

1 A 36V Input Low Supply Current LDO

NO.EA-329-190212

OUTLINE

R1518x is a CMOS-based LDO that specifically designed for automotive applications featuring 1 A output current and 36 V input voltage. In addition to a conventional regulator circuit, R1518x consists of a constant slope circuit as a soft-start function, a fold-back protection circuit, a short current limit circuit, and a thermal shutdown circuit. Besides the low supply current by CMOS, the operating temperature is -40°C to 105°C and the maximum input voltage is 36 V, the R1518x is very suitable for power source of car accessories.

R1518x is available in R1518xxxxB/D/E/F with the internally fixed output voltage, and R1518xxxxD/F with the auto-discharge function at standby.

R1518x001C can adjust the output voltage with an external resistor. R1518xxxxB/C/D internally fixes the soft-start time at 120 μs (Typ). R1518xxxxE/F can adjust the soft-start time with an external capacitor.

R1518x is available in two packages for ultra high wattage: HSOP-6J and TO-252-5-P2.

FEATURES

- Input Voltage Range (Maximum Rating) 3.5 V to 36.0 V (50.0V)
- Operating Temperature rang -40°C to 105°C
- Supply Current Typ. 18 μA
- Standby Current Typ. 0.1 μA
- Dropout Voltage Typ. 0.7 V ($I_{\text{OUT}} = 1 \text{ A}$, $V_{\text{OUT}} = 5.0 \text{ V}$)
- Output Voltage Accuracy $\pm 0.8\%$ ($V_{\text{OUT}} \leq 5.0 \text{ V}$)
- Line Regulation Typ. 0.01%/V
- Packages HSOP-6J, TO-252-5-P2
- Output Voltage Range R1518xxxxB/D/E/F:
2.5V/3.3V/3.4V/5.0V/6.0V/8.5V/9.0V
*Contact Ricoh sales representatives
for other voltages
R1518x001C: Adjustable from 2.5 V to 12.0 V
with external resistor
Feedback Voltage: 2.5 V
- Built-in Short Current Limit Circuit Typ. 150 mA
- Built-in Fold-Back Protection Circuit Min. 1A
- Built-in Thermal Shutdown Circuit Typ. 160°C
- Built-in Soft-start Circuit Typ. 120 μs
R1518xxxxE/F: Adjustable Time Setting with
External Capacitors.

R1518x

NO.EA-329-190212

- Ceramic Capacitors can be used R1518xxxxB/D/E/F: 0.1 μ F or more
R1518x001C: 1.0 μ F or more

APPLICATIONS

- Power source for home appliances such as refrigerators, rice cookers, electric water warmers.
- Power source for notebook PCs, digital TVs, telephones, private LAN systems.
- Power source for office equipment such as copiers, printers, facsimiles, scanners, and projectors

SELECTION GUIDE

The output voltage, version, and package type for this device can be selected at the user's request.

| Product Name | Package | Quantity per Reel | Pb Free | Halogen Free |
|------------------|-------------|-------------------|---------|--------------|
| R1518Sxx1*-E2-FE | HSOP-6J | 1,000 pcs | Yes | Yes |
| R1518Jxx1*-T1-FE | TO-252-5-P2 | 3,000 pcs | Yes | Yes |

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

2.5 V (25) / 3.3 V (33) / 3.4 V (34) / 5.0 V (50) / 6.0 V (60) / 8.5 V (85) / 9.0 V (90)

Note: Contact Ricoh sales representatives for other voltages.

Adjustable output voltage setting type is fixed to (00)

Note: R1518x001C-T1-#E only support

* : Specify the version with desired functions

B: No auto-discharge function

C: No auto-discharge function / Adjustable output voltage setting

D: Auto-discharge function

E: No auto-discharge function / Adjustable soft-start time setting

F: Auto-discharge function / Adjustable soft-start time setting

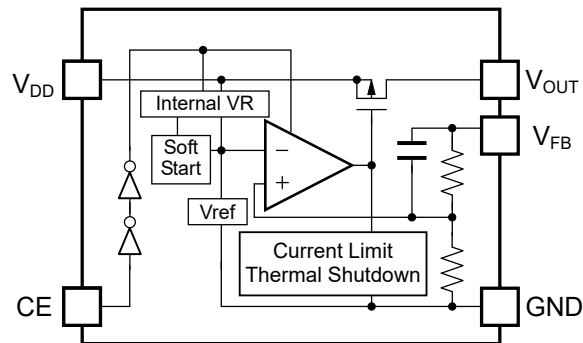
Auto-Discharge function quickly lowers the output voltage to 0 V by releasing the electrical charge in the external capacitor when the chip enable signal is switched from the active mode to the standby mode.

BLOCK DIAGRAMS

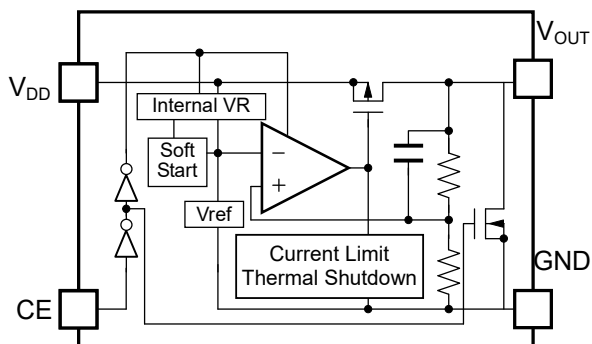
R1518xxxxB



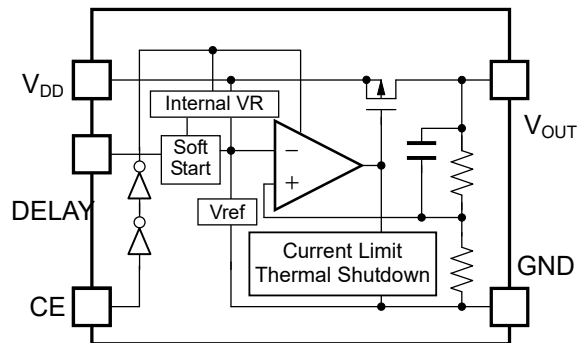
R1518x001C



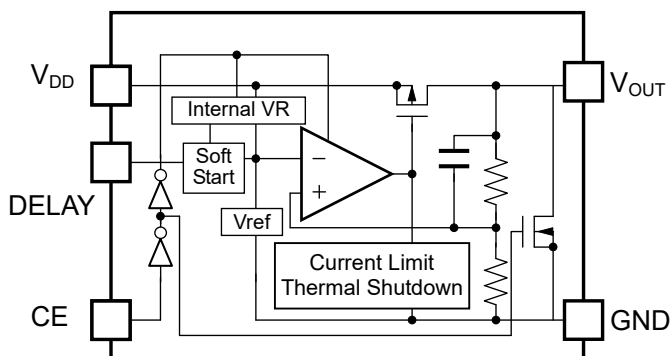
R1518xxxxD



R1518xxxxE



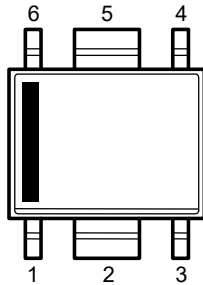
R1518xxxxF



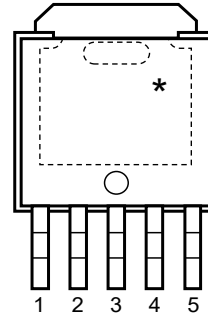
R1518x

NO.EA-329-190212

PIN DESCRIPTION



HSOP-6J



TO-252-5-P2

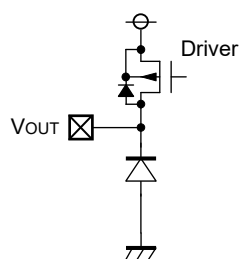
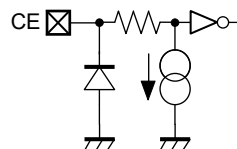
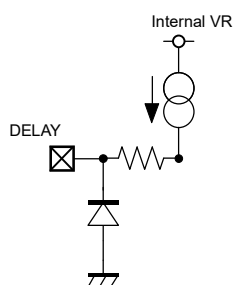
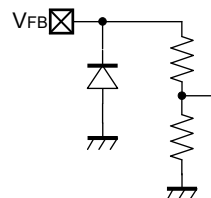
HSOP-6J

| Pin No. | Symbol | Description | |
|---------|--------|--------------------------------|--------------|
| 1 | VDD | Input Pin | |
| 2 | GND | Ground Pin | |
| 3 | NC | No Connection | R1518SxxxB/D |
| | VFB | Feedback Pin | R1518S001C |
| | DELAY | Adjustable Soft-start Time Pin | R1518SxxxE/F |
| 4 | CE | Chip Enable Pin, Active-high | |
| 5 | GND | Ground Pin | |
| 6 | VOUT | Output Pin | |

TO-252-5-P2

| Pin No. | Symbol | Description | |
|---------|--------|--------------------------------|--------------|
| 1 | VDD | Input Pin | |
| 2 | NC | No Connection | R1518Jxx1B/D |
| | VFB | Feedback Pin | R1518J001C |
| | DELAY | Adjustable Soft-start Time Pin | R1518Jxx1E/F |
| 3 | GND | Ground Pin | |
| 4 | CE | Chip Enable Pin, Active-high | |
| 5 | VOUT | Output Pin | |

* The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). The tab is recommended to connect to the ground plane on the board. Otherwise it may be left floating.

PIN EQUIVALENT CIRCUIT DIAGRAMS**V_{OUT} Pin****CE Pin****DELAY Pin**
(R1518xxxxE/F)**V_{FB} Pin**
(R1518x001C)

R1518x

NO.EA-329-190212

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_{FB} | Input Voltage (V_{FB} Pin) | -0.3 to 50 | V | |
| V_{OUT} | Output Voltage | -0.3 to $V_{IN} + 0.3 \leq 50$ | V | |
| P_D | Power Dissipation ⁽²⁾ (JEDEC STD.51-7) | HSOP-6J | 2700 | mW |
| | | TO-252-5-P2 | 3800 | |
| 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 the permanent damages and may degrade the life time and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

RECOMMENDED OPERATING CONDITIONS

Recommended Operating Conditions

| Symbol | Parameter | 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 when they are used over such ratings 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

$V_{IN} = V_{SET} + 1.0 \text{ V}$, $I_{OUT} = 1 \text{ mA}$, $C_{IN} = C_{OUT} = 0.1 \mu\text{F}$, unless otherwise noted.

