300 mA 36 V Input Regulator for High Temperature Applications

NO. EA-345-221111

OUTLINE

The R1511x is a CMOS-based high-voltage resistant and fast response voltage regulator that provides the minimum 300mA of output current. Internally, R1511x 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 –40ºC to 105ºC, and the maximum input voltage is 36V. All these features allow the R1511x to become an ideal power source for industrial equipments such as FAs and smart meters.

R1511x is available in R1511xxxxB with the fixed output voltage type: 3.0V / 3.3V / 3.4V / 5.0V / 6.0V / 8.0V / 8.5V / 9.0V, and R1511x001C with adjustable output voltage type with external resistors. The output voltage accuracy is ±1.0%.

R1511x is available in two types of packages for ultra high wattage: HSOP-6J and TO-252-5-P2.

FEATURES

- Input Voltage Range (Maximum Rating) ····· 3.5V to 36V (50 V)
- Operating Temperature Range ····· -40 to 105°C (※)
- Supply Current ····· Typ. 100μA
- Standby Current ····· Typ. 0.1μA (R1511xxxxB)
- Output Voltage Range ····· R1511xxxxB: 3.0V / 3.3V / 3.4V / 5.0V / 6.0V / 8.0V / 8.5V / 9.0V
  Contact Ricoh sales representatives for other voltages.
  R1511x001C: 3.0V to 12.0V (Adjustable with external resistor)
- Output Voltage Accuracy ····· R1511xxxxB: ±1.0% (T_a=25°C)
- Feedback Voltage ····· R1511x001C: 3.0V ±1.0% (T_a=25°C)
- Output Voltage Temperature-Drift Coefficient ····· Typ. ±60ppm/°C
- Line Regulation ····· Typ. 0.01%/V (V_{DD}=V_{OUT}+0.5V to 36V)
- Dropout Voltage ····· Typ. 0.64V (I_{OUT}=300mA, V_{OUT}=5.0V)
- Package Option ····· HSOP-6J, TO-252-5-P2
- Built-in Output Short-circuit Protection Circuit ····· Typ. 50mA
- Built-in Over-current Protection Circuit ····· Typ. 450mA
- Built-in Thermal Shutdown Circuit ····· Thermal Shutdown Temperature: Typ. 160°C
- Ripple Rejection ····· Typ. 65dB (1kHz)
- Ceramic capacitors are recommended to be used with this IC
  ····· C_{IN}=1.0μF or more, C_{OUT}=6.8μF or more

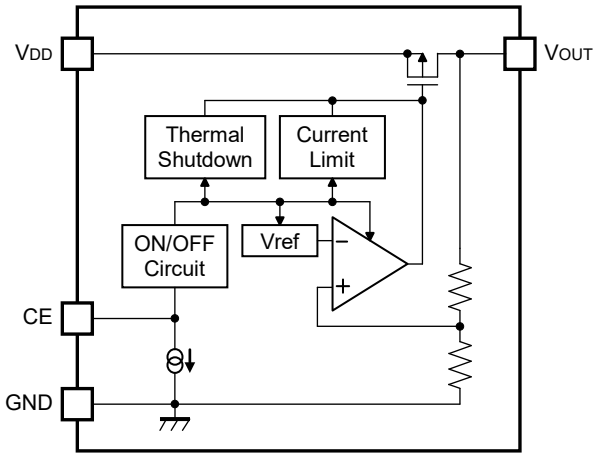
※ This product is usable for the high-temperature applications since have passed a test at the high temperature. In addition, this product has a high-reliability since having passed Ricoh's rigorous quality standards. To distinguish from the consumer products, "-Yx" is added at the end of the product name.

APPLICATIONS

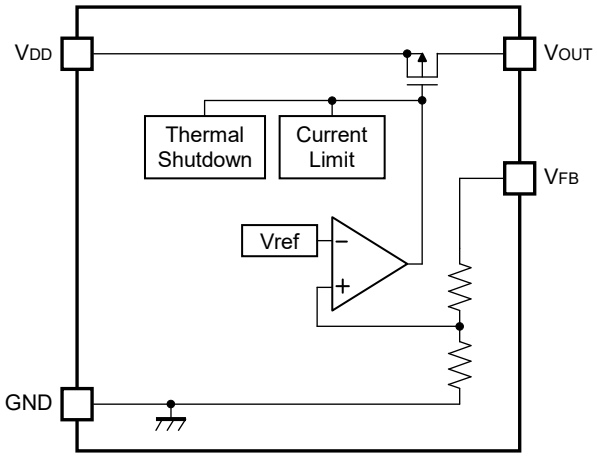
- Industrial equipments such as FAs and smart meters
- Equipments used under high-temperature conditions
- Equipments accompanied by self-heating

BLOCK DIAGRAMS

R1511xxxxB



R1511x001C



SELECTION GUIDE

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

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1511Sxxx∗-E2-YE	HSOP-6J	1,000 pcs	Yes	Yes
R1511Jxxx∗-T1-YE	TO-252-5-P2	3,000 pcs	Yes	Yes

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

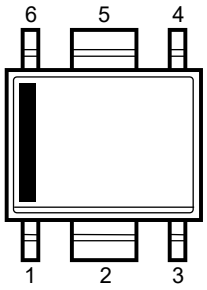
R1511xxxxB: 3.0V (030) / 3.3V (033) / 3.4V (034) / 5.0V (050) / 6.0V (060) / 8.0V (080) / 8.5V (085) / 9.0V (090)
Contact Ricoh sales representatives for other voltages.

R1511x001C: Only (001)

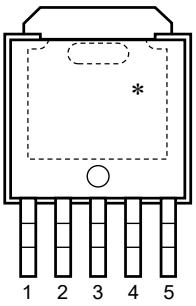
∗ : Specify the version
(B): Fixed output and Built-in Chip Enable (Active-high)
(C): Adjustable output

PIN DESCRIPTIONS

● **HSOP-6J**



● **TO-252-5-P2**



HSOP-6J

Pin No.	Symbol	Description	
1	V_{DD}	Input Pin	
2	GND*1	Ground Pin	
3	GND*1	Ground Pin	
4	CE	R1511SxxxB	Chip Enable Pin (Active-high)
	V_{FB}	R1511S001C	Feed Back Pin
5	GND*1	Ground Pin	
6	V_{OUT}	Output Pin	

*1 The GND pin must be wired together when it is mounted on board.

TO-252-5-P2

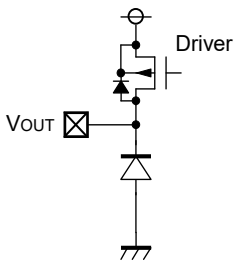
Pin No.	Symbol	Description	
1	V_{DD}	Input Pin	
2	GND*2	Ground Pin	
3	GND*2	Ground Pin	
4	CE	R1511JxxxB	Chip Enable Pin (Active-high)
	V_{FB}	R1511J001C	Feed Back Pin
5	V_{OUT}	Output Pin	

∗) 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.

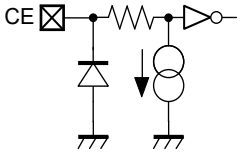
*2 The GND pin must be wired together when it is mounted on board.

PIN EQUIVALENT CIRCUIT DIAGRAMS

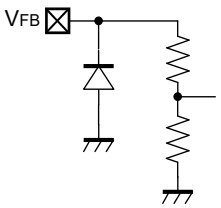
<V_{OUT} Pin>



<CE Pin (R1511xxxxB)>



<V_{FB} Pin (R1511x001C)>



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 ≤ 50		V
I_{OUT}	Output Current	450		mA
P_D	Power Dissipation (HSOP-6J)*2	JEDEC STD. 51-7	2700	mW
	Power Dissipation (TO-252-5-P2)*2	JEDEC STD. 51-7	3800	
Tj	Junction Temperature	-40 to 125		°C
Tstg	Storage Temperature Range	-55 to 125		°C

*1 Duration time: 200ms

*2 Refer to *PACKAGE INFORMATION* for detailed information.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the 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

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	3.5 to 36	V
Ta	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 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.

ELECTRICAL CHARACTERISTICS

C_{IN}=1.0µF, C_{OUT}=6.8µF, unless otherwise noted.
The specifications surrounded by ☐ are guaranteed by design engineering at -40°C ≤ Ta ≤ 105°C.

R1511xxxxB (Ta=25°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
I_{SS}	Supply Current	V_{IN}=V_{SET}+1.0V, I_{OUT}=0mA			100	180	µA
$I_{standby}$	Standby Current	V_{IN}=36V, V_{CE}=0V			0.1	2.0	µA
V_{OUT}	Output Voltage	V_{IN}=V_{SET}+2.0V I_{OUT}=1mA	Ta=25°C	×0.99		×1.01	V
			−40°C≤Ta≤105°C	×0.98		×1.02	
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	V_{IN}=V_{SET}+2.0V 1mA≤I_{OUT}≤300mA	V_{SET}≤5.0V	-20		100	mV
			5.0V<V_{SET}	-20		120	
ΔV_{OUT} /ΔV_{IN}	Line Regulation	V_{SET}+0.5V≤V_{IN}≤36V, I_{OUT}=1mA			0.01	0.02	%/V
V_{DIF}	Dropout Voltage	I_{OUT}=300mA		Refer to the *Product-specific Electrical Characteristics*			
I_{LIM}	Output Current Limit	V_{IN}=V_{SET}+2.5V			450		mA
I_{SC}	Short Current Limit	V_{OUT}=0V			50		mA
V_{CEH}	CE Input Voltage “H”			2.2		36	V
V_{CEL}	CE Input Voltage “L”			0		1.0	V
I_{PD}	CE Pull-down Current	V_{CE}=5.0V			0.2	0.6	µA
		V_{CE}=36V			0.5	1.3	
T_{TSD}	Thermal Shutdown Temparature	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=25ºC).

