

Super low on resistance/Low voltage LDO

NO.EA-123-111027

OUTLINE

The R1173x Series are CMOS-based positive voltage regulator ICs. The R1173x Series have features of super low dropout, 1A output current capability, and -3mV typical load regulation at 1A. Even the output voltage is set at 1.5V, on resistance of internal FET is typically 0.32Ω . Therefore, applications that require a large current at small dropout are suitable for the R1173x series. Low input voltage is acceptable and low output voltage can be set. The minimum input voltage is 1.4V, and the lowest set output voltage is 0.8V. Each of these ICs consists of a voltage reference unit, an error amplifier, resistor net for setting output voltage, a current limit circuit at over-current, a chip enable circuit, a thermal-shutdown circuit, and so on. A stand-by mode with ultra low consumption current can be realized with the chip enable pin. The output voltage types of R1173 are fixed one in the IC and adjustable one (R1173x001x).

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

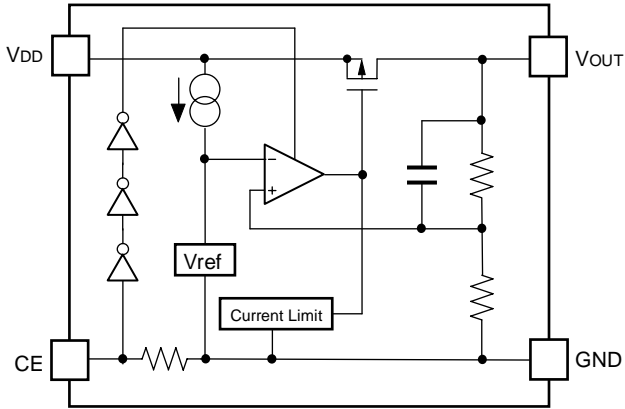
- Output Current 1A
- Supply Current Typ. $60\mu\text{A}$
- Standby Current Typ. $0.1\mu\text{A}$
- Input Voltage Range 1.4V to 6.0V
- Output Voltage Range..... 0.8V to 5.0V (0.1V steps) (R1173xxx1)
1.0V to V_{IN} (R1173x001)
(For other voltages, please refer to MARK INFORMATIONS.)
- Dropout Voltage Typ. 0.32V ($V_{\text{OUT}}=1.5\text{V}$, $I_{\text{OUT}}=1\text{A}$)
Typ. 0.18V ($V_{\text{OUT}}=2.8\text{V}$, $I_{\text{OUT}}=1\text{A}$)
- Ripple Rejection Typ. 70dB ($V_{\text{OUT}}=2.8\text{V}$)
- Output Voltage Accuracy..... $\pm 2.0\%$
- Temperature-drift Coefficient of Output Voltage..... Typ. $\pm 100\text{ppm}/^\circ\text{C}$
- Line Regulation Typ. 0.05%/V
- Load Regulation Typ. -2mV ($I_{\text{OUT}}=300\text{mA}$)
Typ. -3mV ($I_{\text{OUT}}=1\text{A}$)
- Packages SOT-89-5, HSON-6, HSOP-6J
- Low inrush current at turning-on Typ. 500mA
- Built-in Thermal Shutdown Circuit
- Built-in Current Limit Circuit Typ. 250mA
- Output capacitors $C_{\text{IN}}=\text{Ceramic } 4.7\mu\text{F}$
 $C_{\text{OUT}}=\text{Tantalum } 4.7\mu\text{F}$ ($V_{\text{OUT}}<1.0\text{V}$)
 $C_{\text{OUT}}=\text{Ceramic } 4.7\mu\text{F}$ ($V_{\text{OUT}} \geq 1.0\text{V}$)

APPLICATIONS

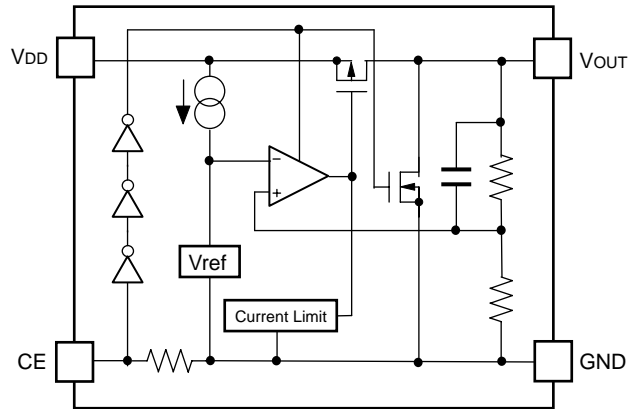
- Local Power source for Notebook PC.
- Local Power source for portable communication equipments, cameras, and videos.
- Local Power source for home appliances.

BLOCK DIAGRAMS

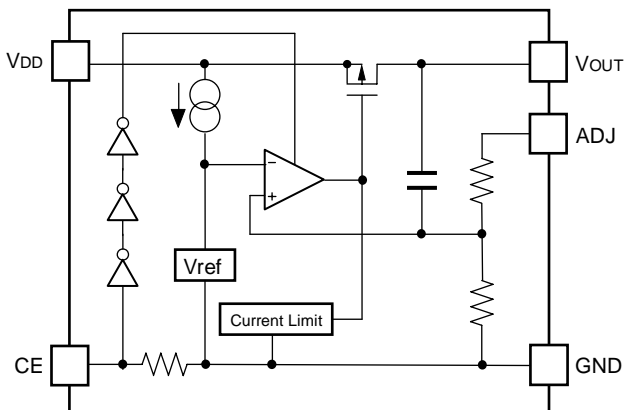
R1173xxx1B



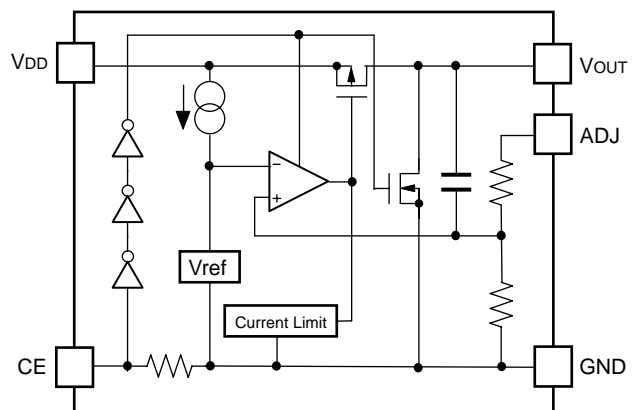
R1173xxx1D



R1173x001B



R1173x001D



SELECTION GUIDE

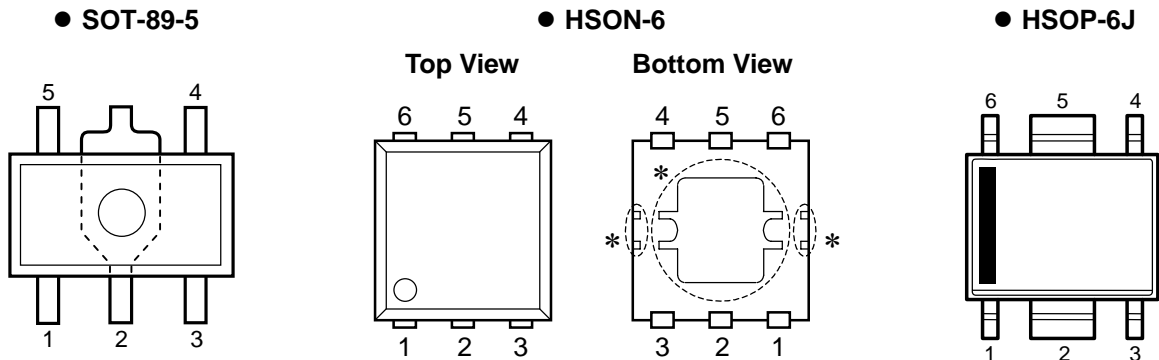
The output voltage, auto discharge function, package for the ICs can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1173Dxx1*-TR-FE	HSOP-6	3,000 pcs	Yes	Yes
R1173Hxx1*-T1-FE	SOT-89-5	1,000 pcs	Yes	Yes
R1173Sxx1*-E2-FE	HSOP-6J	1,000 pcs	Yes	Yes

xx: The output voltage can be designated in the range from 0.8V(08) to 5.0V(50) in 0.1V steps.
 External Setting Type: 00 (ADJ pin voltage is fixed at 1.0V.)
 (For other voltages, please refer to MARK INFORMATIONS.)

* : The auto discharge function at off state are options as follows.
 (B) "H" active, without auto discharge function at off state
 (D) "H" active, with auto discharge function at off state

PIN CONFIGURATIONS




PIN DESCRIPTIONS

●SOT-89-5

Pin No.	Symbol	Description
1	ADJ	ADJUST Pin (R1173H001x)
	NC	No Connection (R1173Hxx1x)
2	GND	Ground Pin
3	CE	Chip Enable Pin ("H" Active)
4	V _{DD}	Input Pin
5	V _{OUT}	Output Pin

●HSON-6

Pin No.	Symbol	Description
1	V _{OUT} *1	Output Pin
2	V _{OUT} *1	Output Pin
3	ADJ	ADJUST Pin (R1173D001x)
	NC	No Connection (R1173Dxx1x)
4	GND	Ground Pin
5	CE	Chip Enable Pin ("H" Active)
6	V _{DD}	Input Pin

*) Tab and tab suspension leads in the  parts are GND level.
 (They are connected to the reverse side of the IC.)
 The tab is better to be connected to the GND, but leaving it open is also acceptable.
 The tab suspension leads should be open and do not connect to other wires or land patterns.

*1) The V_{OUT} pin must be wired together when it is mounted on board.

●HSOP-6J

Pin No.	Symbol	Description
1	V_{OUT}	Output Pin
2	GND* ¹	Ground Pin
3	ADJ	ADJUST Pin (R1173S001x)
	NC	No Connection (R1173Sxx1x)
4	CE	Chip Enable Pin ("H" Active)
5	GND* ¹	Ground Pin
6	V_{DD}	Input Pin

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

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.5	V
V_{CE}	Input Voltage (CE Input Pin)	-0.3 to 6.5	V
V_{OUT}	Output Voltage	-0.3 to $V_{IN}+0.3$	V
P_D	Power Dissipation (SOT-89-5)*	900	mW
	Power Dissipation (HSOP-6)*	900	
	Power Dissipation (HSOP-6J)*	1700	
T_{opt}	Operating Temperature	-40 to 85	°C
T_{stg}	Storage Temperature	-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

• R1173xxxxB/D (Fixed Output Voltage Type)

T_{opt}=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
V _{IN}	Input Voltage		1.4		6.0	V	
I _{SS}	Supply Current	V _{IN} -V _{OUT} =1.0V, V _{CE} =V _{IN} , I _{OUT} =0A		60	100	μA	
I _{standby}	Standby Current	V _{IN} = 6.0V, V _{CE} =0V		0.1	1.0	μA	
V _{OUT}	Output voltage	V _{IN} -V _{OUT} =1.0V I _{OUT} =100mA	V _{OUT} >1.5V	×0.98	×1.02	V	
			V _{OUT} ≤ 1.5V	-30	+30	mV	
ΔV _{OUT} / ΔI _{OUT}	Load regulation	V _{IN} -V _{OUT} =0.3V, 1mA ≤ I _{OUT} ≤ 300mA If V _{OUT} ≤ 1.1V, then V _{IN} =1.4V		-15	-2	15	mV
		V _{IN} -V _{OUT} =0.3V, 1mA ≤ I _{OUT} ≤ 1A If V _{OUT} ≤ 1.1V, then V _{IN} =1.7V			-3		
V _{DIF}	Dropout Voltage	Refer to the following table					
ΔV _{OUT} / ΔV _{IN}	Line regulation	I _{OUT} =100mA, V _{OUT} +0.5V ≤ V _{IN} ≤ 6.0V If V _{OUT} ≤ 0.9V, 1.4V ≤ V _{IN} ≤ 6.0V		0.05	0.20	%/V	
RR	Ripple Rejection	f=1kHz (V _{OUT} ≤ 4.0V) f=1kHz (V _{OUT} >4.0V) Ripple 0.5Vp-p, V _{IN} -V _{OUT} =1.0V, I _{OUT} =100mA If V _{OUT} ≤ 1.2V, V _{IN} -V _{OUT} =1.5V, I _{OUT} =100mA		70 60		dB	
ΔV _{OUT} / ΔT _{opt}	Output Voltage Temperature Coefficient	I _{OUT} =100mA, -40°C ≤ T _{opt} ≤ 85°C		±100		ppm/ °C	
I _{LIM}	Output Current	V _{IN} -V _{OUT} =1.0V	1			A	
I _{SC}	Short Current Limit	V _{OUT} =0V		250		mA	
R _{PD}	Pull-down resistance for CE pin		1.9	5.0	15.0	MΩ	
V _{CEH}	CE Input Voltage "H"		1.0		6.0	V	
V _{CEL}	CE Input Voltage "L"		0		0.4	V	
T _{TSD}	Thermal Shutdown Detector Threshold Temperature	Junction Temperature		150		°C	
T _{TSR}	Thermal Shutdown Released Temperature	Junction Temperature		120		°C	
en	Output Noise	BW=10Hz to 100kHz		30		μVrms	

