

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°C to 105°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.

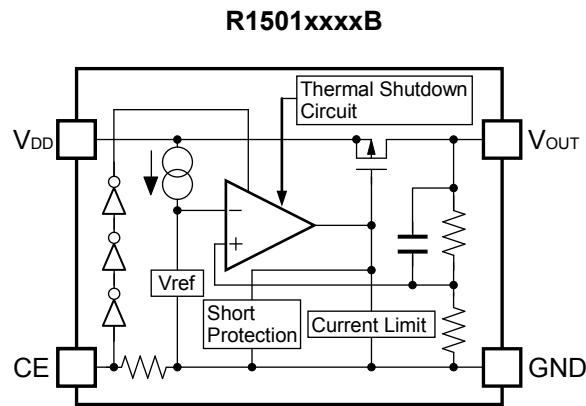
FEATURES

- Supply Current (I_{SS}) Typ. 70 μA
- Standby Current ($I_{standby}$) Typ. 0.1 μA
- 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°C to 105°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



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

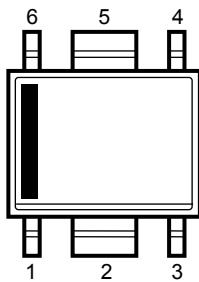
	Operating Temperature Range	Guaranteed Specs Temperature Range	Screening
A	-40°C to 105°C	25°C	High temperature
J	-40°C to 105°C	-40°C to 105°C	High and low temperature

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

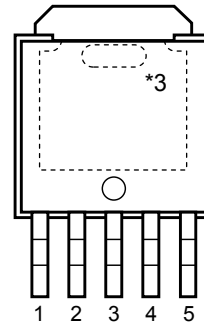
Product Name	Automotive Class Code	
	A	J
R1501SxxxB-E2-AE	✓	
R1501JxxxB-T1-#E	✓	✓

PIN DESCRIPTIONS

HSOP-6J



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	Chip Enable Pin, Active-high.
5	GND ^{*1}	Ground Pin
6	V_{OUT}	Output Pin

^{*1} 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 ^{*2}	Ground Pin
3	GND ^{*2}	Ground Pin
4	CE	Chip Enable Pin, Active-high.
5	V_{OUT}	Output Pin

^{*2} When mounting to board, connect between two GND pins by wiring.

^{*3} 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)		$-0.3 \text{ to } V_{IN} + 0.3 \leq 36$	V
V_{OUT}	Output Voltage		$-0.3 \text{ to } V_{IN} + 0.3 \leq 36$	V
P_D	Power Dissipation (HSOP-6J)* ¹	Standard Land Pattern	2100	mW
		Ultra High Wattage Land Pattern	3400	
	Power Dissipation (TO-252-5-P2)* ¹	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

*¹ 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)

(Ta = 25°C)

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V _{OUT}	Output Voltage	I _{OUT} = 1 mA	Ta = 25°C	x0.98		x1.02	V
			-40°C ≤ Ta ≤ 105°C	x0.965		x1.035	V
I _{SS}	Supply Current	V _{IN} = 24 V, I _{OUT} = 0 A			70	160	μA
I _{standby}	Standby Current	V _{IN} = 24 V, V _{CE} = 0 V			0.1	1.0	μA
ΔV _{OUT} /ΔI _{OUT}	Load Regulation	0.1 mA ≤ I _{OUT} ≤ 200 mA			25	60	mV
		0.1 mA ≤ I _{OUT} ≤ 1 A			125	300	mV
ΔV _{OUT} /ΔV _{IN}	Line Regulation	V _{SET} + 1 V ≤ V _{IN} ≤ 24 V, I _{OUT} = 10 mA			0.05	0.1	%/V
V _{DIF}	Dropout Voltage	I _{OUT} = 200 mA	3.0 V ≤ V _{SET} < 5.0 V		0.135	0.225	V
			5.0 V ≤ V _{SET} < 9.0 V		0.115	0.180	
			9.0 V ≤ V _{SET} < 12.0 V		0.095	0.155	
			12.0 V ≤ V _{SET} ≤ 18.0 V		0.090	0.140	
		I _{OUT} = 1 A	3.0 V ≤ V _{SET} < 5.0 V		0.675	1.125	V
			5.0 V ≤ V _{SET} < 9.0 V		0.575	0.900	
			9.0 V ≤ V _{SET} < 12.0 V		0.475	0.775	
			12.0 V ≤ V _{SET} ≤ 18.0 V		0.450	0.700	
I _{LIM}	Output Current			1			A
I _{SC}	Short Current Limit	V _{OUT} = 0 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		°C
T _{TSR}	Thermal Shutdown Released Temperature	Junction Temperature			135		°C

As all of units, all items except Load Regulation at 0.1 mA ≤ I_{OUT} ≤ 1 A and Dropout Voltage at I_{OUT} = 1 A are tested and specified under load conditions such as T_j ≈ T_a = 25°C.

R1501x

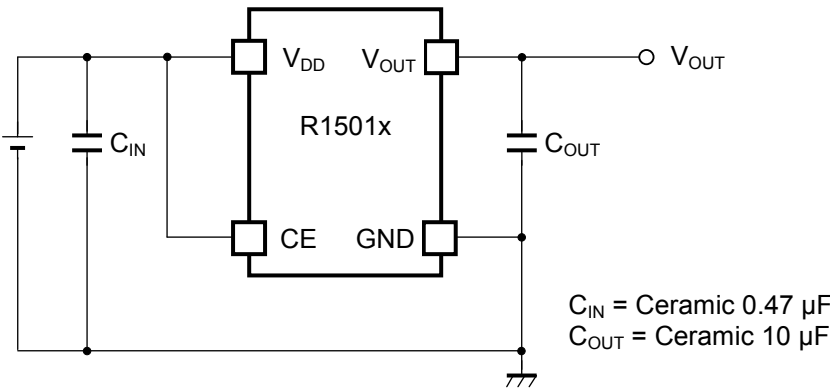
NO.EC-184-160801

 $V_{IN} = V_{SET} + 1.0\text{ V}$, $V_{CE} = V_{IN}$, 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	μA
$I_{standby}$	Standby Current	$V_{IN} = 24\text{ V}$, $V_{CE} = 0\text{ V}$			0.1	1.0	μA
$\Delta V_{OUT}/\Delta I_{OUT}$	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		$^{\circ}\text{C}$

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 μF	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 μF 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.

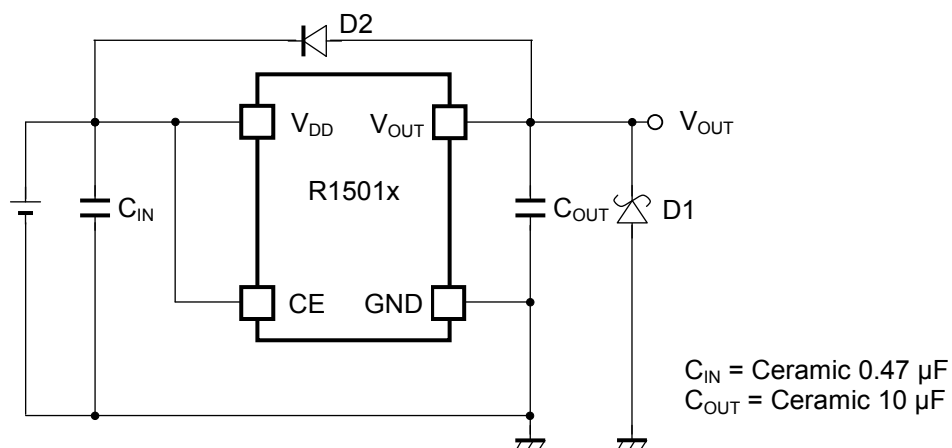
Phase Compensation

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_{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. To prevent damage to the device or the load devices, connecting a schottky diode ($D1$) between the V_{OUT} pin and GND is recommended.

In addition, connect $D2$ if V_{OUT} pin could be higher than V_{DD} pin.

C_{IN} and C_{OUT} 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.

