500mA LDO REGULATOR (Operating Voltage up to 24V)

NO.EA-151-111026

OUTLINE

The R1500x series are CMOS-based positive voltage regulator (VR) ICs. The R1500xxxxB has features of high input voltage operating, 500mA 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 R1500x series.

As the operating temperature range is from -40°C to 105°C and maximum input voltage is up to 24V, the R1500x series are suitable for the constant voltage source for car accessories.

The regulator output voltage is fixed in the R1500x. Output voltage accuracy is ±2.0% and output voltage range is from 3.0V to 12.0V with a step of 0.1V. The chip enable pin realizes ultra low supply current standby mode.

Since the packages for these ICs are the SOT-89-5 for high density mounting of the ICs on boards, and the TO-252-5-P2.

∗) The DMOS (Double Diffused MOS) transistor adopted by R1500x 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 R1500x 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

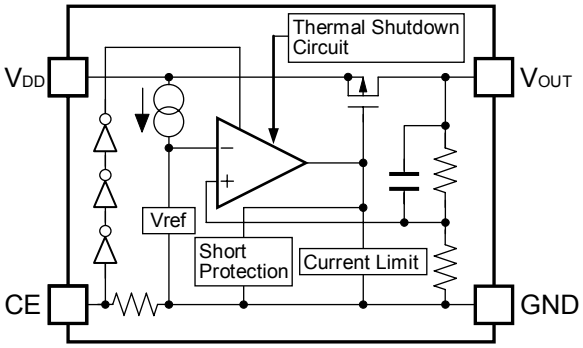
- Input Voltage Range .....4.0V to 24.0V
- Supply Current .....Typ. 70μA
- Standby Current .....Typ. 0.1μA
- Ripple Rejection .....Typ. 60dB (V_{OUT}=5.0V)
- Temperature-Drift Coefficient of Output Voltage .....Typ. ±100ppm/°C
- Output Current.....Min. 500mA (V_{IN}=V_{OUT}+1V)
- Line Regulation .....Typ. 0.05%/V
- Output Voltage Accuracy.....±2%
- Output Voltage.....3.0V to 12.0V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Packages.....SOT-89-5, TO-252-5-P2
- Built-in Current Limit Circuit
- Built-in Fold-Back Circuit
- Built-in Thermal Shutdown Circuit
- Operating Temperature range .....–40°C to 105°C

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

R1500xxxxB



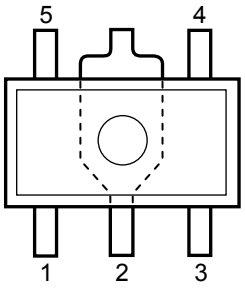
SELECTION GUIDE

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

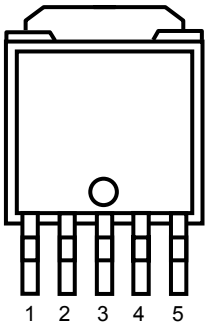
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1500HxxxB-T1-FE	SOT-89-5	1,000 pcs	Yes	Yes
R1500JxxxB-T1-FE	TO-252-5-P2	3,000 pcs	Yes	Yes
xxx : The output voltage can be designated in the range from 3.0V(030) to 12.0V(120) in 0.1V steps. (For other voltages, please refer to MARK INFORMATIONS.)				

PIN CONFIGURATIONS

● **SOT-89-5**



● **TO-252-5-P2**



PIN DESCRIPTIONS

● **SOT-89-5**

Pin No.	Symbol	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

∗) The GND pin must be wired together when it is mounted on board.

● **TO-252-5-P2**

Pin No.	Symbol	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

∗) The GND pin must be wired together when it is mounted on board.

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	36	V
V_{CE}	Input Voltage (CE Pin)	−0.3 to V_{IN} ≦ 36	V
V_{OUT}	Output Voltage	−0.3 to V_{IN} ≦ 36	V
P_D	Power Dissipation (SOT-89-5)*	900	mW
	Power Dissipation (TO-252-5-P2)*	1900	
Topt	Operating Temperature Range	−40 to 105	°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.

ELECTRICAL CHARACTERISTICS

- **R1500xxxxB**

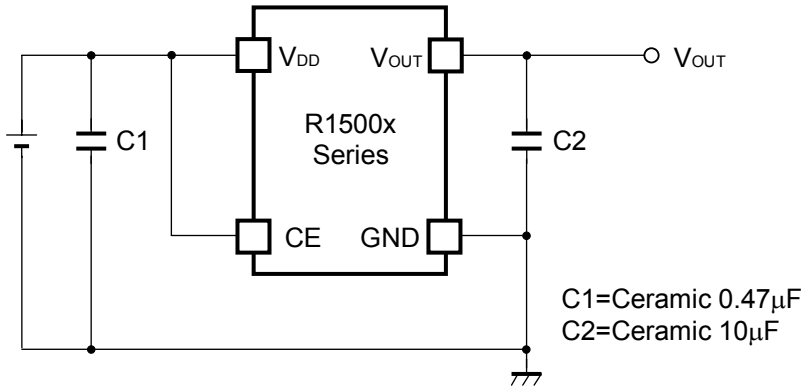
Topt=25°C

Symbol	Item	Conditions		Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage			4		24	V
I_{SS}	Supply Current	$V_{IN}=V_{OUT}+1.0V$, $V_{IN}=V_{CE}$			70	130	μA
$I_{standby}$	Standby Current	$V_{IN}=24V$			0.1	1.0	μA
V_{OUT}	Output Voltage	$V_{IN}=V_{OUT}+1.0V$, $I_{OUT}=100mA$		×0.98		×1.02	V
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	$V_{IN}=V_{OUT}+2.0V$, $0.1mA \leqq I_{OUT} \leqq 200mA$			25	60	mV
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	$V_{OUT}+1V \leqq V_{IN} \leqq 24V$, $I_{OUT}=10mA$			0.05	0.1	%/V
V_{DIF}	Dropout Voltage	$I_{OUT}=200mA$	$3.0V \leqq V_{OUT} < 5.0V$		0.135	0.225	V
			$5.0V \leqq V_{OUT} < 9.0V$		0.115	0.180	
			$9.0V \leqq V_{OUT} \leqq 12.0V$		0.095	0.155	
$\Delta V_{OUT}/\Delta Topt$	Output Voltage Temperature Coefficient	$V_{IN}=V_{OUT}+2.0V$, $I_{OUT}=100\mu A$ $-40°C \leqq Topt \leqq 105°C$			±100		ppm /°C
I_{LIM}	Output Current	$V_{IN}=V_{OUT}+1.0V$		500			mA
I_{SC}	Short Current Limit	$V_{OUT}=0V$			65		mA
RR	Ripple Rejection	f=1kHz, Ripple 0.5Vp-p, $I_{OUT}=100mA$, $V_{IN}=V_{OUT}+2V$	$V_{OUT} \leqq 6.0V$		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		0.4	V
T_{TSD}	Thermal Shutdown Temperature	Junction Temperature			160		°C
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature			135		°C

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.

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.

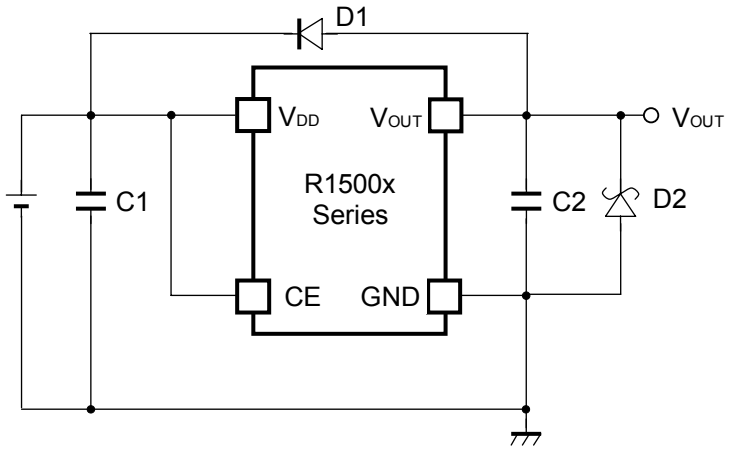
Set external components, especially the output capacitor C2, as close as possible to the ICs, and make wiring as short as possible.