• Dropout Voltage by Output Voltage

T_{opt}=25°C

Output Voltage V _{OUT} (V)	Dropout Voltage V _{DIF} (V)		
	I _{OUT} =300mA		I _{OUT} =1A
	Typ.	Max.	Typ.
0.8 ≤ V _{OUT} < 0.9	0.33	0.57	0.72
0.9 ≤ V _{OUT} < 1.0	0.22	0.47	0.64
1.0 ≤ V _{OUT} < 1.5	0.18	0.32	0.56
1.5 ≤ V _{OUT} < 2.6	0.10	0.15	0.32
2.6 ≤ V _{OUT}	0.05	0.10	0.18

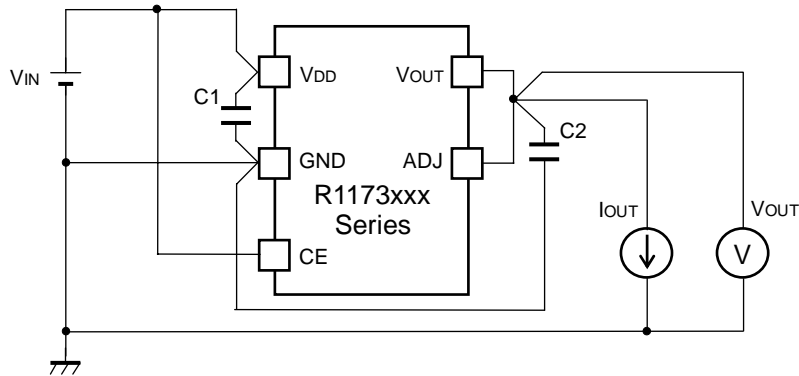
• R1173x001B/D (Adjustable Output Voltage Type)

$T_{opt}=25^{\circ}\text{C}$

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage		1.4		6.0	V
I_{SS}	Supply Current	$V_{OUT}=V_{ADJ}$, $V_{IN}=2.0$, $V_{CE}=V_{IN}$		60	100	μA
$I_{standby}$	Standby Current	$V_{IN}=6.0\text{V}$, $V_{CE}=0\text{V}$		0.1	1.0	μA
V_{OUT}	Reference Voltage for Adjustable Voltage Regulator	$V_{OUT}=V_{ADJ}$, $V_{IN}=2.0\text{V}$ $I_{OUT}=100\text{mA}$	0.970	1.000	1.030	V
RV_{OUT}	Output Voltage Range		1.0		V_{IN}	V
$\Delta V_{OUT}/\Delta I_{OUT}$	Load regulation	$V_{IN}=1.4\text{V}$ $1\text{mA} \leq I_{OUT} \leq 300\text{mA}$	-15	-2	15	mV
		$V_{IN}=1.7\text{V}$ $1\text{mA} \leq I_{OUT} \leq 1\text{A}$		-3		
V_{DIF}	Dropout Voltage	$V_{OUT}=V_{ADJ}$	$I_{OUT}=300\text{mA}$	0.18	0.32	V
			$I_{OUT}=1\text{A}$	0.56		
$\Delta V_{OUT}/\Delta V_{IN}$	Line regulation	$V_{OUT}=V_{ADJ}$, $I_{OUT}=100\text{mA}$ $1.5\text{V} \leq V_{IN} \leq 6.0\text{V}$		0.05	0.20	%/V
RR	Ripple Rejection	$f=1\text{kHz}$ Ripple 0.5Vp-p , $V_{OUT}=V_{ADJ}$, $V_{IN}=2.5\text{V}$ $I_{OUT}=100\text{mA}$		70		dB
$\Delta V_{OUT}/\Delta T_{opt}$	Output Voltage Temperature Coefficient	$I_{OUT}=100\text{mA}$ $-40^{\circ}\text{C} \leq T_{opt} \leq 85^{\circ}\text{C}$		± 100		ppm/ $^{\circ}\text{C}$
I_{LIM}	Output Current	$V_{OUT}=V_{ADJ}$, $V_{IN}=2.0$	1			A
I_{SC}	Short Current Limit	$V_{OUT}=V_{ADJ}=0\text{V}$		250		mA
R_{PD}	Pull-down resistance for CE pin		1.9	5.0	15.0	$\text{M}\Omega$
V_{CEH}	CE Input Voltage "H"		1.0		6.0	V
V_{CEL}	CE Input Voltage "L"		0		0.4	V
T_{TSD}	Thermal Shutdown Detector Threshold Temperature	Junction Temperature		150		$^{\circ}\text{C}$
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature		120		$^{\circ}\text{C}$
en	Output Noise	$\text{BW}=10\text{Hz to }100\text{kHz}$		30		μVrms

Technical Notes on External Components and Typical Application

(Refer to the example of typical application)



Example of the typical application of R1173x (Fixed Output Type)

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 a capacitor as C2. Recommendation value is as follows:

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 a $4.7\mu\text{F}$ or more value capacitor between V_{DD} pin and GND pin as close as possible.

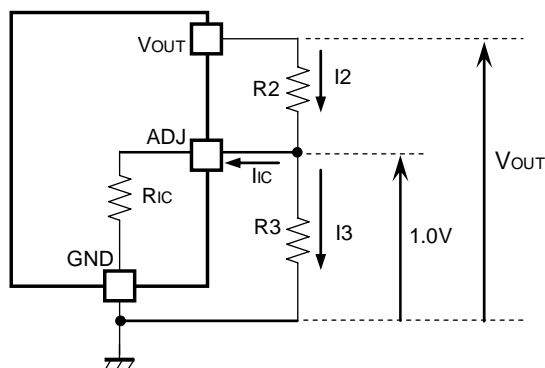
Set an Output capacitor between V_{OUT} pin and GND pin for phase compensation as close as possible.

Output Voltage	C2 recommendation value	Components Recommendation	
$V_{OUT} < 1.0\text{V}$	Tantalum $4.7\mu\text{F}$ or more		
$1.0 \leq V_{OUT} < 3.3\text{V}$	Ceramic $4.7\mu\text{F}$ or more	Kyocera $4.7\mu\text{F}$ (1608) Murata $4.7\mu\text{F}$ (1608) Murata $10\mu\text{F}$ (1608)	Part Number: CM105X5R475M06AB Part Number: GRM188R60J475KE19B Part Number: GRM188B30G106ME46B
$3.3\text{V} \leq V_{OUT}$	Ceramic $4.7\mu\text{F}$ or more	Kyocera $4.7\mu\text{F}$ (thin 2012) Murata $10\mu\text{F}$ (1608)	Part Number: CT21X5R475M06AB Part Number: GRM188B30G106ME46B

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.

Technical Notes on Output Voltage Setting of Adjustable Output type (R1173x001x)



The Output Voltage may be adjustable for any output voltage between its 1.0V reference and its V_{DD} setting level. An external pair of resistors is required, as shown above.

The complete equation for the output voltage is described step by step as follows;

$$I_2 = I_{IC} + I_3 \dots\dots\dots (1)$$

$$I_3 = 1.0/R_3 \dots\dots\dots (2)$$

Thus,

$$I_2 = I_{IC} + 1.0/R_3 \dots\dots\dots (3)$$

Therefore,

$$V_{OUT} = 1.0 + R_2 \times I_2 \dots\dots\dots (4)$$

Put Equation (3) into Equation (4), then

$$\begin{aligned} V_{OUT} &= 1.0 + R_2(I_{IC} + 1.0/R_3) \\ &= 1.0(1 + R_2/R_3) + R_2 \times I_{IC} \dots\dots\dots (5) \end{aligned}$$

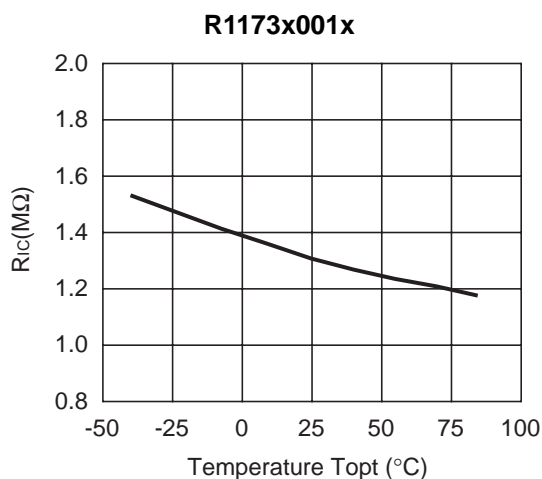
In 2nd term, or $R_2 \times I_{IC}$ will produce an error in V_{OUT} .

In Equation (5),

$$I_{IC} = 1.0/R_{IC} \dots\dots\dots (6)$$

$$\begin{aligned} R_2 \times I_{IC} &= R_2 \times 1.0/R_{IC} \\ &= 1.0 \times R_2/R_{IC} \dots\dots\dots (7) \end{aligned}$$

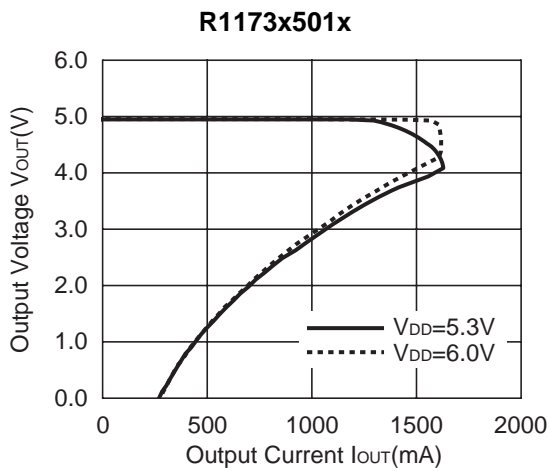
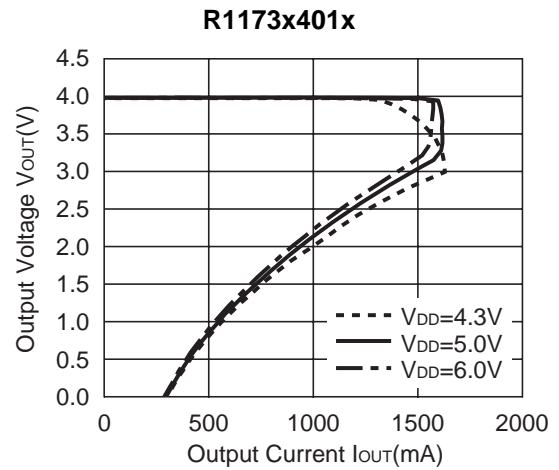
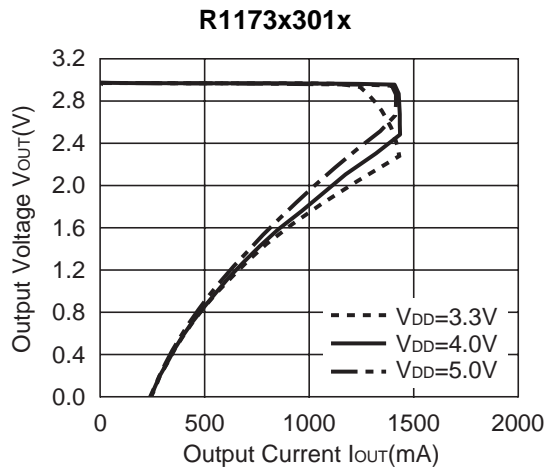
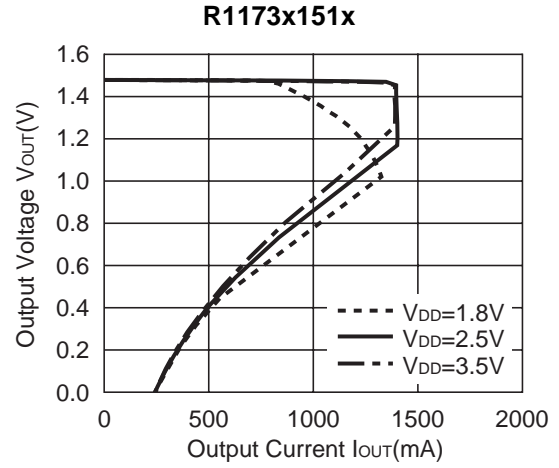
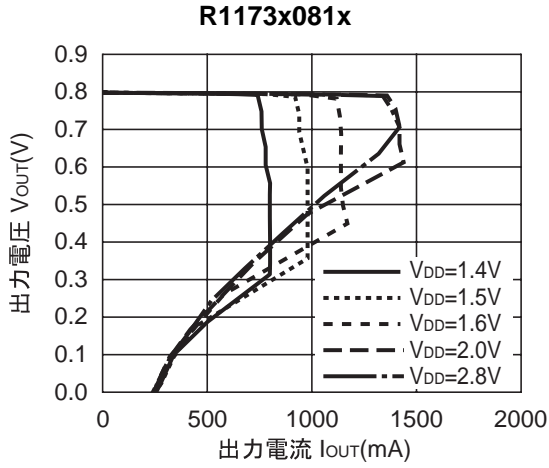
For better accuracy, choosing $R_2 \ll R_{IC}$ reduces this error.



