

## 1 A LDO Regulator (Operating Voltage up to 24 V) for Automotive Applications

NO.EC-184-160801

### OUTLINE

The R1501x is a CMOS-based positive voltage regulator (VR) IC specifically designed for automotive applications. The R1501xxxxB has features of high input voltage operating, 1 A output current drive, and low supply current.

A DMOS transistor\*1 is used for the driver, high voltage operating and low on resistance ( $0.6 \Omega$  at  $V_{OUT} = 10 \text{ V}$ ) device is realized. A standard regulator circuit with a current limit circuit and a thermal shutdown circuit are built in this IC.

As the operating temperature range is from  $-40^\circ\text{C}$  to  $105^\circ\text{C}$  and maximum input voltage is up to 24 V, this IC is suitable for the constant voltage source for car accessories.

The regulator output voltage is fixed in this IC. Output voltage accuracy is  $\pm 2.0\%$  and output voltage range is from 3.0 V to 12.0 V with a step of 0.1 V, and from 12.5 V to 18.0 V with a step of 0.5 V. The chip enable pin realizes ultra low supply current standby mode.

The packages for this IC are the HSOP-6J for high density mounting of the IC on boards, and the TO-252-5-P2 for high wattage.

\*1 The DMOS (Double Diffused MOS) transistor adopted by this IC is characterized by a double diffusion structure which comprises a low density n-type (channel) diffused layer and a high density p-type (sources) diffused layer from the edge of the gate electrode. This IC possesses outstanding properties of high operating voltage and low on-resistance, which have been achieved by the channel length scaled down to submicron dimensions and decreased thickness of the gate oxide film.

### FEATURES

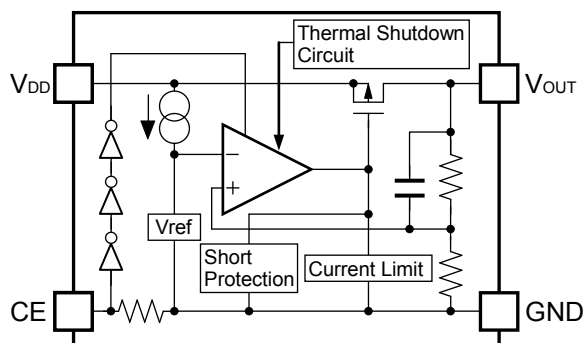
- Supply Current ( $I_{SS}$ ) ..... Typ. 70  $\mu\text{A}$
- Standby Current ( $I_{standby}$ ) ..... Typ. 0.1  $\mu\text{A}$
- Output Current ( $I_{OUT}$ ) ..... Min. 1 A
- Input Voltage Range ( $V_{IN}$ ) ..... 3.0 V to 24.0 V
- Ripple Rejection (RR) ..... Typ. 60 dB ( $V_{SET} = 5.0 \text{ V}$ )
- Output Voltage Range ( $V_{OUT}$ ) ..... 3.0 V to 12.0 V (0.1 V steps)  
12.5 V to 18.0 V (0.5 V steps)
- Output Voltage Accuracy .....  $\pm 2\%$
- Temperature-Drift Coefficient of Output Voltage ..... Typ.  $\pm 100 \text{ ppm}/^\circ\text{C}$
- Line Regulation ..... Typ. 0.05%/V
- Packages ..... HSOP-6J, TO-252-5-P2
- Operating Temperature range .....  $-40^\circ\text{C}$  to  $105^\circ\text{C}$
- Built-in Current Limit Circuit
- Built-in Fold-Back Circuit
- Built-in Thermal Shutdown Circuit

### APPLICATIONS

- Power source for car accessories including car audio equipment, car navigation system, and ETC system.
- Power source for control units including EV inverter and charge control.

**BLOCK DIAGRAMS**

**R1501xxxxB**



**SELECTION GUIDE**

The output voltage and package for the IC can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1501SxxxB-E2-AE	HSOP-6J	1,000 pcs	Yes	Yes
R1501JxxxB-T1-#E	TO-252-5-P2	3,000 pcs	Yes	Yes

xxx : The set output voltage ( $V_{SET}$ ) can be designated in the range from 3.0 V (030) to 12.0 V (120) in 0.1 V steps and 12.5 V (125) to 18.0 V (180) in 0.5 V steps.

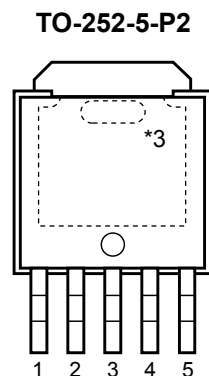
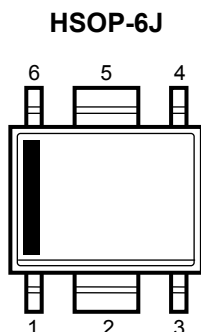
#: Designated Automotive Class Code

	Operating Temperature Range	Guaranteed Specs Temperature Range	Screening
A	-40°C to 105°C	25°C	High temperature
J	-40°C to 105°C	-40°C to 105°C	High and low temperature

Automotive class code (A, J) varies depending on the products.

Product Name	Automotive Class Code	
	A	J
R1501SxxxB-E2-AE	✓	
R1501JxxxB-T1-#E	✓	✓

## PIN DESCRIPTIONS



### HSOP-6J

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

<sup>\*1</sup> When mounting to board, connect between three GND pins by wiring.

### TO-252-5-P2

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

<sup>\*2</sup> When mounting to board, connect between two GND pins by wiring.

<sup>\*3</sup> 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.

**ABSOLUTE MAXIMUM RATINGS**

Symbol	Item		Rating	Unit
$V_{IN}$	Input Voltage		-0.3 to 36	V
$V_{CE}$	Input Voltage (CE Pin)		$-0.3$ to $V_{IN} + 0.3 \leq 36$	V
$V_{OUT}$	Output Voltage		$-0.3$ to $V_{IN} + 0.3 \leq 36$	V
$P_D$	Power Dissipation (HSOP-6J)* <sup>1</sup>	Standard Land Pattern	2100	mW
		Ultra High Wattage Land Pattern	3400	
	Power Dissipation (TO-252-5-P2)* <sup>1</sup>	Standard Land Pattern	2350	
		Ultra High Wattage Land Pattern	4800	
$T_j$	Operating Junction Temperature Range		-40 to 150	°C
$T_{stg}$	Storage Temperature Range		-55 to 150	°C

\*<sup>1</sup> Refer to *POWER DISSIPATION* 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
$V_{IN}$	Input Voltage	3 to 24	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 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

$V_{IN} = V_{SET} + 1.0 \text{ V}$ ,  $V_{CE} = V_{IN}$ , unless otherwise noted.

The specification in   is checked and guaranteed by design engineering at  $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$ .

### R1501xxxxB (-AE)

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

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
$V_{OUT}$	Output Voltage	$I_{OUT} = 1 \text{ mA}$	$T_a = 25^{\circ}\text{C}$	x0.98		x1.02	V
			$-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$	x0.965		x1.035	V
$I_{SS}$	Supply Current	$V_{IN} = 24 \text{ V}$ , $I_{OUT} = 0 \text{ A}$			70	160	$\mu\text{A}$
$I_{standby}$	Standby Current	$V_{IN} = 24 \text{ V}$ , $V_{CE} = 0 \text{ V}$			0.1	1.0	$\mu\text{A}$
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	$0.1 \text{ mA} \leq I_{OUT} \leq 200 \text{ mA}$			25	60	mV
		$0.1 \text{ mA} \leq I_{OUT} \leq 1 \text{ A}$			125	300	mV
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	$V_{SET} + 1 \text{ V} \leq V_{IN} \leq 24 \text{ V}$ , $I_{OUT} = 10 \text{ mA}$			0.05	0.1	%/V
$V_{DIF}$	Dropout Voltage	$I_{OUT} = 200 \text{ mA}$	$3.0 \text{ V} \leq V_{SET} < 5.0 \text{ V}$		0.135	0.225	V
			$5.0 \text{ V} \leq V_{SET} < 9.0 \text{ V}$		0.115	0.180	
			$9.0 \text{ V} \leq V_{SET} < 12.0 \text{ V}$		0.095	0.155	
			$12.0 \text{ V} \leq V_{SET} \leq 18.0 \text{ V}$		0.090	0.140	
		$I_{OUT} = 1 \text{ A}$	$3.0 \text{ V} \leq V_{SET} < 5.0 \text{ V}$		0.675	1.125	V
			$5.0 \text{ V} \leq V_{SET} < 9.0 \text{ V}$		0.575	0.900	
			$9.0 \text{ V} \leq V_{SET} < 12.0 \text{ V}$		0.475	0.775	
			$12.0 \text{ V} \leq V_{SET} \leq 18.0 \text{ V}$		0.450	0.700	
$I_{LIM}$	Output Current			1			A
$I_{SC}$	Short Current Limit	$V_{OUT} = 0 \text{ V}$			65		mA
$V_{CEH}$	CE Input Voltage "H"			2.0		$V_{IN}$	V
$V_{CEL}$	CE Input Voltage "L"			0		0.5	V
$T_{TSD}$	Thermal Shutdown Temperature	Junction Temperature			160		$^{\circ}\text{C}$
$T_{TSR}$	Thermal Shutdown Released Temperature	Junction Temperature			135		$^{\circ}\text{C}$

As all of units, all items except Load Regulation at  $0.1 \text{ mA} \leq I_{OUT} \leq 1 \text{ A}$  and Dropout Voltage at  $I_{OUT} = 1 \text{ A}$  are tested and specified under load conditions such as  $T_j \approx T_a = 25^{\circ}\text{C}$ .

**R1501x**

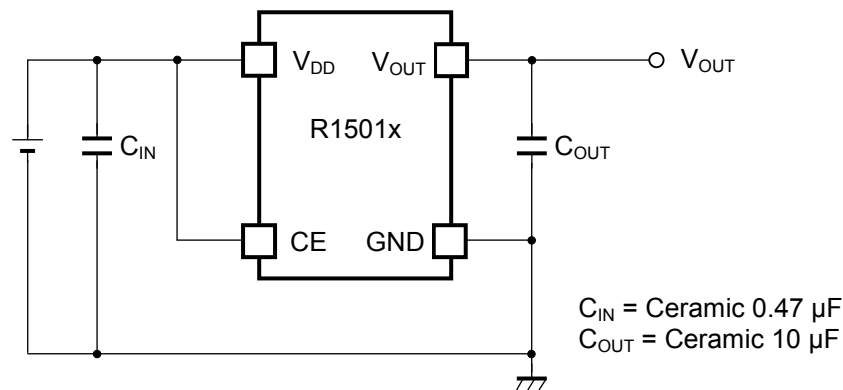
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 $V_{IN} = V_{SET} + 1.0 \text{ V}$ ,  $V_{CE} = V_{IN}$ , unless otherwise noted.**The specification in    is checked and guaranteed by design engineering at  $-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$ .****R1501JxxxB (-JE)** $(-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C})$ 

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
$V_{OUT}$	Output Voltage	$I_{OUT} = 1 \text{ mA}$	$T_a = 25^{\circ}\text{C}$	x0.98		x1.02	V
			$-40^{\circ}\text{C} \leq T_a \leq 105^{\circ}\text{C}$	x0.965		x1.035	V
$I_{SS}$	Supply Current	$V_{IN} = 24 \text{ V}$ , $I_{OUT} = 0 \text{ A}$			70	160	$\mu\text{A}$
$I_{standby}$	Standby Current	$V_{IN} = 24 \text{ V}$ , $V_{CE} = 0 \text{ V}$			0.1	1.0	$\mu\text{A}$
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	$0.1 \text{ mA} \leq I_{OUT} \leq 200 \text{ mA}$			25	60	mV
		$0.1 \text{ mA} \leq I_{OUT} \leq 1 \text{ A}$			125	<span style="border: 1px solid black; padding: 0 2px;">300</span>	mV
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	$V_{SET} + 1 \text{ V} \leq V_{IN} \leq 24 \text{ V}$ , $I_{OUT} = 10 \text{ mA}$			0.05	0.1	%/V
$V_{DIF}$	Dropout Voltage	$I_{OUT} = 200 \text{ mA}$	$3.0 \text{ V} \leq V_{SET} < 5.0 \text{ V}$		0.135	0.225	V
			$5.0 \text{ V} \leq V_{SET} < 9.0 \text{ V}$		0.115	0.180	
			$9.0 \text{ V} \leq V_{SET} < 12.0 \text{ V}$		0.095	0.155	
			$12.0 \text{ V} \leq V_{SET} \leq 18.0 \text{ V}$		0.090	0.140	
		$I_{OUT} = 1 \text{ A}$	$3.0 \text{ V} \leq V_{SET} < 5.0 \text{ V}$		0.675	<span style="border: 1px solid black; padding: 0 2px;">1.125</span>	V
			$5.0 \text{ V} \leq V_{SET} < 9.0 \text{ V}$		0.575	<span style="border: 1px solid black; padding: 0 2px;">0.900</span>	
			$9.0 \text{ V} \leq V_{SET} < 12.0 \text{ V}$		0.475	<span style="border: 1px solid black; padding: 0 2px;">0.775</span>	
			$12.0 \text{ V} \leq V_{SET} \leq 18.0 \text{ V}$		0.450	<span style="border: 1px solid black; padding: 0 2px;">0.700</span>	
$I_{LIM}$	Output Current			1			A
$I_{SC}$	Short Current Limit	$V_{OUT} = 0 \text{ V}$			65		mA
$V_{CEH}$	CE Input Voltage "H"			2.0		$V_{IN}$	V
$V_{CEL}$	CE Input Voltage "L"			0		0.5	V
$T_{TSD}$	Thermal Shutdown Temperature	Junction Temperature			160		$^{\circ}\text{C}$
$T_{TSR}$	Thermal Shutdown Released Temperature	Junction Temperature			135		$^{\circ}\text{C}$

All test items listed under Electrical Characteristics are done except for Dropout Voltage and Load Regulation at 1A Output Current.

