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 Ω at V_{OUT} = 10 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 ±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

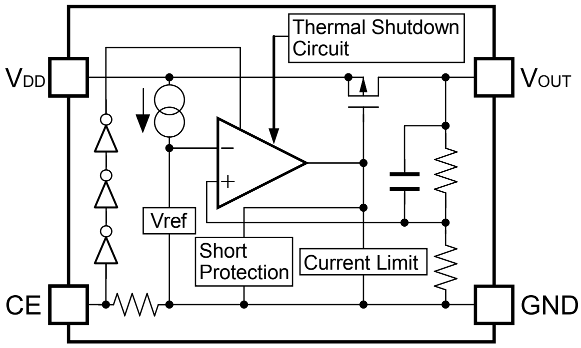
- Supply Current (I_{SS}) .... Typ. 70 µA
- Standby Current (Istandby)... Typ. 0.1 µA
- Output Current (I_{OUT}).. Min. 1 A
- Input Voltage Range (V_{IN}).. 3.0 V to 24.0 V
- Ripple Rejection (RR)... Typ. 60 dB (V_{SET} = 5.0 V)
- Output Voltage Range (V_{OUT})....................................... 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 .... ±2%
- Temperature-Drift Coefficient of Output Voltage.......... Typ. ±100 ppm/°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

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

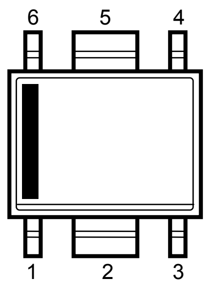
	Operating Temperature Range	Guaranteed Specs Temperature Range	Screening
A	−40°C to 105°C	25°C	High temperature
J	−40°C to 105°C	−40°C to 105°C	High and low temperature

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

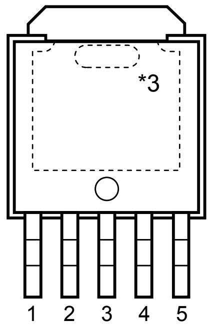
Product Name	Automotive Class Code	
	A	J
R1501SxxxB-E2-AE	✓	
R1501JxxxB-T1-#E	✓	✓

PIN DESCRIPTIONS

HSOP-6J



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 to V_{IN} + 0.3 ≤ 36	V
V_{OUT}	Output Voltage		−0.3 to V_{IN} + 0.3 ≤ 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	
Tj	Operating Junction Temperature Range		−40 to 150	°C
Tstg	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
Ta	Operating Temperature Range	−40 to 105	°C

RECOMMENDED OPERATING CONDITIONS

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

ELECTRICAL CHARACTERISTICS

V_{IN} = V_{SET} + 1.0 V, V_{CE} = V_{IN}, unless otherwise noted.
The specification in $\boxed{}$ is checked and guaranteed by design engineering at −40°C ≤ Ta ≤ 105°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	$\boxed{\text{x0.965}}$		$\boxed{\text{x1.035}}$	V
I_{SS}	Supply Current	V_{IN} = 24 V, I_{OUT} = 0 A			70	$\boxed{160}$	μA
Istandby	Standby Current	V_{IN} = 24 V, V_{CE} = 0 V			0.1	$\boxed{1.0}$	μA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	0.1 mA ≤ I_{OUT} ≤ 200 mA			25	$\boxed{60}$	mV
		0.1 mA ≤ I_{OUT} ≤ 1 A			125	$\boxed{300}$	mV
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{SET} + 1 V ≤ V_{IN} ≤ 24 V, I_{OUT} = 10 mA			0.05	$\boxed{0.1}$	%/V
V_{DIF}	Dropout Voltage	I_{OUT} = 200 mA	3.0 V ≤ V_{SET} < 5.0 V		0.135	$\boxed{0.225}$	V
			5.0 V ≤ V_{SET} < 9.0 V		0.115	$\boxed{0.180}$	
			9.0 V ≤ V_{SET} < 12.0 V		0.095	$\boxed{0.155}$	
			12.0 V ≤ V_{SET} ≤ 18.0 V		0.090	$\boxed{0.140}$	
		I_{OUT} = 1 A	3.0 V ≤ V_{SET} < 5.0 V		0.675	$\boxed{1.125}$	V
			5.0 V ≤ V_{SET} < 9.0 V		0.575	$\boxed{0.900}$	
			9.0 V ≤ V_{SET} < 12.0 V		0.475	$\boxed{0.775}$	
			12.0 V ≤ V_{SET} ≤ 18.0 V		0.450	$\boxed{0.700}$	
I_{LIM}	Output Current			$\boxed{1}$			A
I_{SC}	Short Current Limit	V_{OUT} = 0 V			65		mA
V_{CEH}	CE Input Voltage "H"			$\boxed{2.0}$		$\boxed{V_{IN}}$	V
V_{CEL}	CE Input Voltage "L"			$\boxed{0}$		$\boxed{0.5}$	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 Tj ≈ Ta = 25°C.

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

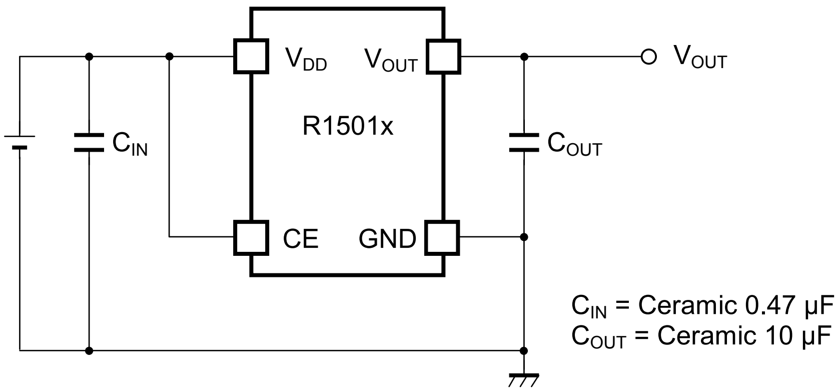
The specification in $\boxed{}$ is checked and guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.

R1501JxxxB (-JE) (−40°C ≤ Ta ≤ 105°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
Istandby	Standby Current	V_{IN} = 24 V, V_{CE} = 0 V			0.1	1.0	μA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	0.1 mA ≤ I_{OUT} ≤ 200 mA			25	60	mV
		0.1 mA ≤ I_{OUT} ≤ 1 A			125	$\boxed{300}$	mV
$\Delta V_{OUT}/\Delta V_{IN}$	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	$\boxed{1.125}$	V
			5.0 V ≤ V_{SET} < 9.0 V		0.575	$\boxed{0.900}$	
			9.0 V ≤ V_{SET} < 12.0 V		0.475	$\boxed{0.775}$	
			12.0 V ≤ V_{SET} ≤ 18.0 V		0.450	$\boxed{0.700}$	
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

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.

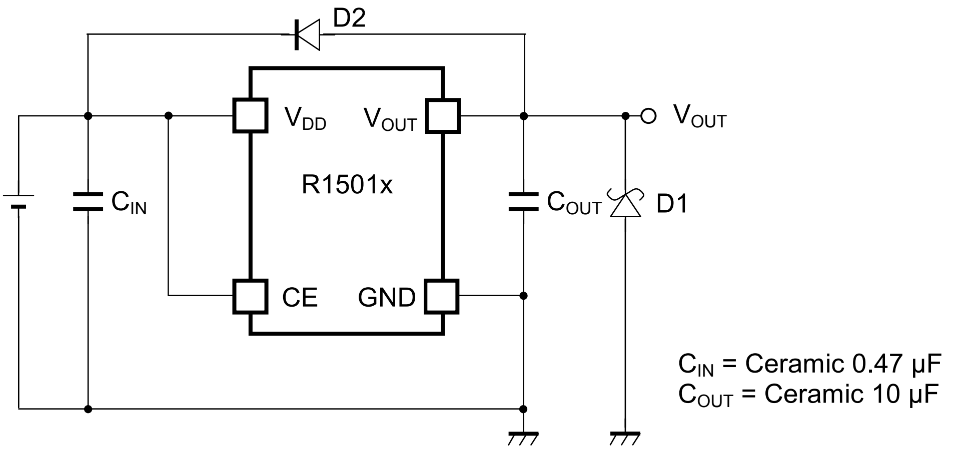
Phase Compensation

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)

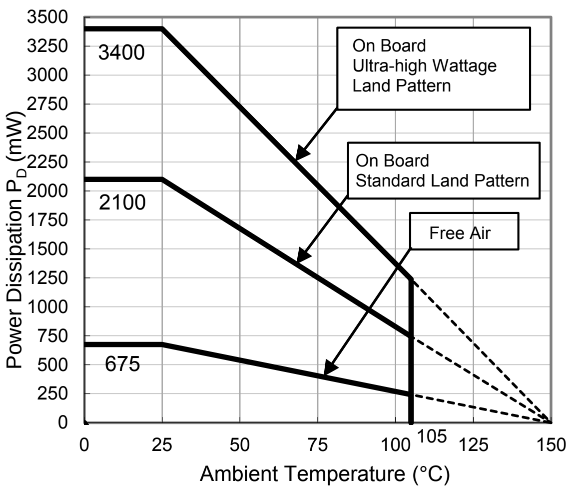
The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

Measurement Conditions

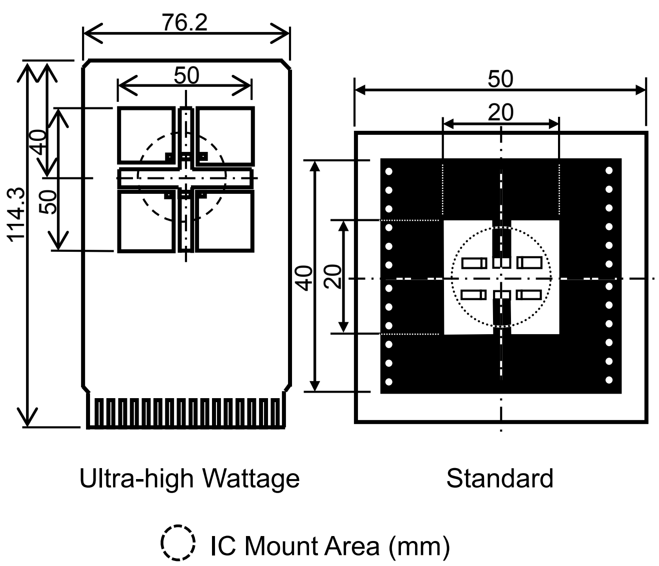
	Ultra-high Wattage Land Pattern	Standard Land Pattern
Environment	Mounting on Board (Wind Velocity = 0 m/s)	Mounting on Board (Wind Velocity = 0 m/s)
Board Material	Glass Cloth Epoxy Plastic (Four-Layer Board)	Glass Cloth Epoxy Plastic (Double-sided Board)
Board Dimensions	76.2 mm × 114.3 mm × 0.8 mm	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