Product-specific Electrical Characteristics

The specifications surrounded by ☐ are guaranteed by design engineering at -40°C ≤ Ta ≤ 105 °C.

(Ta = 25°C)

Product Name	V_{OUT} (V) (Ta = 25°C)			V_{OUT} (V) (−40°C ≤ Ta ≤ 105°C)			V_{DIF} (V) (I_{OUT} = 300 mA)	
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	TYP.	MAX.
R1511x30xx	2.970	3.000	3.030	2.940	3.000	3.060	0.980	1.500
R1511x33xx	3.267	3.300	3.333	3.234	3.300	3.366	0.940	1.400
R1511x34xx	3.366	3.400	3.434	3.332	3.400	3.468		
R1511x50xx	4.950	5.000	5.050	4.900	5.000	5.100	0.640	1.000
R1511x60xx	5.940	6.000	6.060	5.880	6.000	6.120	0.590	0.900
R1511x80xx	7.920	8.000	8.080	7.840	8.000	8.160	0.540	0.800
R1511x85xx	8.415	8.500	8.585	8.330	8.500	8.670	0.470	0.700
R1511x90xx	8.910	9.000	9.090	8.820	9.000	9.180		

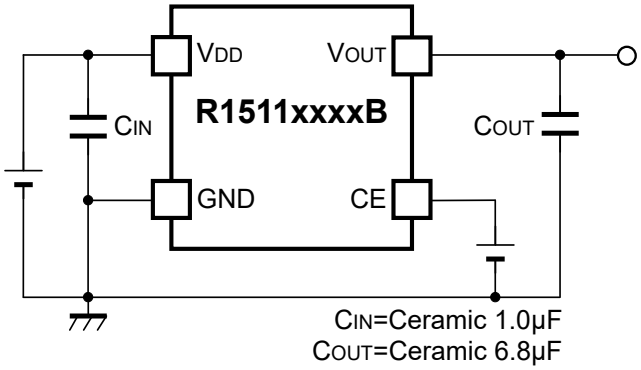
$V_{OUT}=V_{FB}$, C_{IN}=1.0µF, C_{OUT}=6.8µF, unless otherwise noted.
The specifications surrounded by ☐ are guaranteed by design engineering at -40°C ≤ Ta ≤ 105 °C.

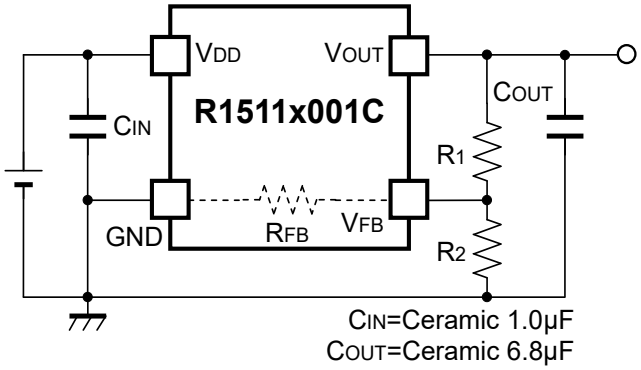
R1511x001C (Ta=25°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
I_{SS}	Supply Current	V_{IN}=4.0V, I_{OUT}=0mA			100	180	µA
V_{OUT}	Output Voltage	V_{IN}=5.0V I_{OUT}=1mA	Ta=25°C	2.97		3.03	V
			−40°C≤Ta≤105°C	2.94		3.06	
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	V_{IN}=5.0V 1mA≤I_{OUT}≤300mA		-20		40	mV
ΔV_{OUT} /ΔV_{IN}	Line Regulation	V_{SET}+0.5V≤V_{IN}≤36V I_{OUT}=1mA			0.01	0.02	%/V
V_{DIF}	Dropout Voltage	I_{OUT}=300mA			0.98	1.5	V
I_{LIM}	Output Current Limit	V_{IN}= V_{SET}+2.5V			450		mA
I_{SC}	Short Current Limit	V_{OUT}=0V			50		mA
R_{FB}	V_{FB} Pin Resistanse			1.0	3.0		MΩ
T_{TSD}	Thermal Shutdown Temparature	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=25ºC).

TYPICAL APPLICATIONS





TECHNICAL NOTES

PCB Layout and GND Wiring

Ensure the V_{DD} and GND lines are sufficiently robust. If their impedance is too high, noise pickup or unstable operation may result. Connect a C_{IN} capacitor with 1.0μF or more value between the V_{DD} and GND pins, and as close as possible to the pins. Likewise, connect a C_{OUT} capacitor with suitable values between the V_{OUT} and GND pins, and as close as possible to the pins (refer to the Typical Application above).

In the case of using HSOP-6J package, make sure to wire No. 2, No. 3, and No. 5 pins to the GND plane. Also, in the case of using TO-252-5-P2 package, make sure to wire No. 2 and No. 3 pins to the GND plane.

Phase Compensation

In the R1511x, phase compensation is provided to secure stable operation even when the load current is varied. For this purpose, make sure to use a C_{OUT} capacitor.

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.

Depending on the capacitor size, manufacturer, and part number, the bias characteristics and temperature characteristics are different. Evaluate the circuit taking actual characteristics into account.

Thermal Shutdown

R1511x contains a thermal shutdown circuit, which stops regulator operation if the junction temperature of R1511x becomes higher than 160ºC (Typ.). Additionally, if the junction temperature after the regulator being stopped decreases to a level below 135ºC (Typ.), it restarts regulator operation. As a result the operation of the thermal shutdown circuit causes the regulator repeatedly to turn off and on until the causes of overheating are removed. As a consequence a pulse shaped output voltage occurs.

Adjustable Output Voltage Setting (R1511x001C)

The output voltage of R1511x001C 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}.

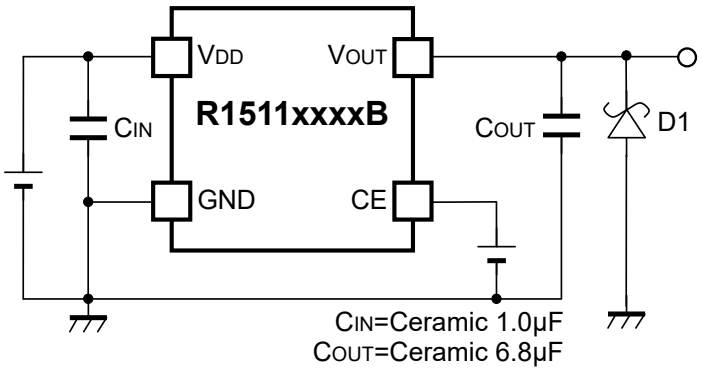
$$V_{OUT} = V_{FB} \times ((R1 + R2) / R2)$$

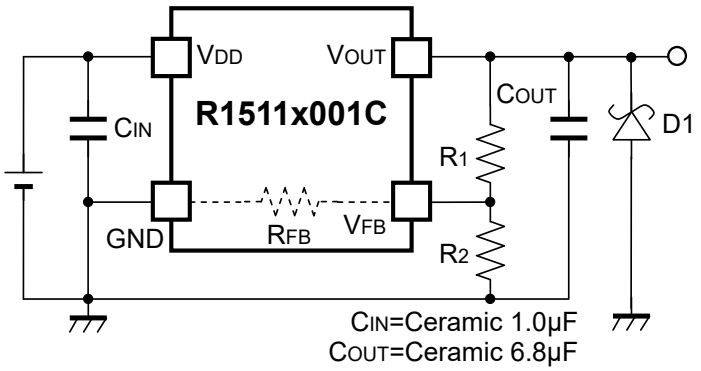
Recommended Range: 3.0 V ≤ V_{OUT} ≤ 12.0 V
V_{FB} = 3.0 V

R_{FB} of the R1511x001C is approximately Min. 1.0 MΩ (guaranteed by design). For better accuracy, setting R1 << R_{FB} reduces errors. The resistance value for R2 should be set to 39 kΩ 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.

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 (C_{OUT}) 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.

PACKAGE INFORMATION

POWER DISSIPATION (HSOP-6J)

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.

