1A LDO REGULATOR (Operating Voltage up to 24V)

NO.EA-184-111026

OUTLINE

The R1501x series are CMOS-based positive voltage regulator (VR) ICs. The R1501xxxxB has features of high input voltage operating, 1A output current drive, and low supply current.

A DMOS transistor is used for the driver, high voltage operating and low on resistance (0.6Ω at V_{OUT}=10V) device is realized. A standard regulator circuit with a current limit circuit and a thermal shutdown circuit are built in the R1501x series.

As the operating temperature range is from -40°C to 105°C and maximum input voltage is up to 24V, the R1501x series are suitable for the constant voltage source for digital home appliances and car accessories.

The regulator output voltage is fixed in the R1501x. Output voltage accuracy is ±2.0% and output voltage range is from 3.0V to 12.0V with a step of 0.1V, and from 12.5V to 18.0V with a step of 0.5V. The chip enable pin realizes ultra low supply current standby mode.

Since the packages for these ICs are the HSOP-6J for high density mounting of the ICs on boards, and the TO-252-5-P2.

∗) The DMOS (Double Diffused MOS) transistor adopted by R1501x 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. The R1501x series possess 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

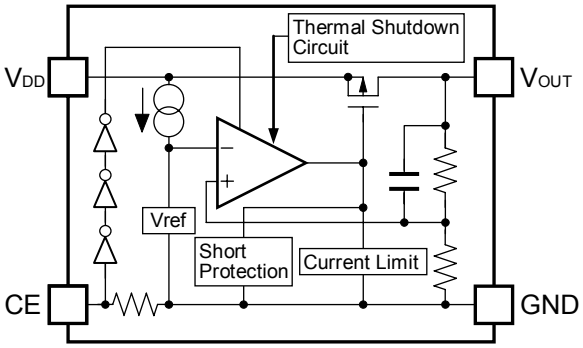
- Supply Current ..... Typ. 70μA
- Standby Current ..... Typ. 0.1μA
- Output Current ..... Min. 1A
- Input Voltage Range ..... 3.0V to 24.0V
- Ripple Rejection ..... Typ. 60dB (V_{OUT}=5.0V)
- Output Voltage Range ..... 3.0V to 12.0V (0.1V steps)
  12.5V to 18.0V (0.5V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Output Voltage Accuracy ..... ±2%
- Temperature-Drift Coefficient of Output Voltage ..... Typ. ±100ppm/°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 home appliances such as refrigerators, rice cookers, electric water warmers, etc.
- Power source for car audio equipment, car navigation system, ETC system, etc.
- Power source for notebook PCs, digital TVs, cordless phones, and private LAN system, etc.
- Power source for office equipment machines such as copiers, printers, facsimiles, scanners, projectors, etc.

BLOCK DIAGRAMS

R1501xxxxB



SELECTION GUIDE

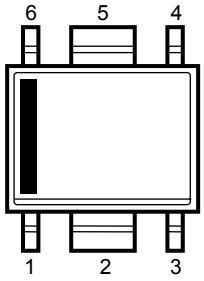
The output voltage, package, etc. for the ICs can be selected at the user's request.

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

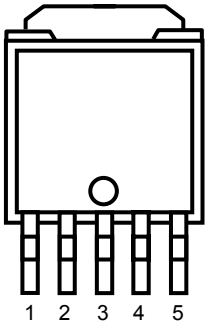
xxx : The output voltage can be designated in the range from 3.0V(030) to 12.0V(120) in 0.1V steps and 12.5V(125) to 18.0V(180) in 0.5V steps.
(For other voltages, please refer to MARK INFORMATIONS.)

PIN CONFIGURATIONS

● **HSOP-6J**



● **TO-252-5-P2**



PIN DESCRIPTIONS

● **HSOP-6J**

Pin No	Symbol	Pin Description
1	V_{DD}	Input Pin
2	GND*	Ground Pin
3	GND*	Ground Pin
4	CE	Chip Enable Pin ("H" Active)
5	GND*	Ground Pin
6	V_{OUT}	Output Pin

∗) No.2, No.3 and No.5 pins must be wired short each other and connected to the GND plane when it is mounted on board.

● **TO-252-5-P2**

Pin No	Symbol	Pin Description
1	V_{DD}	Input Pin
2	GND*	Ground Pin
3	GND*	Ground Pin
4	CE	Chip Enable Pin ("H" Active)
5	V_{OUT}	Output Pin

∗) No.2 and No.3 pins must be wired short each other and connected to the GND plane when it is mounted on board.

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)*	1700	mW
	Power Dissipation (TO-252-5-P2)*	1900	
Topt	Operating Temperature Range	−40 to 105	°C
Tj	Operating Junction Temperature Range	−40 to 125	°C
Tstg	Storage Temperature Range	−55 to 125	°C

∗) For Power Dissipation, please refer to PACKAGE 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 (ELECTRICAL CHARACTERISTICS)

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

- **R1501xxxxB**

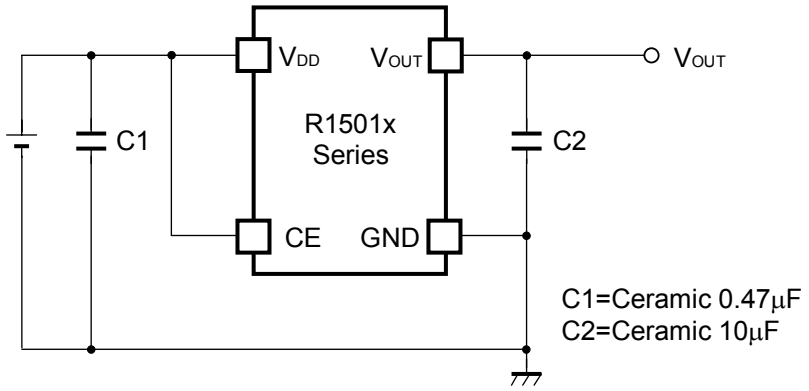
V_{IN}=V_{OUT}+1.0V, V_{CE}=V_{IN}, unless otherwise noted.
The specification in ☐ is checked and guaranteed by design engineering at −40°C ≦ Topt ≦ 105°C.

Topt=25°C

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage			3		24	V
I_{SS}	Supply Current	V_{IN}=24V, I_{OUT}=0A			70	160	μA
Istandby	Standby Current	V_{IN}=24V, V_{CE}=0V			0.1	1.0	μA
V_{OUT}	Output Voltage	I_{OUT}=1mA	Topt=25°C	×0.98		×1.02	V
			−40°C ≦ Topt ≦ 105°C	×0.965		×1.035	V
ΔV_{OUT} /ΔI_{OUT}	Load Regulation	0.1mA ≦ I_{OUT} ≦ 200mA			25	60	mV
		0.1mA ≦ I_{OUT} ≦ 1A *guaranteed by design engineering			125	300	mV
ΔV_{OUT} /ΔV_{IN}	Line Regulation	V_{OUT}+1V ≦ V_{IN} ≦ 24V, I_{OUT}=10mA			0.05	0.1	%/V
V_{DIF}	Dropout Voltage	I_{OUT}=200mA	3.0V ≦ V_{OUT} < 5.0V		0.135	0.225	V
			5.0V ≦ V_{OUT} < 9.0V		0.115	0.180	
			9.0V ≦ V_{OUT} < 12.0V		0.095	0.155	
			12.0V ≦ V_{OUT} ≦ 18.0V		0.090	0.140	
		I_{OUT}=1A *guaranteed by design engineering	3.0V ≦ V_{OUT} < 5.0V		0.675	1.125	V
			5.0V ≦ V_{OUT} < 9.0V		0.575	0.900	
			9.0V ≦ V_{OUT} < 12.0V		0.475	0.775	
			12.0V ≦ V_{OUT} ≦ 18.0V		0.450	0.700	
ΔV_{OUT} /ΔTopt	Output Voltage Temperature Coefficient	I_{OUT}=1mA −40°C ≦ Topt ≦ 105°C			±100		ppm /°C
I_{LIM}	Output Current			1			A
I_{SC}	Short Current Limit	V_{OUT}=0V			65		mA
RR	Ripple Rejection	f=1kHz, Ripple 0.5Vp-p, I_{OUT}=100mA, V_{IN}=V_{OUT}+2V	V_{OUT} ≦ 6.0V		60		dB
			V_{OUT} > 6.0V		50		
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 of unit are tested and specified under load conditions such that Topt=25°C except for Output Voltage Temperature Coefficient, Ripple Rejection, Thermal Shutdown Temperature, Thermal Shutdown Released Temperature, Load Regulation at 0.1mA ≦ I_{OUT} ≦ 1A, Dropout Voltage at I_{OUT}=1A.

TYPICAL APPLICATION



(External Components)
C2: Ceramic 10μF MURATA: GRM32DB31E106K (size: 3225)

TECHNICAL NOTES

When using these ICs, consider the following points:

Phase Compensation

In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use a capacitor C2 with good frequency characteristics and ESR (Equivalent Series Resistance).

If you use a tantalum type capacitor and ESR value of the capacitor is large, output might be unstable. Evaluate your circuit with considering frequency characteristics.

Depending on the capacitor size, manufacturer, and part number, the bias characteristics and temperature characteristics are different. Evaluate the circuit with actual using capacitors.

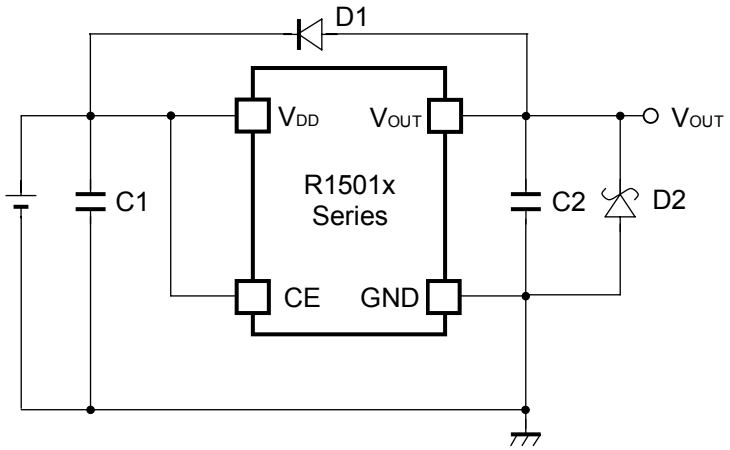
PCB Layout

Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with a capacitance value as much as 0.47μF or more between V_{DD} and GND pin, and as close as possible to the pins.

