RICOH

800mA LDO REGULATOR

R1170x SERIES

NO. EA-084-0502

OUTLINE

The R1170x Series are positive voltage regulator ICs by CMOS process. The R1170x Series have features of high ripple rejection, low dropout voltage, high output voltage accuracy, low consumption current. Each of these ICs consists of a voltage reference unit, an error amplifier, resistor net for setting output voltage, a current limit circuit at short mode, a chip enable circuit, and thermal-shunt circuit. Output Voltage of R1170 is fixed in the IC.

Low consumption current by the merit of CMOS process and built-in transistors with low ON-resistance make low dropout voltage and chip enable function prolong the battery life. These regulators are remarkable improvement on the current regulators in terms of ripple rejection, input transient response, and load transient response.

Maximum Output Current is large for its compact size.

Thus, the R1170x Series are suitable for various power sources for portable appliances.

Since the packages for these ICs are the SOT-89-5 package, HSON-6,or HSOP-6J, high density mounting of the ICs on boards is possible.

FEATURES

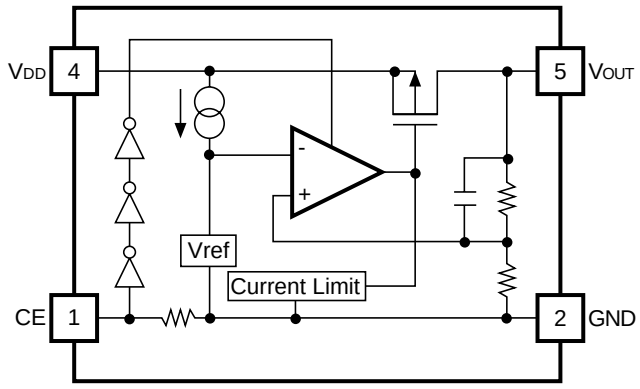
- Ultra-Low Supply Current..... Typ. 80μA
- Low Standby Current ..... Typ. 0.1μA
- Output Current ..... Min. 800mA (V_{IN}=V_{OUT}+1.0V)
- Output Voltage ..... Stepwise setting with a step of 0.1V in the range of 1.5V to 5.0V
- High Output Voltage Accuracy ..... ±2.0%
- Low Dropout Voltage..... Typ. 0.12V (V_{OUT}=3.0V, I_{OUT}=300mA)
- Line Regulation ..... Typ. 0.05%/V
- Small Package SOT-89-5, HSON-6,HSOP-6J
- Built-in Current Limit Circuit
- Built-in Thermal Shunt Circuit
- Low Temperature-drift Coefficient of Output Voltage ... Typ.±100ppm/°C

APPLICATIONS

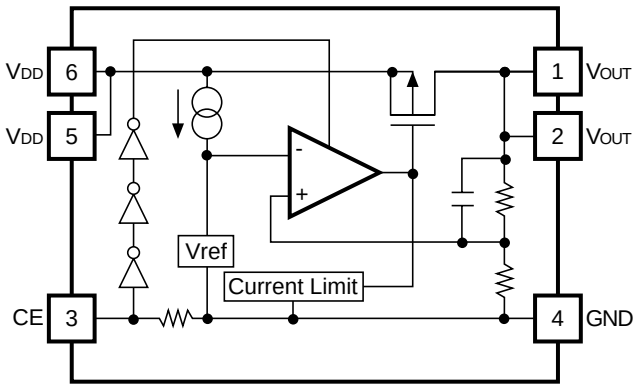
- Local Power source for Notebook PC.
- Local Power source for portable appliances, cameras, and videos.
- Local Power source for equipment of battery-use.
- Local Power source for home appliances.

BLOCK DIAGRAMS

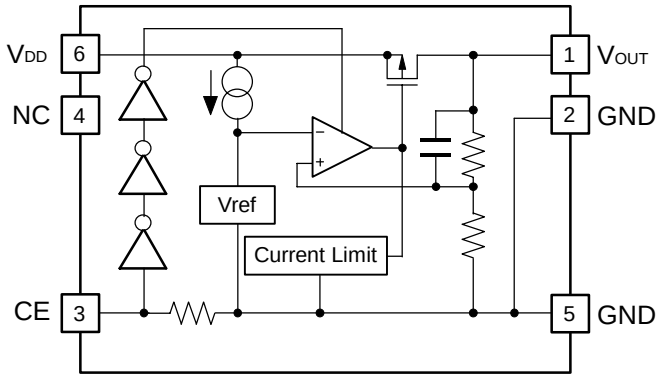
R1170H Series



R1170D Series



R1170S Series



SELECTION GUIDE

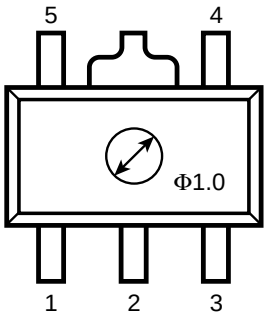
The output voltage, the chip-enable polarity, the taping type can be selected at the user's request.
The selection can be made with the part number as follows;

R1170x<u>xx</u>1x-<u>xx</u> ←Part Number
↑↑ ↑↑
a b c d

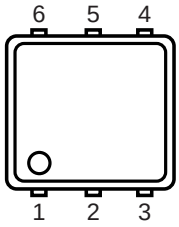
Code	Contents
a	Package Type; H: SOT-89-5, D: HSON-6, S:HSOP-6J
b	Designation of Output Voltage (V_{OUT}) Stepwise setting with 0.1V increment in the range from 1.5V to 5.0V
c	Designation of option; A: Built-in Chip Enable Circuit, Active at "L" B: Built-in Chip Enable Circuit, Active at "H"
d	Designation of Taping Type; T1 or T2 (SOT-89-5), TR (HSON-6), E2 (HSOP-6J) (Refer to Taping Specifications)

PIN CONFIGURATION

● **SOT-89-5**



● **HSON-6**



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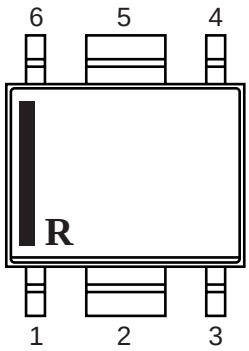


PIN DESCRIPTION

● **SOT-89-5**

Pin No	Symbol	Description
1	$\overline{CE}$ or CE	Chip Enable Pin
2	GND	Ground Pin
3	NC	No Connection
4	V_{DD}	Input Pin
5	V_{OUT}	Voltage Regulator Output Pin

● **HSON-6**

Pin No	Symbol	Description
1	V_{OUT}	Voltage Regulator Output Pin
2	V_{OUT}	Voltage Regulator Output Pin
3	$\overline{CE}$ or CE	Chip Enable Pin
4	GND	Ground Pin
5	V_{DD}	Input Pin
6	V_{DD}	Input Pin

● **HSOP-6J**

Pin No	Symbol	Description
1	V_{OUT}	Voltage Regulator Output Pin
2	GND	Ground Pin
3	$\overline{CE}$ or CE	Chip Enable Pin
4	NC	No Connection
5	GND	Ground Pin
6	V_{DD}	Input Pin

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	7.0	V
V_{CE}	Input Voltage ($\overline{CE}$ or CE Input Pin)	−0.3 ~ V_{IN}+0.3	V
V_{OUT}	Output Voltage	−0.3 ~ V_{IN}+0.3	V
I_{OUT}	Output Current	1.2	A
P_D	Power Dissipation	Internally limited	
Topt	Operating Temperature	−40 ~ 85	°C
Tstg	Storage Temperature	−55 ~ 125	°C

ELECTRICAL CHARACTERISTICS

- **R1170xxxxA**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage				6.0	V
I_{SS1}	Supply Current1	V_{IN}−V_{OUT}=1.0V, V_{CE}=GND		80	160	μA
Istb	Standby Current	V_{IN}=V_{CE}=6.0V		0.1	1.0	μA
V_{OUT}	Output voltage	V_{IN}−V_{OUT}=1.0V I_{OUT}=100mA	×0.98		×1.02	V
I_{OUT1}	Output Current	V_{IN}−V_{OUT}=1.0V	800			mA
ΔV_{OUT}/ ΔI_{OUT}	Load regulation	V_{IN}−V_{OUT}=1.0V 1mA ≦ I_{OUT} ≦ 300mA		30	100	mV
V_{DIF}	Dropout Voltage	I_{OUT}=300mA	Refer to Dropout Voltage Table			
ΔV_{OUT}/ ΔV_{IN}	Line regulation	I_{OUT}=100mA V_{OUT}+0.5V ≦ V_{IN} ≦ 6.0V		0.05	0.30	%/V
RR	Ripple Rejection	f=1kHz, Ripple 0.5Vp−p 1.5V ≦ V_{IN} ≦ 4.0V: V_{IN}−V_{OUT}=1.0V 4.1V ≦ V_{IN} ≦ 5.0V: V_{IN}−V_{OUT}=0.75V		50		dB
ΔV_{OUT}/ ΔT	Output Voltage Temperature Coefficient	I_{OUT}=10mA −40°C ≦ Topt ≦ 85°C		±100		ppm/°C
I_{LIM}	Short Current Limit	V_{OUT}=0V		40		mA
R_{PU}	Pull-up resistancefor $\overline{CE}$ pin		1.25	2.50	5.00	MΩ
V_{CEH}	$\overline{CE}$ Input Voltage "H"		1.50		V_{IN}	V
V_{CEL}	$\overline{CE}$ Input Voltage "L"		0.00		0.25	V
T_{TSD}	Thermal Shutdown Detector Threshold Temperature	Junction Temperature		150		°C
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature		120		°C