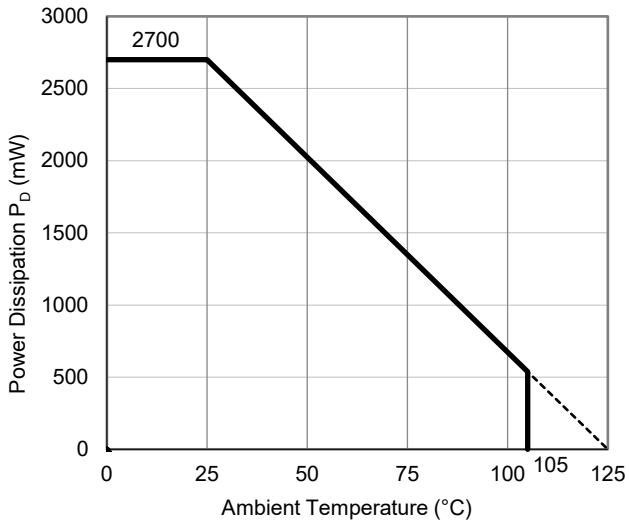
Measurement Conditions

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

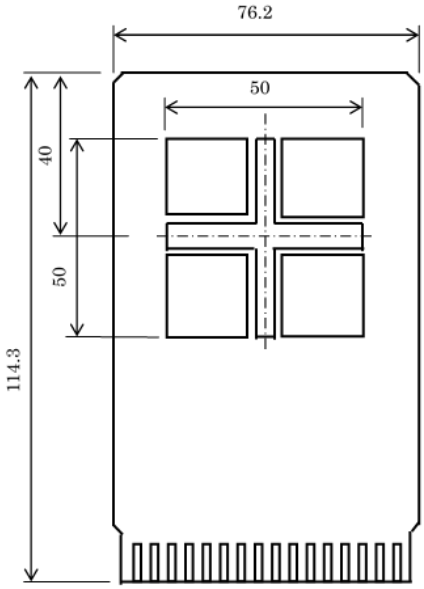
Measurement Result (Ta = 25°C, Tjmax = 125°C)

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

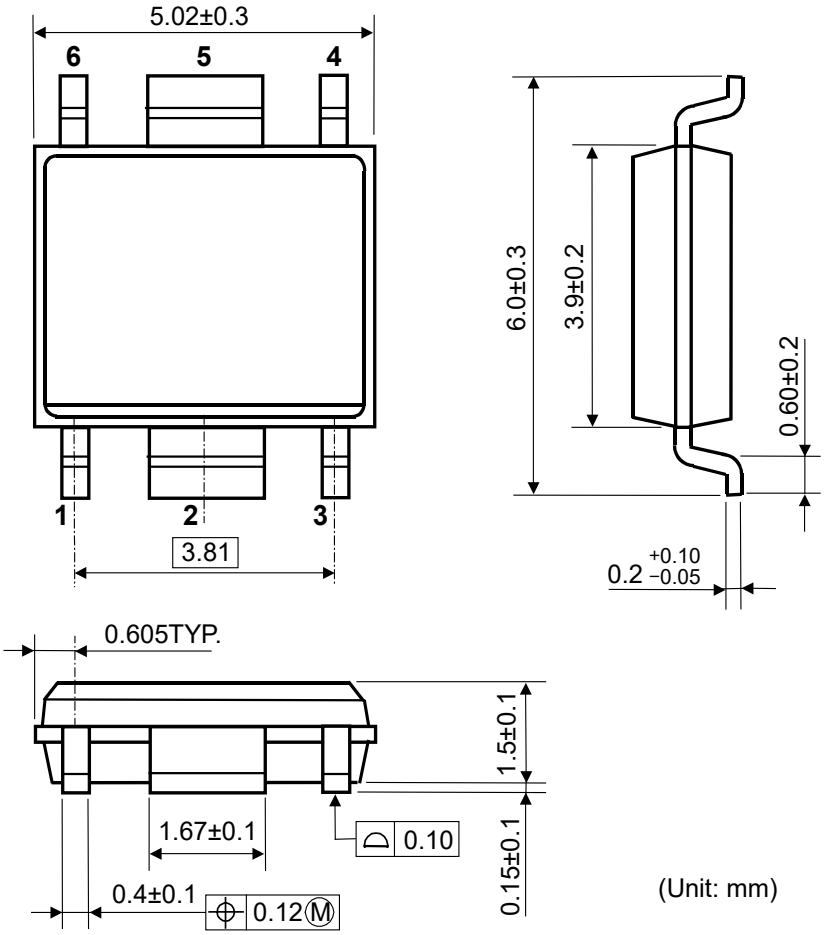


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

PACKAGE DIMENSIONS (HSOP-6J)

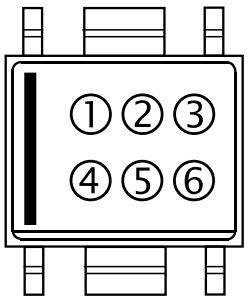


Package Dimensions (HSOP-6J)

MARK SPECIFICATION (HSOP-6J)

①②③④: Product Code … **Refer to *MARK SPECIFICATION TABLE***

⑤⑥: Lot Number … Alphanumeric Serial Number



Mark Specification (HSOP-6J)

MARK SPECIFICATION TABLE (HSOP-6J)

R1511SxxxB

Product Name	① ② ③ ④	V_{SET}
R1511S030B	S 3 0 B	3.0 V
R1511S033B	S 3 3 B	3.3 V
R1511S034B	S 3 4 B	3.4 V
R1511S050B	S 5 0 B	5.0 V
R1511S060B	S 6 0 B	6.0 V
R1511S080B	S 8 0 B	8.0 V
R1511S085B	S 8 5 B	8.5 V
R1511S090B	S 9 0 B	9.0 V

R1511S001C
(Adjustable Output Voltage Setting Type)

Product Name	① ② ③ ④	V_{SET}
R1511S001C	S 0 0 C	-

POWER DISSIPATION (TO-252-5-P2)

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

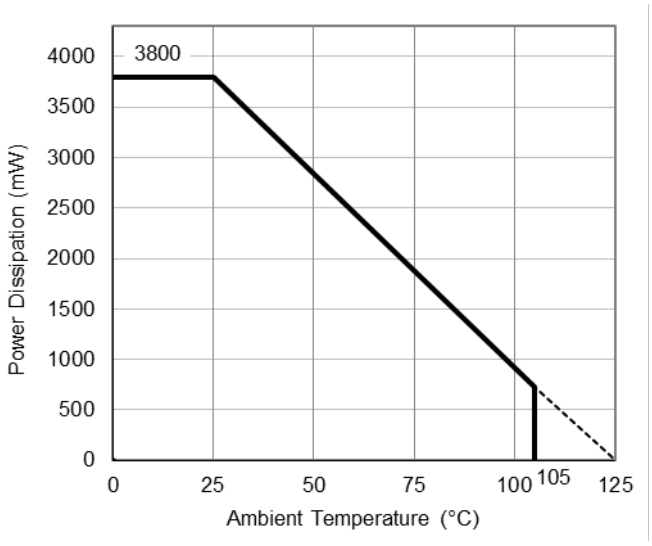
Item	Measurement Conditions
Environment	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm
Copper Ratio	Outer Layer (First Layer): Less than 95% of 50 mm Square Inner Layers (Second and Third Layers): Approx.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

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

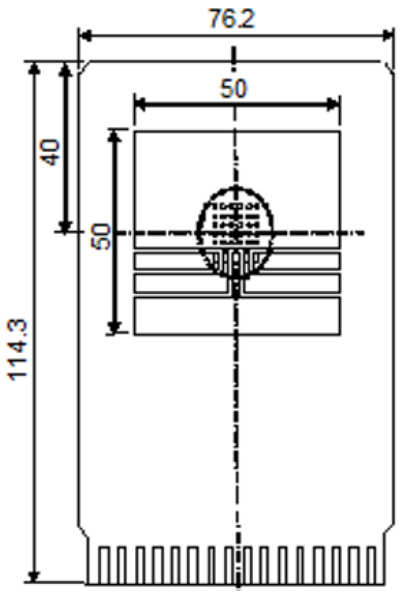
Item	Measurement Result
Power Dissipation	3800 mW
Thermal Resistance (θja)	θja = 26°C/W
Thermal Characterization Parameter (ψjt)	ψjt = 7°C/W

θja: Junction-to-Ambient Thermal Resistance

ψjt: Junction-to-Top Thermal Characterization Parameter

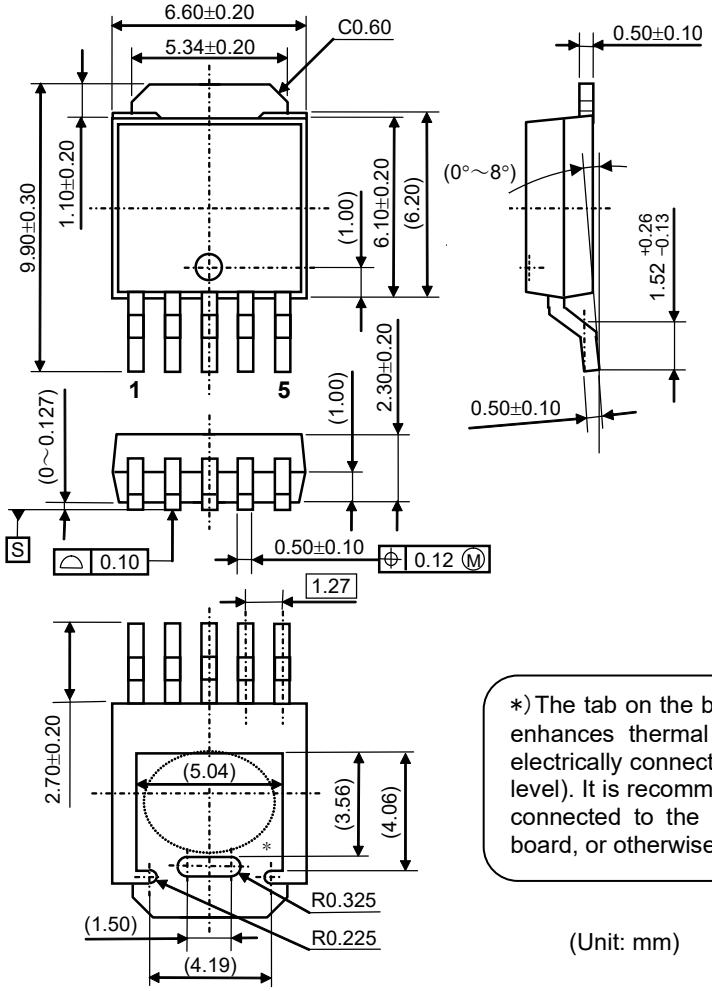


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

PACKAGE DIMENSIONS (TO-252-5-P2)



∗) 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 floating.