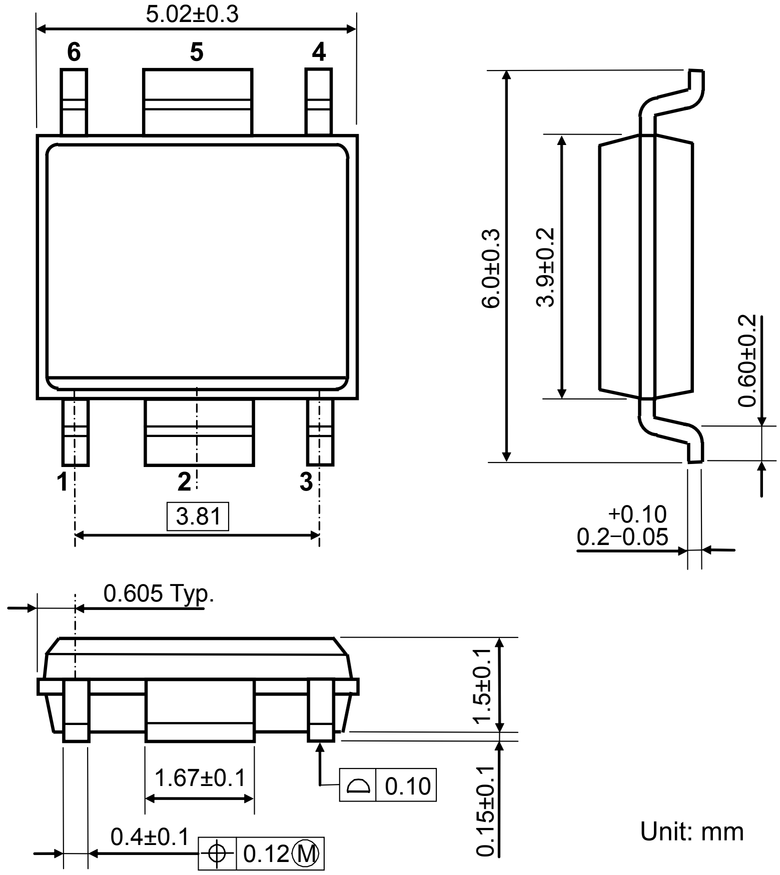


Power Dissipation vs. Ambient Temperature



Measurement Board Pattern

PACKAGE DIMENSIONS (HSOP-6J)

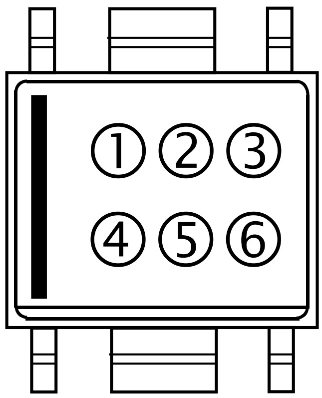


Unit: mm

MARK SPECIFICATIONS (HSOP-6J)

①②③④: Product Code … <u>Refer to *R1501x MARK SPECIFICATION TABLE*</u>

⑤⑥: Lot Number … Alphanumeric Serial Number



R1501x MARK SPECIFICATION TABLE (HSOP-6J)

Product Name	①②③④	V_{SET}
R1501S030B	H 0 3 0	3.0 V
R1501S031B	H 0 3 1	3.1 V
R1501S032B	H 0 3 2	3.2 V
R1501S033B	H 0 3 3	3.3 V
R1501S034B	H 0 3 4	3.4 V
R1501S035B	H 0 3 5	3.5 V
R1501S036B	H 0 3 6	3.6 V
R1501S037B	H 0 3 7	3.7 V
R1501S038B	H 0 3 8	3.8 V
R1501S039B	H 0 3 9	3.9 V
R1501S040B	H 0 4 0	4.0 V
R1501S041B	H 0 4 1	4.1 V
R1501S042B	H 0 4 2	4.2 V
R1501S043B	H 0 4 3	4.3 V
R1501S044B	H 0 4 4	4.4 V
R1501S045B	H 0 4 5	4.5 V
R1501S046B	H 0 4 6	4.6 V
R1501S047B	H 0 4 7	4.7 V
R1501S048B	H 0 4 8	4.8 V
R1501S049B	H 0 4 9	4.9 V
R1501S050B	H 0 5 0	5.0 V
R1501S051B	H 0 5 1	5.1 V
R1501S052B	H 0 5 2	5.2 V
R1501S053B	H 0 5 3	5.3 V
R1501S054B	H 0 5 4	5.4 V
R1501S055B	H 0 5 5	5.5 V
R1501S056B	H 0 5 6	5.6 V
R1501S057B	H 0 5 7	5.7 V
R1501S058B	H 0 5 8	5.8 V
R1501S059B	H 0 5 9	5.9 V
R1501S060B	H 0 6 0	6.0 V
R1501S061B	H 0 6 1	6.1 V
R1501S062B	H 0 6 2	6.2 V
R1501S063B	H 0 6 3	6.3 V
R1501S064B	H 0 6 4	6.4 V
R1501S065B	H 0 6 5	6.5 V
R1501S066B	H 0 6 6	6.6 V
R1501S067B	H 0 6 7	6.7 V
R1501S068B	H 0 6 8	6.8 V
R1501S069B	H 0 6 9	6.9 V

Product Name	①②③④	V_{SET}
R1501S070B	H 0 7 0	7.0 V
R1501S071B	H 0 7 1	7.1 V
R1501S072B	H 0 7 2	7.2 V
R1501S073B	H 0 7 3	7.3 V
R1501S074B	H 0 7 4	7.4 V
R1501S075B	H 0 7 5	7.5 V
R1501S076B	H 0 7 6	7.6 V
R1501S077B	H 0 7 7	7.7 V
R1501S078B	H 0 7 8	7.8 V
R1501S079B	H 0 7 9	7.9 V
R1501S080B	H 0 8 0	8.0 V
R1501S081B	H 0 8 1	8.1 V
R1501S082B	H 0 8 2	8.2 V
R1501S083B	H 0 8 3	8.3 V
R1501S084B	H 0 8 4	8.4 V
R1501S085B	H 0 8 5	8.5 V
R1501S086B	H 0 8 6	8.6 V
R1501S087B	H 0 8 7	8.7 V
R1501S088B	H 0 8 8	8.8 V
R1501S089B	H 0 8 9	8.9 V
R1501S090B	H 0 9 0	9.0 V
R1501S091B	H 0 9 1	9.1 V
R1501S092B	H 0 9 2	9.2 V
R1501S093B	H 0 9 3	9.3 V
R1501S094B	H 0 9 4	9.4 V
R1501S095B	H 0 9 5	9.5 V
R1501S096B	H 0 9 6	9.6 V
R1501S097B	H 0 9 7	9.7 V
R1501S098B	H 0 9 8	9.8 V
R1501S099B	H 0 9 9	9.9 V
R1501S100B	H 1 0 0	10.0 V
R1501S101B	H 1 0 1	10.1 V
R1501S102B	H 1 0 2	10.2 V
R1501S103B	H 1 0 3	10.3 V
R1501S104B	H 1 0 4	10.4 V
R1501S105B	H 1 0 5	10.5 V
R1501S106B	H 1 0 6	10.6 V
R1501S107B	H 1 0 7	10.7 V
R1501S108B	H 1 0 8	10.8 V
R1501S109B	H 1 0 9	10.9 V

Product Name	①②③④	V_{SET}
R1501S110B	H 1 1 0	11.0 V
R1501S111B	H 1 1 1	11.1 V
R1501S112B	H 1 1 2	11.2 V
R1501S113B	H 1 1 3	11.3 V
R1501S114B	H 1 1 4	11.4 V
R1501S115B	H 1 1 5	11.5 V
R1501S116B	H 1 1 6	11.6 V
R1501S117B	H 1 1 7	11.7 V
R1501S118B	H 1 1 8	11.8 V
R1501S119B	H 1 1 9	11.9 V
R1501S120B	H 1 2 0	12.0 V
R1501S125B	H 1 2 5	12.5 V
R1501S130B	H 1 3 0	13.0 V
R1501S135B	H 1 3 5	13.5 V
R1501S140B	H 1 4 0	14.0 V
R1501S145B	H 1 4 5	14.5 V
R1501S150B	H 1 5 0	15.0 V
R1501S155B	H 1 5 5	15.5 V
R1501S160B	H 1 6 0	16.0 V
R1501S165B	H 1 6 5	16.5 V
R1501S170B	H 1 7 0	17.0 V
R1501S175B	H 1 7 5	17.5 V
R1501S180B	H 1 8 0	18.0 V

POWER DISSIPATION (TO-252-5-P2)

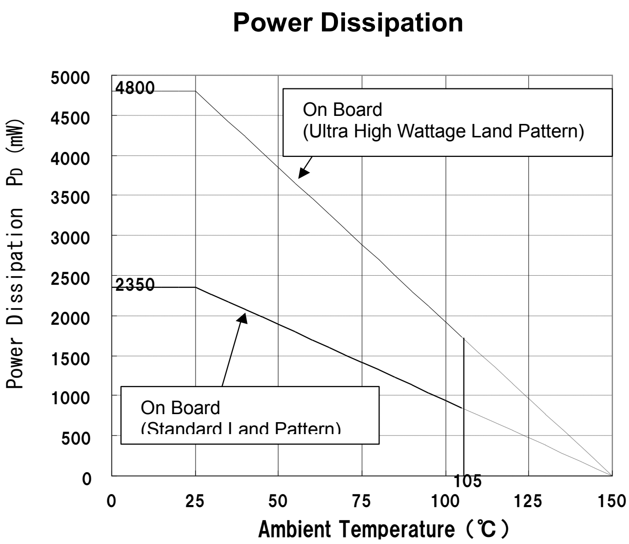
Power Dissipation (P_D) depends on conditions of mounting on board.
This specification is based on the measurement at the condition below:

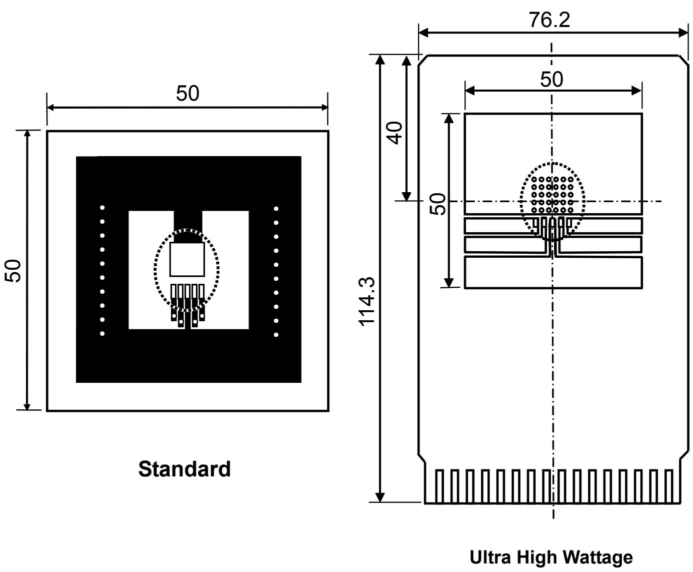
* Measurement conditions

	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 (Ta=25°C, Tjmax=150°C)