Set external components, especially the output capacitor C2, as close as possible to the ICs, and make wiring as short as possible.

No.2 pin, No.3 pin and No.5 pin of HSOP-6J package must be wired to the GND plane when it is mounted on board. No.2 pin and No.3 pin of TO-252-5-P2 package must be wired to the GND plane when it is mounted on board.

TYPICAL APPLICATION FOR PREVENTING IC DESTRUCTION

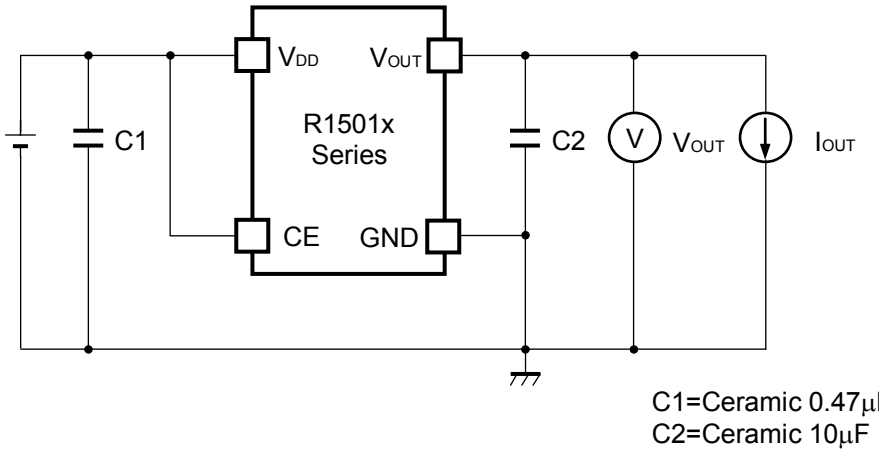


C1: 0.47μF or more (preventing for unstable operation)
C2: 10μF or more (preventing for unstable operation)

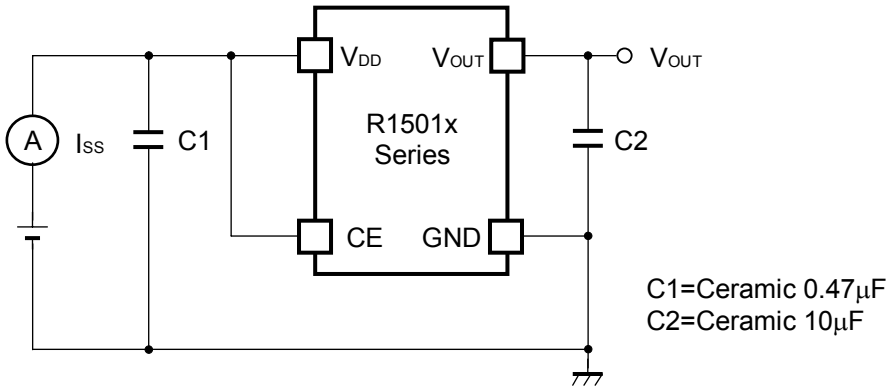
D1: If V_{OUT} pin could be higher than V_{IN} pin, D1 is necessary.
D2: If V_{OUT} pin could be lower than GND pin, SBD is necessary.

Note: Do not force the voltage to V_{OUT} pin.

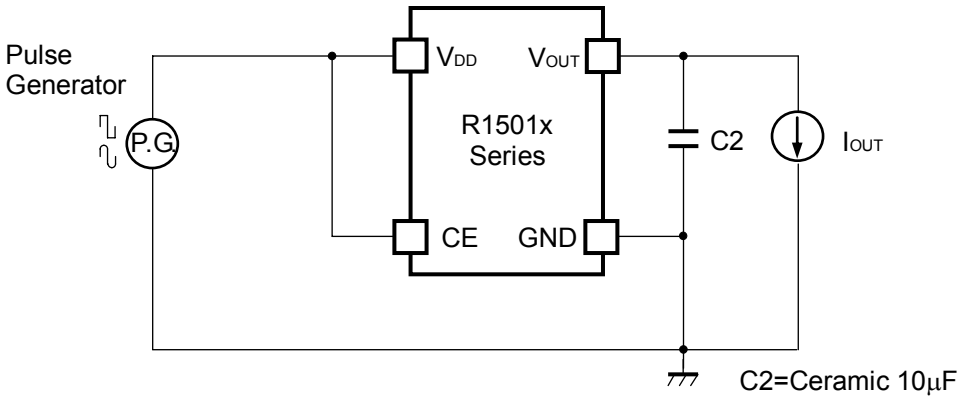
TEST CIRCUITS



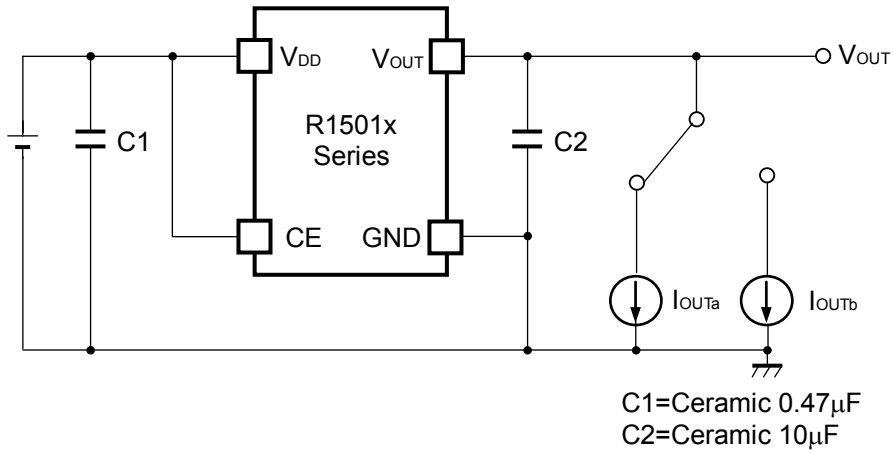
Basic Test Circuit



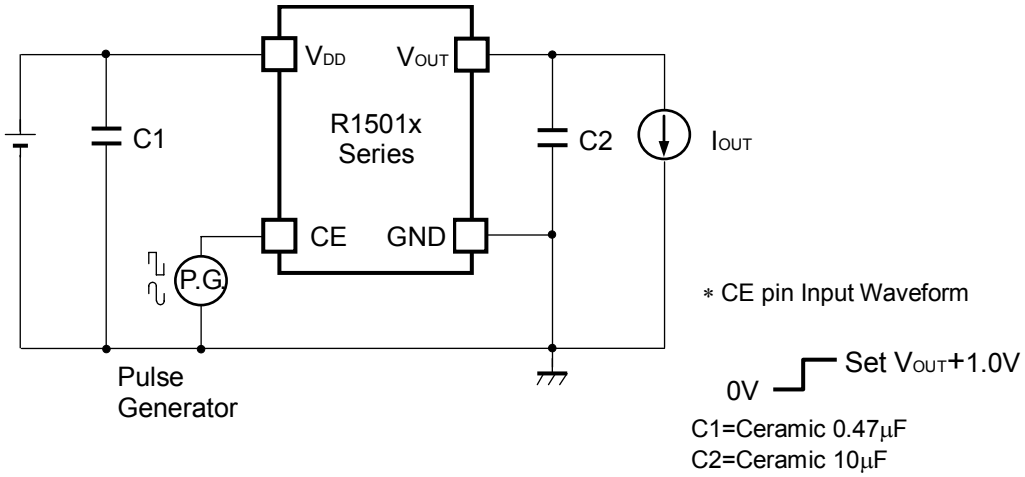
Test Circuit for Supply Current



Test Circuit for Ripple Rejection, Input Transient Response



Test Circuit for Load Transient Response



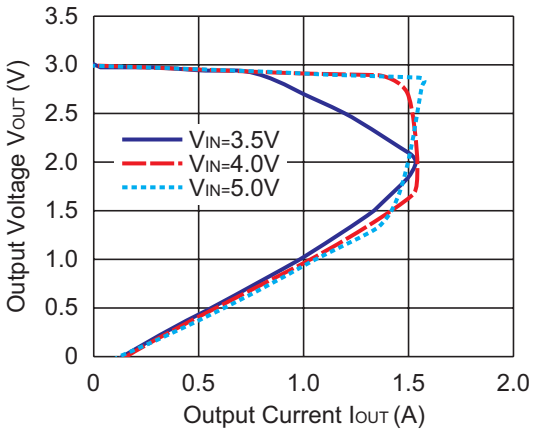
Test Circuit for Turn On Speed with CE pin

TYPICAL CHARACTERISTICS

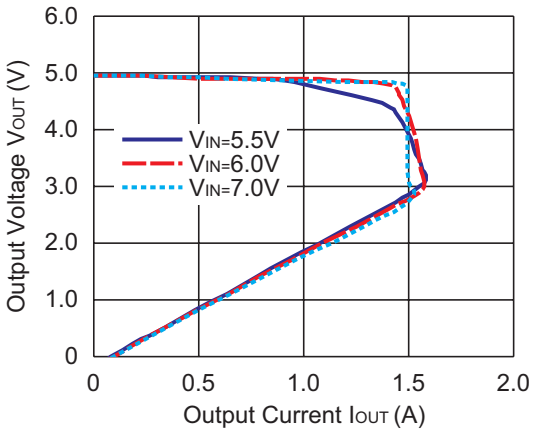
∗Topt=25°C, unless otherwise noted.

