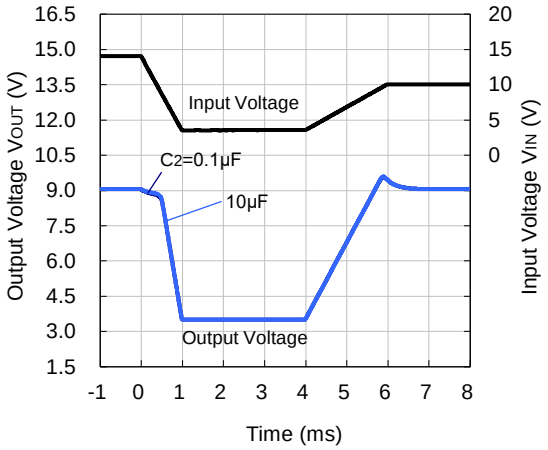


**15) Cranking (Ta = 25°C)**

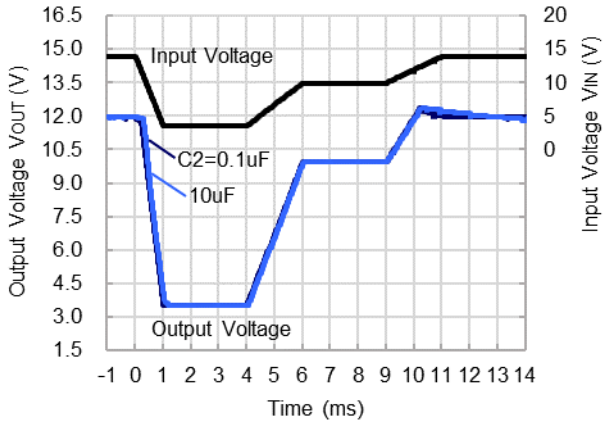
**R1524x050B**




**R1524x090B**




**R1524x120B**

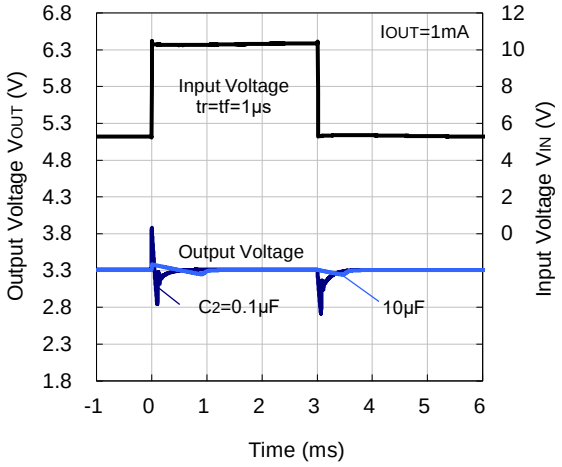


**Input Transient/Load Transient vs. Output Capacity (C2)**

R1524 performs a stable operation by using 0.1 µF 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 µF 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.

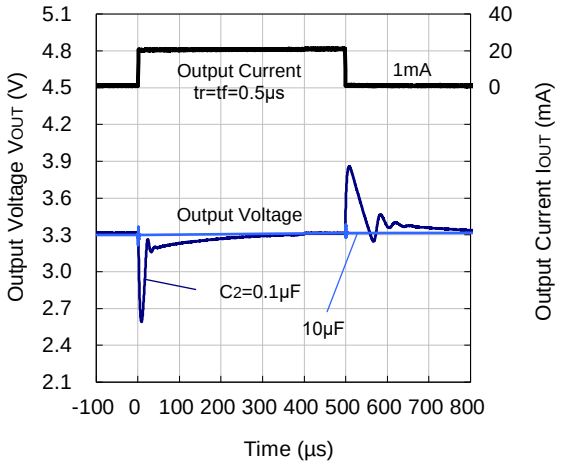
Input Transient Response

**R1524x033B**



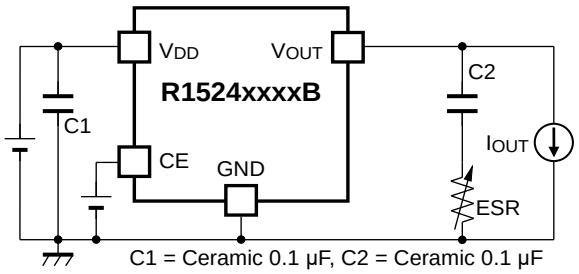

Load Transient Response

**R1524x033B**

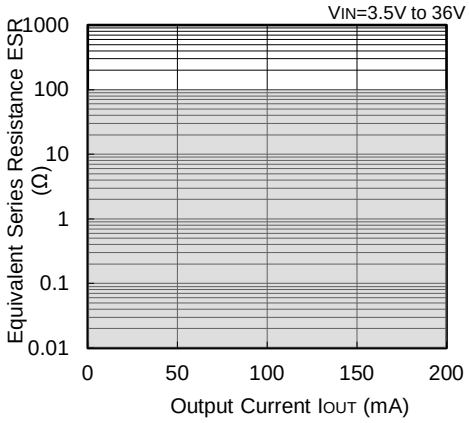



## ESR vs. Output Current

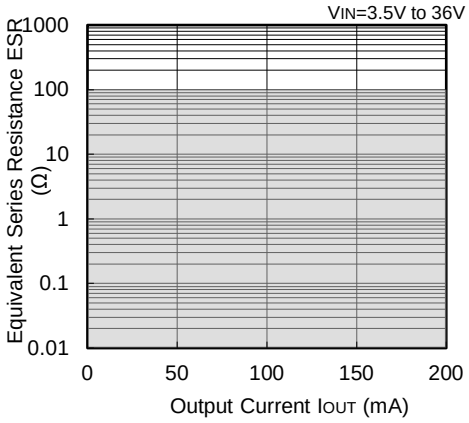
It is recommended that a ceramic type capacitor be used for this device. However, other types of capacitors having lower ESR can also be used. The relation between the output current ($I_{OUT}$) and the ESR of output capacitor is shown below.



