

## 150 mA Voltage Regulator (Wide Input Voltage Range) for High Temperature Applications

NO. EA-346-140319

### OUTLINE

The R1514x is a positive voltage regulator (VR) IC featuring 150 mA output current that is developed with CMOS process technology. The R1514xxxxB has features of high input voltage and ultra-low supply current. A peak current limit circuit, a short current limit circuit, and a thermal shutdown circuit are built in the R1514x. R1514x is very suitable for power source of industrial equipments such as FAs and smart meters since its operating temperature is  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$  and the maximum input voltage is 36 V.

The output voltage is fixed in the R1514xxxxB and can be selected from the following: 2.5 V / 2.8 V / 3.0 V / 3.3 V / 3.4 V / 5.0 V / 6.0 V / 8.0 V / 8.5 V / 9.0 V / 12.0 V. The Output voltage accuracy is  $\pm 2\%$ .

The packages for this IC are the SOT-89-5 for space saving and the HSOP-6J for higher power applications.

### FEATURES

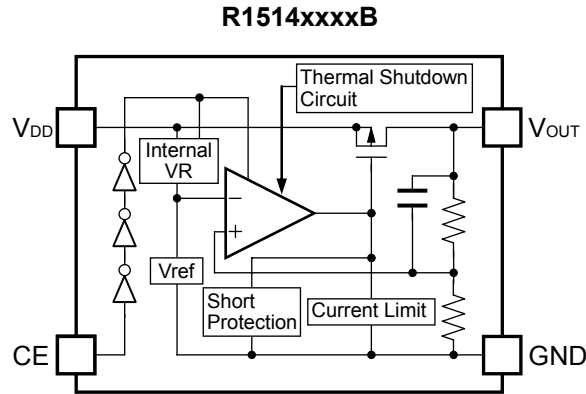
- Input Voltage Range (Maximum Rating) ..... 4 V to 36 V (50 V)
- Operating Temperature .....  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$  (※)
- Supply Current ( $I_{SS}$ ) ..... Typ. 9  $\mu\text{A}$
- Standby Current ( $I_{standby}$ ) ..... Typ. 0.1  $\mu\text{A}$
- Temperature-Drift Coefficient of Output Voltage... Typ.  $\pm 100$  ppm/ $^{\circ}\text{C}$
- Output Current ( $I_{OUT}$ ) ..... Min. 150 mA ( $V_{IN} = V_{OUT} + 3.0$  V; R1514x050B)
- Line Regulation..... Typ. 0.05%/V
- Output Voltage Accuracy .....  $\pm 2\%$
- Output Voltage Range ( $V_{OUT}$ ) ..... 2.5V / 2.8V / 3.0V / 3.3V / 3.4V / 5.0V / 6.0V / 8.0V /  
8.5V / 9.0V / 12.0V  
Contact Ricoh sales representatives for other voltages.
- Packages ..... SOT-89-5, HSOP-6J
- Built-in Short Current Limit Circuit..... Typ. 50 mA
- Built-in Peak Current Limit Circuit
- Built-in Thermal Shutdown Circuit

※ 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 DIAGRAM



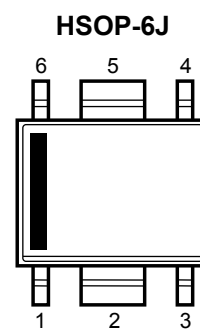
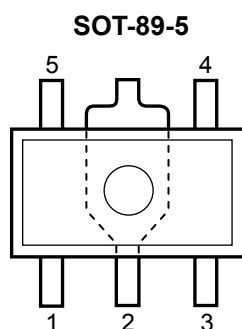
### SELECTION GUIDE

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

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1514HxxxB-T1-YE	SOT-89-5	1,000 pcs	Yes	Yes
R1514SxxxB-E2-YE	HSOP-6J	1,000 pcs	Yes	Yes

xxx: Specify the set output voltage ( $V_{SET}$ )  
2.5 V (025) / 2.8 V (028) / 3.0 V (030) / 3.3 V (033) / 3.4 V (034) / 5.0 V (050) / 6.0 V (060) /  
8.0 V (080) / 8.5 V (085) / 9.0 V (090) / 12.0 V (120)

## PIN DESCRIPTIONS



### SOT-89-5

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

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

### HSOP-6J

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

<sup>\*2</sup> The GND pin must be wired together when it is mounted on board.

**ABSOLUTE MAXIMUM RATINGS**

Symbol	Item	Rating	Unit	
V <sub>IN</sub>	Input Voltage	-0.3 to 50	V	
V <sub>IN</sub>	Peak Input Voltage <sup>*3</sup>	60	V	
V <sub>CE</sub>	Input Voltage (CE Pin)	-0.3 to V <sub>IN</sub> + 0.3 ≤ 50	V	
V <sub>OUT</sub>	Output Voltage	-0.3 to V <sub>IN</sub> + 0.3 ≤ 50	V	
I <sub>OUT</sub>	Output Current	250	mA	
P <sub>D</sub>	Power Dissipation (SOT-89-5) <sup>*4</sup>	Standard Land Pattern	900	mW
		High Wattage Land Pattern	1300	
	Power Dissipation (HSOP-6J) <sup>*4</sup>	Standard Land Pattern	1700	
		Ultra High Wattage Land Pattern	2700	
T <sub>j</sub>	Junction Temperature	-40 to 125	°C	
T <sub>stg</sub>	Storage Temperature Range	-55 to 125	°C	

<sup>\*3</sup> Duration time = 200 ms

<sup>\*4</sup> Refer to *PACKAGE INFORMATION* for detailed information.

**ABSOLUTE MAXIMUM RATINGS**

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

**RECOMMENDED OPERATING CONDITIONS**

Symbol	Item	Rating	Unit
V <sub>IN</sub>	Input Voltage	4 to 36	V
T <sub>a</sub>	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

$V_{IN} = V_{SET} + 3.0 \text{ V}$ ,  $C_{IN} = 0.1 \mu\text{F}$ ,  $C_{OUT} = 0.1 \mu\text{F}$ , unless otherwise noted.

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

### R1514xxxxB

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

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
$I_{SS}$	Supply Current	$I_{OUT} = 0 \text{ mA}$		9	<span style="border: 1px solid black; padding: 0 2px;">20</span>	$\mu\text{A}$
$I_{standby}$	Standby Current	$V_{IN} = 36 \text{ V}$ , $V_{CE} = 0 \text{ V}$		0.1	<span style="border: 1px solid black; padding: 0 2px;">1.0</span>	$\mu\text{A}$
$V_{OUT}$	Output Voltage	$I_{OUT} = 1 \text{ mA}$	$T_a = 25^\circ\text{C}$	x 0.98	x 1.02	V
			$-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$	<span style="border: 1px solid black; padding: 0 2px;">x 0.97</span>	<span style="border: 1px solid black; padding: 0 2px;">x 1.03</span>	
$I_{OUT}$	Output Current		Refer to the <i>Product-specific Electrical Characteristics</i>			
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	$1 \text{ mA} \leq I_{OUT} \leq 40 \text{ mA}$	Refer to the <i>Product-specific Electrical Characteristics</i>			
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	$V_{OUT} + 1.5 \text{ V} \leq V_{IN} \leq 36 \text{ V}$ , $I_{OUT} = 1 \text{ mA}$		0.05	<span style="border: 1px solid black; padding: 0 2px;">0.20</span>	%/V
$V_{DIF}$	Dropout Voltage	$I_{OUT} = 20 \text{ mA}$	Refer to the <i>Product-specific Electrical Characteristics</i>			
$I_{SC}$	Short Current Limit	$V_{OUT} = 0 \text{ V}$		50		mA
$V_{CEH}$	CE Input Voltage "H"		<span style="border: 1px solid black; padding: 0 2px;">1.5</span>		$V_{IN}$	V
$V_{CEL}$	CE Input Voltage "L"		0.0		<span style="border: 1px solid black; padding: 0 2px;">0.3</span>	V
$T_{TSD}$	Thermal Shutdown Temperature	Junction Temperature		160		$^\circ\text{C}$
$T_{TSR}$	Thermal Shutdown Released Temperature	Junction Temperature		130		$^\circ\text{C}$

