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

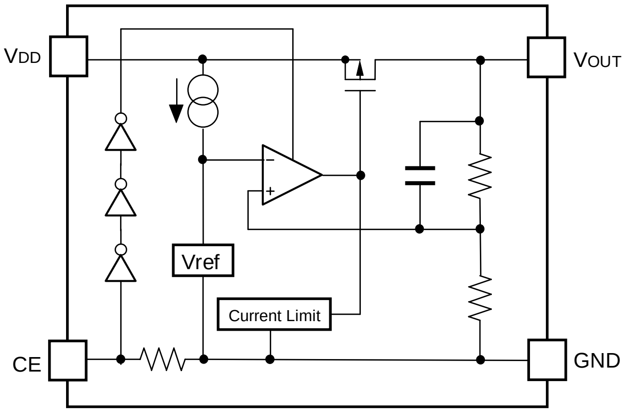
- Output Current 1A
- Supply Current .... Typ. 60μA
- Standby Current .... Typ. 0.1μA
- Input Voltage Range .... 1.4V to 6.0V
- Output Voltage Range... 0.8V to 5.0V (0.1V steps) (R1173xxx1)
  1.0V to V_{IN} (R1173x001)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Dropout Voltage .... Typ. 0.32V (V_{OUT}=1.5V, I_{OUT}=1A)
  Typ. 0.18V (V_{OUT}=2.8V, I_{OUT}=1A)
- Ripple Rejection.. Typ. 70dB (V_{OUT}=2.8V)
- Output Voltage Accuracy.. ±2.0%
- Temperature-drift Coefficient of Output Voltage........... Typ. ±100ppm/°C
- Line Regulation .... Typ. 0.05%/V
- Load Regulation... Typ. −2mV (I_{OUT}=300mA)
  Typ. −3mV (I_{OUT}=1A)
- 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_{IN}=Ceramic 4.7μF
  C_{OUT}=Tantalum 4.7μF (V_{OUT}<1.0V)
  C_{OUT}=Ceramic 4.7μF ($V_{OUT} \geqq$ 1.0V)

APPLICATIONS

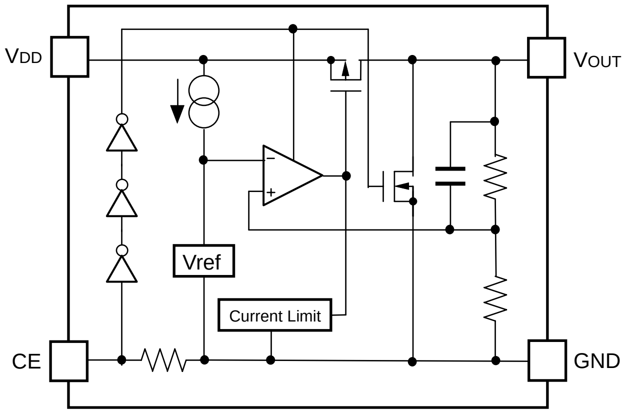
- Local Power source for Notebook PC.
- Local Power source for portable communication equipments, cameras, and videos.
- Local Power source for home appliances.