No.2 pin and No.3 pin of SOT-89-5 and TO-252-5-P2 package must be wired to the GND plane when it is mounted on board.

Thermal Shutdown

There is the built-in thermal-shutdown function in R1500x series. It discontinues operation of the IC when the junction temperature becomes over 160°C (Typ.) and IC re-operates when the junction temperature under 135°C. If the temperature increasing keeps the IC repeats ON and OFF operating. The output becomes the pulse condition.

TYPICAL APPLICATION FOR PREVENTING IC DESTRUCTION

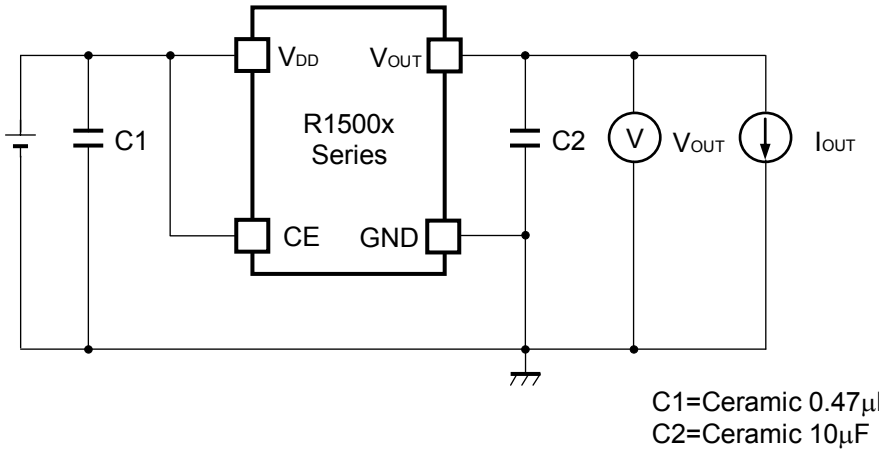


C1: 0.47μF or more (preventing for unstable operation)
C2: 10μF or more (preventing for unstable operation)

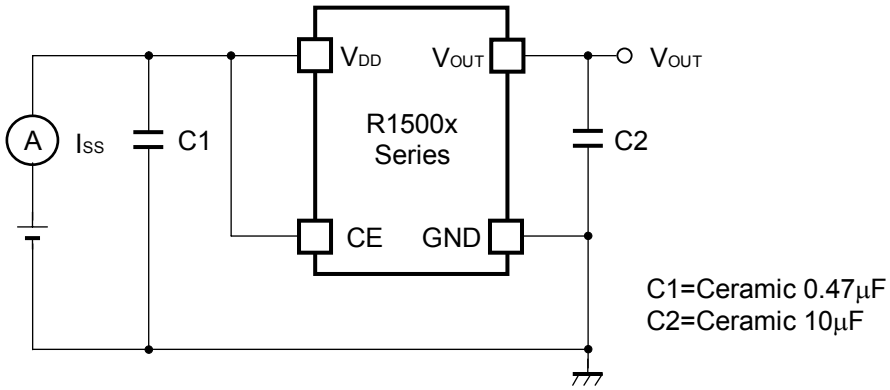
D1: If V_{OUT} pin could be higher than V_{IN} pin, D1 is necessary.
D2: If V_{OUT} pin could be lower than GND pin, SBD is necessary.