- **R1170xxxxB**

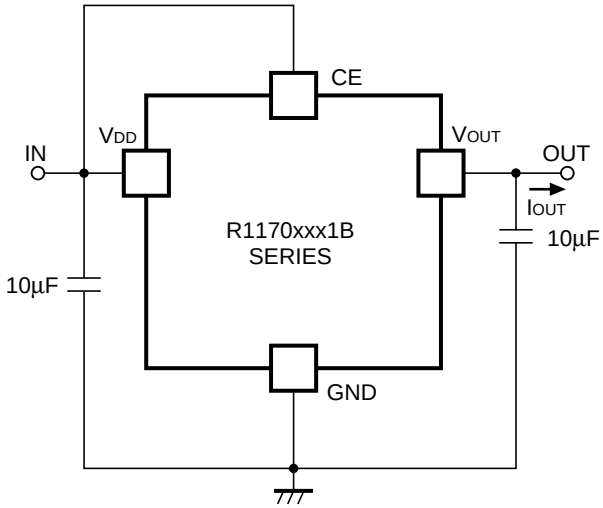
Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Input voltage				6.0	V
I_{SS1}	Supply Current1	V_{IN}–V_{OUT}=1.0V,V_{CE}=V_{IN}		80	160	μA
Istb	Standby Current	V_{IN}=6.0V,V_{CE}=GND		0.1	1.0	μA
V_{OUT}	Reference Voltage for Adjustable Voltage Regulator	V_{IN}–V_{OUT}=1.0V I_{OUT}=100mA	×0.98		×1.02	V
I_{OUT1}	Output Current	V_{IN}–V_{OUT}=1.0V	800			mA
ΔV_{OUT}/ ΔI_{OUT}	Load regulation	V_{IN}–V_{OUT}=1.0V 1mA ≦ I_{OUT} ≦ 300mA		30	100	mV
V_{DIF}	Dropout Voltage	I_{OUT}=300mA	Refer to Dropout Voltage Table			
ΔV_{OUT}/ ΔV_{IN}	Line regulation	I_{OUT}=100mA V_{OUT}+0.5V ≦ V_{IN} ≦ 6.0V		0.05	0.30	%/V
RR	Ripple Rejection	f=1kHz, Ripple 0.5Vp–p 1.5V ≦ V_{IN} ≦ 4.0V: V_{IN}–V_{OUT}=1.0V 4.1V ≦ V_{IN} ≦ 5.0V: V_{IN}–V_{OUT}=0.75V		50		dB
ΔV_{OUT}/ ΔT	Output Voltage Temperature Coefficient	–40°C ≦ Topt ≦ 85°C		±100		ppm/°C
I_{LIM}	Short Current Limit	V_{OUT}=0V		40		mA
R_{PU}	Pull-down resistance for CE pin		1.25	2.50	5.00	MΩ
V_{CEH}	CE Input Voltage "H"		1.5		V_{IN}	V
V_{CEL}	CE Input Voltage "L"		0.00		0.25	V
T_{TSD}	Thermal Shutdown Detector Threshold Temperature	Junction Temperature		150		°C
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature		120		°C

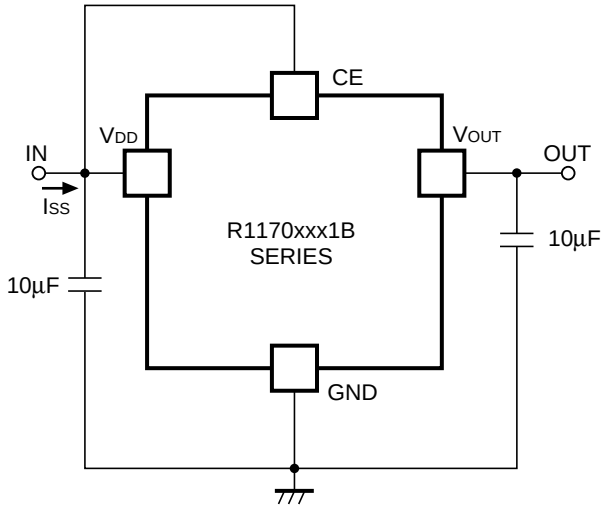
- **Dropout Voltage by Output Voltage (Topt=25°C)**

Output Voltage V_{OUT} (V)	Dropout Voltage (V)	
	Typ.	Max.
V_{OUT}=1.5	0.35	0.45
V_{OUT}=1.6	0.30	0.35
V_{OUT}=1.7	0.25	0.30
1.8 ≦ V_{OUT} ≦ 2.0	0.20	0.25
2.1 ≦ V_{OUT} ≦ 2.4	0.15	0.20
2.5 ≦ V_{OUT} ≦ 5.0	0.12	0.18

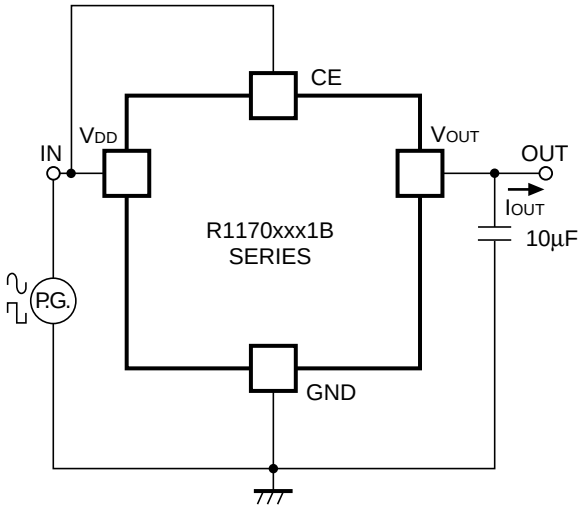
TEST CIRCUITS



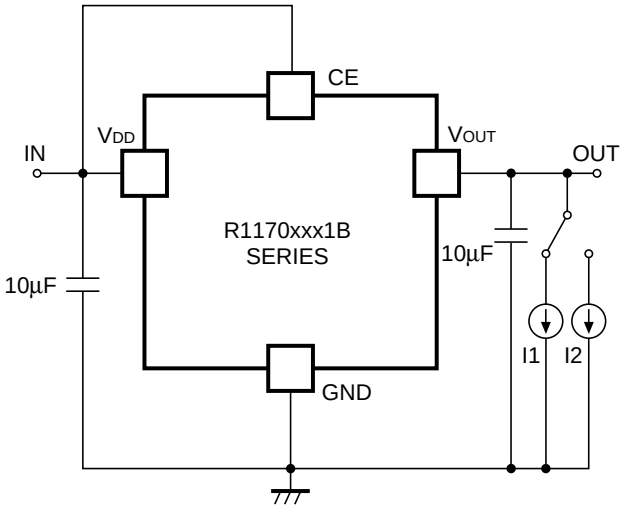
Standard Test Circuit



Supply Current Test Circuit



**Test Circuit for Ripple Rejection,
Input Transient Response**



Test Circuit for Load Transient Response

Technical Notes on External Components and Typical Application

Phase Compensation

In these ICs, phase compensation is made with the output capacitor for securing stable operation even if the load current is varied. For this purpose, use as much as 10µF Capacitor as C_L.

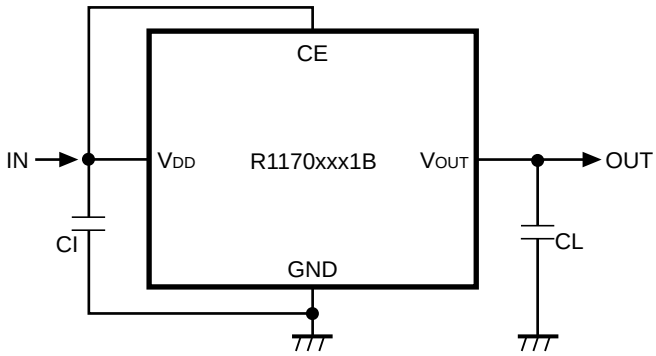
If you use a tantalum type capacitor and ESR value of the capacitor is large, output might be unstable. Evaluate your circuit with considering frequency characteristics. Further, refer to the Typical Characteristics No. 12.

Mounting on PCB

Make V_{DD} and GND lines sufficient. If their impedance is high, a current flows, the noise picked up or unstable operation may result. Further use as much as 10µF capacitor between V_{DD} pin and GND pin as close as possible.

Set an Output capacitor between V_{OUT} pin and GND pin for phase compensation as close as possible.