BLOCK DIAGRAMS

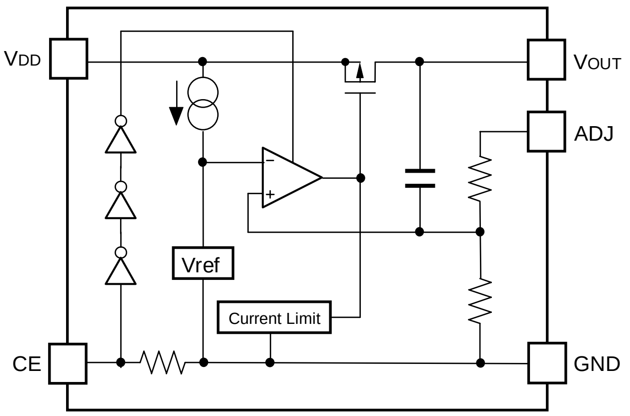
R1173xxx1B



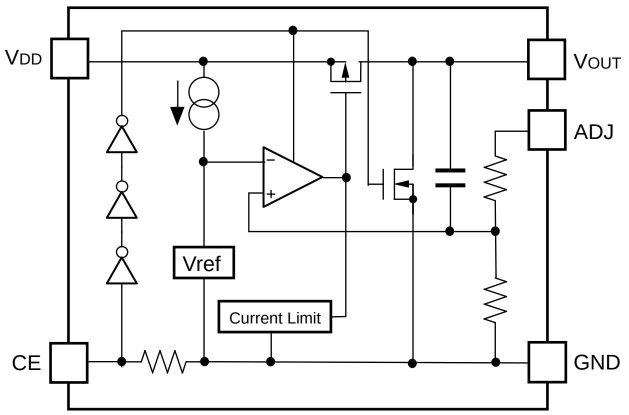
R1173xxx1D



R1173x001B



R1173x001D



SELECTION GUIDE

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

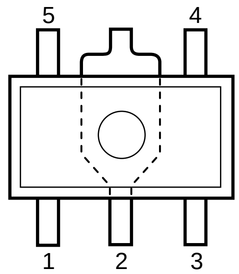
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1173Dxx1∗-TR-FE	HSON-6	3,000 pcs	Yes	Yes
R1173Hxx1∗-T1-FE	SOT-89-5	1,000 pcs	Yes	Yes
R1173Sxx1∗-E2-FE	HSOP-6J	1,000 pcs	Yes	Yes

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.)

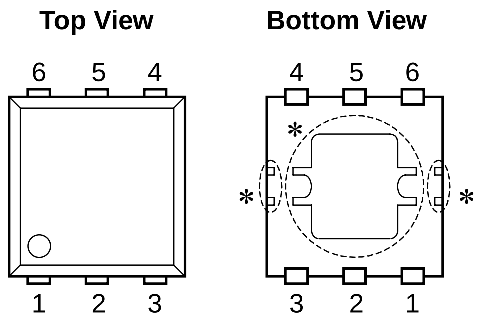
∗ : The auto discharge function at off state are options as follows.
(B) "H" active, without auto discharge function at off state
(D) "H" active, with auto discharge function at off state

PIN CONFIGURATIONS

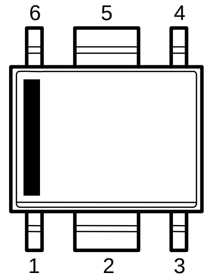
● SOT-89-5



● HSON-6



● HSOP-6J



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 (HSON-6)*	900	
	Power Dissipation (HSOP-6J)*	1700	
Topt	Operating Temperature	–40 to 85	°C
Tstg	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)

Topt=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
Istandby	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
		$V_{IN}-V_{OUT}$=1.0V, I_{OUT}=100mA; V_{OUT} ≦ 1.5V	–30		+30	mV
$\Delta V_{OUT}/\Delta I_{OUT}$	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				
$\Delta V_{OUT}/\Delta V_{IN}$	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
$\Delta V_{OUT}/\Delta Topt$	Output Voltage Temperature Coefficient	I_{OUT}=100mA, –40°C ≦ Topt ≦ 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

Topt=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

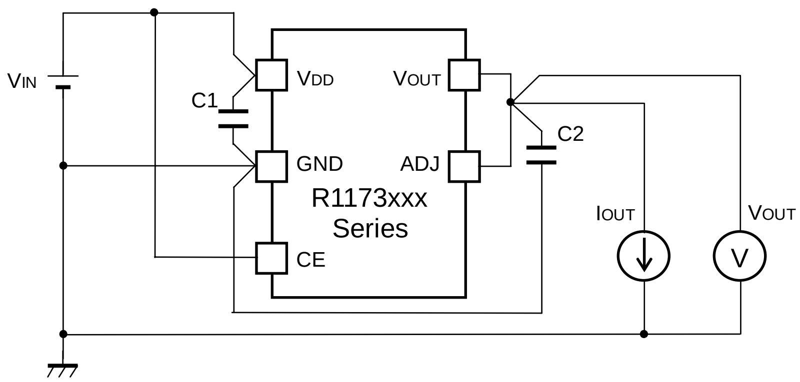
- **R1173x001B/D (Adjustable Output Voltage Type)**