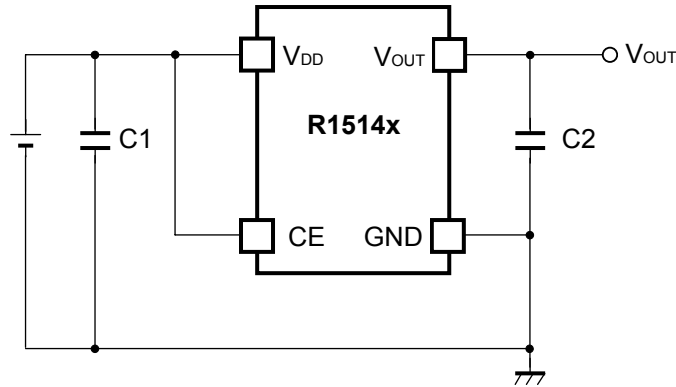
All test items listed under Electrical Characteristics are done under the pulse load condition ( $T_j \approx T_a = 25^\circ\text{C}$ ).

### Product-specific Electrical Characteristics

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

Product Name	$V_{OUT} \text{ (V)}$					$I_{OUT} \text{ (mA)}$		$\Delta V_{OUT}/\Delta I_{OUT} \text{ (mV)}$		$V_{DIF} \text{ (V)}$		
	$T_a = 25^\circ\text{C}$			$-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$		$T_a = 25^\circ\text{C}$	$-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$			$T_a = 25^\circ\text{C}$	$-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$	$-40^\circ\text{C} \leq T_a \leq 105^\circ\text{C}$
	MIN.	TYP.	MAX.	MIN.	TYP.	MIN.	MIN.	TYP.	MAX.	TYP.	MAX.	MAX.
R1514x025B	2.450	2.500	2.550	<span style="border: 1px solid black; padding: 0 2px;">2.425</span>	<span style="border: 1px solid black; padding: 0 2px;">2.575</span>	100	<span style="border: 1px solid black; padding: 0 2px;">90</span>	10	<span style="border: 1px solid black; padding: 0 2px;">25</span>	/	1.5	<span style="border: 1px solid black; padding: 0 2px;">1.5</span>
R1514x028B	2.744	2.800	2.856	<span style="border: 1px solid black; padding: 0 2px;">2.716</span>	<span style="border: 1px solid black; padding: 0 2px;">2.884</span>						1.2	<span style="border: 1px solid black; padding: 0 2px;">1.2</span>
R1514x030B	2.940	3.000	3.060	<span style="border: 1px solid black; padding: 0 2px;">2.910</span>	<span style="border: 1px solid black; padding: 0 2px;">3.090</span>	1.0	<span style="border: 1px solid black; padding: 0 2px;">1.0</span>					
R1514x033B	3.234	3.300	3.366	<span style="border: 1px solid black; padding: 0 2px;">3.201</span>	<span style="border: 1px solid black; padding: 0 2px;">3.399</span>	0.7	<span style="border: 1px solid black; padding: 0 2px;">0.7</span>					
R1514x034B	3.332	3.400	3.468	<span style="border: 1px solid black; padding: 0 2px;">3.298</span>	<span style="border: 1px solid black; padding: 0 2px;">3.502</span>	0.6	<span style="border: 1px solid black; padding: 0 2px;">0.7</span>					
R1514x050B	4.900	5.000	5.100	<span style="border: 1px solid black; padding: 0 2px;">4.850</span>	<span style="border: 1px solid black; padding: 0 2px;">5.150</span>	150	<span style="border: 1px solid black; padding: 0 2px;">150</span>	20	<span style="border: 1px solid black; padding: 0 2px;">35</span>	0.20	0.35	<span style="border: 1px solid black; padding: 0 2px;">0.40</span>
R1514x060B	5.880	6.000	6.120	<span style="border: 1px solid black; padding: 0 2px;">5.820</span>	<span style="border: 1px solid black; padding: 0 2px;">6.180</span>							
R1514x080B	7.840	8.000	8.160	<span style="border: 1px solid black; padding: 0 2px;">7.760</span>	<span style="border: 1px solid black; padding: 0 2px;">8.240</span>							
R1514x085B	8.330	8.500	8.670	<span style="border: 1px solid black; padding: 0 2px;">8.245</span>	<span style="border: 1px solid black; padding: 0 2px;">8.755</span>							
R1514x090B	8.820	9.000	9.180	<span style="border: 1px solid black; padding: 0 2px;">8.730</span>	<span style="border: 1px solid black; padding: 0 2px;">9.270</span>							
R1514x120B	11.760	12.000	12.240	<span style="border: 1px solid black; padding: 0 2px;">11.640</span>	<span style="border: 1px solid black; padding: 0 2px;">12.360</span>							

## TYPICAL APPLICATION



### External Components:

C1 (C <sub>IN</sub> )	0.1 $\mu$ F (Ceramic)
C2 (C <sub>OUT</sub> )	0.1 $\mu$ F (Ceramic)

## TECHNICAL NOTES

### 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 a capacitor with a suitable value between the  $V_{DD}$  and GND, and as close as possible to the pins.

### Phase Compensation

Phase Compensation of the R1514x has been made internally for stable operation even though the load current would vary. Therefore, without the capacitors, C1 and C2, the output voltage is regulated, however, for more stable operation, use capacitors as C1 and C2. Especially, if the input line is long and impedance is high, C1 is necessary. Moreover, if you use rather large C2, transient response will be improved. Recommended value is in the range from 0.1  $\mu$ F to 10  $\mu$ F. Wiring should be made as short as possible.

Connect the capacitor, C1 between  $V_{DD}$  pin and GND and C2 between  $V_{OUT}$  and GND as close as possible.

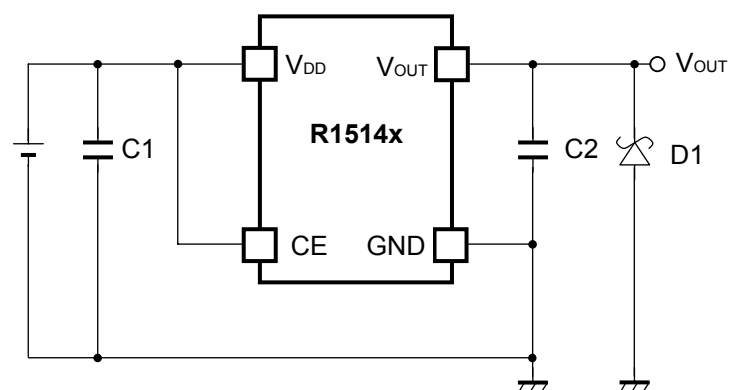
### Thermal Shutdown

Thermal shutdown function is included in the R1514x, if the junction temperature is more than or equal to 160°C (Typ.), the operation of regulator would stop. After that, when the junction temperature is less than or equal to 130°C (Typ.), the operation of regulator would restart. Unless the cause of rising temperature would remove, the regulator repeats on and off, and output waveform would be like consecutive pulses.

### Chip Enable Circuit

Do not make voltage level of chip enable pin keep floating level, or in between  $V_{CEH}$  and  $V_{CEL}$ . Otherwise, the output voltage would be unstable or indefinite, or unexpected current would flow internally.

## TYPICAL APPLICATION FOR IC CHIP BREAKDOWN PREVENTION



When a sudden surge of electrical current travels along the V<sub>OUT</sub> 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<sub>OUT</sub> pin and GND has the effect of preventing damage to them.