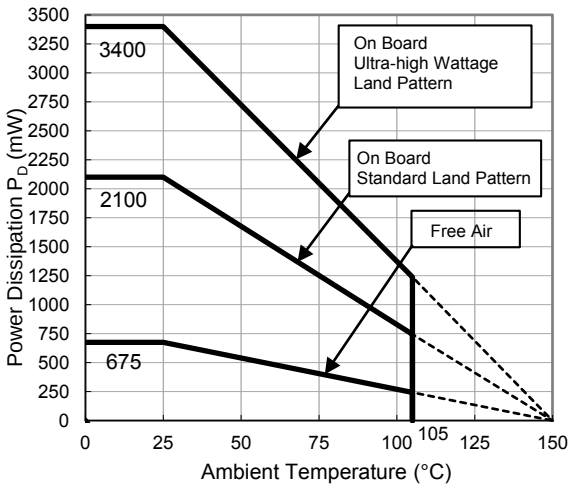
Measurement Conditions

	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

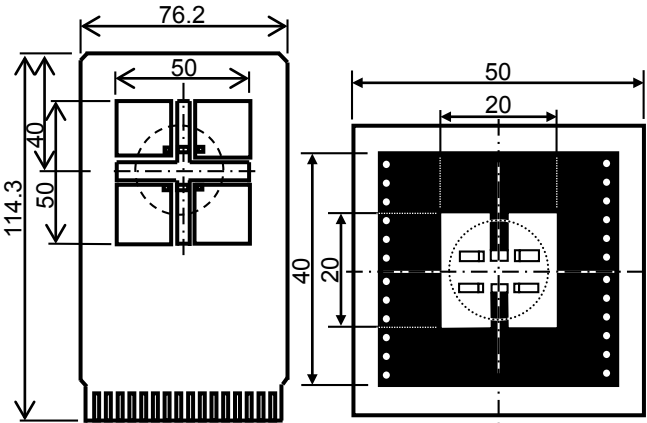
Measurement Result

(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



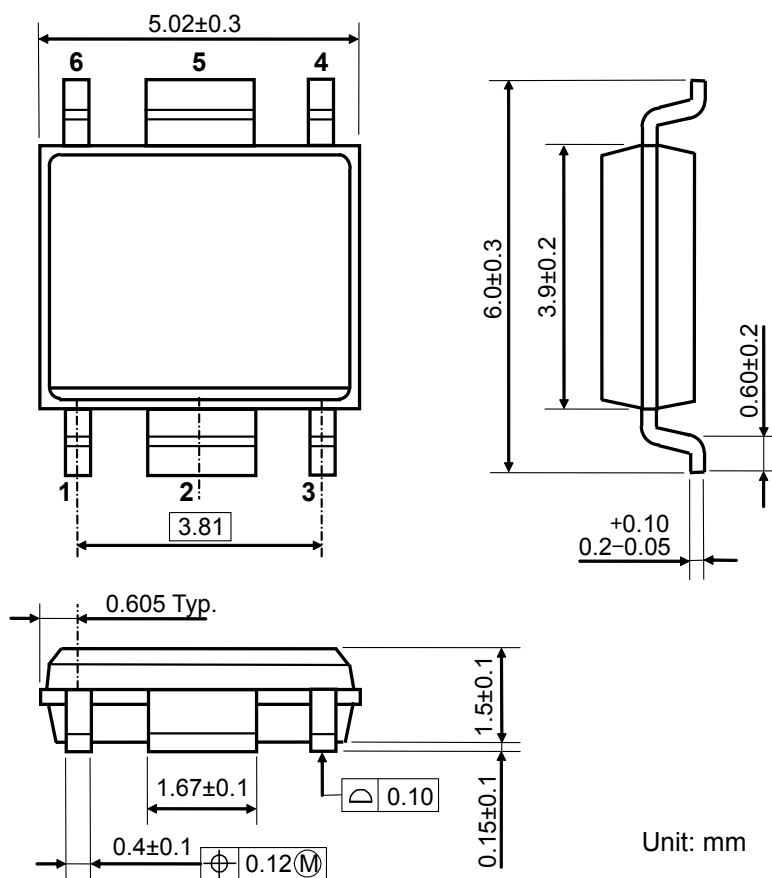
Power Dissipation vs. Ambient Temperature



IC Mount Area (mm)

Measurement Board Pattern

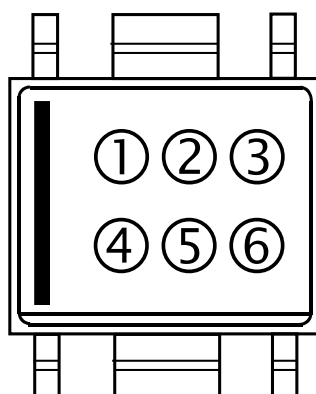
PACKAGE DIMENSIONS (HSOP-6J)



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 _{SET}	Product Name	①②③④	V _{SET}	Product Name	①②③④	V _{SET}
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:

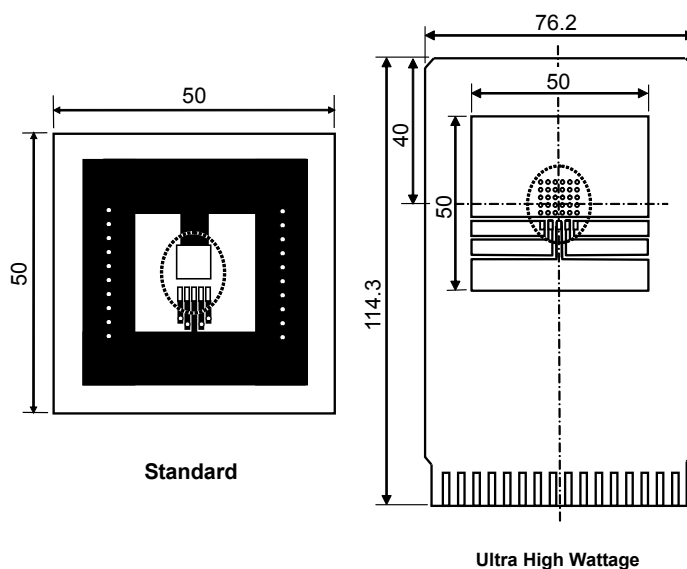
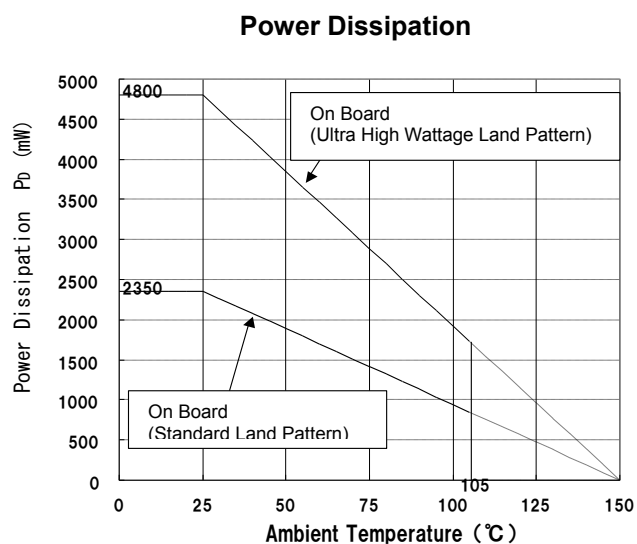
* Measurement conditions

	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	ϕ 0.5mm x 24pcs	ϕ 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)

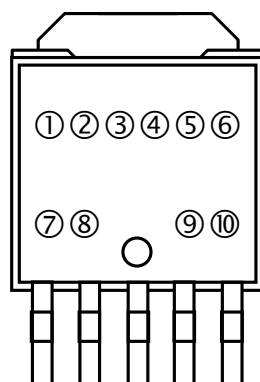
[illegible]

*) 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)

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 _{SET}
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 _{SET}
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

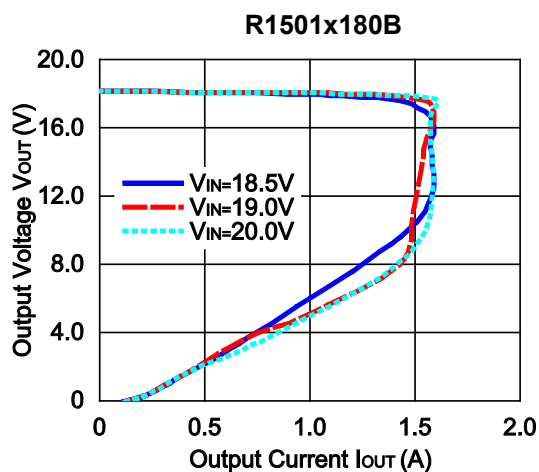
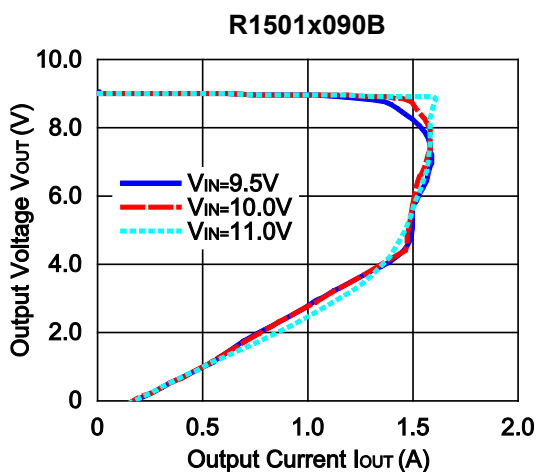
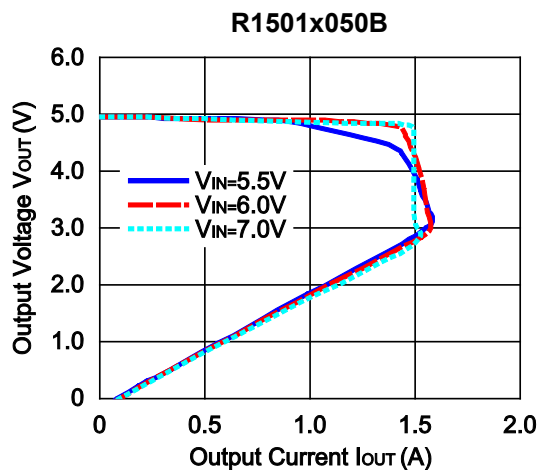
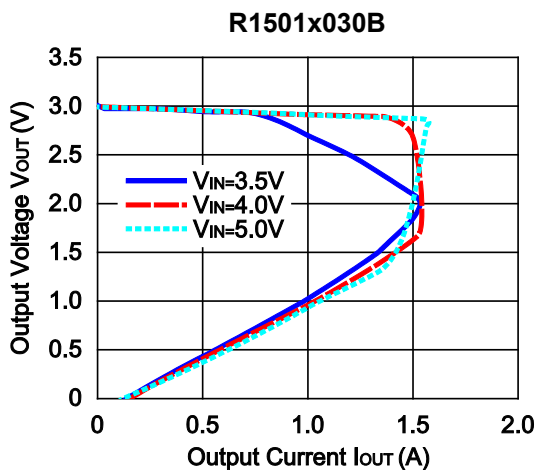
Product Name	①②③④⑤⑥⑦⑧	V _{SET}
R1501J110B	A 1 J 1 1 0 B	11.0 V
R1501J111B	A 1 J 1 1 1 B	11.1 V
R1501J112B	A 1 J 1 1 2 B	11.2 V
R1501J113B	A 1 J 1 1 3 B	11.3 V
R1501J114B	A 1 J 1 1 4 B	11.4 V
R1501J115B	A 1 J 1 1 5 B	11.5 V
R1501J116B	A 1 J 1 1 6 B	11.6 V
R1501J117B	A 1 J 1 1 7 B	11.7 V
R1501J118B	A 1 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