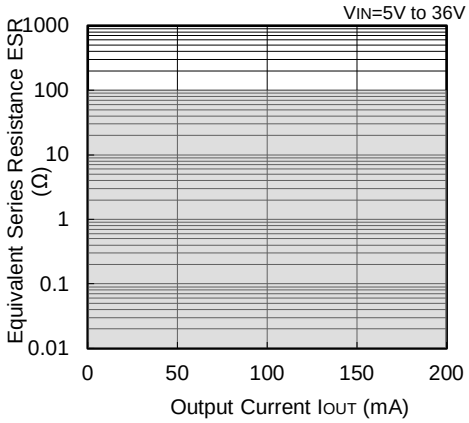
**R1524x018B**



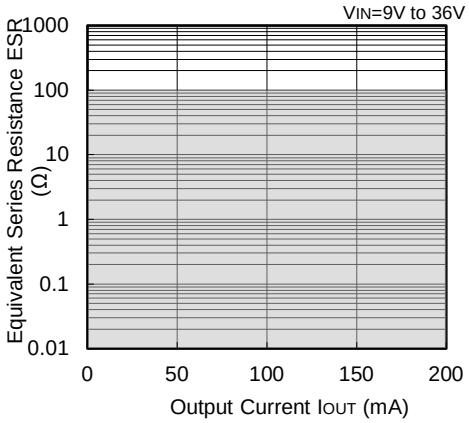

**R1524x033B**



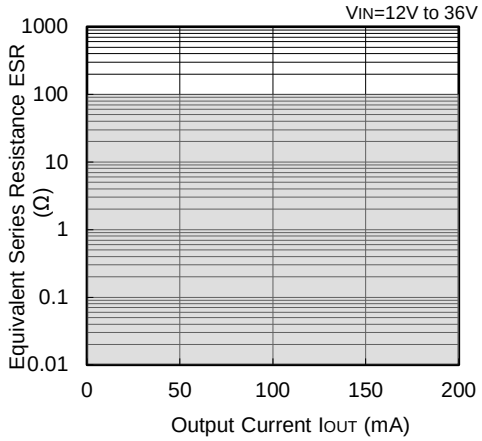

**R1524x050B**




**R1524x090B**




**R1524x120B**




**Measurement Conditions**

Frequency Band: 10 Hz to 2 MHz

Measurement Temperature: −40°C to 125°C

Hatched area: Noise level is 40 μV (average) or below

Ceramic Capacitors:
$C_{IN}$ = 0.1 μF, Murata, GRM188R71H104JA93D
$C_{OUT}$ = 0.1 μF, TDK, CGA3E2X7R1E104K

Ver. A

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**

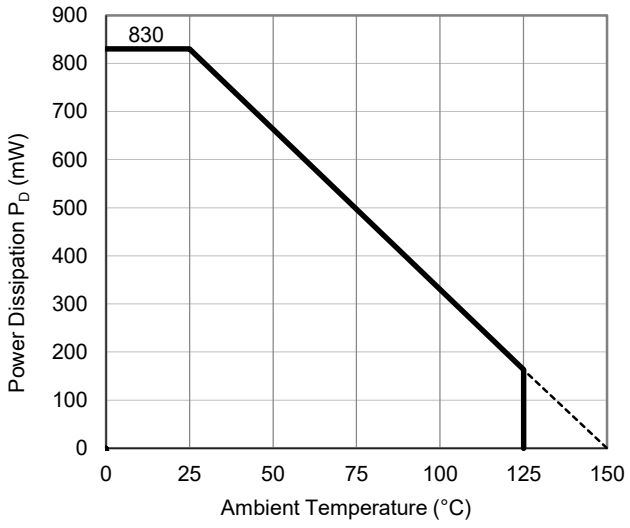
| Item | Measurement Conditions |
|---|---|
| Environment | Mounting on Board (Wind Velocity = 0 m/s) |
| Board Material | Glass Cloth Epoxy Plastic (Four-Layer Board) |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm |
| Copper Ratio | Outer Layer (First Layer): Less than 95% of 50 mm Square<br>Inner 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 = 150°C)