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

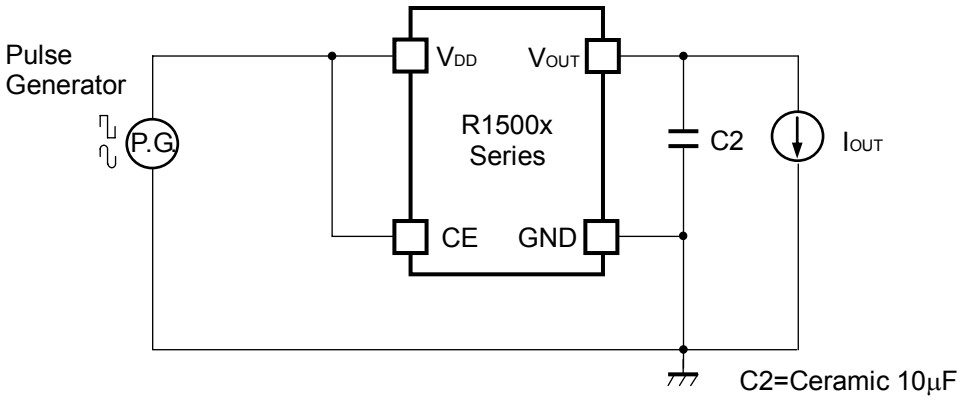
TEST CIRCUITS



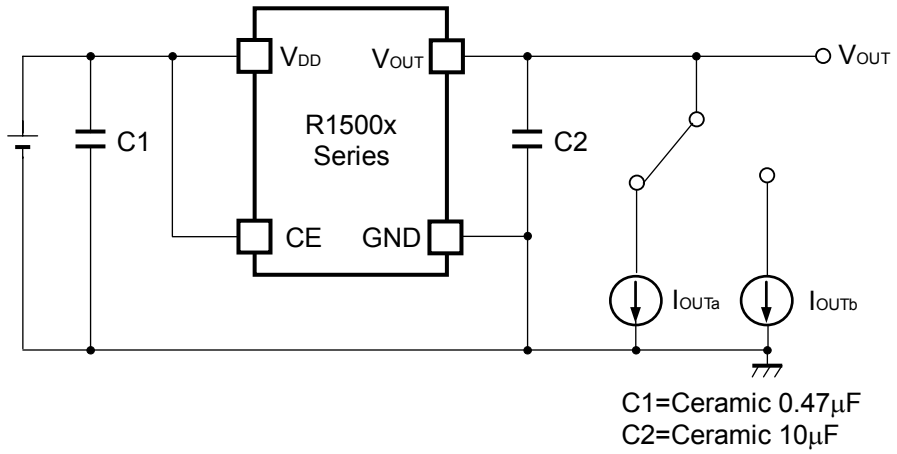
Basic Test Circuit



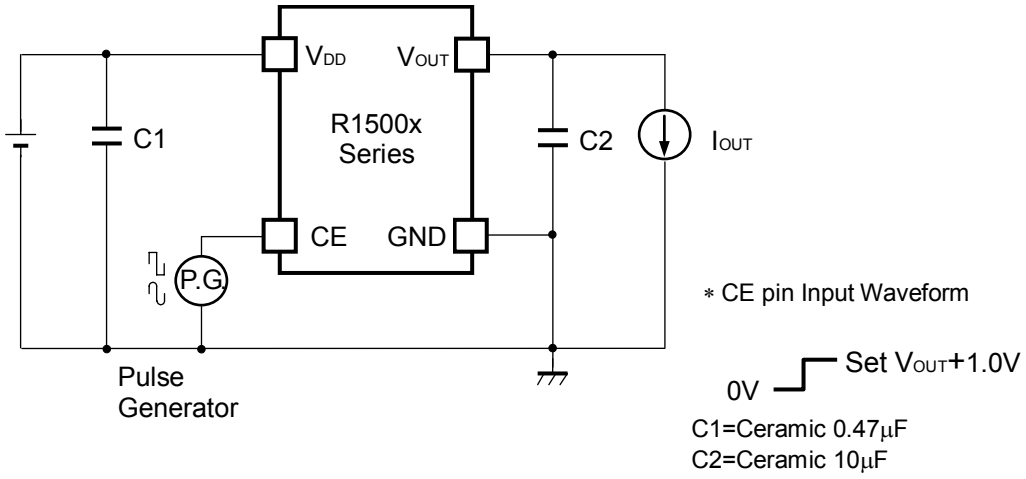
Test Circuit for Supply Current



Test Circuit for Ripple Rejection, Input Transient Response



Test Circuit for Load Transient Response

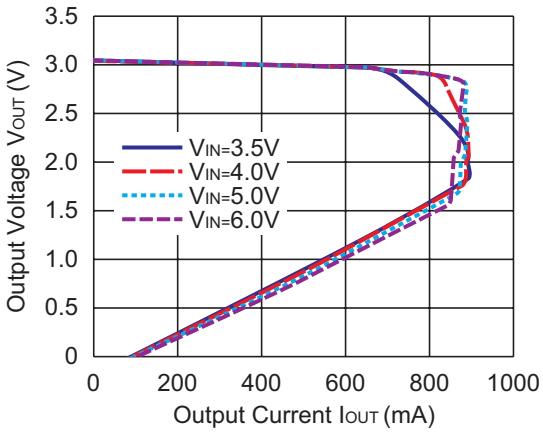


Test Circuit for Turn On Speed with CE pin

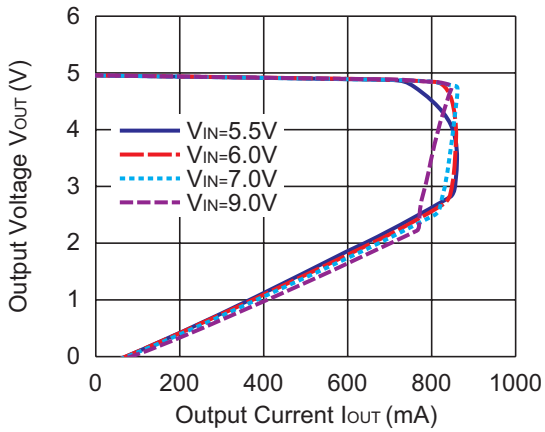
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current (C1=Ceramic 0.47µF, C2=Ceramic 10µF, Topt=25°C)

R1500x030B



R1500x050B



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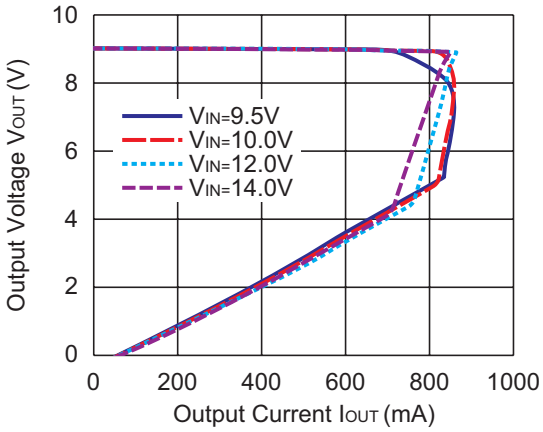

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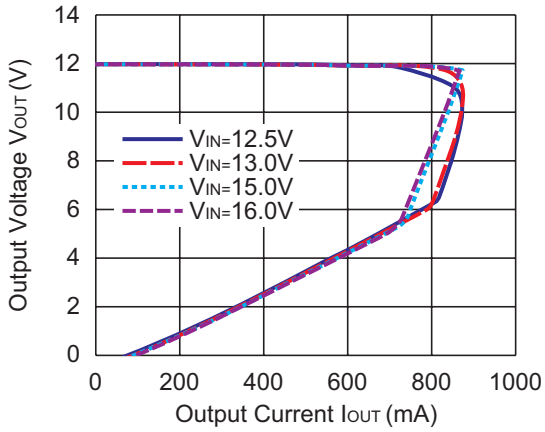
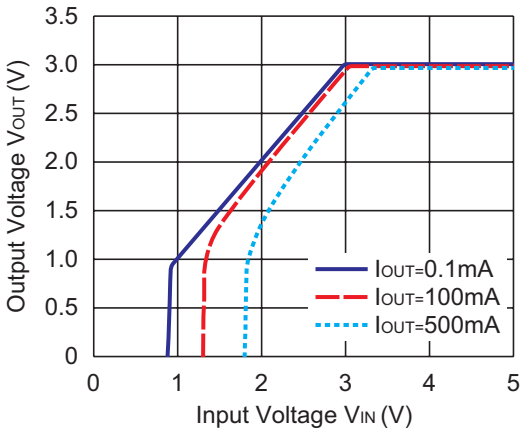


2) Output Voltage vs. Input Voltage (C1=Ceramic 0.47µF, C2=Ceramic 10µF, Topt=25°C)

R1500x030B



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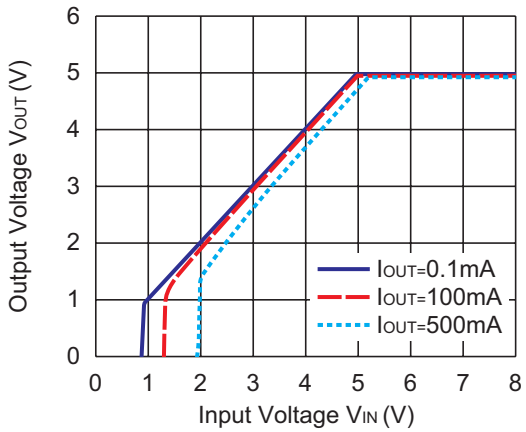

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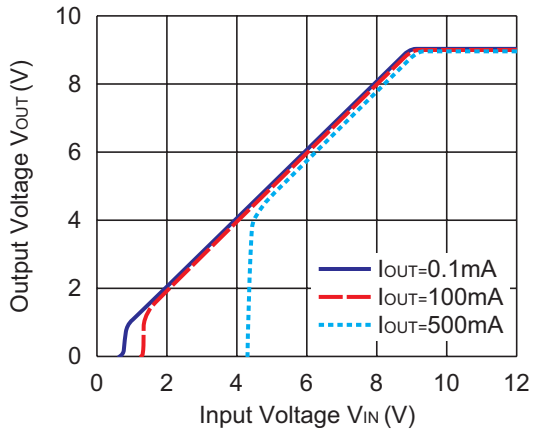

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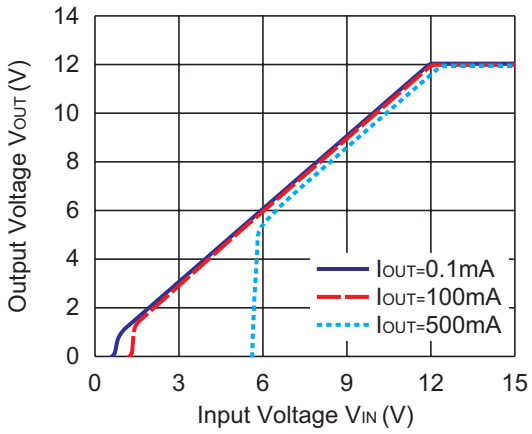
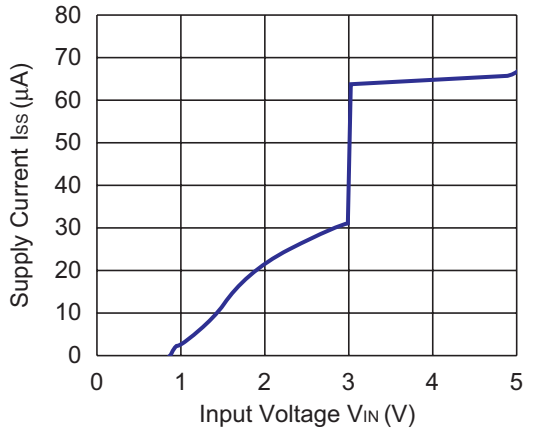