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

R1518xxxxB/D

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

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit | |
|---|---|---|---|---|--|---|---|
| V_{OUT} | Output Voltage | $T_a = 25^\circ\text{C}$ | $V_{SET} \leq 5.0 \text{ V}$ | $\times 0.992$ | | $\times 1.008$ | V |
| | | | $V_{SET} > 5.0 \text{ V}$ | $\times 0.99$ | | $\times 1.01$ | V |
| | | $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$ | $V_{SET} \leq 5.0 \text{ V}$ | $\times 0.982$ | | $\times 1.018$ | V |
| | | | $V_{SET} > 5.0 \text{ V}$ | $\times 0.98$ | | $\times 1.02$ | V |
| $\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$ | Load Regulation | $V_{IN} = V_{SET} + 2.0 \text{ V}$, $1 \text{ mA} \leq I_{OUT} \leq 250 \text{ mA}$ | -15 | 3 | 25 | mV | |
| | | $V_{IN} = V_{SET} + 2.0 \text{ V}$, $1 \text{ mA} \leq I_{OUT} \leq 1 \text{ A}$ | -60 | 10 | 60 | mV | |
| V_{DIF} | Dropout Voltage | $I_{OUT} = 1 \text{ A}$ | Refer to the <i>Product-specific Electrical Characteristics</i> | | | | |
| I_{SS} | Supply Current | $I_{OUT} = 0 \text{ mA}$ | | 18 | 36 | μA | |
| $I_{standby}$ | Standby Current | $V_{CE} = 0 \text{ V}$ | | 0.1 | 2.0 | μA | |
| $\frac{\Delta V_{OUT}}{\Delta V_{IN}}$ | Line Regulation | $V_{SET} + 0.5 \text{ V} \leq V_{IN} \leq 36 \text{ V}$, if $V_{IN} \leq 3.5 \text{ V}$ | | 0.01 | 0.02 | %/V | |
| $\frac{\Delta V_{OUT}}{\Delta T_a}$ | Output Voltage Temperature Coefficient | $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$ | | ± 60 | | ppm/ $^\circ\text{C}$ | |
| I_{LIM} | Output Current Limit | $V_{IN} = V_{SET} + 2.0 \text{ V}$ | 1 | | | A | |
| I_{SC} | Short Current Limit | $V_{OUT} = 0 \text{ V}$ | | 150 | | mA | |
| I_{PD} | CE Pull-down Current | $V_{CE} = 5 \text{ V}$ | | 0.2 | 0.6 | μA | |
| | | $V_{CE} = 36 \text{ V}$ | | 0.5 | 1.3 | μA | |
| t_{D1} | Soft-start Time 1 | | | 120 | | μs | |
| V_{CEH} | CE Input Voltage "H" | | 2.2 | | | V | |
| V_{CEL} | CE Input Voltage "L" | | | | 1.0 | V | |
| T_{TSD} | Thermal Shutdown Detection Temperature | Junction Temperature | | 160 | | $^\circ\text{C}$ | |
| T_{TSR} | Thermal Shutdown Released Temperature | Junction Temperature | | 135 | | $^\circ\text{C}$ | |
| R_{LOW} | Low Output Nch Tr. ON Resistance (R1518xxxxD) | $V_{IN} = 14.0 \text{ V}$, $V_{CE} = 0 \text{ V}$ | | 3.2 | | k Ω | |

All test items listed under Electrical Characteristics are done under the pulse load condition ($T_j \approx T_a = 25^\circ\text{C}$) except for Output Voltage Temperature Coefficient and Soft-start Time 1.

R1518x

NO.EA-329-190212

 $V_{IN} = V_{SET} + 1.0 \text{ V}$, $I_{OUT} = 1 \text{ mA}$, $C_{IN} = 0.1 \text{ }\mu\text{F}$, $C_{OUT} = 1.0 \text{ }\mu\text{F}$, unless otherwise noted.The specifications surrounded by are guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$.**R1518x001C**

(Ta = 25°C)

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit |
|---------------------------------------|---|---|---|----------|---|---------------|
| V_{FB} | Feedback Voltage | Ta = 25°C | 2.480 | | 2.520 | V |
| | | $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$ | 2.455 | | 2.545 | V |
| ΔV_{OUT} $/\Delta I_{OUT}$ | Load Regulation | $V_{IN} = V_{SET} + 2.0 \text{ V}$ $1 \text{ mA} \leq I_{OUT} \leq 250 \text{ mA}$ | -10 | 3 | 10 | mV |
| | | $V_{IN} = V_{SET} + 2.0 \text{ V}$ $1 \text{ mA} \leq I_{OUT} \leq 1 \text{ A}$ | -25 | 5 | 35 | mV |
| V_{DIF} | Dropout Voltage | $V_{SET} = V_{FB}$, $I_{OUT} = 1 \text{ A}$ | | 1.0 | 1.8 | V |
| I_{SS} | Supply Current | $I_{OUT} = 0 \text{ mA}$ | | 18 | 36 | μA |
| $I_{standby}$ | Standby Current | $V_{CE} = 0 \text{ V}$ | | 0.1 | 2.0 | μA |
| ΔV_{OUT} $/\Delta V_{IN}$ | Line Regulation | $V_{SET} = V_{FB}$, $3.5 \text{ V} \leq V_{IN} \leq 36 \text{ V}$ | | 0.01 | 0.02 | %/V |
| ΔV_{OUT} $/\Delta T_a$ | Output Voltage Temperature Coefficient | $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$ | | ± 60 | | ppm /°C |
| I_{LIM} | Output Current Limit | $V_{IN} = V_{SET} + 2.0 \text{ V}$ | 1 | | | A |
| I_{SC} | Short Current Limit | $V_{OUT} = V_{FB} = 0 \text{ V}$ | | 150 | | mA |
| I_{PD} | CE Pull-down Current | $V_{CE} = 5 \text{ V}$ | | 0.2 | 0.6 | μA |
| | | $V_{CE} = 36 \text{ V}$ | | 0.5 | 1.3 | μA |
| t_{D1} | Soft-start Time 1 | | | 120 | | μs |
| V_{CEH} | CE Input Voltage "H" | | 2.2 | | | V |
| V_{CEL} | CE Input Voltage "L" | | | | 1.0 | V |
| 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 ($T_j \approx T_a = 25^{\circ}\text{C}$) except for Output Voltage Temperature coefficient and Soft-start Time 1.

$V_{IN} = V_{SET} + 1.0 \text{ V}$, $I_{OUT} = 1 \text{ mA}$, $C_{IN} = C_{OUT} = 0.1 \mu\text{F}$, unless otherwise noted.

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

R1518xxxxE/F

(Ta = 25°C)

| Symbol | Item | Conditions | Min. | Typ. | Max. | Unit | |
|---|---|---|---|---|--|---|---|
| V_{OUT} | Output Voltage | Ta = 25°C | $V_{SET} \leq 5.0 \text{ V}$ | $\times 0.992$ | | $\times 1.008$ | V |
| | | | $V_{SET} > 5.0 \text{ V}$ | $\times 0.99$ | | $\times 1.01$ | V |
| | | $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$ | $V_{SET} \leq 5.0 \text{ V}$ | $\times 0.982$ | | $\times 1.018$ | V |
| | | | $V_{SET} > 5.0 \text{ V}$ | $\times 0.98$ | | $\times 1.02$ | V |
| $\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$ | Load Regulation | $V_{IN} = V_{SET} + 2.0 \text{ V}$, $1 \text{ mA} \leq I_{OUT} \leq 250 \text{ mA}$ | -15 | 3 | 25 | mV | |
| | | $V_{IN} = V_{SET} + 2.0 \text{ V}$, $1 \text{ mA} \leq I_{OUT} \leq 1 \text{ A}$ | -60 | 10 | 60 | mV | |
| V_{DIF} | Dropout Voltage | $I_{OUT} = 1 \text{ A}$ | Refer to the <i>Product-specific Electrical Characteristics</i> | | | | |
| I_{SS} | Supply Current | $I_{OUT} = 0 \text{ mA}$ | | 18 | 36 | μA | |
| Istandby | Standby Current | $V_{CE} = 0 \text{ V}$ | | 0.1 | 2.0 | μA | |
| $\frac{\Delta V_{OUT}}{\Delta V_{IN}}$ | Line Regulation | $V_{SET} + 0.5 \text{ V} \leq V_{IN} \leq 36 \text{ V}$, if $V_{IN} \leq 3.5 \text{ V}$ | | 0.01 | 0.02 | %/V | |
| $\frac{\Delta V_{OUT}}{\Delta T_a}$ | Output Voltage Temperature Coefficient | $-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$ | | ± 60 | | ppm/ $^\circ\text{C}$ | |
| I_{LIM} | Output Current Limit | $V_{IN} = V_{SET} + 2.0 \text{ V}$ | 1 | | | A | |
| I_{SC} | Short Current Limit | $V_{OUT} = 0 \text{ V}$ | | 150 | | mA | |
| I_{PD} | CE Pull-down Current | $V_{CE} = 5 \text{ V}$ | | 0.2 | 0.6 | μA | |
| | | $V_{CE} = 36 \text{ V}$ | | 0.5 | 1.3 | μA | |
| I_{DELAY} | DELAY Current | DELAY = GND | 1.5 | 2.5 | 3.5 | μA | |
| t_{D1} | Soft-start Time 1 | DELAY = OPEN | | 26 | | μs | |
| t_{D2} | Soft-start Time 2 | DELAY = 0.001 μF | 210 | 290 | 415 | μs | |
| V_{CEH} | CE Input Voltage "H" | | 2.2 | | | V | |
| V_{CEL} | CE Input Voltage "L" | | | | 1.0 | V | |
| T_{TSD} | Thermal Shutdown Detection Temperature | Junction Temperature | | 160 | | $^\circ\text{C}$ | |
| T_{TSR} | Thermal Shutdown Released Temperature | Junction Temperature | | 135 | | $^\circ\text{C}$ | |
| R_{LOW} | Low Output Nch Tr. ON Resistance (R1518xxx1F) | $V_{IN} = 14.0 \text{ V}$, $V_{CE} = 0 \text{ V}$ | | 3.2 | | k Ω | |

All test items listed under Electrical Characteristics are done under the pulse load condition ($T_j \approx T_a = 25^\circ\text{C}$) except for Output Voltage Temperature Coefficient, Soft-start Time 1, and Soft-start Time 2.

R1518x

NO.EA-329-190212

The specifications surrounded by are guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$.**R1518xxxxB/D/E/F Product-specific Electrical Characteristics****($T_a = 25^{\circ}\text{C}$)**

| Product Name | V_{OUT} [V] ($T_a = 25^{\circ}\text{C}$) | | | V_{OUT} [V] ($-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$) | | | V_{DIF} [V] | |
|--------------|---|-------|-------|--|-------|------------------------------------|----------------------|-----------------------------------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. | Typ. | Max. |
| R1518x251x | 2.480 | 2.500 | 2.520 | <input type="text" value="2.455"/> | 2.500 | <input type="text" value="2.545"/> | 1.00 | <input type="text" value="1.80"/> |
| R1518x331x | 3.274 | 3.300 | 3.326 | <input type="text" value="3.241"/> | 3.300 | <input type="text" value="3.359"/> | 0.90 | <input type="text" value="1.60"/> |
| R1518x341x | 3.373 | 3.400 | 3.427 | <input type="text" value="3.339"/> | 3.400 | <input type="text" value="3.461"/> | | |
| R1518x501x | 4.960 | 5.000 | 5.040 | <input type="text" value="4.910"/> | 5.000 | <input type="text" value="5.090"/> | 0.70 | <input type="text" value="1.30"/> |
| R1518x601x | 5.940 | 6.000 | 6.060 | <input type="text" value="5.880"/> | 6.000 | <input type="text" value="6.120"/> | | |
| R1518x851x | 8.415 | 8.500 | 8.585 | <input type="text" value="8.330"/> | 8.500 | <input type="text" value="8.670"/> | 0.65 | <input type="text" value="1.10"/> |
| R1518x901x | 8.910 | 9.000 | 9.090 | <input type="text" value="8.820"/> | 9.000 | <input type="text" value="9.180"/> | 0.65 | <input type="text" value="1.10"/> |

OPERATION DESCRIPTION

Thermal Shutdown Function

Thermal shutdown function is included in this device. If the junction temperature is more than or equal to 160°C (Typ.), the operation of the regulator would stop. After that, when the junction temperature is less than or equal to 135°C (Typ.), the operation of the regulator would restart. Unless the cause of rising temperature is removed, the regulator repeats on and off, and output waveform would be like consecutive pulses.