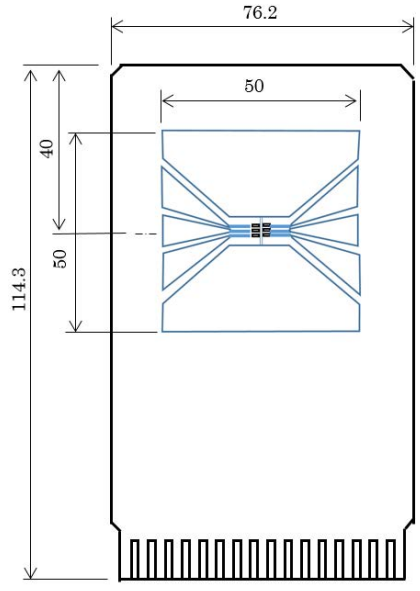
| Item | Measurement Result |
|---|---|
| Power Dissipation | 830 mW |
| Thermal Resistance (θja) | θja = 150°C/W |
| Thermal Characterization Parameter (ψjt) | ψjt = 51°C/W |

θja: Junction-to-Ambient Thermal Resistance

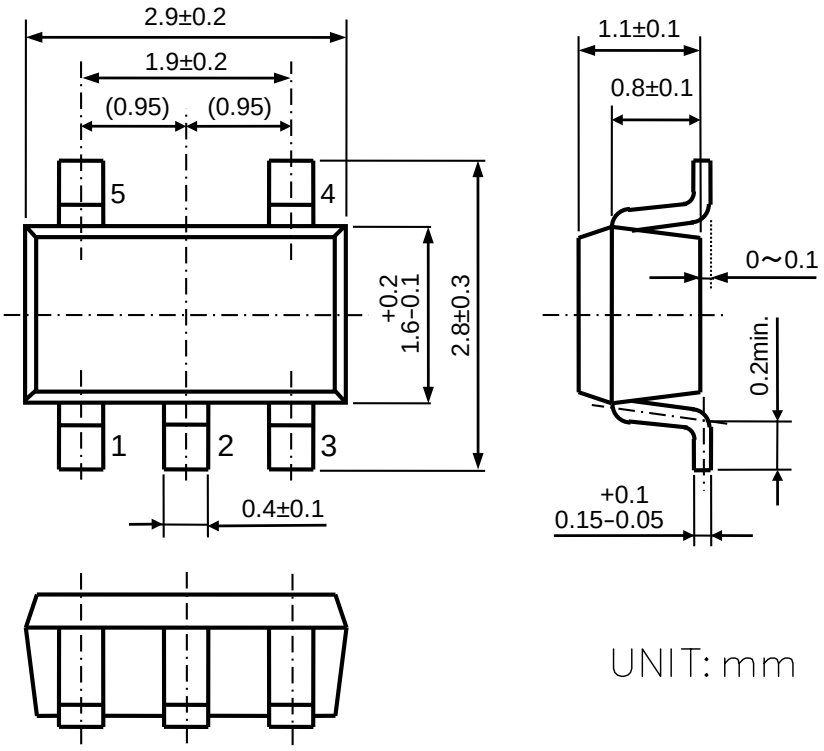
ψjt: Junction-to-Top Thermal Characterization Parameter




**Power Dissipation vs. Ambient Temperature**



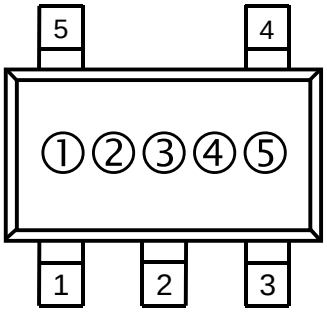

**Measurement Board Pattern**




**SOT-23-5 Package Dimensions**

①②③: Product Code ⋯ Refer to *Part Marking List*

④⑤: Lot Number ⋯ Alphanumeric Serial Number




**SOT-23-5 Part Markings**

| NOTICE |
| --- |
| There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or our distributor before attempting to use AOI. |

**R1524NxxxB Part Marking List**

| Product Name | ① | ② | ③ | $V_{SET}$ |
|---|---|---|---|---|
| R1524N018B | C | T | 7 | 1.8 V |
| R1524N025B | C | T | 8 | 2.5 V |
| R1524N028B | C | T | 9 | 2.8 V |
| R1524N030B | C | S | 0 | 3.0 V |
| R1524N033B | C | T | 0 | 3.3 V |
| R1524N034B | C | T | 1 | 3.4 V |
| R1524N050B | C | T | 2 | 5.0 V |
| R1524N055B | C | S | 1 | 5.5 V |
| R1524N060B | C | T | 3 | 6.0 V |
| R1524N064B | C | S | 2 | 6.4 V |
| R1524N070B | C | S | 5 | 7.0 V |
| R1524N075B | C | S | 4 | 7.5 V |
| R1524N080B | C | T | 4 | 8.0 V |
| R1524N085B | C | T | 5 | 8.5 V |
| R1524N090B | C | T | 6 | 9.0 V |
| R1524N100B | C | S | 6 | 10.0 V |
| R1524N105B | C | S | 7 | 10.5 V |
| R1524N110B | C | S | 8 | 11.0 V |
| R1524N120B | C | S | 9 | 12.0 V |