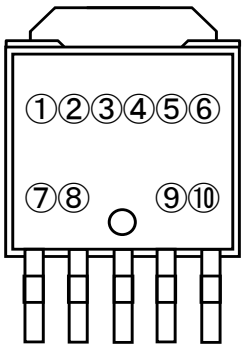
(Unit: mm)

Package Dimensions (TO-252-5-P2)

MARK SPECIFICATION (TO-252-5-P2)

①②③④⑤⑥⑦⑧: Product Code … **Refer to *MARK SPECIFICATION TABLE***

⑨⑩: Lot Number … Alphanumeric Serial Number



Mark Specification (TO-252-5-P2)

MARK SPECIFICATION TABLE (TO-252-5-P2)

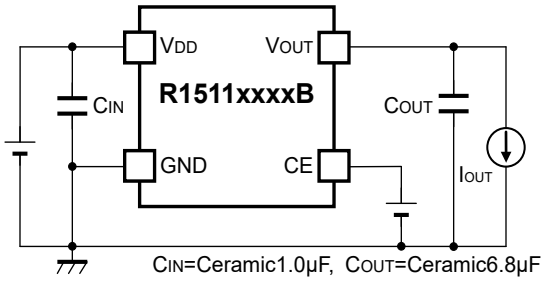
R1511JxxxB

Product Name	①②③④⑤⑥⑦⑧	V_{SET}
R1511J030B	H 1 J 0 3 0 B	3.0 V
R1511J033B	H 1 J 0 3 3 B	3.3 V
R1511J034B	H 1 J 0 3 4 B	3.4 V
R1511J050B	H 1 J 0 5 0 B	5.0 V
R1511J060B	H 1 J 0 6 0 B	6.0 V
R1511J080B	H 1 J 0 8 0 B	8.0 V
R1511J085B	H 1 J 0 8 5 B	8.5 V
R1511J090B	H 1 J 0 9 0 B	9.0 V

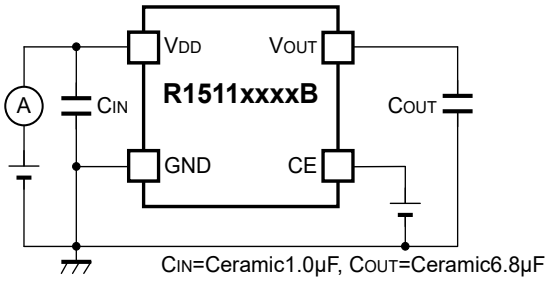
R1511J001C
(Adjustable Output Voltage Setting Type)

Product Name	①②③④⑤⑥⑦⑧	V_{SET}
R1511J001C	H 1 J 0 0 1 C	-

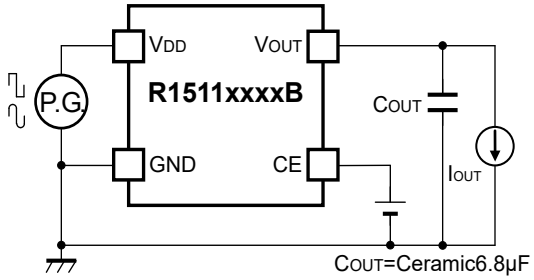
TEST CIRCUITS



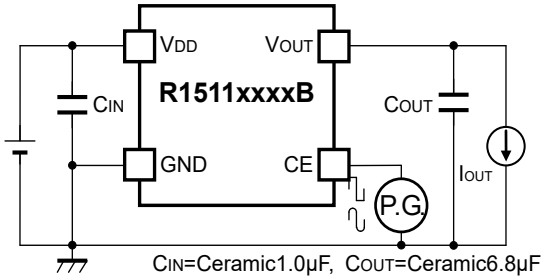
R1511xxxxB Basic Test Circuit



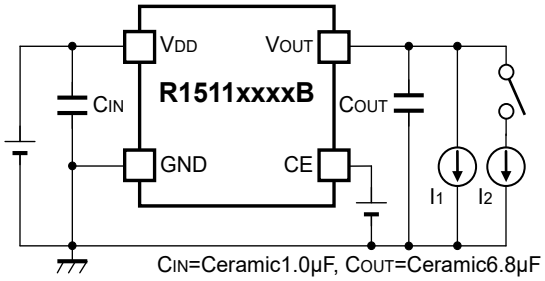
R1511xxxxB Test Circuit for Supply Current



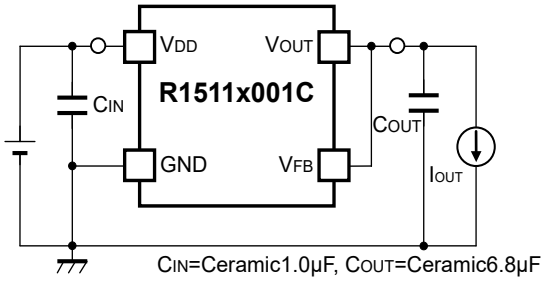
R1511xxxxB Test Circuit for Ripple Rejection and Regulator Input Transient Response



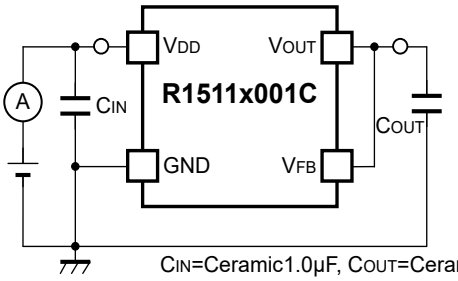
R1511xxxxB Test Circuit for CE Start-up



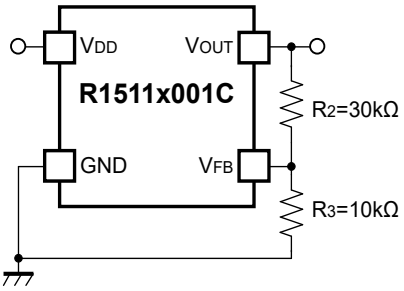
R1511xxxxB Test Circuit for Load Transient Response



R1511x001C Basic Test Circuit



R1511x001C Test Circuit for Supply Current



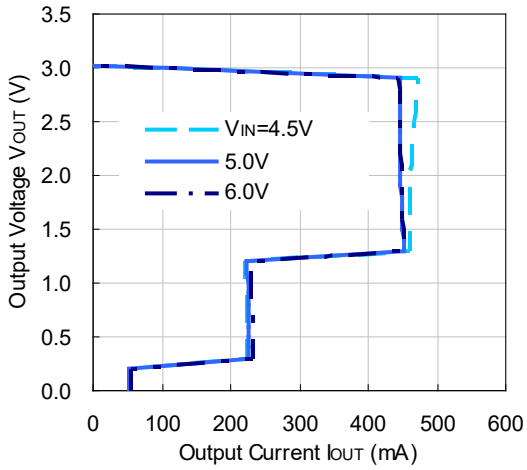
R1511x001C Case of output voltage adjustment by external resistors

TYPICAL CHARACTERISTICS

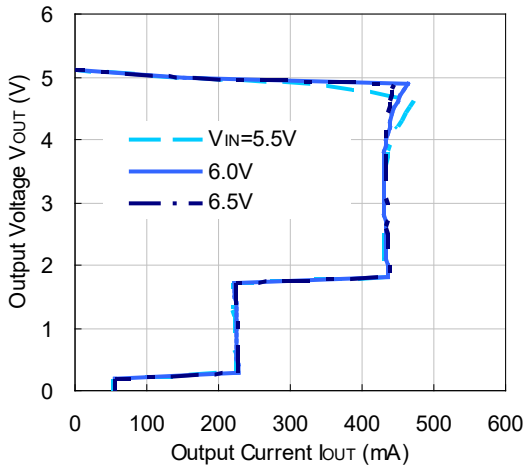
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

1) Output Voltage vs. Output Current (Ta=25ºC)