(Refer to the example of typical application)



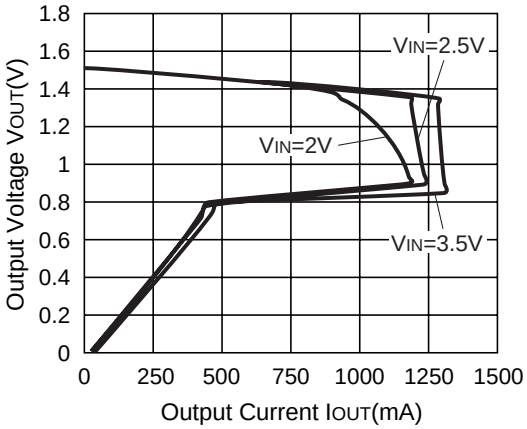
CI=10µF(Ceramic), CL=10µF(Ceramic)

Example of the typical application of R1170xxxxB

TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current (Topt=25°C)

R1170x151B



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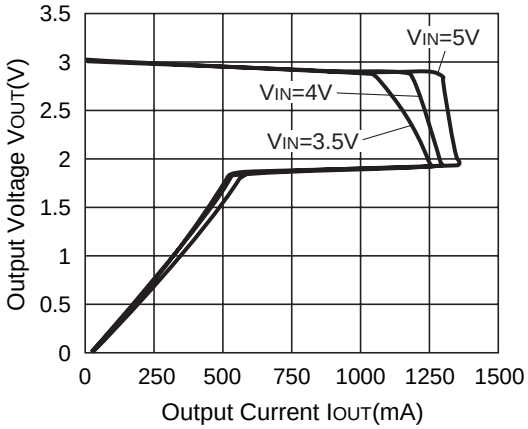

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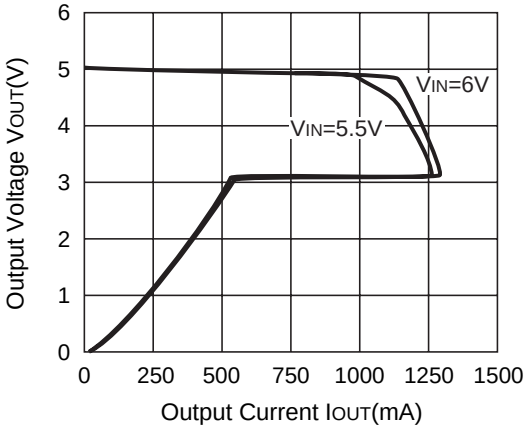

2) Output Voltage vs. Input Voltage (Topt=25°C)

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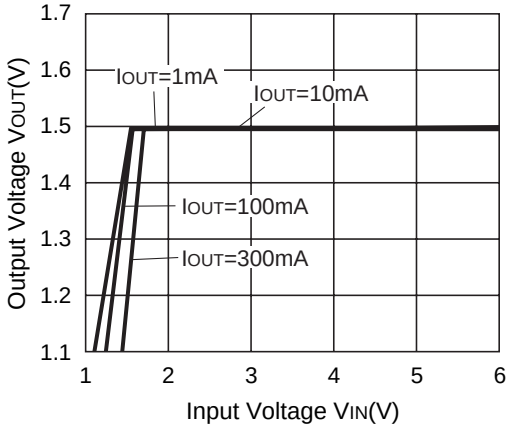

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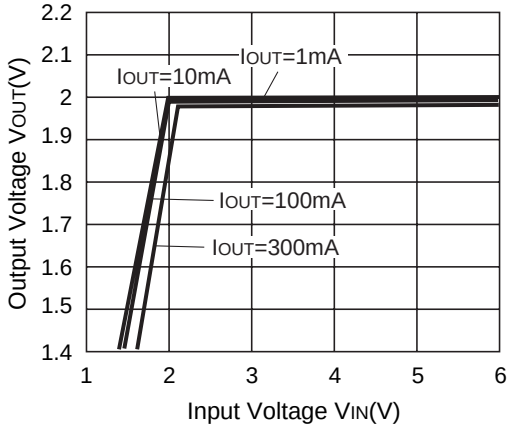

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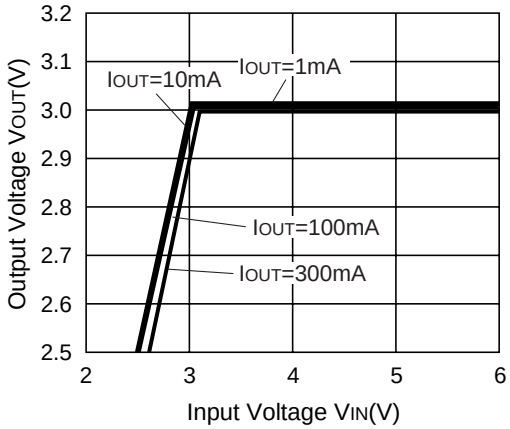

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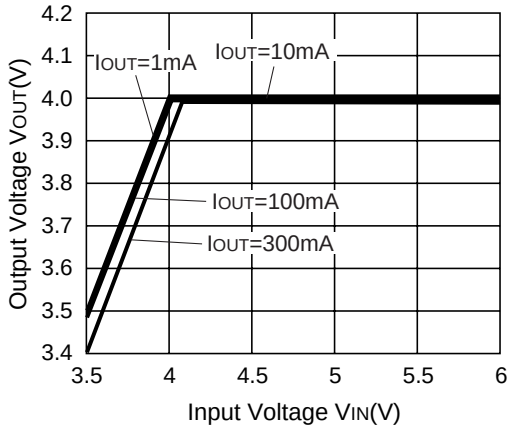

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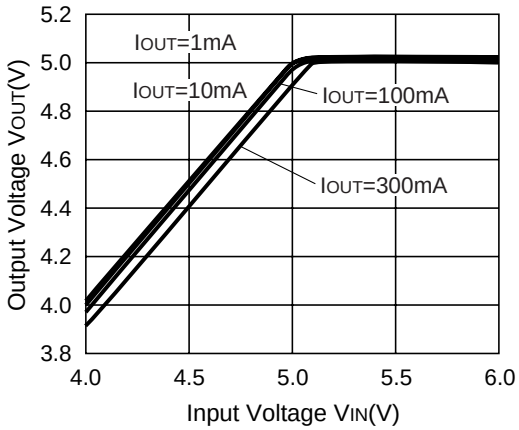
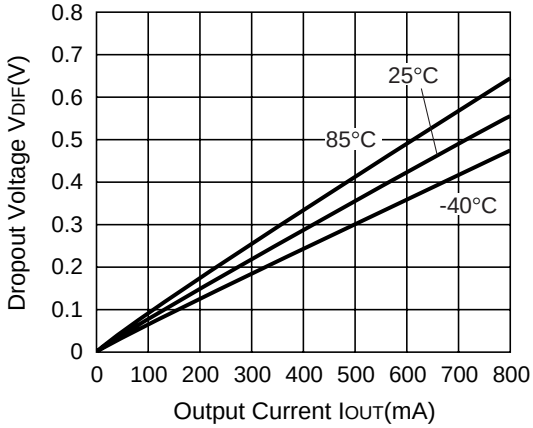


3) Dropout Voltage vs. Output Current

R1170x151B



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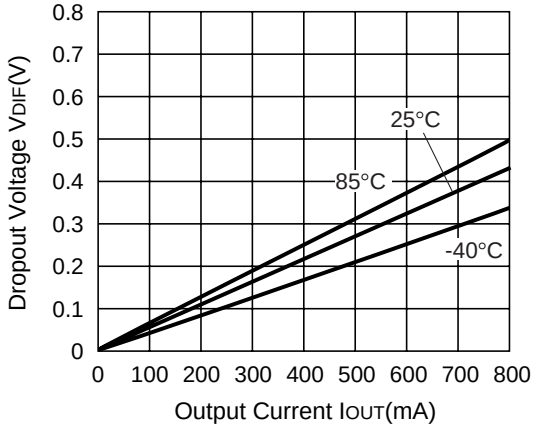

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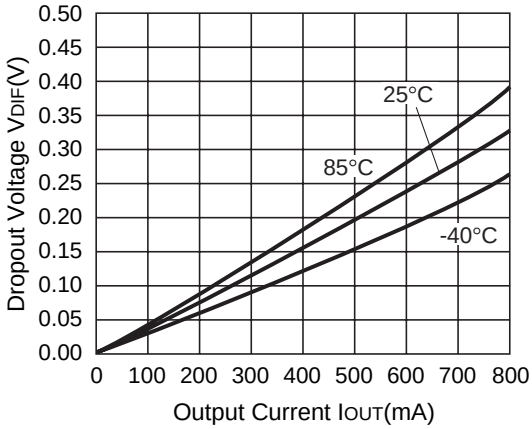