Ver. A

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**

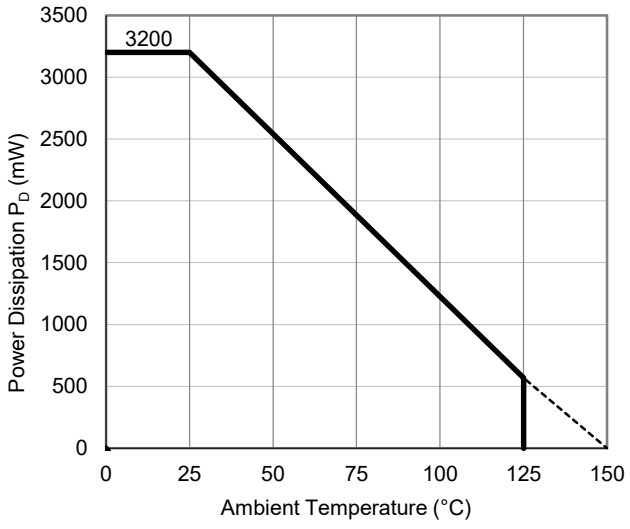
| Item | Measurement Conditions |
|---|---|
| Environment | Mounting on Board (Wind Velocity = 0 m/s) |
| Board Material | Glass Cloth Epoxy Plastic (Four-Layer Board) |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm |
| Copper Ratio | Outer Layer (First Layer): Less than 95% of 50 mm Square<br>Inner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

**Measurement Result** (Ta = 25°C, Tjmax = 150°C)

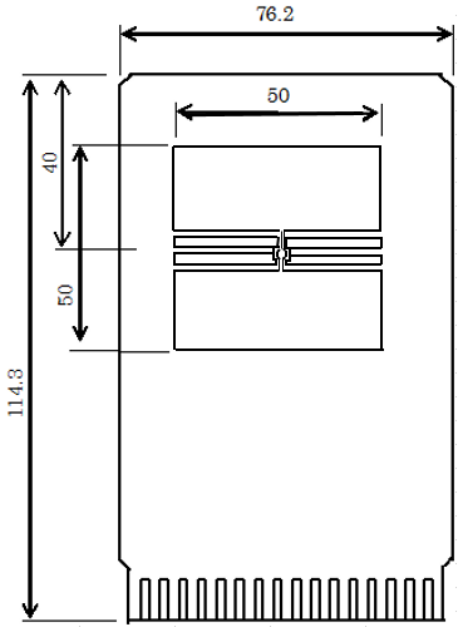
| Item | Measurement Result |
|---|---|
| Power Dissipation | 3200 mW |
| Thermal Resistance ($\theta$ja) | $\theta$ja = 38°C/W |
| Thermal Characterization Parameter ($\psi$jt) | $\psi$jt = 13°C/W |

$\theta$ja: Junction-to-Ambient Thermal Resistance

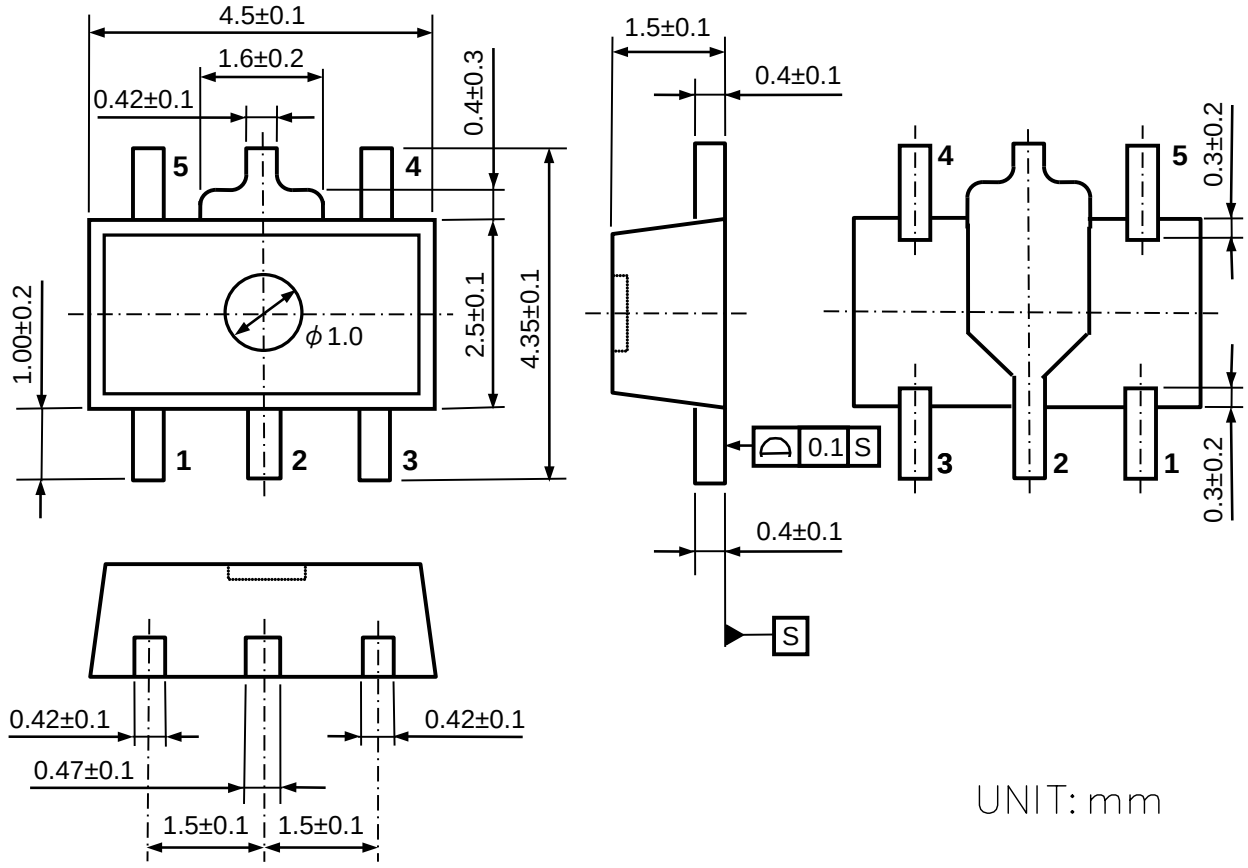
$\psi$jt: Junction-to-Top Thermal Characterization Parameter