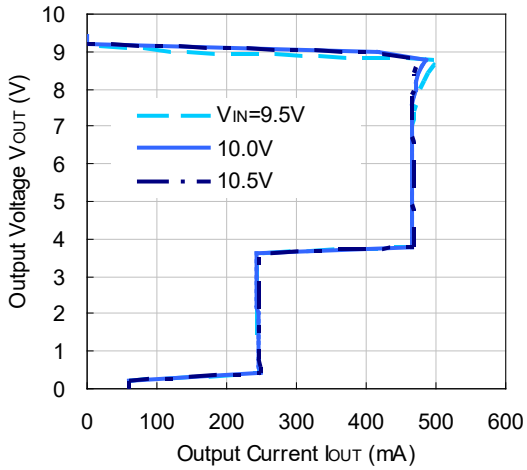
R1511x030B



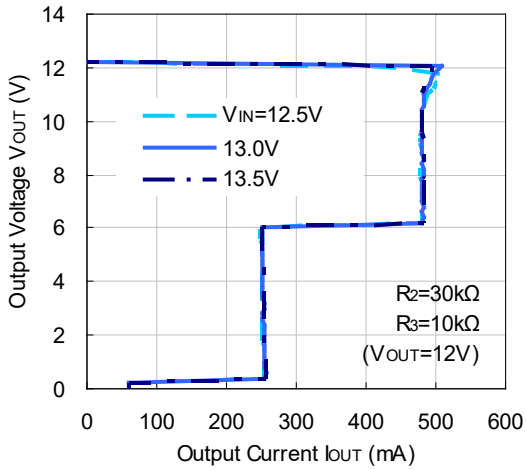
R1511x050B



R1511x090B

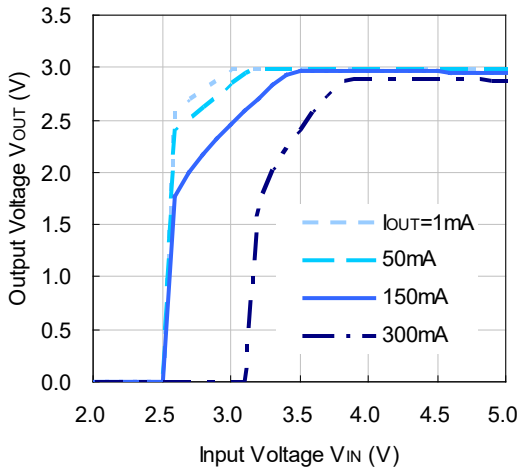


R1511x001C

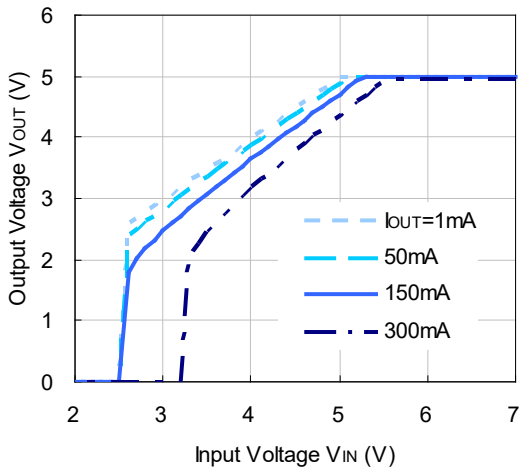


2) Output Voltage vs. Input Voltage (Ta=25ºC)

R1511x030B



R1511x050B



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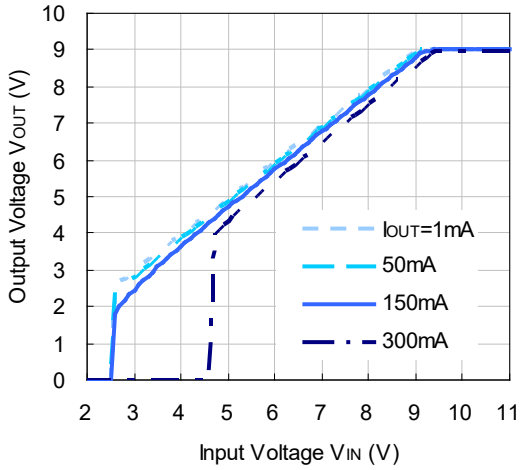
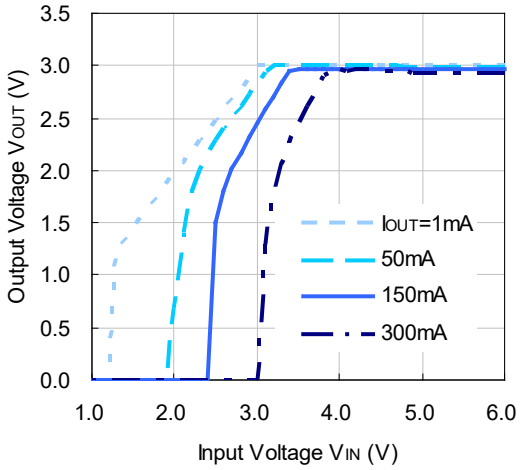
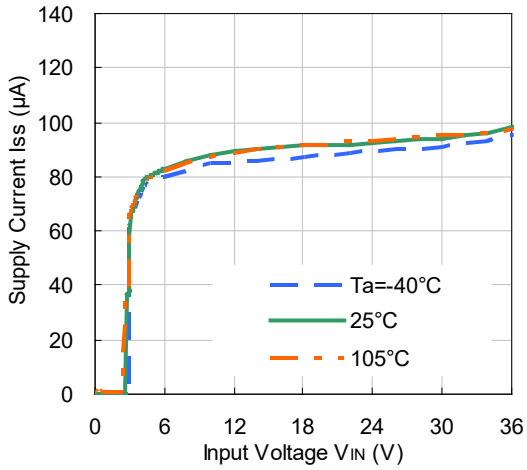


R1511x001C

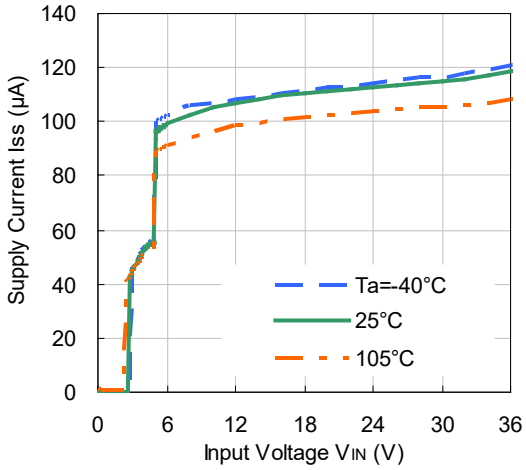


3) Supply Current vs. Input Voltage

R1511x030B



R1511x050B



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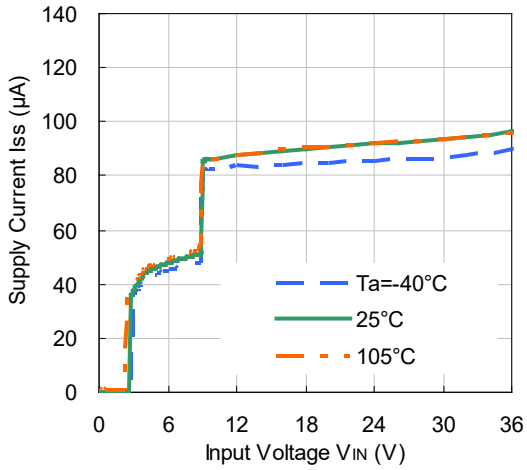
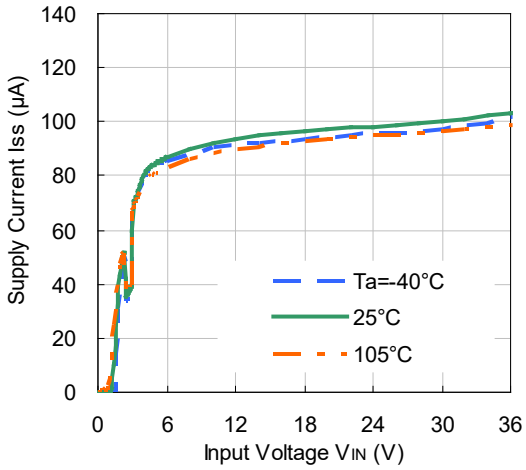
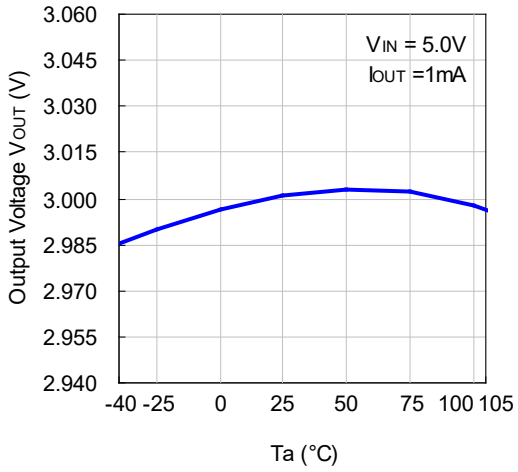