## TYPICAL APPLICATION



### External Components

Parts Type	Parts Name	Manufacturer
$C_{OUT}$	Ceramic Capacitor 10 $\mu$ F	MURATA: GRM32DB31E106K (size: 3225)

## TECHNICAL NOTES

### PCB Layout

Make  $V_{DD}$  and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor  $C_{IN}$  with a capacitance value as much as 0.47  $\mu$ F or more between  $V_{DD}$  pin and GND, and as close as possible to the pins.

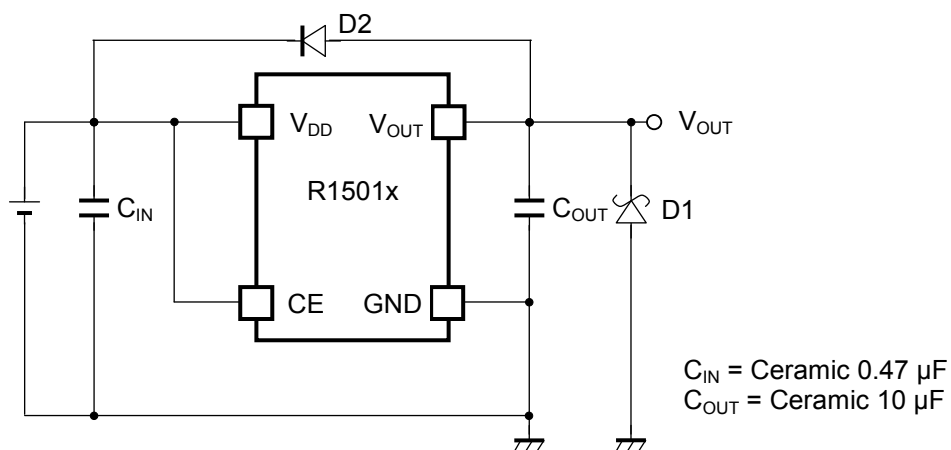
Connect external components, especially the output capacitor  $C_{OUT}$ , with a suitable value between the  $V_{DD}$  and GND, and as close as possible to the pins.

### Phase Compensation

In this IC, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use a capacitor  $C_{OUT}$  with good frequency characteristics and Equivalent Series Resistance (ESR).

When using a tantalum type capacitor that the ESR value is large, output might be unstable. Evaluate the circuit considering frequency characteristics.

As the bias and the temperature characteristics vary by the capacitor size, manufacturer, and part number, evaluate the circuit with actual using capacitors.

**TYPICAL APPLICATION FOR PREVENTING IC DESTRUCTION**

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 (C<sub>OUT</sub>) and a short circuit inductor generates a negative voltage and may damage the device or the load devices. To prevent damage to the device or the load devices, connecting a schottky diode (D1) between the V<sub>OUT</sub> pin and GND is recommended.

In addition, connect D2 if V<sub>OUT</sub> pin could be higher than V<sub>DD</sub> pin.

C<sub>IN</sub> and C<sub>OUT</sub> are necessary for preventing unstable operation.



## PACKAGE INFORMATION

### POWER DISSIPATION (HSOP-6J)

The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

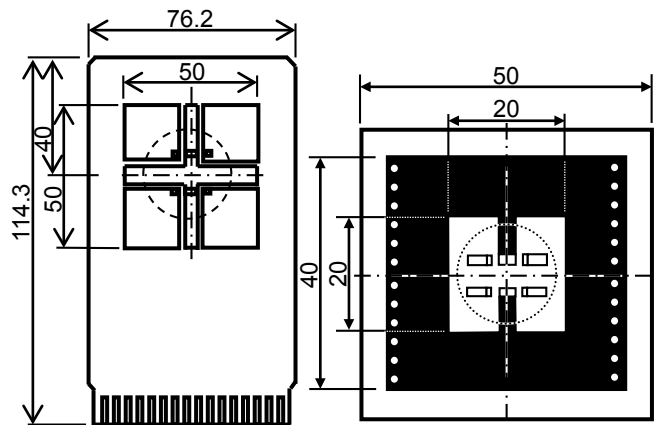
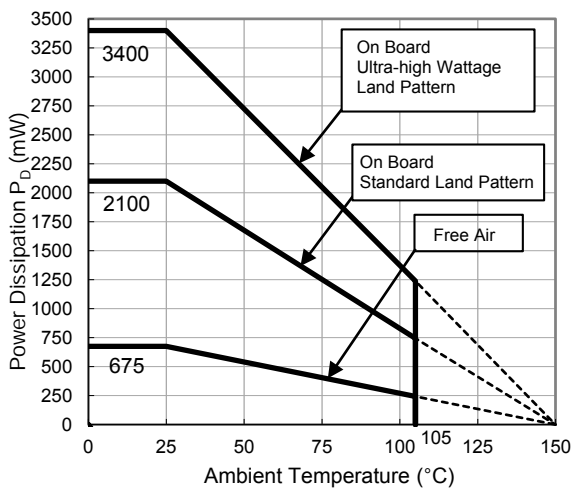
#### Measurement Conditions

	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 (Four-Layer Board)	Glass Cloth Epoxy Plastic (Double-sided Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm	50 mm × 50 mm × 1.6 mm
Copper Ratio	96%	50%
Through-holes	φ 0.3 mm × 28 pcs	φ 0.5 mm × 24 pcs

#### Measurement Result

(Ta = 25°C, Tjmax = 150°C)

	Ultra-high Wattage Land Pattern	Standard Land Pattern	Free Air
Power Dissipation	3400 mW	2100 mW	675 mW
Thermal Resistance	37°C/W	59°C/W	185°C/W



Ultra-high Wattage

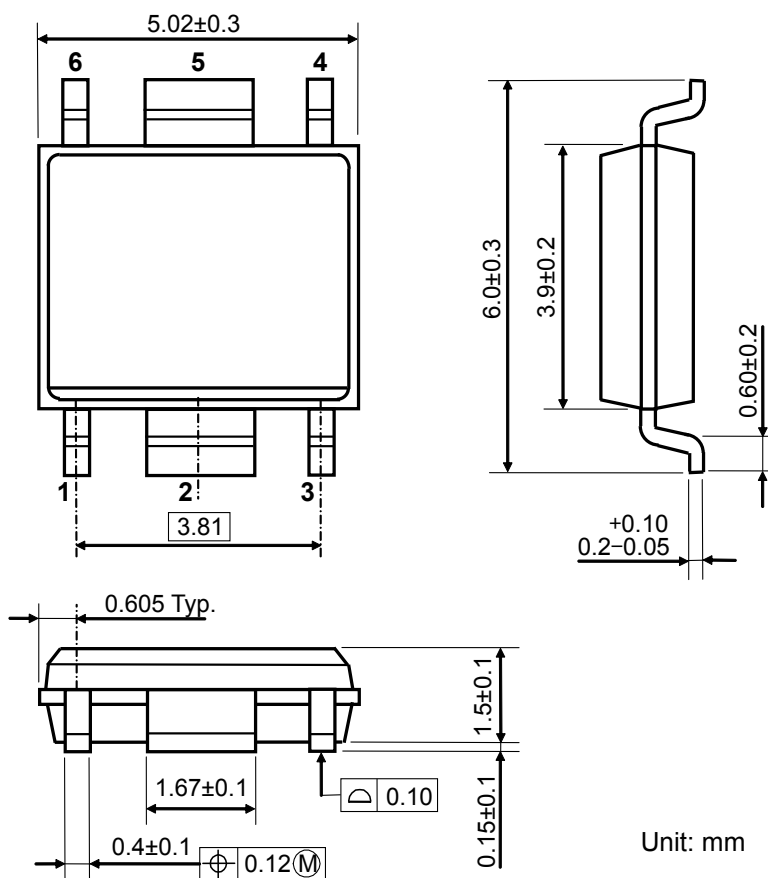
Standard

○ IC Mount Area (mm)

Power Dissipation vs. Ambient Temperature

Measurement Board Pattern

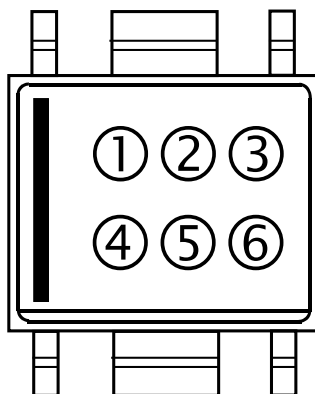
PACKAGE DIMENSIONS (HSOP-6J)



MARK SPECIFICATIONS (HSOP-6J)

①②③④: Product Code ... Refer to R1501x MARK SPECIFICATION TABLE

⑤⑥: Lot Number ... Alphanumeric Serial Number



## R1501x MARK SPECIFICATION TABLE (HSOP-6J)

Product Name	①②③④	V <sub>SET</sub>	Product Name	①②③④	V <sub>SET</sub>	Product Name	①②③④	V <sub>SET</sub>
R1501S030B	H 0 3 0	3.0 V	R1501S070B	H 0 7 0	7.0 V	R1501S110B	H 1 1 0	11.0 V
R1501S031B	H 0 3 1	3.1 V	R1501S071B	H 0 7 1	7.1 V	R1501S111B	H 1 1 1	11.1 V
R1501S032B	H 0 3 2	3.2 V	R1501S072B	H 0 7 2	7.2 V	R1501S112B	H 1 1 2	11.2 V
R1501S033B	H 0 3 3	3.3 V	R1501S073B	H 0 7 3	7.3 V	R1501S113B	H 1 1 3	11.3 V
R1501S034B	H 0 3 4	3.4 V	R1501S074B	H 0 7 4	7.4 V	R1501S114B	H 1 1 4	11.4 V
R1501S035B	H 0 3 5	3.5 V	R1501S075B	H 0 7 5	7.5 V	R1501S115B	H 1 1 5	11.5 V
R1501S036B	H 0 3 6	3.6 V	R1501S076B	H 0 7 6	7.6 V	R1501S116B	H 1 1 6	11.6 V
R1501S037B	H 0 3 7	3.7 V	R1501S077B	H 0 7 7	7.7 V	R1501S117B	H 1 1 7	11.7 V
R1501S038B	H 0 3 8	3.8 V	R1501S078B	H 0 7 8	7.8 V	R1501S118B	H 1 1 8	11.8 V
R1501S039B	H 0 3 9	3.9 V	R1501S079B	H 0 7 9	7.9 V	R1501S119B	H 1 1 9	11.9 V
R1501S040B	H 0 4 0	4.0 V	R1501S080B	H 0 8 0	8.0 V	R1501S120B	H 1 2 0	12.0 V
R1501S041B	H 0 4 1	4.1 V	R1501S081B	H 0 8 1	8.1 V	R1501S125B	H 1 2 5	12.5 V
R1501S042B	H 0 4 2	4.2 V	R1501S082B	H 0 8 2	8.2 V	R1501S130B	H 1 3 0	13.0 V
R1501S043B	H 0 4 3	4.3 V	R1501S083B	H 0 8 3	8.3 V	R1501S135B	H 1 3 5	13.5 V
R1501S044B	H 0 4 4	4.4 V	R1501S084B	H 0 8 4	8.4 V	R1501S140B	H 1 4 0	14.0 V
R1501S045B	H 0 4 5	4.5 V	R1501S085B	H 0 8 5	8.5 V	R1501S145B	H 1 4 5	14.5 V
R1501S046B	H 0 4 6	4.6 V	R1501S086B	H 0 8 6	8.6 V	R1501S150B	H 1 5 0	15.0 V
R1501S047B	H 0 4 7	4.7 V	R1501S087B	H 0 8 7	8.7 V	R1501S155B	H 1 5 5	15.5 V
R1501S048B	H 0 4 8	4.8 V	R1501S088B	H 0 8 8	8.8 V	R1501S160B	H 1 6 0	16.0 V
R1501S049B	H 0 4 9	4.9 V	R1501S089B	H 0 8 9	8.9 V	R1501S165B	H 1 6 5	16.5 V
R1501S050B	H 0 5 0	5.0 V	R1501S090B	H 0 9 0	9.0 V	R1501S170B	H 1 7 0	17.0 V
R1501S051B	H 0 5 1	5.1 V	R1501S091B	H 0 9 1	9.1 V	R1501S175B	H 1 7 5	17.5 V
R1501S052B	H 0 5 2	5.2 V	R1501S092B	H 0 9 2	9.2 V	R1501S180B	H 1 8 0	18.0 V
R1501S053B	H 0 5 3	5.3 V	R1501S093B	H 0 9 3	9.3 V			
R1501S054B	H 0 5 4	5.4 V	R1501S094B	H 0 9 4	9.4 V			
R1501S055B	H 0 5 5	5.5 V	R1501S095B	H 0 9 5	9.5 V			
R1501S056B	H 0 5 6	5.6 V	R1501S096B	H 0 9 6	9.6 V			
R1501S057B	H 0 5 7	5.7 V	R1501S097B	H 0 9 7	9.7 V			
R1501S058B	H 0 5 8	5.8 V	R1501S098B	H 0 9 8	9.8 V			
R1501S059B	H 0 5 9	5.9 V	R1501S099B	H 0 9 9	9.9 V			
R1501S060B	H 0 6 0	6.0 V	R1501S100B	H 1 0 0	10.0 V			
R1501S061B	H 0 6 1	6.1 V	R1501S101B	H 1 0 1	10.1 V			
R1501S062B	H 0 6 2	6.2 V	R1501S102B	H 1 0 2	10.2 V			
R1501S063B	H 0 6 3	6.3 V	R1501S103B	H 1 0 3	10.3 V			
R1501S064B	H 0 6 4	6.4 V	R1501S104B	H 1 0 4	10.4 V			
R1501S065B	H 0 6 5	6.5 V	R1501S105B	H 1 0 5	10.5 V			
R1501S066B	H 0 6 6	6.6 V	R1501S106B	H 1 0 6	10.6 V			
R1501S067B	H 0 6 7	6.7 V	R1501S107B	H 1 0 7	10.7 V			
R1501S068B	H 0 6 8	6.8 V	R1501S108B	H 1 0 8	10.8 V			
R1501S069B	H 0 6 9	6.9 V	R1501S109B	H 1 0 9	10.9 V			