**Power Dissipation vs. Ambient Temperature**



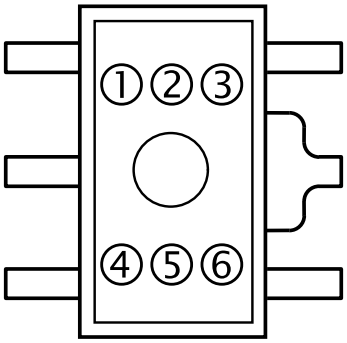

**Measurement Board Pattern**




**SOT-89-5 Package Dimensions**

①②③④: Product Code ⋯ Refer to *Part Marking List*

⑤⑥: Lot Number ⋯ Alphanumeric Serial Number




**SOT-89-5 Part Markings**

| NOTICE |
| --- |
| There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or our distributor before attempting to use AOI. |

**R1524HxxxB Part Marking List**

| Product Name | ① ② ③ | $V_{SET}$ |
|---|---|---|
| R1524H018B | J 1 8 B | 1.8 V |
| R1524H025B | J 2 5 B | 2.5 V |
| R1524H028B | J 2 8 B | 2.8 V |
| R1524H030B | J 3 0 B | 3.0 V |
| R1524H033B | J 3 3 B | 3.3 V |
| R1524H034B | J 3 4 B | 3.4 V |
| R1524H050B | J 5 0 B | 5.0 V |
| R1524H055B | J 5 5 B | 5.5 V |
| R1524H060B | J 6 0 B | 6.0 V |
| R1524H064B | J 6 4 B | 6.4 V |
| R1524H070B | J 7 0 B | 7.0 V |
| R1524H075B | J 7 5 B | 7.5 V |
| R1524H080B | J 8 0 B | 8.0 V |
| R1524H085B | J 8 5 B | 8.5 V |
| R1524H090B | J 9 0 B | 9.0 V |
| R1524H100B | J A 0 B | 10.0 V |
| R1524H105B | J A 5 B | 10.5 V |
| R1524H110B | J B 0 B | 11.0 V |
| R1524H120B | J C 0 B | 12.0 V |

Ver. A

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**

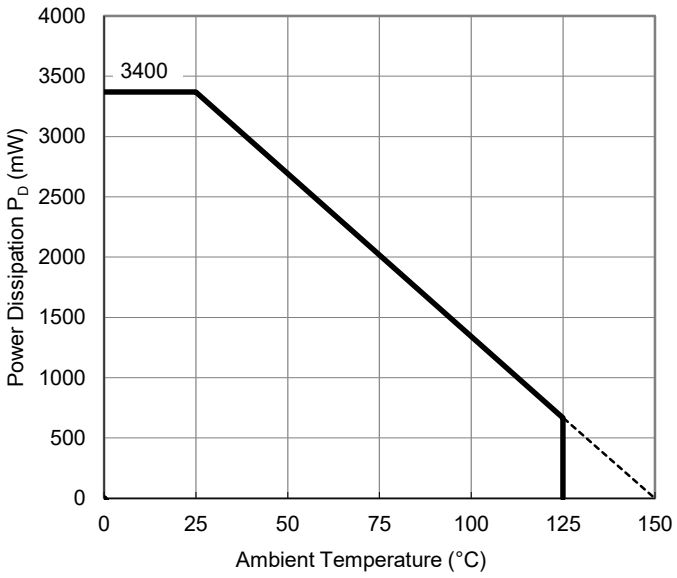
| Item | Measurement Conditions |
|---|---|
| Environment | Mounting on Board (Wind Velocity = 0 m/s) |
| Board Material | Glass Cloth Epoxy Plastic (Four-Layer Board) |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm |
| Copper Ratio | Outer Layer (First Layer): Less than 95% of 50 mm Square<br>Inner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

**Measurement Result** (Ta = 25°C, Tjmax = 150°C)

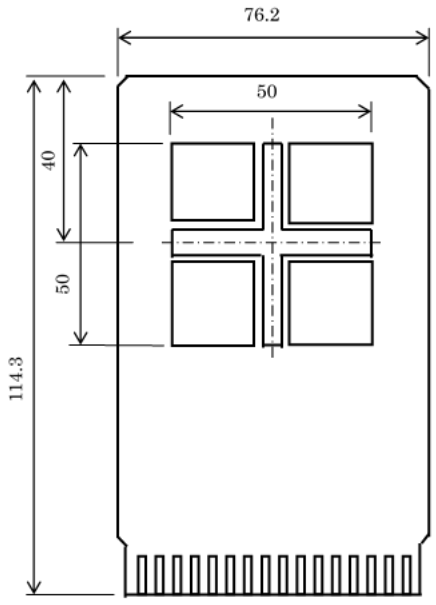
| Item | Measurement Result |
|---|---|
| Power Dissipation | 3400 mW |
| Thermal Resistance ($\theta$ja) | $\theta$ja = 37°C/W |
| Thermal Characterization Parameter ($\psi$jt) | $\psi$jt = 7°C/W |