R1511x001C

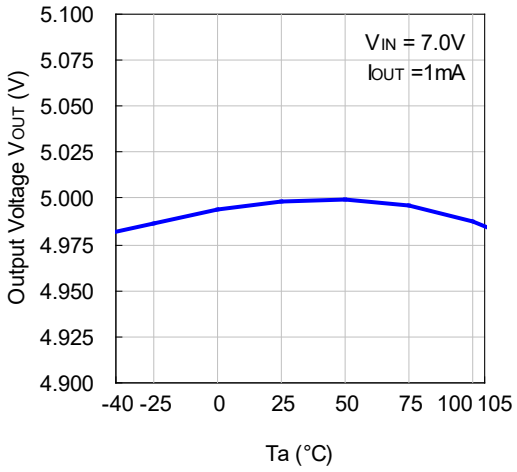


4) Output Voltage vs. Ambient Temperature

R1511x030B



R1511x050B



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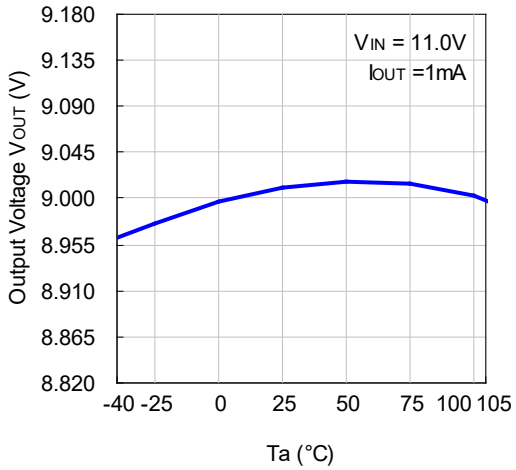
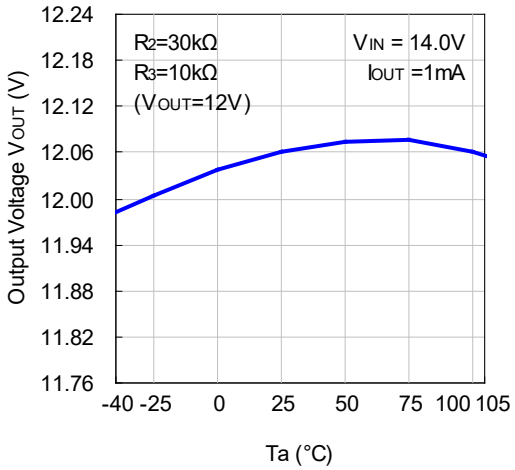
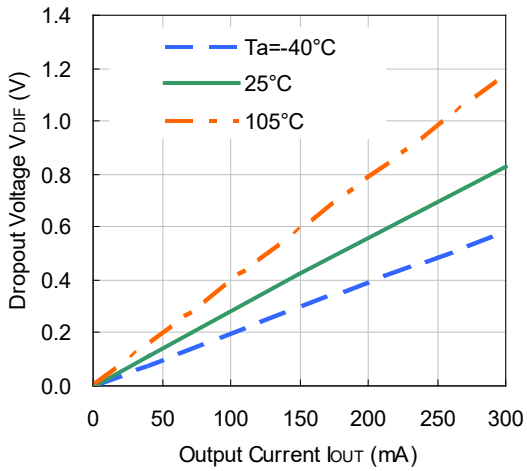


R1511x001C

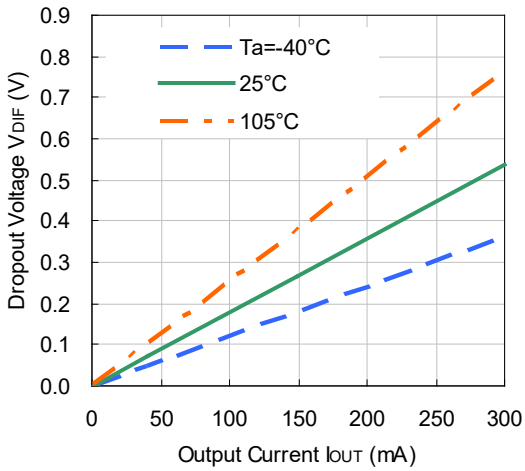


5) Dropout Voltage vs. Output Current

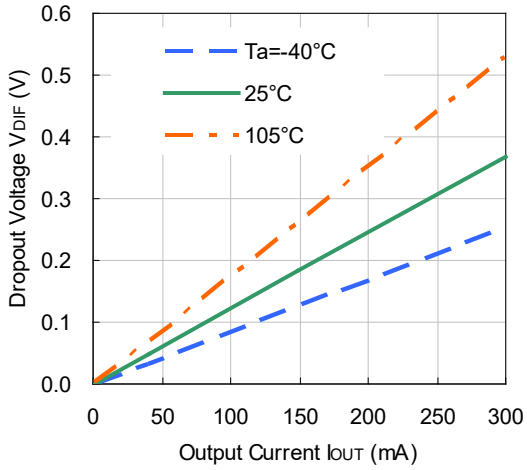
R1511x030B/ R1511x001C



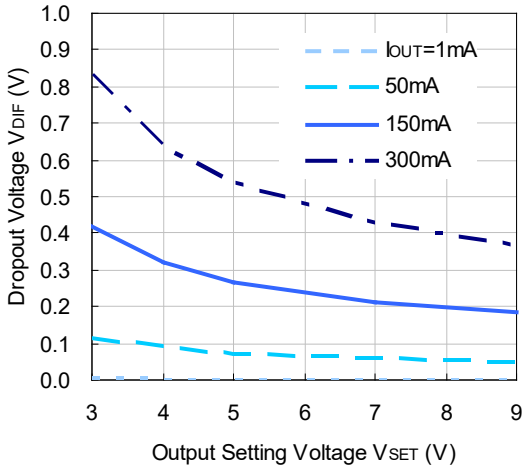
R1511x050B



R1511x090B

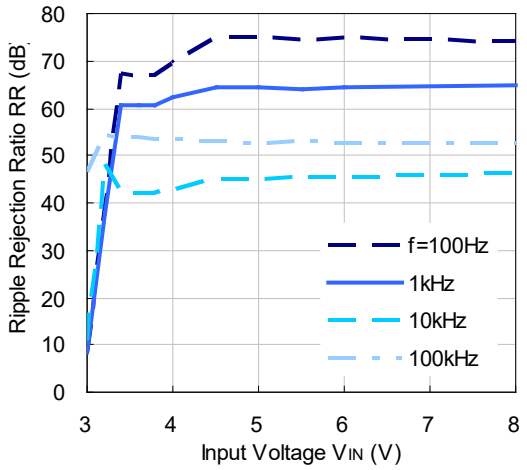


6) Dropout Voltage vs. Setting Voltage (Ta=25ºC)

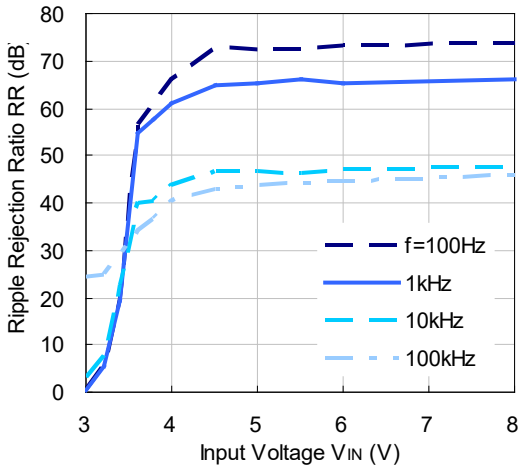


7) Ripple Rejection vs. Input Bias Voltage (Ta=25°C, Ripple=0.5Vpp)

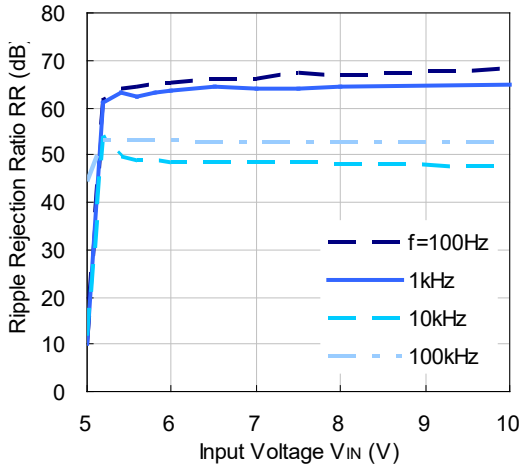
R1511x030B/R1511x001C (IOUT=1mA)



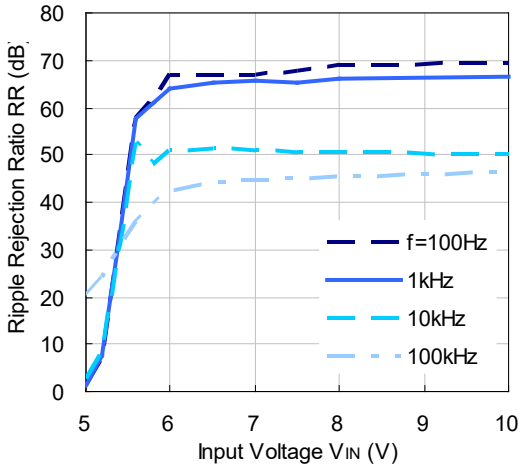
R1511x030B/R1511x001C (IOUT=100mA)



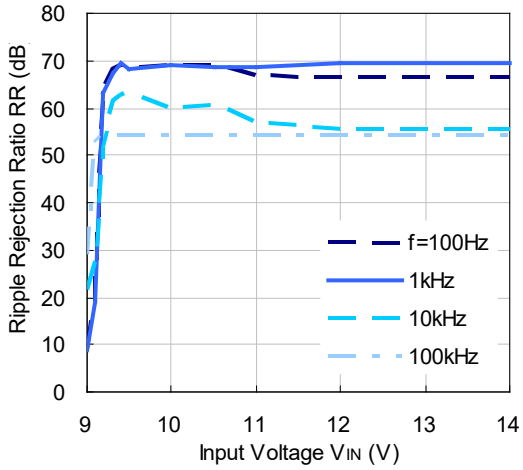
R1511x050B (IOUT=1mA)