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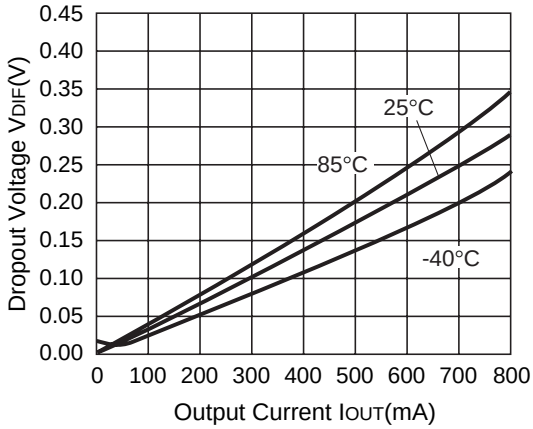

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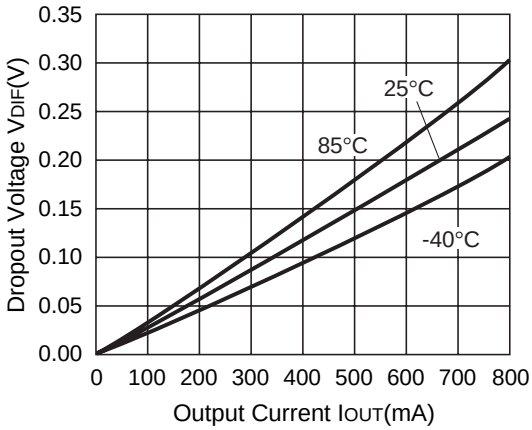

4) Output Voltage vs. Temperature

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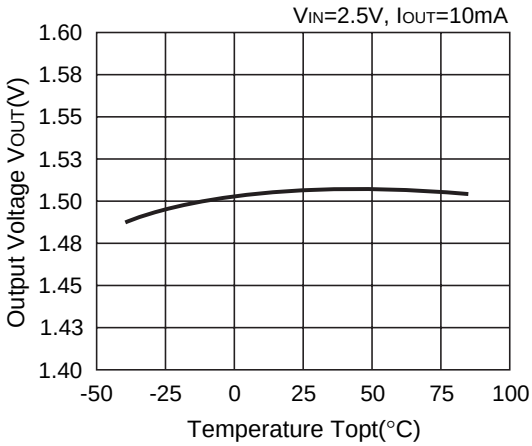

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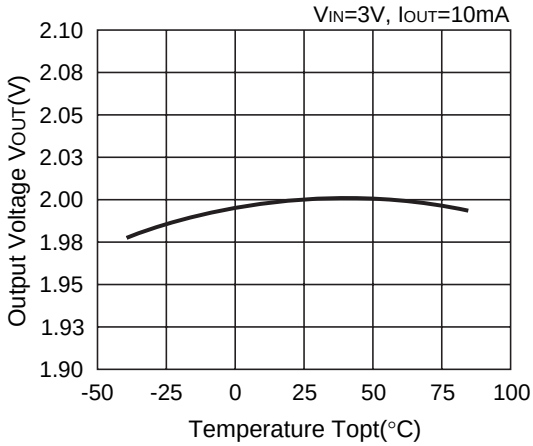

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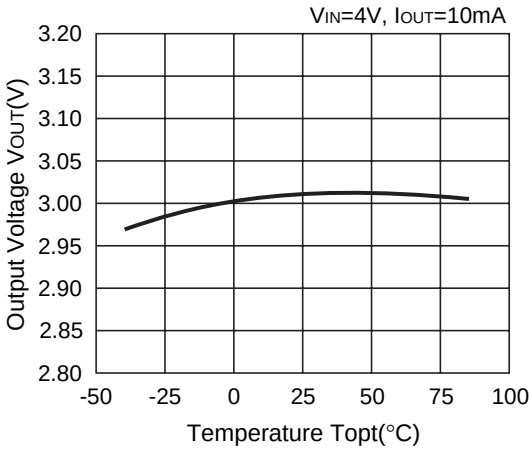

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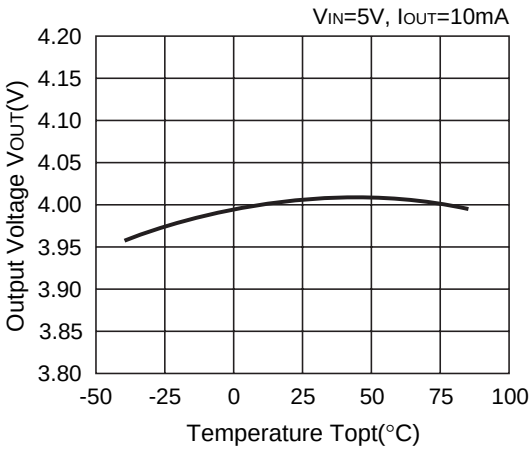

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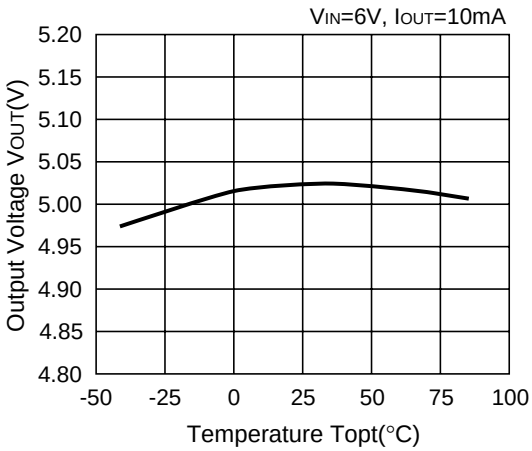
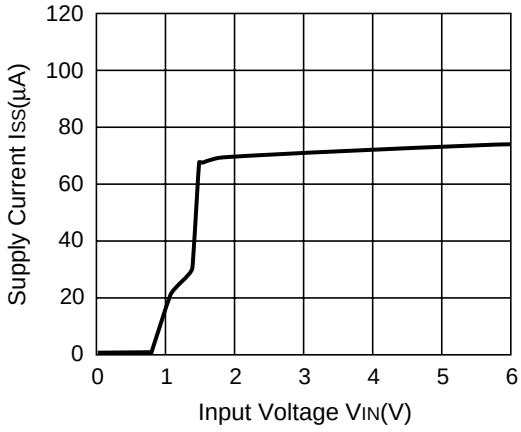


5) Supply Current vs. Input Voltage (Topt=25°C)

R1170x151B



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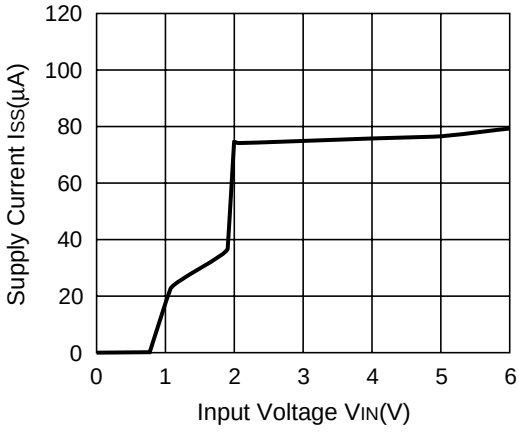

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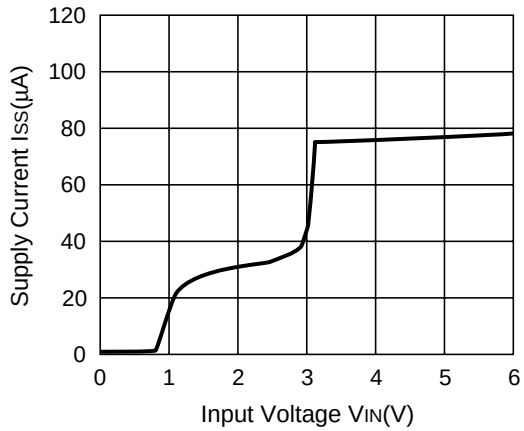

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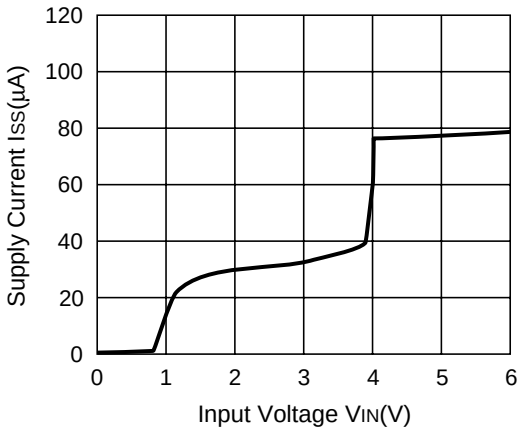