*) The graph is a typical characteristic, please evaluate the circuit with an actual condition.

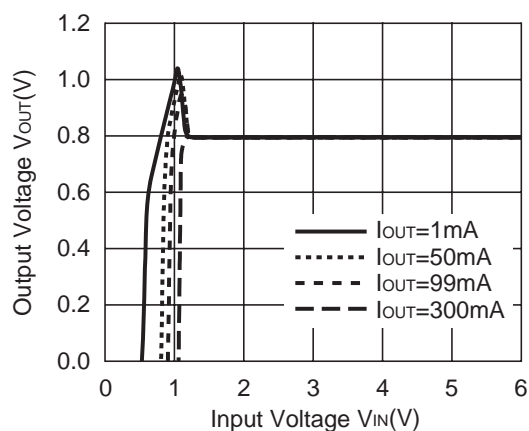
TYPICAL CHARACTERISTICS

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

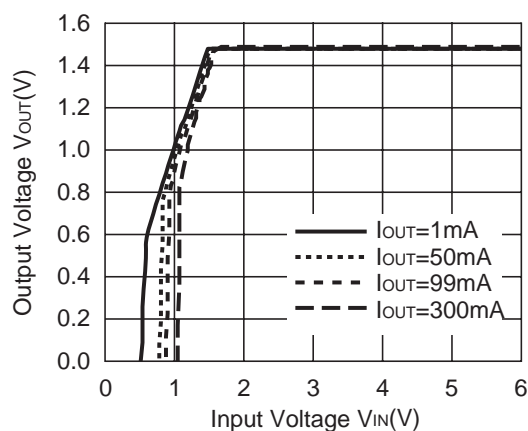


2) Output Voltage vs. Input Voltage ($T_{opt}=25^{\circ}\text{C}$)

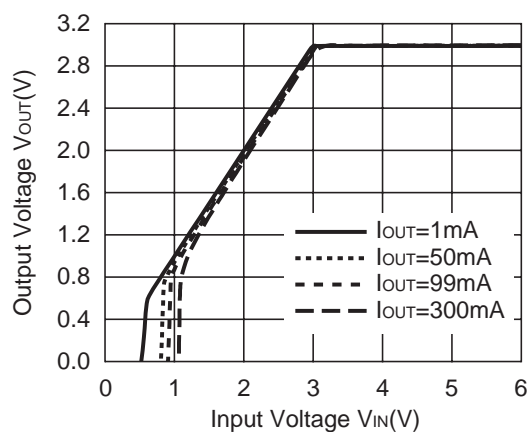
R1173x081x



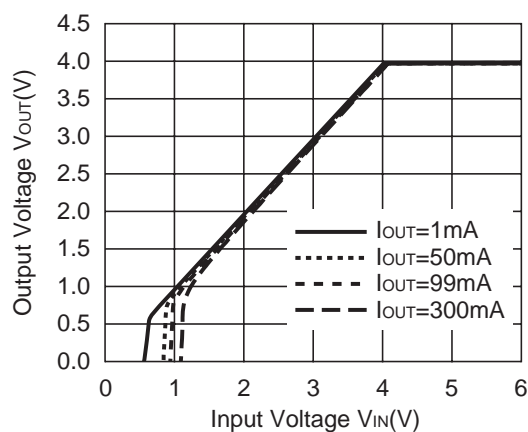
R1173x151x



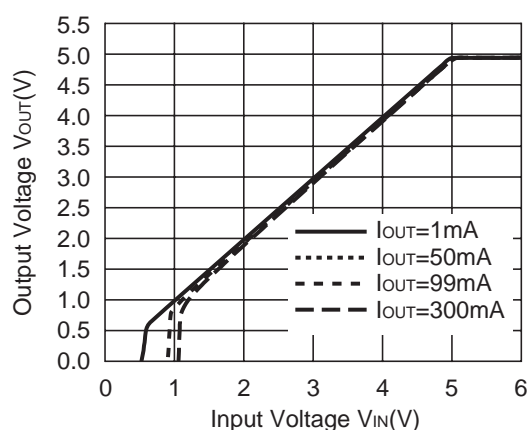
R1173x301x



R1173x401x

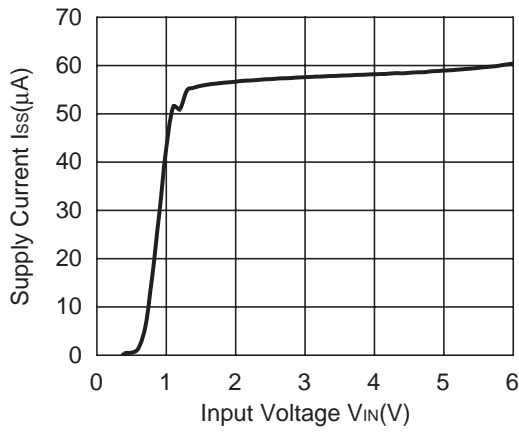


R1173x501x

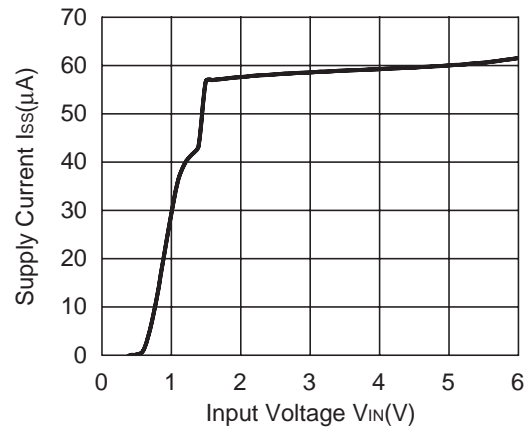


3) Dropout Voltage vs. Output Current (Topt=25°C)

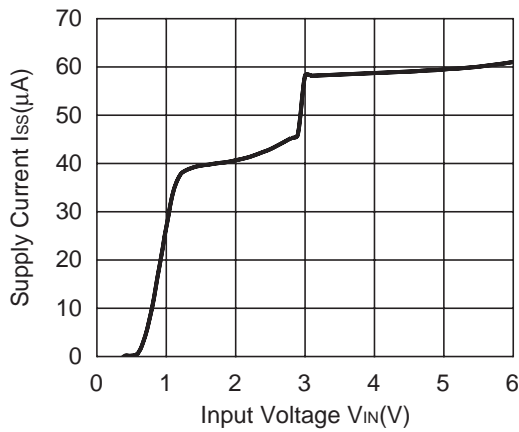
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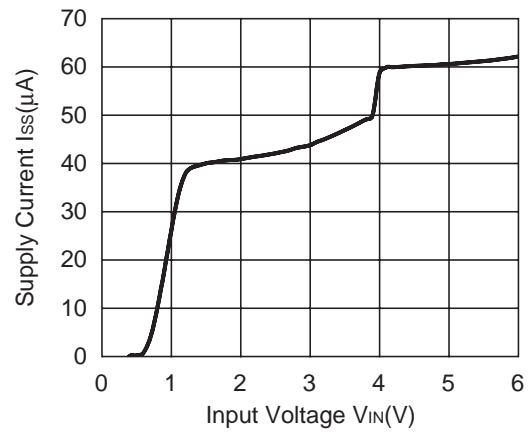
R1173x151x



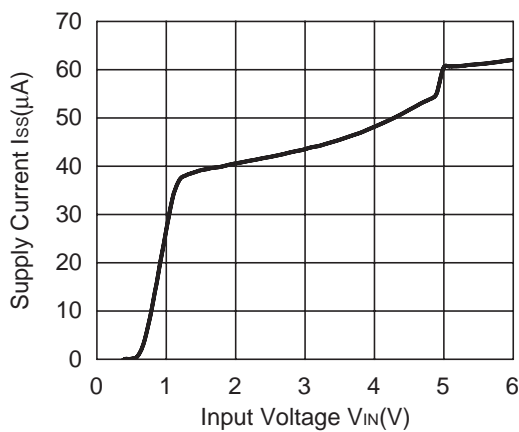
R1173x301x

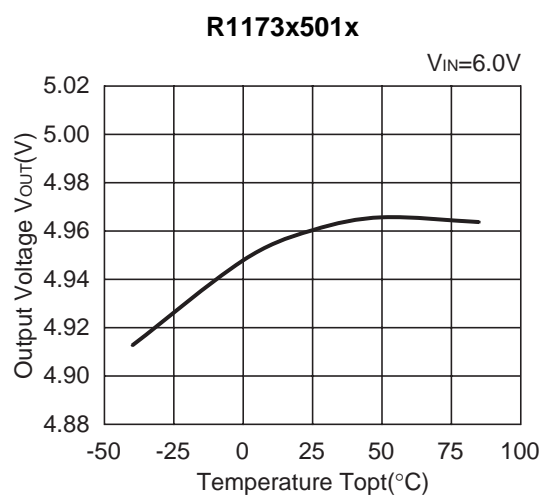
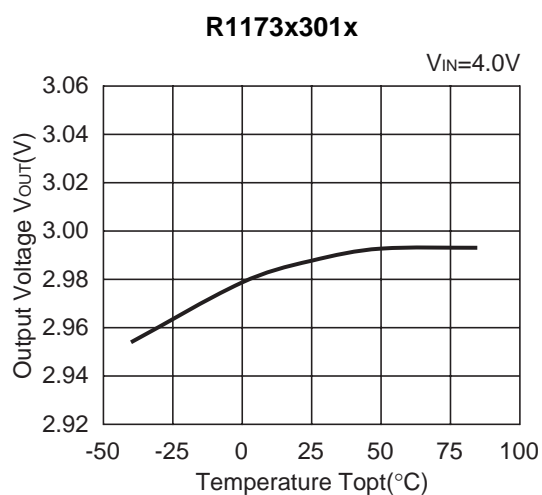
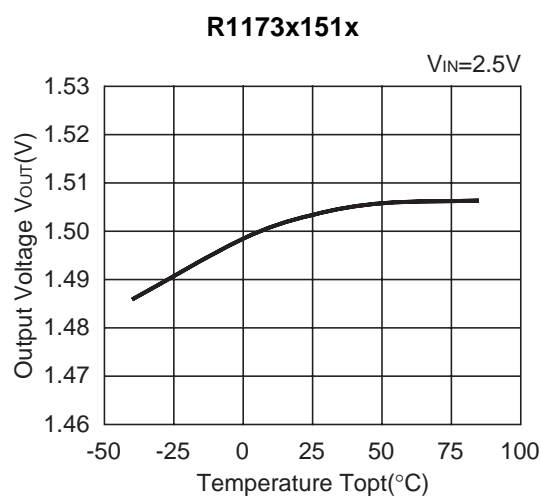
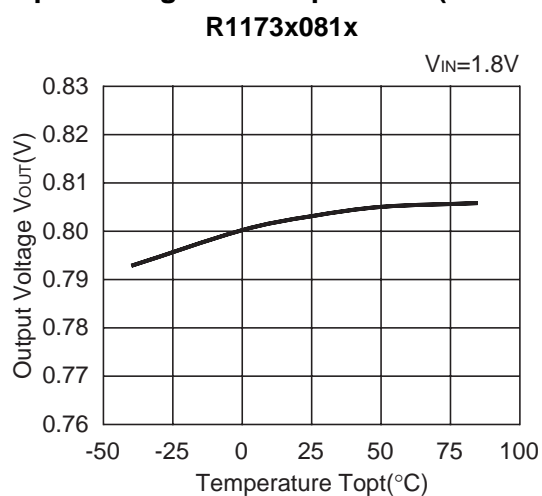