1) Output Voltage vs. Output Current (C1=Ceramic 0.47µF, C2=Ceramic 10µF)

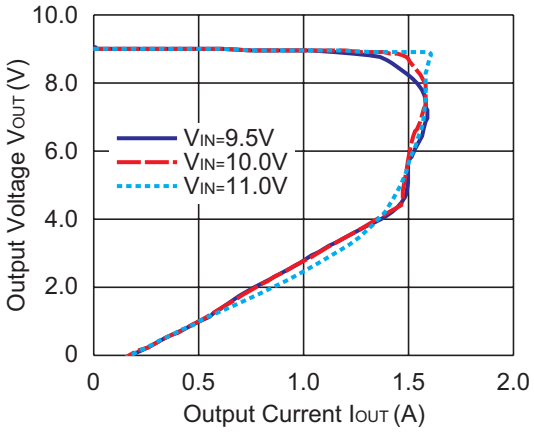
R1501x030B



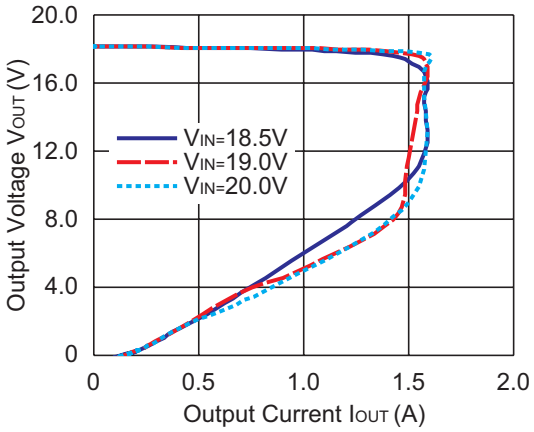
R1501x050B



R1501x090B

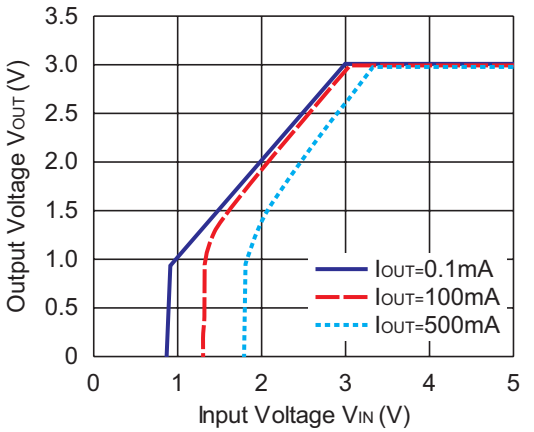


R1501x180B

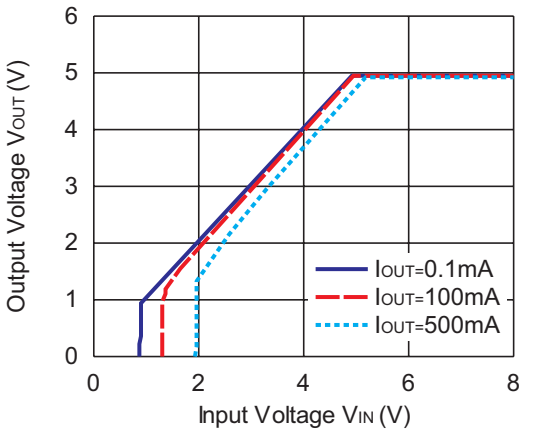


2) Output Voltage vs. Input Voltage (C1=Ceramic 0.47µF, C2=Ceramic 10µF)

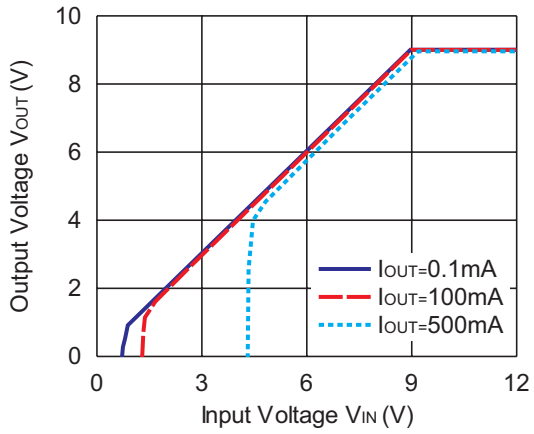
R1501x030B



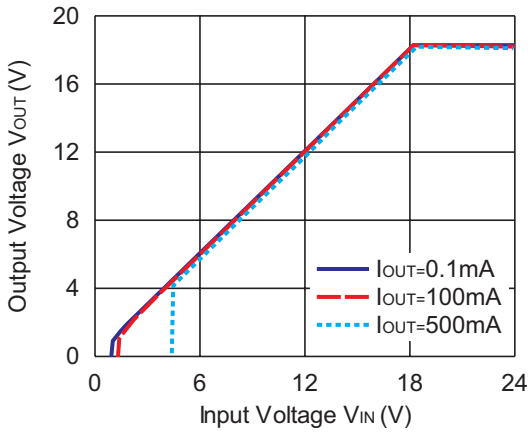
R1501x050B



R1501x090B

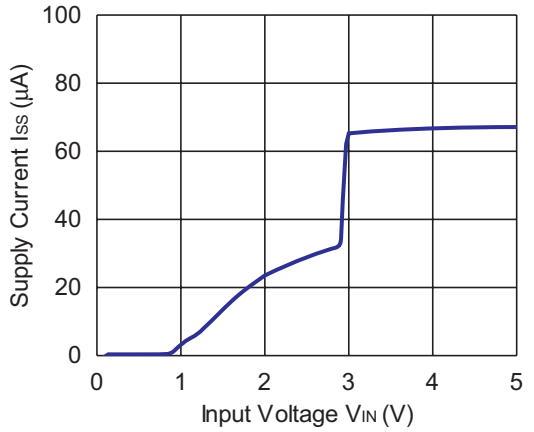


R1501x180B

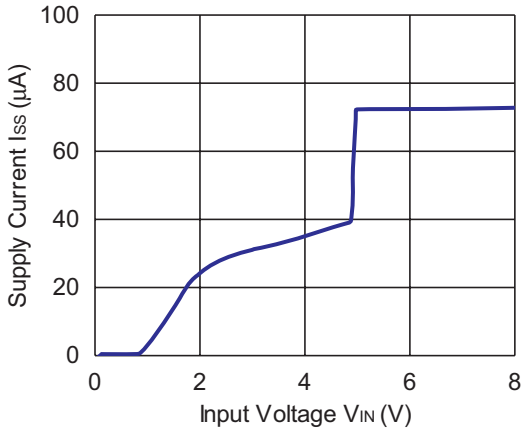


3) Supply Current vs. Input Voltage (C1=Ceramic 0.47µF, C2=Ceramic 10µF)

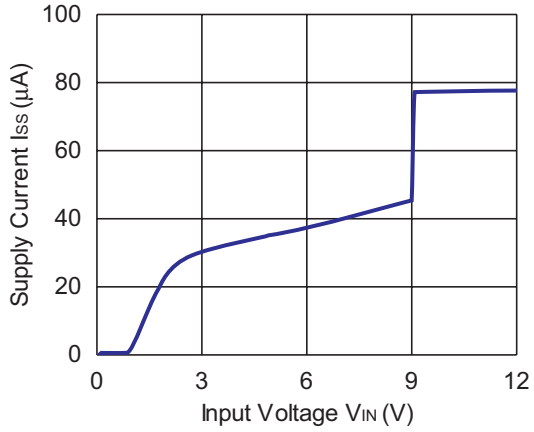
R1501x030B



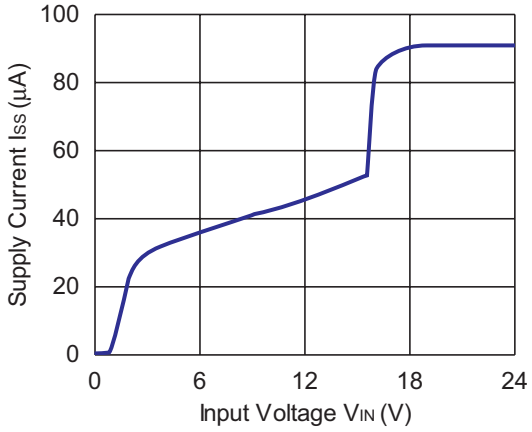
R1501x050B



R1501x090B

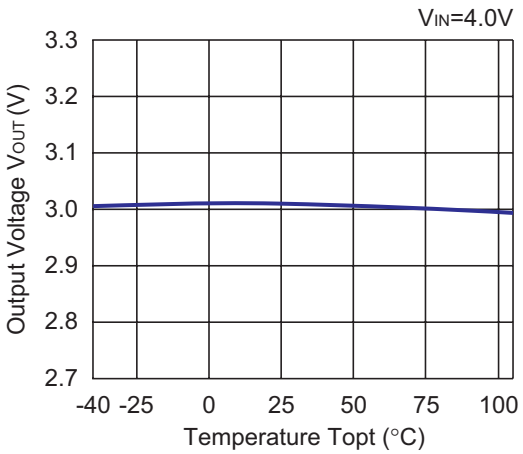


R1501x180B

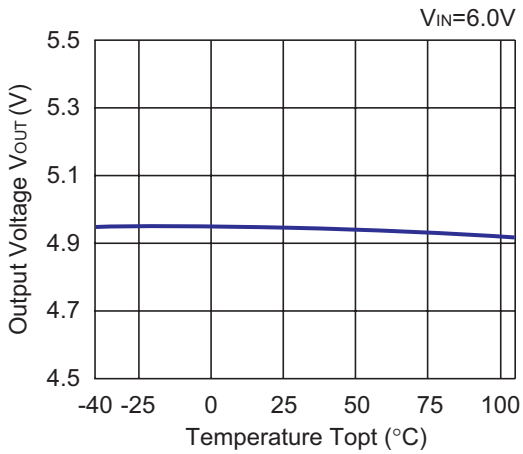


4) Output Voltage vs. Temperature (C1=Ceramic 0.47µF, C2=Ceramic 10µF, I_{OUT}=1mA)