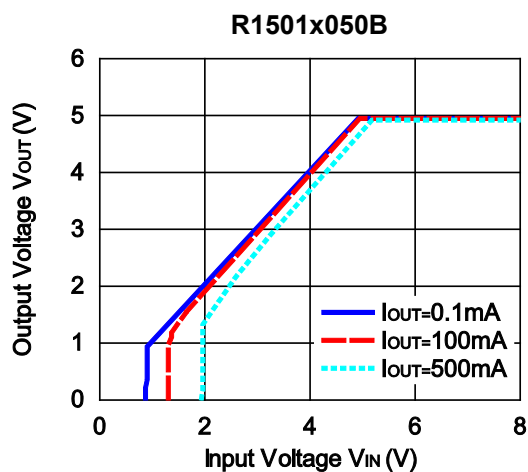
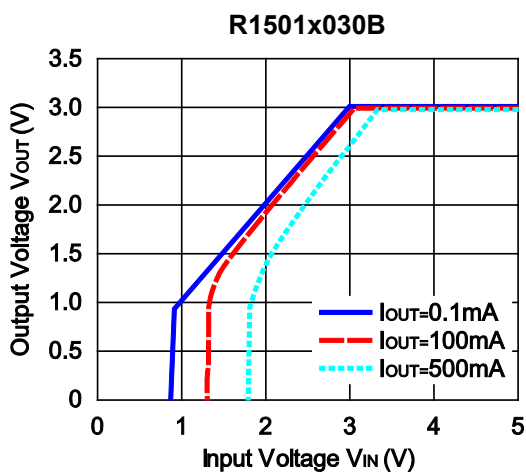
$T_a = 25^\circ\text{C}$, unless otherwise noted.

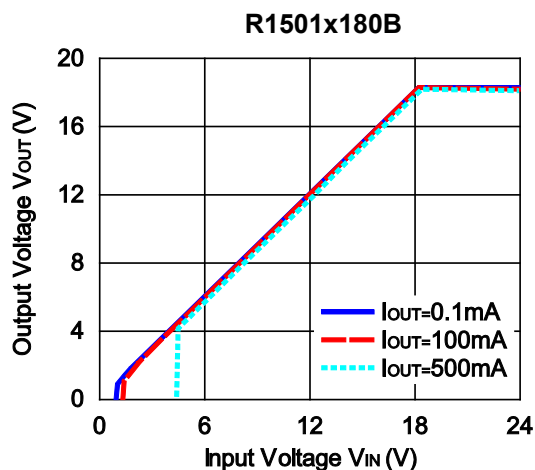
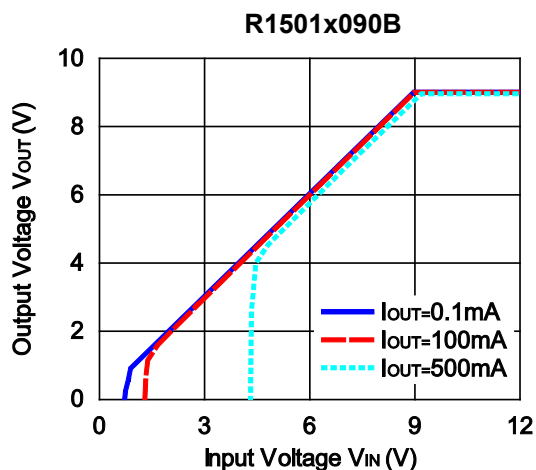
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

1) Output Voltage vs. Output Current (C_{IN} = Ceramic 0.47 μF , C_{OUT} = Ceramic 10 μF)

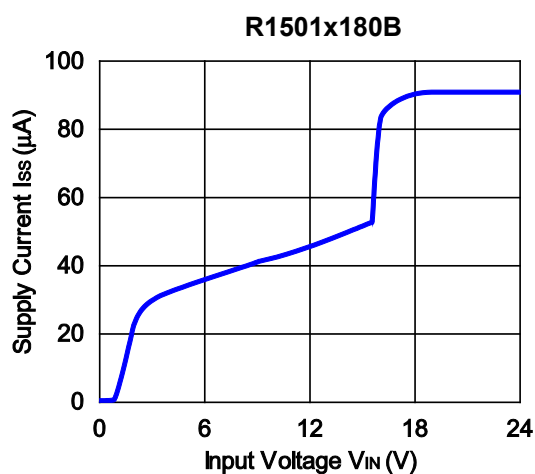
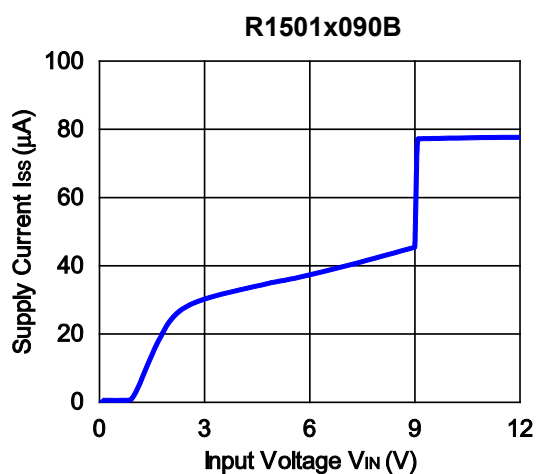
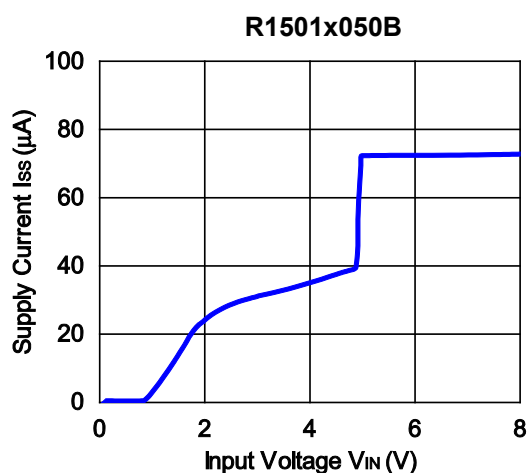
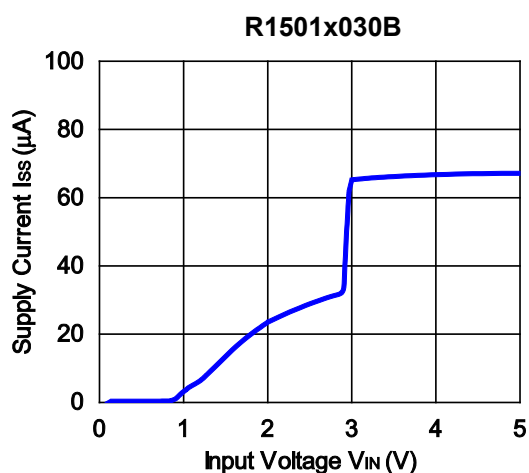


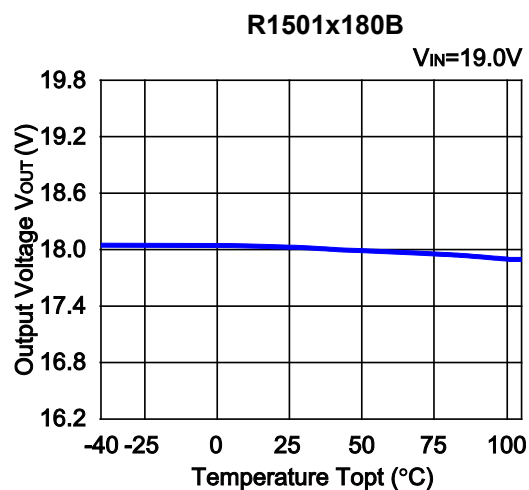
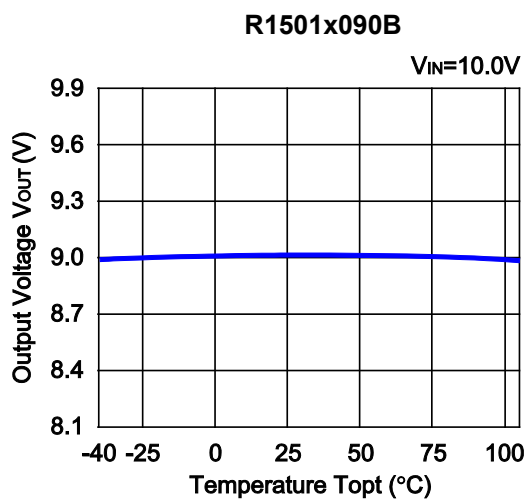
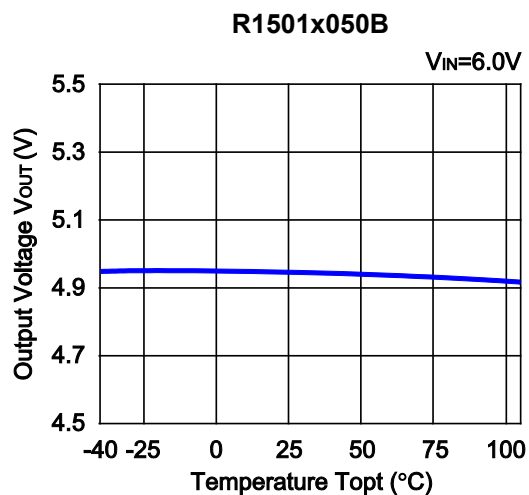
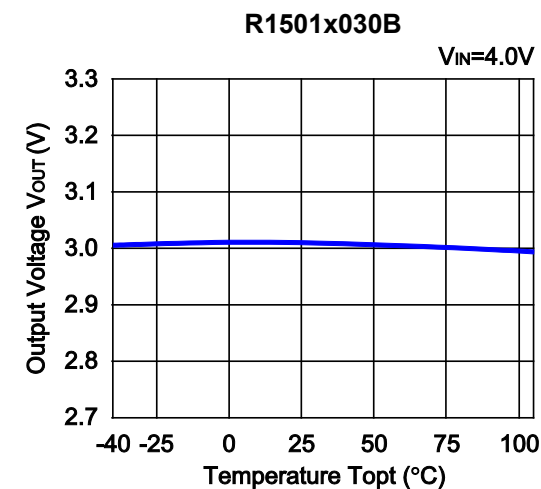
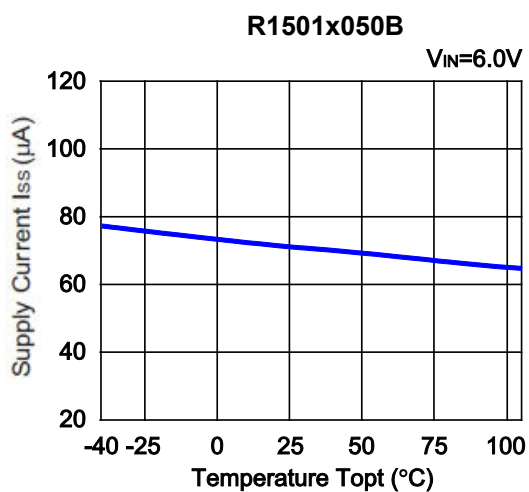
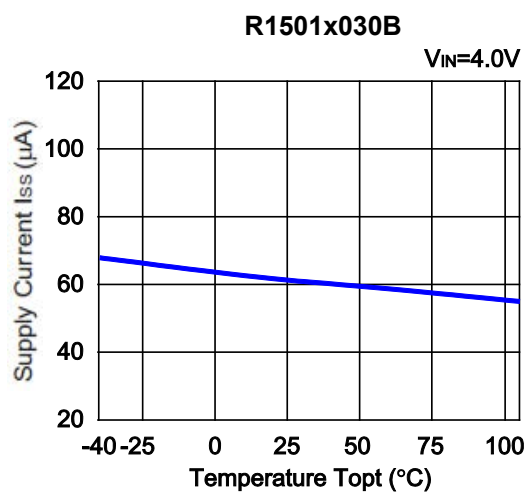
2) Output Voltage vs. Input Voltage (C_{IN} = Ceramic 0.47 μF , C_{OUT} = Ceramic 10 μF)