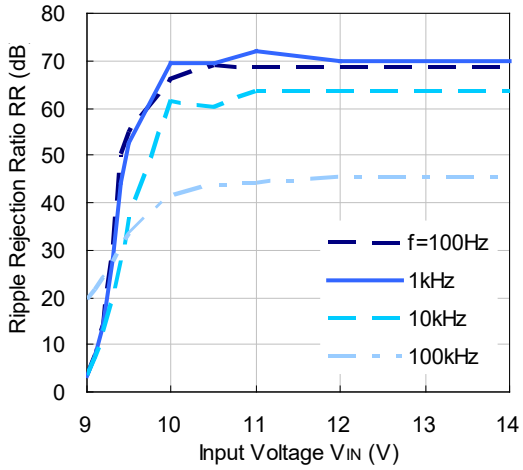
R1511x050B (IOUT=100mA)



R1511x090B (I_{OUT}=1mA)

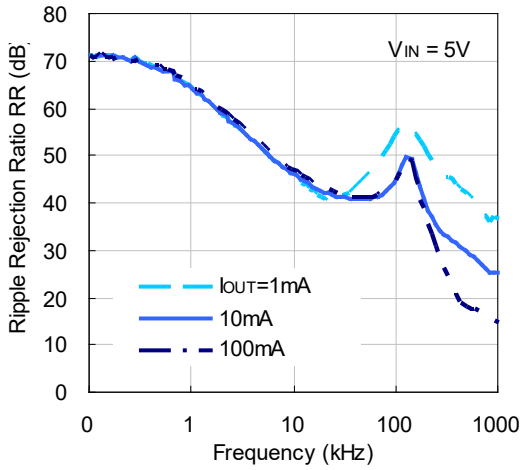


R1511x090B (I_{OUT}=100mA)

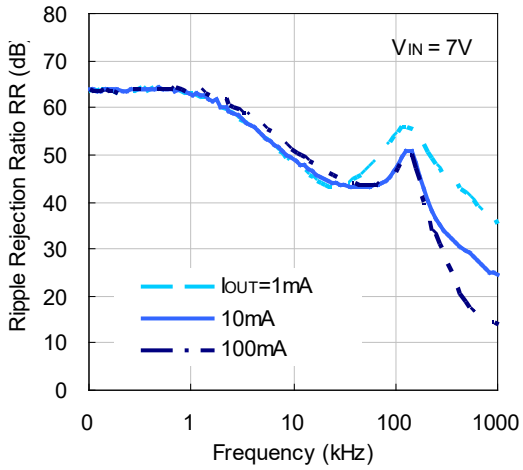


8) Ripple Rejection vs. Frequency (Ta=25°C, Ripple=0.5Vpp)

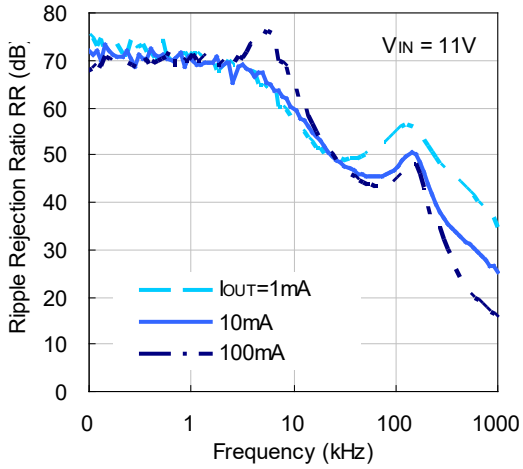
R1511x030B/R1511x001C



R1511x050B

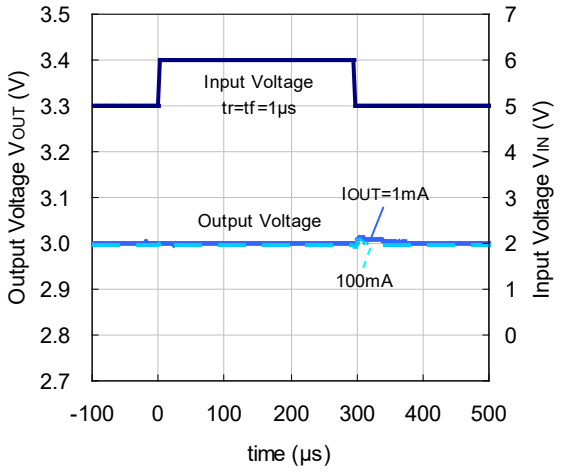


R1511x090B

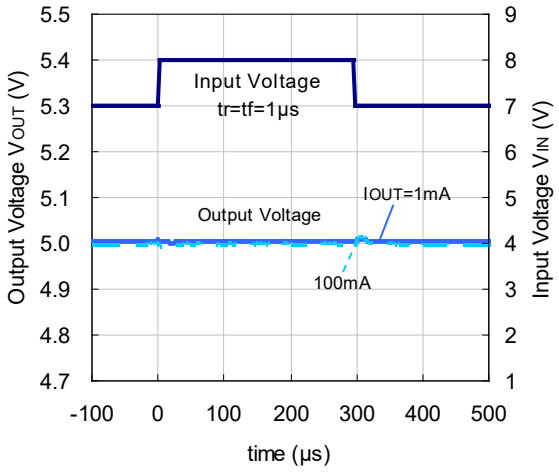


9) Input Transient Response (Ta=25°C)

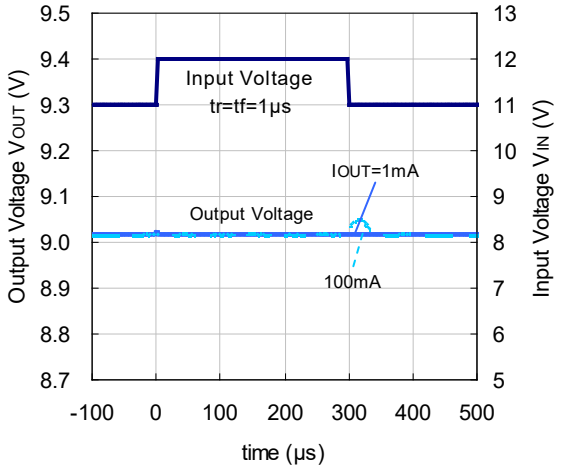
R1511x030B



R1511x050B

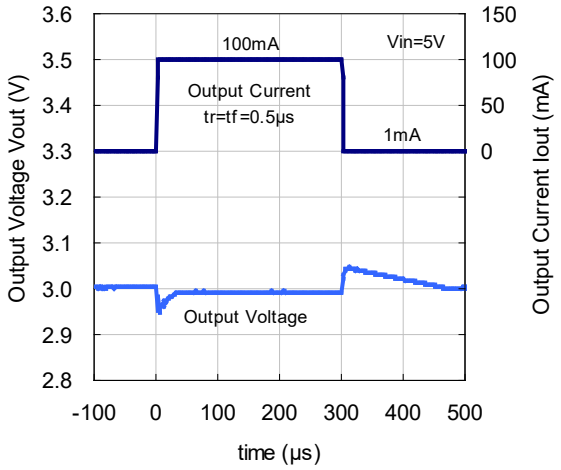


R1511x090B

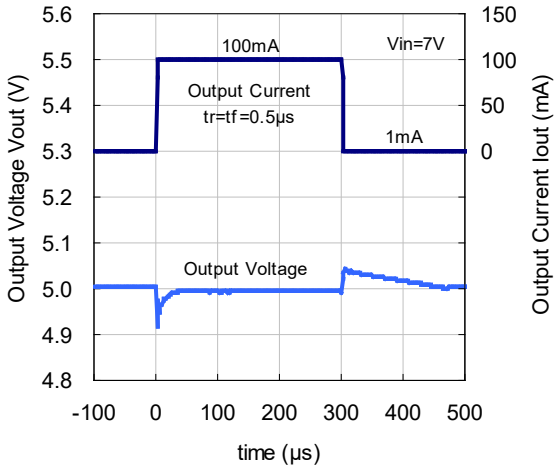


10) Load Transient Response (Ta=25°C)