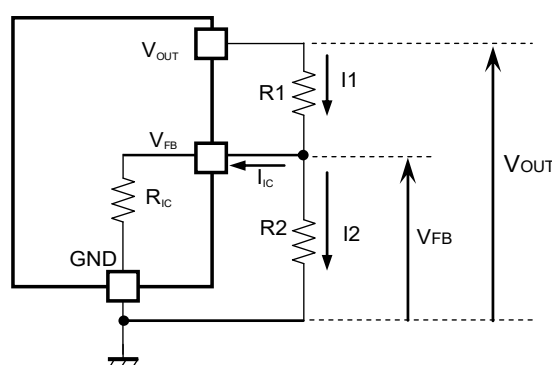
Adjustable Output Voltage Setting (R1518x001C)

The output voltage of R1518x001C can be adjusted by using the external divider resistors (R1, R2). By using the following equation, the output voltage (V_{OUT}) can be determined. The voltage which is fixed inside the IC is described as V_{FB} .

$$V_{OUT} = V_{FB} \times ((R1 + R2) / R2)$$

Recommended Range: $2.5 \text{ V} \leq V_{OUT} \leq 12.0 \text{ V}$

$$V_{FB} = 2.5 \text{ V}$$



Output Voltage Adjustment Using External Divider Resistors (R1, R2)

R_{IC} of the R1518x001C is approximately Typ. 1.35 M Ω ($T_a=25^\circ\text{C}$, guaranteed by design engineering). For better accuracy, setting $R1 \ll R_{IC}$ reduces errors. The resistance value for R2 should be set to 10 k Ω or lower. It is easily affected by noises when setting the value of R1 and R2 larger, which makes the impedance of V_{FB} pin larger.

R_{IC} could be affected by the temperature, therefore evaluate the circuit taking the actual conditions of use into account when deciding the resistance values for R1 and R2.

R1518x

NO.EA-329-190212

Soft-start Function

R1518x is equipped with a constant slope circuit, which achieves a soft-start function. This circuit allows the output voltage to start up gradually when the CE is turned on. The constant slope circuit minimizes the inrush current at the start-up and also prevents the overshoot of the output voltage. For R1518xxxxB/C/D, the capacitor to create the start-up slope is built in this device that does not require any external components. The start-up time and the start-up slope angle are fixed inside the device. As for R1518xxxxE/F, the soft-start time is adjustable by inserting the external capacitor to DELAY pin. By using the following equation, the relation between the soft-start time t_D [s] and DELAY pin capacitor C_D [F] is determined.

$$t_D = ((C_D + 90 \times 10^{-12}) / I_{\text{DELAY}}) \times 0.73$$

When the capacitor C_D of R1518xxxxE/F is not used, use the DELAY pin as OPEN. At that time, $C_D = 0$ in the above equation, therefore the start-up time is about 26 μs . However, be sure to consider approximately 50 μs of CE delay time.

Conventional Inrush Current Limit Circuit

(Diagrammatic sketch)



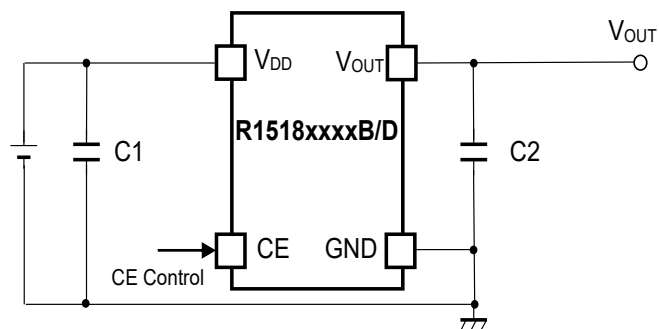
Constant Slope Circuit

(Diagrammatic sketch)

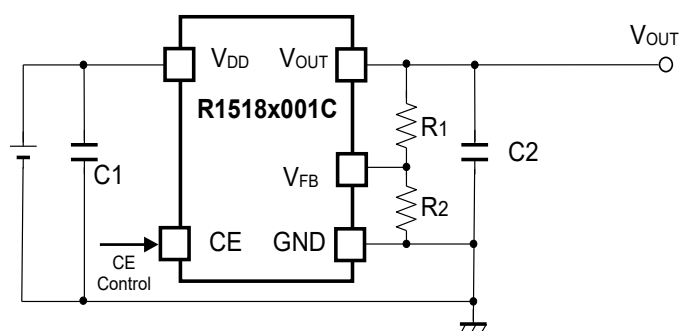


APPLICATION INFORMATION

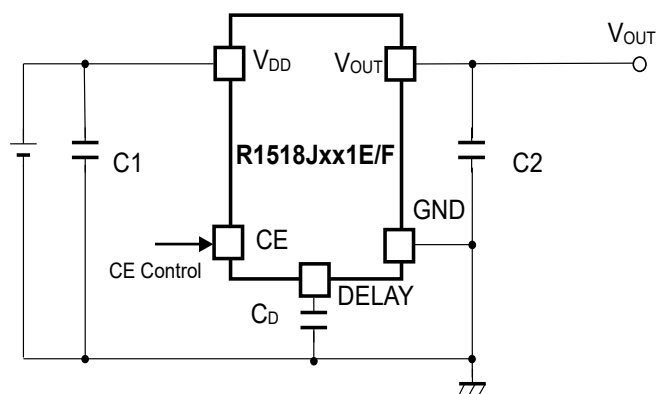
TYPICAL APPLICATION



R1518xxxxB/D Typical Application



R1518x001C Typical Application



R1518xxxxE/F Typical Application

R1518x

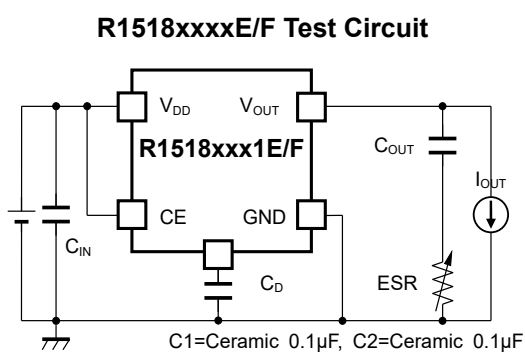
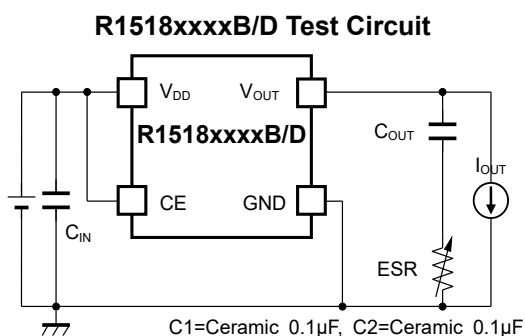
NO.EA-329-190212

External Components :

| Symbol | Description |
|--------------------------|-----------------|
| R1518xxxxB//D/E/F | |
| C1 (C _{IN}) | 0.1μF (Ceramic) |
| C2 (C _{OUT}) | 0.1μF (Ceramic) |
| R1518x001C | |
| C1 (C _{IN}) | 0.1μF (Ceramic) |
| C2 (C _{OUT}) | 1.0μF (Ceramic) |

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.

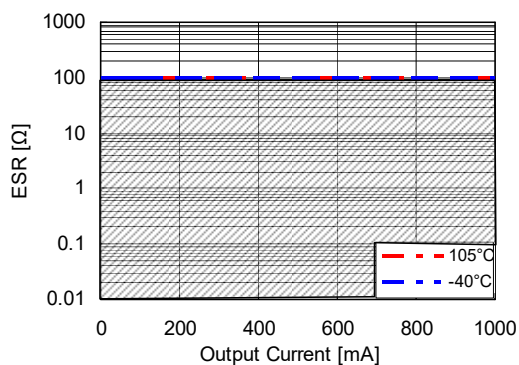


Measurement conditions

- Frequency Band: 10 Hz to 2 MHz
- Measurement Temperature: -40°C to 105°C
- Hatched area: Noise level is 40 µV (average) or below
- Capacitor: C1 = Ceramic 0.1 µF, C2 = 0.1 µF

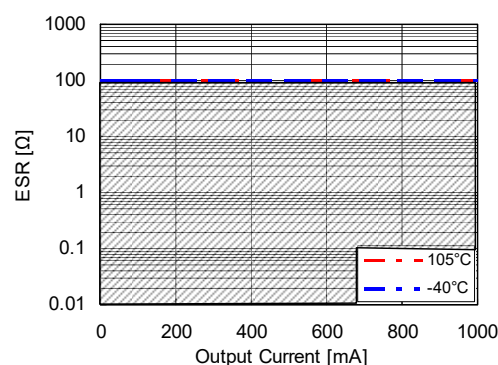
R1518x25xx Output Current I_{OUT} vs. ESR

$V_{in}=2.5V$ to 36V



R1518x85xx Output Current I_{OUT} vs. ESR

$V_{in}=8.5V$ to 36V



TECHNICAL NOTES

Phase Compensation

In LDO regulators, phase compensation is provided to secure stable operation even when the load current is varied. For this purpose, use 0.1 μF or more (R1518xxxxB/D/E/F), 1.0 μF or more (R1518x001C) of the capacitor C2. When using a tantalum type capacitor and the ESR (Equivalent Series Resistance) value is large, the output might be unstable. Evaluate the circuit including consideration of frequency characteristics. For the externally adjustable output voltage type (R1518x001C), use 10 $\text{k}\Omega$ or lower resistance R2.

PCB Layout

Ensure the V_{DD} and GND lines are sufficiently robust. If their impedance is too high, noise pickup or unstable operation may result. Connect 0.1 μF or more of the capacitor C1 between the V_{DD} and GND, and as close as possible to the pins.

In addition, connect the capacitor C2 between V_{OUT} and GND, and as close as possible to the pins.