**POWER DISSIPATION (TO-252-5-P2)**

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

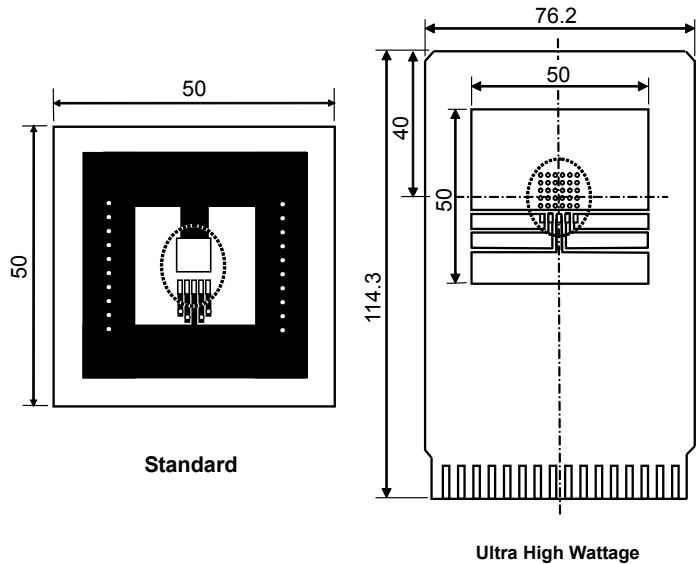
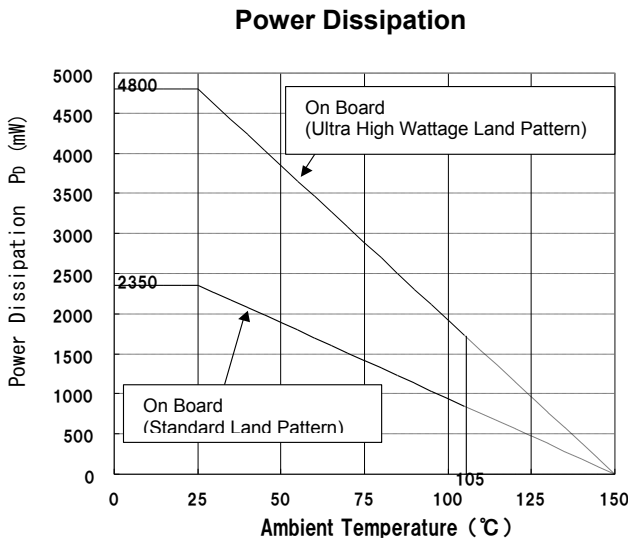
**\* Measurement conditions**

	Standard Land Pattern	Ultra High Wattage Land Pattern
Environment	Mounting on board (Wind velocity 0m/s)	
Board Material	Glass cloth epoxy plastic (Double layers)	Glass cloth epoxy plastic (Four-layers)
Board Dimensions	50mm x 50mm x 1.6mm	76.2mm x 114.3mm x 0.8mm
Copper Ratio	Top side: Approx. 50%, Back side: Approx. 50%	Top, Back side: Approx. 96%, 2nd, 3rd: 100%
Through - hole	$\phi$ 0.5mm x 24pcs	$\phi$ 0.4mm x 30pcs

**\* Measurement Results**

( $T_a=25^\circ\text{C}$ ,  $T_{j\text{max}}=150^\circ\text{C}$ )

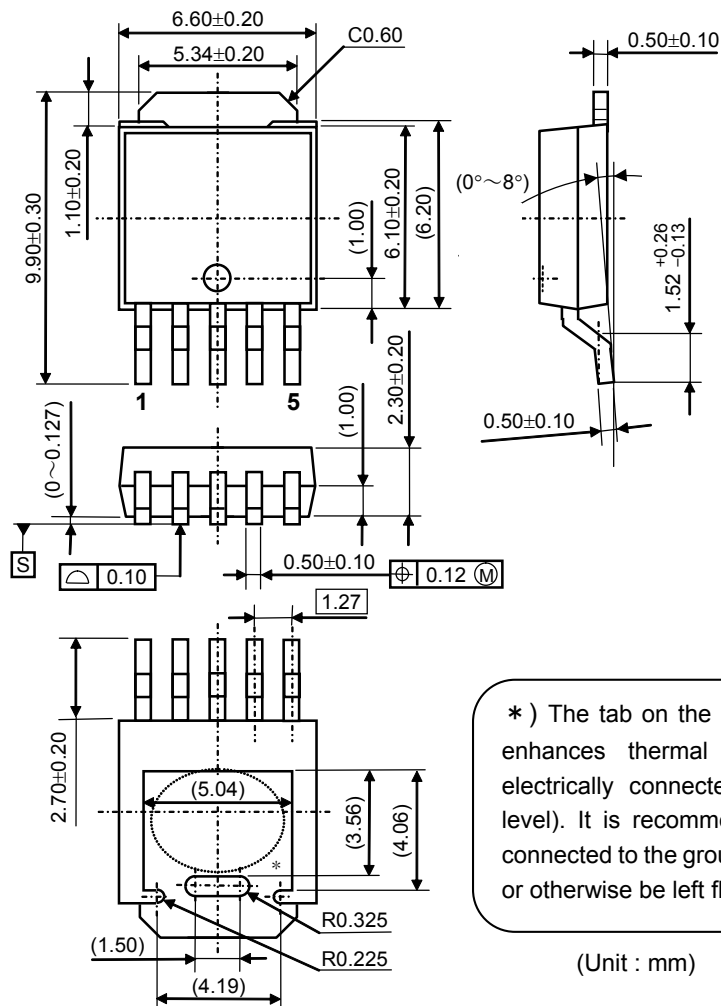
	Standard Land Pattern	Ultra High Wattage Land Pattern
Power Dissipation	2350mW	4800mW
Thermal Resistance	$\theta_{ja}=(150-25^\circ\text{C})/2.35\text{W}= 53^\circ\text{C/W}$	$\theta_{ja}= (150-25^\circ\text{C})/4.8\text{W} = 26^\circ\text{C/W}$
	$\theta_{jc}= 17^\circ\text{C/W}$	$\theta_{jc}= 7^\circ\text{C/W}$



**Measurement Board Pattern**

○ IC Mount Area (Unit: mm)

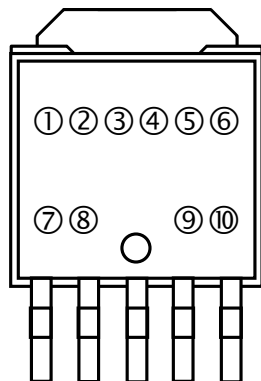
**PACKAGE DIMENSIONS (TO-252-5-P2)**



**MARK SPECIFICATIONS (TO-252-5-P2)**

①②③④⑤⑥⑦⑧: Product Code ... Refer to R1501x MARK SPECIFICATION TABLE

⑨⑩: Lot Number ... Alphanumeric Serial Number



**R1501x**

NO.EC-184-160801

**R1501x MARK SPECIFICATION TABLE (TO-252-5-P2)**

Product Name	①②③④⑤⑥⑦⑧	V <sub>SET</sub>
R1501J030B	A 1 J 0 3 0 B	3.0 V
R1501J031B	A 1 J 0 3 1 B	3.1 V
R1501J032B	A 1 J 0 3 2 B	3.2 V
R1501J033B	A 1 J 0 3 3 B	3.3 V
R1501J034B	A 1 J 0 3 4 B	3.4 V
R1501J035B	A 1 J 0 3 5 B	3.5 V
R1501J036B	A 1 J 0 3 6 B	3.6 V
R1501J037B	A 1 J 0 3 7 B	3.7 V
R1501J038B	A 1 J 0 3 8 B	3.8 V
R1501J039B	A 1 J 0 3 9 B	3.9 V
R1501J040B	A 1 J 0 4 0 B	4.0 V
R1501J041B	A 1 J 0 4 1 B	4.1 V
R1501J042B	A 1 J 0 4 2 B	4.2 V
R1501J043B	A 1 J 0 4 3 B	4.3 V
R1501J044B	A 1 J 0 4 4 B	4.4 V
R1501J045B	A 1 J 0 4 5 B	4.5 V
R1501J046B	A 1 J 0 4 6 B	4.6 V
R1501J047B	A 1 J 0 4 7 B	4.7 V
R1501J048B	A 1 J 0 4 8 B	4.8 V
R1501J049B	A 1 J 0 4 9 B	4.9 V
R1501J050B	A 1 J 0 5 0 B	5.0 V
R1501J051B	A 1 J 0 5 1 B	5.1 V
R1501J052B	A 1 J 0 5 2 B	5.2 V
R1501J053B	A 1 J 0 5 3 B	5.3 V
R1501J054B	A 1 J 0 5 4 B	5.4 V
R1501J055B	A 1 J 0 5 5 B	5.5 V
R1501J056B	A 1 J 0 5 6 B	5.6 V
R1501J057B	A 1 J 0 5 7 B	5.7 V
R1501J058B	A 1 J 0 5 8 B	5.8 V
R1501J059B	A 1 J 0 5 9 B	5.9 V
R1501J060B	A 1 J 0 6 0 B	6.0 V
R1501J061B	A 1 J 0 6 1 B	6.1 V
R1501J062B	A 1 J 0 6 2 B	6.2 V
R1501J063B	A 1 J 0 6 3 B	6.3 V
R1501J064B	A 1 J 0 6 4 B	6.4 V
R1501J065B	A 1 J 0 6 5 B	6.5 V
R1501J066B	A 1 J 0 6 6 B	6.6 V
R1501J067B	A 1 J 0 6 7 B	6.7 V
R1501J068B	A 1 J 0 6 8 B	6.8 V
R1501J069B	A 1 J 0 6 9 B	6.9 V