3) Supply Current vs. Input Voltage (C1=Ceramic 0.47µF, C2=Ceramic 10µF, Topt=25°C)

R1500x030B



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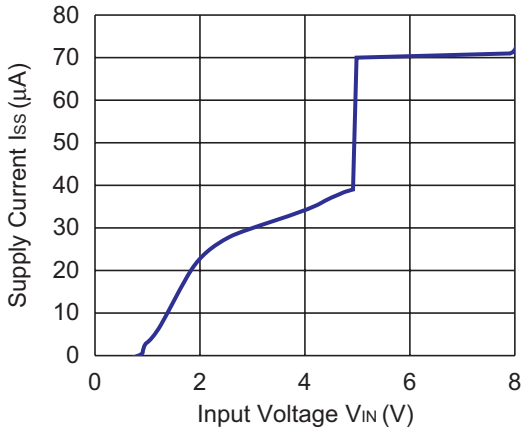

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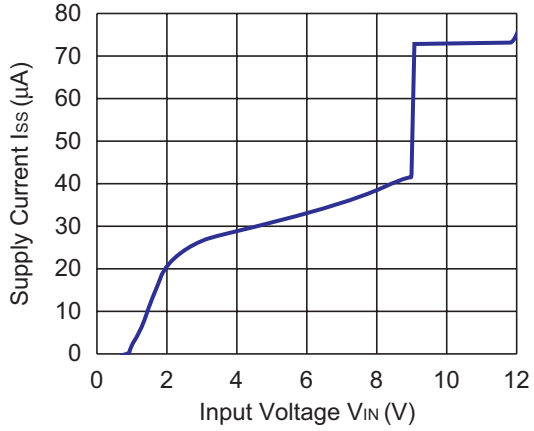

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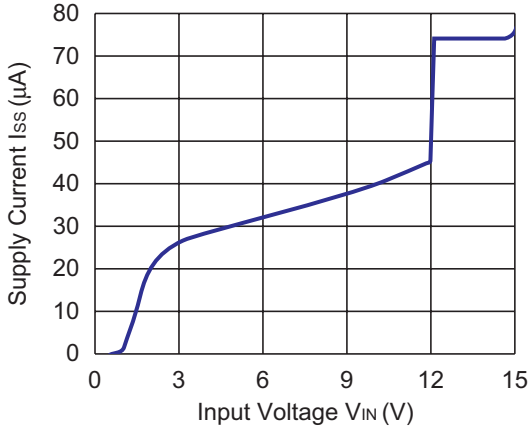
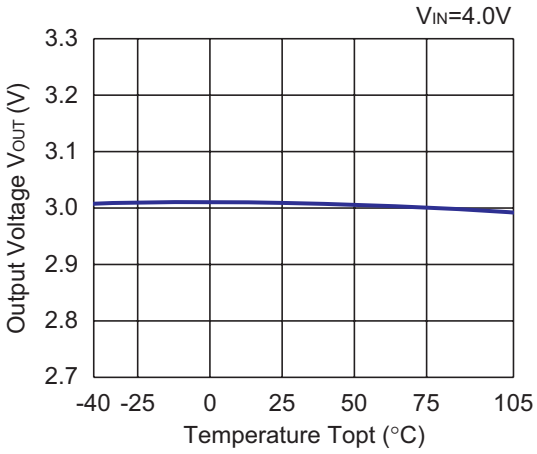


4) Output Voltage vs. Temperature (C1=Ceramic 0.47µF, C2=Ceramic 10µF, I_{OUT}=100mA)

R1500x030B



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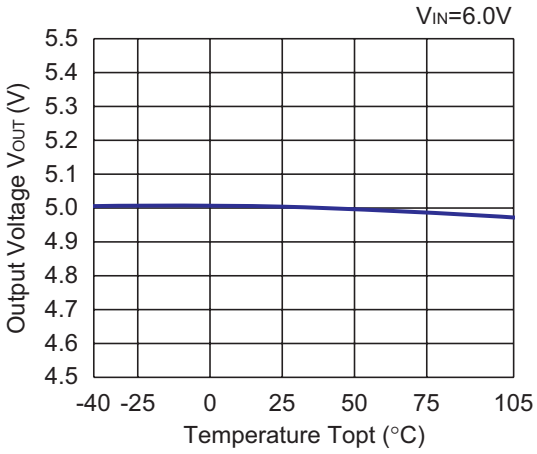

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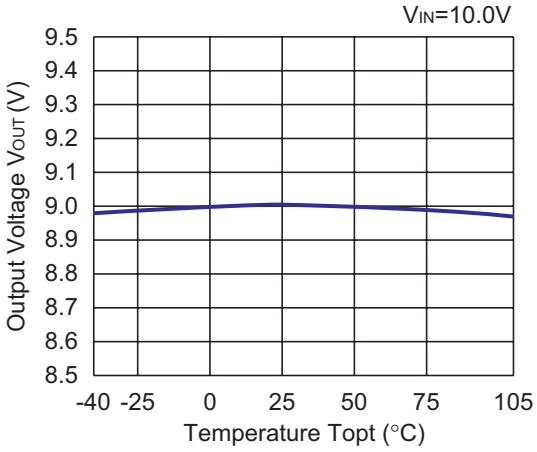

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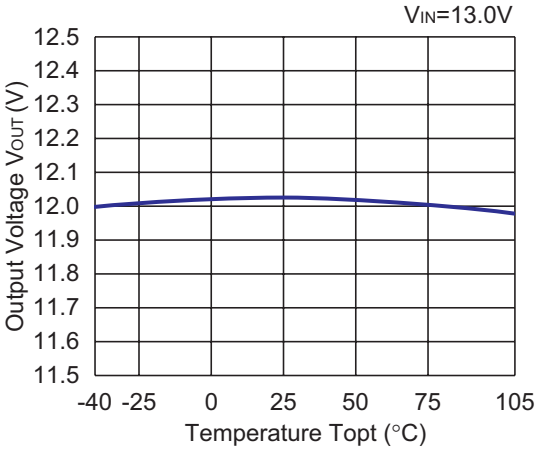
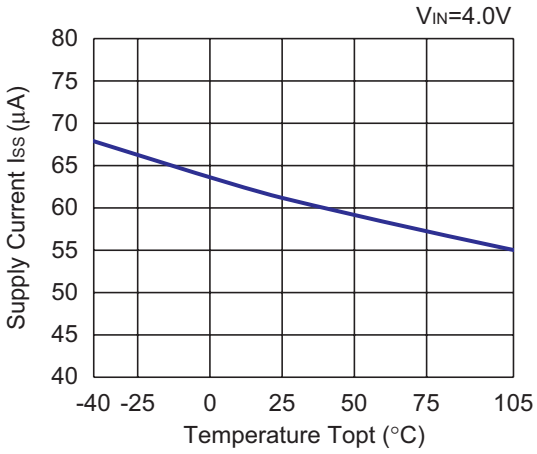


5) Supply Current vs. Temperature (C1=Ceramic 0.47µF, C2=Ceramic 10µF, I_{OUT}=0mA)

R1500x030B



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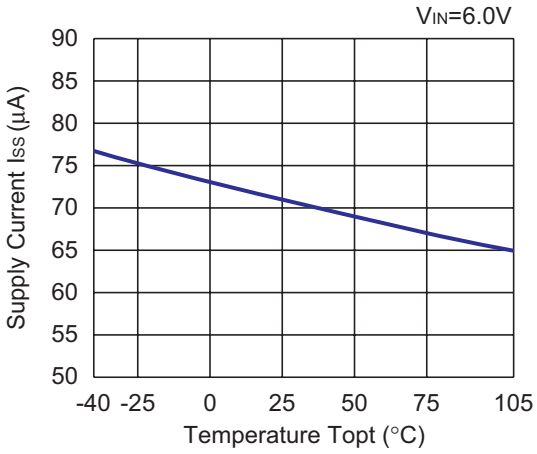