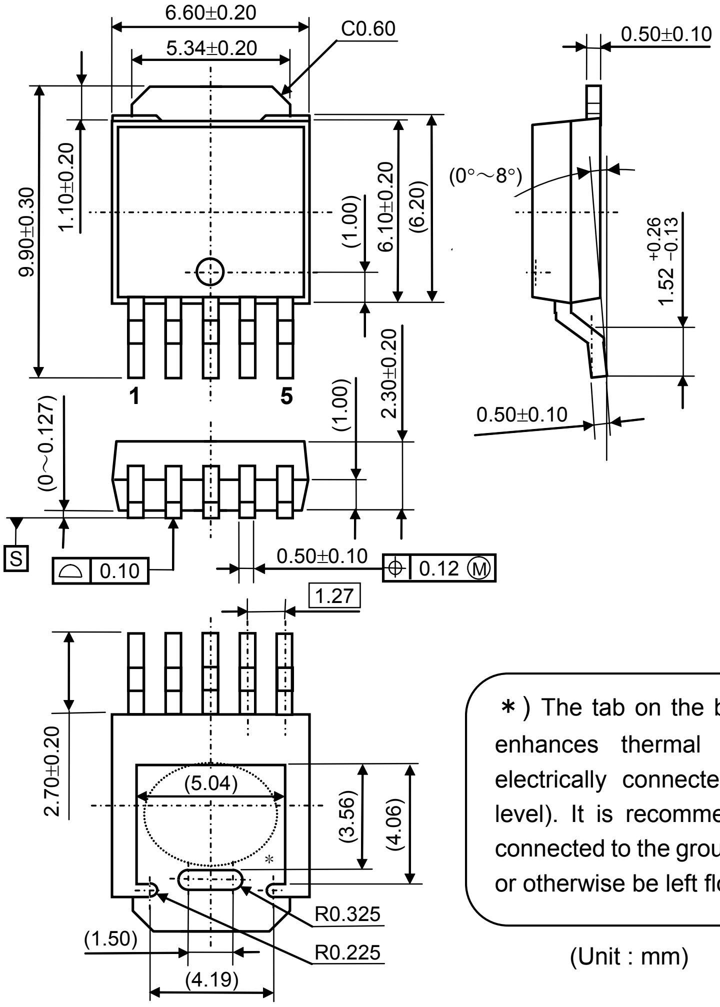
	Standard Land Pattern	Ultra High Wattage Land Pattern
Power Dissipation	2350mW	4800mW
Thermal Resistance	θja=(150-25°C)/2.35W= 53°C/W	θja= (150-25°C)/4.8W = 26°C/W
	θjc= 17°C/W	θjc= 7°C/W





Measurement Board Pattern
IC Mount Area (Unit: mm)

PACKAGE DIMENSIONS (TO-252-5-P2)



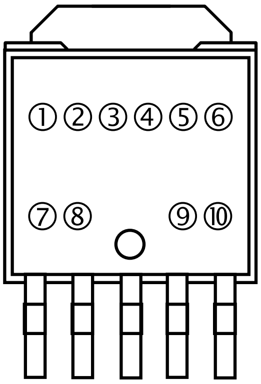
＊) The tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). It is recommended that the tab be connected to the ground plane on the board, or otherwise be left floating.

(Unit : mm)

MARK SPECIFICATIONS (TO-252-5-P2)

①②③④⑤⑥⑦⑧: Product Code … Refer to *R1501x MARK SPECIFICATION TABLE*

⑨⑩: Lot Number … Alphanumeric Serial Number



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

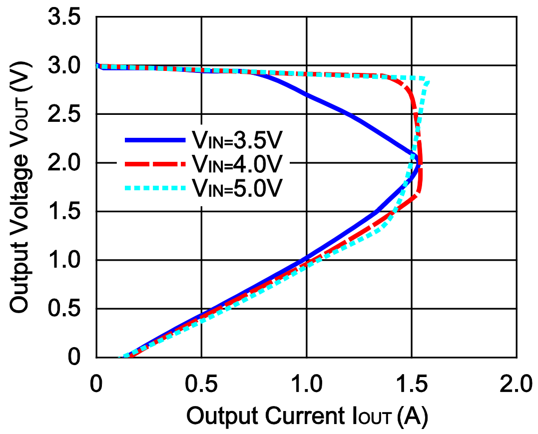
TYPICAL CHARACTERISTICS

Ta = 25°C, unless otherwise noted.

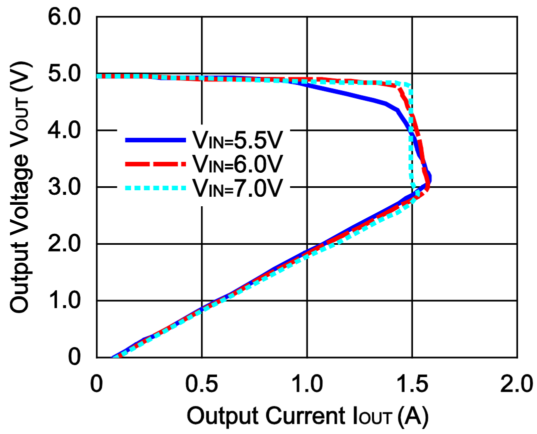
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

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

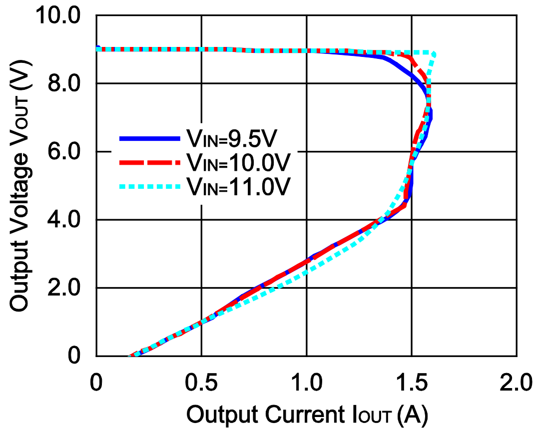
R1501x030B



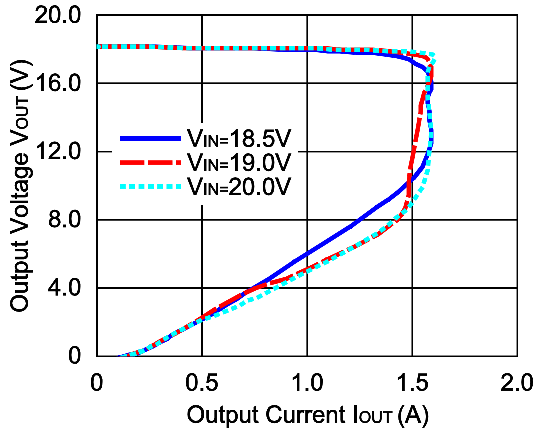
R1501x050B



R1501x090B

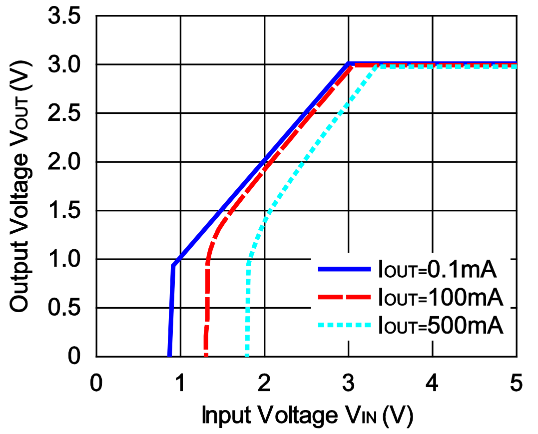


R1501x180B

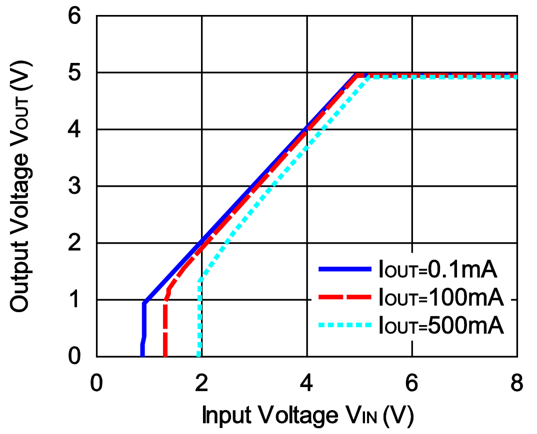


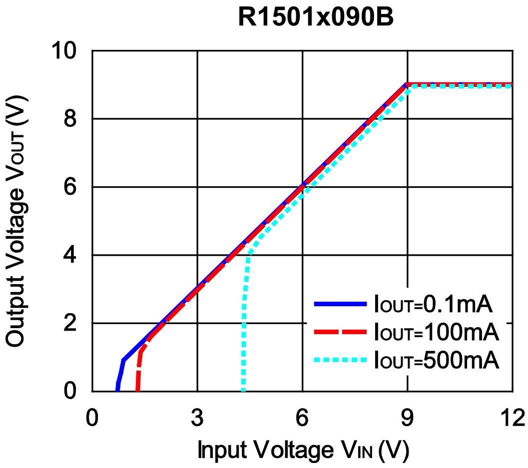
2) Output Voltage vs. Input Voltage (C_{IN} = Ceramic 0.47 μF, C_{OUT} = Ceramic 10 μF)