TYPICAL CHARACTERISTICS

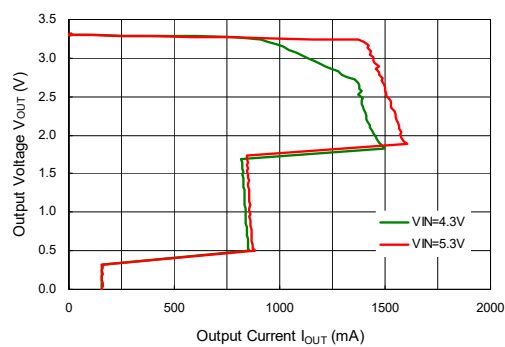
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

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

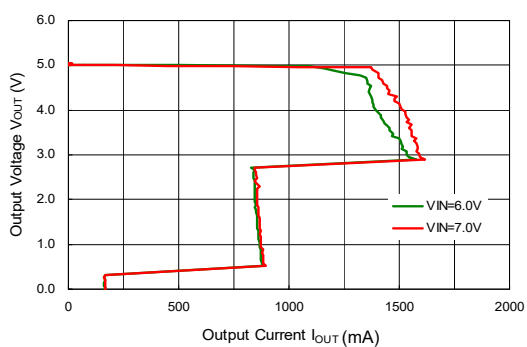
R1518x25xx, R1518x001C



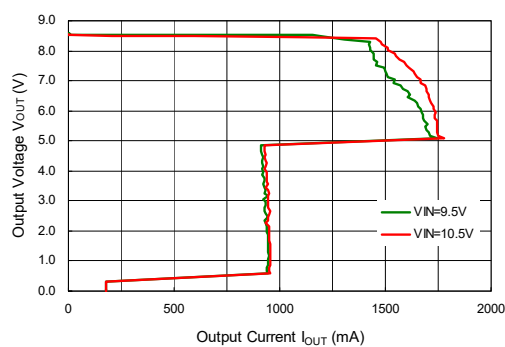
R1518x33xx



R1518x50xx

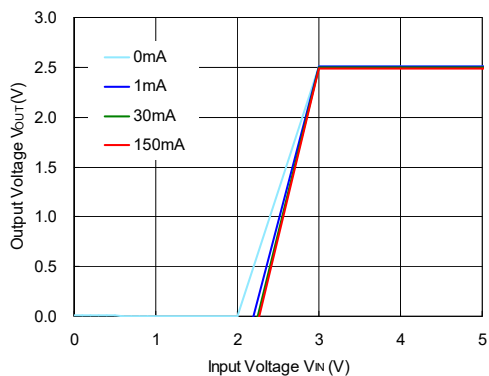


R1518x85xx

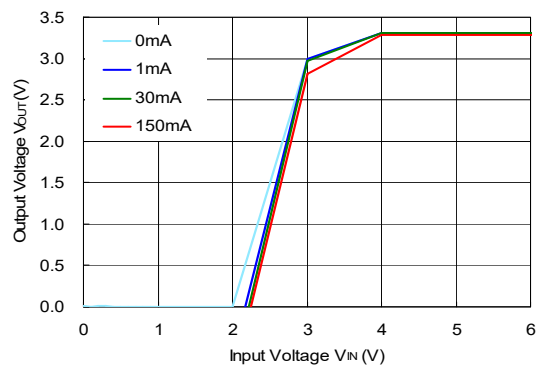


2) Output Voltage vs. Input Voltage (Ta = 25°C)

R1518x25xx



R1518x33xx



R1518x

NO.EA-329-190212

R1518x50xx

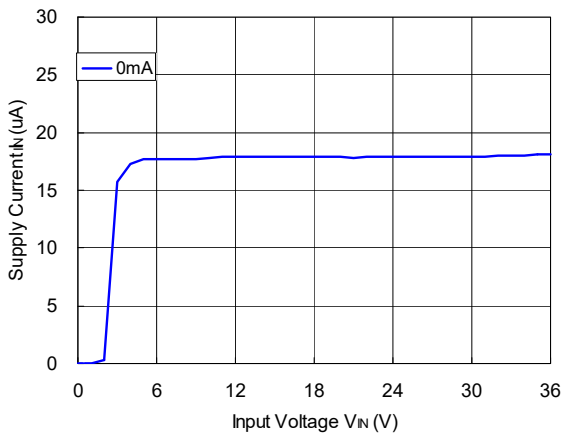


R1518x85xx

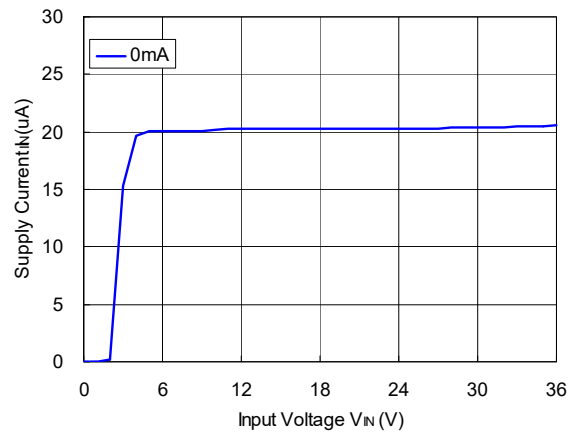


3) Supply Current vs. Input Voltage

R1518x25xx, R1518x001C



R1518x33xx



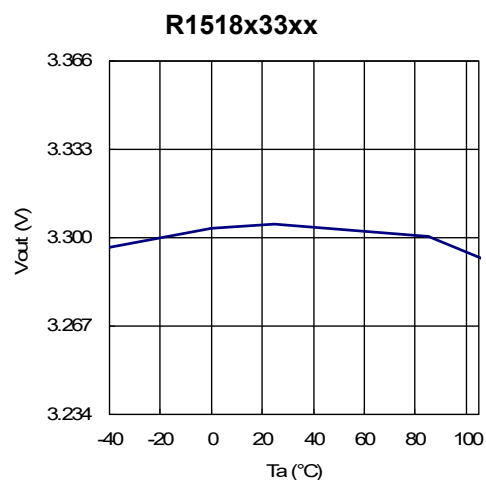
R1518x50xx



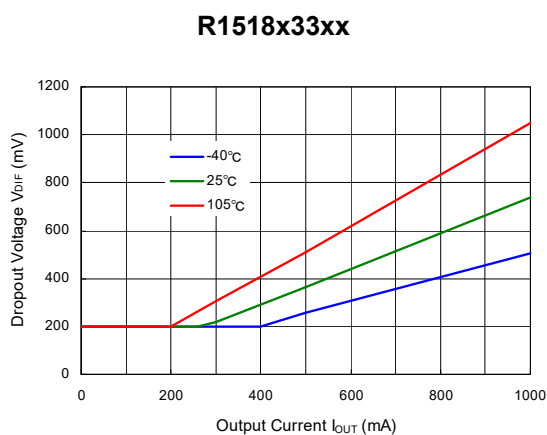
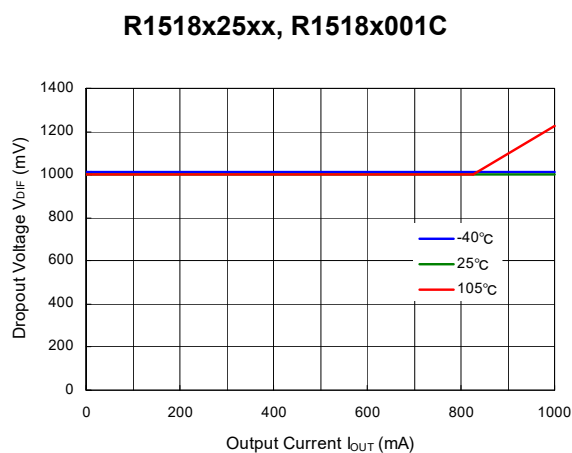
R1518x85xx



4) Output Voltage vs. Operating Temperature



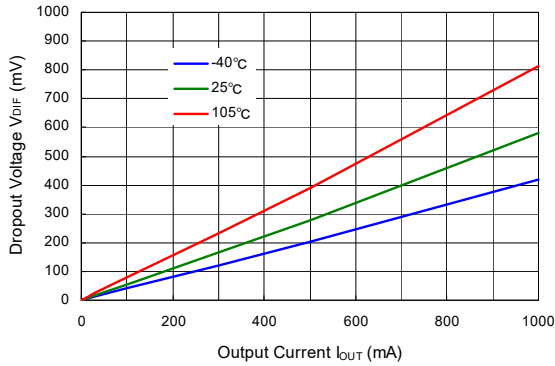
5) Dropout Voltage vs. Output Current



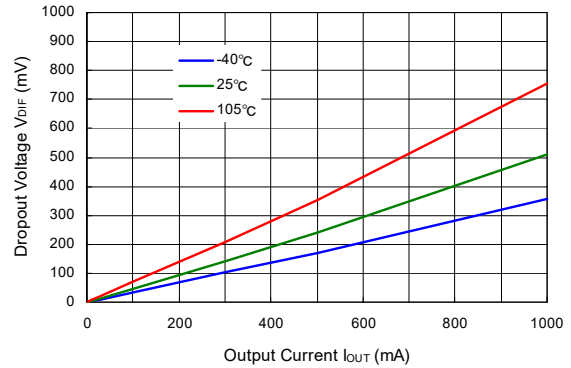
R1518x

NO.EA-329-190212

R1518x50xx



R1518x85xx

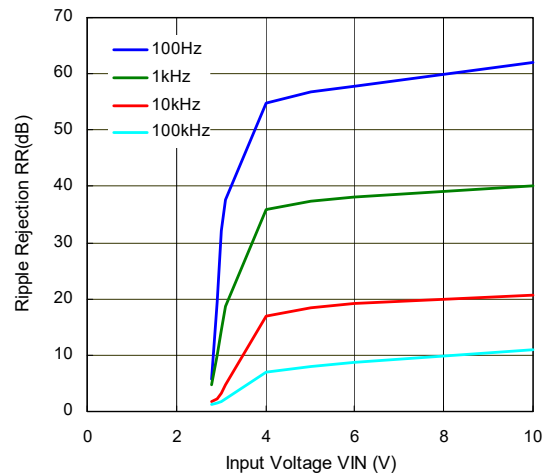


6) Ripple Rejection vs. Input Voltage ($T_a = 25^\circ\text{C}$, Ripple = 0.5 Vpp)

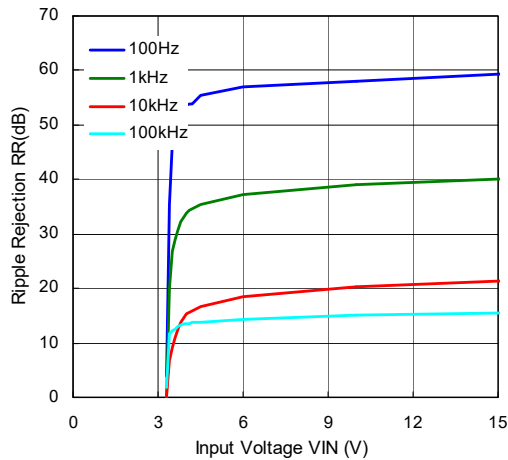
R1518x25xx, R1518x001C ($I_{OUT} = 1 \text{ mA}$)



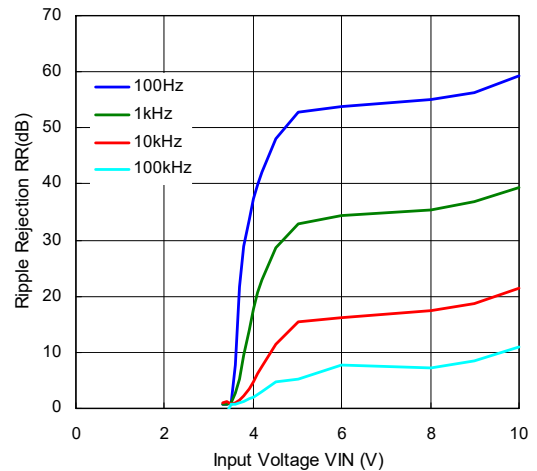
R1518x25xx, R1518x001C ($I_{OUT} = 300 \text{ mA}$)