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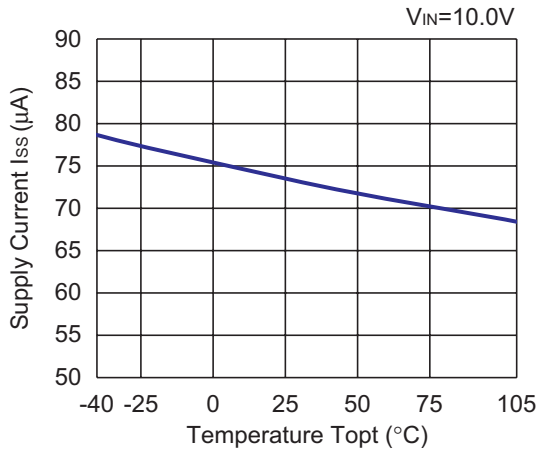

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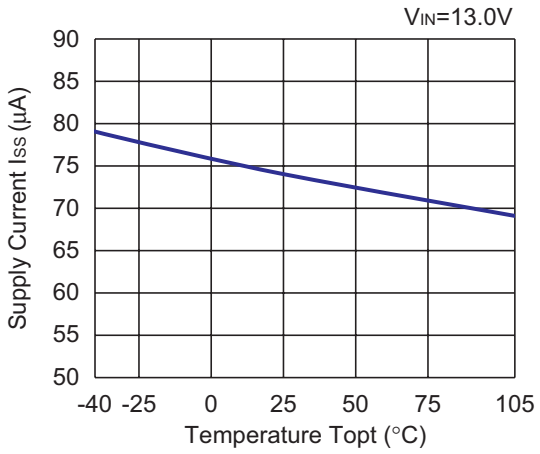
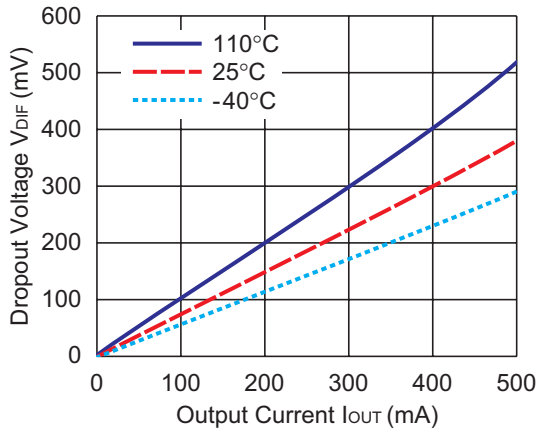


6) Dropout Voltage vs. Output Current (C1=Ceramic 0.47µF, C2=Ceramic 10µF)

R1500x030B



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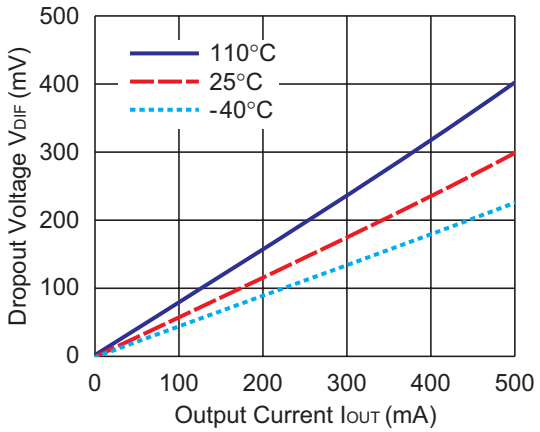

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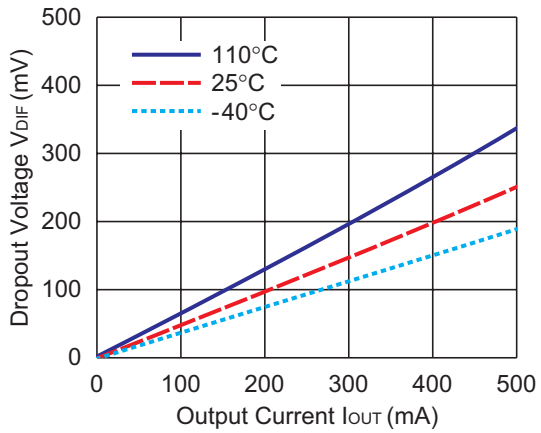
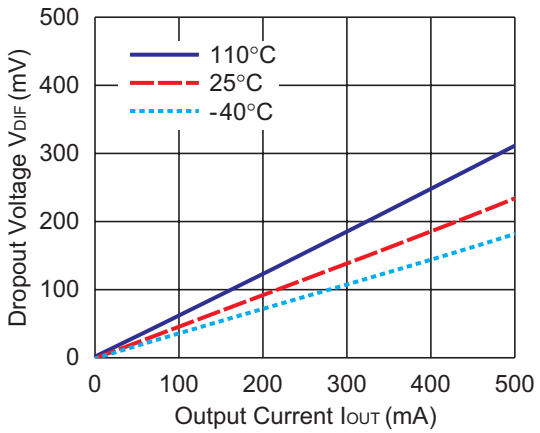
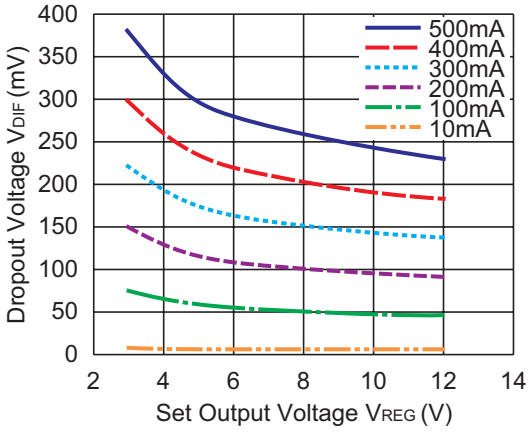


R1500x120B

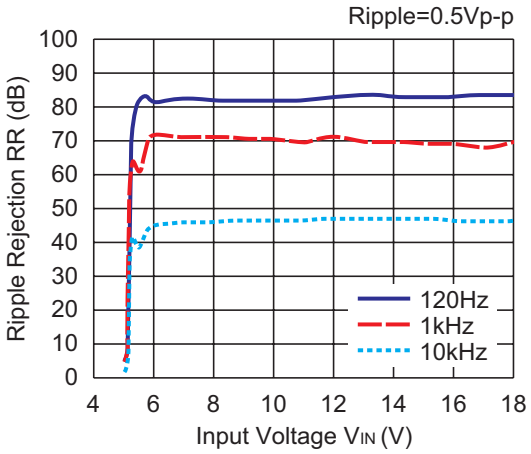


7) Dropout Voltage vs. Set Output Voltage (C1=Ceramic 0.47µF, C2=Ceramic 10µF, Topt=25°C)

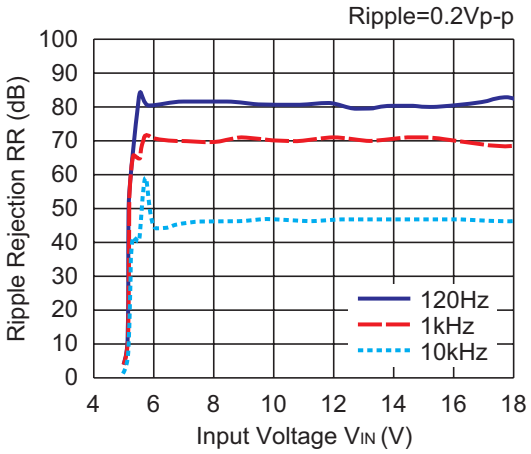


8) Ripple Rejection vs. Input Bias Voltage (C1=none, C2=Ceramic 10µF, IOUT=100mA, Topt=25°C)