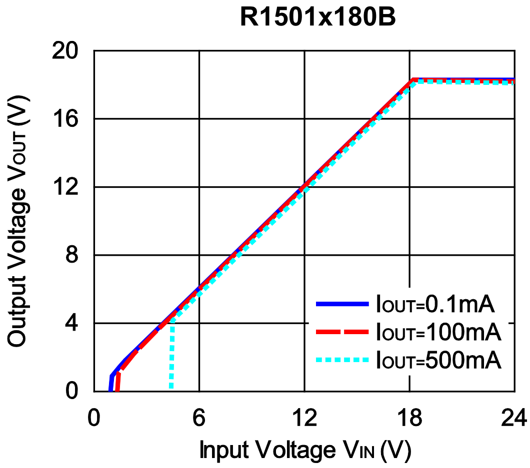
R1501x030B



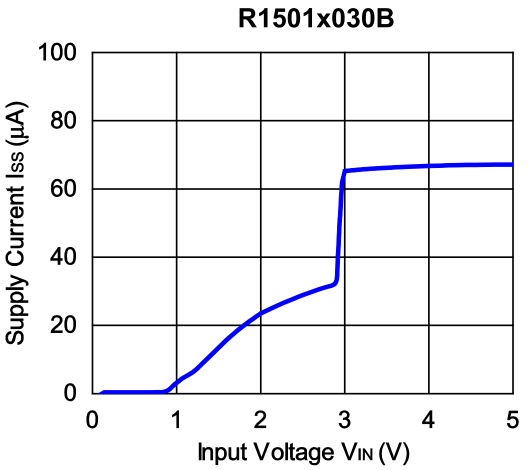
R1501x050B

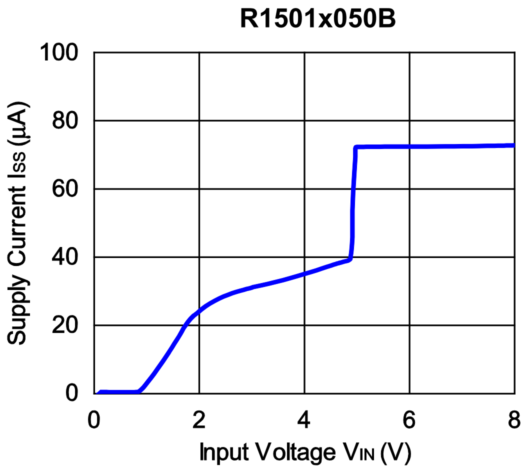


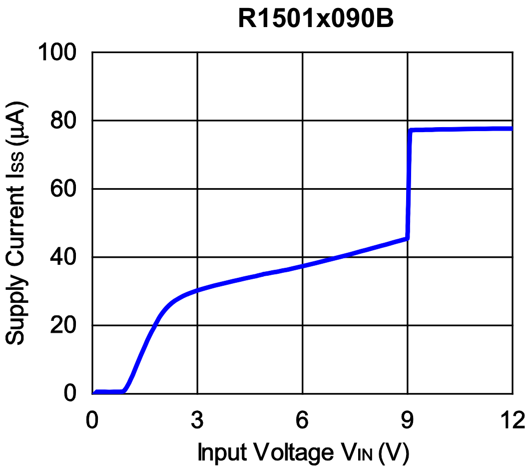


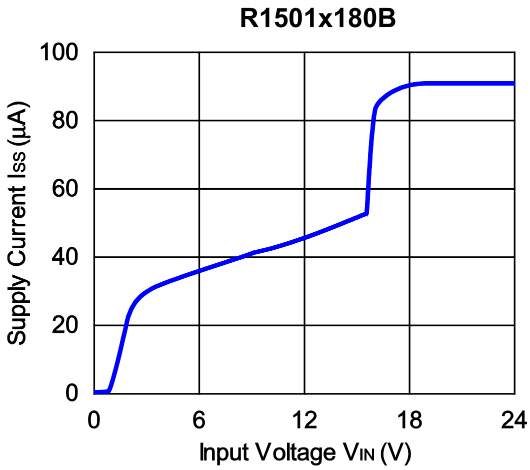


3) Supply Current vs. Input Voltage (C_{IN} = Ceramic 0.47 μF, C_{OUT} = Ceramic 10 μF)



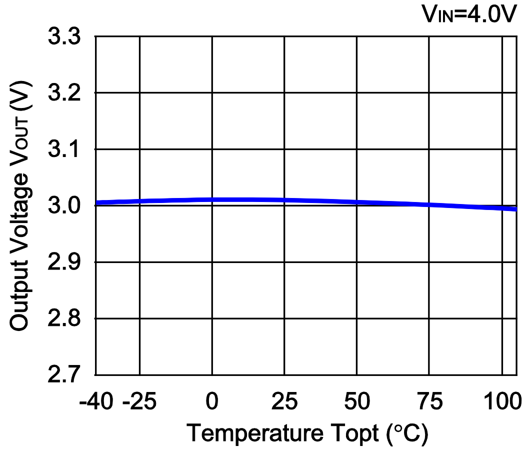




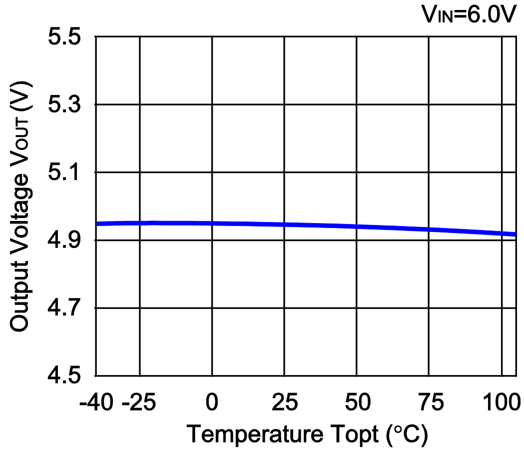


4) Output Voltage vs. Temperature (C_{IN} = Ceramic 0.47 µF, C_{OUT} = Ceramic 10 µF, I_{OUT} = 1 mA)

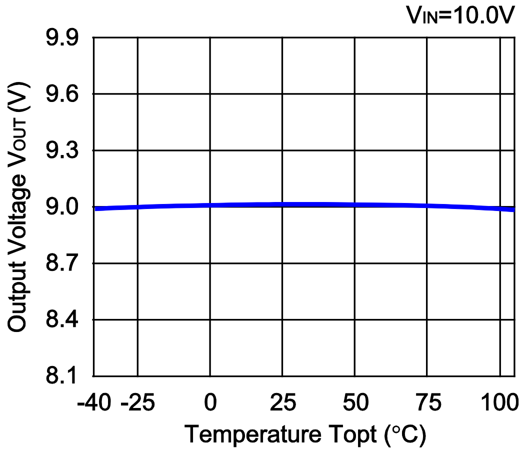
R1501x030B



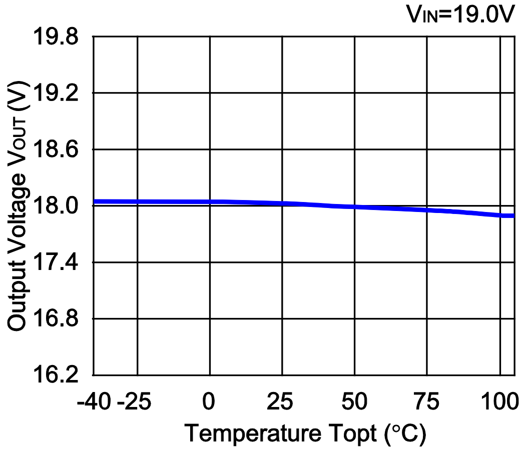
R1501x050B



R1501x090B

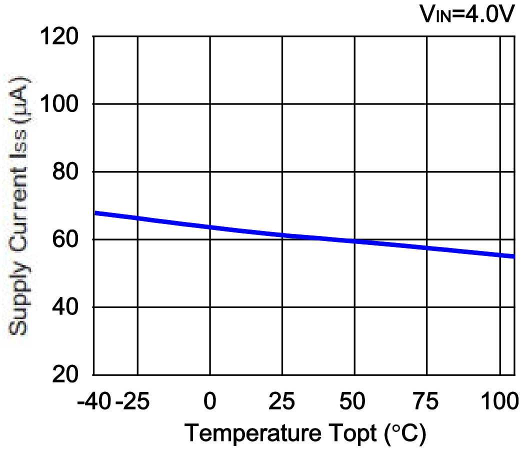


R1501x180B

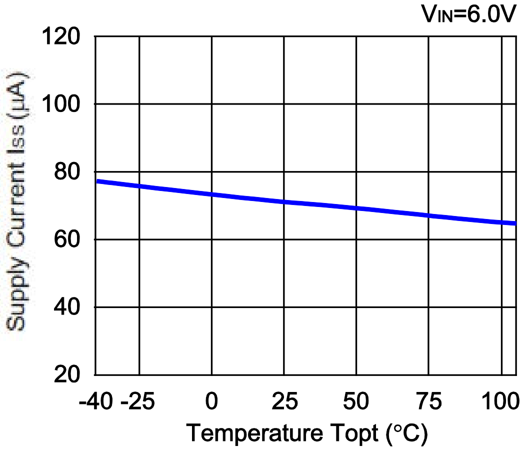


5) Supply Current vs. Temperature (C_{IN} = Ceramic 0.47 µF, C_{OUT} = Ceramic 10 µF, I_{OUT} = 0 mA)

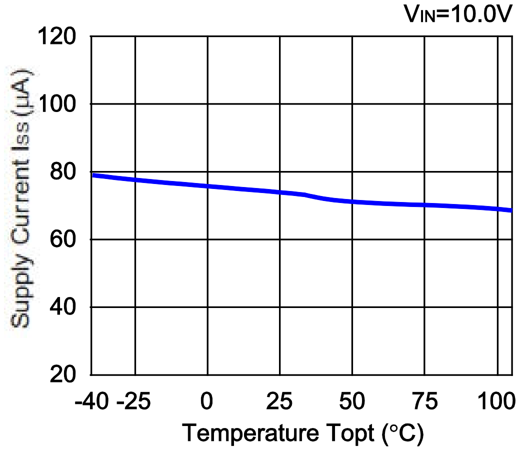
R1501x030B



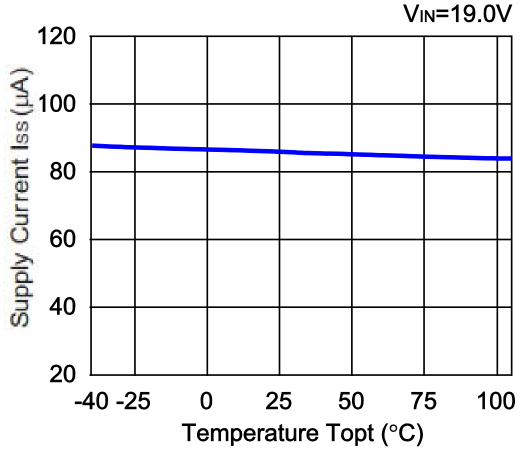
R1501x050B



R1501x090B

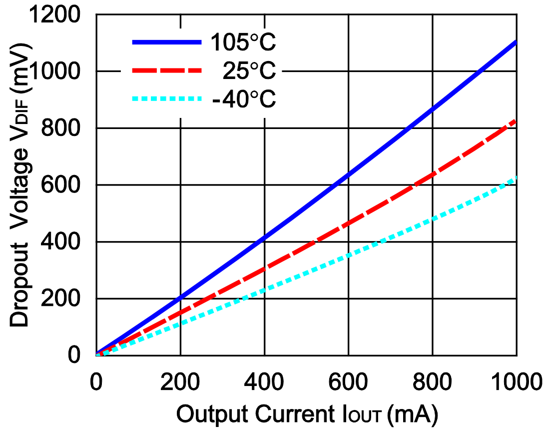


R1501x180B

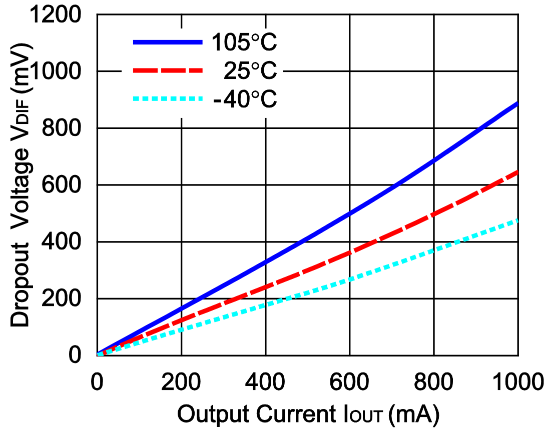


6) Dropout Voltage vs. Output Current (C_{IN} = Ceramic 0.47 μF, C_{OUT} = Ceramic 10 μF)