R1518x33xx ($I_{OUT} = 1 \text{ mA}$)



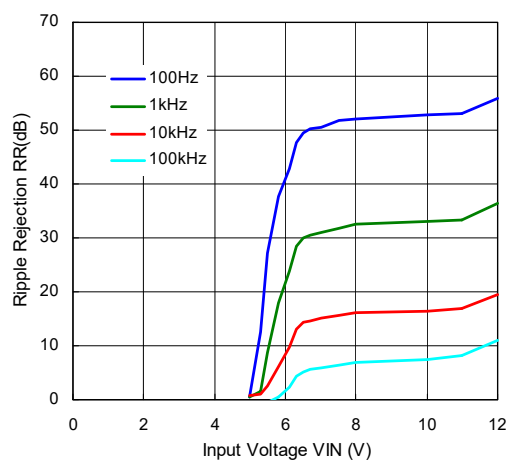
R1518x33xx ($I_{OUT} = 300 \text{ mA}$)



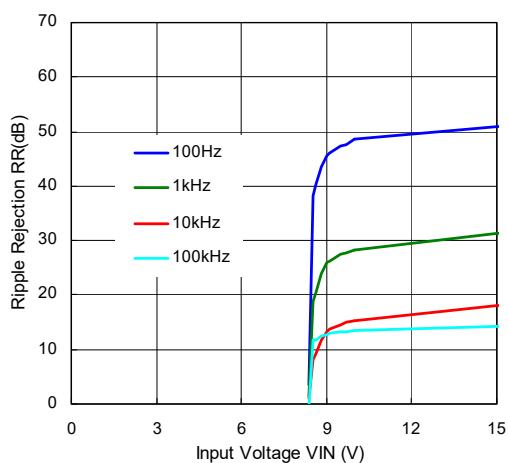
R1518x50xx (I_{OUT} = 1 mA)



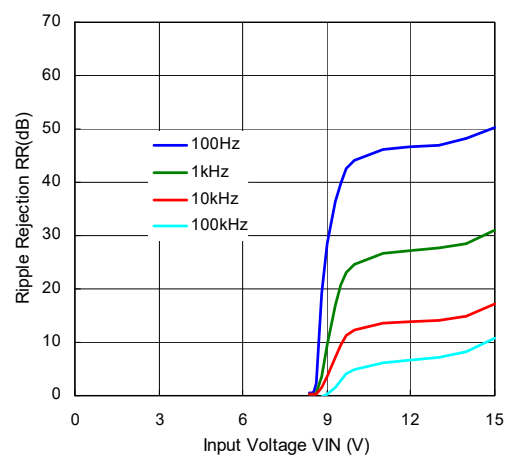
R1518x50xx (I_{OUT} = 300 mA)



R1518x85xx (I_{OUT} = 1 mA)

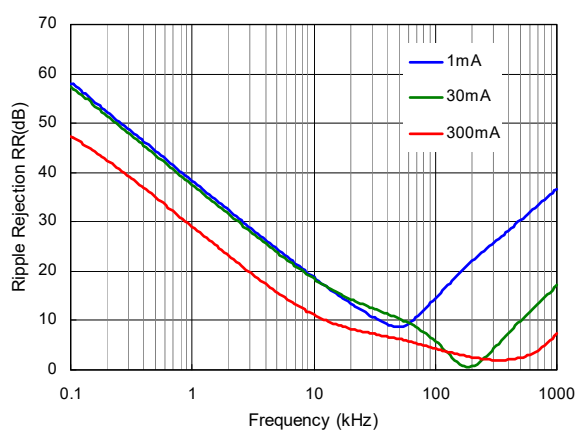


R1518x85xx (I_{OUT} = 300 mA)

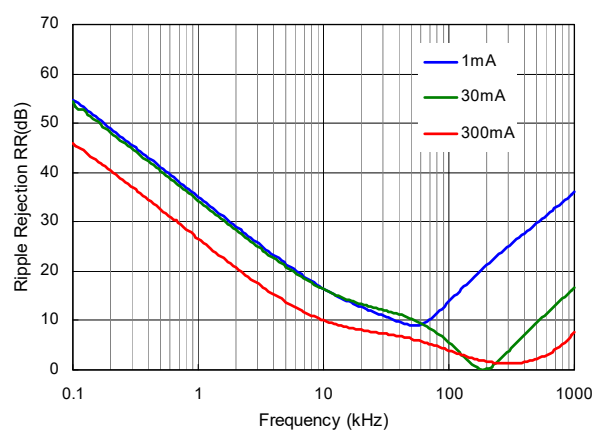


7) Ripple Rejection vs. Frequency (Ta = 25°C, Ripple = 0.5 Vpp)

R1518x25xx, R1518x001C



R1518x33xx



R1518x

NO.EA-329-190212

R1518x50xx



R1518x85xx



8) Input Transient Response ($T_a = 25^\circ\text{C}$, $I_{OUT} = 1\text{ mA}$, $t_r = t_f = 5\ \mu\text{s}$)

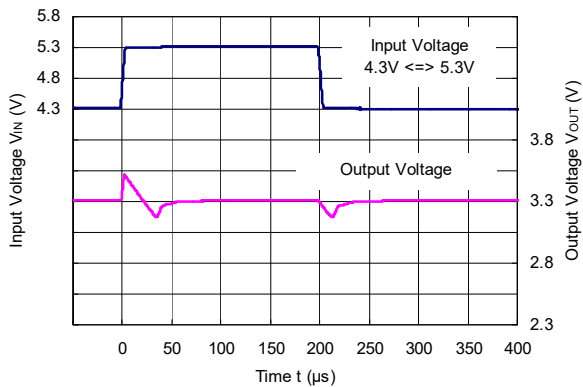
R1518x25xx, R1518x001C ($C_2 = 0.1\ \mu\text{F}$)



R1518x25xx, R1518x001C ($C_2 = 10\ \mu\text{F}$)



R1518x33xx ($C_2 = 0.1\ \mu\text{F}$)



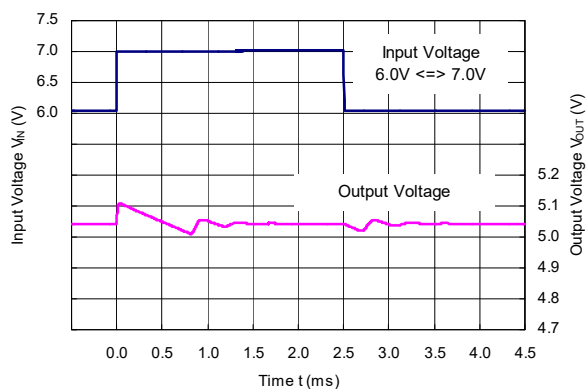
R1518x33xx ($C_2 = 10\ \mu\text{F}$)



R1518x50xx (C2 = 0.1 μ F)



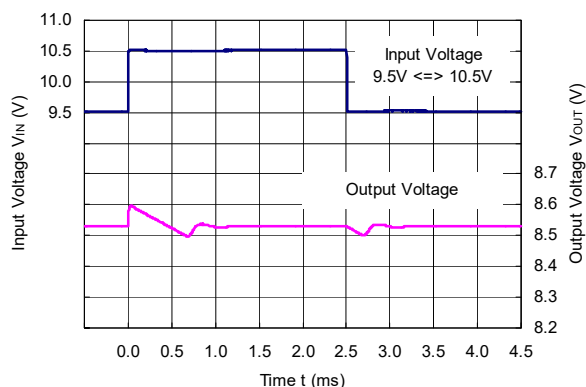
R1518x50xx (C2 = 10 μ F)



R1518x85xx (C2 = 0.1 μ F)

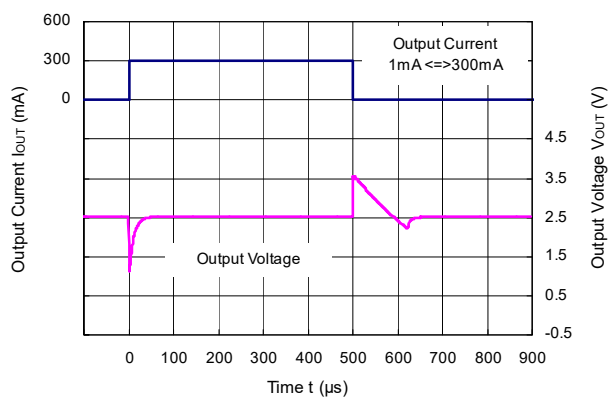


R1518x85xx (C2 = 10 μ F)

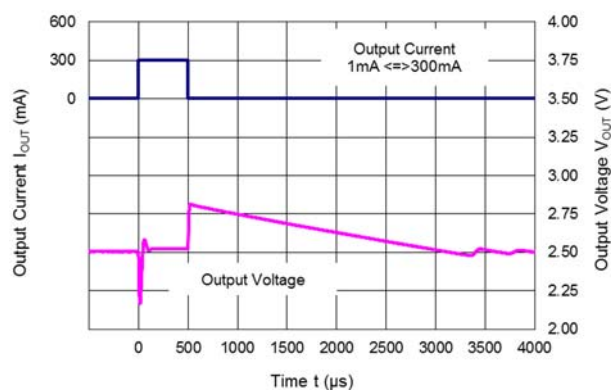


9) Load Transient Response ($T_a = 25^\circ\text{C}$, $V_{IN} = V_{OUT} + 1.0\text{ V}$, $t_r = t_f = 0.5\ \mu\text{s}$)

R1518x25xx, R1518x001C (C2 = 0.1 μ F)



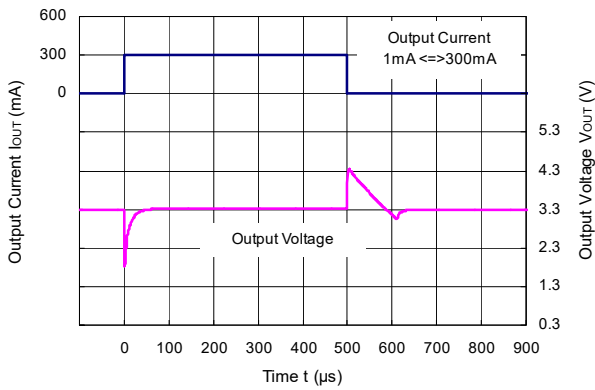
R1518x25xx, R1518x001C (C2 = 10 μ F)