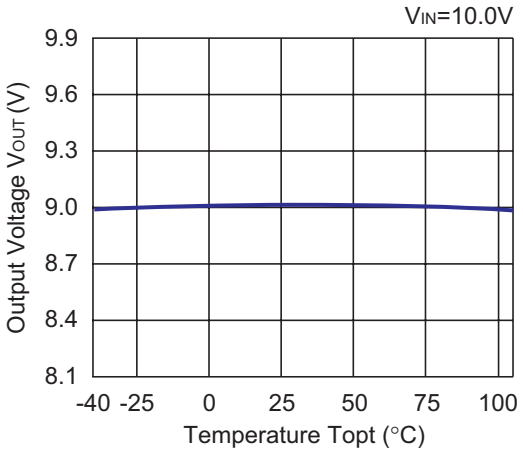
R1501x030B



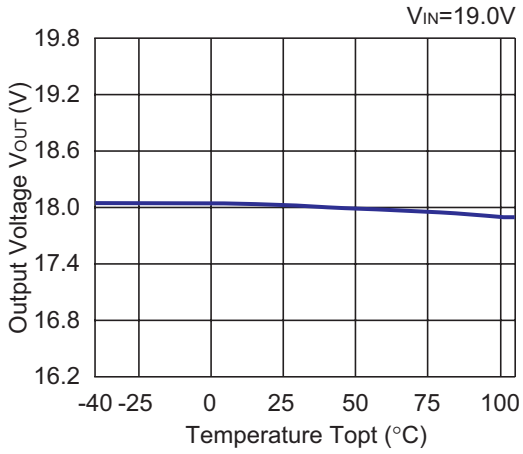
R1501x050B



R1501x090B

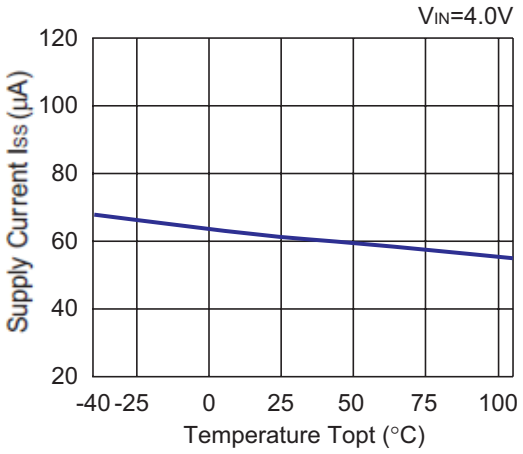


R1501x180B

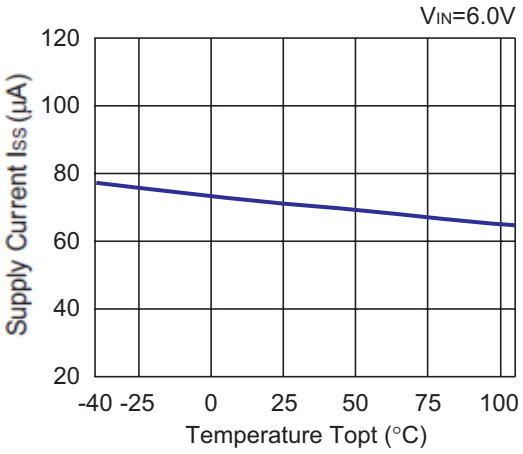


5) Supply Current vs. Temperature (C1=Ceramic 0.47µF, C2=Ceramic 10µF, I_{OUT}=0mA)

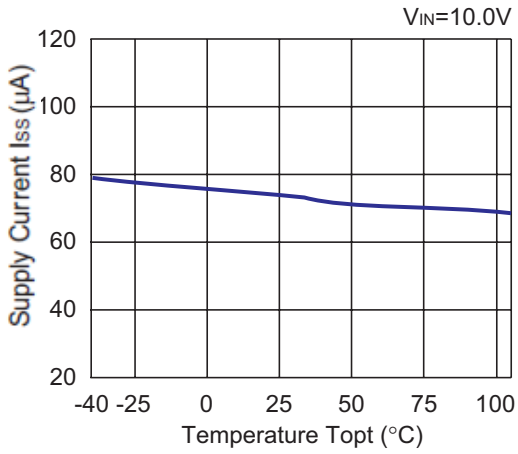
R1501x030B



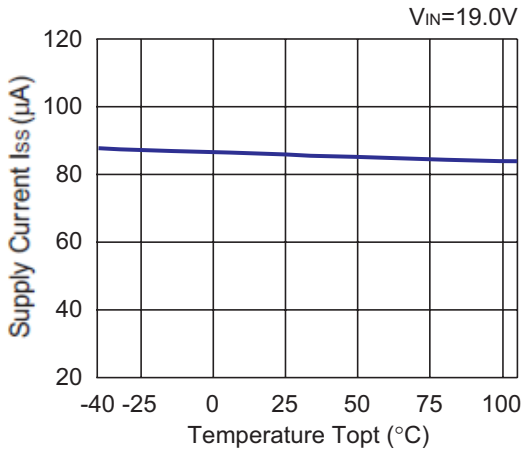
R1501x050B



R1501x090B

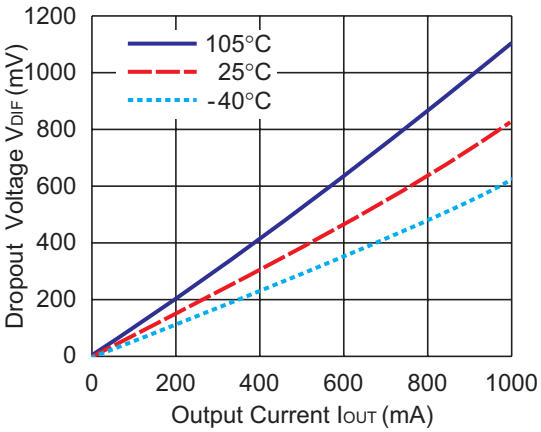


R1501x180B

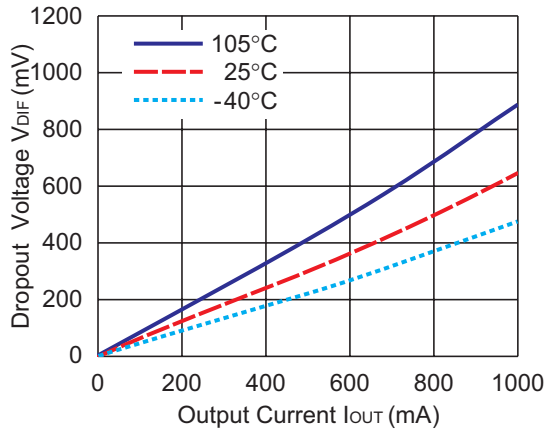


6) Dropout Voltage vs. Output Current (C1=Ceramic 0.47µF, C2=Ceramic 10µF)

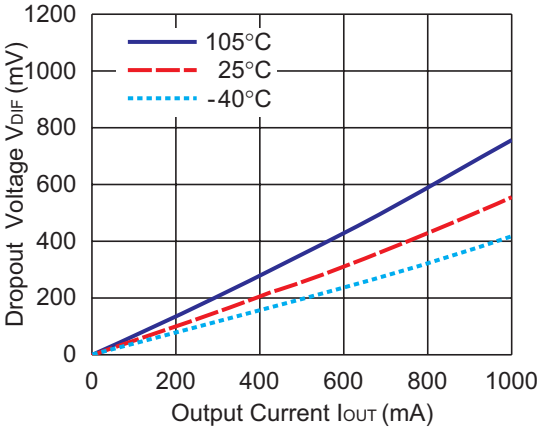
R1501x030B



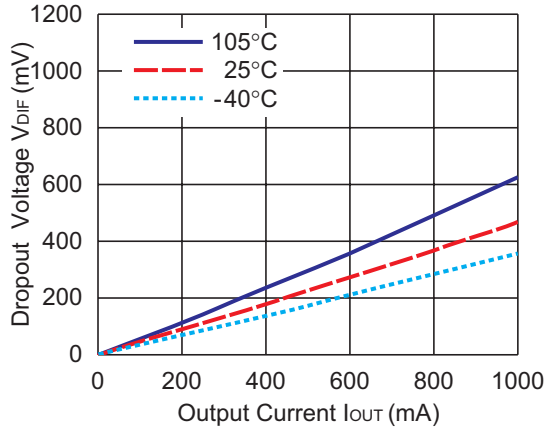
R1501x050B



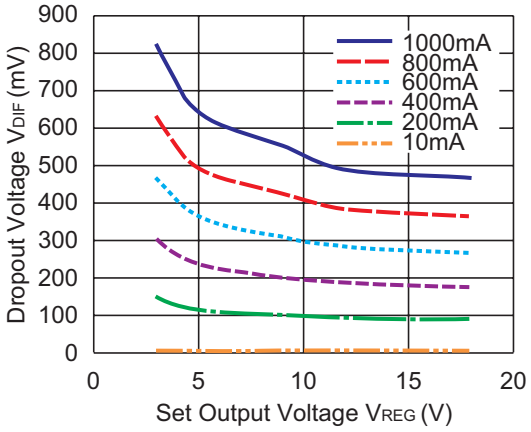
R1501x090B



R1501x180B

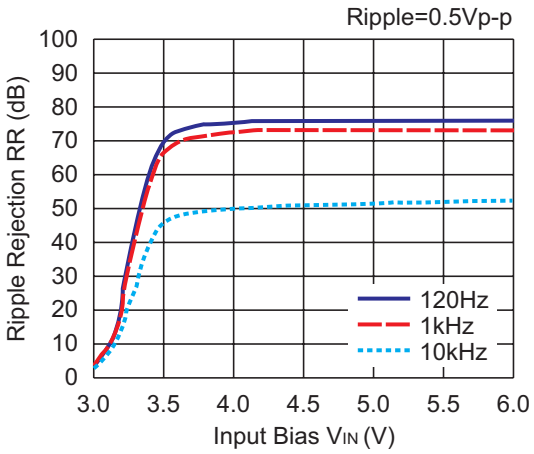


7) Dropout Voltage vs. Set Output Voltage (C1=Ceramic 0.47µF, C2=Ceramic 10µF)