**PACKAGE INFORMATION**

**POWER DISSIPATION (SOT89-5)**

Power Dissipation ( $P_D$ ) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

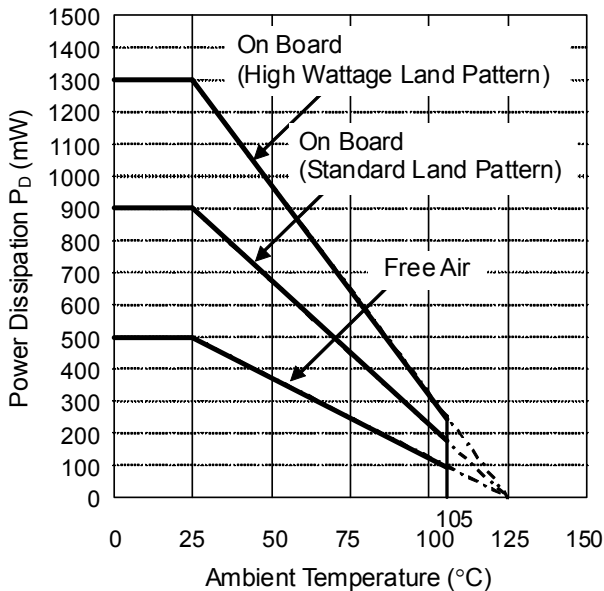
**Measurement Conditions (SOT89-5)**

	High Wattage Land Pattern	Standard Land Pattern
Environment	Mounting on board (Wind velocity = 0 m/s)	Mounting on board (Wind velocity = 0 m/s)
Board Material	Glass cloth epoxy plastic (Double sided)	Glass cloth epoxy plastic (Double sided)
Board Dimensions	30 mm x 30 mm x 1.6 mm	50 mm x 50 mm x 1.6 mm
Copper Ratio	Top side: Approx. 20% , Back side: Approx. 100%	Top side: Approx. 10% , Back side: Approx. 100%
Through-hole	$\phi$ 0.85 mm x 10 pcs	-

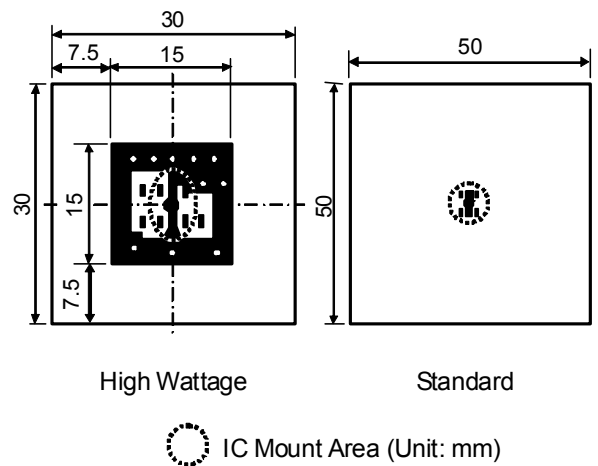
**Measurement Result (SOT89-5)**

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

	High Wattage Land Pattern	Standard Land Pattern	Free Air
Power Dissipation	1300 mW	900 mW	500 mW
Thermal Resistance	77°C/W	111°C/W	200°C/W



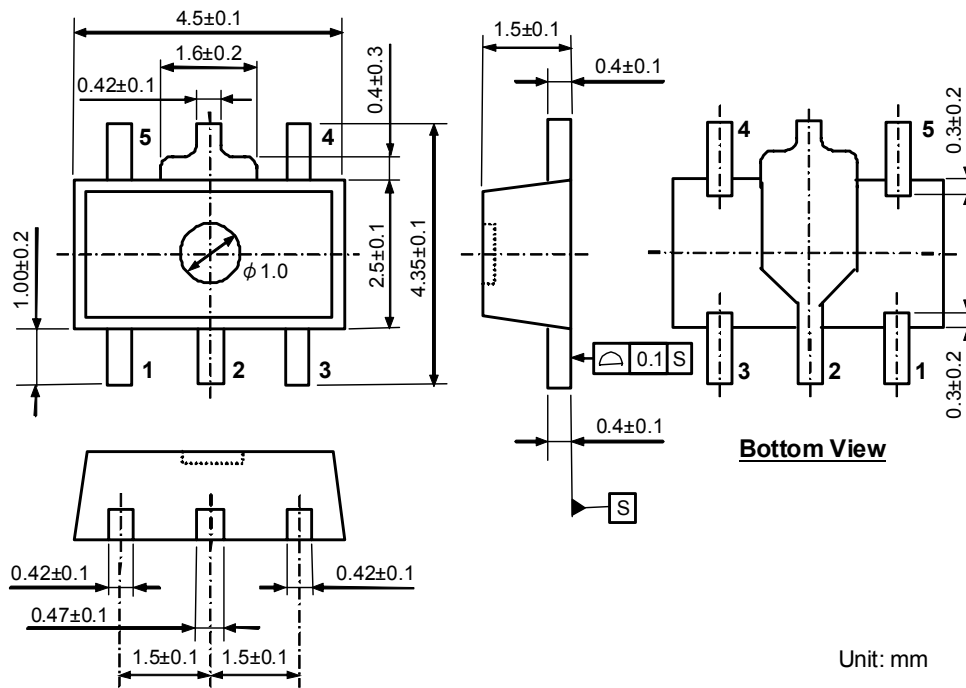
**Power Dissipation vs. Ambience Temperature (SOT89-5)**



**Measurement Board Pattern (SOT89-5)**



**PACKAGE DIMENSIONS (SOT89-5)**

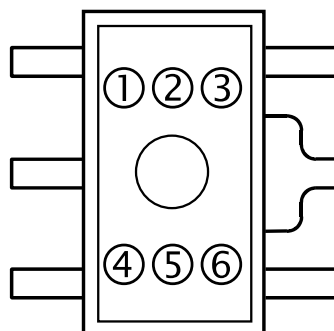


Unit: mm

**MARK SPECIFICATION (SOT-89-5)**

①②③④: Product Code ... Refer to R1514H MARK SPECIFICATION TABLE (SOT-89-5)

⑤⑥: Lot Number ... Alphanumeric Serial Number



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**R1514x-Y**NO. EA-346-140319

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**R1514H MARK SPECIFICATION TABLE (SOT-89-5)**

Product Name	①②③④	V <sub>SET</sub>
R1514H025B	M 0 2 5	2.5 V
R1514H028B	M 0 2 8	2.8 V
R1514H030B	M 0 3 0	3.0 V
R1514H033B	M 0 3 3	3.3 V
R1514H034B	M 0 3 4	3.4 V
R1514H050B	M 0 5 0	5.0 V
R1514H060B	M 0 6 0	6.0 V
R1514H080B	M 0 8 0	8.0 V
R1514H085B	M 0 8 5	8.5 V
R1514H090B	M 0 9 0	9.0 V
R1514H120B	M 1 2 0	12.0 V

### POWER DISSIPATION (HSOP-6J)

Power Dissipation ( $P_D$ ) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:

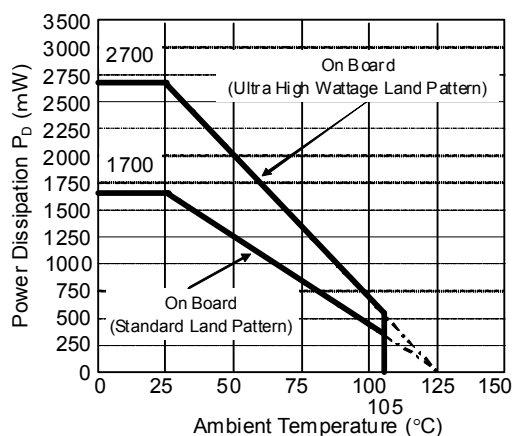
#### Measurement Conditions

	Ultra High Wattage Land Pattern	Standard Land Pattern
Environment	Mounting on Board (Wind velocity = 0 m/s)	Mounting on Board (Wind velocity = 0 m/s)
Board Material	Glass cloth epoxy plastic (4 Layers)	Glass cloth epoxy plastic (2 Layers)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm	50 mm × 50 mm × 1.6 mm
Copper Ratio	96%	50%
Through-hole	φ0.3 mm × 28 pcs	φ0.5 mm × 24 pcs