R1173x401x

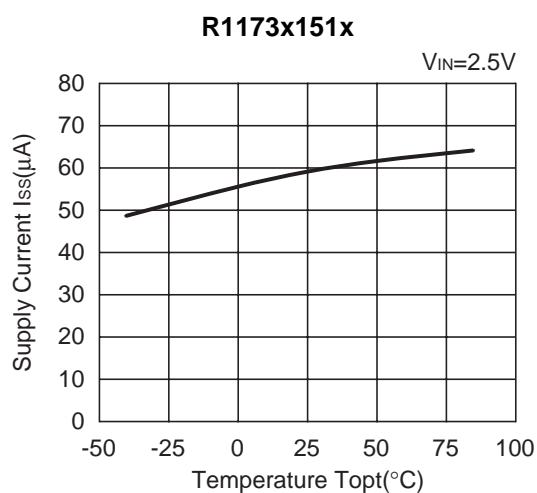
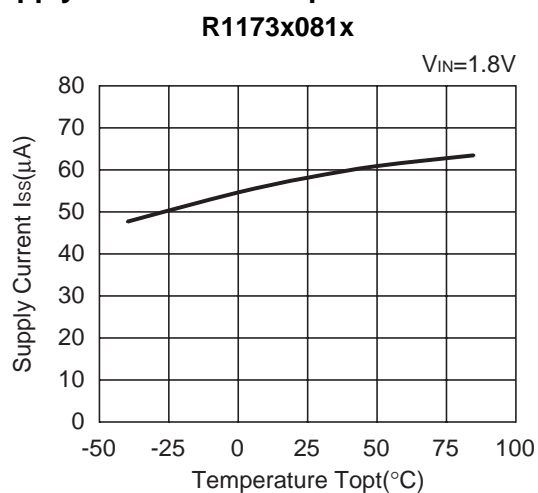


R1173x501x

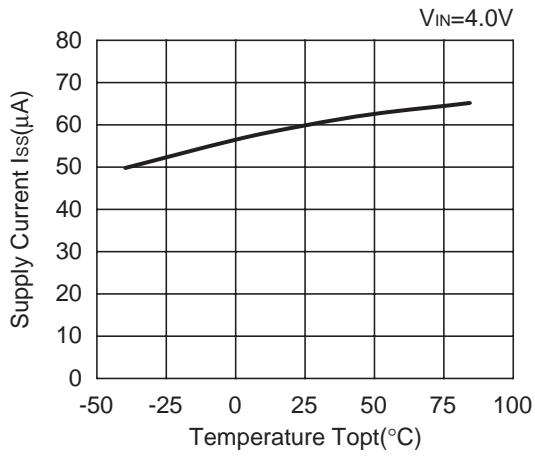


4) Output Voltage vs. Temperature ($I_{OUT}=100mA$)

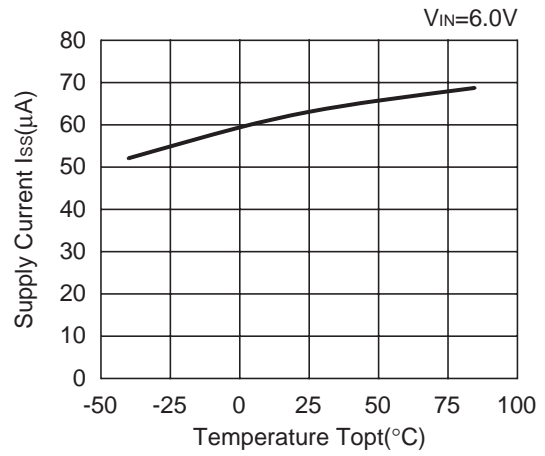
5) Supply Current vs. Temperature



R1173x301x

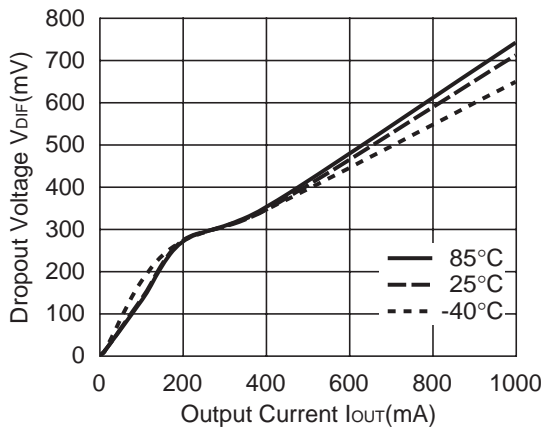


R1173x501x

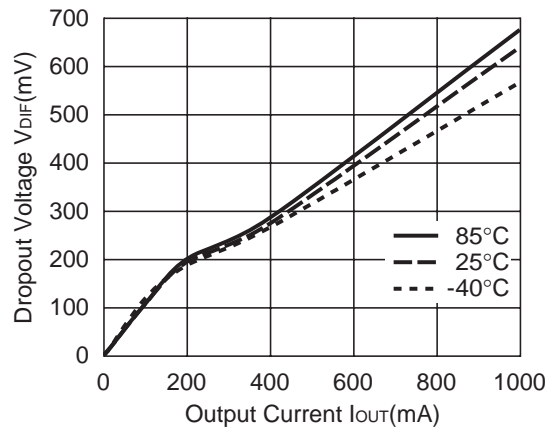


6) Dropout Voltage vs. Output Current

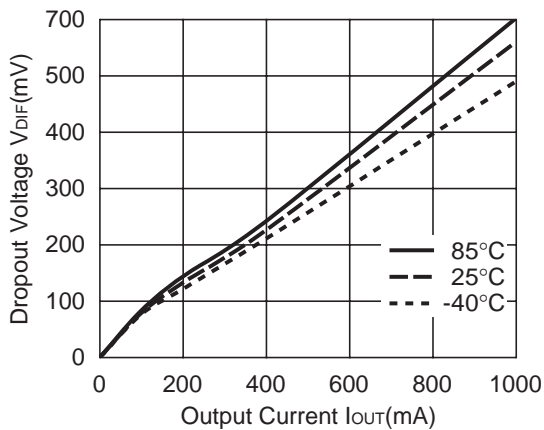
R1173x081x



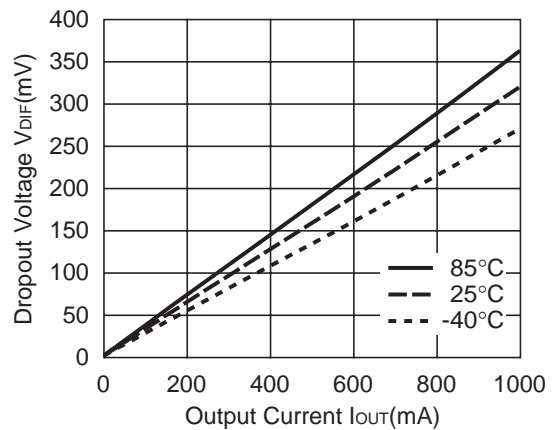
R1173x091x

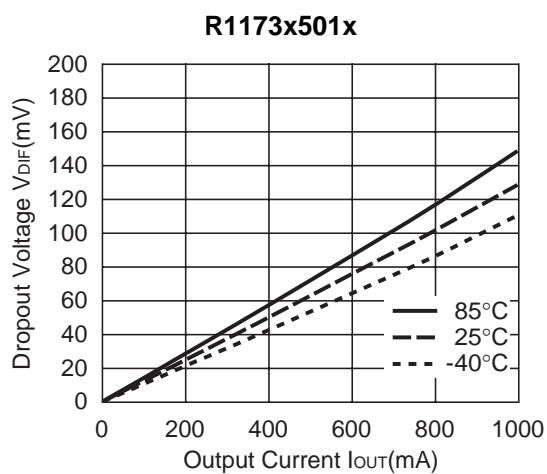
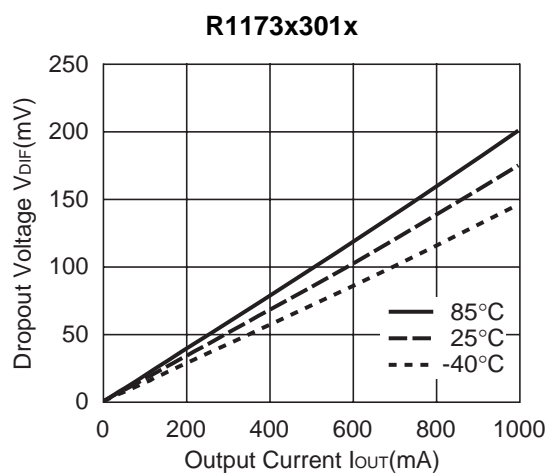


R1173x101x

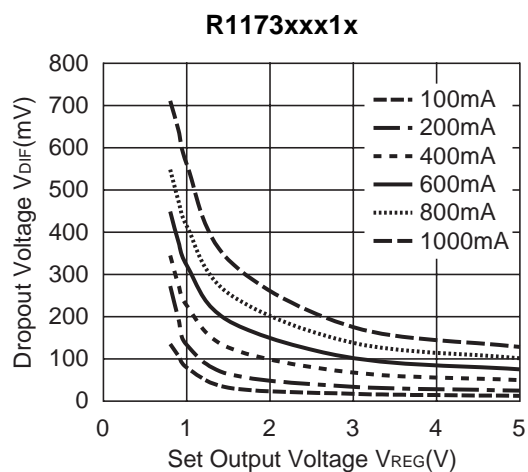


R1173x151x

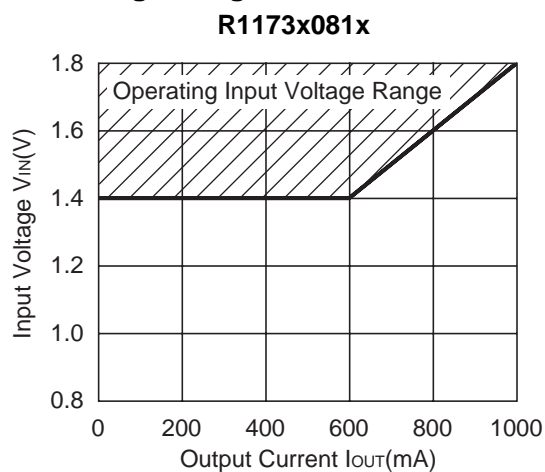




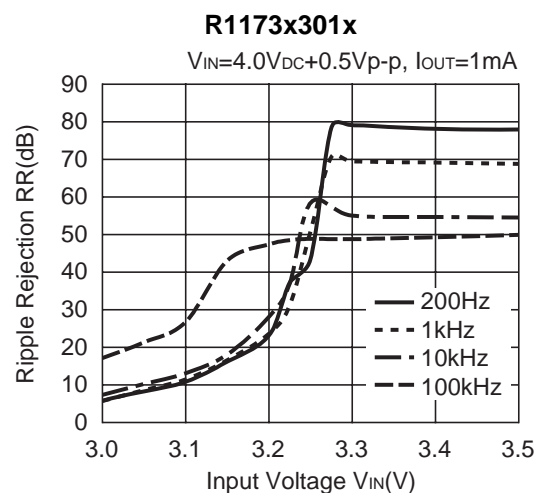
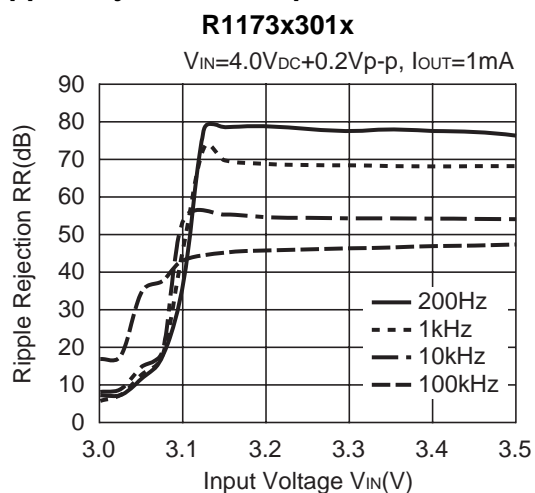
7) Dropout Voltage vs. Set Output Voltage