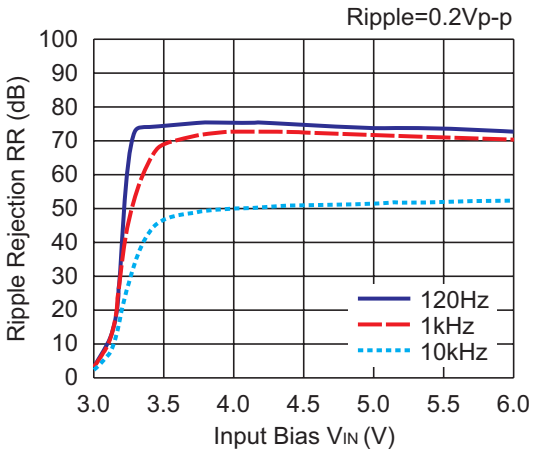


8) Ripple Rejection vs. Input Bias Voltage (C1=none, C2=Ceramic 10µF, I_{OUT}=100mA)

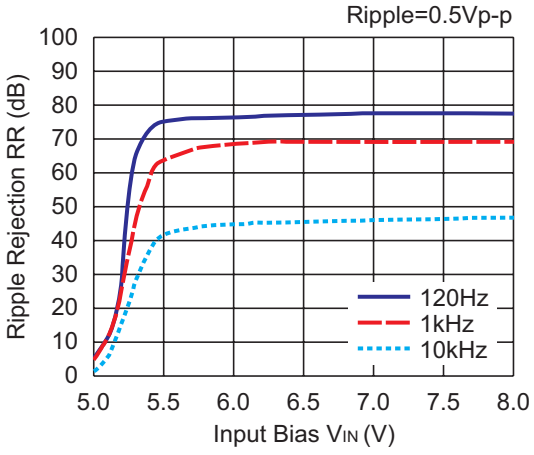
R1501x030B



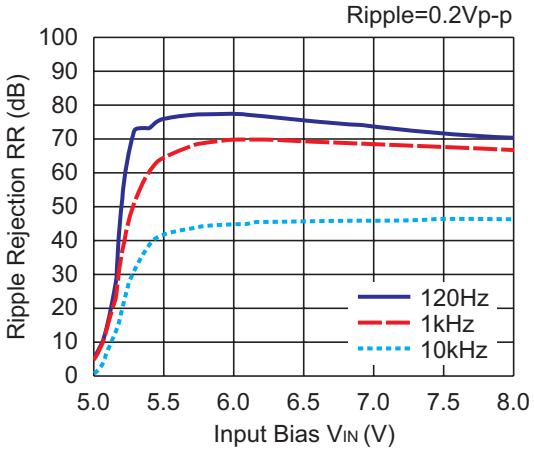
R1501x030B



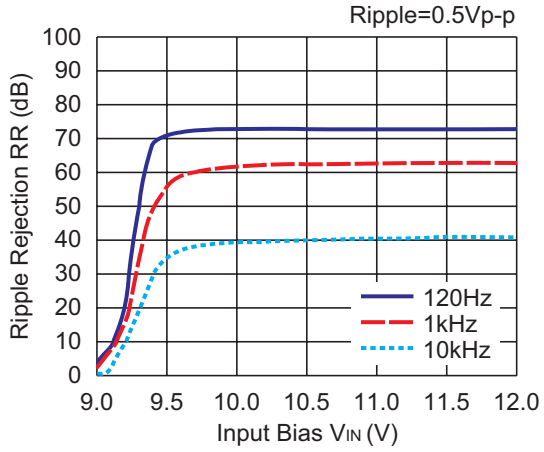
R1501x050B



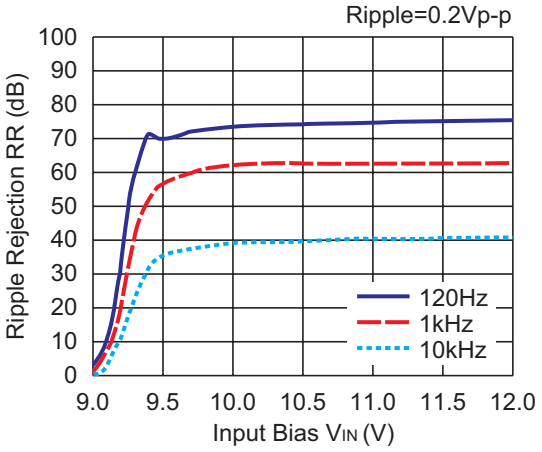
R1501x050B



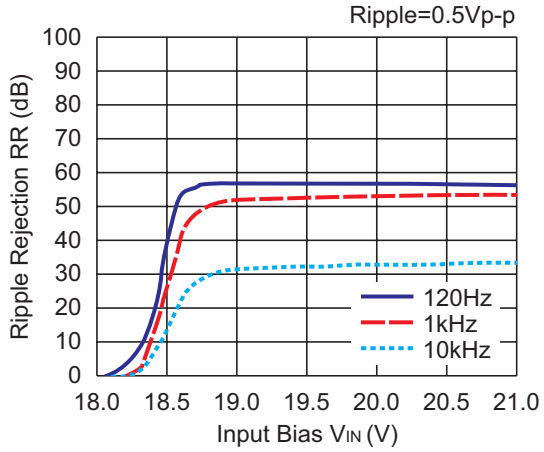
R1501x090B



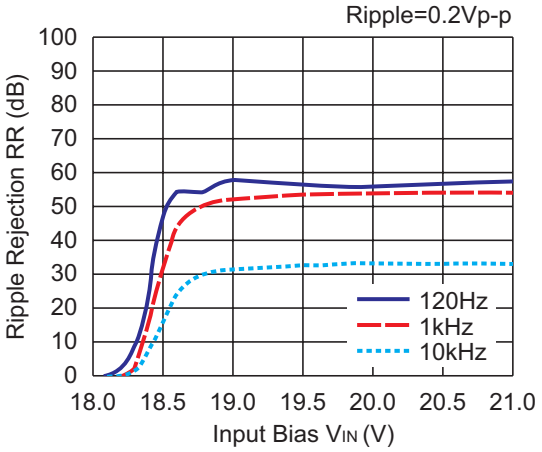
R1501x090B



R1501x180B

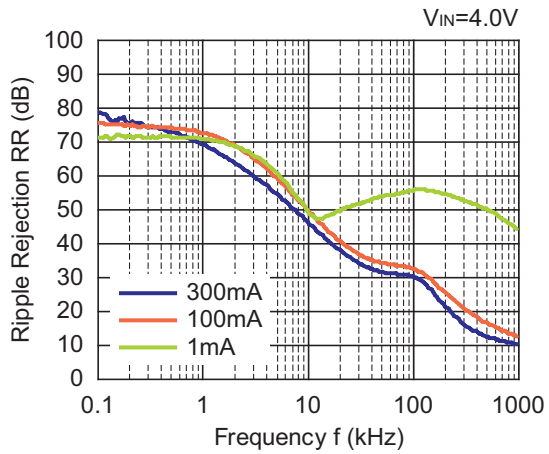


R1501x180B

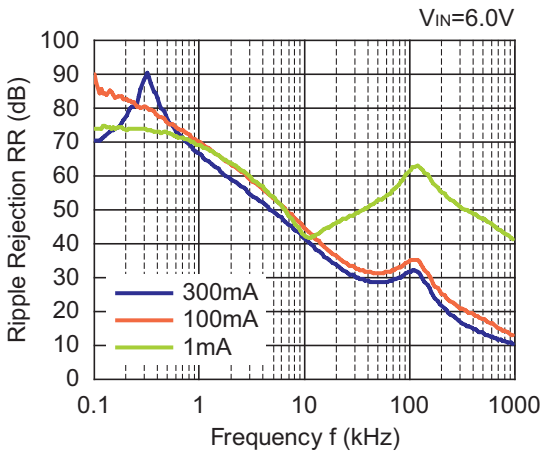


9) Ripple Rejection vs. Frequency (C1=none, C2=Ceramic 10µF, Ripple=0.5V_{p-p})