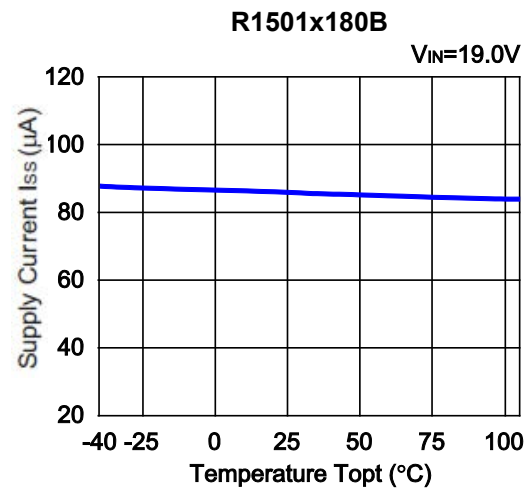
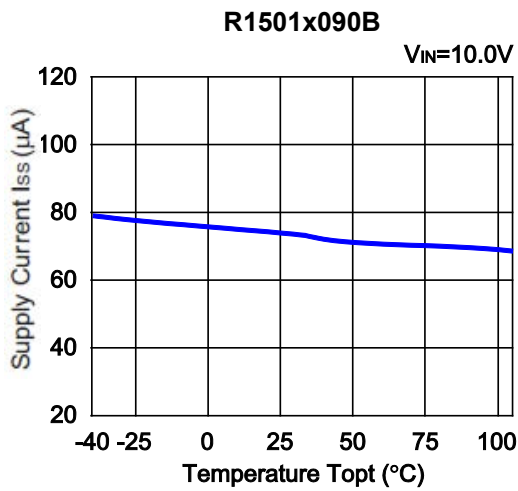




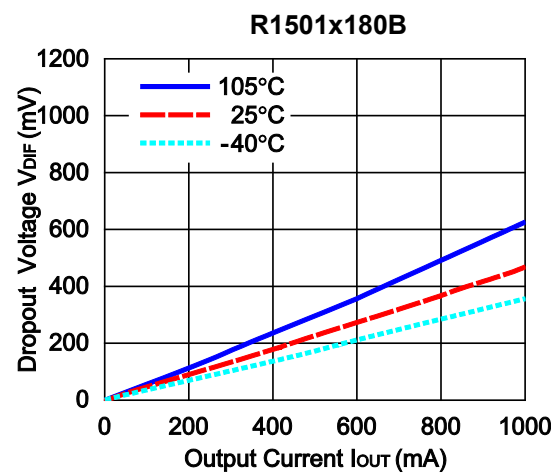
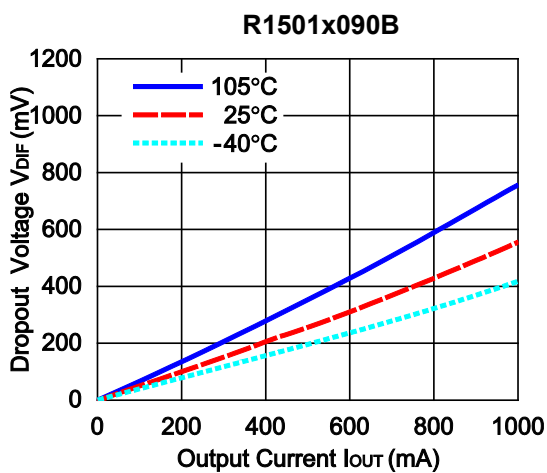
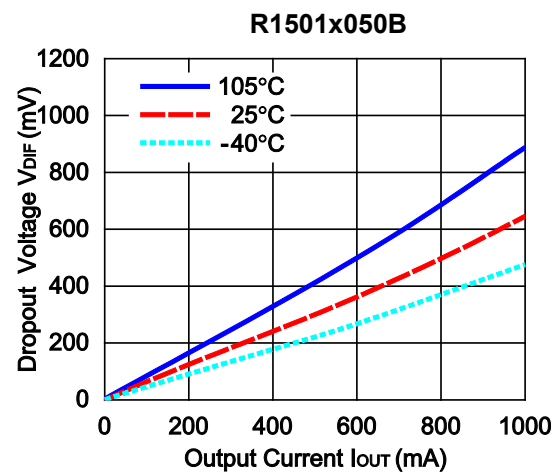
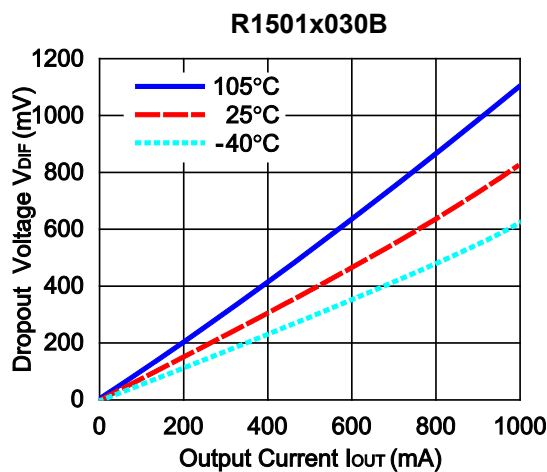
3) Supply Current vs. Input Voltage (C_{IN} = Ceramic 0.47 μF , C_{OUT} = Ceramic 10 μF)



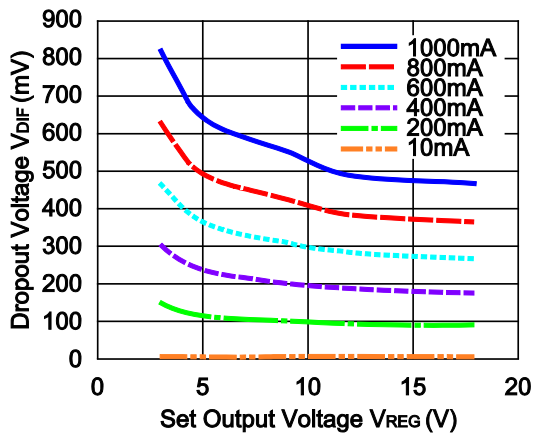
4) Output Voltage vs. Temperature (C_{IN} = Ceramic 0.47 μ F, C_{OUT} = Ceramic 10 μ F, I_{OUT} = 1 mA)**5) Supply Current vs. Temperature (C_{IN} = Ceramic 0.47 μ F, C_{OUT} = Ceramic 10 μ F, I_{OUT} = 0 mA)**