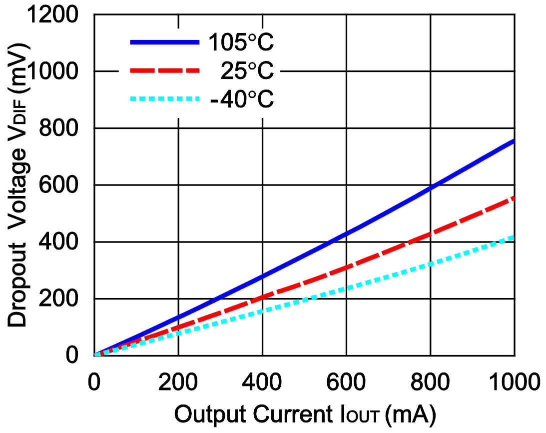
R1501x030B



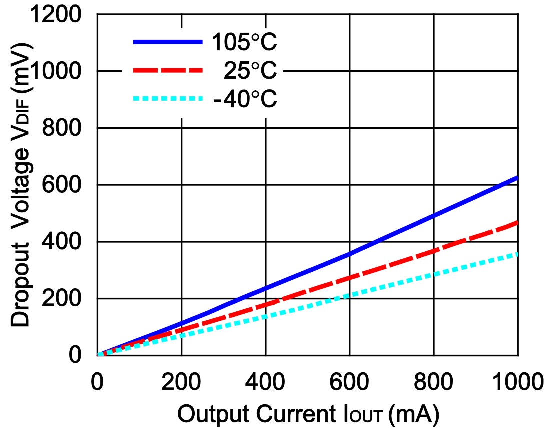
R1501x050B



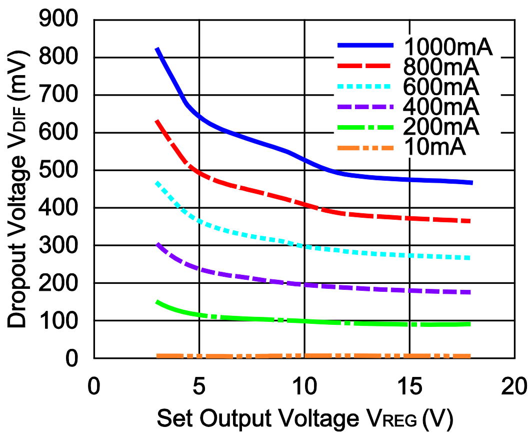
R1501x090B



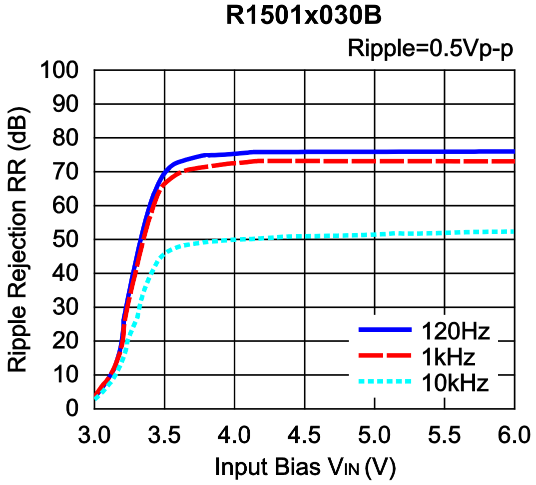
R1501x180B

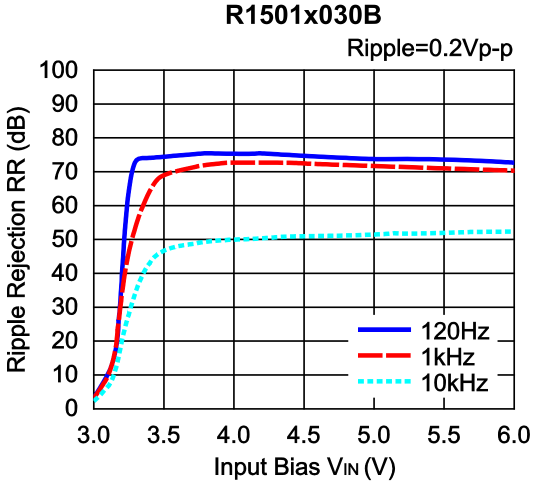


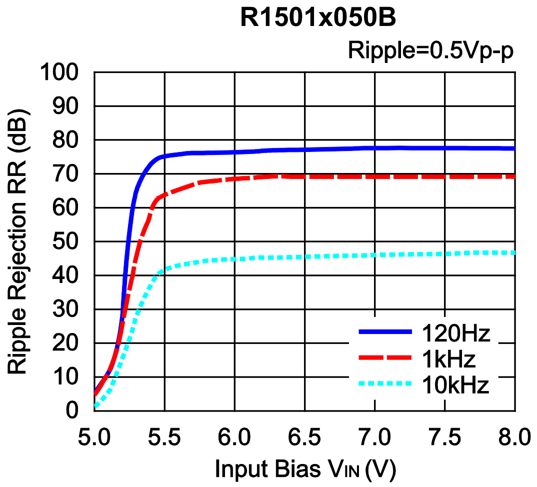
7) Dropout Voltage vs. Set Output Voltage (C_{IN} = Ceramic 0.47 µF, C_{OUT} = Ceramic 10 µF)

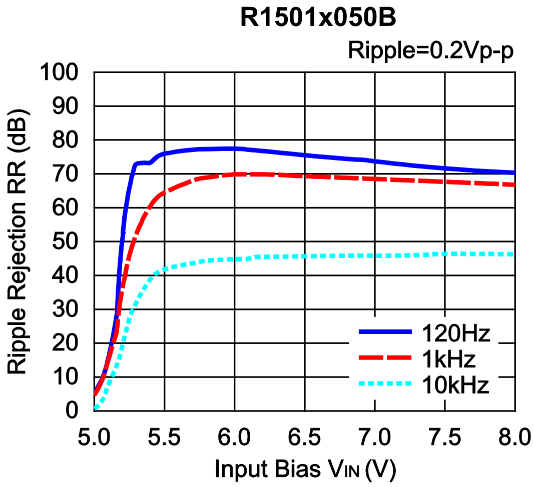


8) Ripple Rejection vs. Input Bias Voltage (C_{IN} = none, C_{OUT} = Ceramic 10 µF, I_{OUT} = 100 mA