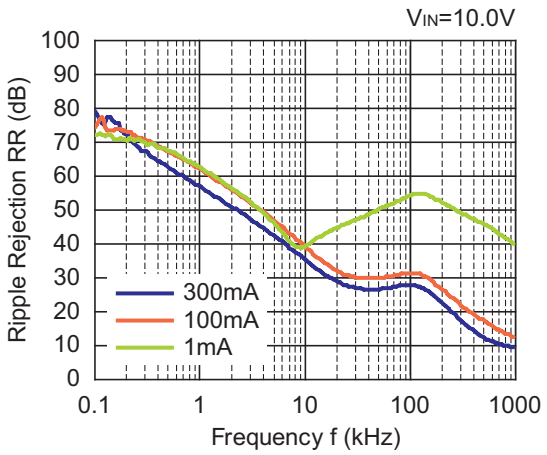
R1501x030B



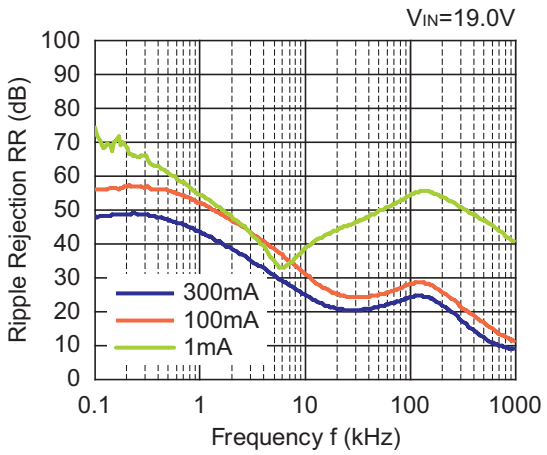
R1501x050B



R1501x090B

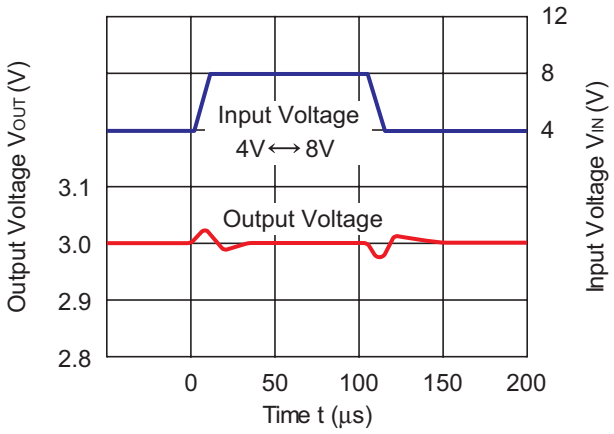


R1501x180B

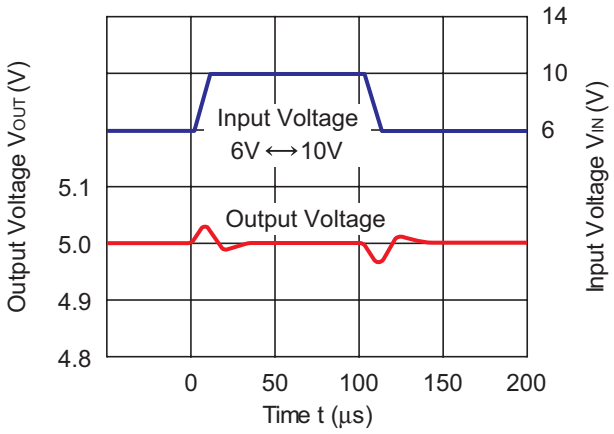


10) Input Transient Response (C1=none, C2=Ceramic 10µF, IOUT=100mA, tr=tf=10µs)

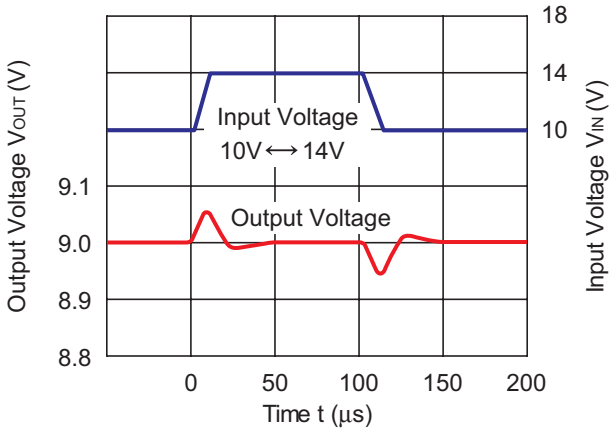
R1501x030B



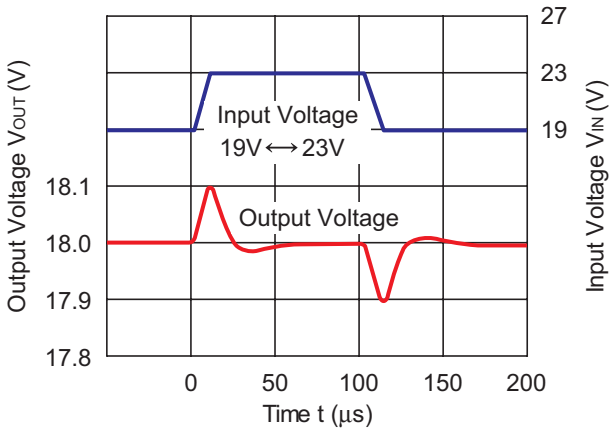
R1501x050B



R1501x090B

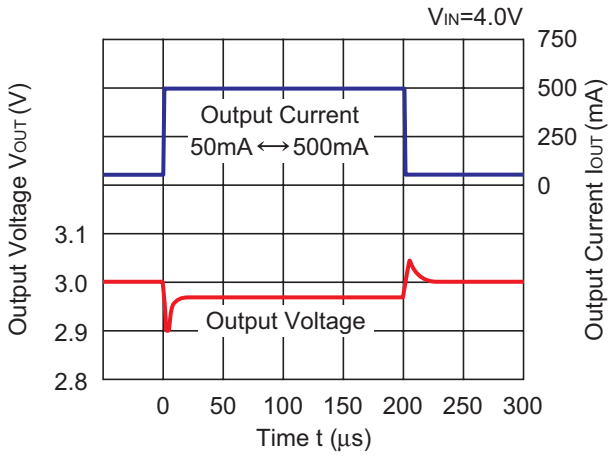


R1501x180B

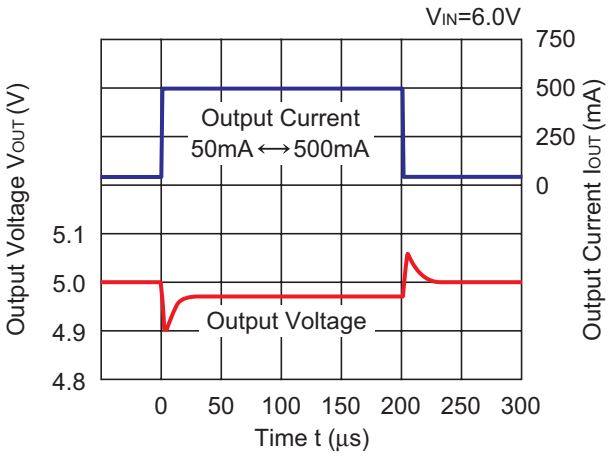


11) Load Transient Response (C1=Ceramic 0.47µF, C2=Ceramic 10µF, tr=tf=0.5µs)

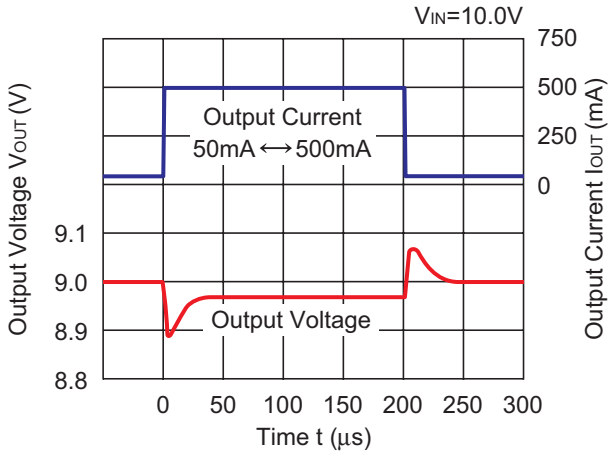
R1501x030B



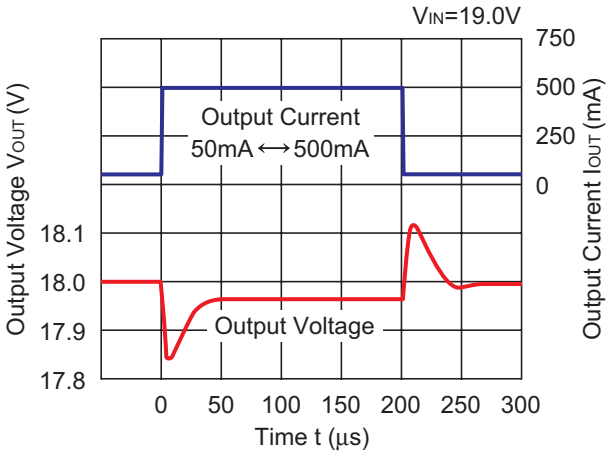
R1501x050B



R1501x090B

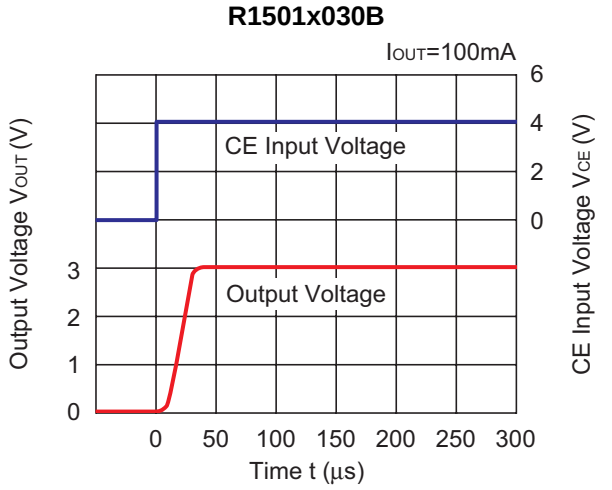


R1501x180B

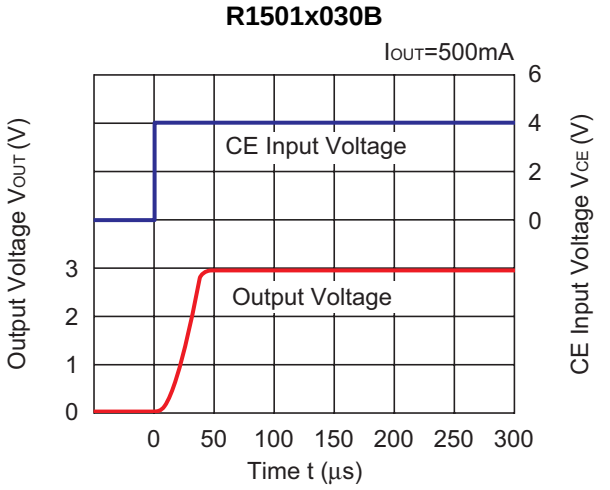


12) Turn On Speed with CE pin (C1=Ceramic 0.47µF, C2=Ceramic 10µF, tr=tf=0.5µs)