Product Name	①②③④⑤⑥⑦⑧	V <sub>SET</sub>
R1501H070B	A 1 J 0 7 0 B	7.0 V
R1501J071B	A 1 J 0 7 1 B	7.1 V
R1501J072B	A 1 J 0 7 2 B	7.2 V
R1501J073B	A 1 J 0 7 3 B	7.3 V
R1501J074B	A 1 J 0 7 4 B	7.4 V
R1501J075B	A 1 J 0 7 5 B	7.5 V
R1501J076B	A 1 J 0 7 6 B	7.6 V
R1501J077B	A 1 J 0 7 7 B	7.7 V
R1501J078B	A 1 J 0 7 8 B	7.8 V
R1501J079B	A 1 J 0 7 9 B	7.9 V
R1501J080B	A 1 J 0 8 0 B	8.0 V
R1501J081B	A 1 J 0 8 1 B	8.1 V
R1501J082B	A 1 J 0 8 2 B	8.2 V
R1501J083B	A 1 J 0 8 3 B	8.3 V
R1501J084B	A 1 J 0 8 4 B	8.4 V
R1501J085B	A 1 J 0 8 5 B	8.5 V
R1501J086B	A 1 J 0 8 6 B	8.6 V
R1501J087B	A 1 J 0 8 7 B	8.7 V
R1501J088B	A 1 J 0 8 8 B	8.8 V
R1501J089B	A 1 J 0 8 9 B	8.9 V
R1501J090B	A 1 J 0 9 0 B	9.0 V
R1501J091B	A 1 J 0 9 1 B	9.1 V
R1501J092B	A 1 J 0 9 2 B	9.2 V
R1501J093B	A 1 J 0 9 3 B	9.3 V
R1501J094B	A 1 J 0 9 4 B	9.4 V
R1501J095B	A 1 J 0 9 5 B	9.5 V
R1501J096B	A 1 J 0 9 6 B	9.6 V
R1501J097B	A 1 J 0 9 7 B	9.7 V
R1501J098B	A 1 J 0 9 8 B	9.8 V
R1501J099B	A 1 J 0 9 9 B	9.9 V
R1501J100B	A 1 J 1 0 0 B	10.0 V
R1501J101B	A 1 J 1 0 1 B	10.1 V
R1501J102B	A 1 J 1 0 2 B	10.2 V
R1501J103B	A 1 J 1 0 3 B	10.3 V
R1501J104B	A 1 J 1 0 4 B	10.4 V
R1501J105B	A 1 J 1 0 5 B	10.5 V
R1501J106B	A 1 J 1 0 6 B	10.6 V
R1501J107B	A 1 J 1 0 7 B	10.7 V
R1501J108B	A 1 J 1 0 8 B	10.8 V
R1501J109B	A 1 J 1 0 9 B	10.9 V

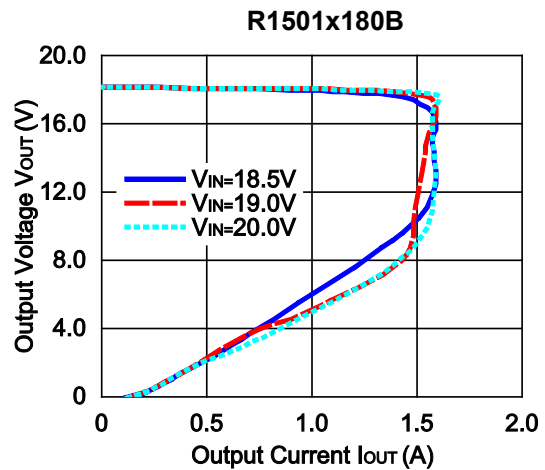
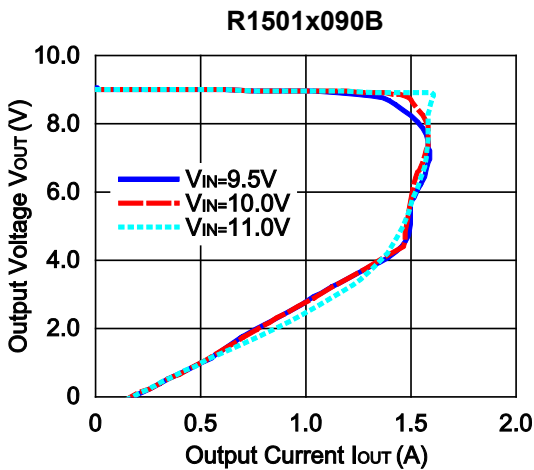
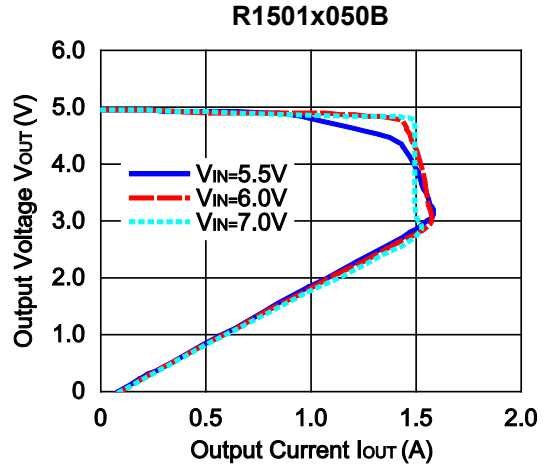
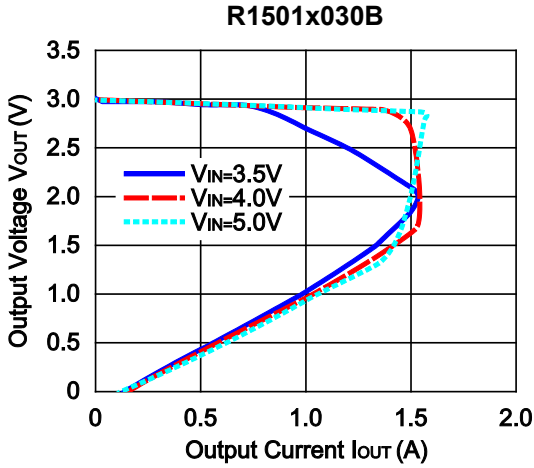
Product Name	①②③④⑤⑥⑦⑧	V <sub>SET</sub>
R1501J110B	A 1 J 1 1 0 B	11.0 V
R1501J111B	A 1 J 1 1 1 B	11.1 V
R1501J112B	A 1 J 1 1 2 B	11.2 V
R1501J113B	A 1 J 1 1 3 B	11.3 V
R1501J114B	A 1 J 1 1 4 B	11.4 V
R1501J115B	A 1 J 1 1 5 B	11.5 V
R1501J116B	A 1 J 1 1 6 B	11.6 V
R1501J117B	A 1 J 1 1 7 B	11.7 V
R1501J118B	A 1 J 1 1 8 B	11.8 V
R1501J119B	A 1 J 1 1 9 B	11.9 V
R1501J120B	A 1 J 1 2 0 B	12.0 V
R1501J125B	A 1 J 1 2 5 B	12.5 V
R1501J130B	A 1 J 1 3 0 B	13.0 V
R1501J135B	A 1 J 1 3 5 B	13.5 V
R1501J140B	A 1 J 1 4 0 B	14.0 V
R1501J145B	A 1 J 1 4 5 B	14.5 V
R1501J150B	A 1 J 1 5 0 B	15.0 V
R1501J155B	A 1 J 1 5 5 B	15.5 V
R1501J160B	A 1 J 1 6 0 B	16.0 V
R1501J165B	A 1 J 1 6 5 B	16.5 V
R1501J170B	A 1 J 1 7 0 B	17.0 V
R1501J175B	A 1 J 1 7 5 B	17.5 V
R1501J180B	A 1 J 1 8 0 B	18.0 V

**TYPICAL CHARACTERISTICS**

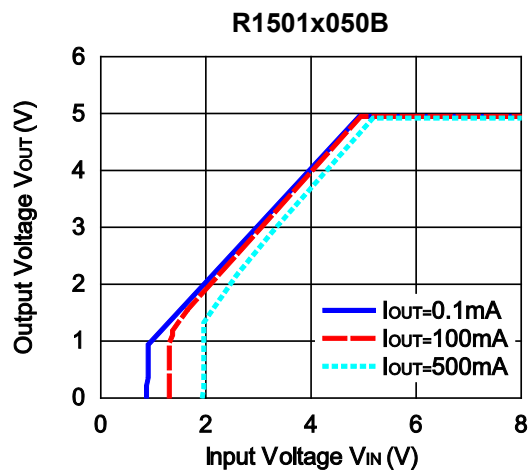
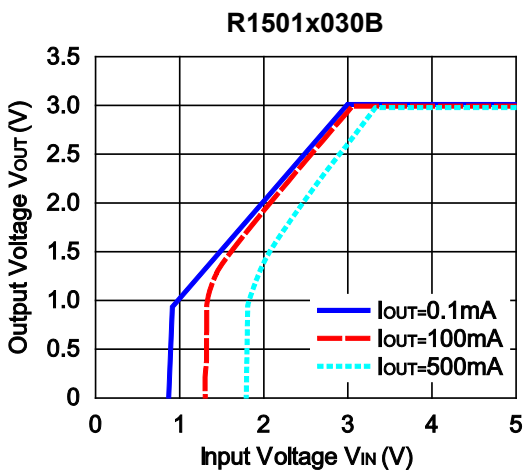
Ta = 25°C, unless otherwise noted.

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

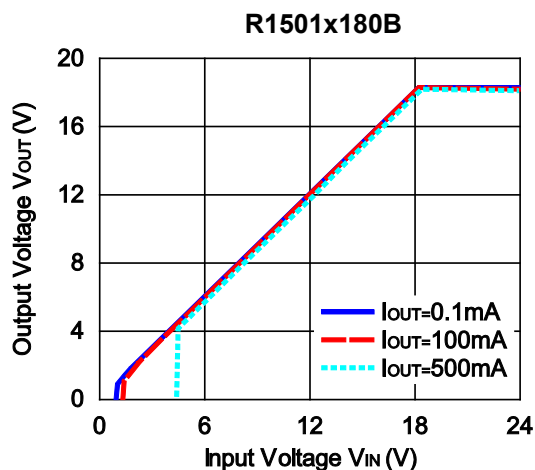
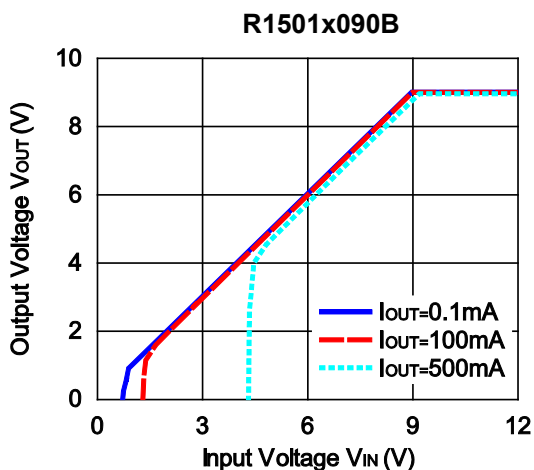
**1) Output Voltage vs. Output Current (C<sub>IN</sub> = Ceramic 0.47 μF, C<sub>OUT</sub> = Ceramic 10 μF)**



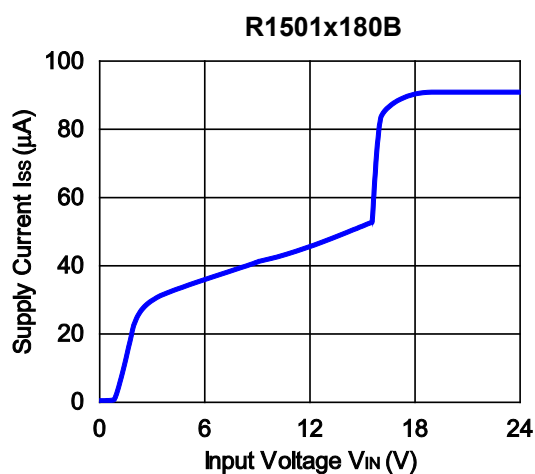
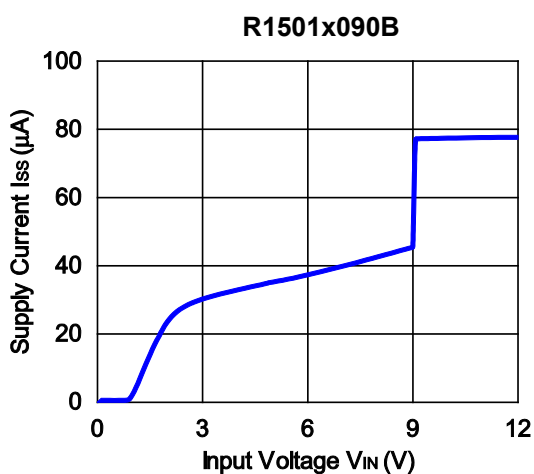
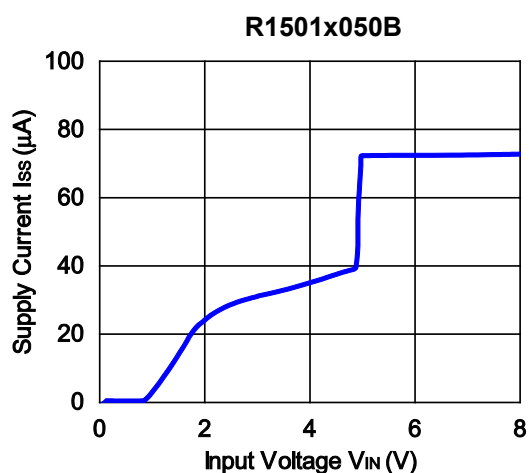
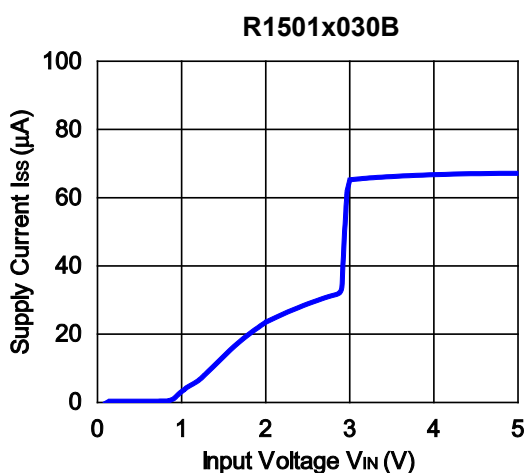
**2) Output Voltage vs. Input Voltage (C<sub>IN</sub> = Ceramic 0.47 μF, C<sub>OUT</sub> = Ceramic 10 μF)**