#### Measurement Result

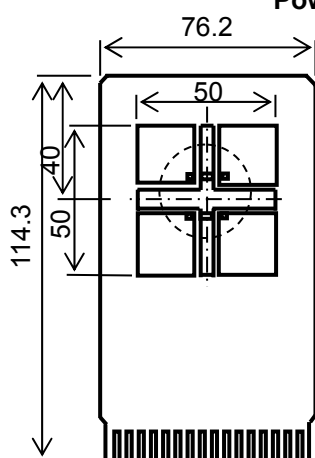
( $T_a = 25^\circ\text{C}$ ,  $T_{j\text{max}} = 125^\circ\text{C}$ )

	Ultra High Wattage Land Pattern	Standard Land Pattern	Free Air
Power Dissipation	2700 mW	1700 mW	540 mW
Thermal Resistance	37°C/W	59°C/W	185°C/W

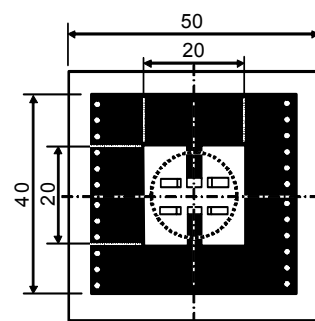


Power Dissipation

#### Power Dissipation vs. Ambience Temperature (HSOP-6J)



Ultra High Wattage Land Pattern  
IC Mount Area (Unit: mm)



Standard

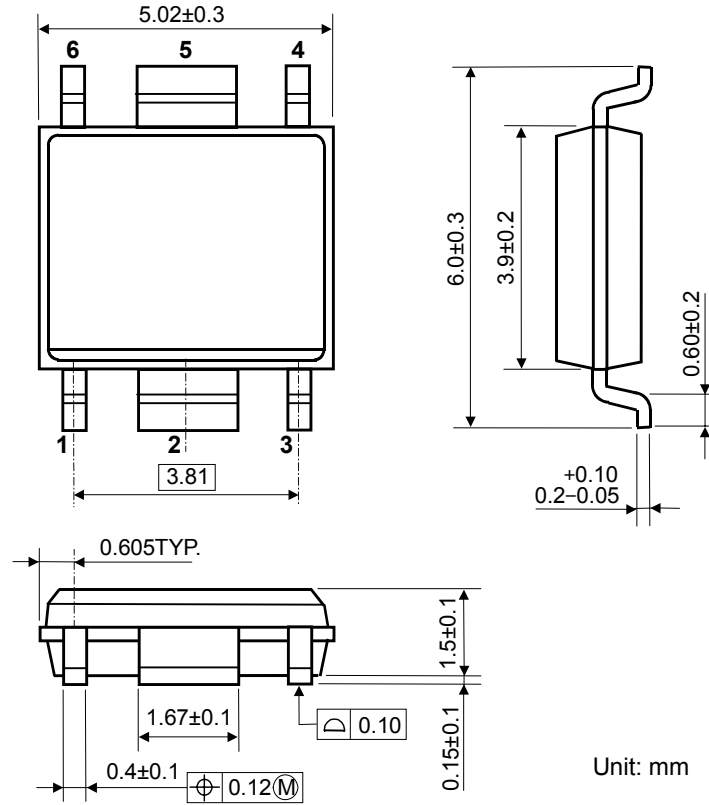
Measurement Board Pattern  
IC Mount Area (Unit: mm)

#### Measurement Board Pattern (HSOP-6J)

**R1514x-Y**

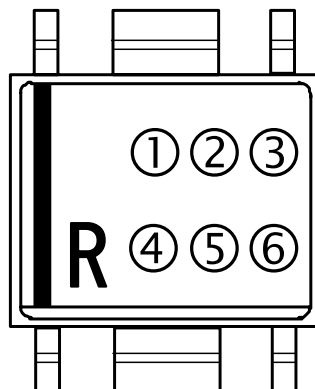
NO. EA-346-140319

**PACKAGE DIMENSIONS (HSOP-6J)**



**MARK SPECIFICATION (HSOP-6J)**

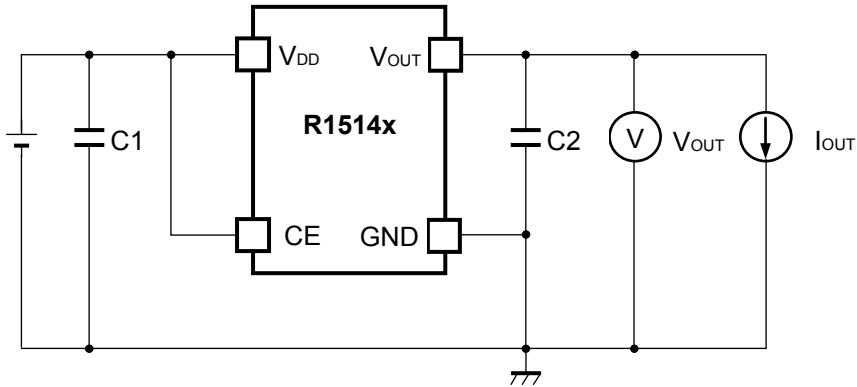
- ①②③④: Product Code ... **Refer to R1514S MARK SPECIFICATION TABLE (HSOP-6J)**
- ⑤⑥: Lot Number ... Alphanumeric Serial Number



**R1514S MARK SPECIFICATION TABLE (HSOP-6J)**

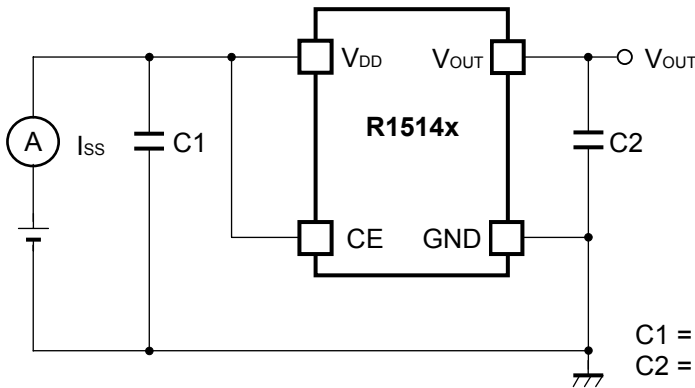
<b>Product Name</b>	<b>①②③④</b>	<b>V<sub>SET</sub></b>
R1514S025B	E 0 2 5	2.5 V
R1514S028B	E 0 2 8	2.8 V
R1514S030B	E 0 3 0	3.0 V
R1514S033B	E 0 3 3	3.3 V
R1514S034B	E 0 3 4	3.4 V
R1514S050B	E 0 5 0	5.0 V
R1514S060B	E 0 6 0	6.0 V
R1514S080B	E 0 8 0	8.0 V
R1514S085B	E 0 8 5	8.5 V
R1514S090B	E 0 9 0	9.0 V
R1514S120B	E 1 2 0	12.0 V