Topt=25°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	$V_{IN}=6.0V$, $V_{CE}=0V$			0.1	1.0	μA
V_{OUT}	Reference Voltage for Adjustable Voltage Regulator	$V_{OUT}=V_{ADJ}$, $V_{IN}=2.0V$ $I_{OUT}=100mA$		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	$V_{IN}=1.4V$ $1mA \leqq I_{OUT} \leqq 300mA$		−15	−2	15	mV
		$V_{IN}=1.7V$ $1mA \leqq I_{OUT} \leqq 1A$			−3		
V_{DIF}	Dropout Voltage	$V_{OUT}=V_{ADJ}$	$I_{OUT}=300mA$		0.18	0.32	V
			$I_{OUT}=1A$		0.56		
$\Delta V_{OUT}/\Delta V_{IN}$	Line regulation	$V_{OUT}=V_{ADJ}$, $I_{OUT}=100mA$ $1.5V \leqq V_{IN} \leqq 6.0V$			0.05	0.20	%/V
RR	Ripple Rejection	f=1kHz Ripple 0.5Vp−p, $V_{OUT}=V_{ADJ}$, $V_{IN}=2.5V$ $I_{OUT}=100mA$			70		dB
$\Delta V_{OUT}/\Delta Topt$	Output Voltage Temperature Coefficient	$I_{OUT}=100mA$ $-40°C \leqq Topt \leqq 85°C$			±100		ppm/°C
I_{LIM}	Output Current	$V_{OUT}=V_{ADJ}$, $V_{IN}=2.0$		1			A
I_{SC}	Short Current Limit	$V_{OUT}=V_{ADJ}=0V$			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

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 4.7μF or more value capacitor between V_{DD} pin and GND pin as close as possible.

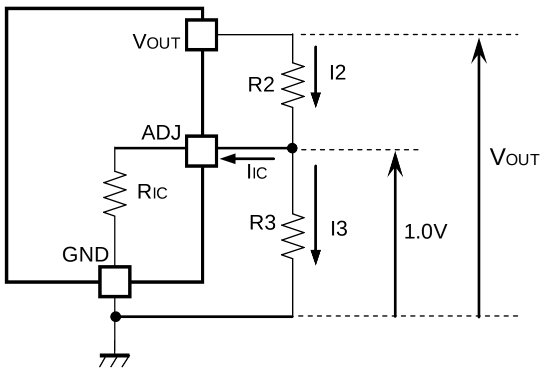
Set an Output capacitor between V_{OUT} pin and GND pin for phase compensation as close as possible.

Output Voltage	C2 recommendation value	Components Recommendation
V_{OUT}<1.0V	Tantalum 4.7μF or more	
1.0 ≦ V_{OUT}<3.3V	Ceramic 4.7μF or more	Kyocera 4.7μF (1608) Part Number: CM105X5R475M06AB Murata 4.7μF (1608) Part Number: GRM188R60J475KE19B Murata 10μF (1608) Part Number: GRM188B30G106ME46B
3.3V ≦ V_{OUT}	Ceramic 4.7μF or more	Kyocera 4.7μF (thin 2012) Part Number: CT21X5R475M06AB Murata 10μF (1608) 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;

$I2=I_{IC}+I3$ .... (1)

$I3=1.0/R3$ .... (2)

Thus,

$I2=I_{IC}+1.0/R3$ .... (3)

Therefore,

$V_{OUT}=1.0+R2\times I2$ .... (4)

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

$V_{OUT}=1.0+R2(I_{IC}+1.0/R3)$

$=1.0(1+R2/R3)+R2\times I_{IC}$ .... (5)

In 2nd term, or $R2\times I_{IC}$ will produce an error in V_{OUT}.

In Equation (5),

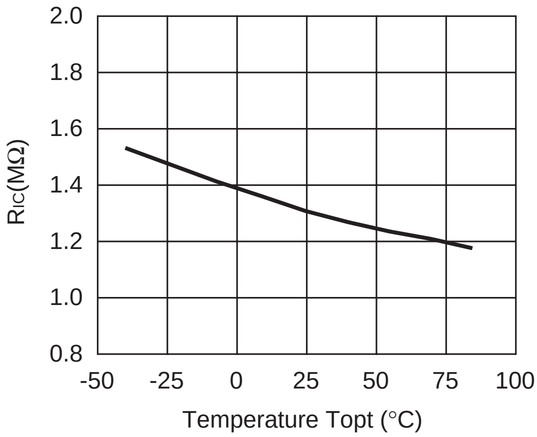
$I_{IC}=1.0/R_{IC}$ .... (6)

$R2\times I_{IC}=R2\times 1.0/R_{IC}$

$=1.0\times R2/R_{IC}$ .... (7)

For better accuracy, choosing R2 ($<<R_{IC}$) reduces this error.