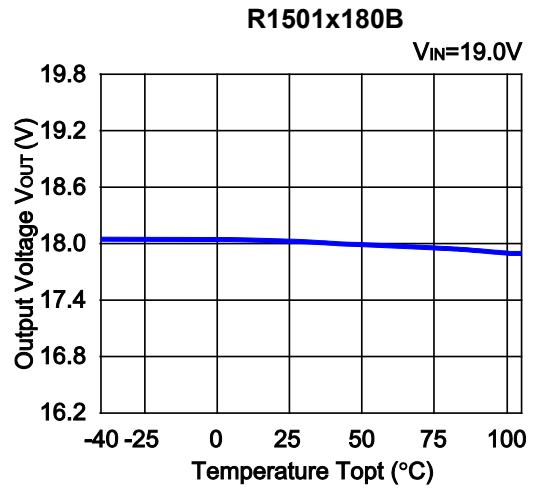
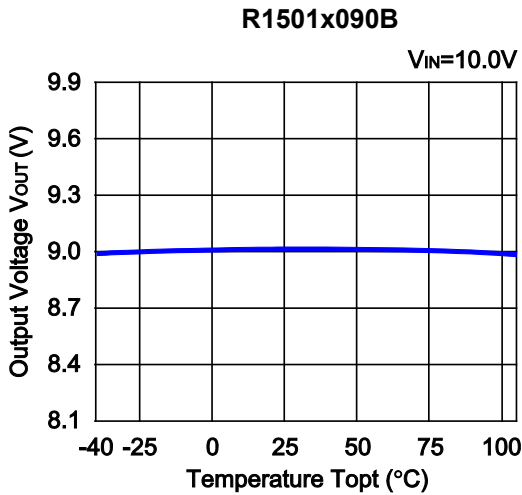
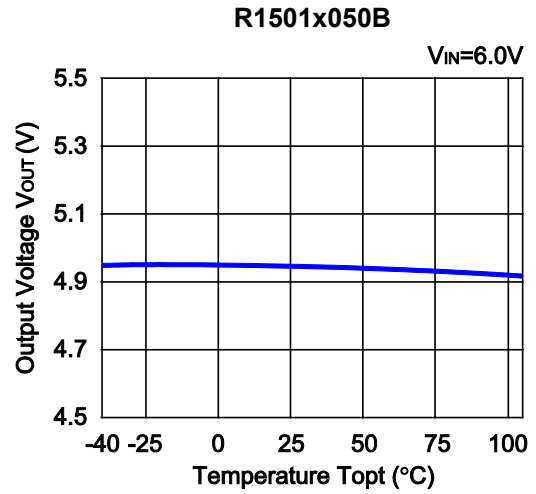
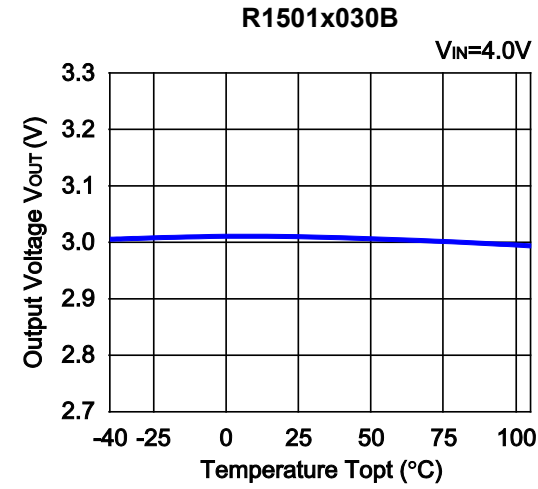
3) Supply Current vs. Input Voltage ( $C_{IN}$  = Ceramic 0.47  $\mu$ F,  $C_{OUT}$  = Ceramic 10  $\mu$ F)



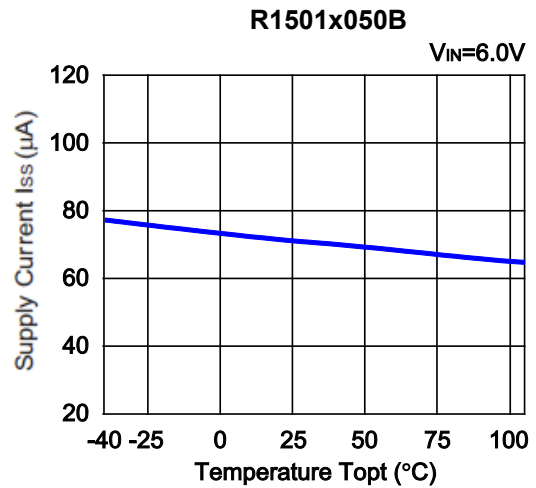
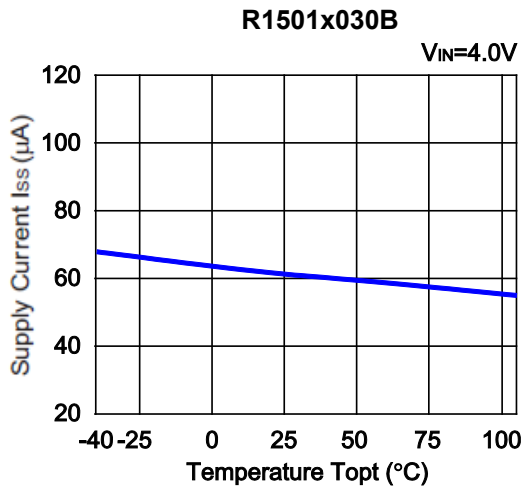
# R1501x

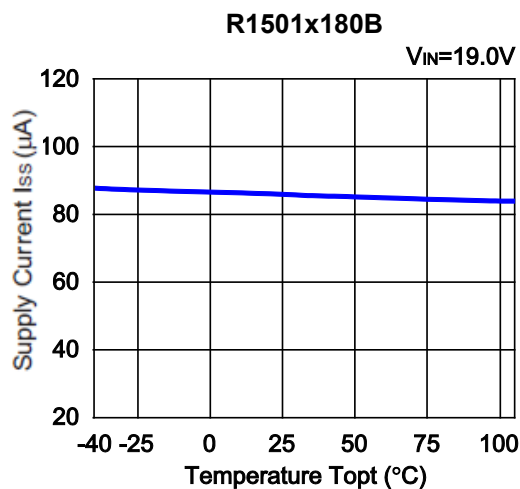
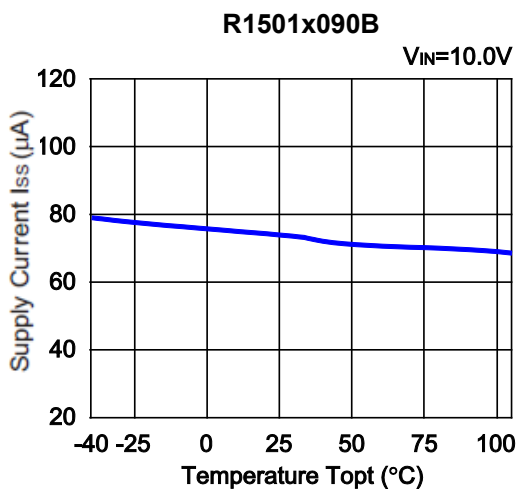
NO.EC-184-160801

## 4) Output Voltage vs. Temperature ( $C_{IN}$ = Ceramic 0.47 $\mu$ F, $C_{OUT}$ = Ceramic 10 $\mu$ F, $I_{OUT}$ = 1 mA)

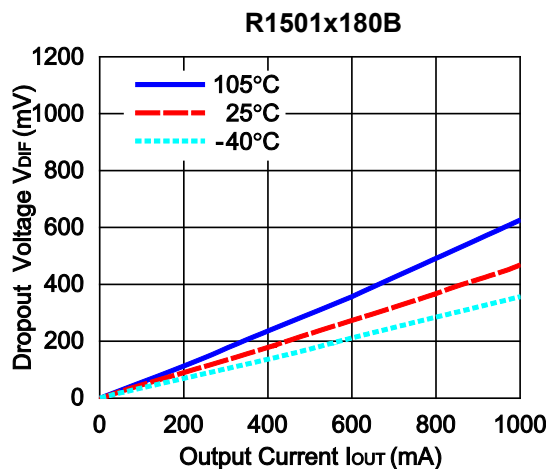
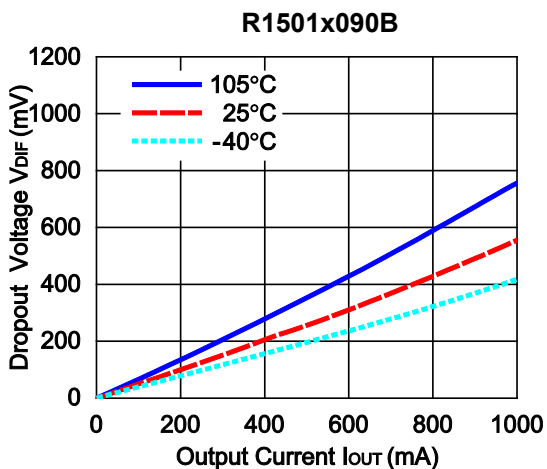
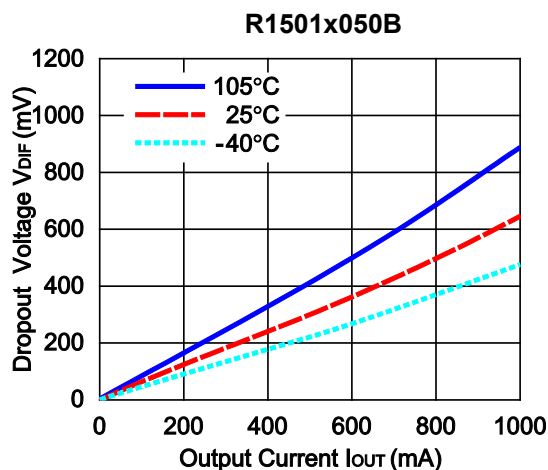
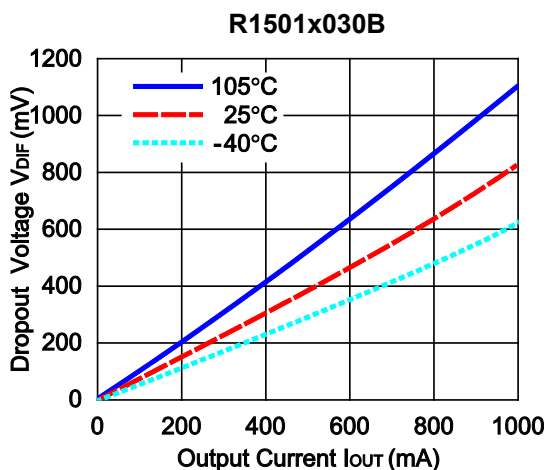


## 5) Supply Current vs. Temperature ( $C_{IN}$ = Ceramic 0.47 $\mu$ F, $C_{OUT}$ = Ceramic 10 $\mu$ F, $I_{OUT}$ = 0 mA)