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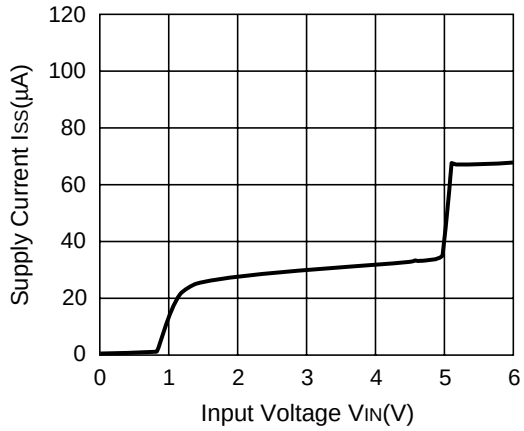
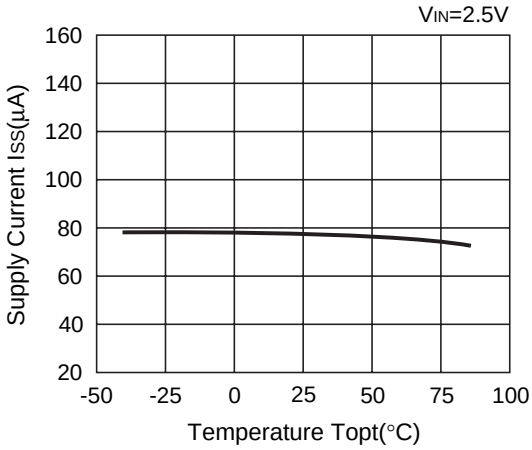


6) Supply Current vs. Temperature

R1170x151B



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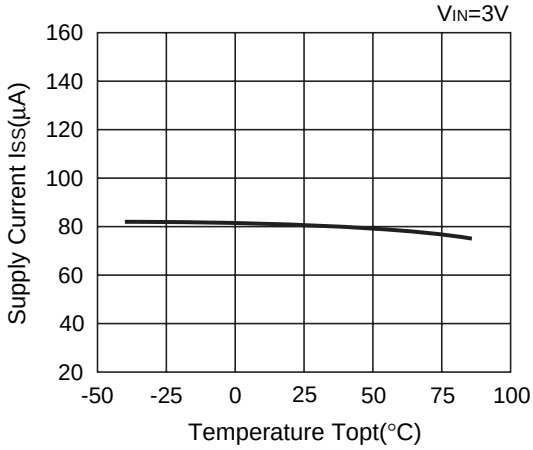

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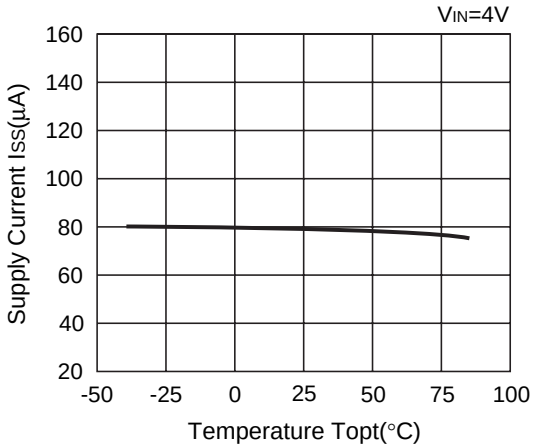
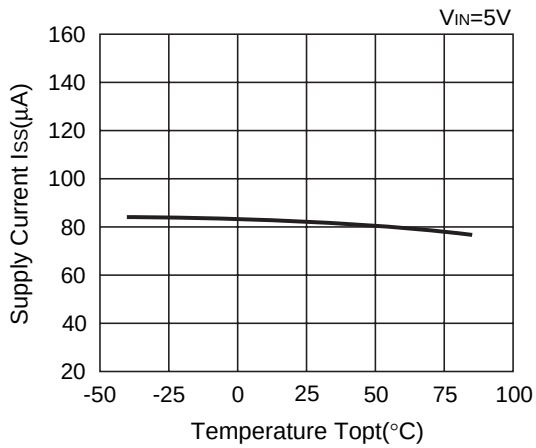
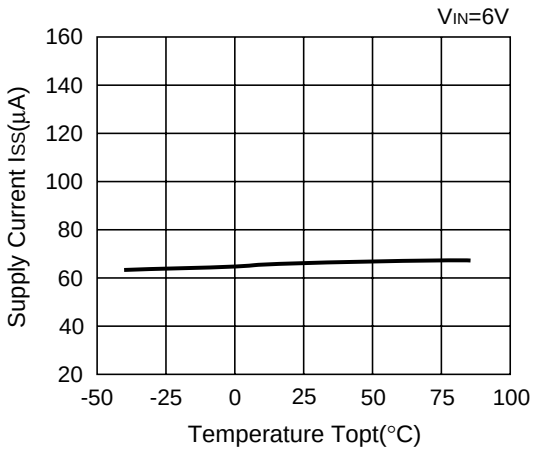


R1170x401B

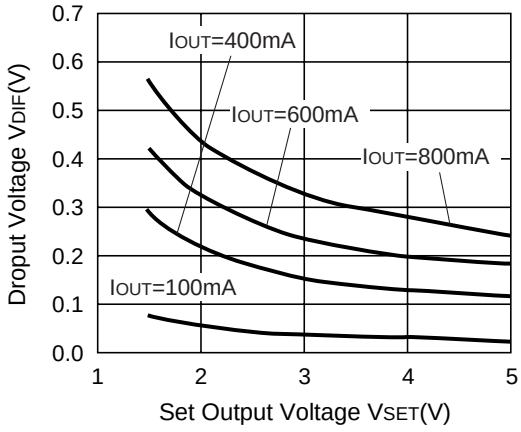


R1170x501B



7) Dropout Voltage vs. Set Output Voltage (Topt=25°C)