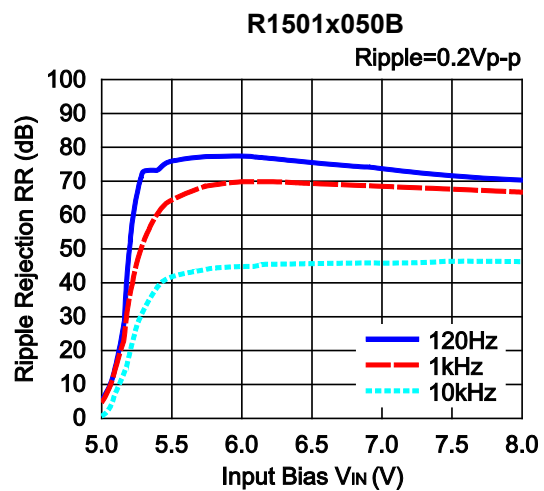
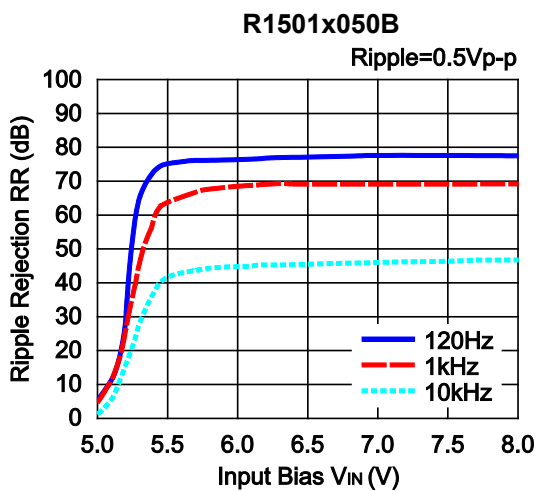
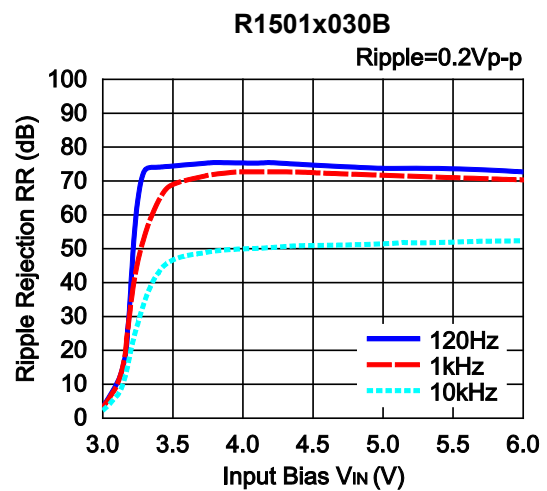
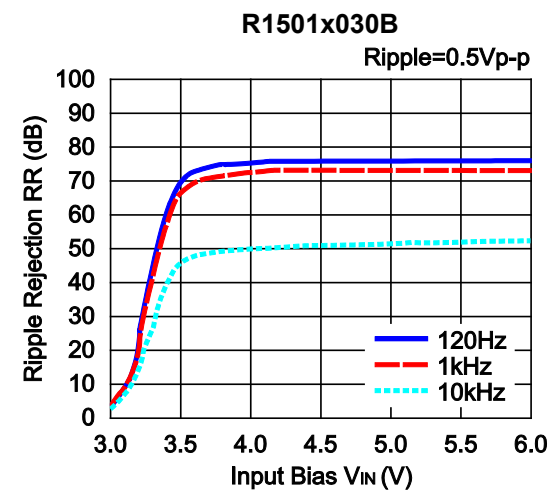
6) Dropout Voltage vs. Output Current (C_{IN} = Ceramic 0.47 μF , C_{OUT} = Ceramic 10 μF)

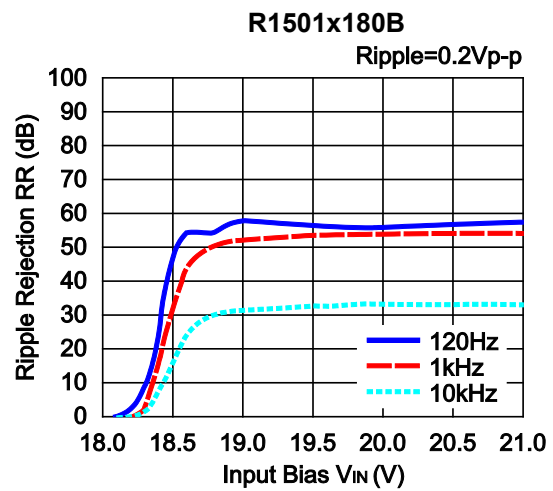
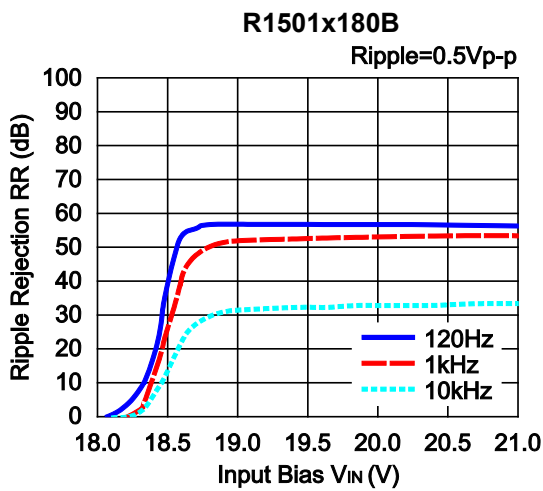
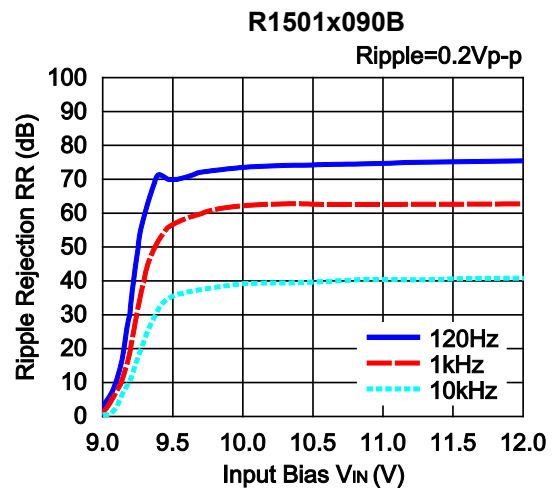
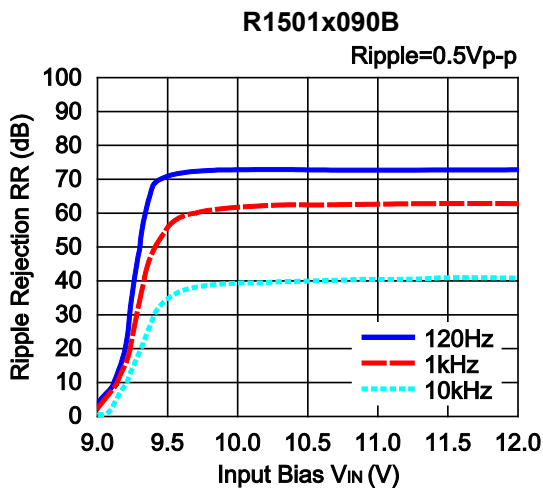


7) Dropout Voltage vs. Set Output Voltage (C_{IN} = Ceramic 0.47 μ F, C_{OUT} = Ceramic 10 μ F)

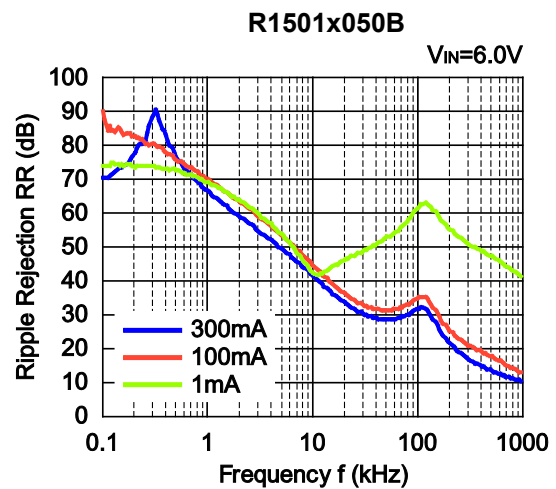
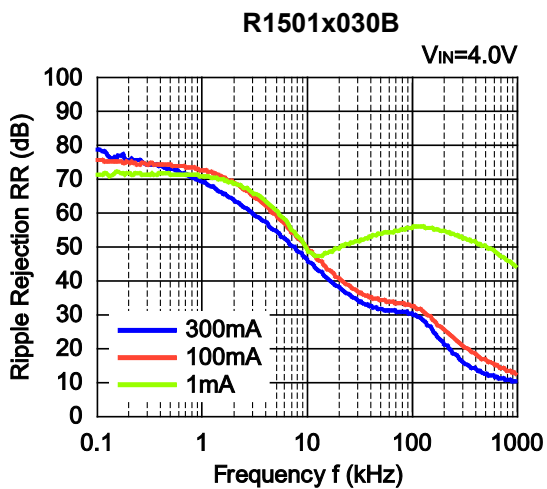


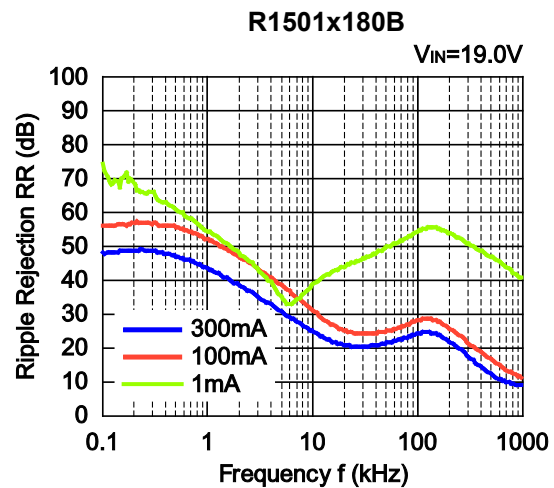
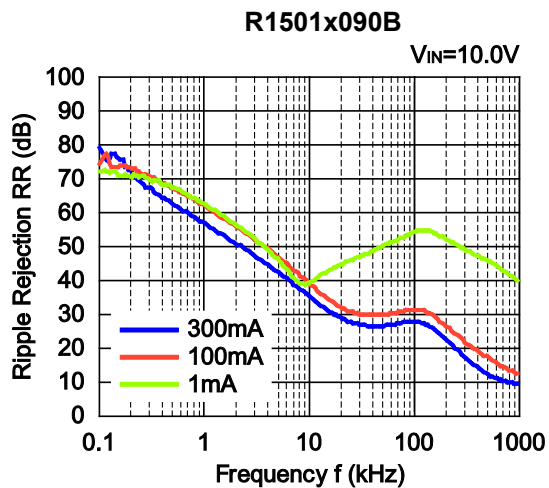
8) Ripple Rejection vs. Input Bias Voltage (C_{IN} = none, C_{OUT} = Ceramic 10 μ F, I_{OUT} = 100 mA)