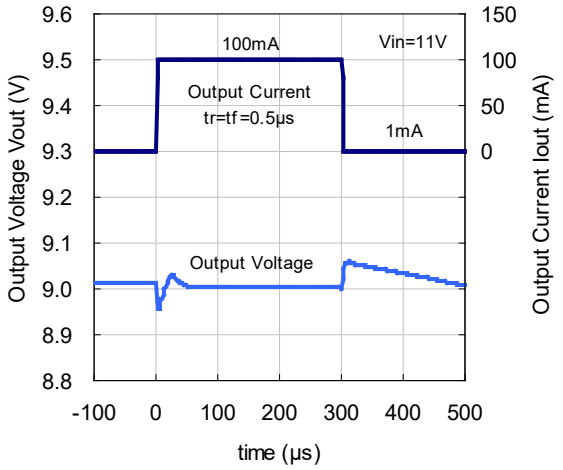
R1511x030B



R1511x050B

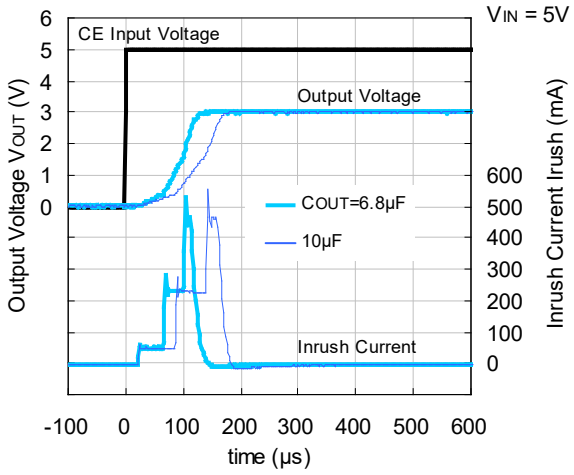


R1511x090B

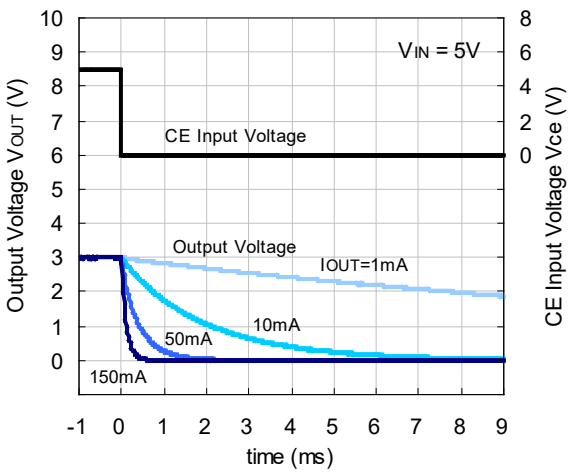


11) CE Response (Ta=25°C)

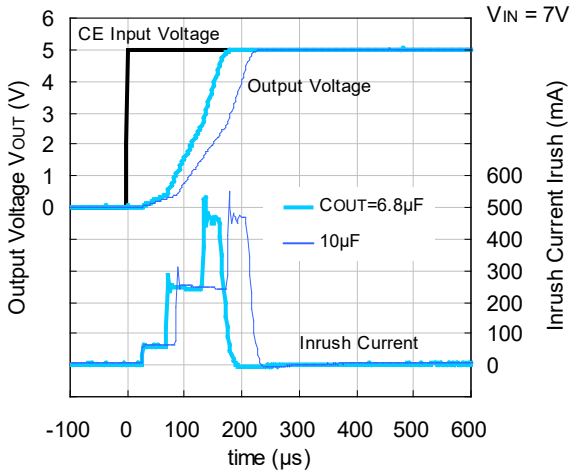
R1511x030B (Turn On)



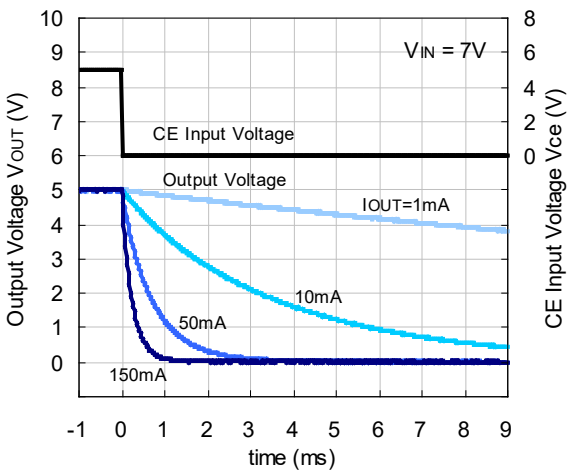
R1511x030B (Turn Off)



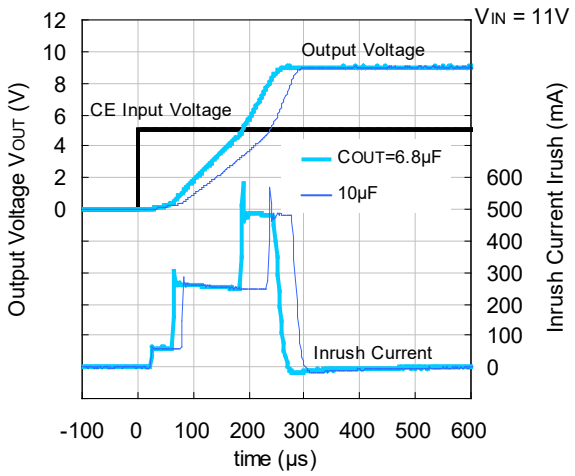
R1511x050B (Turn On)



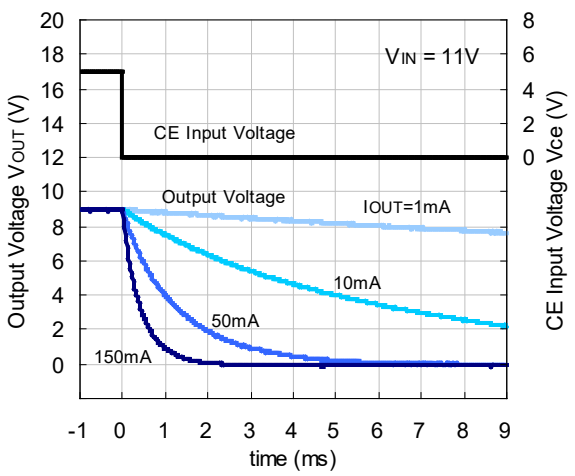
R1511x050B (Turn Off)



R1511x090B (Turn On)

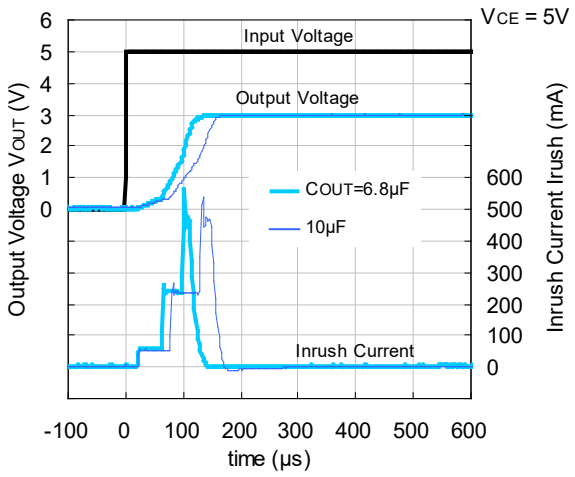


R1511x090B (Turn Off)

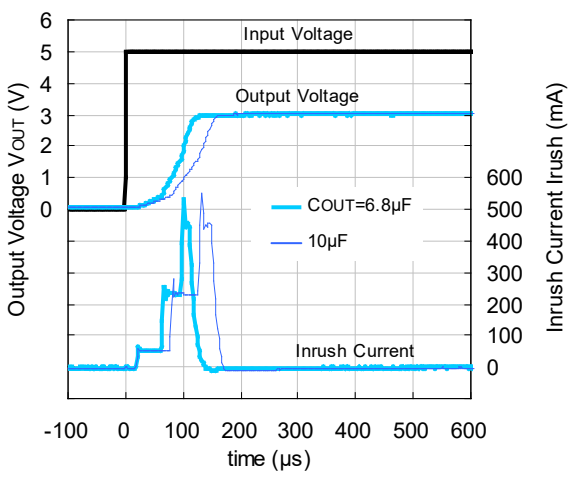


12) Start Up Waveform (Ta=25°C)

R1511x030B

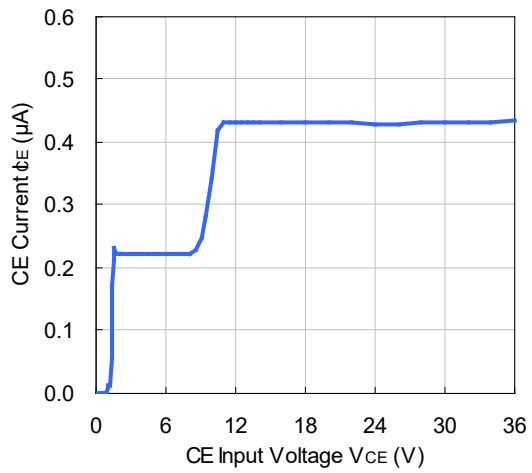


R1511x001C



13) CE Pin Current Vs. CE Input Voltage

R1511xxxxB



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    - Traffic control system
    - Combustion equipment

    In case your company desires to use this product for any applications other than general electronic equipment mentioned above, make sure to contact our company in advance. Note that the important requirements mentioned in this section are not applicable to cases where operation requirements such as application conditions are confirmed by our company in writing after consultation with your company.
6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. The products have been designed and tested to function within controlled environmental conditions. Do not use products under conditions that deviate from methods or applications specified in this datasheet. Failure to employ the products in the proper applications can lead to deterioration, destruction or failure of the products. We shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of the products.
8. Quality Warranty
    8-1. Quality Warranty Period
    In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
    8-2. Quality Warranty Remedies
    When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.
    Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
    8-3. Remedies after Quality Warranty Period
    With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
12. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.

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Nisshinbo Micro Devices Inc.

Official website
https://www.nisshinbo-microdevices.co.jp/en/

Purchase information
https://www.nisshinbo-microdevices.co.jp/en/buy/