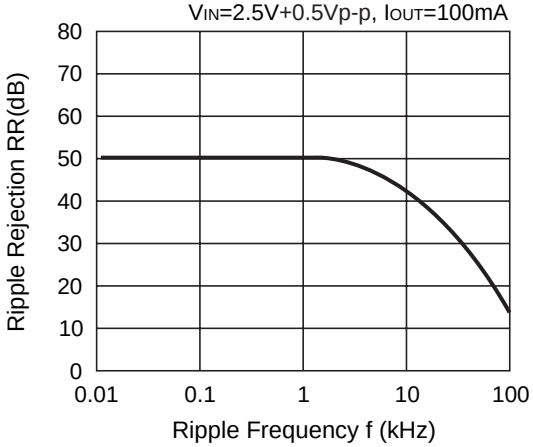
R1170x



8) Ripple Rejection vs. Frequency

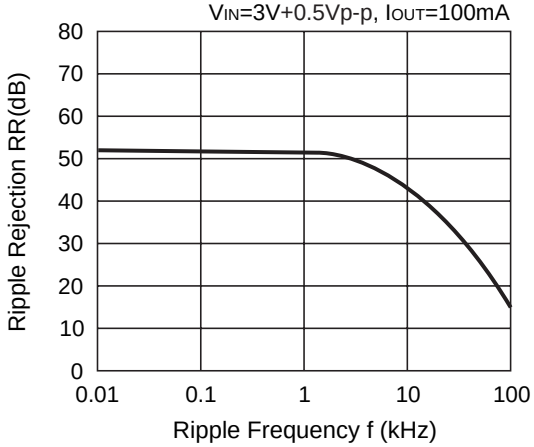
R1170x151B

V_{IN}=2.5V+0.5Vp-p, I_{OUT}=100mA



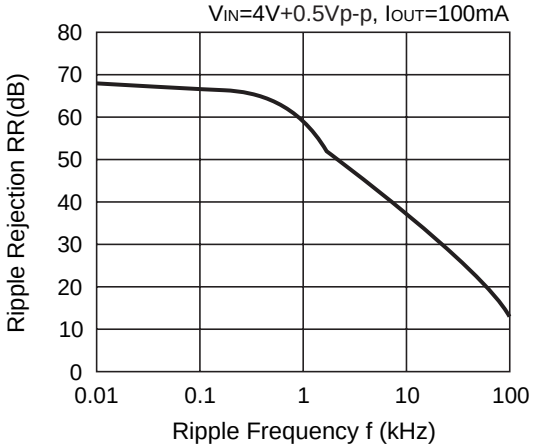
R1170x201B

V_{IN}=3V+0.5Vp-p, I_{OUT}=100mA



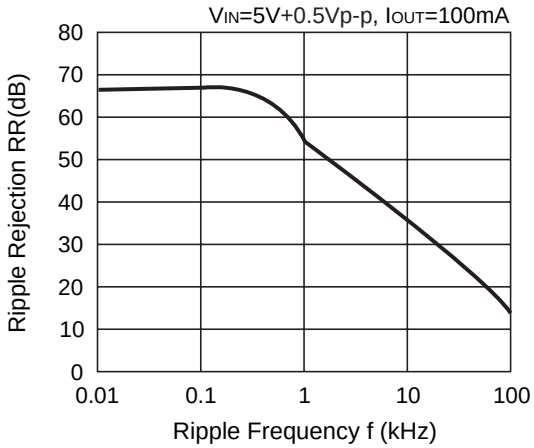
R1170x301B

V_{IN}=4V+0.5Vp-p, I_{OUT}=100mA



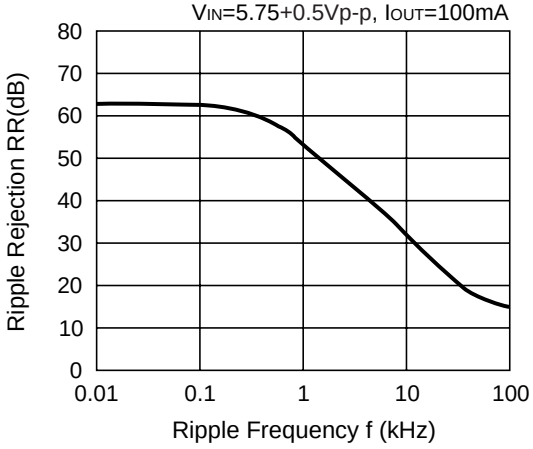
R1170x401B

V_{IN}=5V+0.5Vp-p, I_{OUT}=100mA



R1170x501B

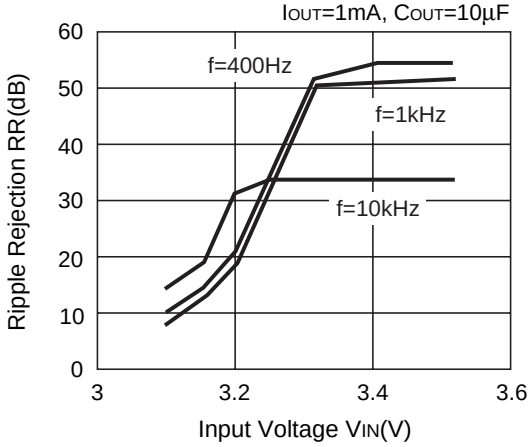
V_{IN}=5.75+0.5Vp-p, I_{OUT}=100mA



9) Ripple Rejection vs. Input Voltage

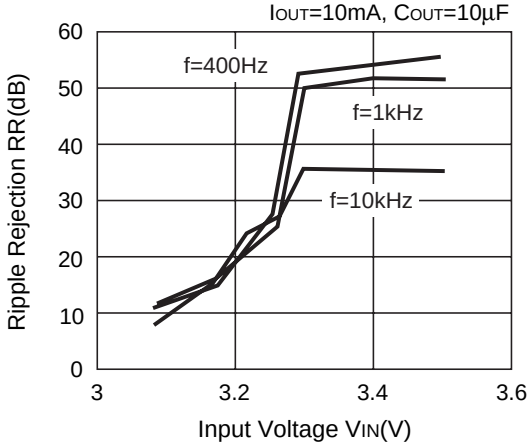
R1170x301B

I_{OUT}=1mA, C_{OUT}=10µF



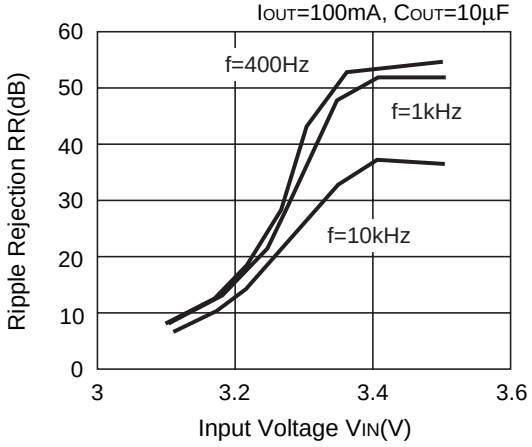
R1170x301B

I_{OUT}=10mA, C_{OUT}=10µF



R1170x301B

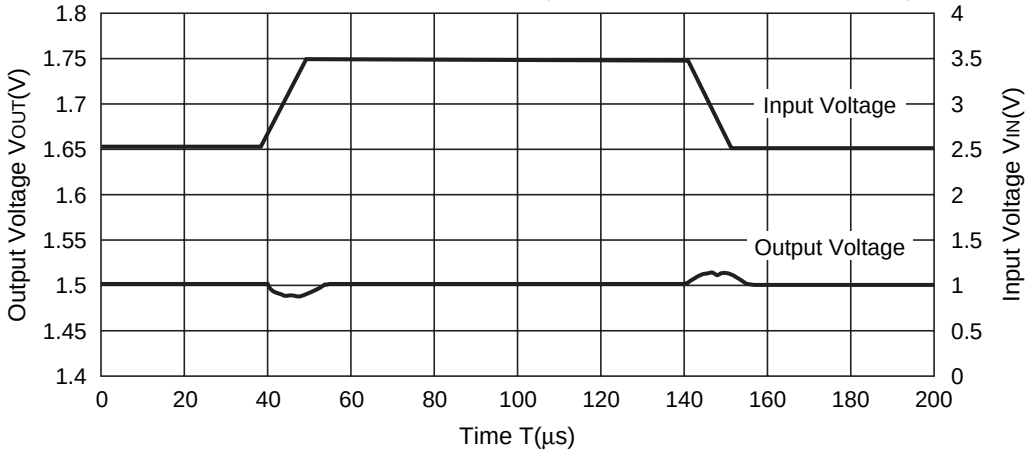
I_{OUT}=100mA, C_{OUT}=10µF



10) Input Transient Response (Topt=25°C)