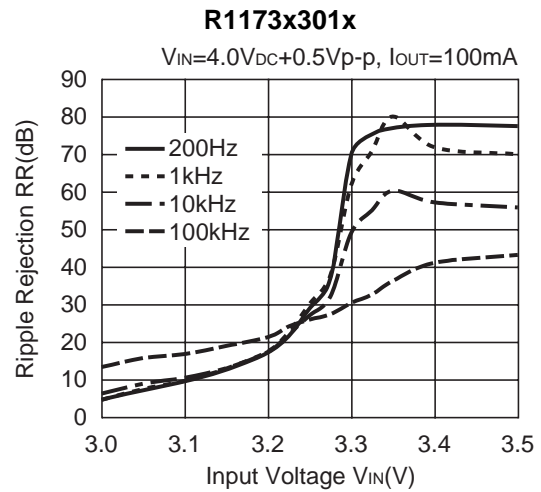
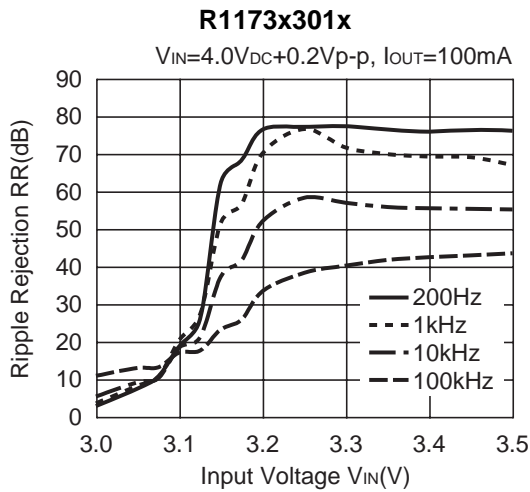
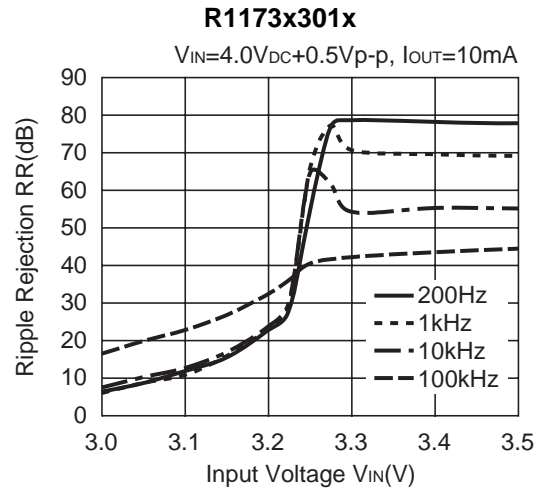
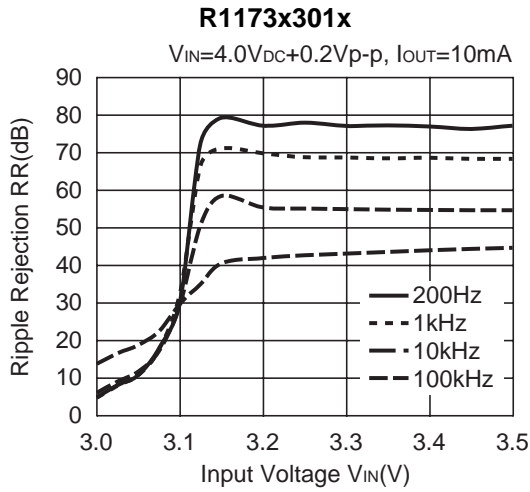


8) 0.8V Output type, Operating Input Voltage Range

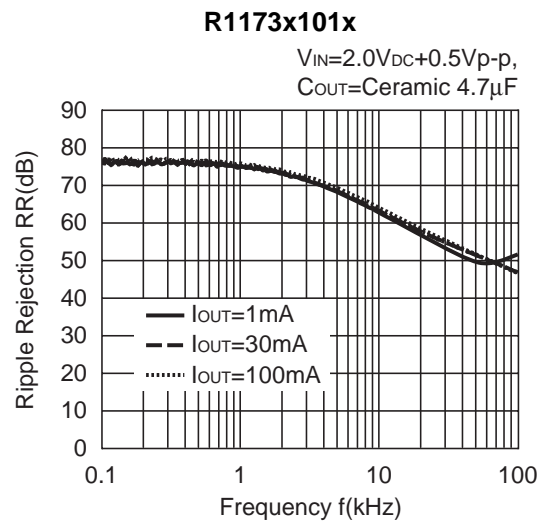
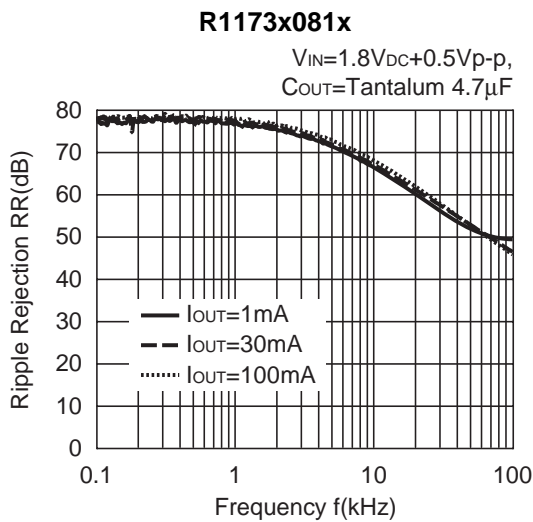


9) Ripple Rejection vs. Input Bias



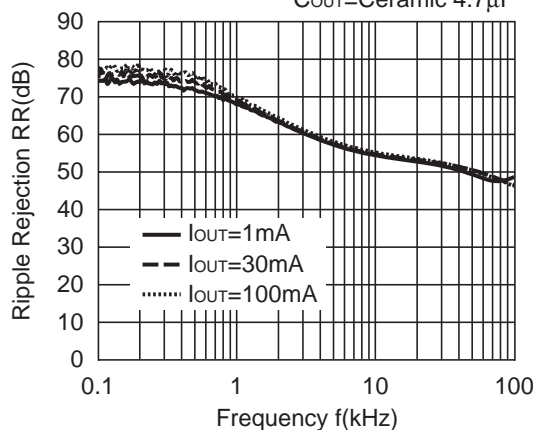


10) Ripple Rejection vs. Frequency

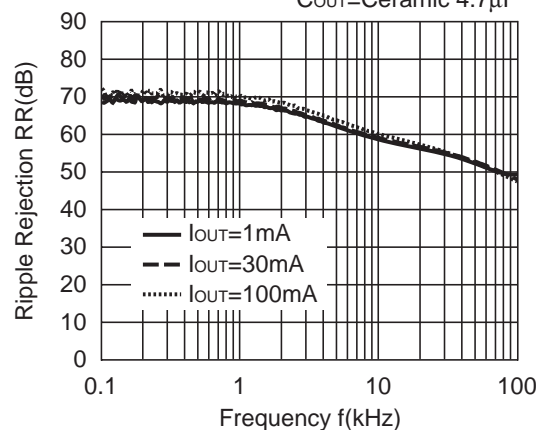


R1173x301x

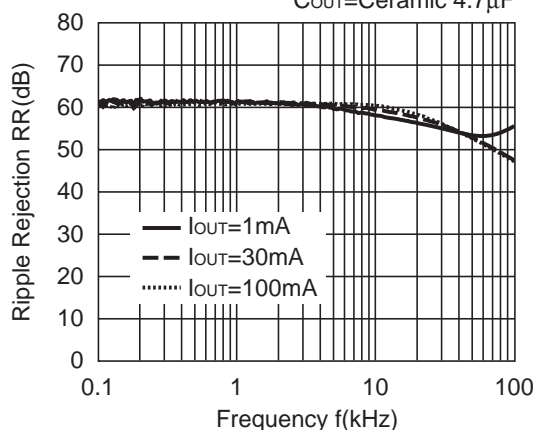
$V_{IN}=4.0V_{DC}+0.5V_{p-p}$,
 $C_{OUT}=\text{Ceramic } 4.7\mu F$

**R1173x401x**

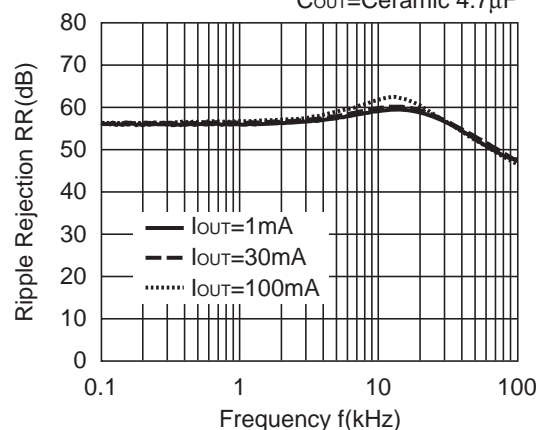
$V_{IN}=5.0V_{DC}+0.5V_{p-p}$,
 $C_{OUT}=\text{Ceramic } 4.7\mu F$

**R1173x451x**

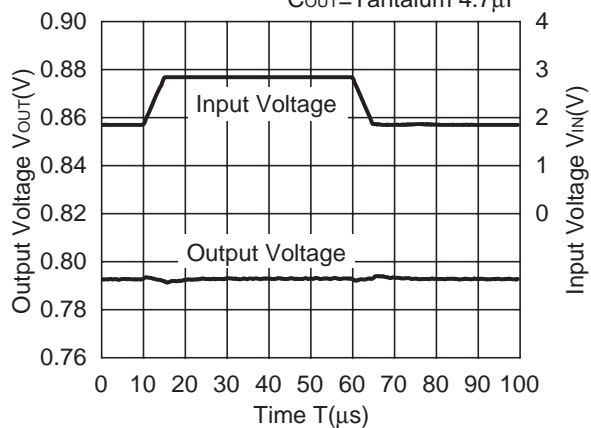
$V_{IN}=5.5V_{DC}+0.5V_{p-p}$,
 $C_{OUT}=\text{Ceramic } 4.7\mu F$

**R1173x501x**

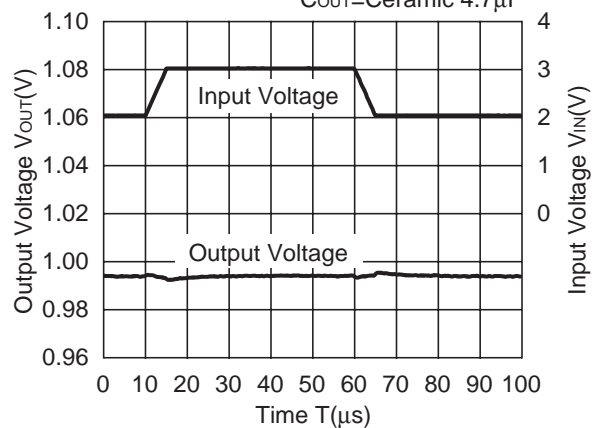
$V_{IN}=6.0V_{DC}+0.5V_{p-p}$,
 $C_{OUT}=\text{Ceramic } 4.7\mu F$

**11) Line Transient Response ($T_r=T_f=5\mu s$, $I_{OUT}=100\text{mA}$)****R1173x081x**

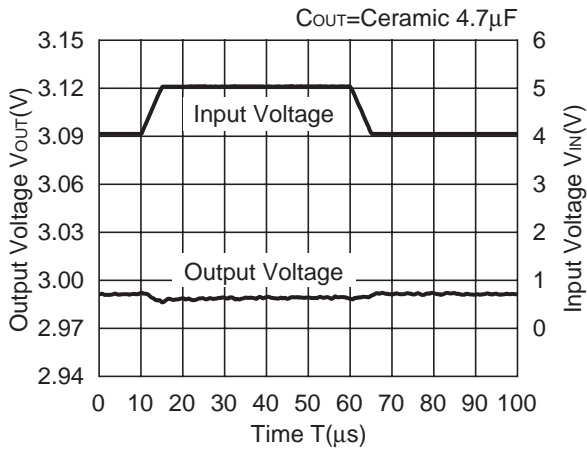
$C_{OUT}=\text{Tantalum } 4.7\mu F$

**R1173x101x**

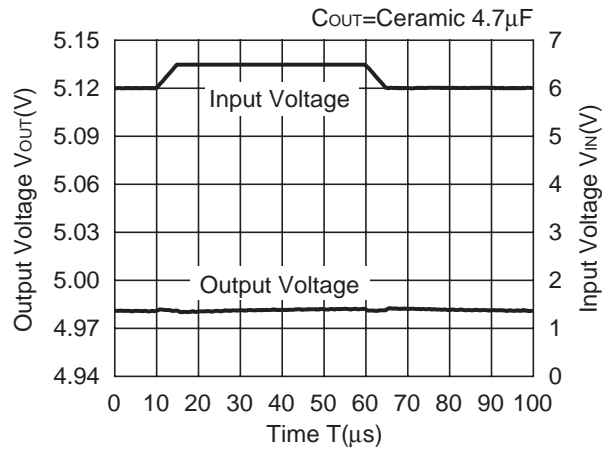
$C_{OUT}=\text{Ceramic } 4.7\mu F$



R1173x301x

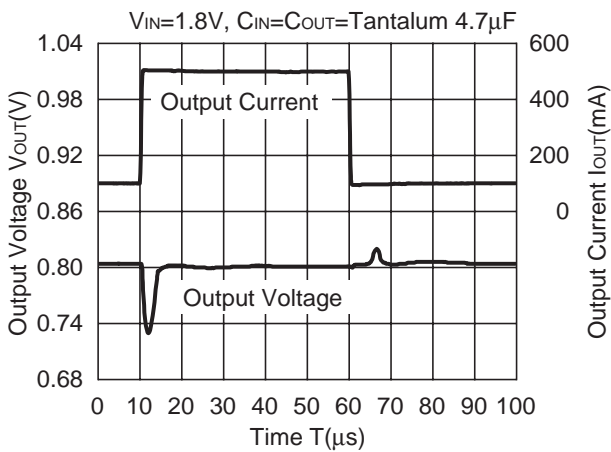


R1173x501x

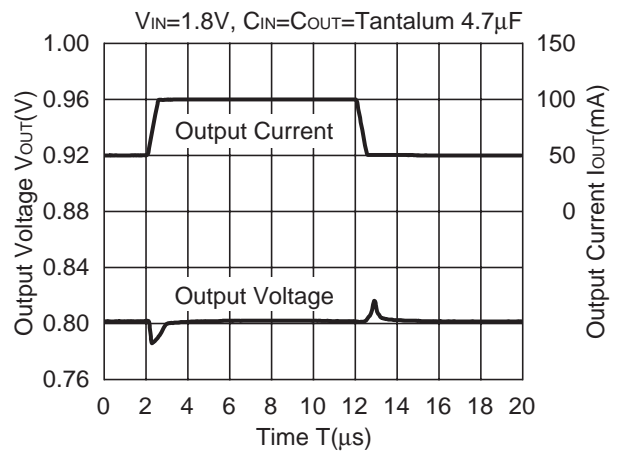


12) Load Transient Response ($T_r=T_f=500\text{ns}$)