R1500x050B

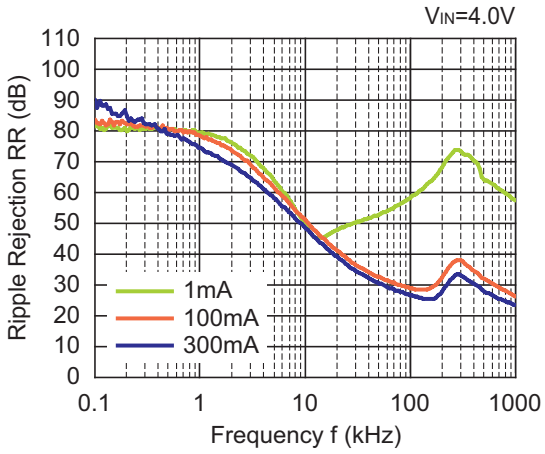


R1500x050B

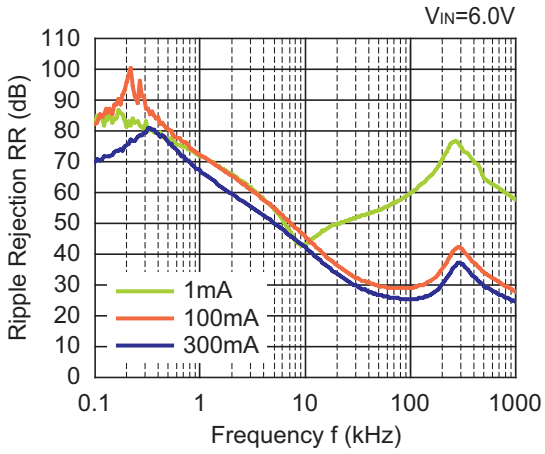


9) Ripple Rejection vs. Frequency (C1=none, C2=Ceramic 10µF, Ripple=0.5Vp-p)

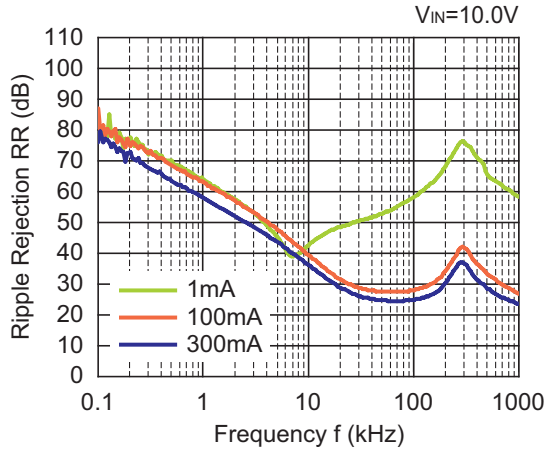
R1500x030B



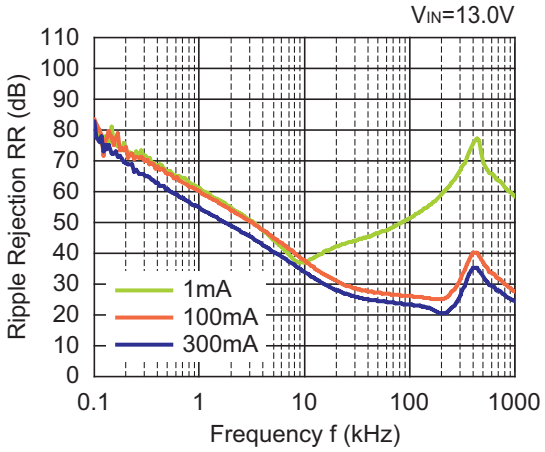
R1500x050B



R1500x090B

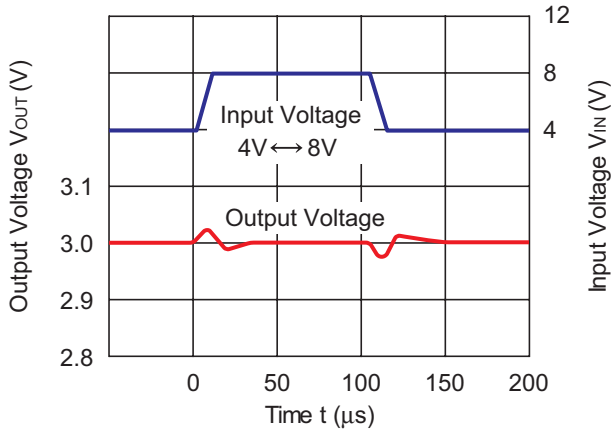


R1500x120B



10) Input Transient Response (C1=none, C2=Ceramic 10µF, IOUT=100mA, tr=tf=10µs, Topt=25°C)

R1500x030B



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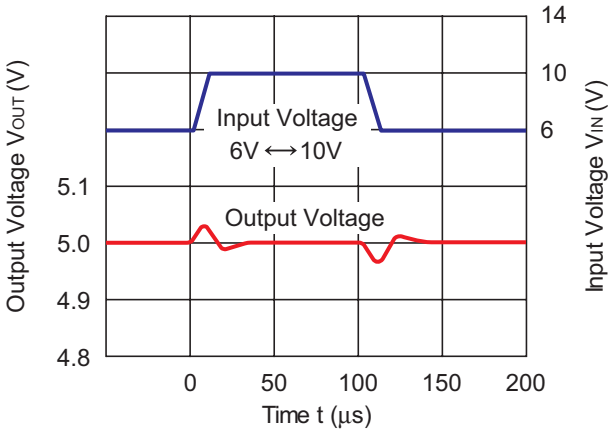

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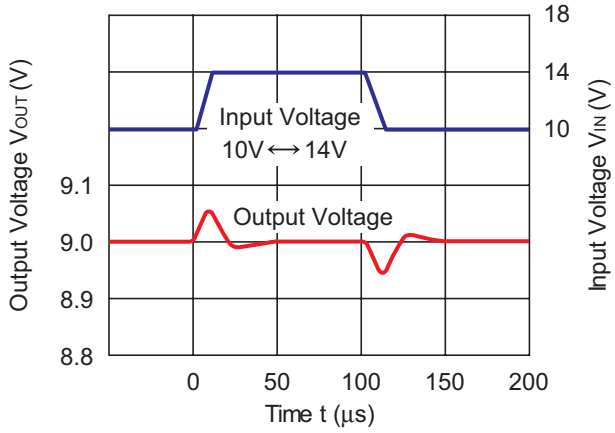
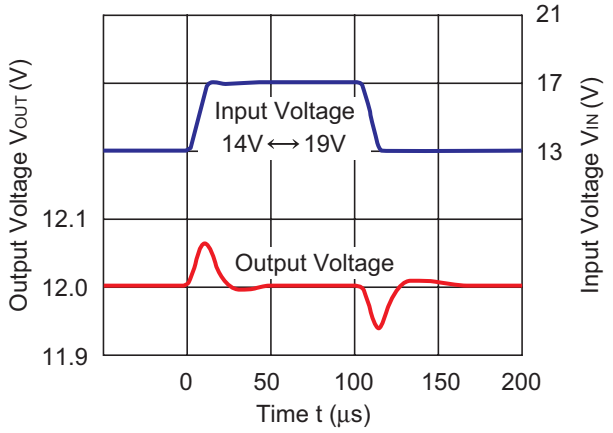
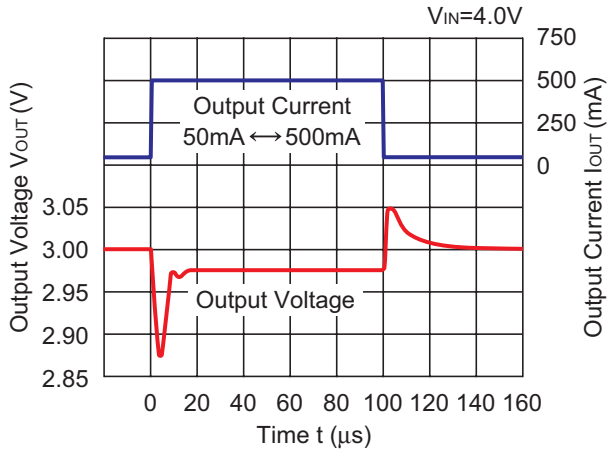