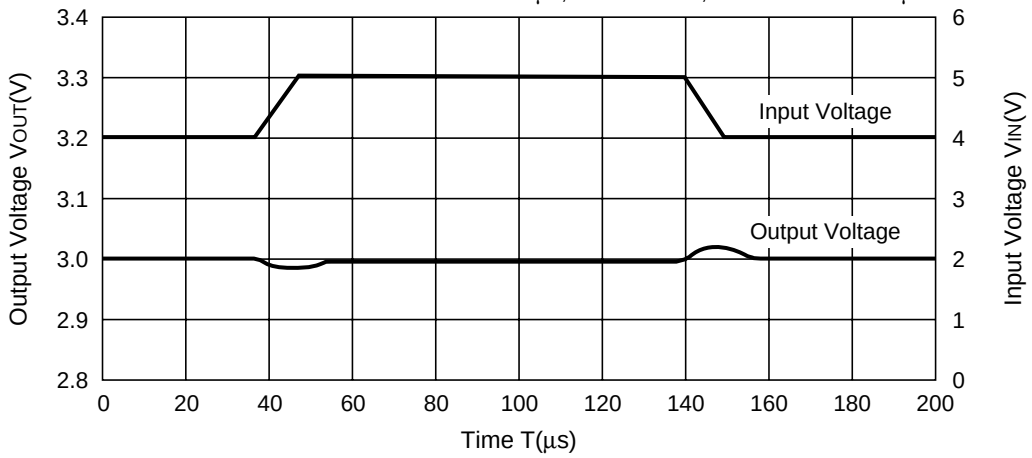
R1170x151B

tr=tf=10µs, I_{OUT}=100mA, C_{OUT}=Ceramic 10µF



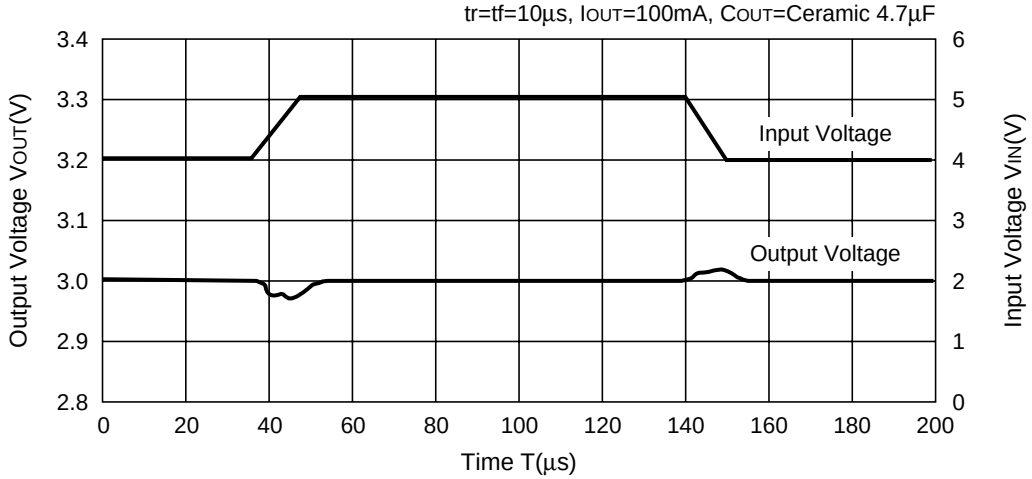
R1170x301B

tr=tf=10µs, IOUT=100mA, COUT=Ceramic 10µF



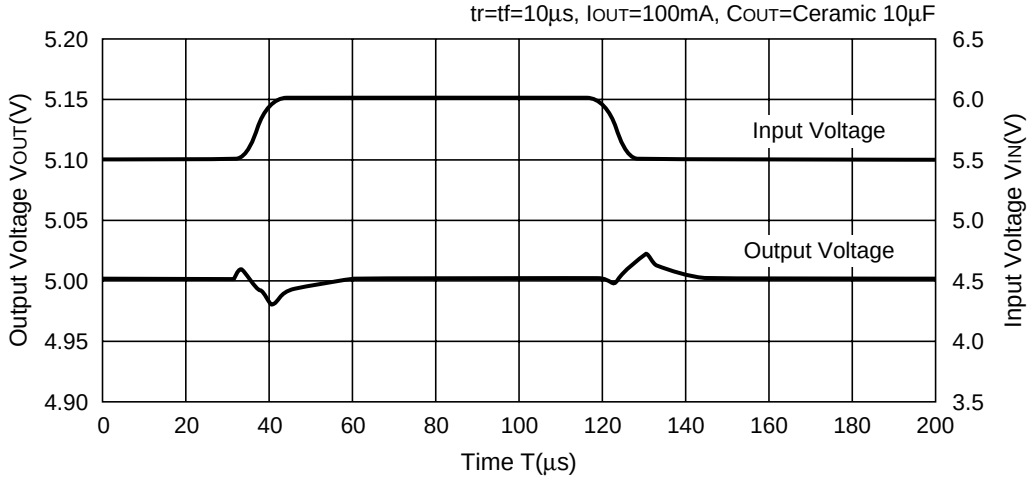
R1170x301B

tr=tf=10µs, IOUT=100mA, COUT=Ceramic 4.7µF



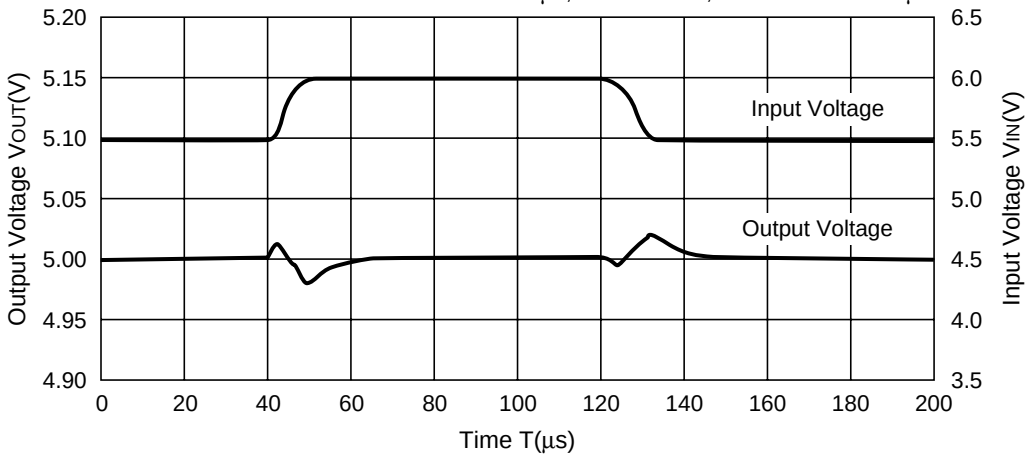
R1170x501B

tr=tf=10µs, IOUT=100mA, COUT=Ceramic 10µF



R1170x501B

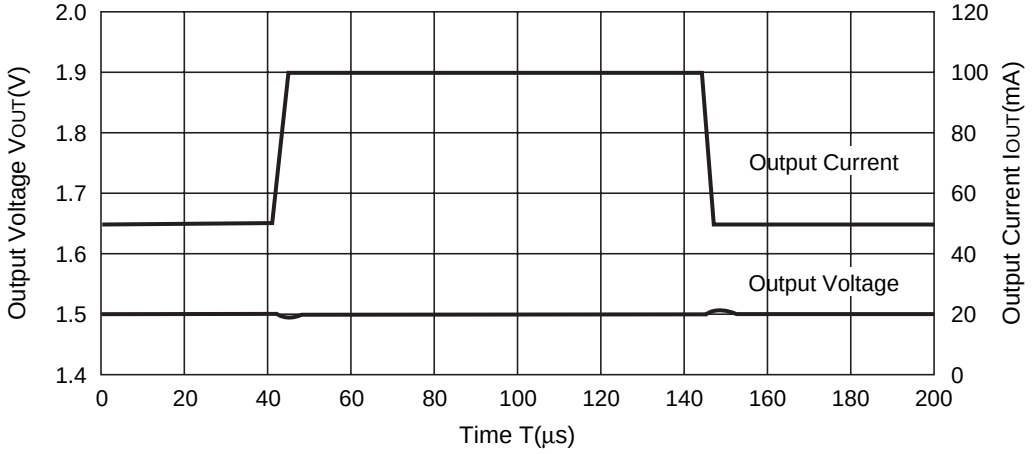
tr=tf=10µs, I_{OUT}=100mA, C_{OUT}=Ceramic 4.7µF



11) Load Transient Response (Topt=25°C)