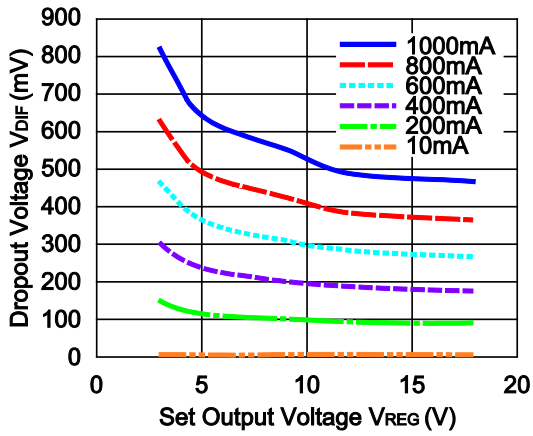




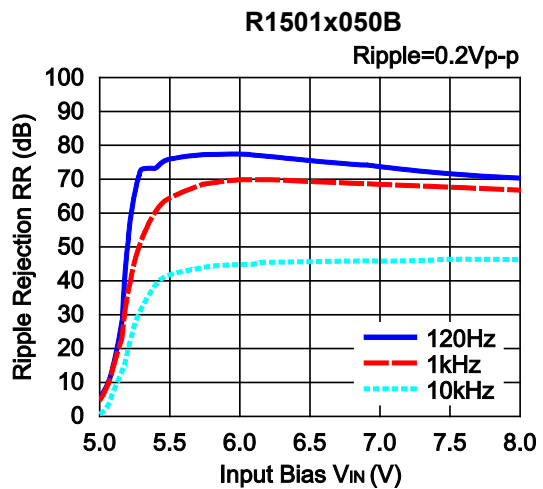
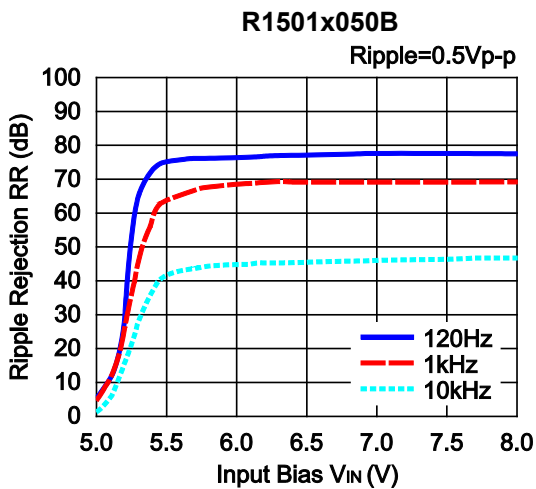
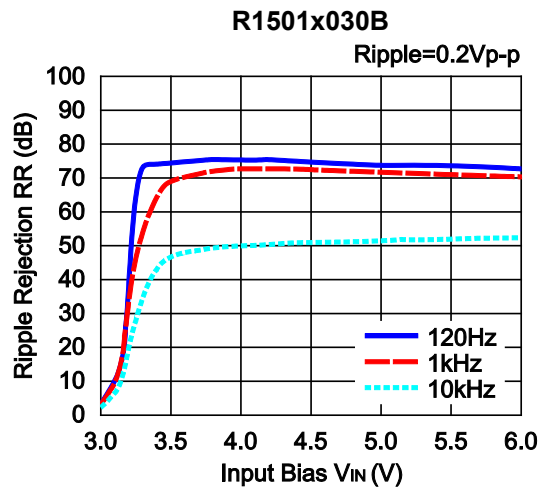
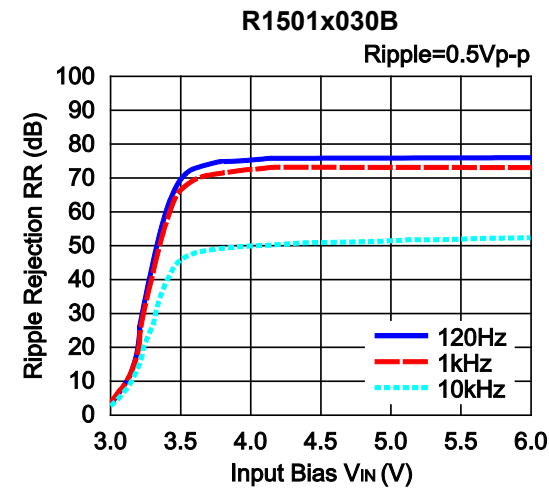
6) Dropout Voltage vs. Output Current ( $C_{IN}$  = Ceramic 0.47  $\mu F$ ,  $C_{OUT}$  = Ceramic 10  $\mu F$ )



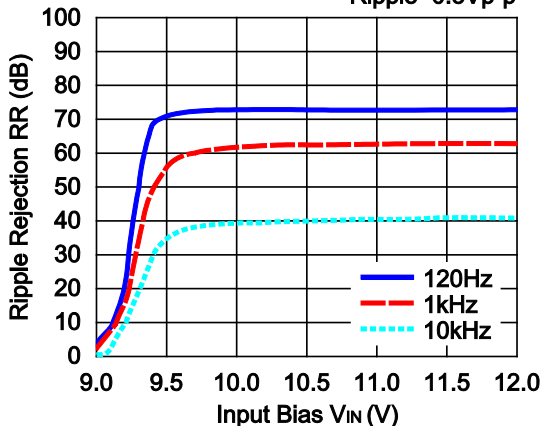
**7) Dropout Voltage vs. Set Output Voltage ( $C_{IN}$  = Ceramic 0.47  $\mu$ F,  $C_{OUT}$  = Ceramic 10  $\mu$ F)**



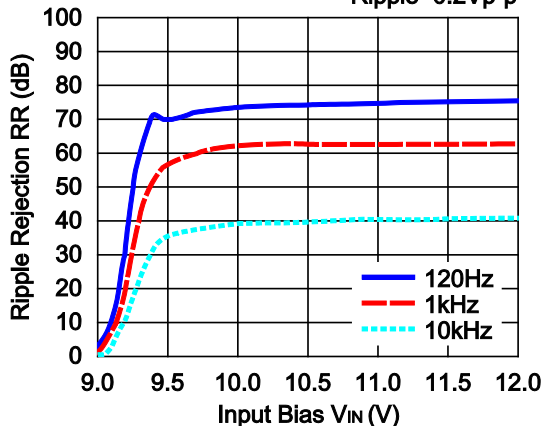
**8) Ripple Rejection vs. Input Bias Voltage ( $C_{IN}$  = none,  $C_{OUT}$  = Ceramic 10  $\mu$ F,  $I_{OUT}$  = 100 mA)**



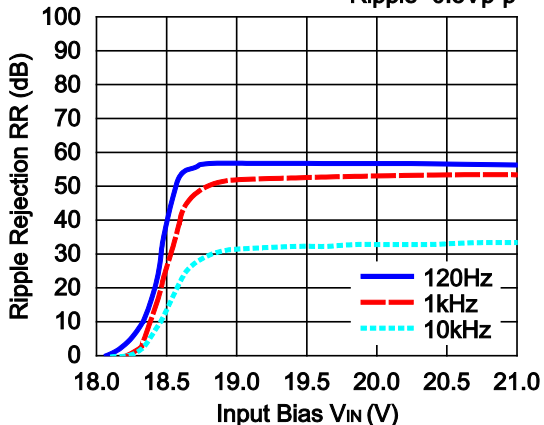
**R1501x090B**  
Ripple=0.5Vp-p



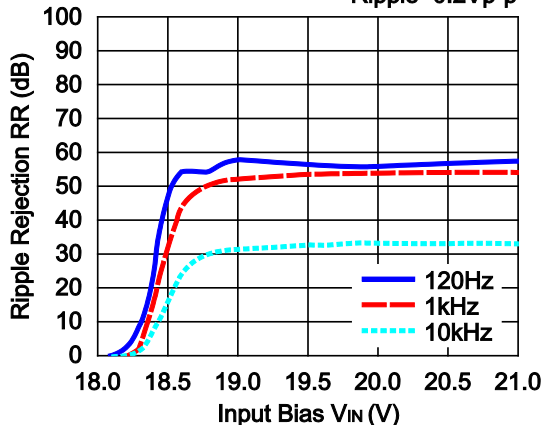
**R1501x090B**  
Ripple=0.2Vp-p



**R1501x180B**  
Ripple=0.5Vp-p

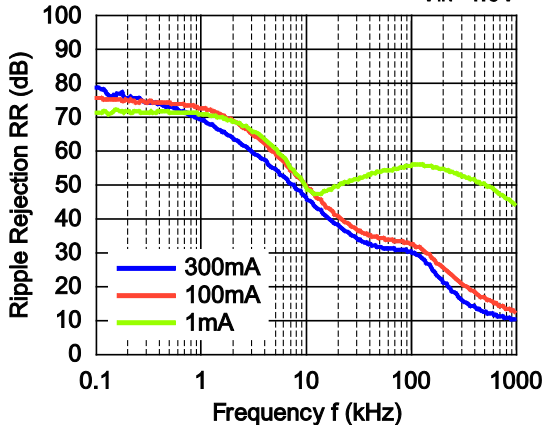


**R1501x180B**  
Ripple=0.2Vp-p

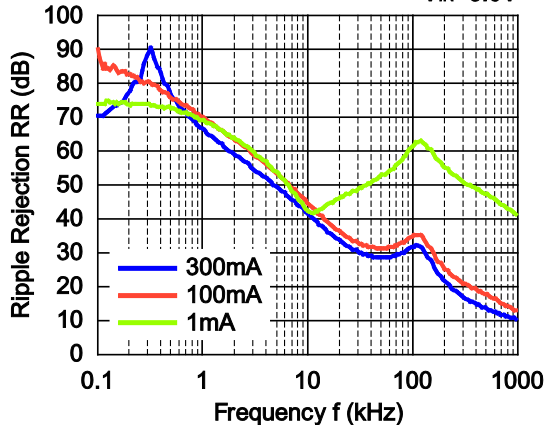


9) Ripple Rejection vs. Frequency ( $C_{IN}$  = none,  $C_{OUT}$  = Ceramic 10  $\mu$ F, Ripple = 0.5 Vp-p)

**R1501x030B**  
 $V_{IN}=4.0V$

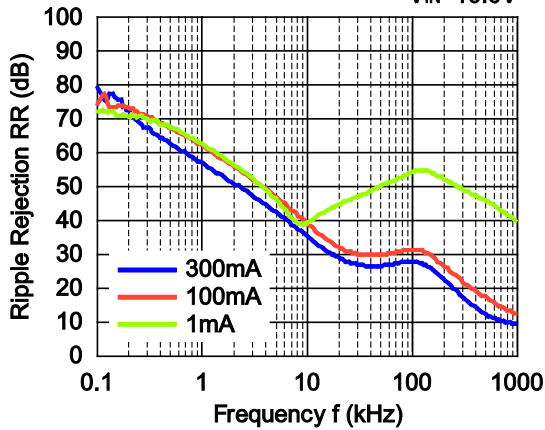


**R1501x050B**  
 $V_{IN}=6.0V$



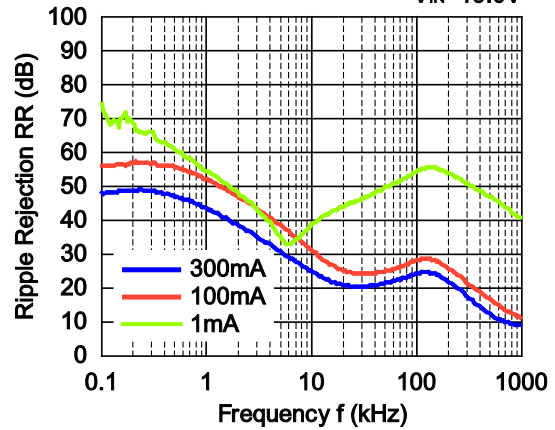
R1501x090B

$V_{IN}=10.0V$



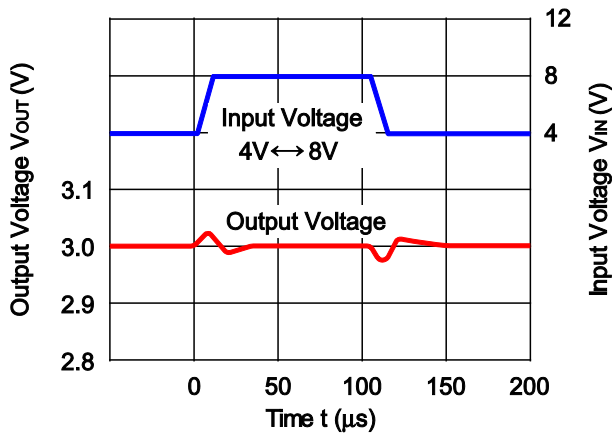
R1501x180B

$V_{IN}=19.0V$

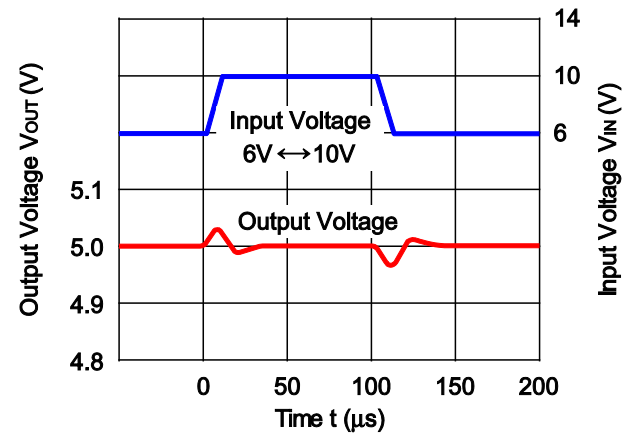


10) Input Transient Response ( $C_{IN}$  = none,  $C_{OUT}$  = Ceramic 10  $\mu F$ ,  $I_{OUT}$  = 100 mA,  $t_r = t_f = 10 \mu s$ )