**TEST CIRCUITS**



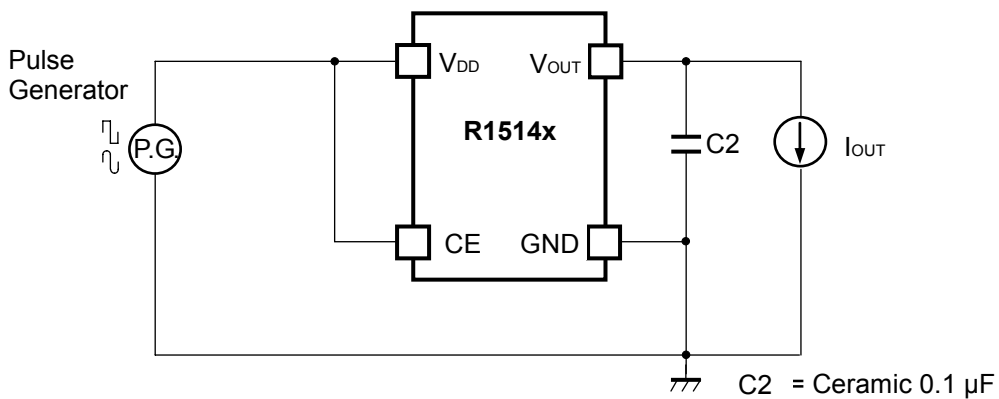
C1 = Ceramic 0.1  $\mu$ F  
C2 = Ceramic 0.1  $\mu$ F

**Basic Test Circuit**



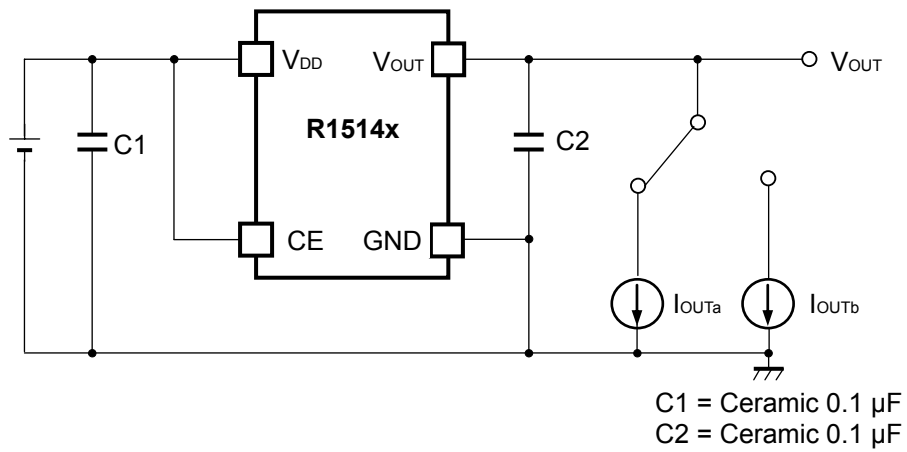
C1 = Ceramic 0.1  $\mu$ F  
C2 = Ceramic 0.1  $\mu$ F

**Test Circuit for Supply Current**



C2 = Ceramic 0.1  $\mu$ F

**Test Circuit for Line Transient Response**

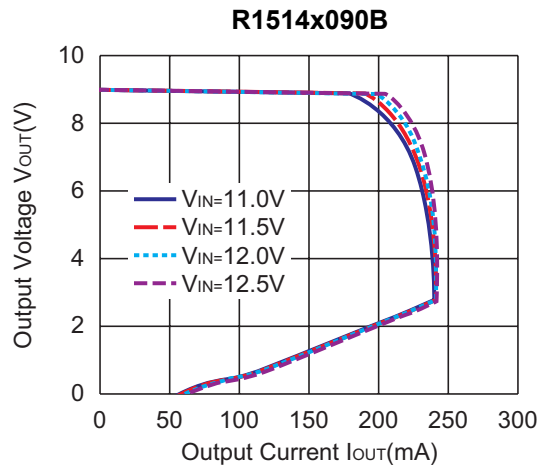
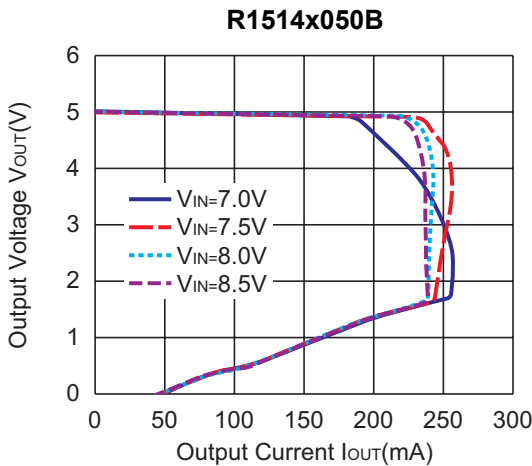
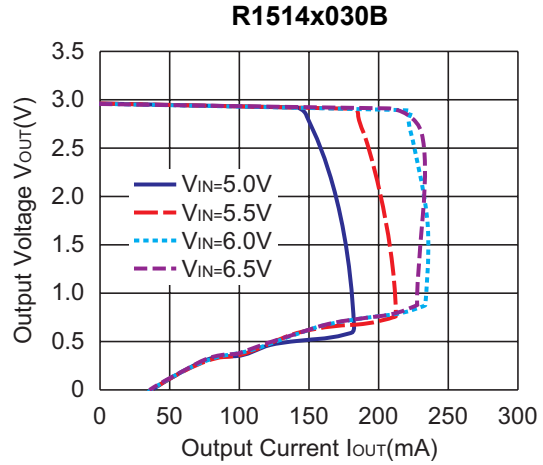
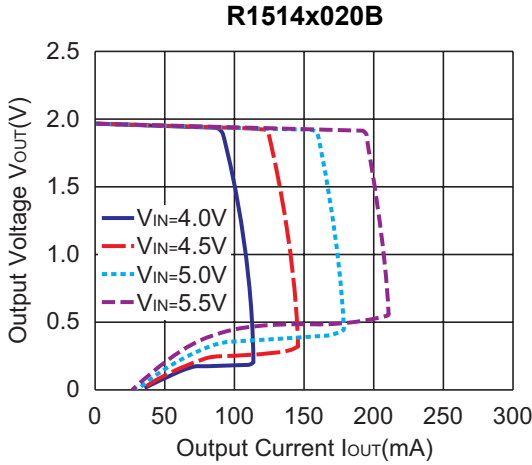


**Test Circuit for Load Transient Response**

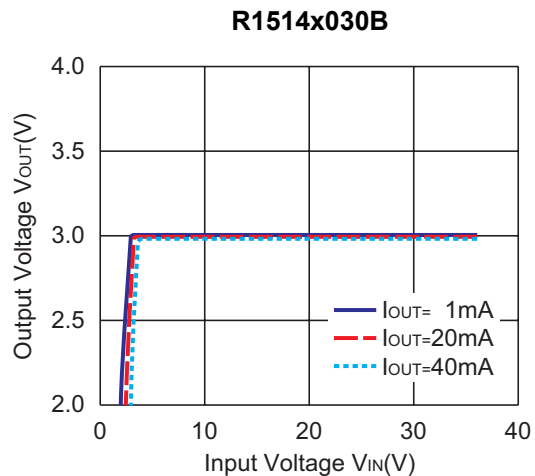
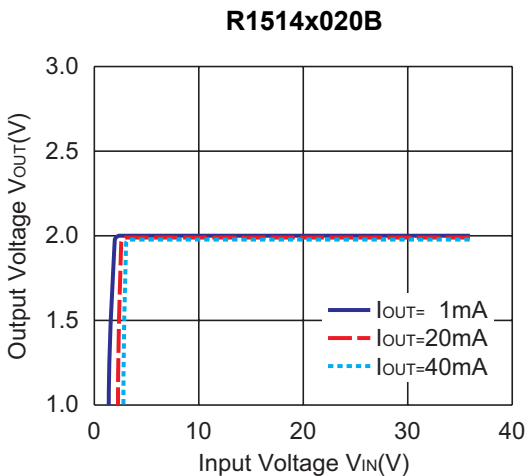
## TYPICAL CHARACTERISTICS