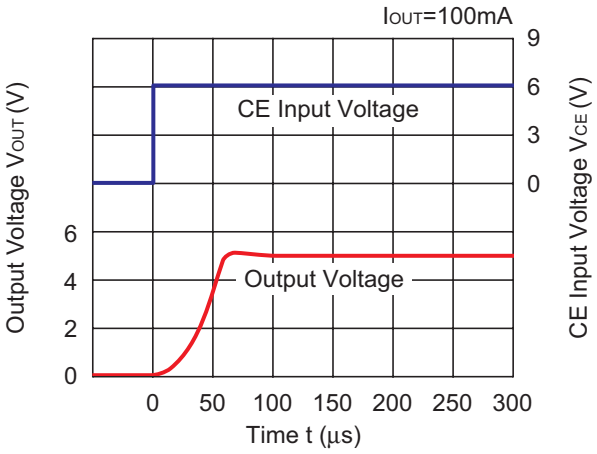
R1501x030B



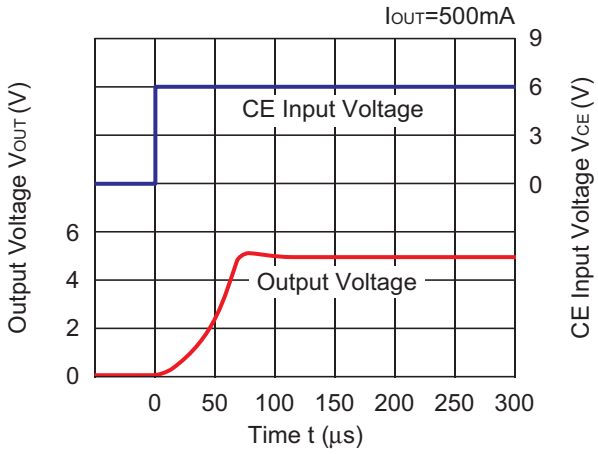
R1501x030B



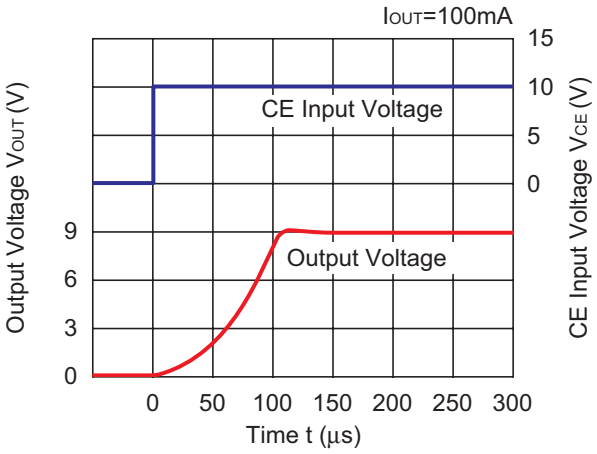
R1501x050B



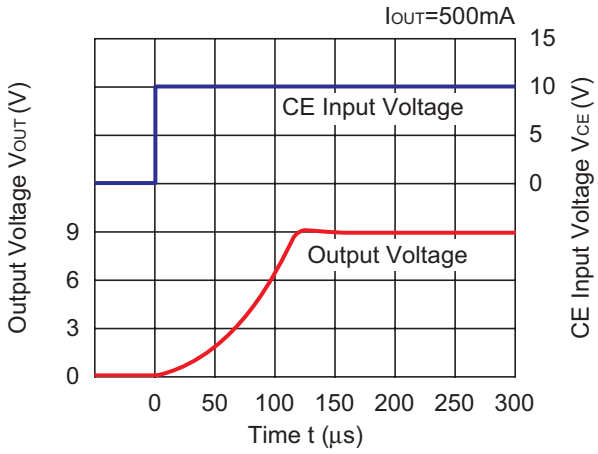
R1501x050B



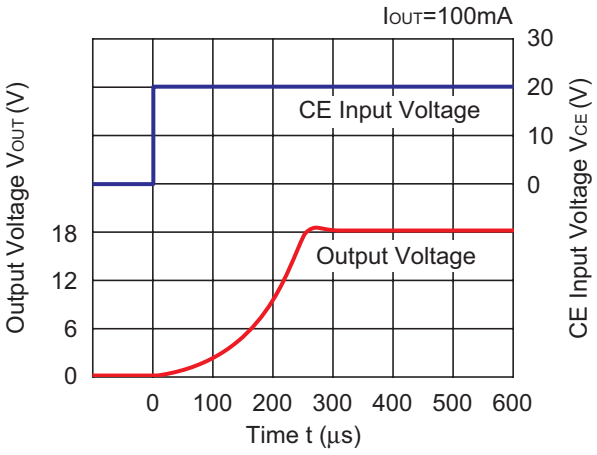
R1501x090B



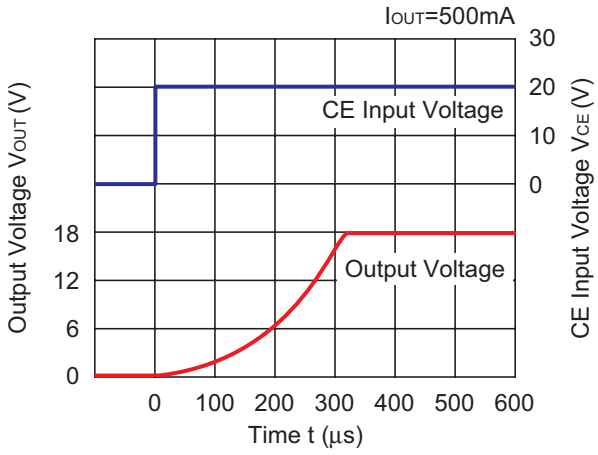
R1501x090B



R1501x180B

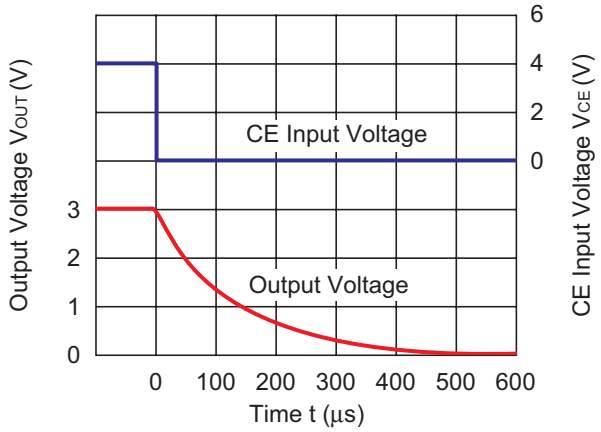


R1501x180B

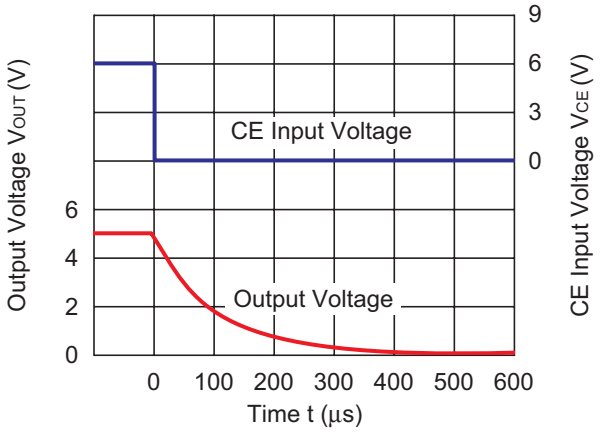


13) Turn Off Speed with CE (C1=Ceramic 0.47µF, C2=Ceramic 10µF, I_{OUT}=500mA, tr=tf=0.5µs)

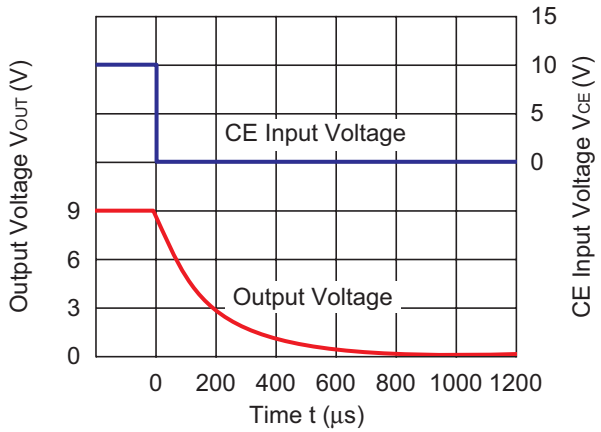
R1501x030B



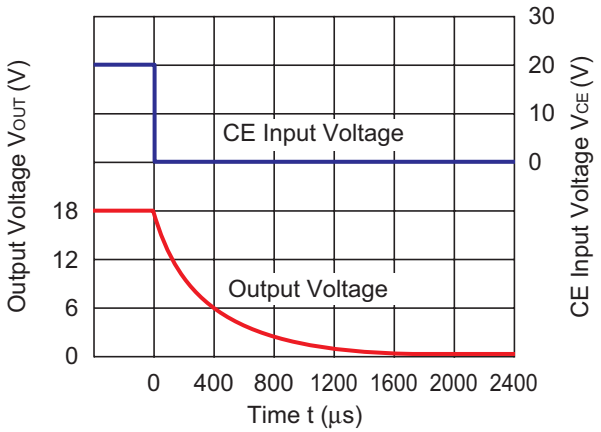
R1501x050B



R1501x090B



R1501x180B



ESR vs. Output Current

When using these ICs, consider the following points:

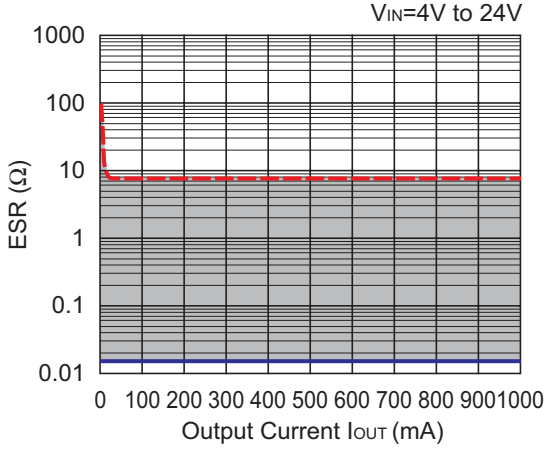
The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.
The conditions when the white noise level is under the specified certain level are marked as the hatched area in the graph.