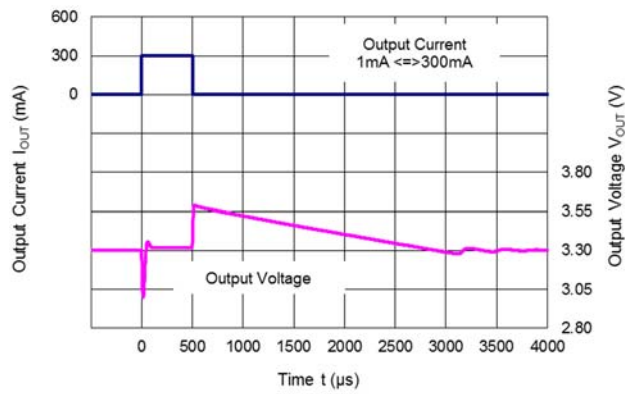
R1518x

NO.EA-329-190212

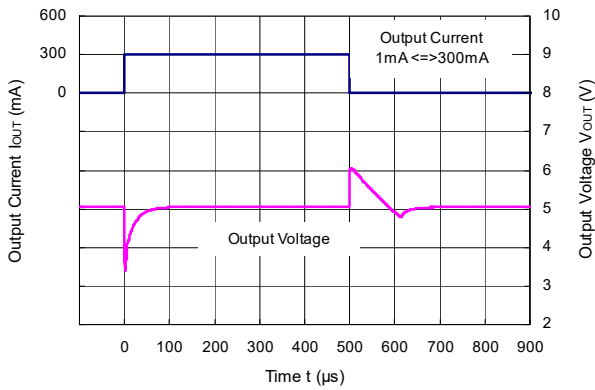
R1518x33xx (C2 = 0.1 μ F)



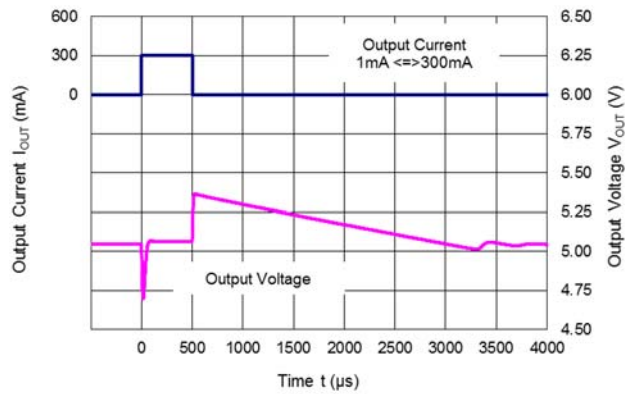
R1518x33xx (C2 = 10 μ F)



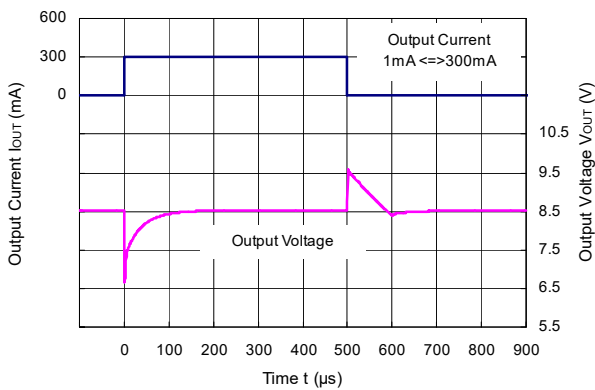
R1518x50xx (C2 = 0.1 μ F)



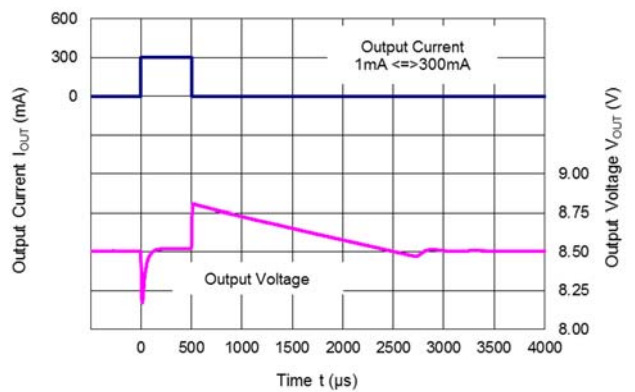
R1518x50xx (C2 = 10 μ F)



R1518x85xx (C2 = 0.1 μ F)

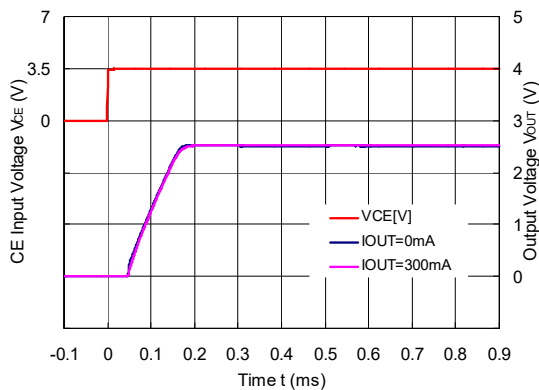


R1518x85xx (C2 = 10 μ F)

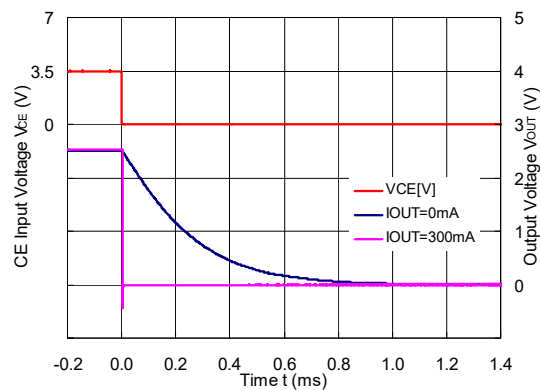


10) CE Transient Response (Ta = 25°C)

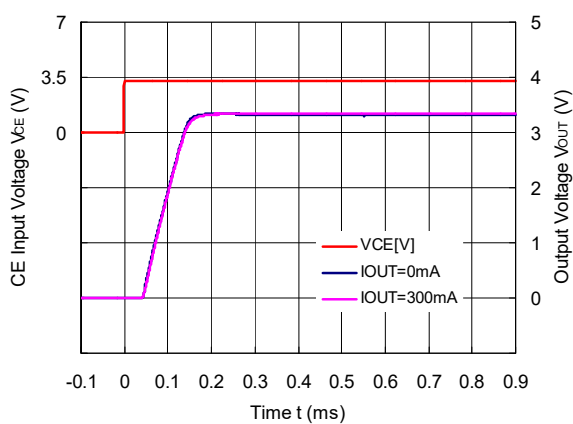
R1518x25xB/D, R1518x001C (C2 = 0.1 μF)



R1518x25xD (C2 = 0.1 μF)



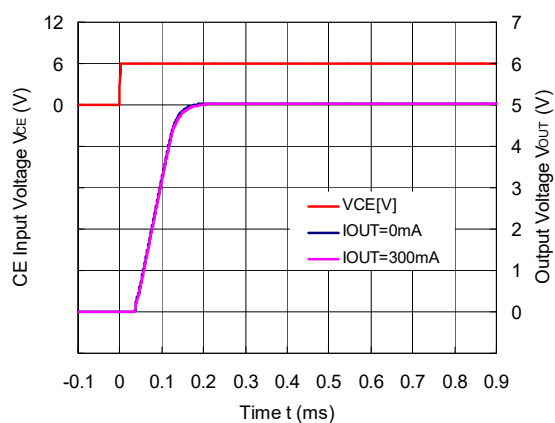
R1518x33xB/D (C2 = 0.1 μF)



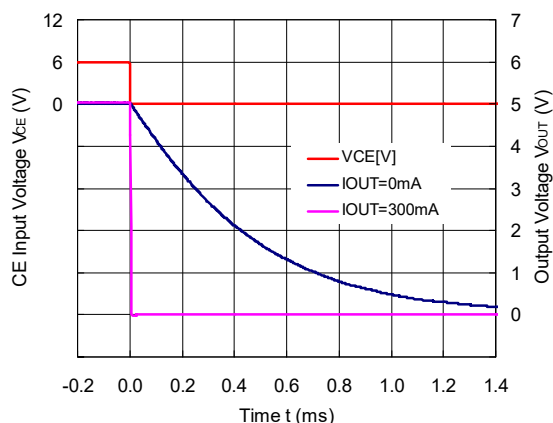
R1518x33xD (C2 = 0.1 μF)



R1518x50xB/D (C2 = 0.1 μF)



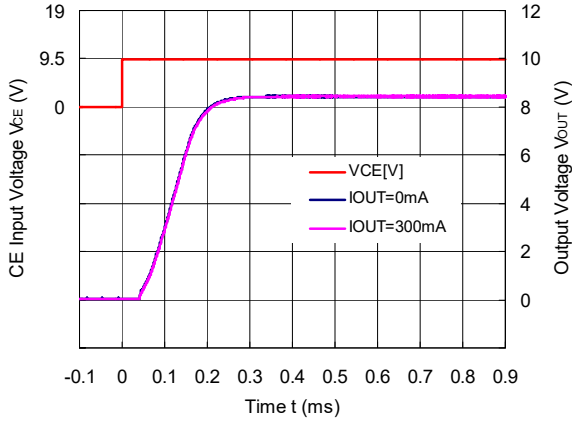
R1518x50xD (C2 = 0.1 μF)



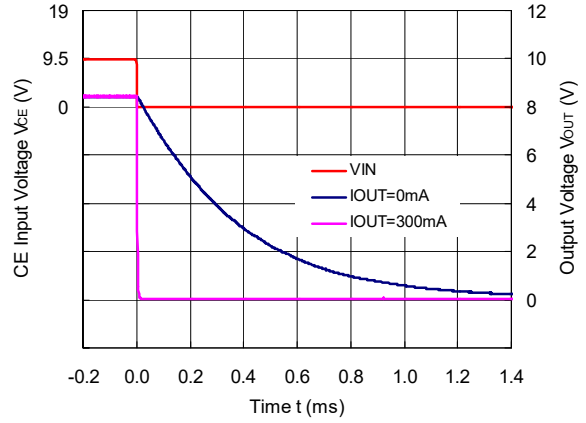
R1518x

NO.EA-329-190212

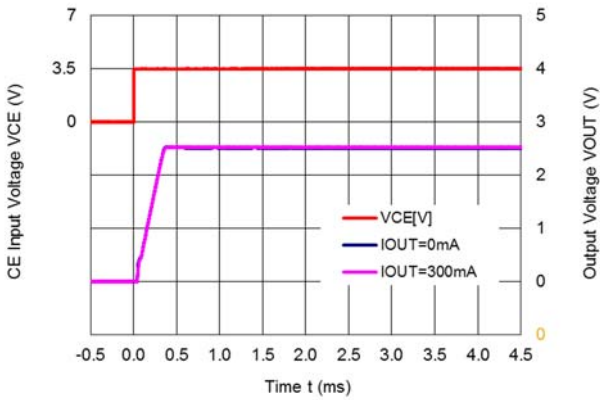
R1518x85xB/D (C2 = 0.1 μ F)



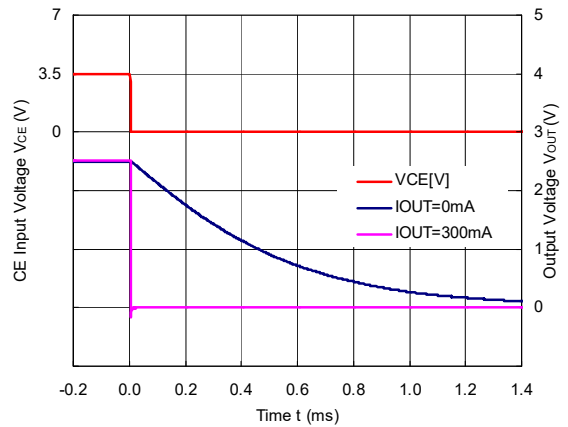
R1518x85xD (C2 = 0.1 μ F)