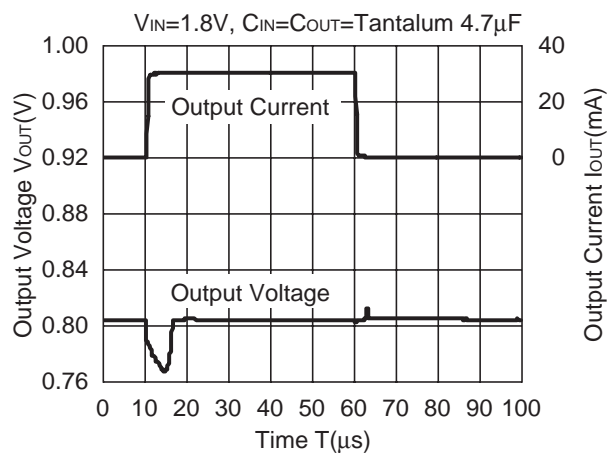
R1173x081x



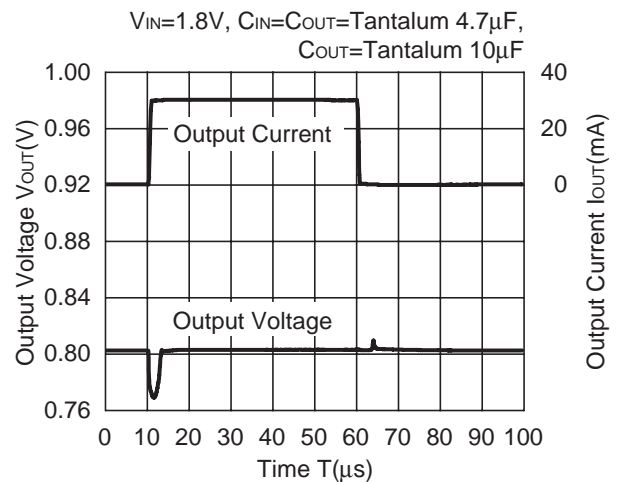
R1173x081x



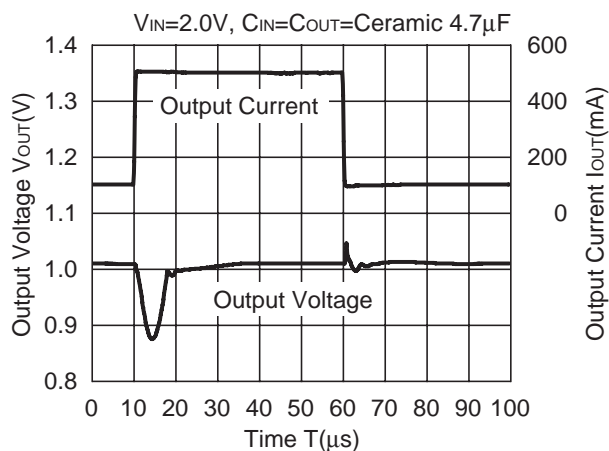
R1173x081x



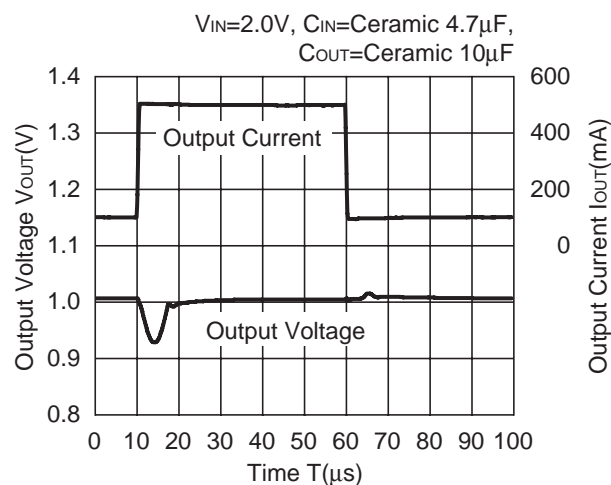
R1173x081x



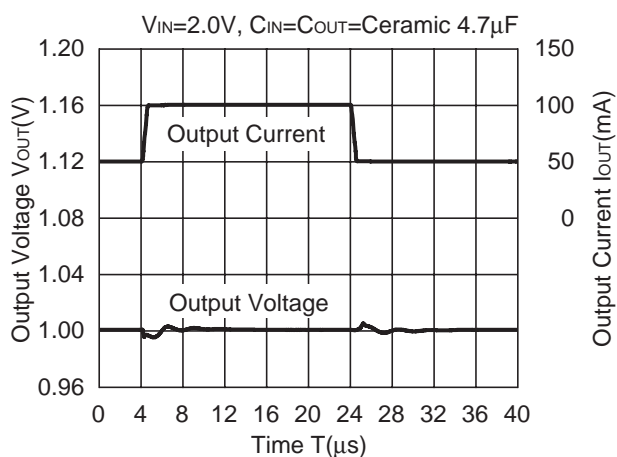
R1173x101x



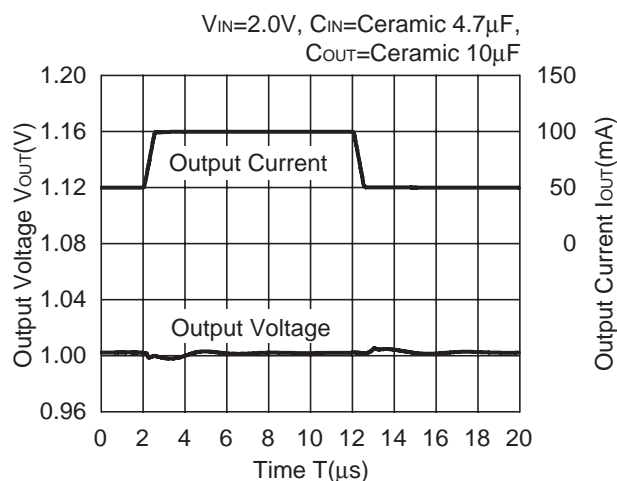
R1173x101x



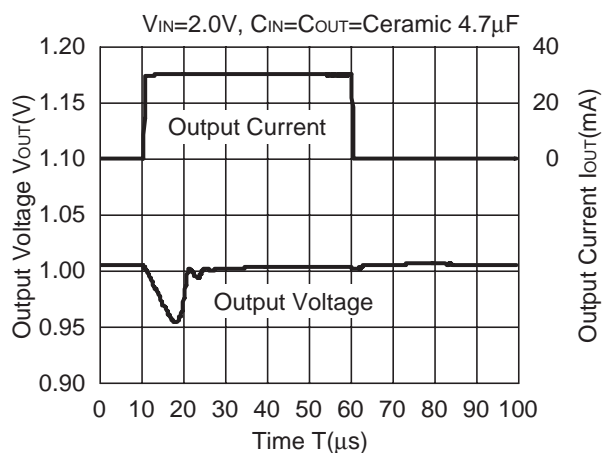
R1173x101x



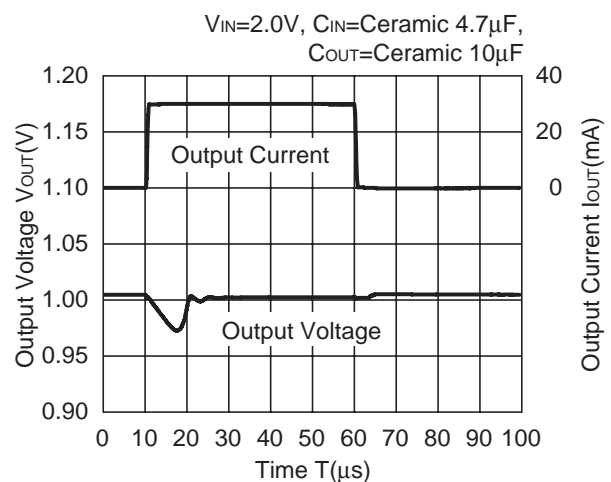
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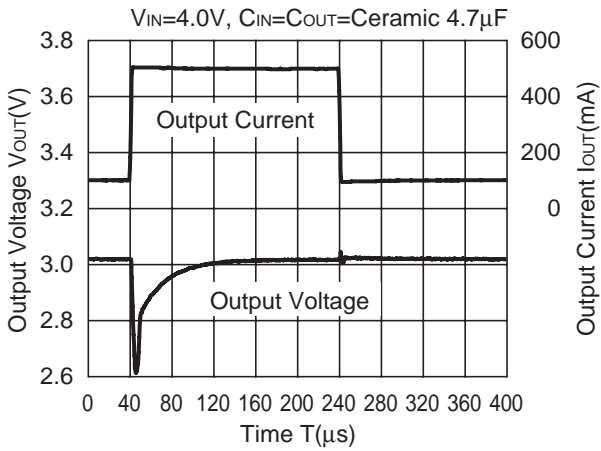
R1173x101x



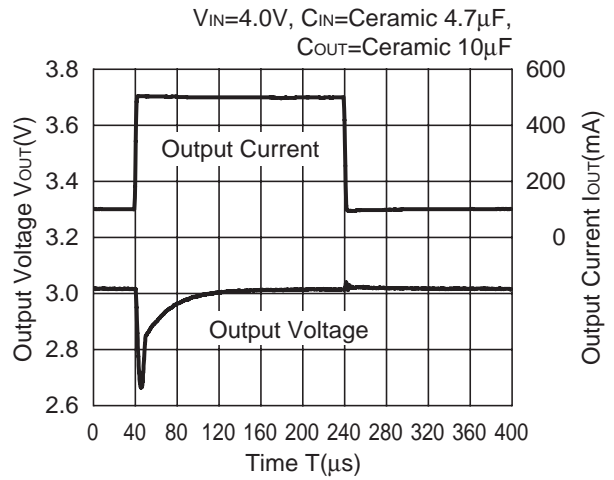
R1173x101x



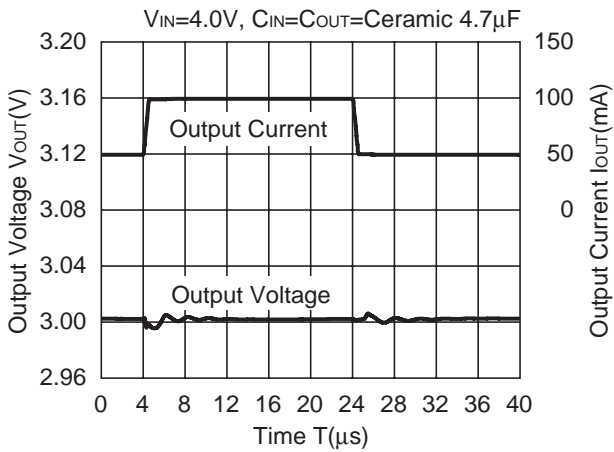
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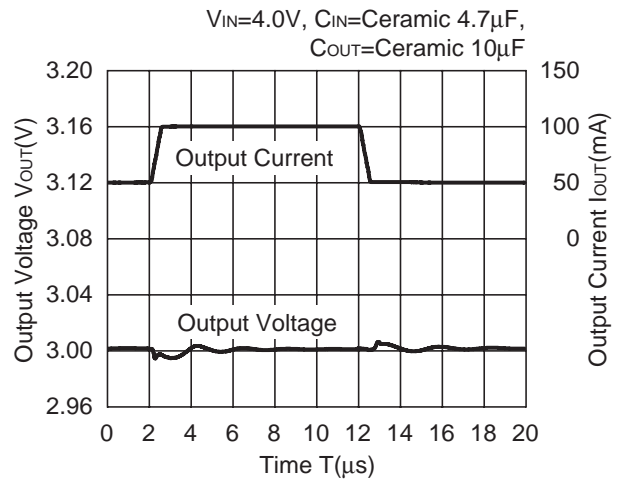
R1173x301x