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

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

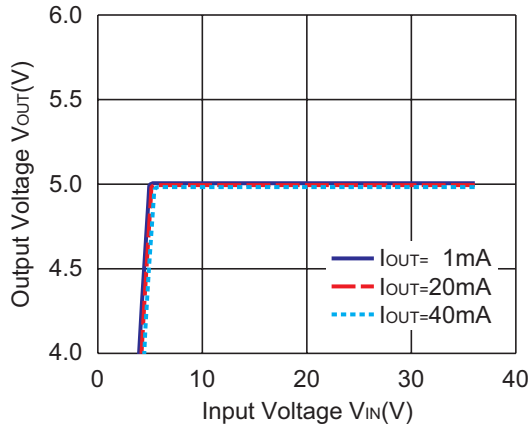


### 2) Output Voltage vs. Input Voltage (Ta = 25°C)

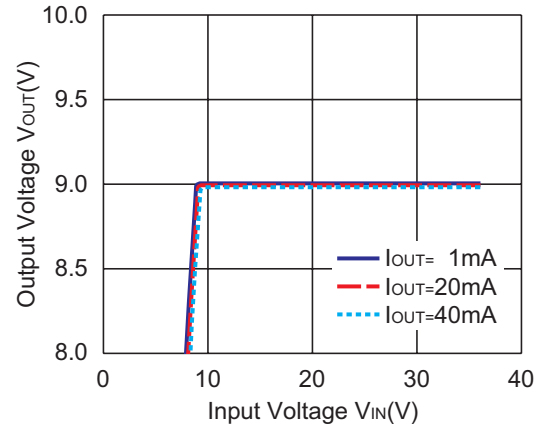




R1514x050B

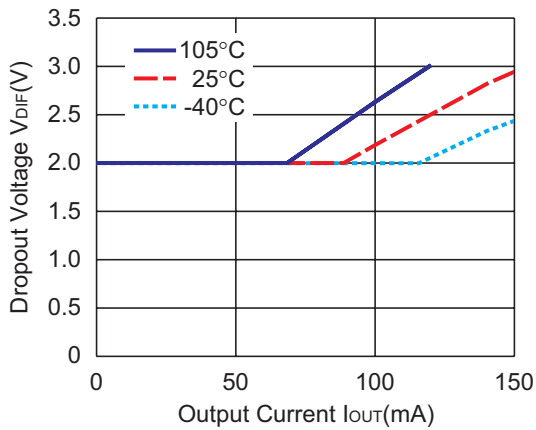


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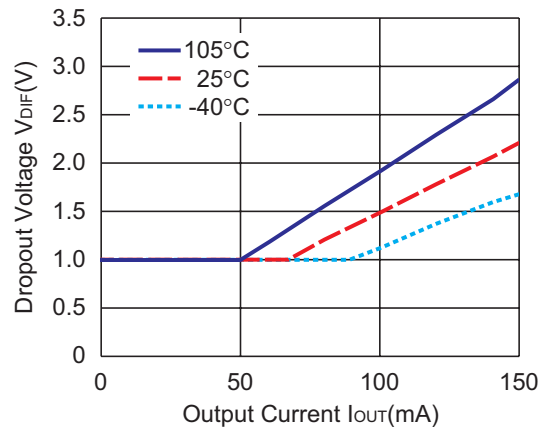


3) Dropout Voltage vs. Output Current

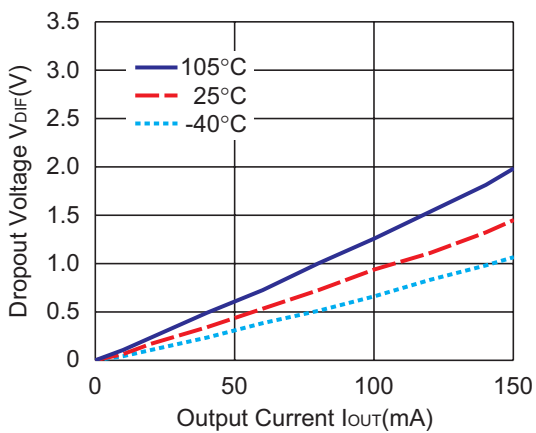
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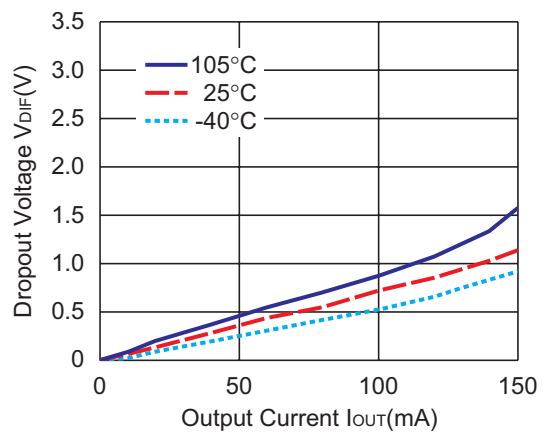
R1514x030B



R1514x050B



R1514x090B

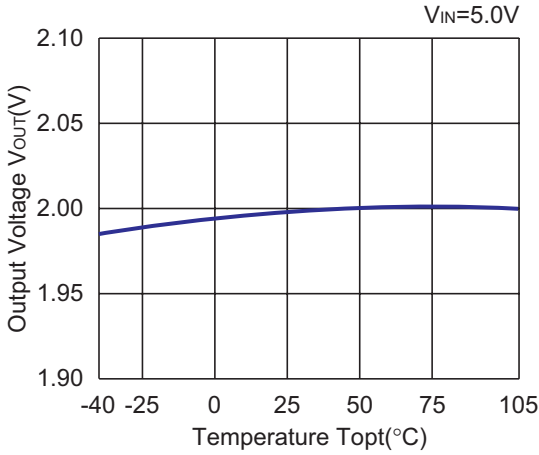


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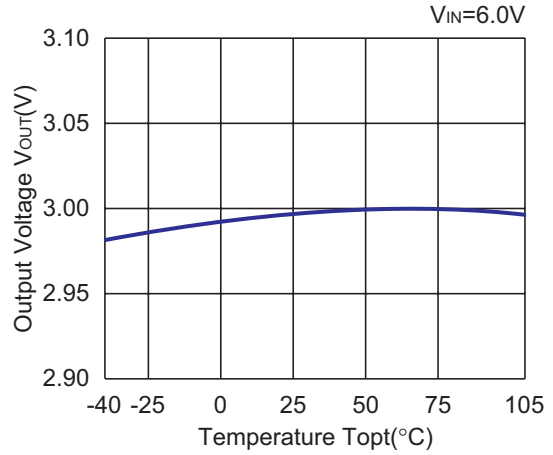
NO. EA-346-140319