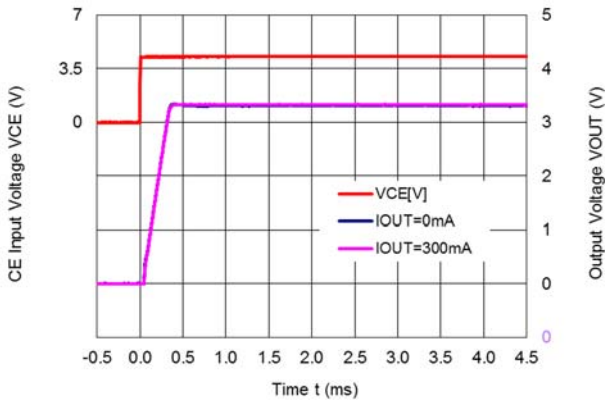
R1518x25xE/F (C2 = 0.1 μ F, C_D = 1 nF)



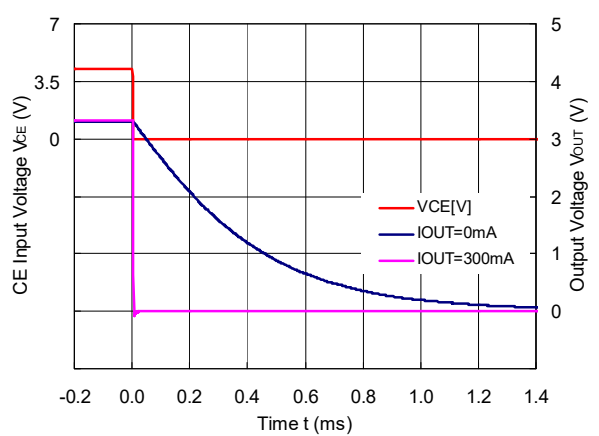
R1518x25xF (C2 = 0.1 μ F, C_D = 1 nF)



R1518x33xE/F (C2 = 0.1 μ F, C_D = 1 nF)



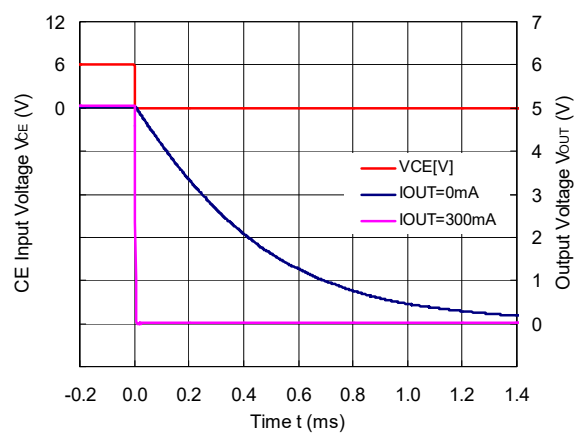
R1518x33xF (C2 = 0.1 μ F, C_D = 1 nF)



R1518x50xE/F (C₂ = 0.1 μF, C_D = 1 nF)



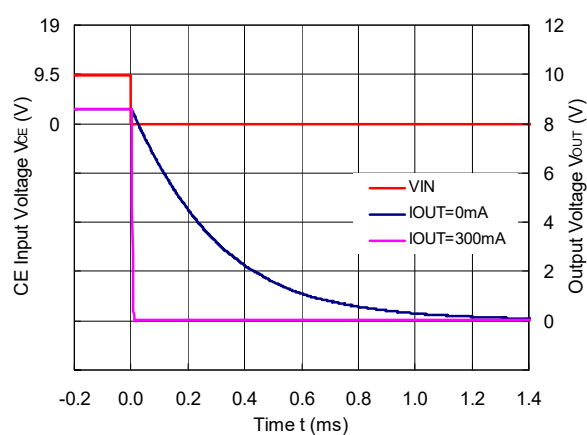
R1518x50xF (C₂ = 0.1 μF, C_D = 1 nF)



R1518x851E/F (C₂ = 0.1 μF, C_D = 1 nF)



R1518x851F (C₂ = 0.1 μF, C_D = 1 nF)



R1518x

NO.EA-329-190212

11) Inrush Current Prevention Circuit ($T_a = 25^\circ\text{C}$, $I_{OUT} = 1\text{ mA}$)

R1518x25xB/D, R1518x001C



R1518x33xB/D



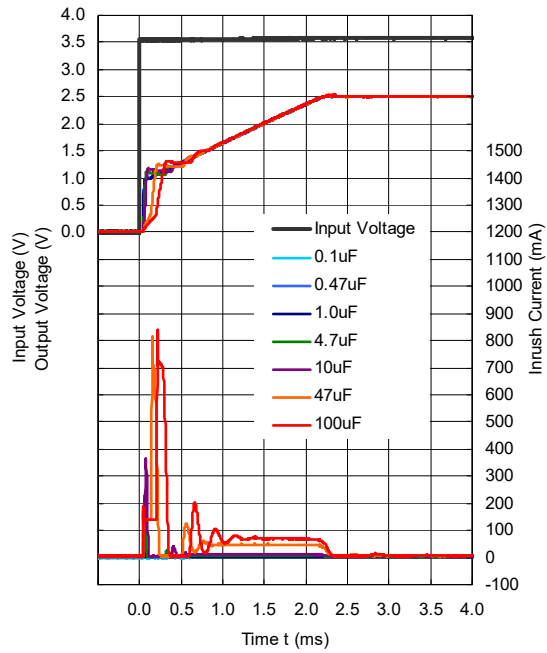
R1518x50xB/D



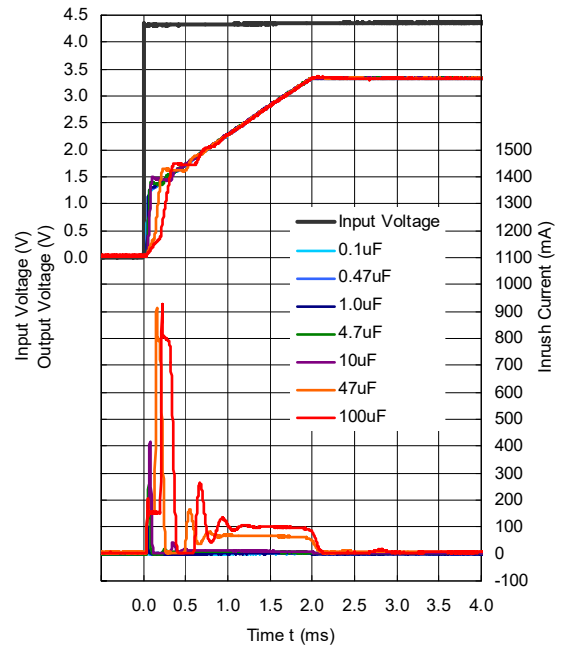
R1518x85xB/D



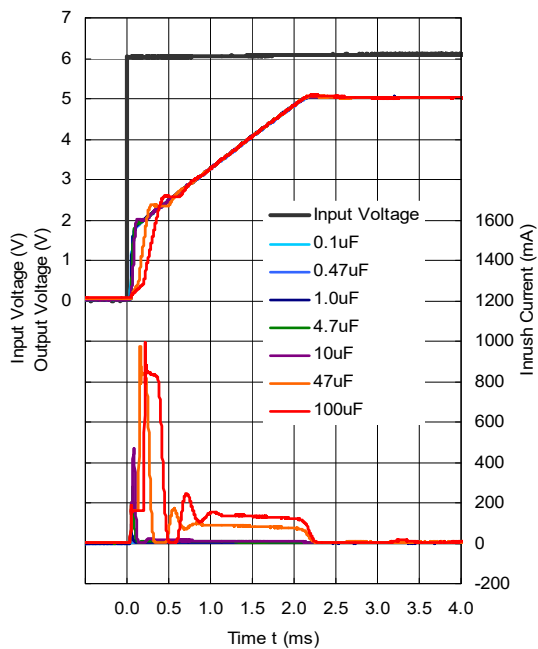
R1518x25xE/F ($C_D = 10\text{ nF}$)



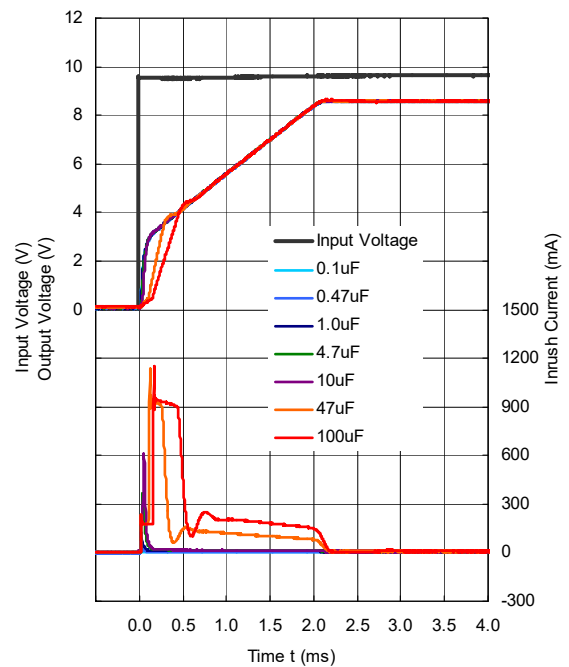
R1518x33xE/F ($C_D = 10\text{ nF}$)



R1518x50xE/F ($C_D = 10\text{ nF}$)



R1518x85xE/F ($C_D = 10\text{ nF}$)



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 Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square |
| Through-holes | φ 0.3 mm × 28 pcs |

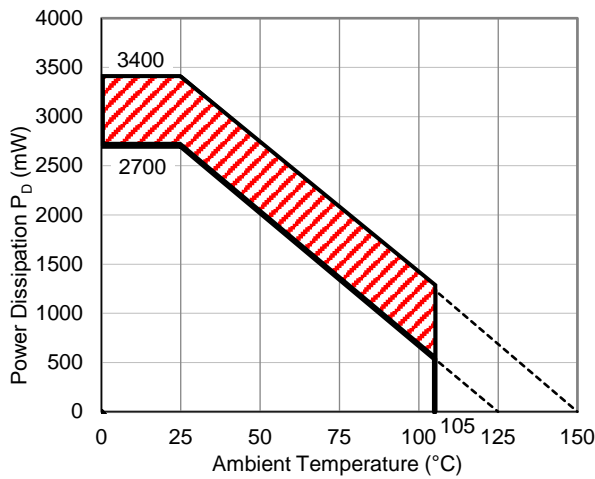
Measurement Result

(Ta = 25°C, Tjmax = 125°C)

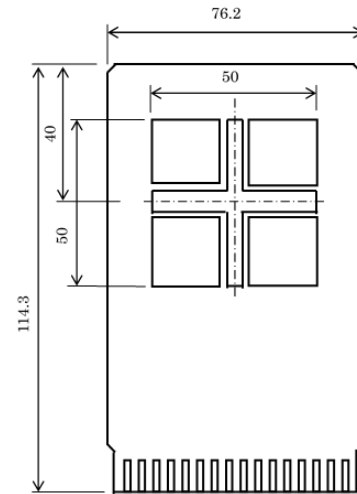
| Item | Measurement Result |
|--|--------------------|
| Power Dissipation | 2700 mW |
| Thermal Resistance (θja) | θja = 37°C/W |
| Thermal Characterization Parameter (ψjt) | ψjt = 7°C/W |