$\theta$ja: Junction-to-Ambient Thermal Resistance

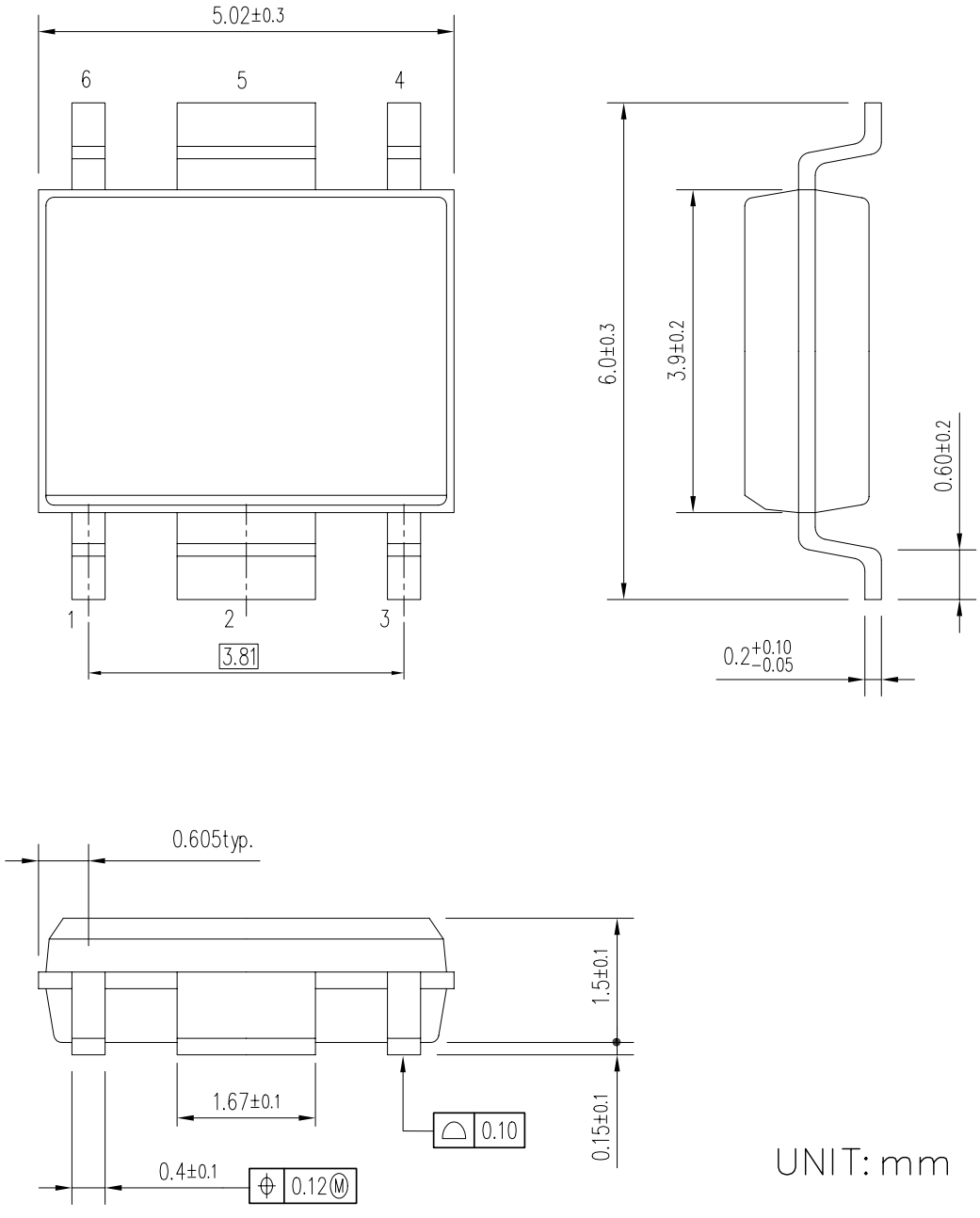
$\psi$jt: Junction-to-Top Thermal Characterization Parameter




**Power Dissipation vs. Ambient Temperature**



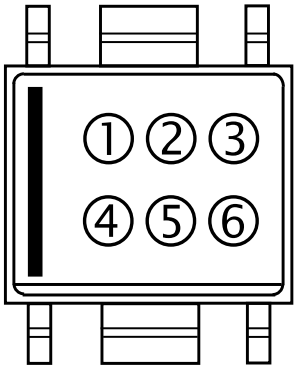

**Measurement Board Pattern**




**HSOP-6J Package Dimensions**

①②③④: Product Code ⋯ Refer to *Part Marking List*

⑤⑥: Lot Number ⋯ Alphanumeric Serial Number




**HSOP-6J Part Markings**

| NOTICE |
| --- |
| There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or our distributor before attempting to use AOI. |