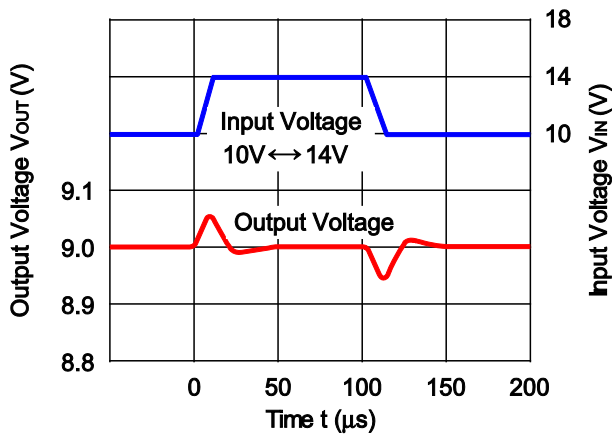
R1501x030B



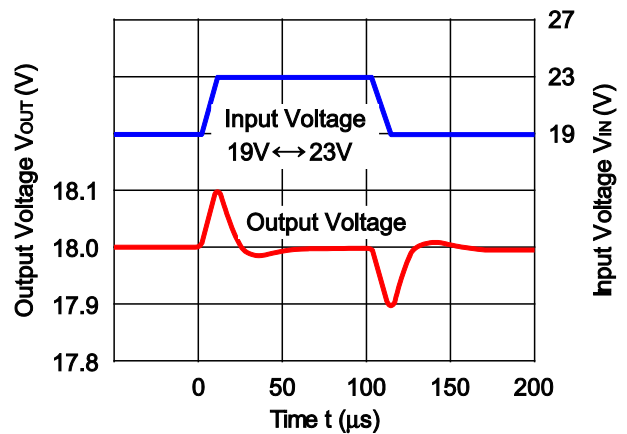
R1501x050B



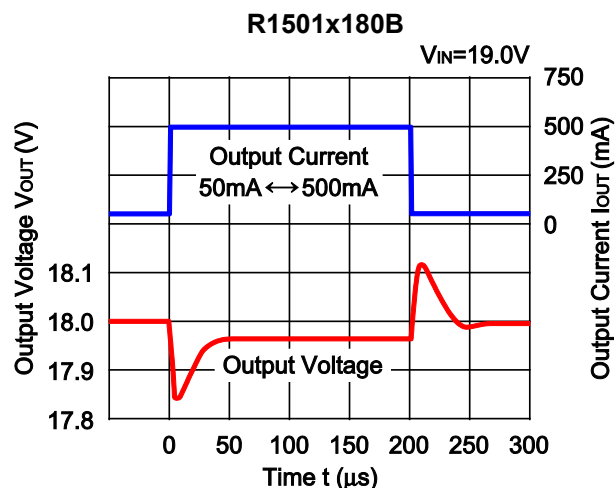
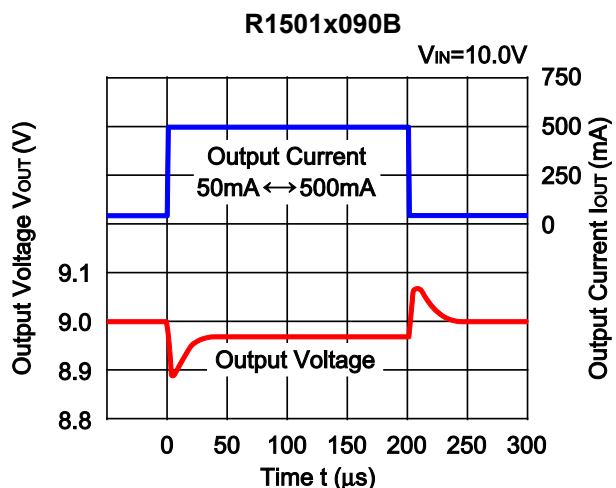
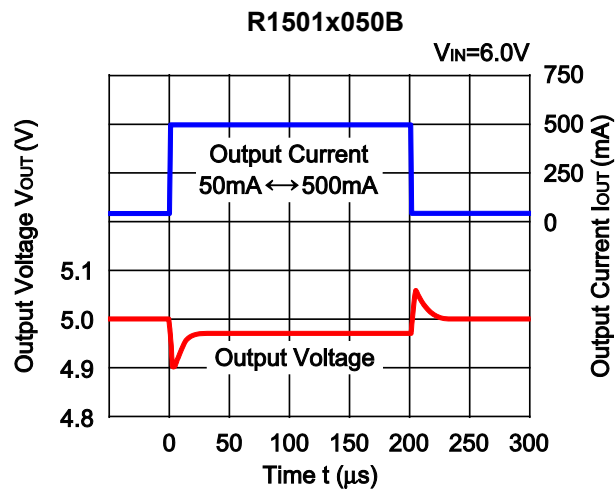
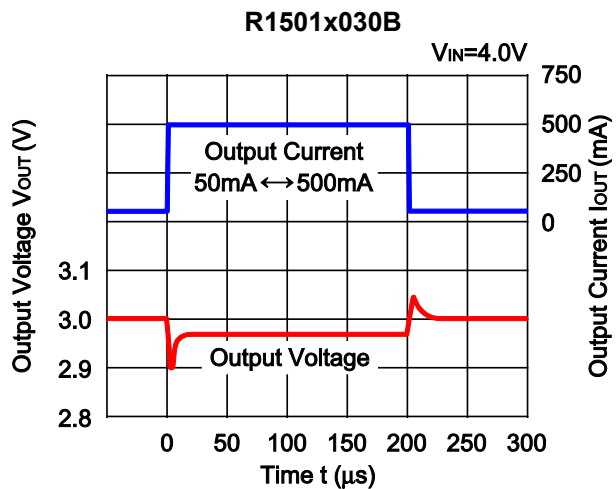
R1501x090B



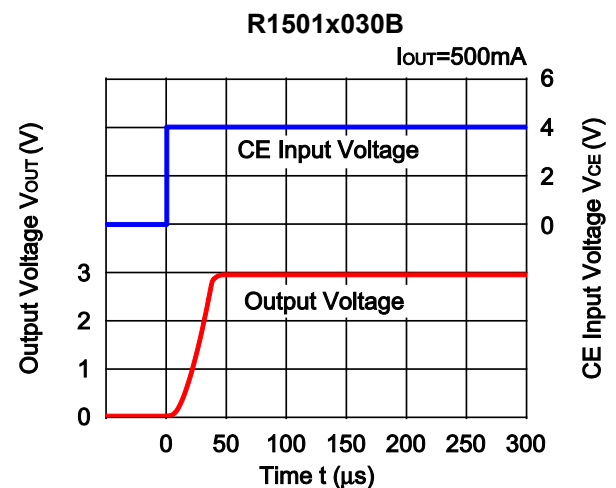
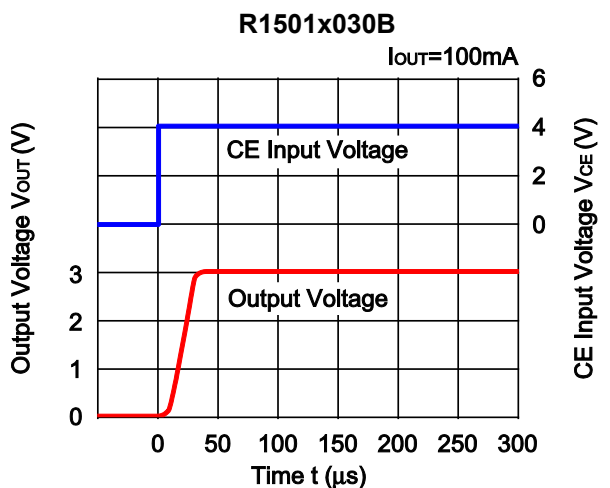
R1501x180B

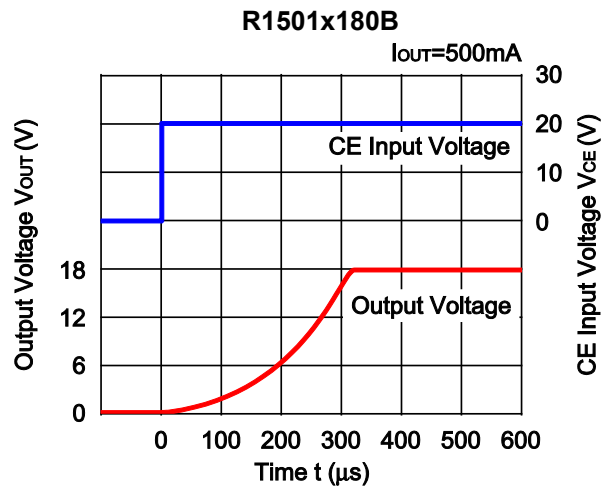
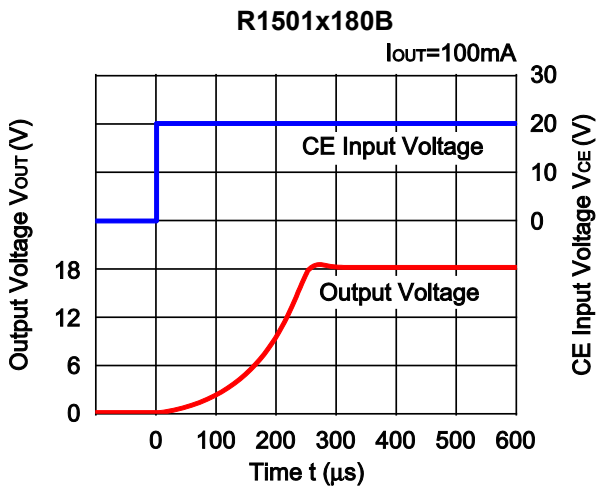
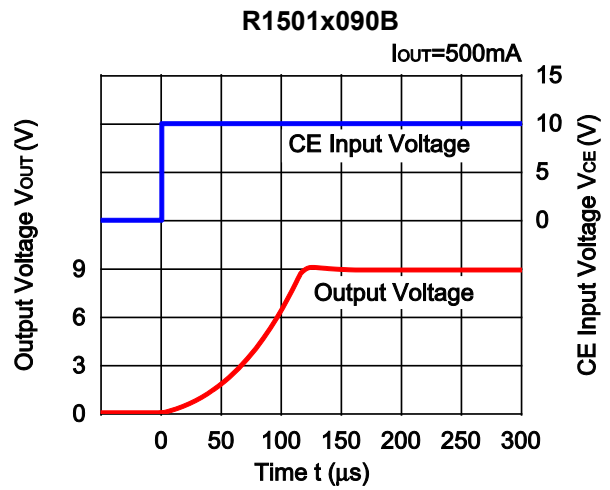
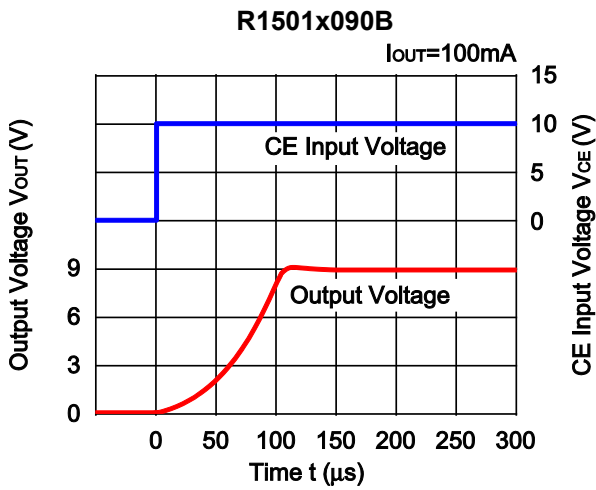
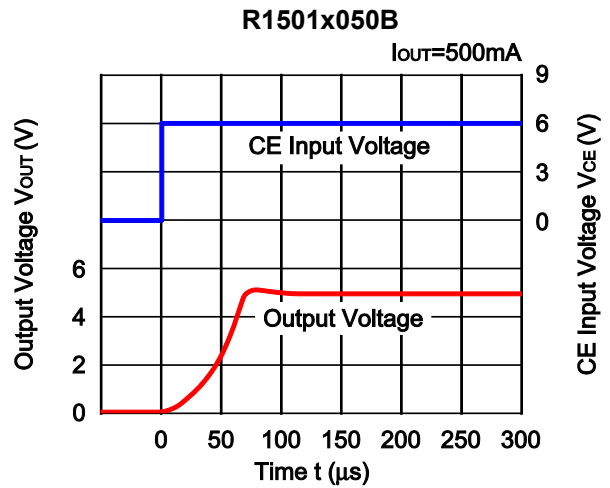
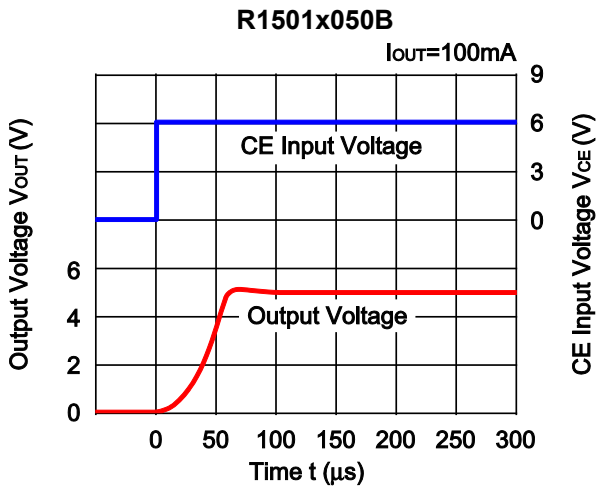