R1173x001x

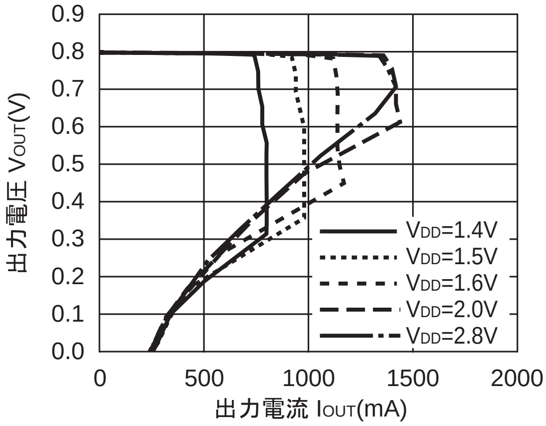


∗) The graph is a typical characteristic , please evaluate the circuit with an actual condition.

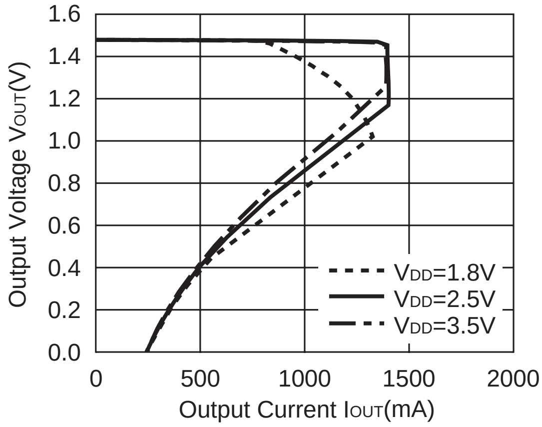
TYPICAL CHARACTERISTICS

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

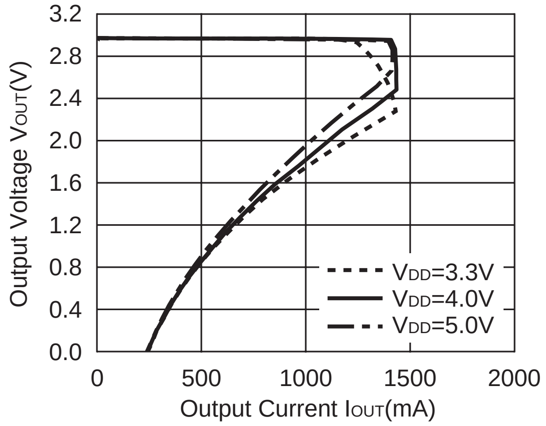
R1173x081x



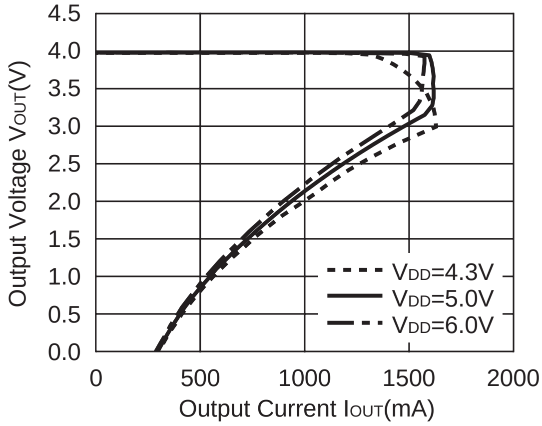
R1173x151x



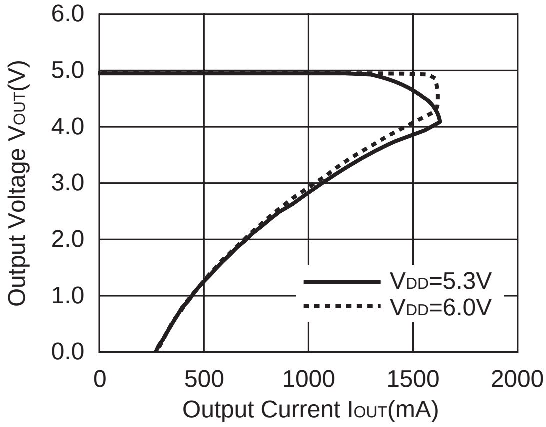
R1173x301x



R1173x401x

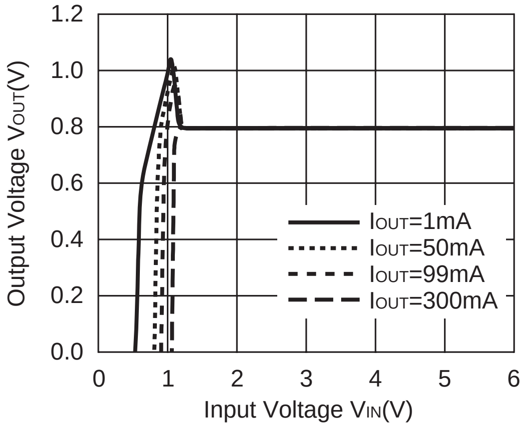