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



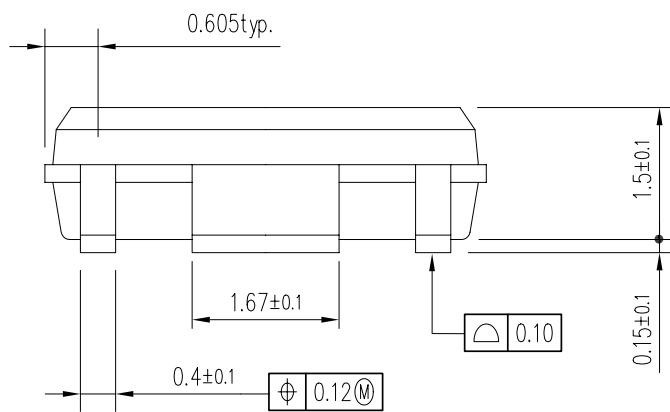
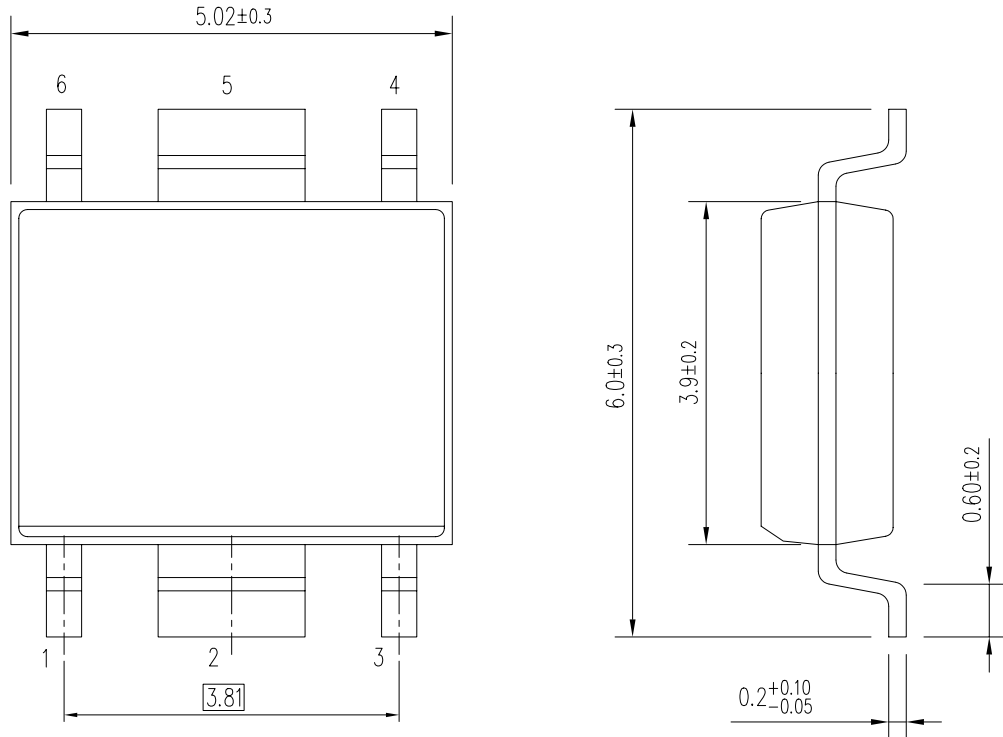
Power Dissipation vs. Ambient Temperature



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 |



UNIT: mm

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. 51-7.

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 x 114.3 mm x 0.8 mm |
| Copper Ratio | Outer Layer (First Layer): Approx.95% of 50 mm Square Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square |
| Through-holes | φ 0.3 mm x 21 pcs |

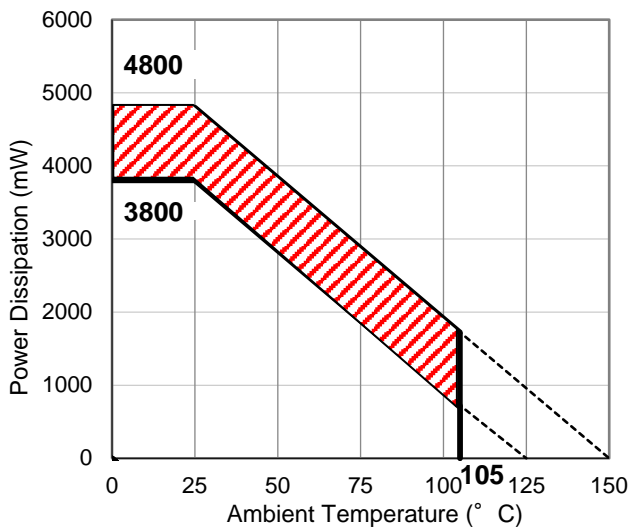
Measurement Result

(Ta = 25°C, Tjmax = 125°C)

| Item | Measurement Result |
|--|--------------------|
| Power Dissipation | 3800 mW |
| Thermal Resistance (θja) | θja = 26°C/W |
| Thermal Characterization Parameter (ψjt) | ψjt = 7°C/W |

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter



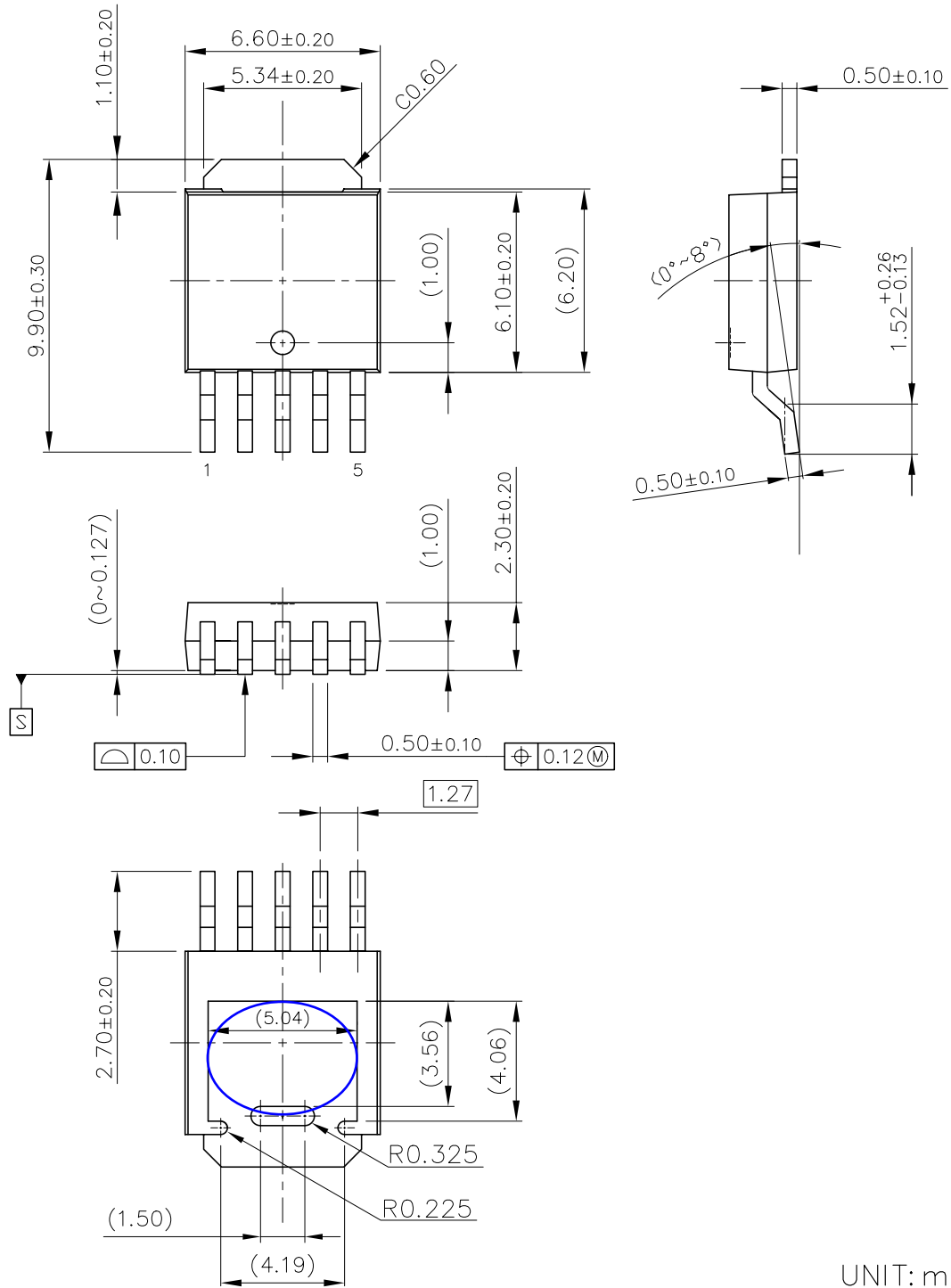
Power Dissipation vs. Ambient Temperature



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 |



UNIT: mm

TO-252-5-P2 Package Dimensions

* The tab on the bottom of the package shown by blue circle is a 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.



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Sales & Support Offices

Ricoh Electronic Devices Co., Ltd.

Shin-Yokohama Office (International Sales)

2-3, Shin-Yokohama 3-chome, Kohoku-ku, Yokohama-shi, Kanagawa, 222-8530, Japan
Phone: +81-50-3814-7687 Fax: +81-45-474-0074

Ricoh Americas Holdings, Inc.

675 Campbell Technology Parkway, Suite 200 Campbell, CA 95008, U.S.A.
Phone: +1-408-610-3105

Ricoh Europe (Netherlands) B.V.

Semiconductor Support Centre

Prof. W.H. Keesomlaan 1, 1183 DJ Amstelveen, The Netherlands
Phone: +31-20-5474-309

Ricoh International B.V. - German Branch

Semiconductor Sales and Support Centre

Oberrather Strasse 6, 40472 Düsseldorf, Germany
Phone: +49-211-6546-0

Ricoh Electronic Devices Korea Co., Ltd.

3F, Haesung Bldg, 504, Teheran-ro, Gangnam-gu, Seoul, 135-725, Korea
Phone: +82-2-2135-5700 Fax: +82-2-2051-5713

Ricoh Electronic Devices Shanghai Co., Ltd.

Room 403, No.2 Building, No.690 Bibo Road, Pu Dong New District, Shanghai 201203,
People's Republic of China
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

Ricoh Electronic Devices Shanghai Co., Ltd.

Shenzhen Branch

1205, Block D (Jinlong Building), Kingkey 100, Hongbao Road, Luohu District,
Shenzhen, China
Phone: +86-755-8348-7600 Ext 225

Ricoh Electronic Devices Co., Ltd.

Taipei office

Room 109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623

Mouser Electronics

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Телефон: 8 (812) 309-75-97 (многоканальный)

Факс: 8 (812) 320-03-32

Электронная почта: ocean@oceanchips.ru

Web: <http://oceanchips.ru/>

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А