**R1524SxxxB Part Marking List**

| Product Name | ① | ② | ③ | ④ | $V_{SET}$ |
|---|---|---|---|---|---|
| R1524S018B | A | 1 | 8 | B | 1.8 V |
| R1524S025B | A | 2 | 5 | B | 2.5 V |
| R1524S028B | A | 2 | 8 | B | 2.8 V |
| R1524S030B | A | 3 | 0 | B | 3.0 V |
| R1524S033B | A | 3 | 3 | B | 3.3 V |
| R1524S034B | A | 3 | 4 | B | 3.4 V |
| R1524S050B | A | 5 | 0 | B | 5.0 V |
| R1524S055B | A | 5 | 5 | B | 5.5 V |
| R1524S060B | A | 6 | 0 | B | 6.0 V |
| R1524S064B | A | 6 | 4 | B | 6.4 V |
| R1524S070B | A | 7 | 0 | B | 7.0 V |
| R1524S075B | A | 7 | 5 | B | 7.5 V |
| R1524S080B | A | 8 | 0 | B | 8.0 V |
| R1524S085B | A | 8 | 5 | B | 8.5 V |
| R1524S090B | A | 9 | 0 | B | 9.0 V |
| R1524S100B | A | A | 0 | B | 10.0 V |
| R1524S105B | A | A | 5 | B | 10.5 V |
| R1524S110B | A | B | 0 | B | 11.0 V |
| R1524S120B | A | C | 0 | B | 12.0 V |

Ver. 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**

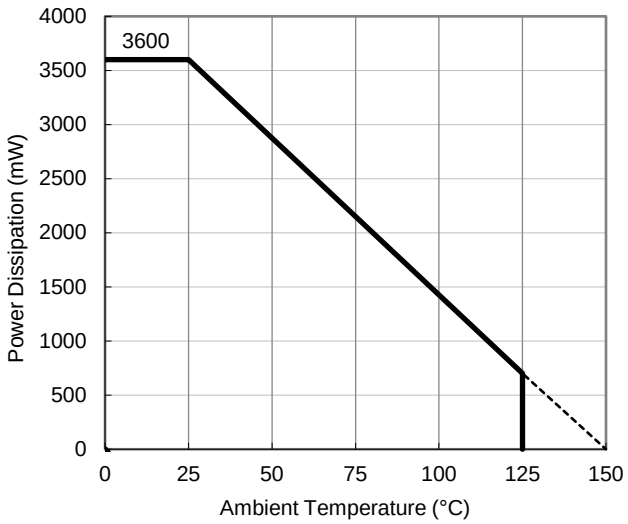
| Item | Measurement Conditions |
|---|---|
| Environment | Mounting on Board (Wind Velocity = 0 m/s) |
| Board Material | Glass Cloth Epoxy Plastic (Four-Layer Board) |
| Board Dimensions | 76.2 mm × 114.3 mm × 0.8 mm |
| Copper Ratio | Outer Layer (First Layer): Less than 95% of 50 mm Square<br>Inner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

**Measurement Result** (Ta = 25°C, Tjmax = 150°C)

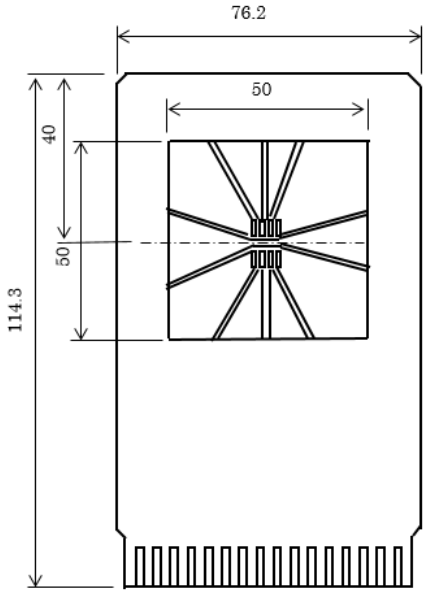
| Item | Measurement Result |
|---|---|
| Power Dissipation | 3600 mW |
| Thermal Resistance ($\theta$ja) | $\theta$ja = 34.5°C/W |
| Thermal Characterization Parameter ($\psi$jt) | $\psi$jt = 10°C/W |