R1500x120B

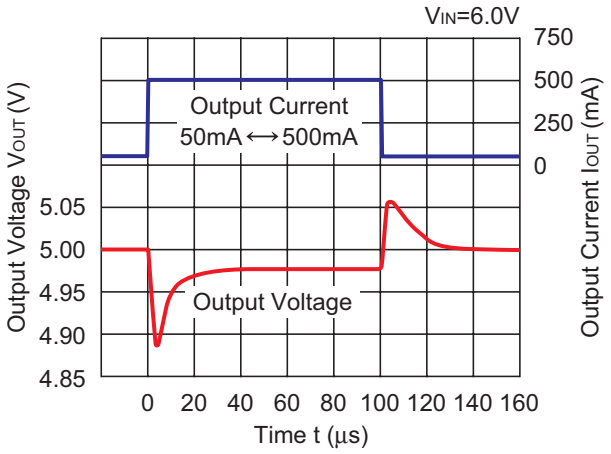


11) Load Transient Response (C1=Ceramic 0.47µF, C2=Ceramic 10µF, tr=tf=0.5µs, Topt=25°C)

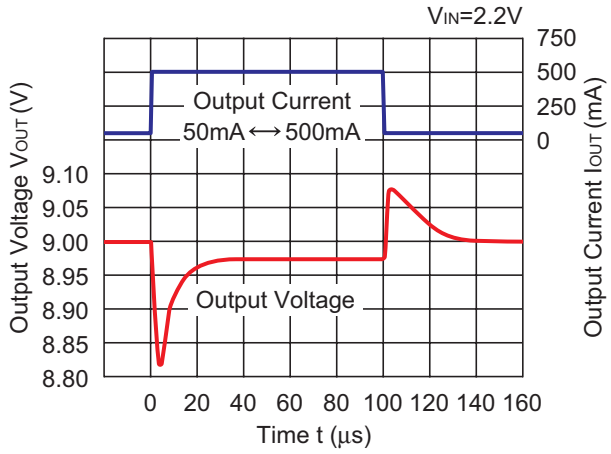
R1500x030B



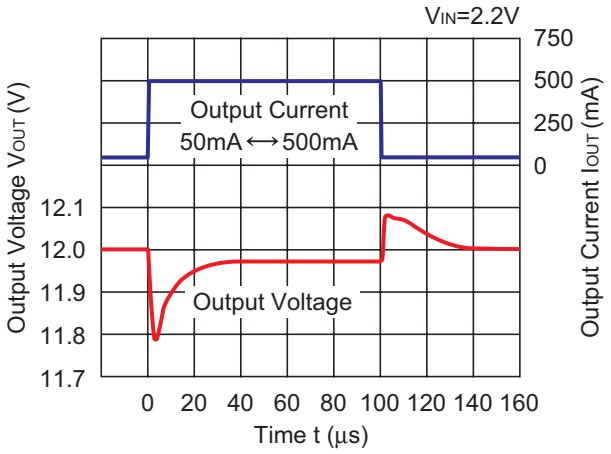
R1500x050B



R1500x090B

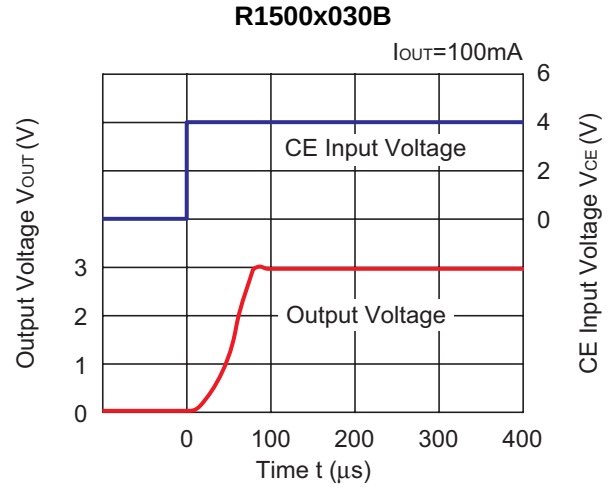


R1500x120B

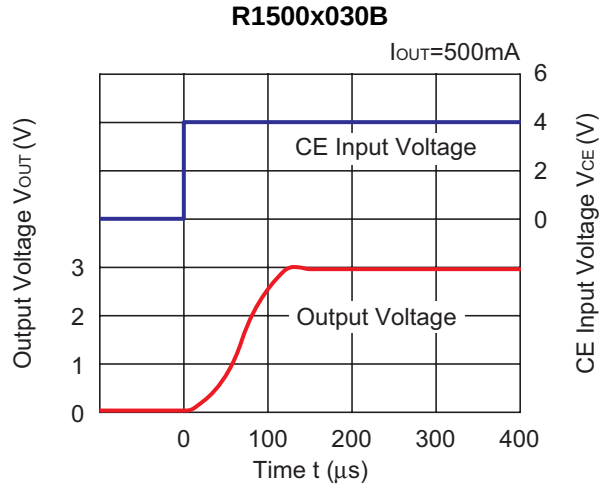


12) Turn On Speed with CE pin (C1=Ceramic 0.47µF, C2=Ceramic 10µF, Topt=25°C)