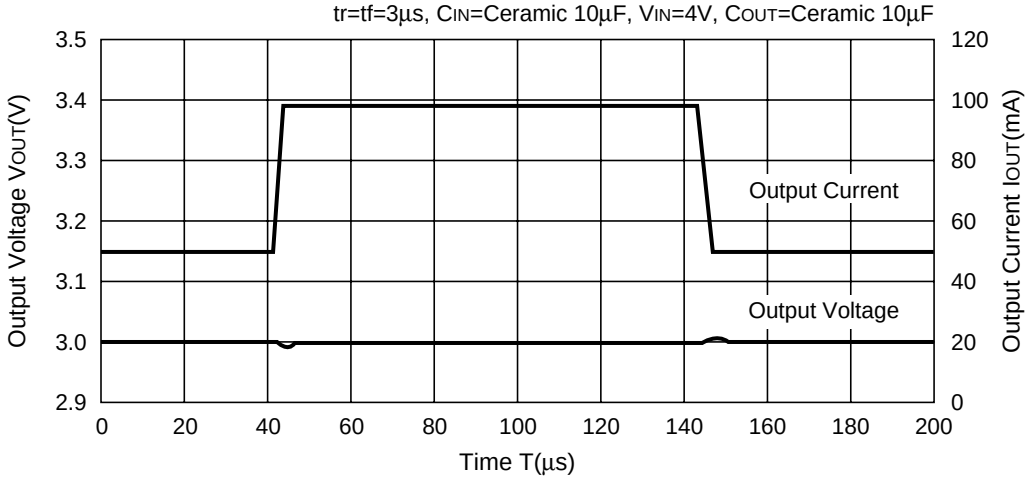
R1170x151B

tr=tf=3µs, C_{IN}=Ceramic 10µF, V_{IN}=2.5V, C_{OUT}=Ceramic 10µF



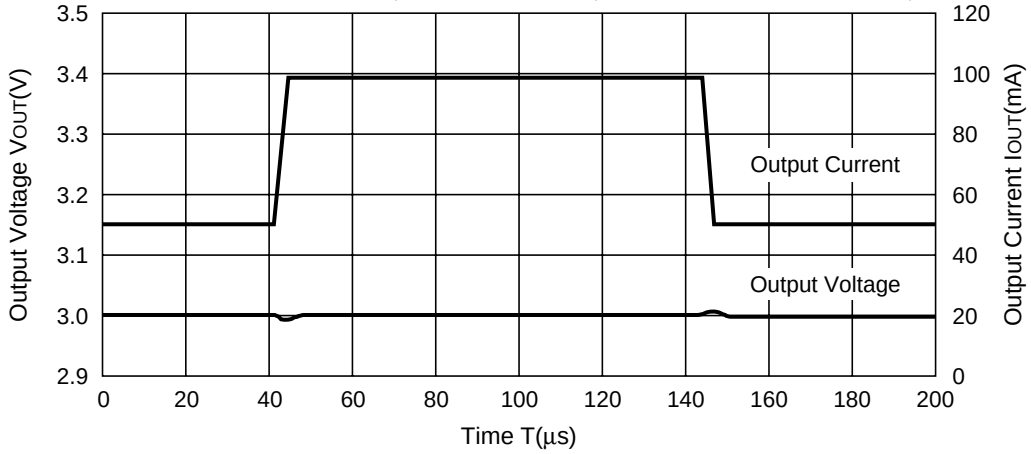
R1170x301B

tr=tf=3µs, C_{IN}=Ceramic 10µF, V_{IN}=4V, C_{OUT}=Ceramic 10µF



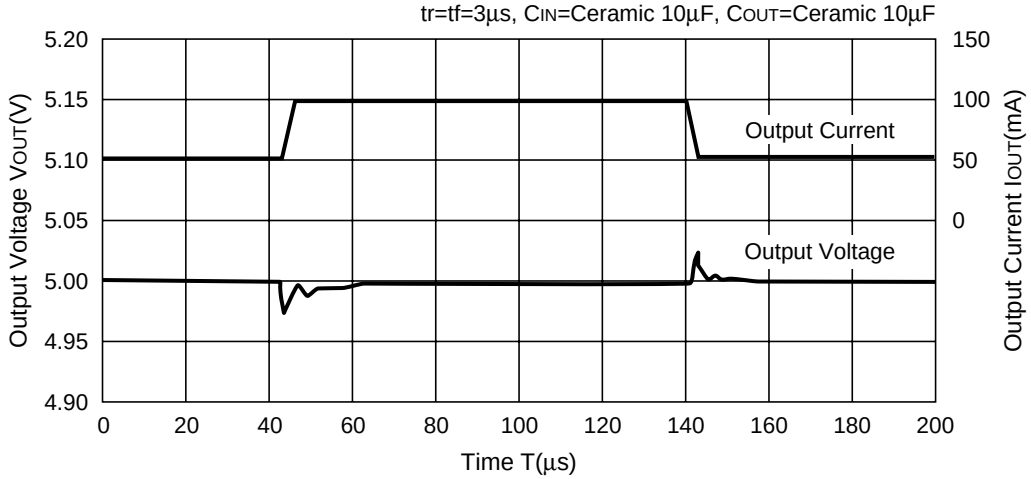
R1170x301B

tr=tf=3µs, CIN=Ceramic 10µF, VIN=4V, COUT=Ceramic 4.7µF



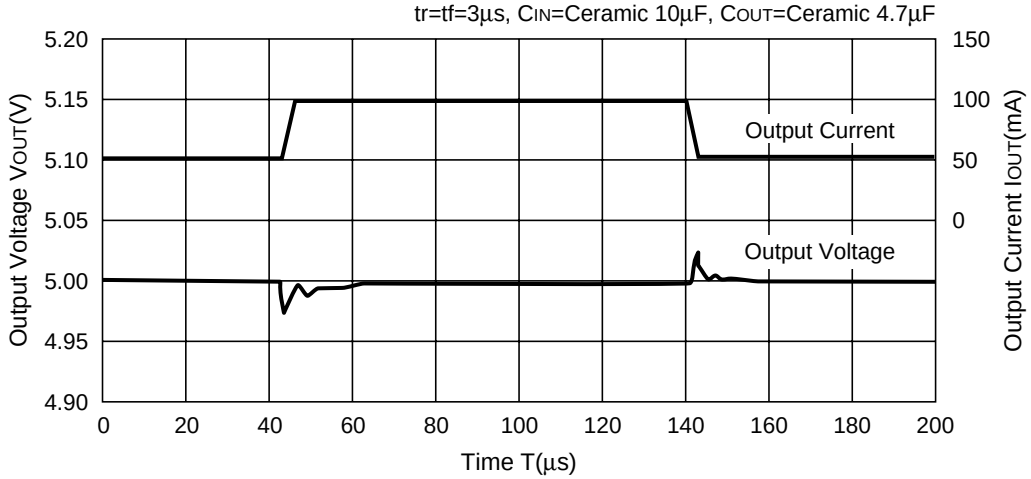
R1170x501B

tr=tf=3µs, CIN=Ceramic 10µF, COUT=Ceramic 10µF

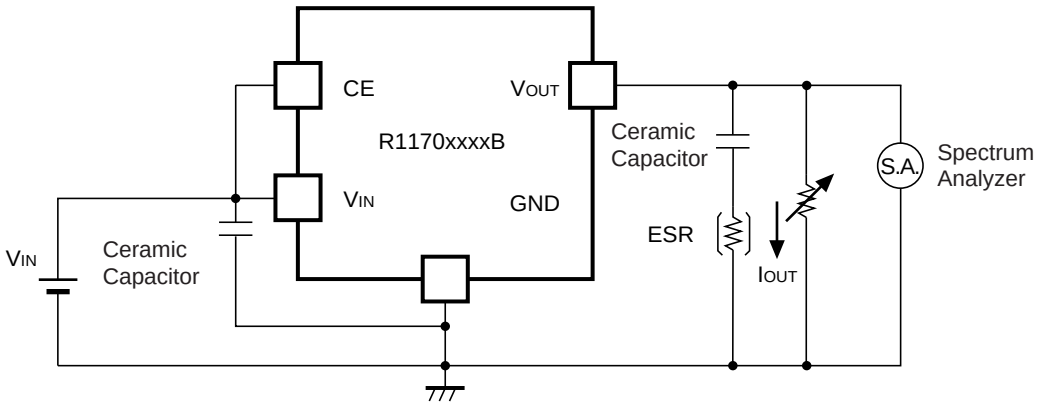


R1170x501B

tr=tf=3µs, CIN=Ceramic 10µF, COUT=Ceramic 4.7µF



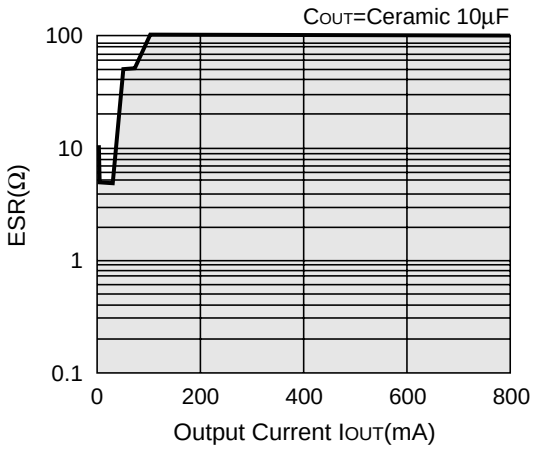
12) Stable Area (Topt=25°C, V_{IN} = Set Output Voltage+1V, C_{IN} = Ceramic 10μF)



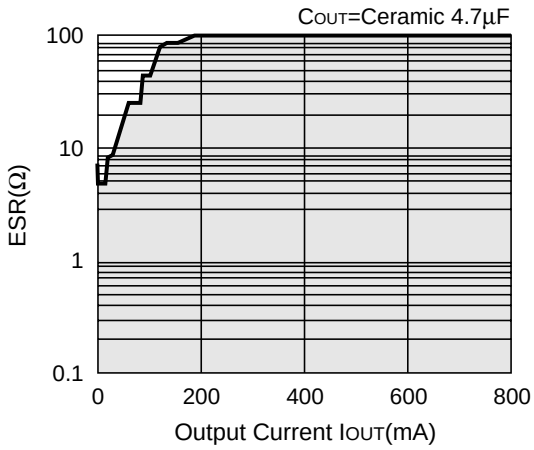
As an output capacitor for this IC, Ceramic capacitor is recommendable. However, other low ESR type capacitor can be used with this IC.

For your reference, noise level is tested with the circuit as shown above, and if the noise level is 40μV or less than 40μV, the ESR values are plotted as stable area. Upper limit is described in the next four graphs, or ESR vs. Output Current. (Hatched area is the stable area.)

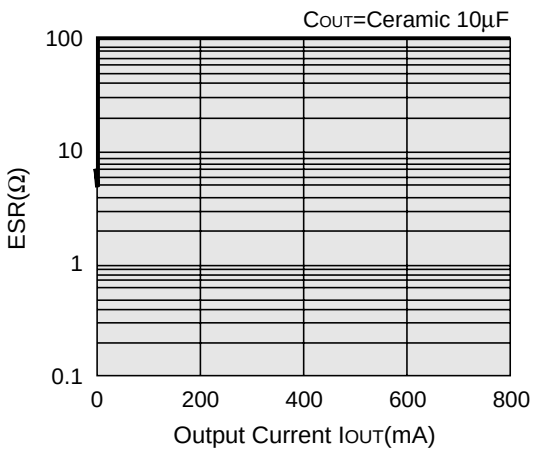
R1170x151B



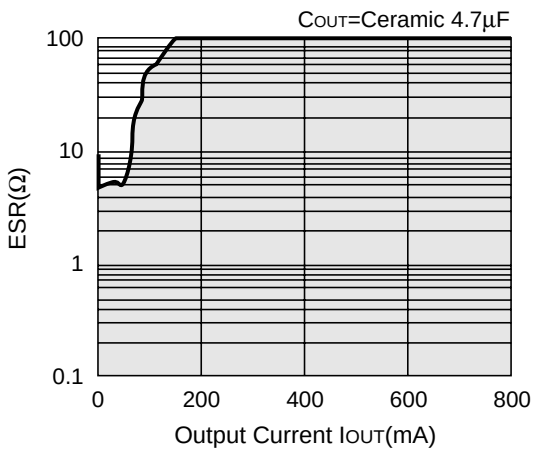
R1170x151B



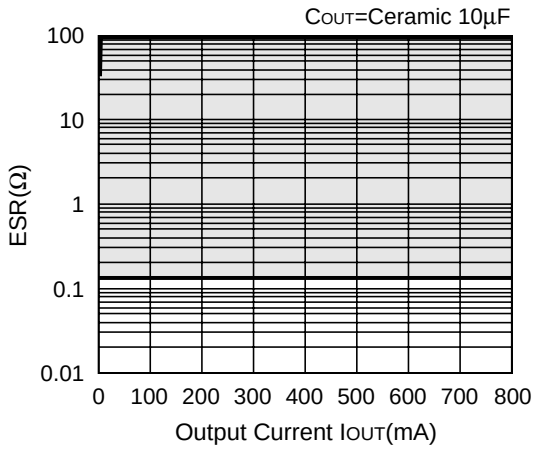
R1170x301B



R1170x301B



R1170x501B



R1170x501B