R1173x501x



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

R1173x081x



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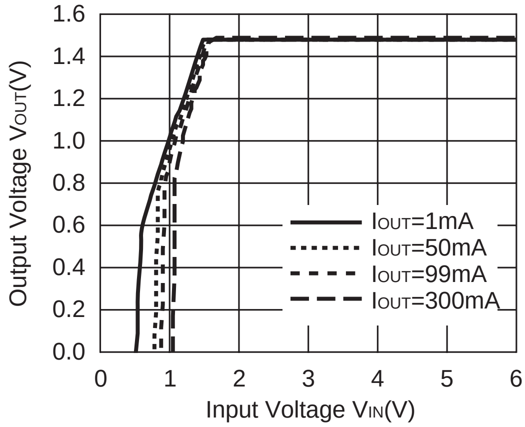

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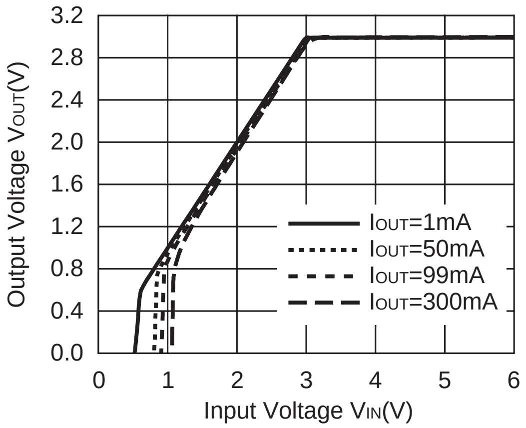
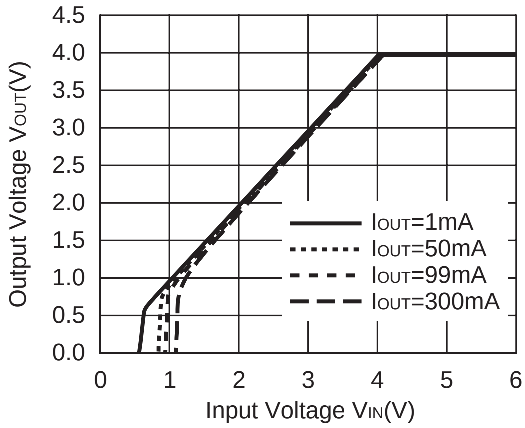


R1173x401x



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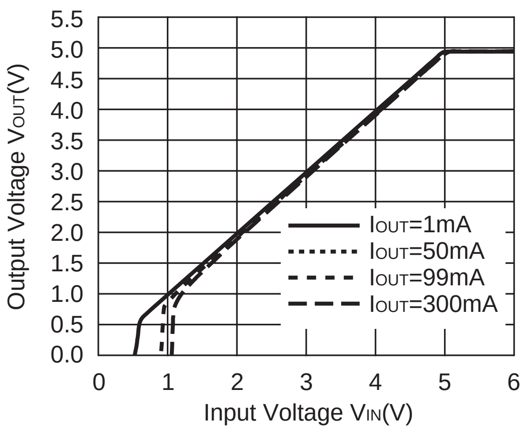
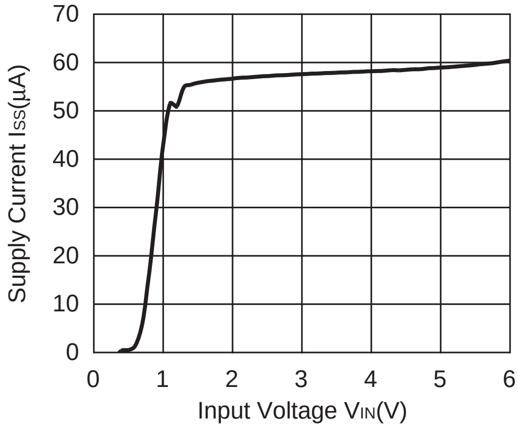