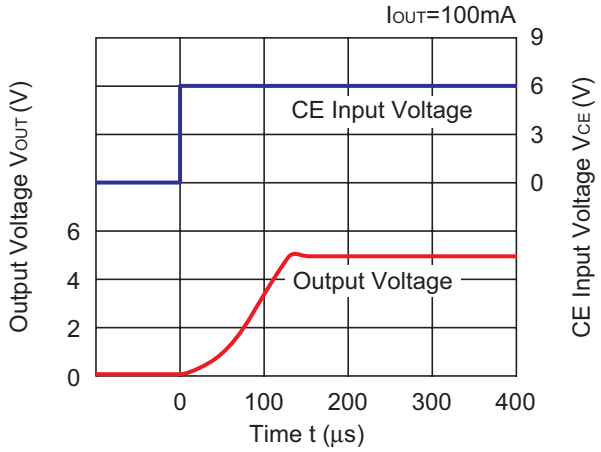
R1500x030B



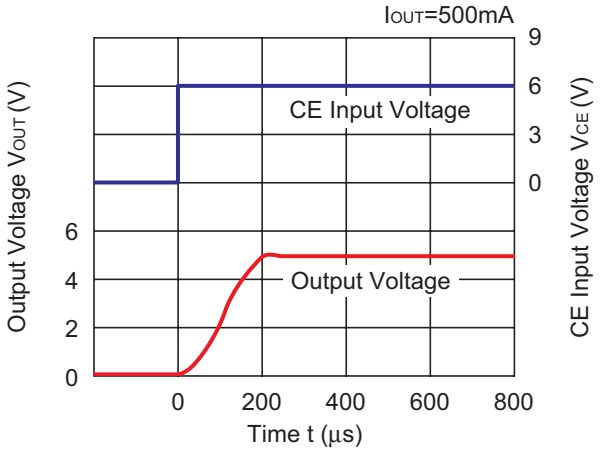
R1500x030B



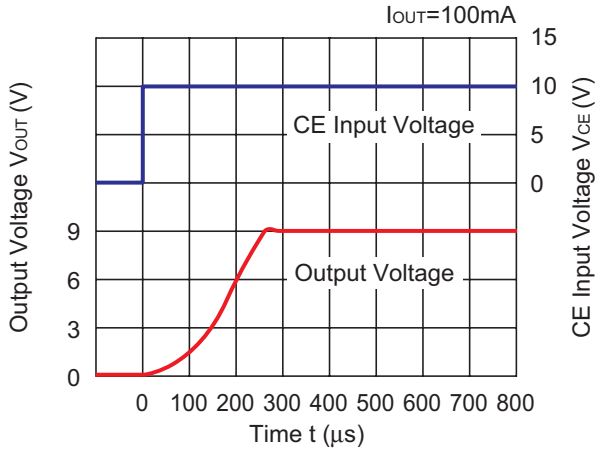
R1500x050B



R1500x050B



R1500x090B



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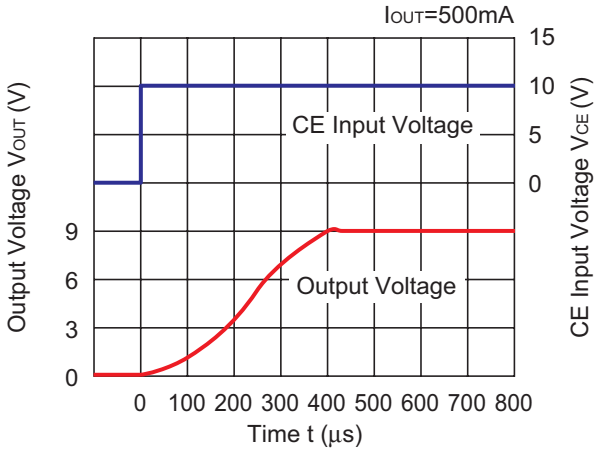
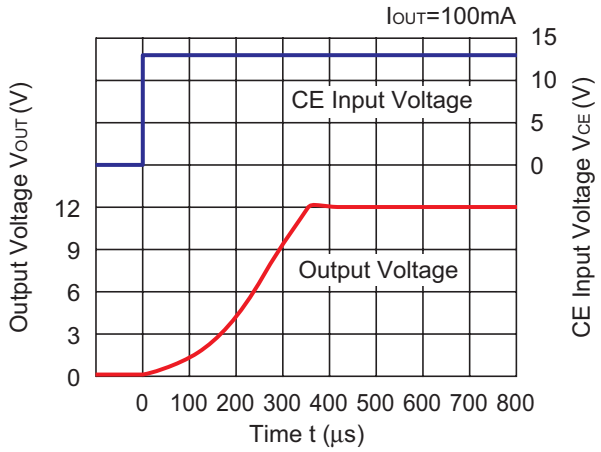


R1500x120B



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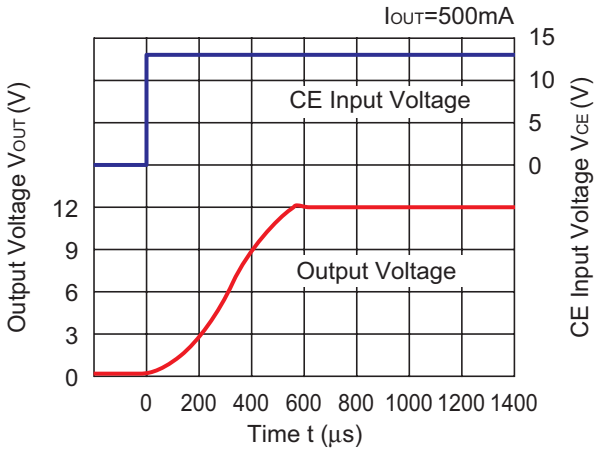
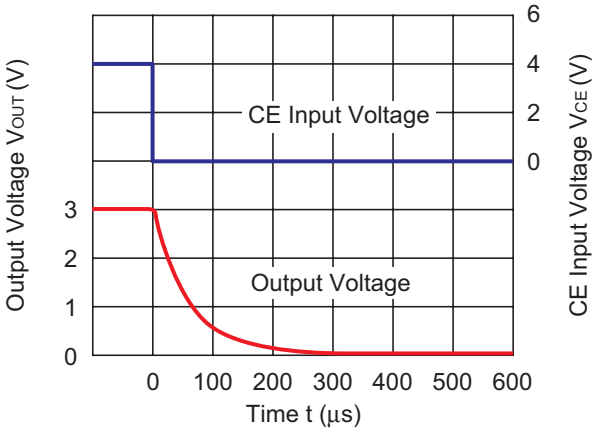


13) Turn Off Speed with CE (C1=Ceramic 0.47µF, C2=Ceramic 10µF, I_{OUT}=500mA, Topt=25°C)

R1500x030B



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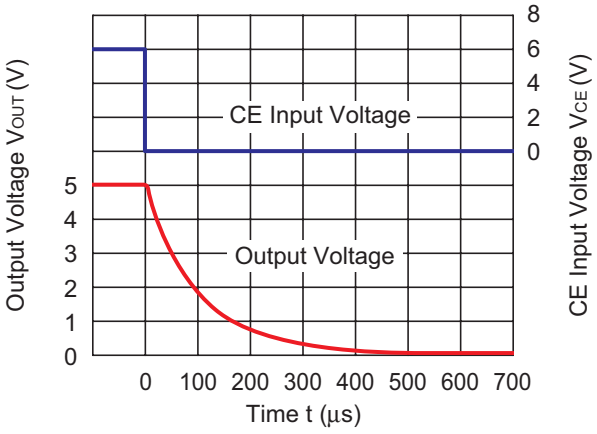
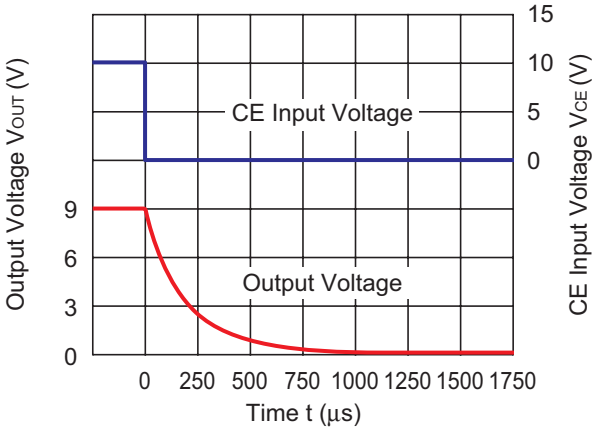
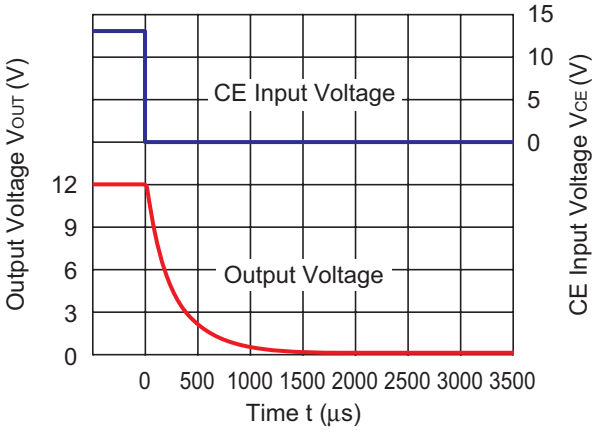


R1500x090B



R1500x120B



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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