Measurement conditions

Input Voltage : V_{OUT} +1V to 24V
Frequency Band : 10Hz to 1MHz
Temperature : –40°C to 105°C
Capacitor : C1=Ceramic 0.47µF
C2=Ceramic 10µF

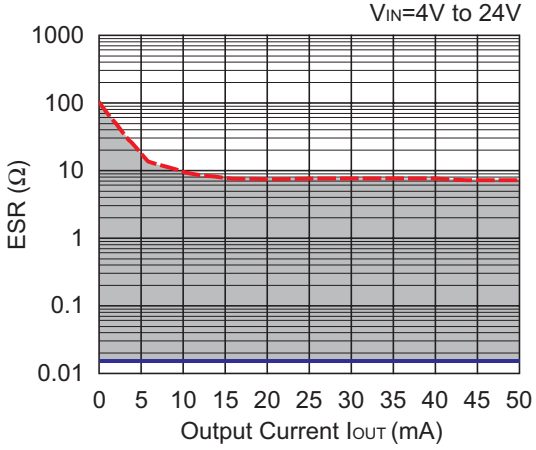
R1501x030B

Noise level ≦ 40µVrms
V_{IN}=4V to 24V



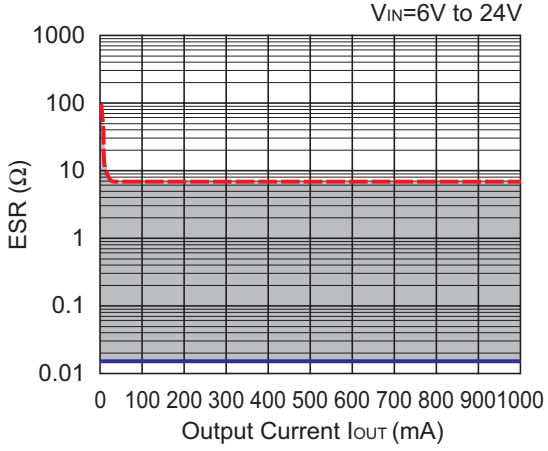
R1501x030B

Noise level ≦ 40µVrms
V_{IN}=4V to 24V



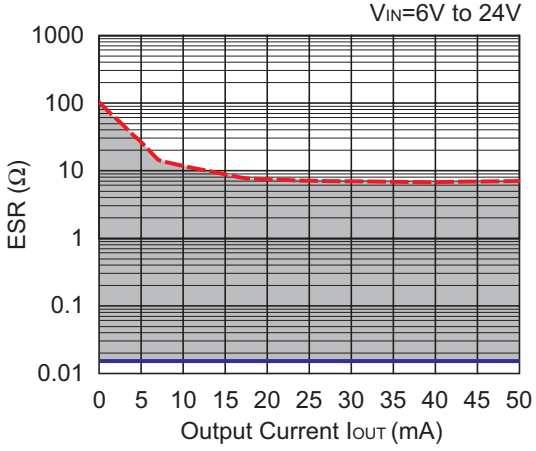
R1501x050B

Noise level ≦ 50µVrms
V_{IN}=6V to 24V



R1501x050B

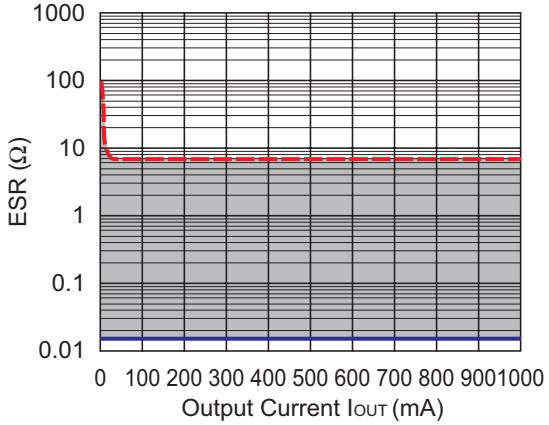
Noise level ≦ 50µVrms
V_{IN}=6V to 24V



R1501x090B

Noise level ≦ 120μVrms

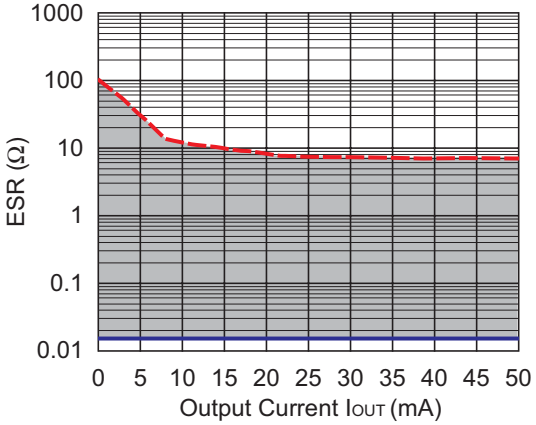
V_{IN}=10V to 24V



R1501x090B

Noise level ≦ 120μVrms

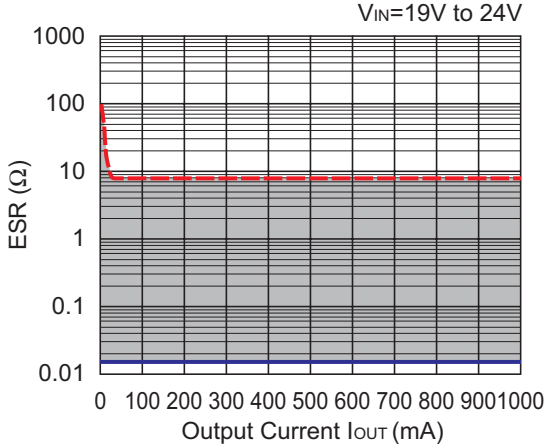
V_{IN}=10V to 24V



R1501x180B

Noise level ≦ 220μVrms

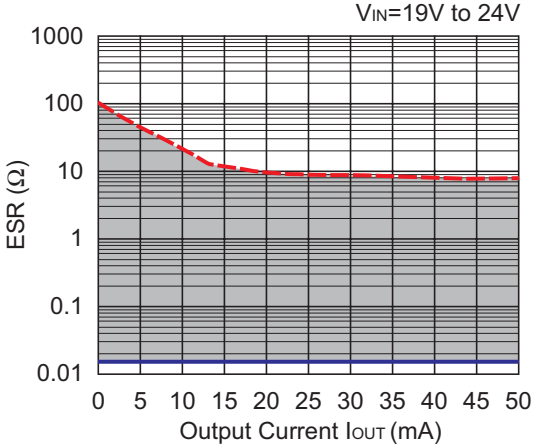
V_{IN}=19V to 24V



R1501x180B

Noise level ≦ 220μVrms

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 Ricoh 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 prior written consent of Ricoh.
3. Please be sure to take any necessary formalities under relevant laws or regulations before exporting or otherwise taking out of your country the products or the technical information described herein.
4. The technical information described in this document shows typical characteristics of 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 Ricoh's or any third party's intellectual property rights or any other rights.
5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). 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 (aircraft, spacevehicle, nuclear reactor control system, traffic control system, automotive and transportation equipment, combustion equipment, safety devices, life support system etc.) should first contact us.
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, firecontainment 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. Anti-radiation design is not implemented in the products described in this document.
8. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.

RICOH COMPANY., LTD. Electronic Devices Company

■Ricoh presented with the Japan Management Quality Award for 1999.
Ricoh continually strives to promote customer satisfaction, and shares the achievements of its management quality improvement program with people and society.

■Ricoh awarded ISO 14001 certification.
The Ricoh Group was awarded ISO 14001 certification, which is an international standard for environmental management systems, at both its domestic and overseas production facilities. Our current aim is to obtain ISO 14001 certification for all of our business offices.

RoHS Compliant
Ricoh completed the organization of the Lead-free production for all of our products. After Apr. 1, 2006, we will ship out the lead free products only. Thus, all products that will be shipped from now on comply with RoHS Directive.

http://www.ricoh.com/LSI/

RICOH COMPANY, LTD.
Electronic Devices Company
● Higashi-Shinagawa Office (International Sales)
3-32-3, Higashi-Shinagawa, Shinagawa-ku, Tokyo 140-8655, Japan
Phone: +81-3-5479-2857 Fax: +81-3-5479-0502

RICOH EUROPE (NETHERLANDS) B.V.
● Semiconductor Support Centre
Prof. W.H.Keesomlaan 1, 1183 DL Amstelveen, The Netherlands
P.O.Box 114, 1180 AC Amstelveen
Phone: +31-20-5474-309 Fax: +31-20-5474-791

RICOH ELECTRONIC DEVICES KOREA Co., Ltd.
11 floor, Haesung 1 building, 942, Daechidong, Gangnamgu, Seoul, Korea
Phone: +82-2-2135-5700 Fax: +82-2-2135-5705

RICOH ELECTRONIC DEVICES SHANGHAI Co., Ltd.
Room403, No.2 Building, 690#Bi Bo Road, Pu Dong New district, Shanghai 201203, People's Republic of China
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

RICOH COMPANY, LTD.
Electronic Devices Company
● Taipei office
Room109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan (R.O.C.)
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623