3) Dropout Voltage vs. Output Current (Topt=25°C)

R1173x081x



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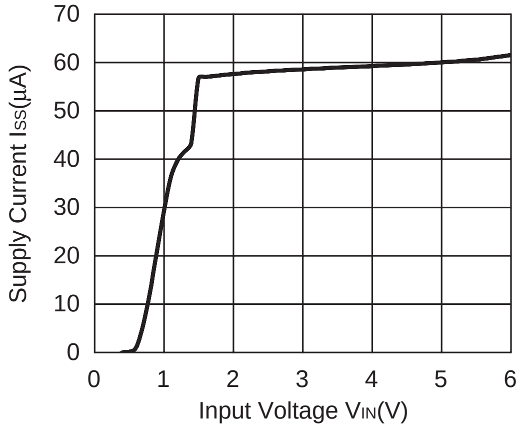
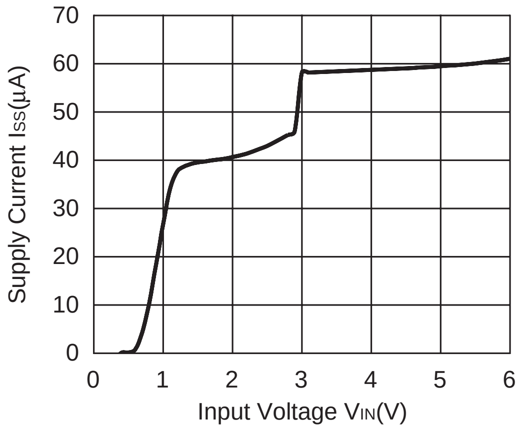


R1173x301x



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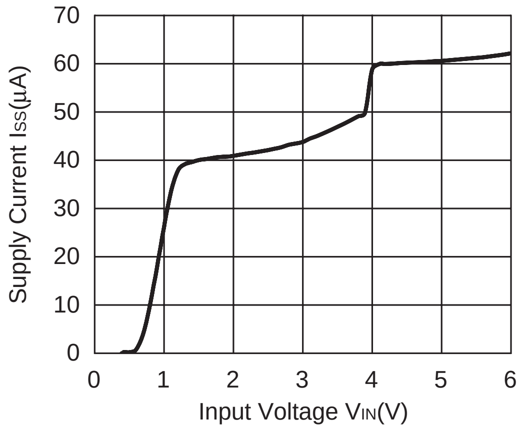

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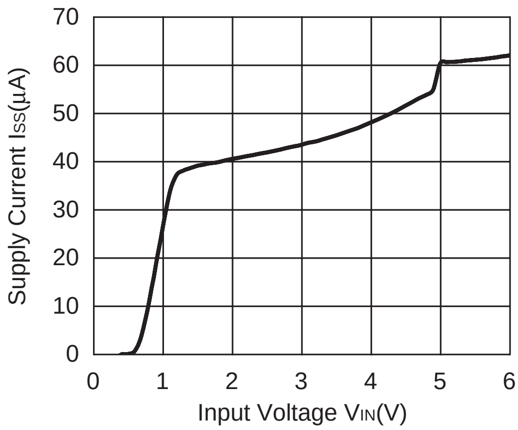
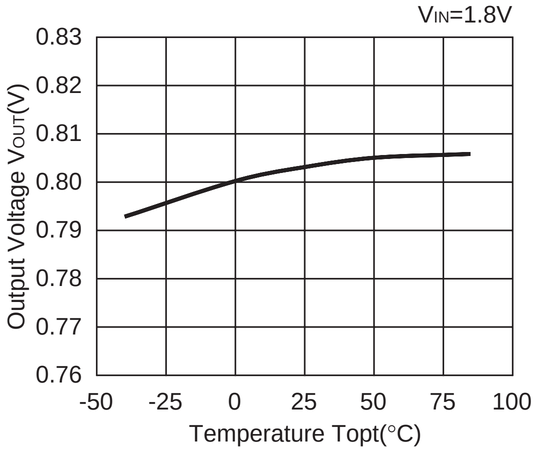


4) Output Voltage vs. Temperature (I_{OUT}=100mA)