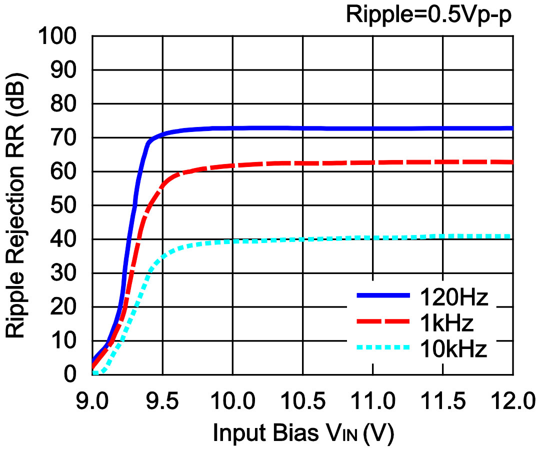






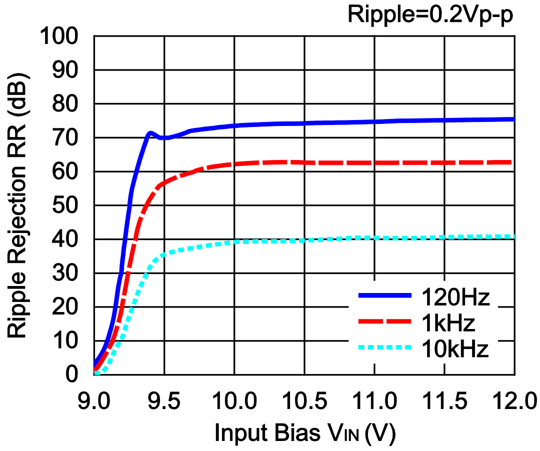
R1501x090B

Ripple=0.5Vp-p



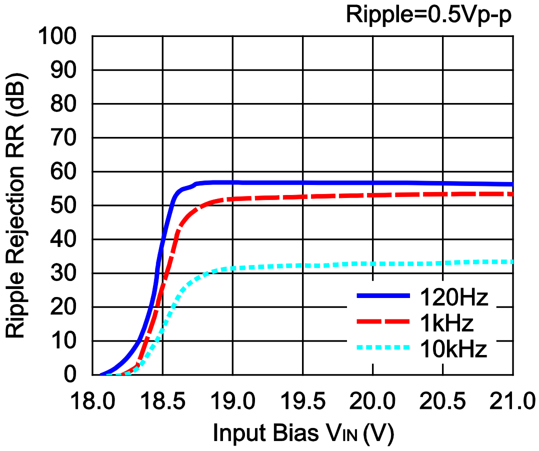
R1501x090B

Ripple=0.2Vp-p



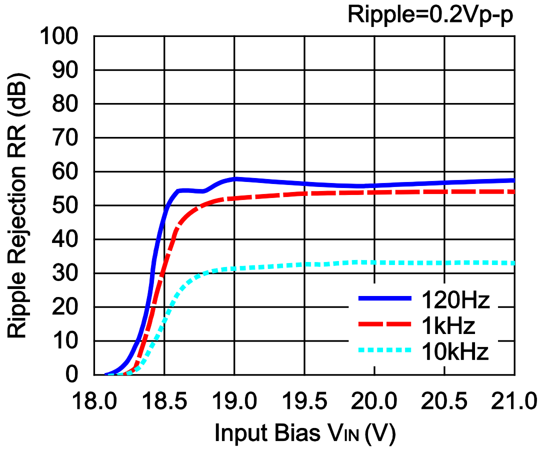
R1501x180B

Ripple=0.5Vp-p



R1501x180B

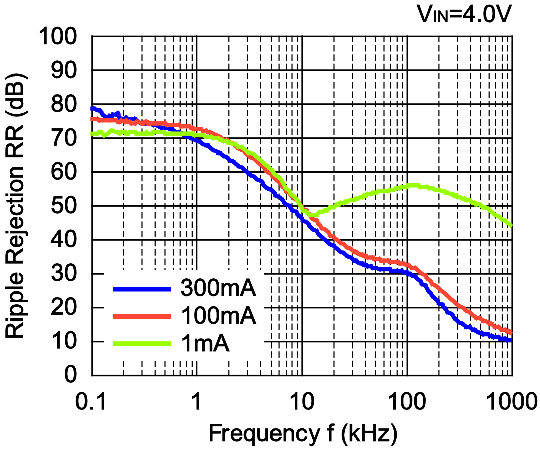
Ripple=0.2Vp-p



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

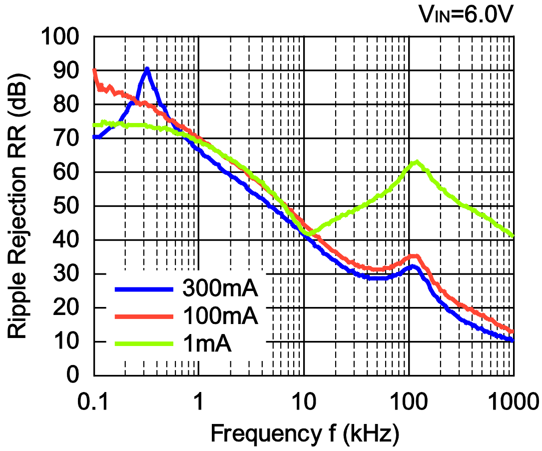
R1501x030B

V_{IN}=4.0V

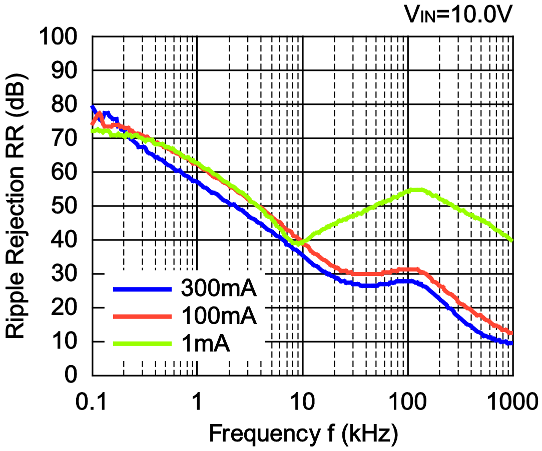


R1501x050B

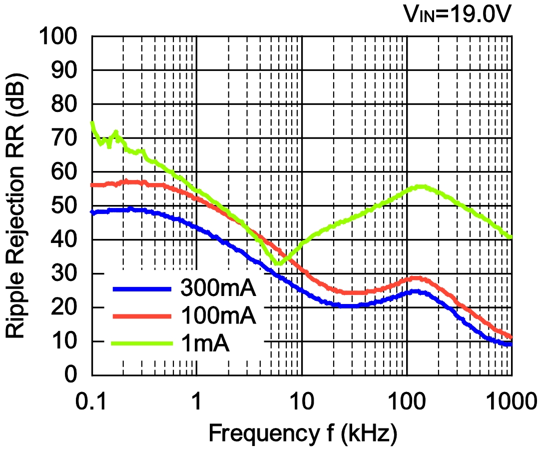
V_{IN}=6.0V



R1501x090B

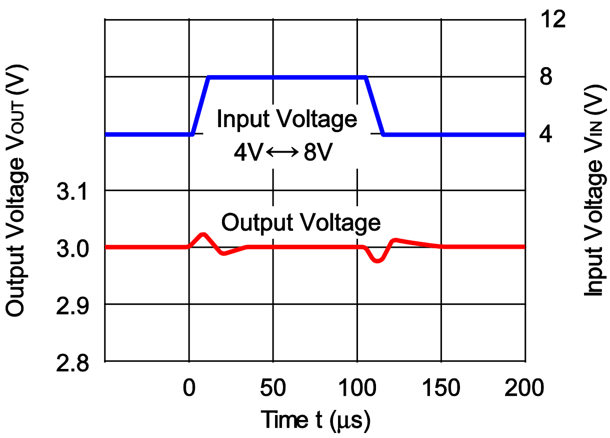


R1501x180B

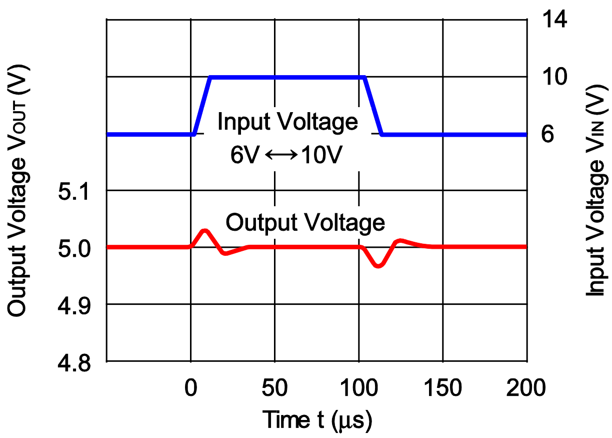


10) Input Transient Response (C_{IN} = none, C_{OUT} = Ceramic 10 µF, I_{OUT} = 100 mA, tr = tf = 10 µs)

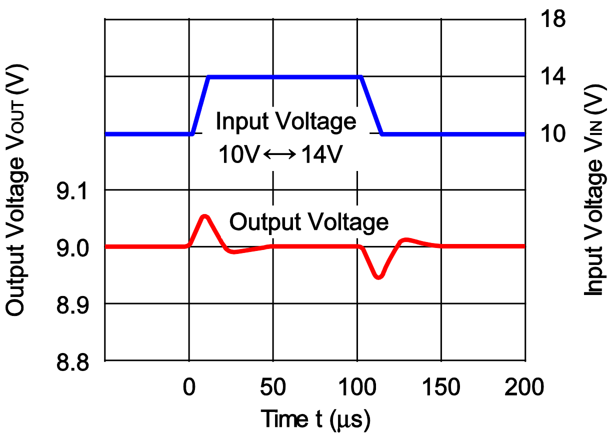
R1501x030B



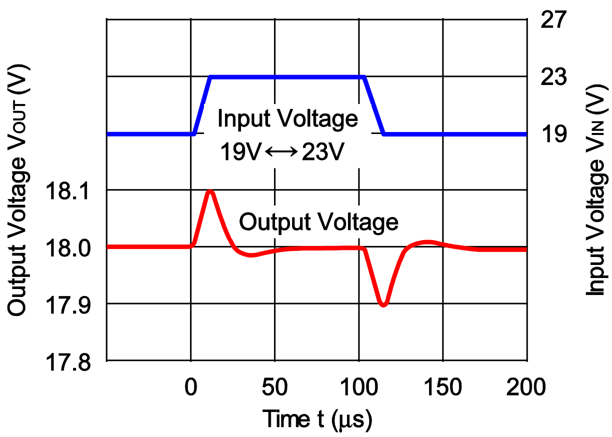
R1501x050B



R1501x090B

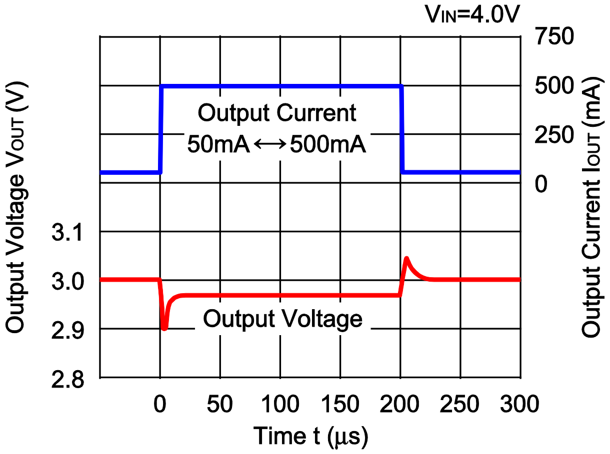


R1501x180B

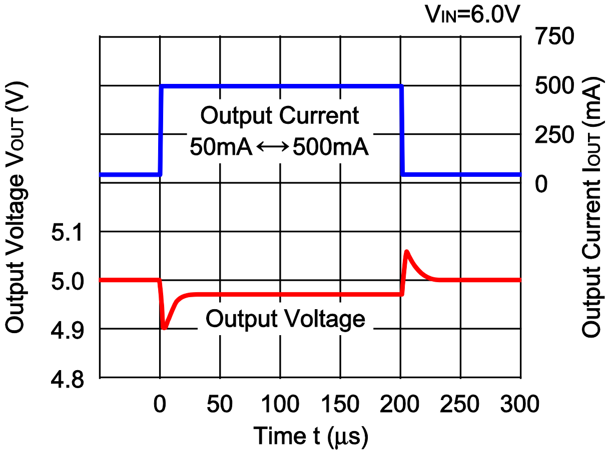


11) Load Transient Response (C_{IN} = Ceramic 0.47 µF, C_{OUT} = Ceramic 10 µF, tr = tf = 0.5 µs)