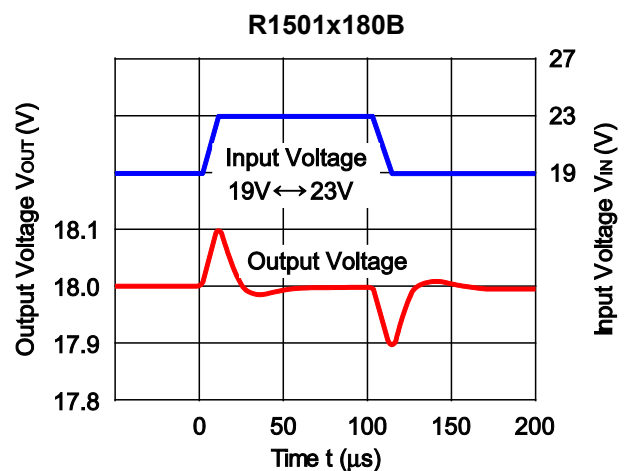
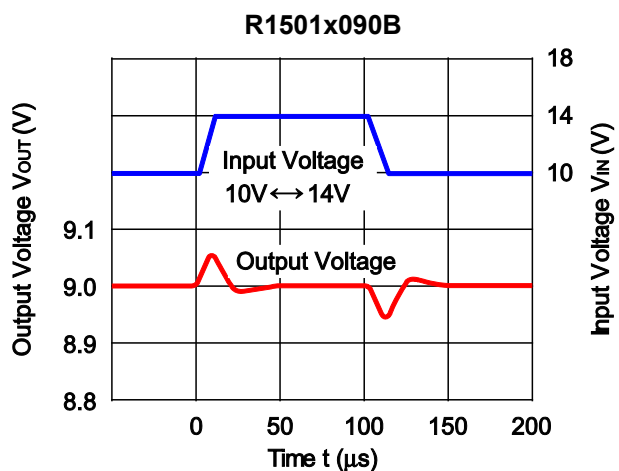
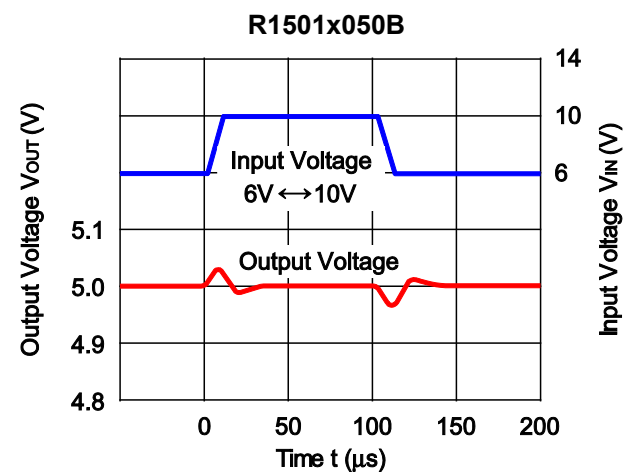
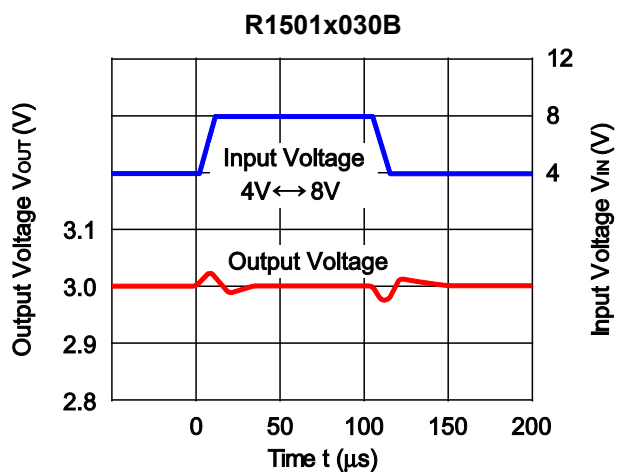


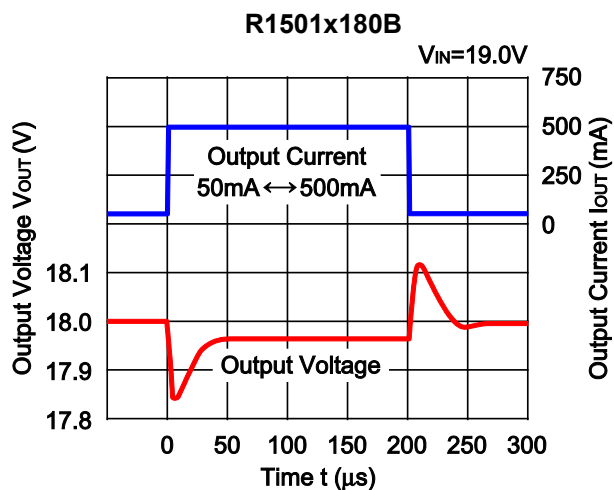
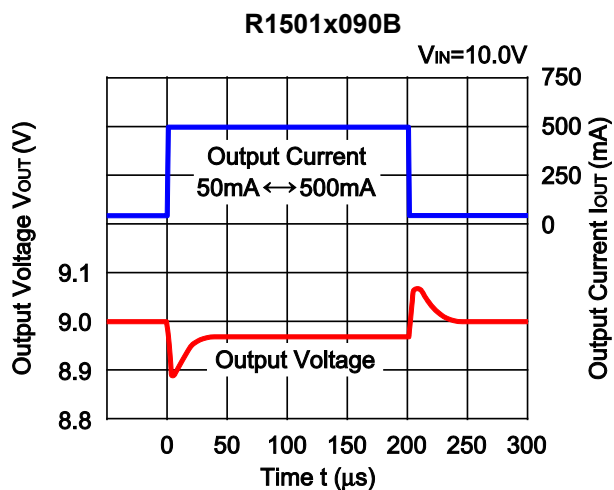
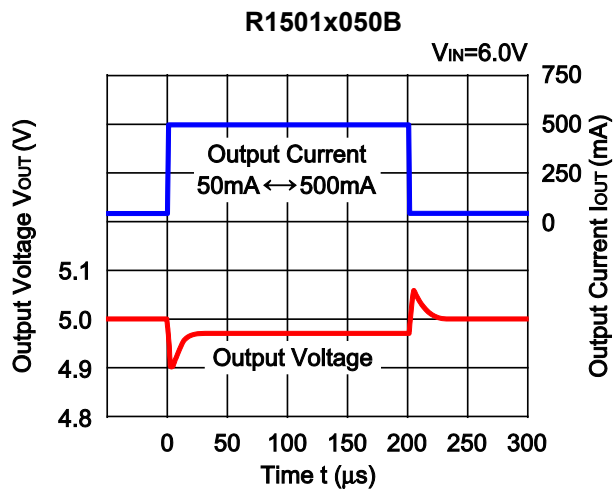
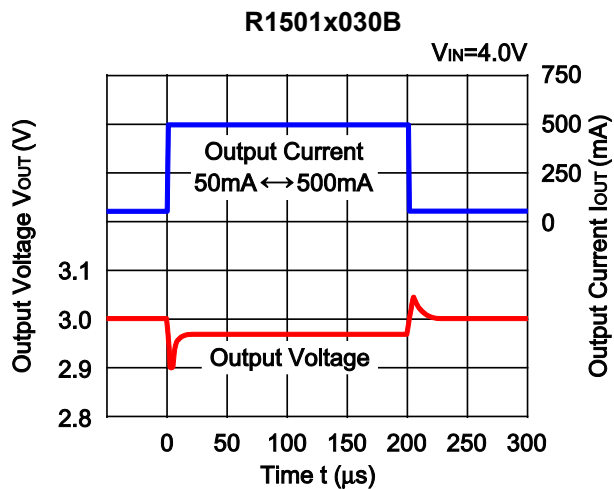
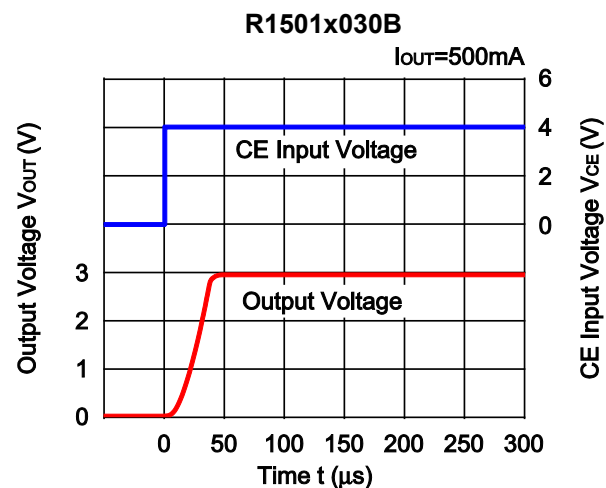
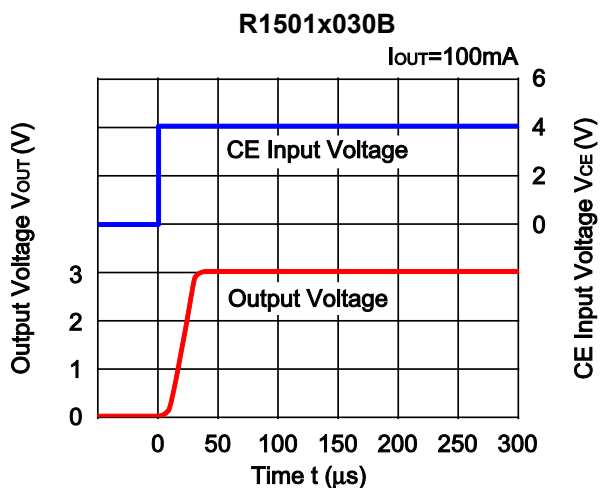
9) Ripple Rejection vs. Frequency (C_{IN} = none, C_{OUT} = Ceramic 10 μ F, Ripple = 0.5 Vp-p)