R1173x081x



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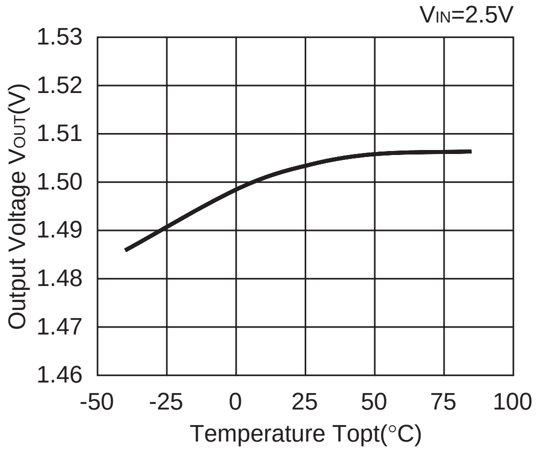
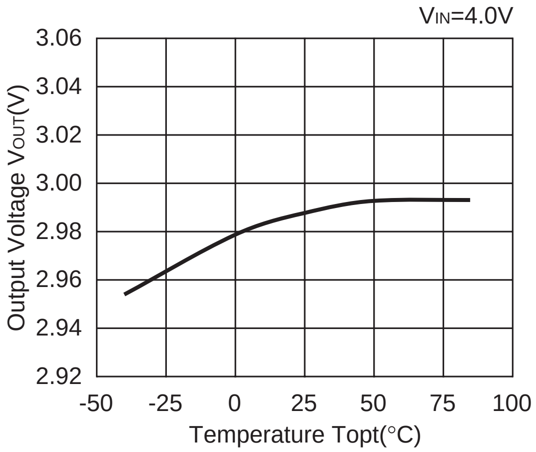
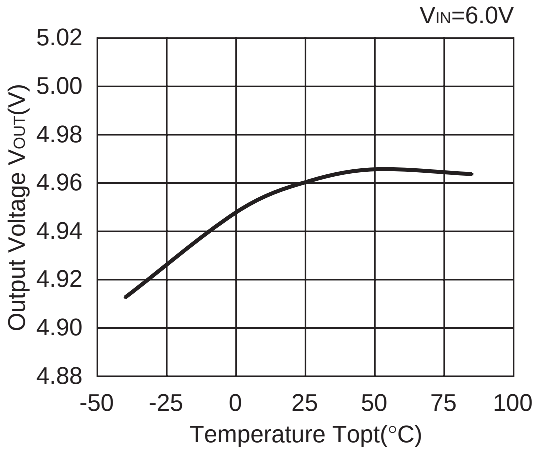