## 4) Output Voltage vs. Temperature

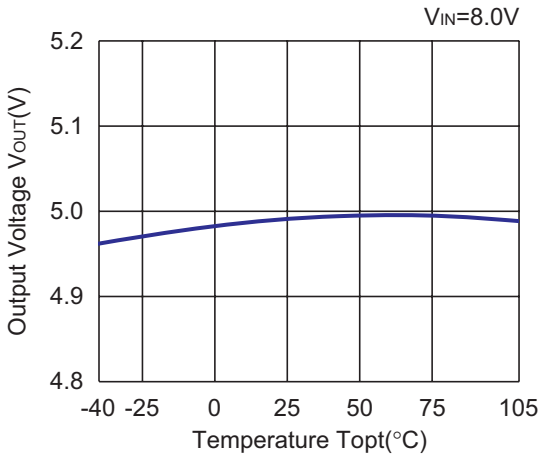
### R1514x020B



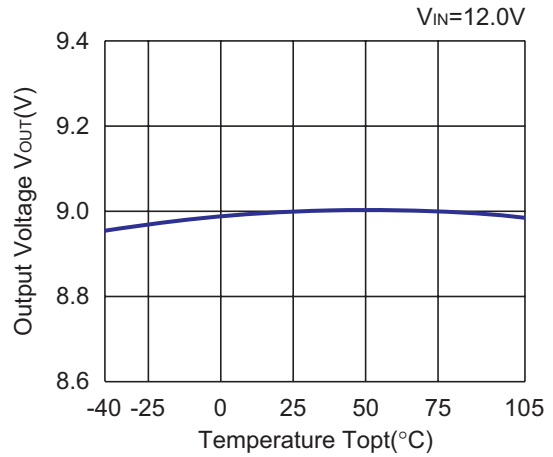
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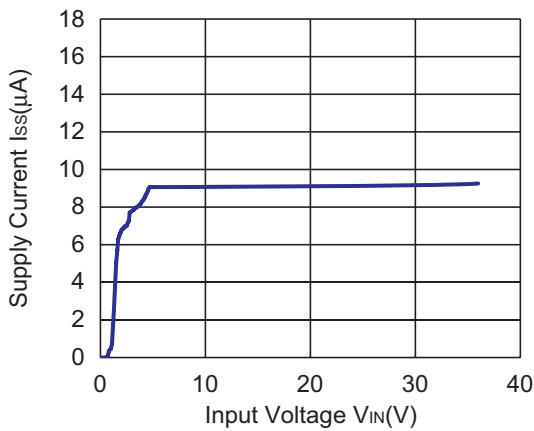


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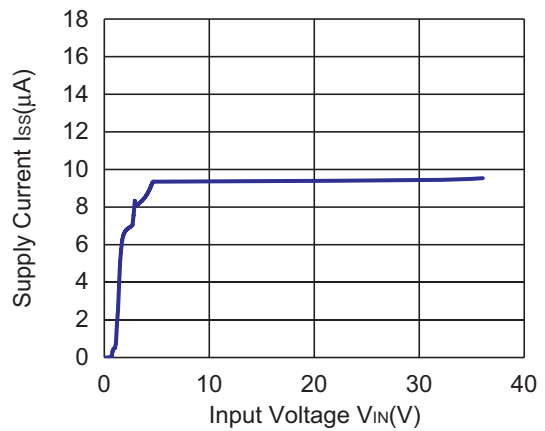


## 5) Supply Current vs. Input Voltage (Ta = 25°C)

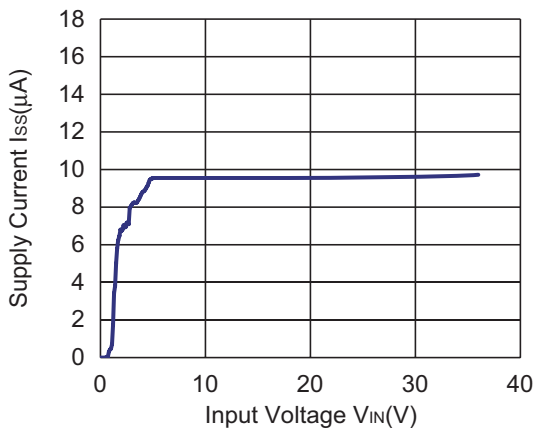
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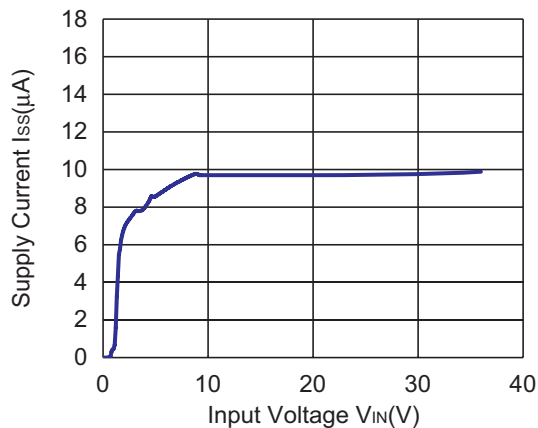
### R1514x030B



R1514x050B

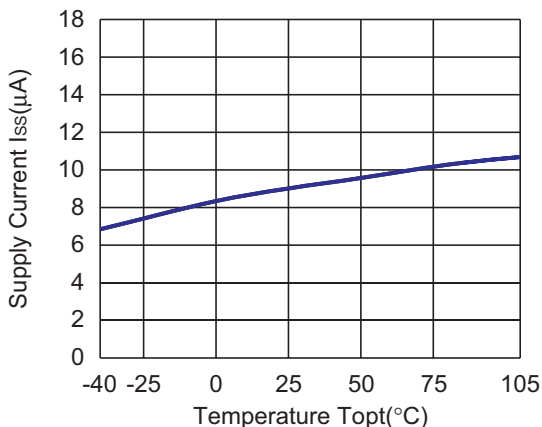


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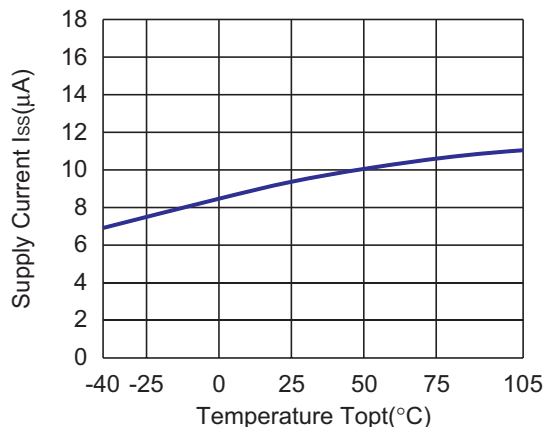