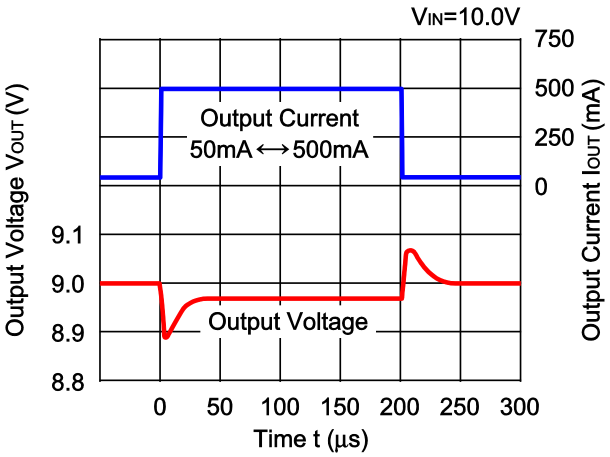
R1501x030B



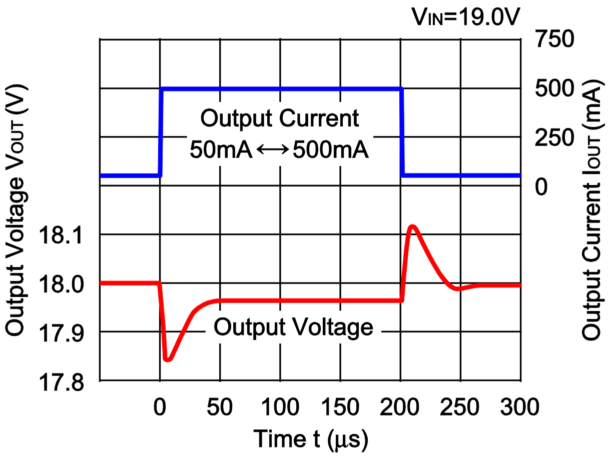
R1501x050B



R1501x090B

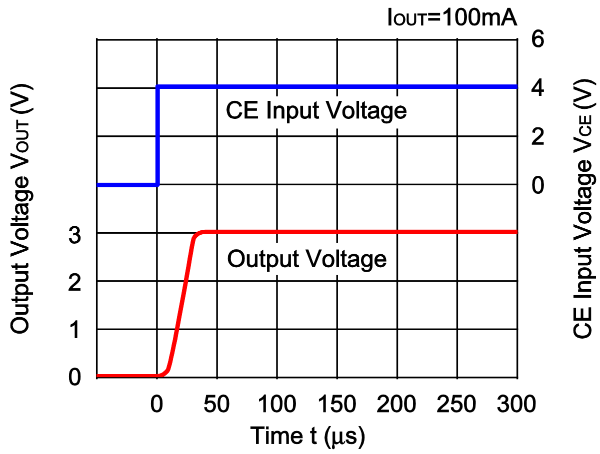


R1501x180B

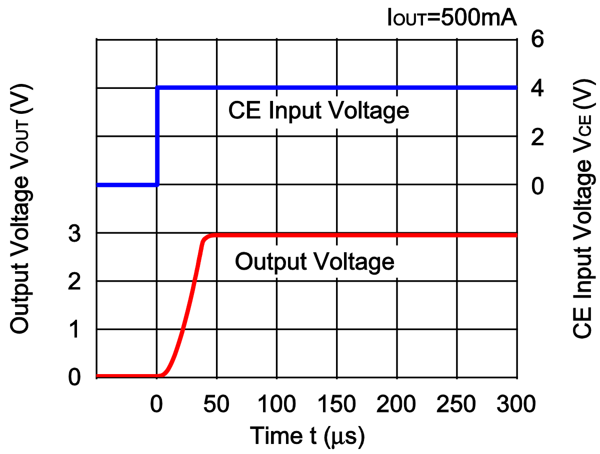


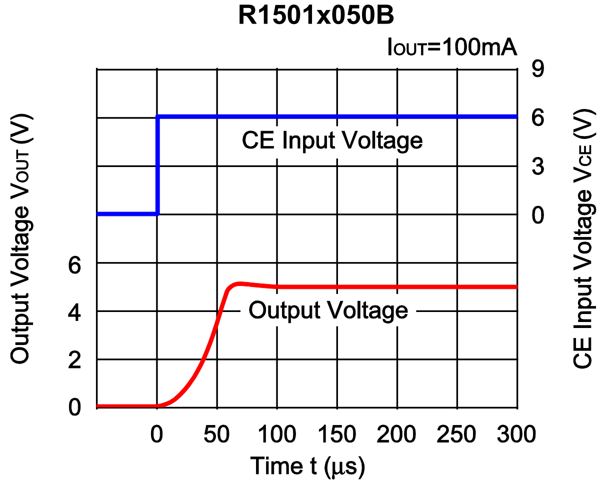
12) Turn On Speed with CE pin (C_{IN} = Ceramic 0.47 µF, C_{OUT} = Ceramic 10 µF, tr = tf = 0.5 µs)

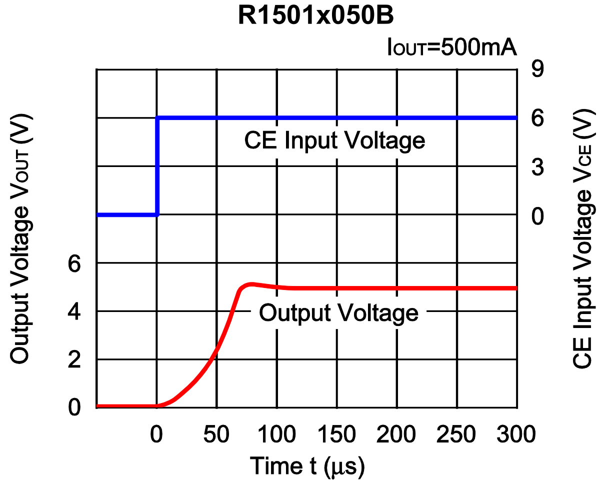
R1501x030B

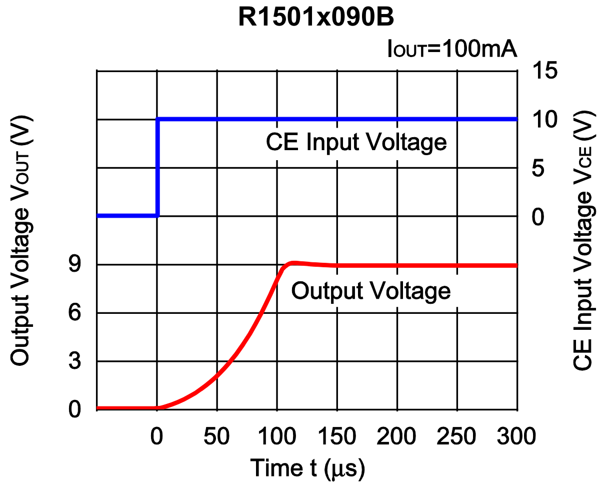


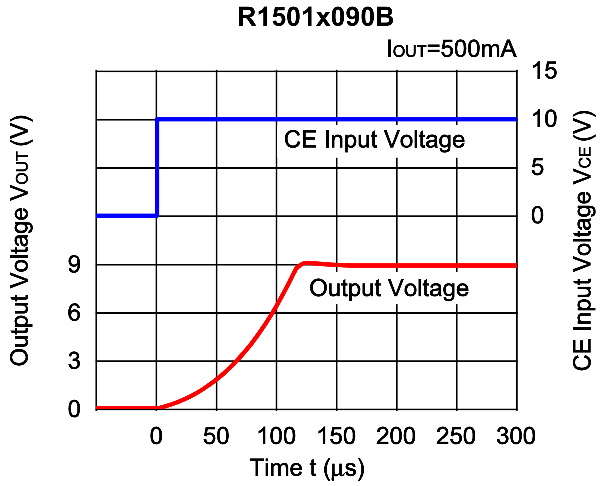
R1501x030B

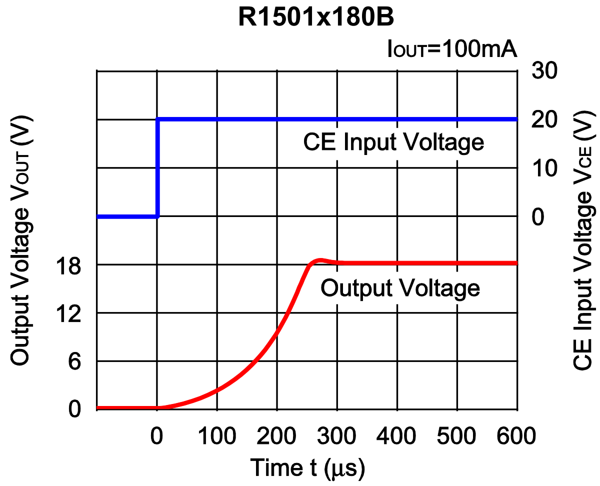


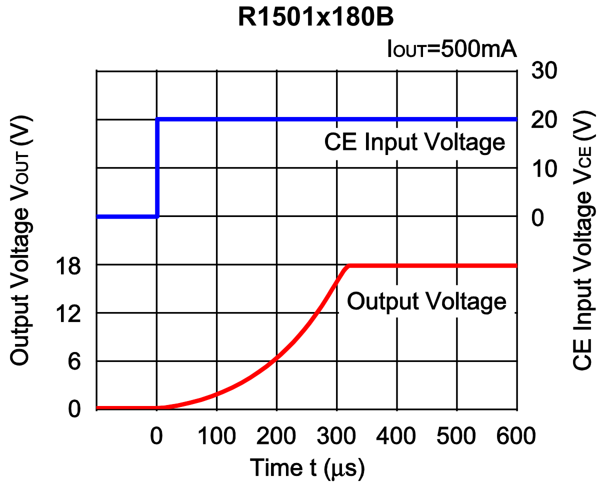

R1501x050B
IOUT=100mA
CE Input Voltage
Output Voltage
Output Voltage VOUT (V)
CE Input Voltage VCE (V)
Time t (µs)
0
50
100
150
200
250
300
0
2
4
6
0
3
6
9


R1501x050B
IOUT=500mA
CE Input Voltage
Output Voltage
Output Voltage VOUT (V)
CE Input Voltage VCE (V)
Time t (µs)
0
50
100
150
200
250
300
0
2
4
6
0
3
6
9

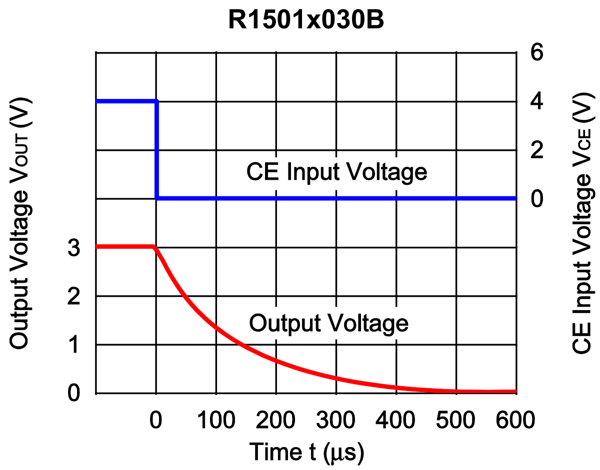

R1501x090B
IOUT=100mA
CE Input Voltage
Output Voltage
Output Voltage VOUT (V)
CE Input Voltage VCE (V)
Time t (µs)
0
50
100
150
200
250
300
0
3
6
9
0
5
10
15