$\theta$ja: Junction-to-Ambient Thermal Resistance

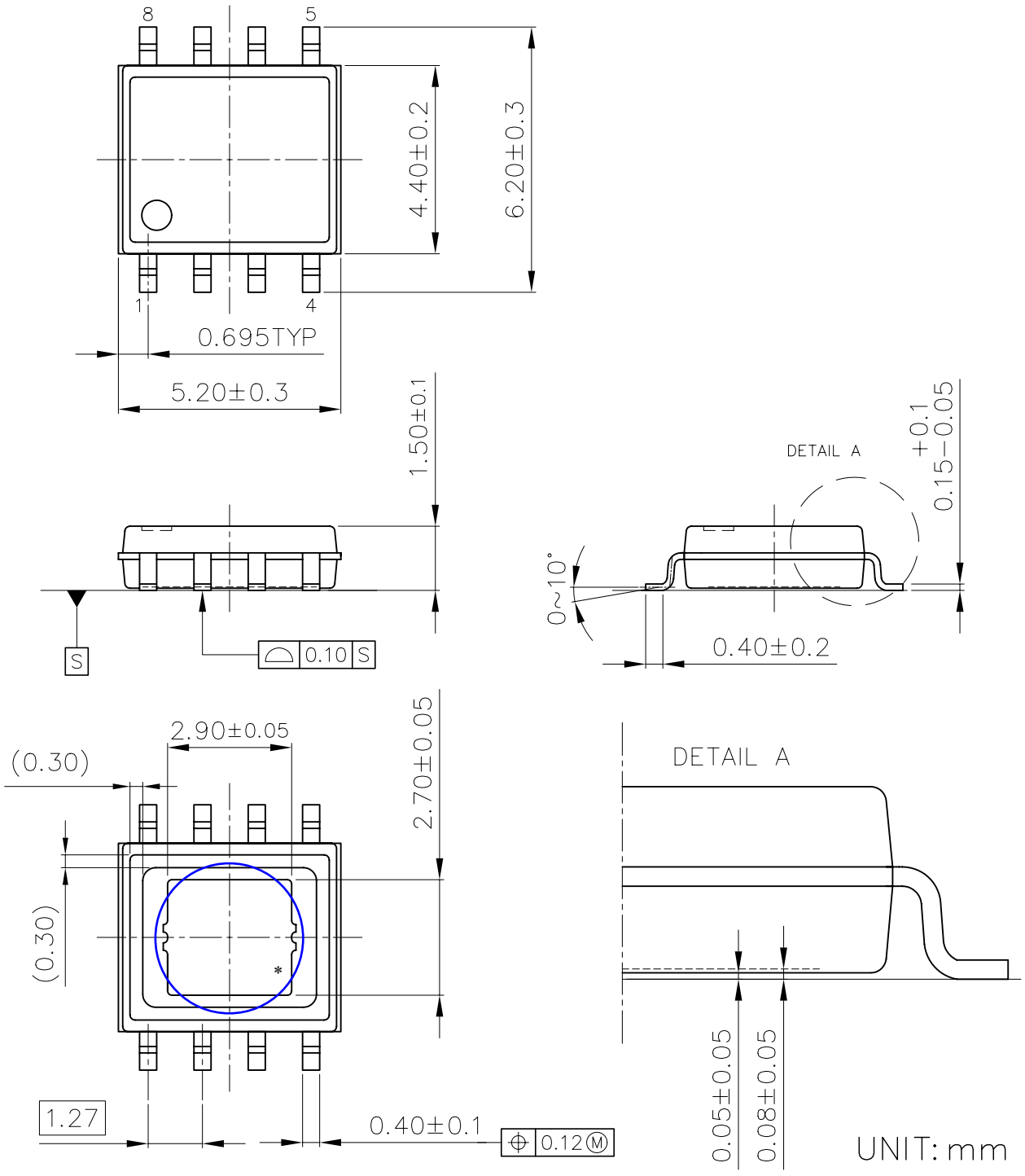
$\psi$jt: Junction-to-Top Thermal Characterization Parameter




**Power Dissipation vs. Ambient Temperature**




**Measurement Board Pattern**

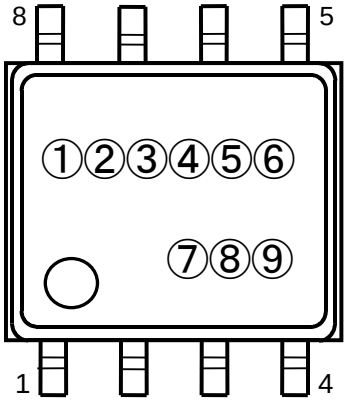



**HSOP-8E Package Dimensions**

∗ The tab on the bottom of the package shown by blue circle is substrate potential (GND). It is recommended that this tab be connected to the ground plane on the board but it is possible to leave the tab floating.

①②③④⑤⑥: Product Code ⋯ Refer to *Part Marking List*

⑦⑧⑨: Lot Number ⋯ Alphanumeric Serial Number




**HSOP-8E Part Markings**

| NOTICE |
| --- |
| There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact our sales or our distributor before attempting to use AOI. |

**R1524SxxxH Part Marking List**

| Product Name | ① ② ③ ④ ⑤ ⑥ | $V_{SET}$ |
|---|---|---|
| R1524S018H | R S 0 1 7 A | 1.8 V |
| R1524S025H | R S 0 1 7 B | 2.5 V |
| R1524S028H | R S 0 1 7 C | 2.8 V |
| R1524S030H | R S 0 1 7 D | 3.0 V |
| R1524S033H | R S 0 1 7 E | 3.3 V |
| R1524S034H | R S 0 1 7 F | 3.4 V |
| R1524S050H | R S 0 1 7 H | 5.0 V |
| R1524S055H | R S 0 1 7 J | 5.5 V |
| R1524S060H | R S 0 1 7 K | 6.0 V |
| R1524S064H | R S 0 1 7 L | 6.4 V |
| R1524S070H | R S 0 1 7 S | 7.0 V |
| R1524S075H | R S 0 1 7 R | 7.5 V |
| R1524S080H | R S 0 1 7 M | 8.0 V |
| R1524S085H | R S 0 1 7 N | 8.5 V |
| R1524S090H | R S 0 1 7 P | 9.0 V |
| R1524S100H | R S 0 1 7 T | 10.0 V |
| R1524S105H | R S 0 1 7 U | 10.5 V |
| R1524S110H | R S 0 1 7 V | 11.0 V |
| R1524S120H | R S 0 1 7 W | 12.0 V |

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    - Various Safety Devices
    - Traffic control system
    - Combustion equipment

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    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.

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    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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