6) Supply Current vs. Temperature

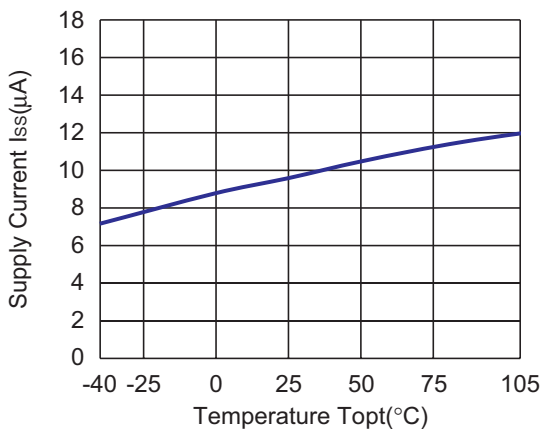
R1514x020B



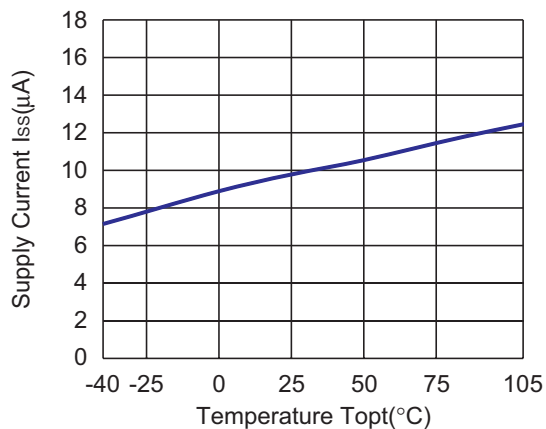
R1514x030B



R1514x050B



R1514x090B

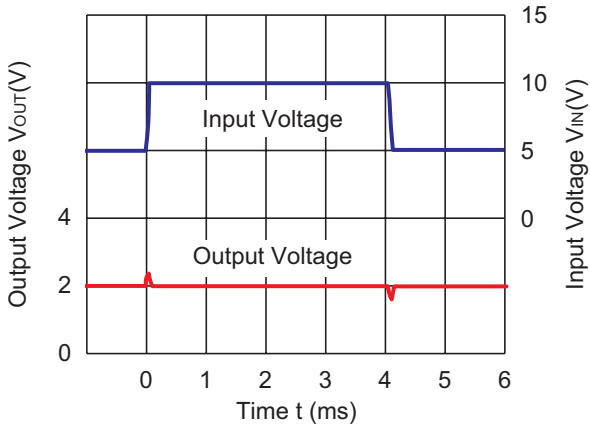


# R1514x-Y

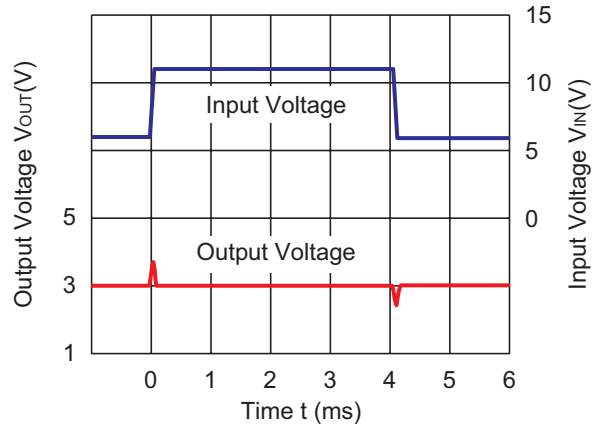
NO. EA-346-140319

## 7) Input Transient Response ( $I_{OUT} = 1 \text{ mA}$ , $t_r = t_f = 50 \mu\text{s}$ , $C_2 = \text{Ceramic } 0.1 \mu\text{F}$ , $T_a = 25^\circ\text{C}$ )

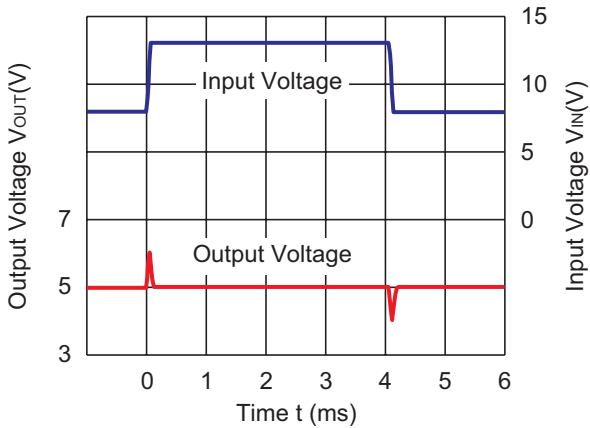
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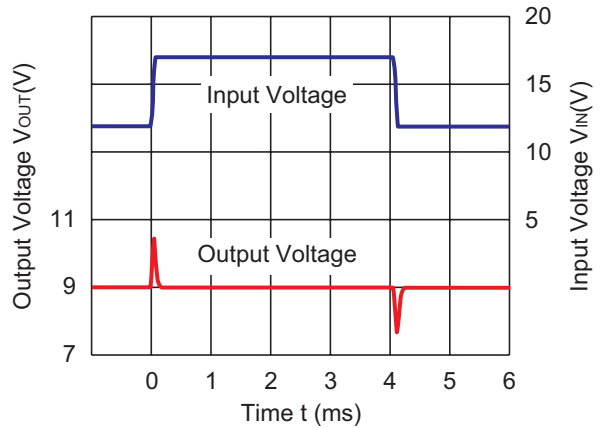
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### R1514x050B



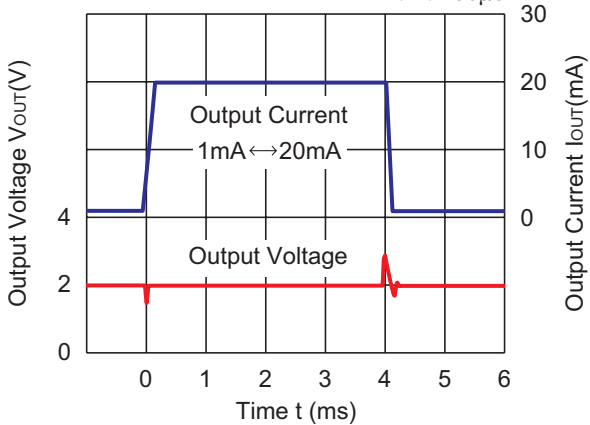
### R1514x090B



## 8) Load Transient Response ( $C_2 = \text{Ceramic } 0.1 \mu\text{F}$ , $T_a = 25^\circ\text{C}$ )

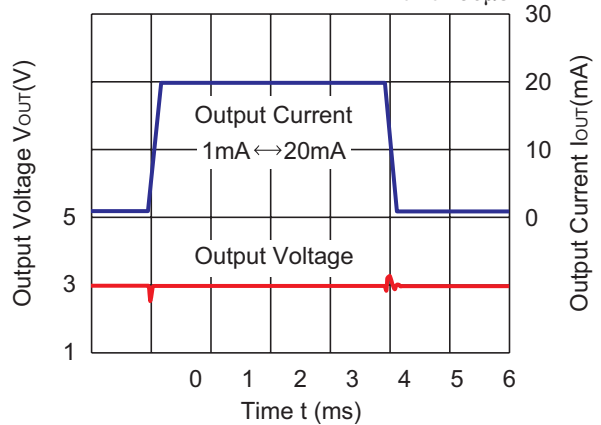
### R1514x020B

$V_{IN} = 5.0\text{V}$   
 $t_r = t_f = 50\mu\text{s}$



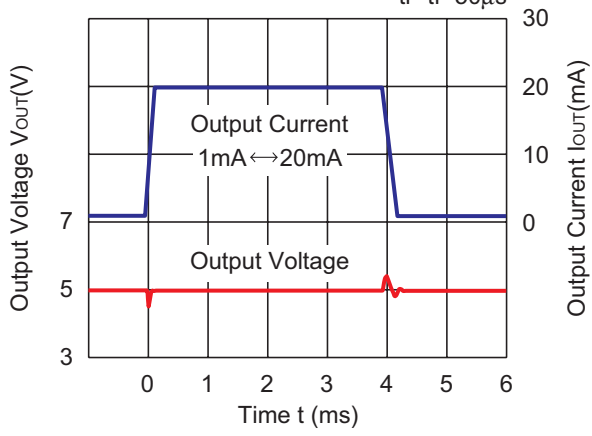
### R1514x030B

$V_{IN} = 6.0\text{V}$   
 $t_r = t_f = 50\mu\text{s}$



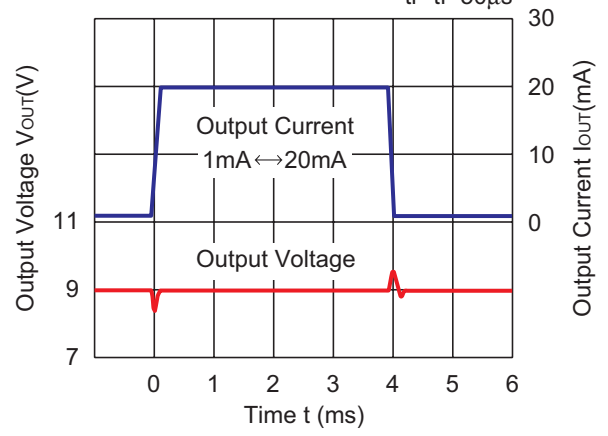
R1514x050B

$V_{IN}=8.0V$   
 $tr=tf=50\mu s$



R1514x090B

$V_{IN}=12.0V$   
 $tr=tf=50\mu s$





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