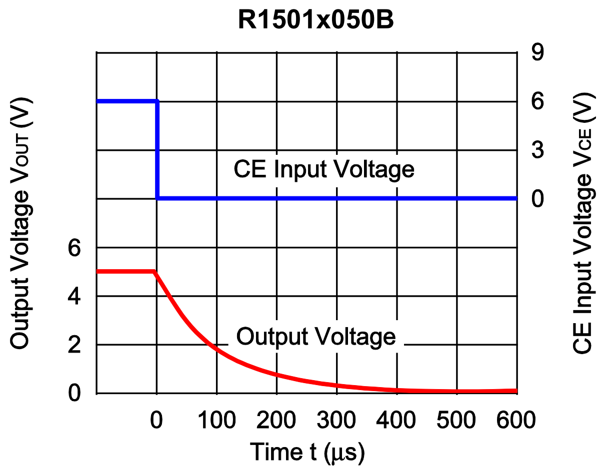

R1501x090B
IOUT=500mA
CE Input Voltage
Output Voltage
Output Voltage VOUT (V)
CE Input Voltage VCE (V)
Time t (µs)
0
50
100
150
200
250
300
0
3
6
9
0
5
10
15

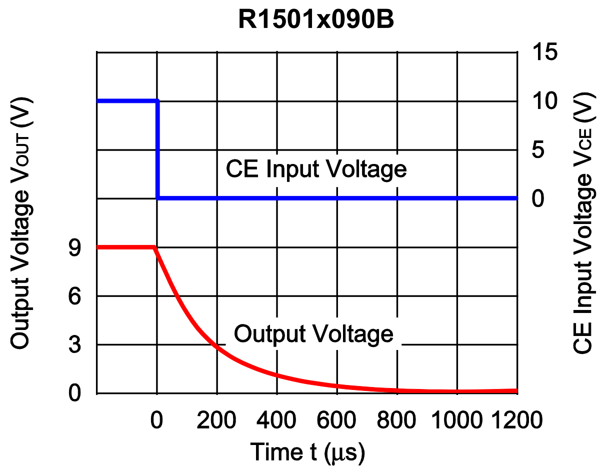

R1501x180B
IOUT=100mA
CE Input Voltage
Output Voltage
Output Voltage VOUT (V)
CE Input Voltage VCE (V)
Time t (µs)
0
100
200
300
400
500
600
0
6
12
18
0
10
20
30

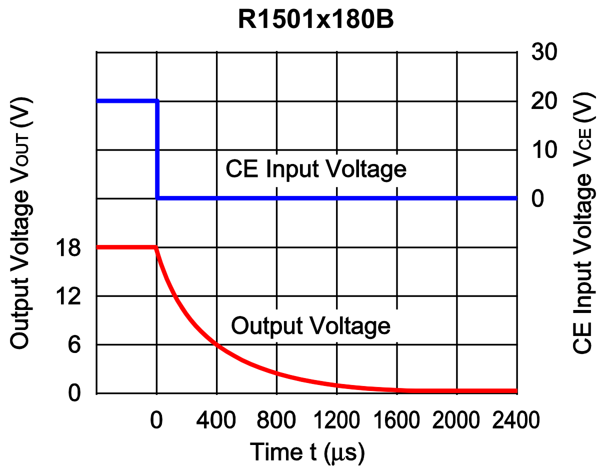

R1501x180B
IOUT=500mA
CE Input Voltage
Output Voltage
Output Voltage VOUT (V)
CE Input Voltage VCE (V)
Time t (µs)
0
100
200
300
400
500
600
0
6
12
18
0
10
20
30

13) Turn Off Speed with CE (C_{IN} = Ceramic 0.47 µF, C_{OUT} = Ceramic 10 µF, I_{OUT} = 500 mA, tr = tf = 0.5 µs)









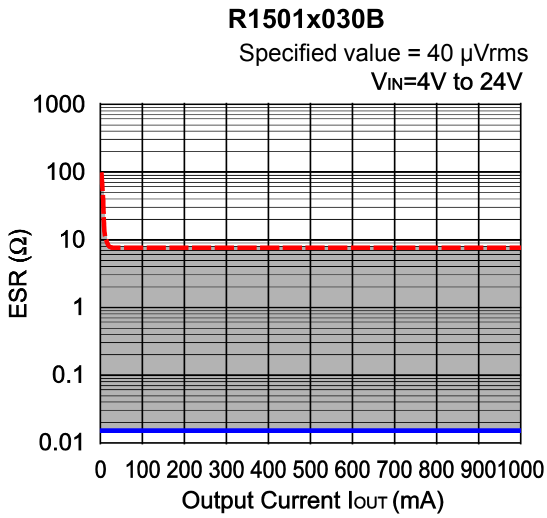
ESR vs. Output Current

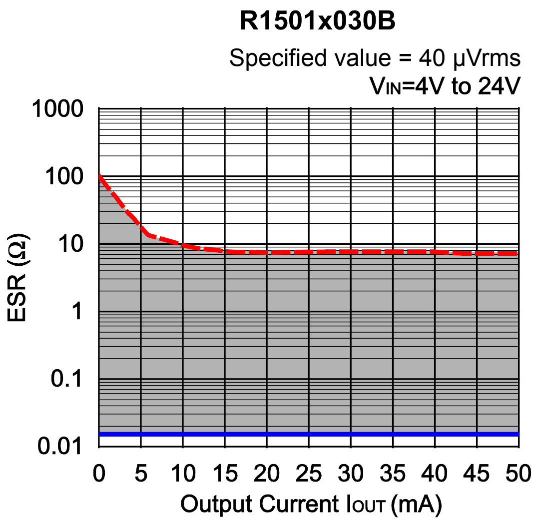
When using this IC, consider the following points:

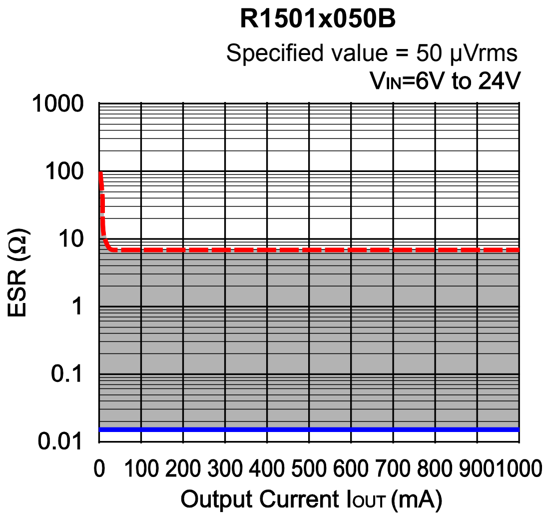
The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.
The conditions when the white noise level is less than or equal to the specified value are marked as the hatched area in the graph.

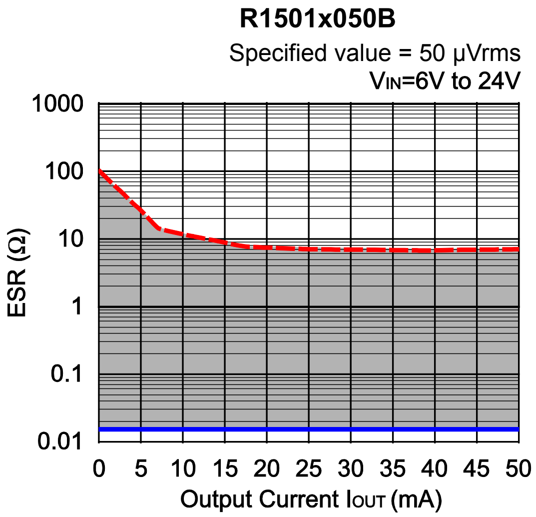
Measurement conditions

Input Voltage: V_{OUT} + 1 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

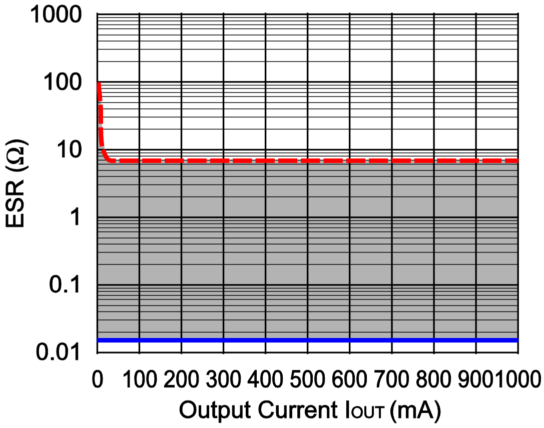




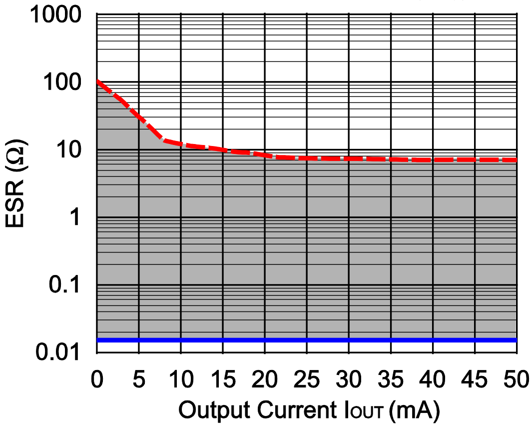




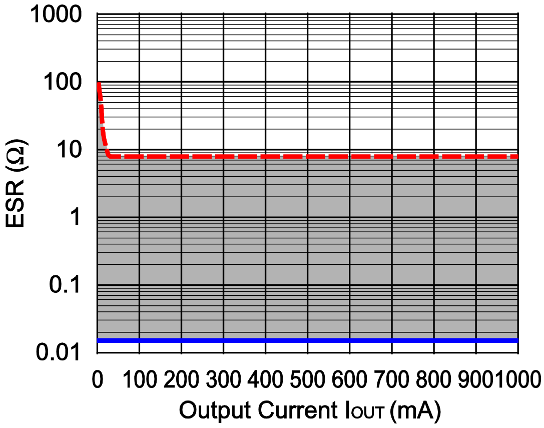
R1501x090B
Specified value = 120 μVrms
V_{IN}=10V to 24V



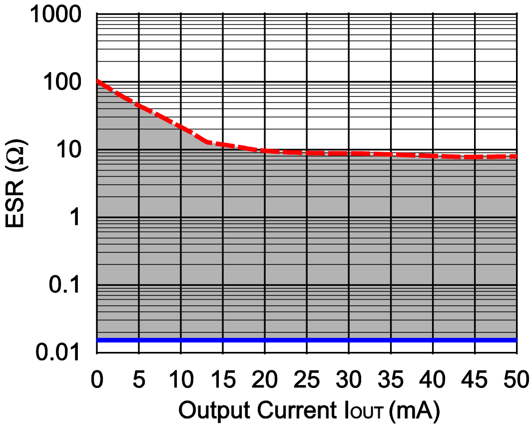
R1501x090B
Specified value = 120 μVrms
V_{IN}=10V to 24V



R1501x180B
Specified value = 220 μVrms
V_{IN}=19V to 24V



R1501x180B
Specified value = 220 μVrms
V_{IN}=19V to 24V



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