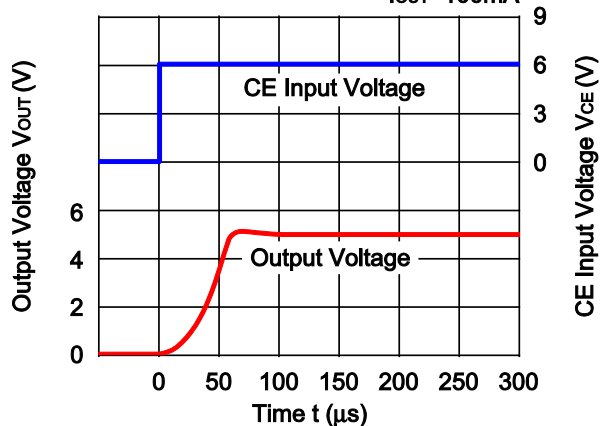


10) Input Transient Response (C_{IN} = none, C_{OUT} = Ceramic 10 μF , I_{OUT} = 100 mA, $t_r = t_f = 10 \mu s$)

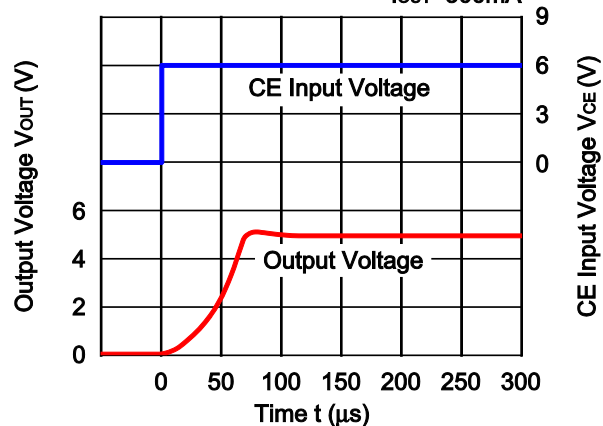


11) Load Transient Response (C_{IN} = Ceramic 0.47 μ F, C_{OUT} = Ceramic 10 μ F, $t_r = t_f = 0.5$ μ s)12) Turn On Speed with CE pin (C_{IN} = Ceramic 0.47 μ F, C_{OUT} = Ceramic 10 μ F, $t_r = t_f = 0.5$ μ s)

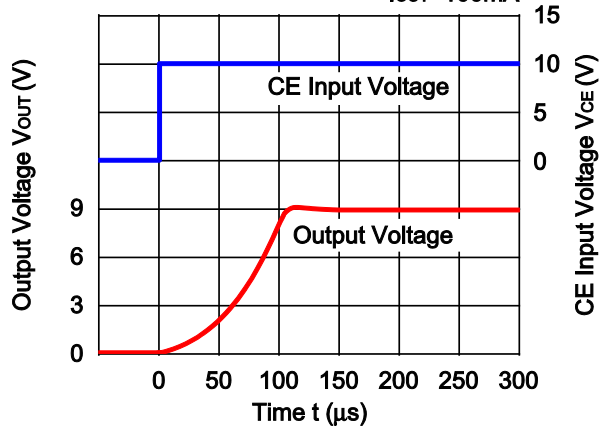
R1501x050B

 $I_{OUT}=100mA$ 

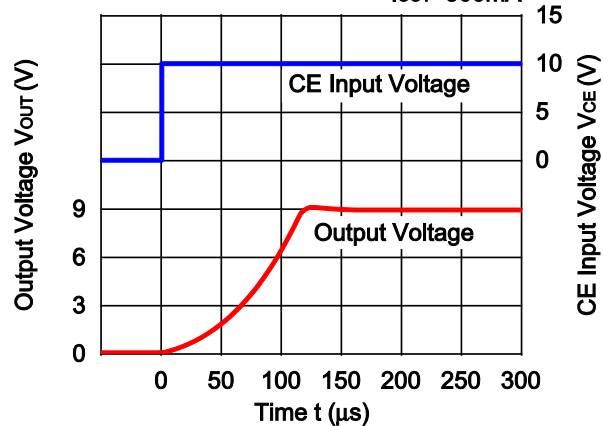
R1501x050B

 $I_{OUT}=500mA$ 

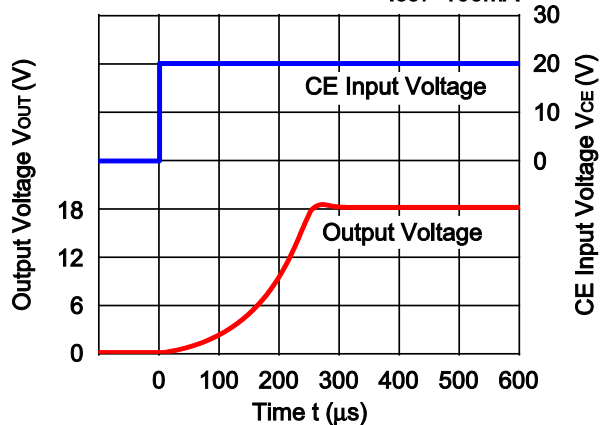
R1501x090B

 $I_{OUT}=100mA$ 

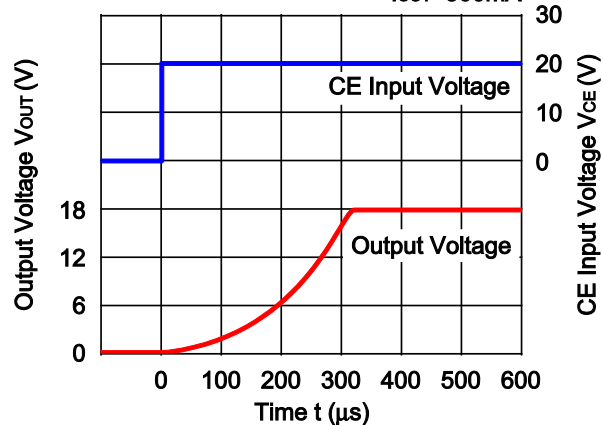
R1501x090B

 $I_{OUT}=500mA$ 

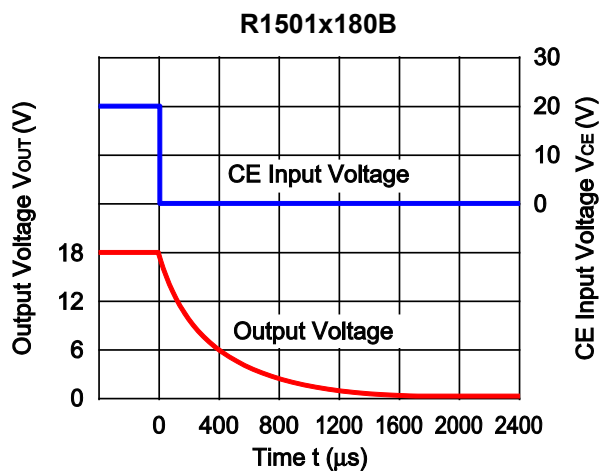
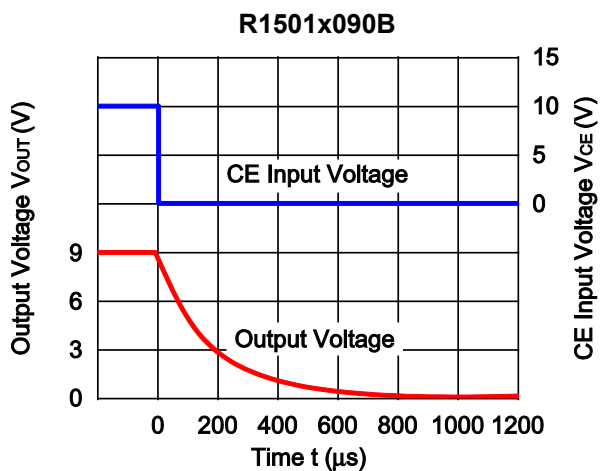
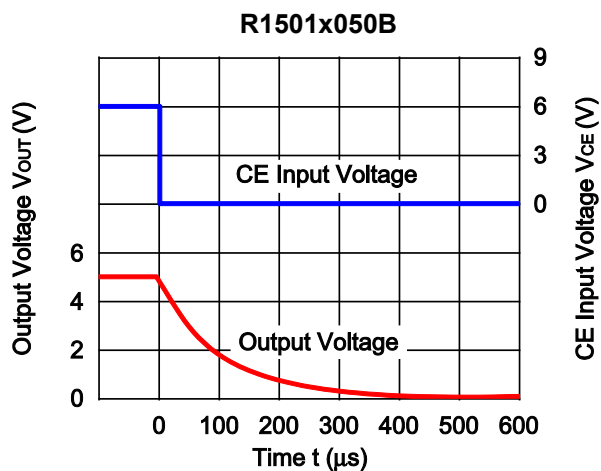
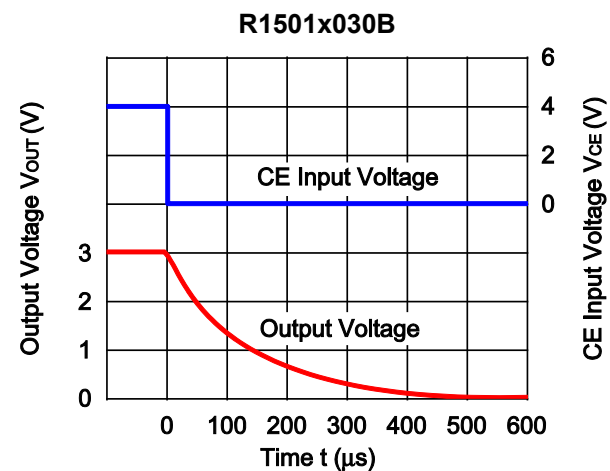
R1501x180B