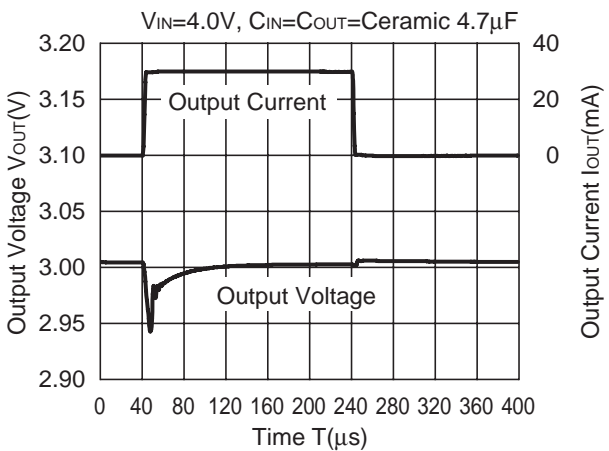
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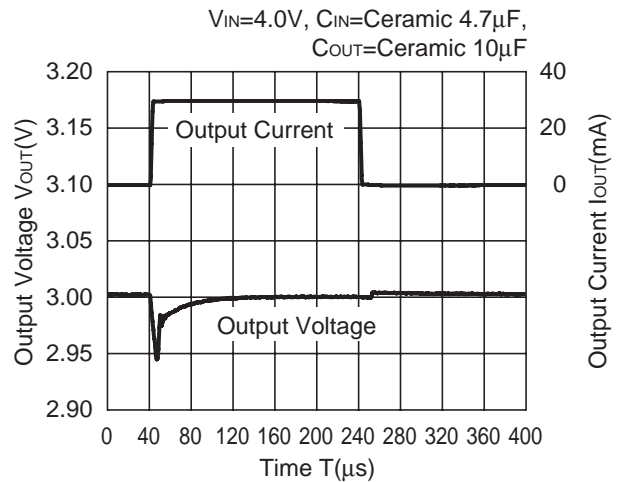
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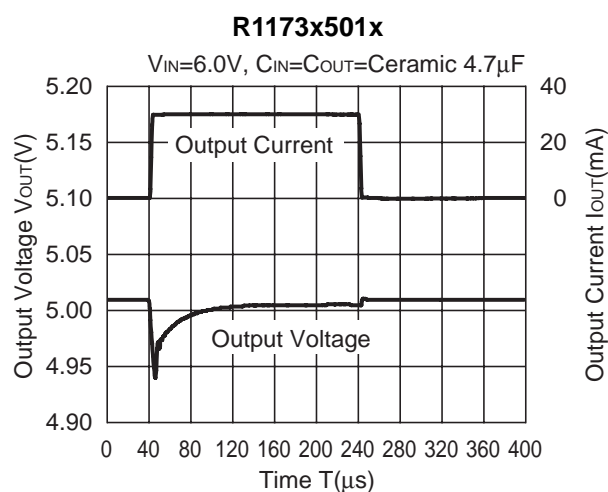
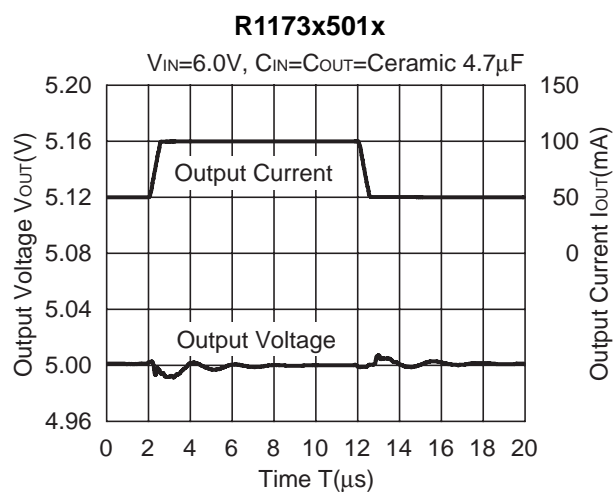
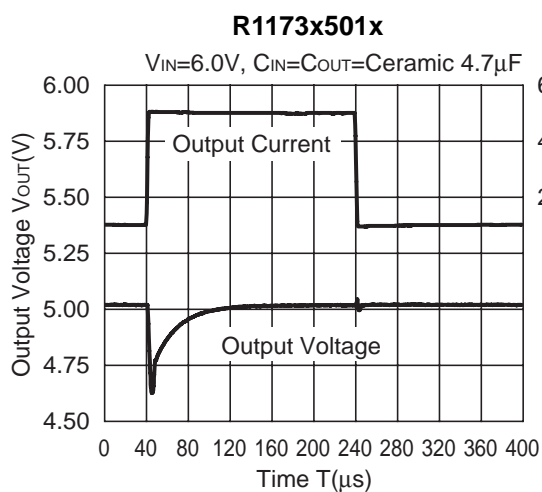


R1173x301x

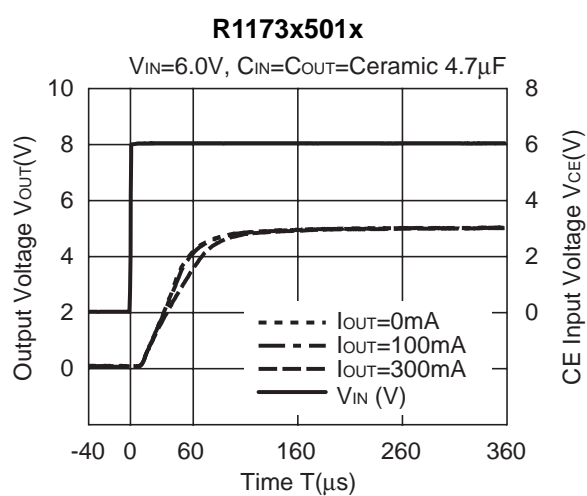
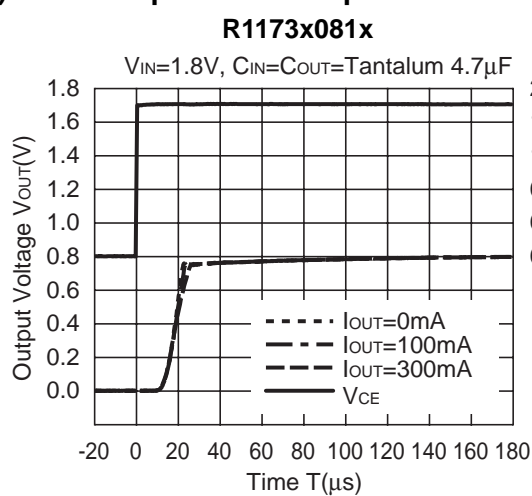