11) Load Transient Response ( $C_{IN}$  = Ceramic 0.47  $\mu$ F,  $C_{OUT}$  = Ceramic 10  $\mu$ F,  $t_r$  =  $t_f$  = 0.5  $\mu$ s)



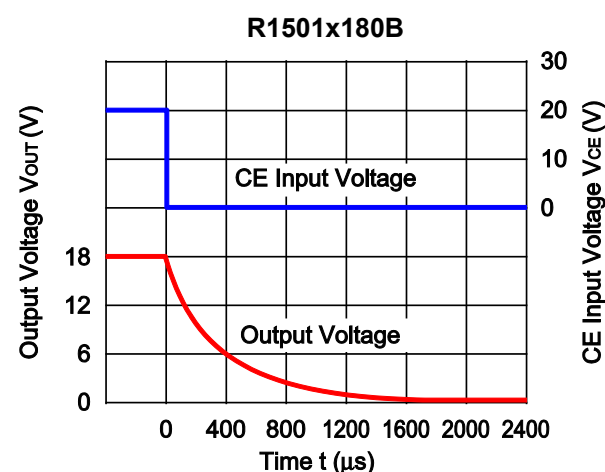
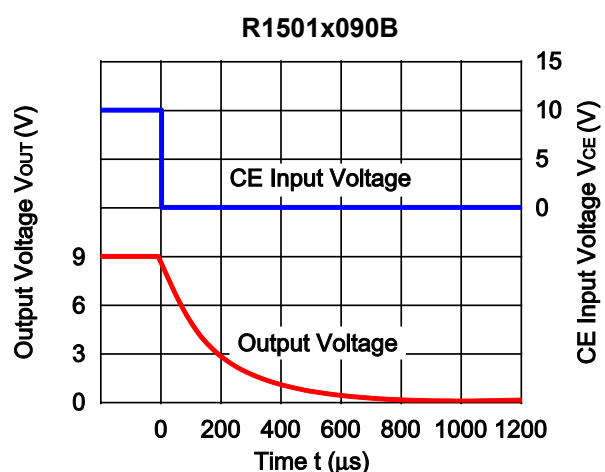
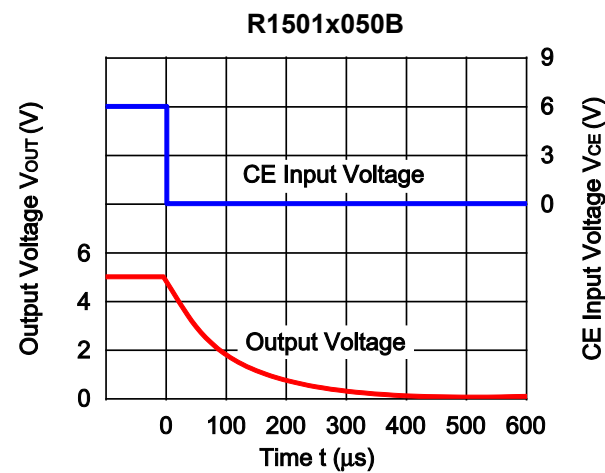
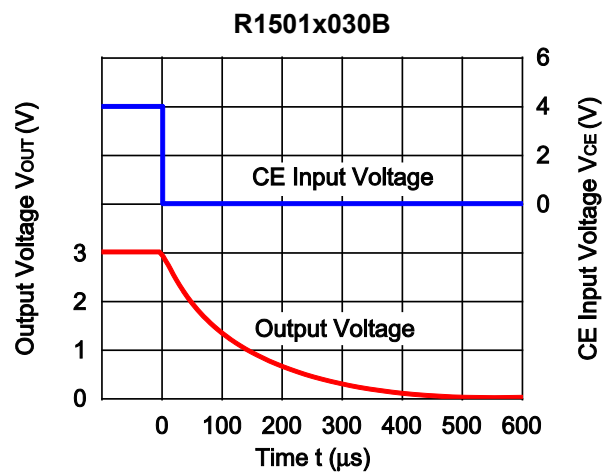
12) Turn On Speed with CE pin ( $C_{IN}$  = Ceramic 0.47  $\mu$ F,  $C_{OUT}$  = Ceramic 10  $\mu$ F,  $t_r$  =  $t_f$  = 0.5  $\mu$ s)







13) Turn Off Speed with CE ( $C_{IN}$  = Ceramic 0.47  $\mu$ F,  $C_{OUT}$  = Ceramic 10  $\mu$ F,  $I_{OUT}$  = 500 mA,  $t_r$  =  $t_f$  = 0.5  $\mu$ s)



## ESR vs. Output Current

When using this IC, consider the following points:

The relations between  $I_{OUT}$  (Output Current) and ESR of an output capacitor are shown below. The conditions when the white noise level is less than or equal to the specified value are marked as the hatched area in the graph.

### Measurement conditions

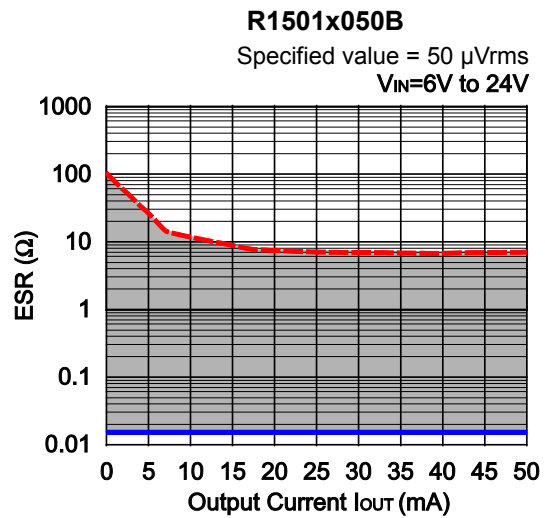
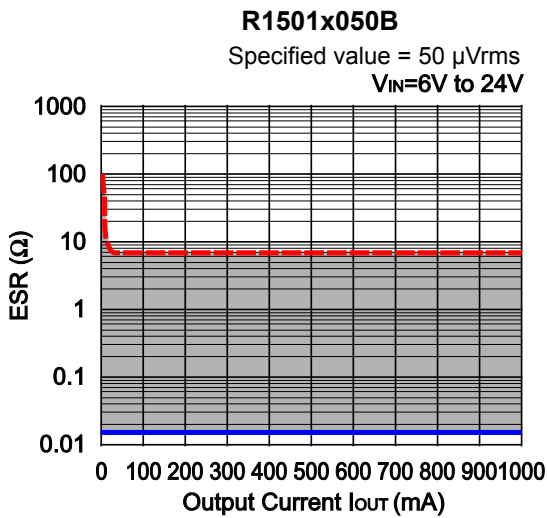
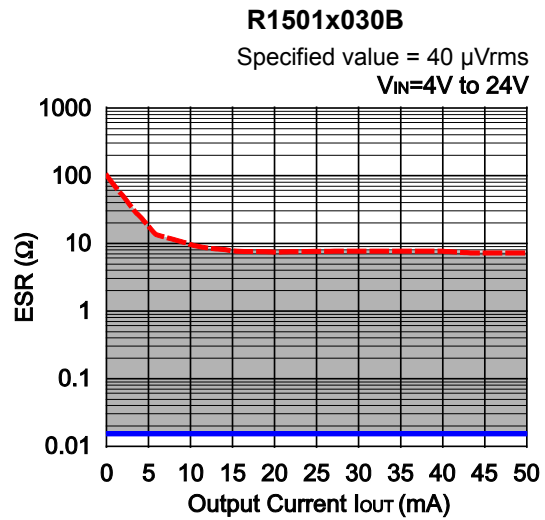
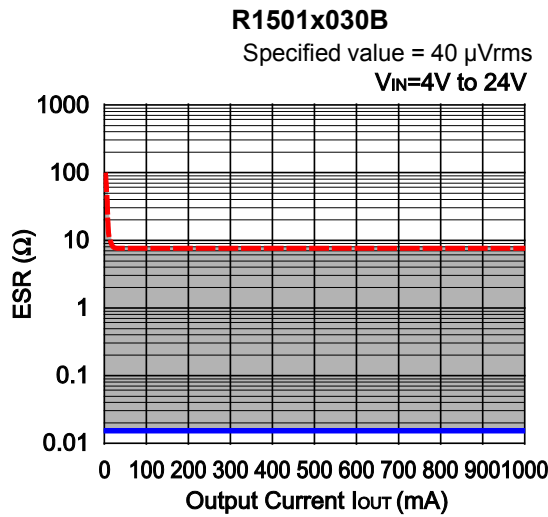
Input Voltage:  $V_{OUT} + 1\text{ V}$  to 24 V

Frequency Band: 10 Hz to 1 MHz

Temperature:  $-40^{\circ}\text{C}$  to  $105^{\circ}\text{C}$

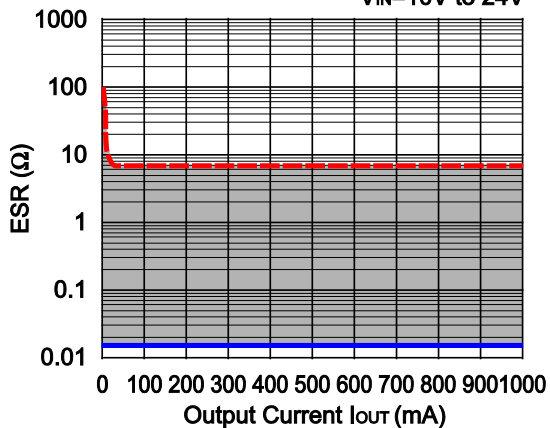
Capacitor:  $C_{IN}$  = Ceramic 0.47  $\mu\text{F}$

$C_{OUT}$  = Ceramic 10  $\mu\text{F}$



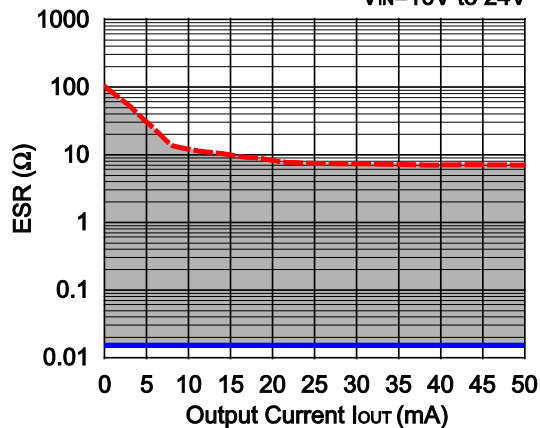
**R1501x090B**

Specified value = 120  $\mu$ Vrms  
 $V_{IN}$ =10V to 24V



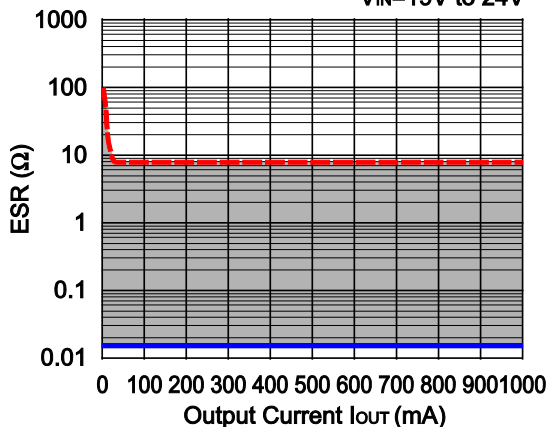
**R1501x090B**

Specified value = 120  $\mu$ Vrms  
 $V_{IN}$ =10V to 24V



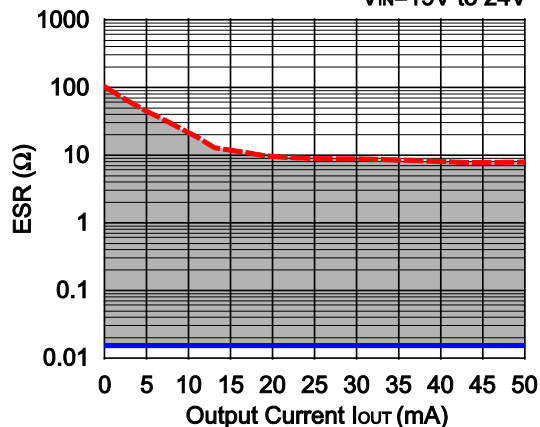
**R1501x180B**

Specified value = 220  $\mu$ Vrms  
 $V_{IN}$ =19V to 24V



**R1501x180B**

Specified value = 220  $\mu$ Vrms  
 $V_{IN}$ =19V to 24V





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