 $I_{OUT}=100mA$ 

R1501x180B

 $I_{OUT}=500mA$ 

13) Turn Off Speed with CE (C_{IN} = Ceramic 0.47 μ F, C_{OUT} = Ceramic 10 μ 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

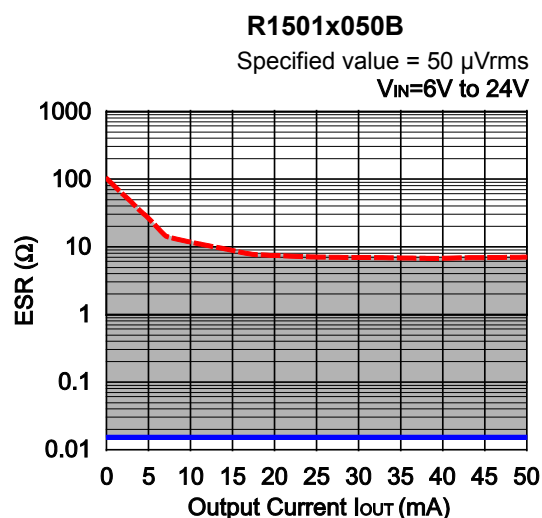
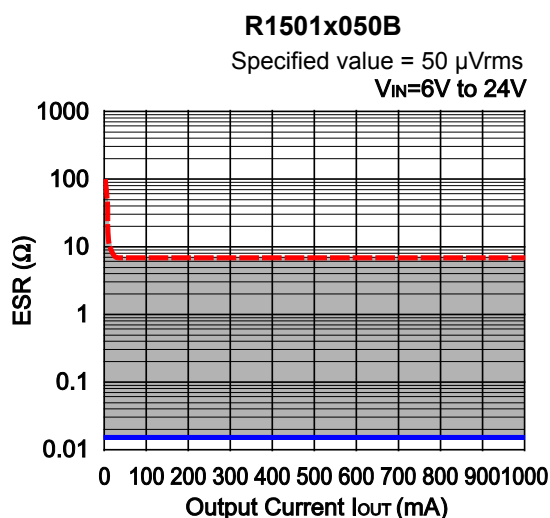
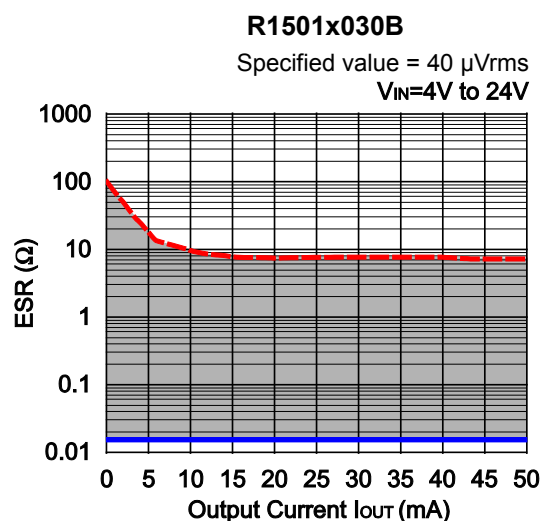
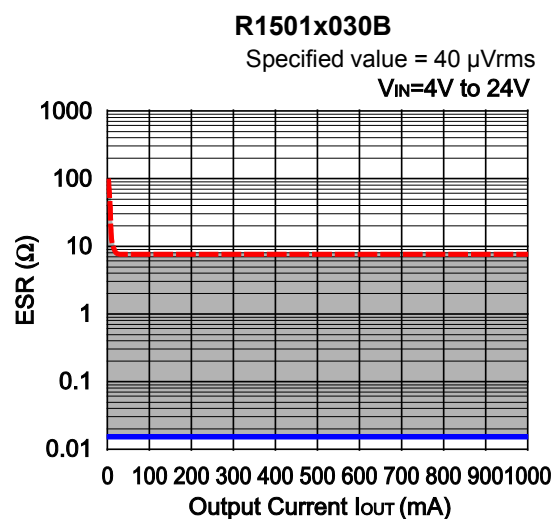
Input Voltage: $V_{OUT} + 1\text{ V}$ to 24 V

Frequency Band: 10 Hz to 1 MHz

Temperature: -40°C to 105°C

Capacitor: C_{IN} = Ceramic 0.47 μF

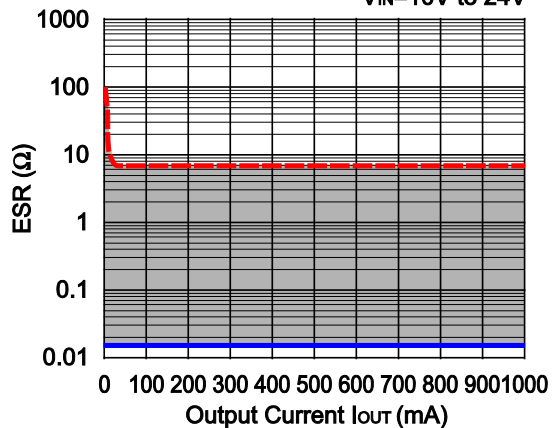
C_{OUT} = Ceramic 10 μF



R1501x090B

Specified value = 120 μ Vrms

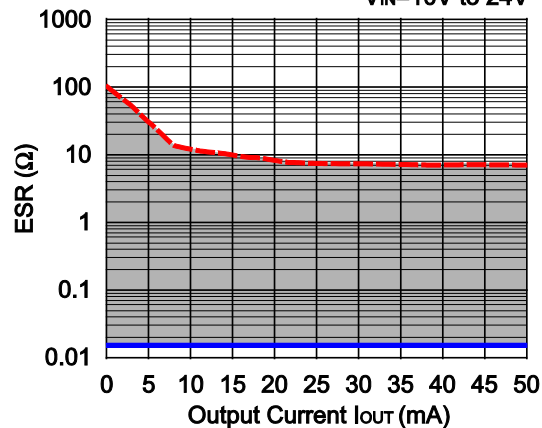
V_{IN} =10V to 24V



R1501x090B

Specified value = 120 μ Vrms

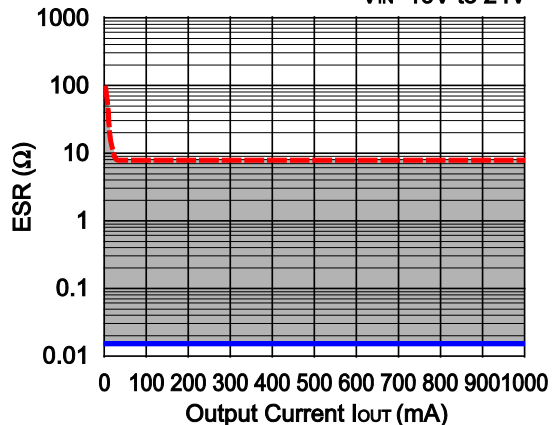
V_{IN} =10V to 24V



R1501x180B

Specified value = 220 μ Vrms

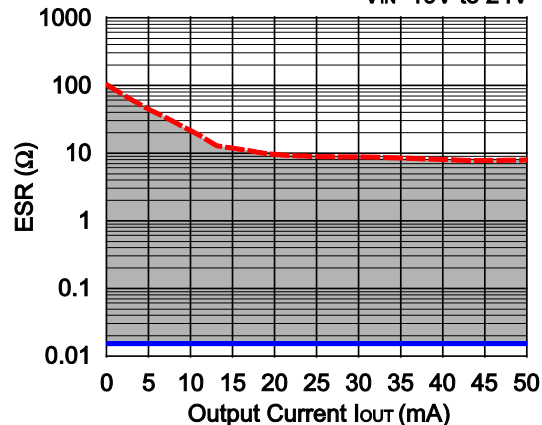
V_{IN} =19V to 24V



R1501x180B

Specified value = 220 μ Vrms

V_{IN} =19V to 24V



1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to our sales representatives for the latest information thereon.
2. The materials in this document may not be copied or otherwise reproduced in whole or in part without the prior written consent of us.
3. This product and any technical information relating thereto are subject to complementary export controls (so-called KNOW controls) under the Foreign Exchange and Foreign Trade Law, and related politics ministerial ordinance of the law. (Note that the complementary export controls are inapplicable to any application-specific products, except rockets and pilotless aircraft, that are insusceptible to design or program changes.) Accordingly, when exporting or carrying abroad this product, follow the Foreign Exchange and Foreign Trade Control Law and its related regulations with respect to the complementary export controls.
4. The technical information described in this document shows typical characteristics and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under our or any third party's intellectual property rights or any other rights.
5. The products listed in this document are intended and designed for automotive applications. Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death should first contact us.
 - Aerospace Equipment
 - Equipment Used in the Deep Sea
 - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
 - Life Maintenance Medical Equipment
 - Fire Alarms / Intruder Detectors
 - Vehicle Control Equipment (airplane, railroad, ship, etc.)
 - Various Safety Devices
 - 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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