R1173x301x



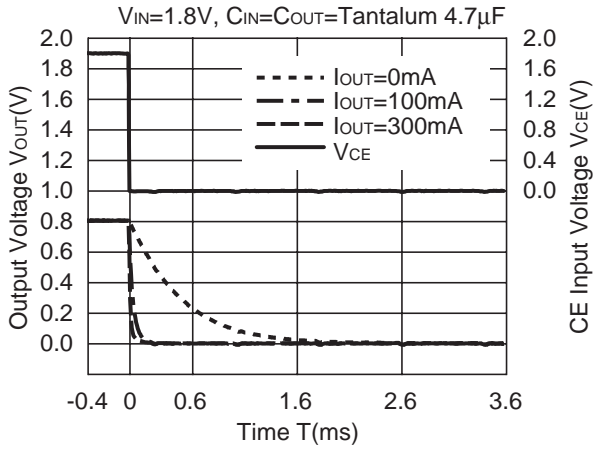


13) Turn-on speed with CE pin control

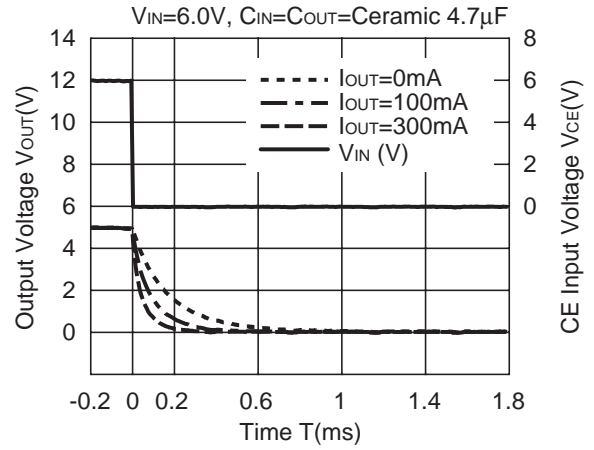


14) Turn-off speed with CE pin control

R1173x081D

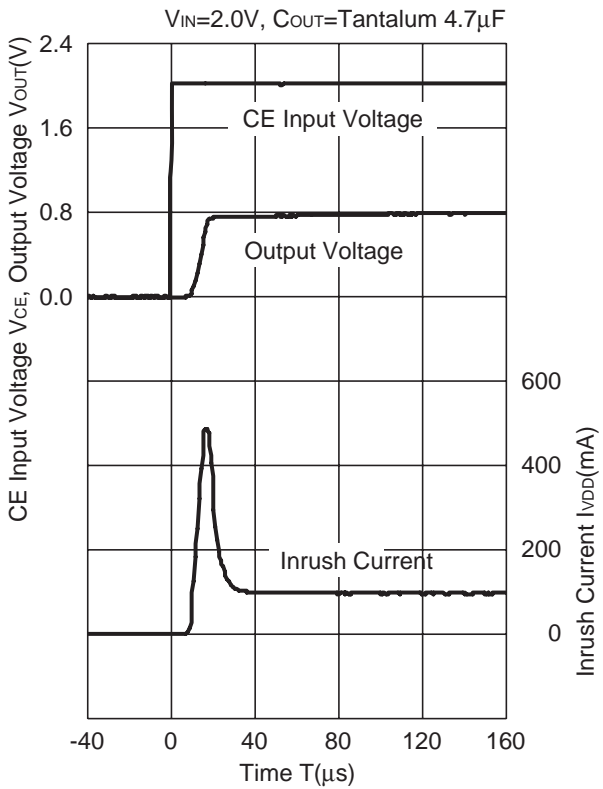


R1173x501D

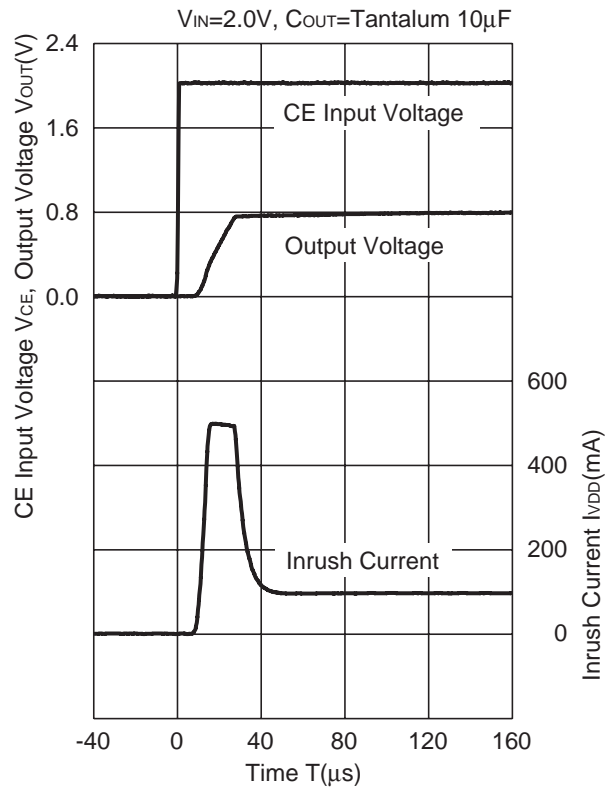


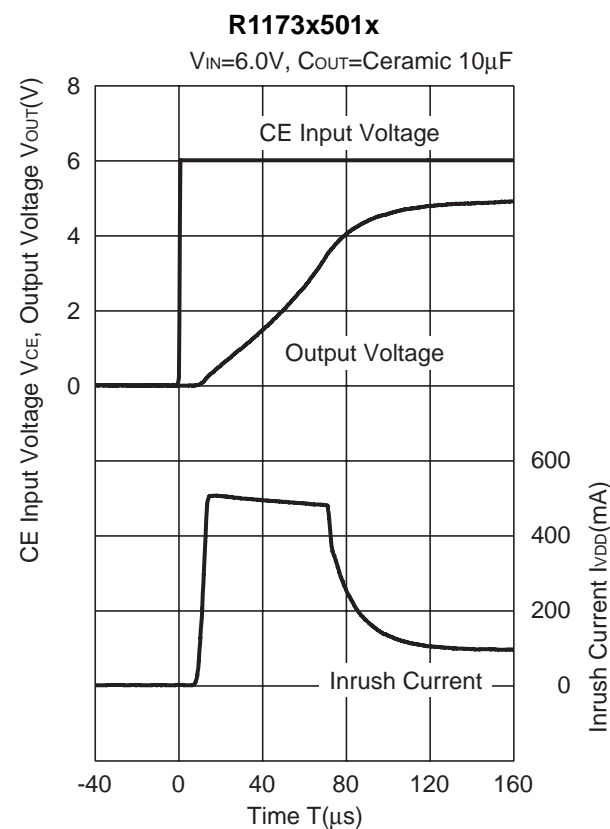
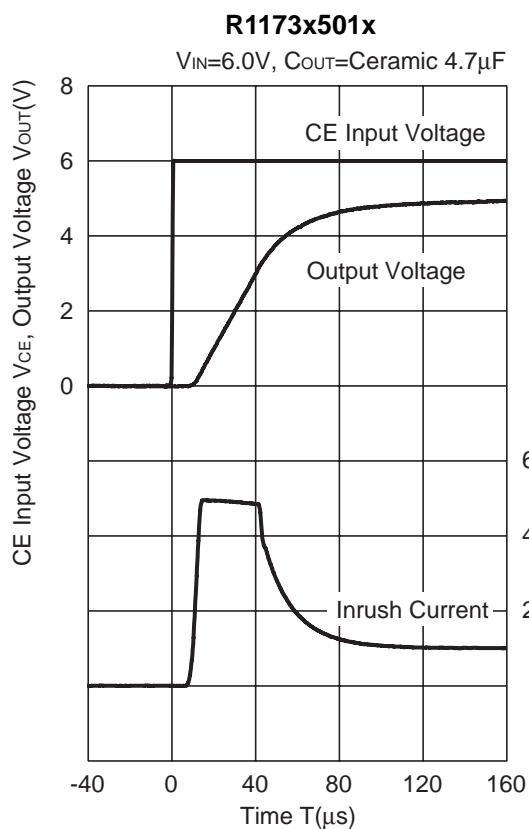
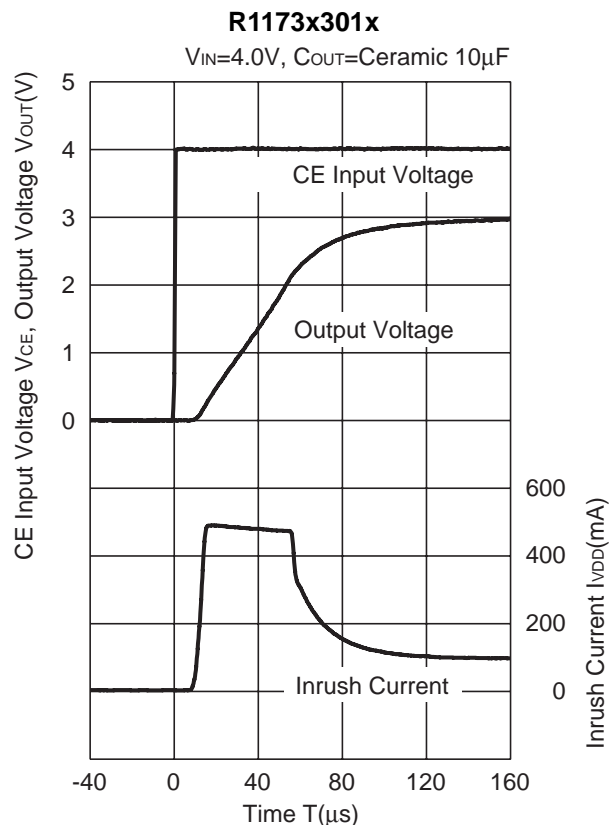
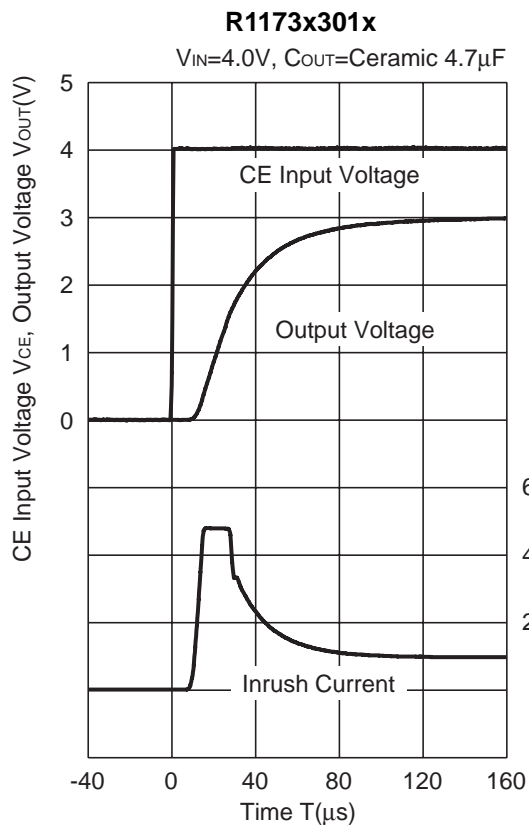
15) Inrush Current

R1173x081x



R1173x081x

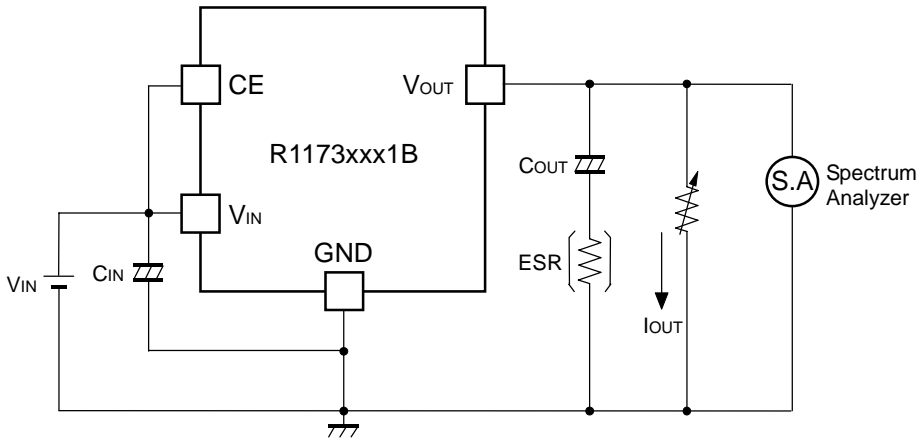




16) Stable Area: ESR limit vs. Load current

0.8V to 3.3V Output type : $C_{OUT}=4.7\mu\text{F}$ (Kyocera CM105X5R475M06AB)

5.0V Output type : $C_{OUT}=4.7\mu\text{F}$ (Kyocera CT21X5R475K06AB)

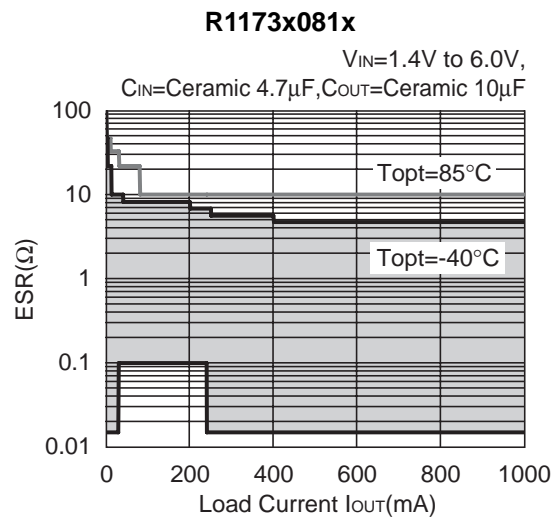
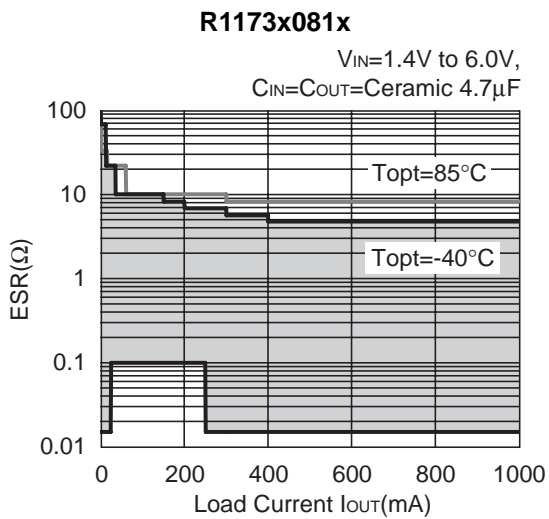


Measurement Conditions

- $V_{IN}=V_{OUT}+1\text{V}$
- Frequency=10Hz to 1MHz
- $T_{opt}=25^{\circ}\text{C}$

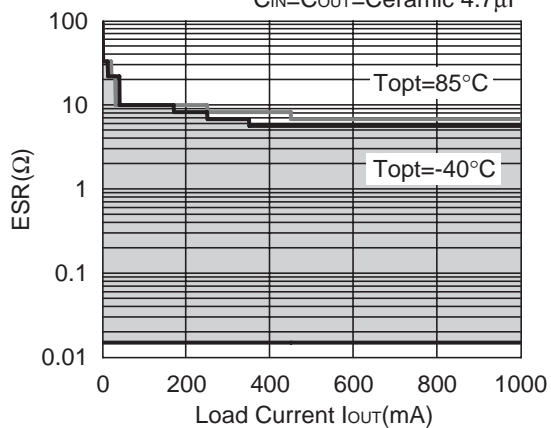
As an output capacitor for this IC, Ceramic capacitor is recommendable. However, other low ESR type capacitor can be used with this IC.

For your reference, noise level is tested, and if the noise level is $40\mu\text{V}$ or less than $40\mu\text{V}$, the ESR values are plotted as stable area. Upper limit is described in the next five graphs, or ESR vs. Output Current. (Hatched area is the stable area.)



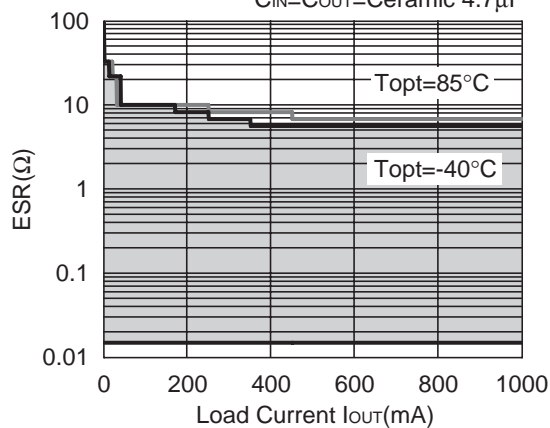
R1173x101x

$V_{IN}=1.4V$ to $6.0V$,
 $C_{IN}=C_{OUT}=\text{Ceramic } 4.7\mu F$



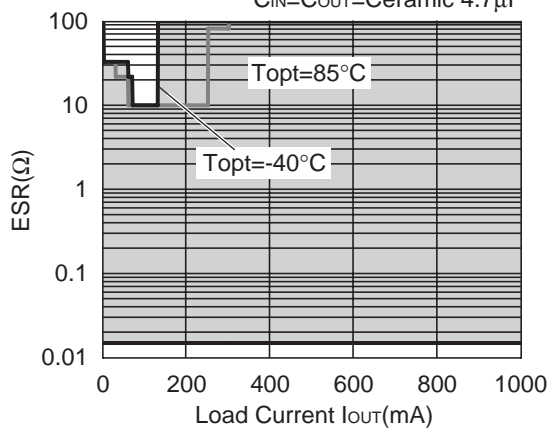
R1173x301x

$V_{IN}=3.1V$ to $6.0V$,
 $C_{IN}=C_{OUT}=\text{Ceramic } 4.7\mu F$



R1173x501x

$V_{IN}=3.1V$ to $6.0V$,
 $C_{IN}=C_{OUT}=\text{Ceramic } 4.7\mu F$





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Sales & Support Offices

RICOH ELECTRONIC DEVICES CO., LTD.

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 DJ Amstelveen, The Netherlands
Phone: +31-20-5474-309

RICOH ELECTRONIC DEVICES KOREA CO., LTD.

3F, Haesung Bldg. 504, Teheran-ro, Gangnam-gu, Seoul, 135-725, Korea
Phone: +82-2-2135-5700 Fax: +82-2-2051-5713

RICOH ELECTRONIC DEVICES SHANGHAI CO., LTD.

Room 403, No.2 Building, No.690 Bilbo Road, Pu Dong New District, Shanghai 201203,
People's Republic of China
Phone: +86-21-5027-3200 Fax: +86-21-5027-3299

RICOH ELECTRONIC DEVICES CO., LTD.

Taipei office
Room 109, 10F-1, No.51, Hengyang Rd., Taipei City, Taiwan (R.O.C.)
Phone: +886-2-2313-1621/1622 Fax: +886-2-2313-1623