R1173x301x

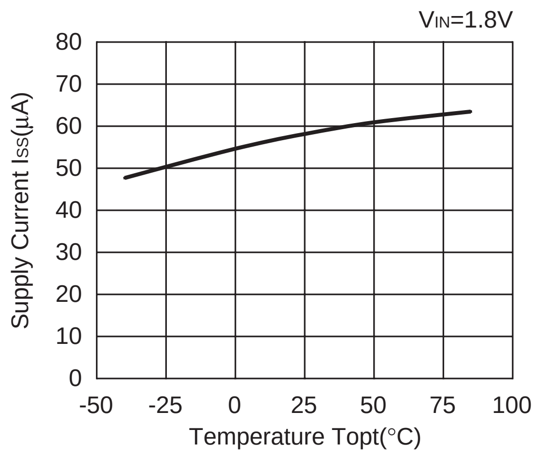


R1173x501x

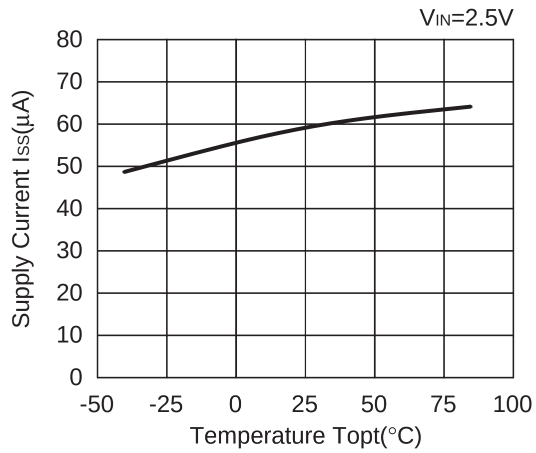


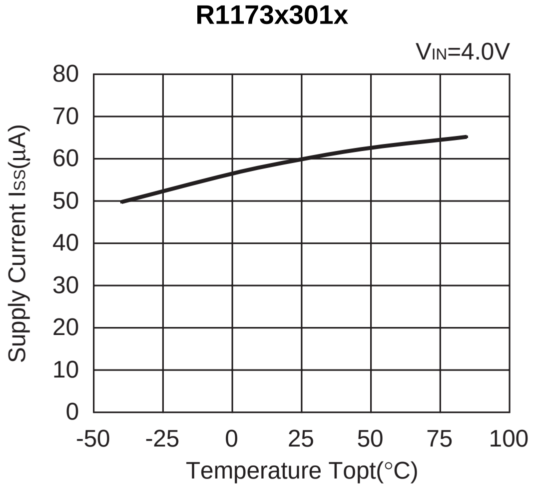
5) Supply Current vs. Temperature

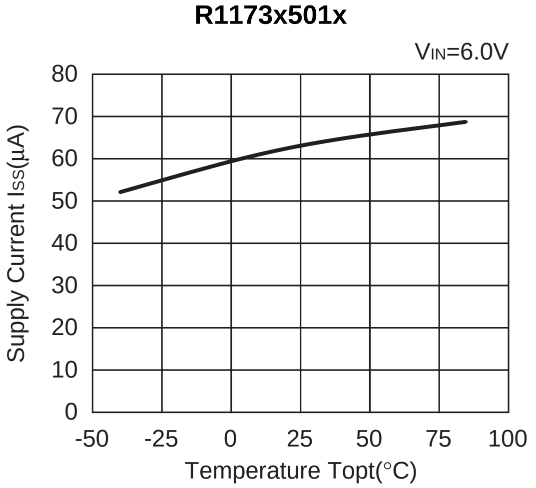
R1173x081x



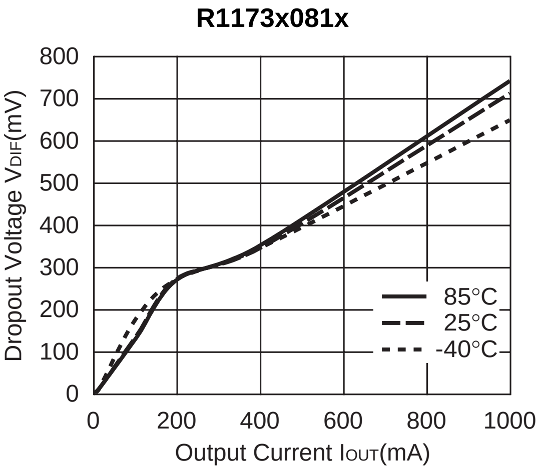
R1173x151x

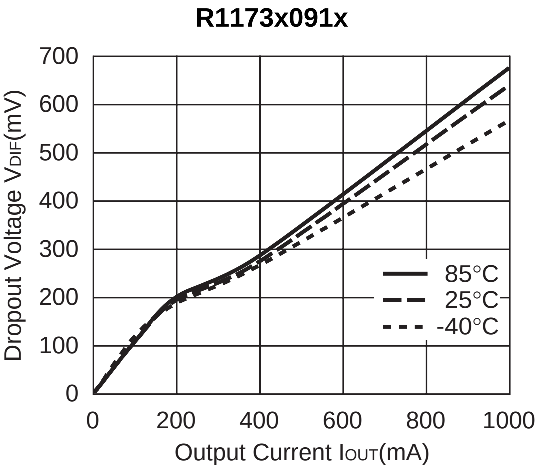


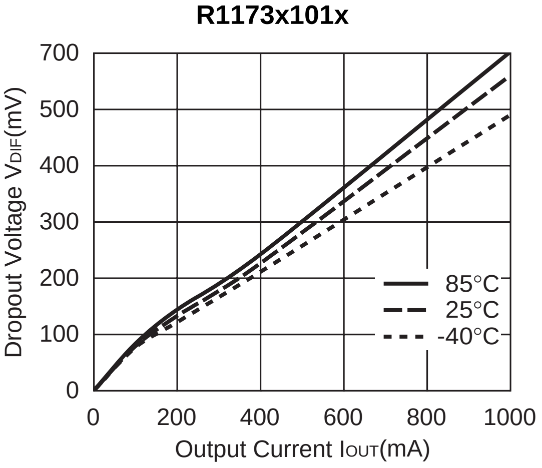


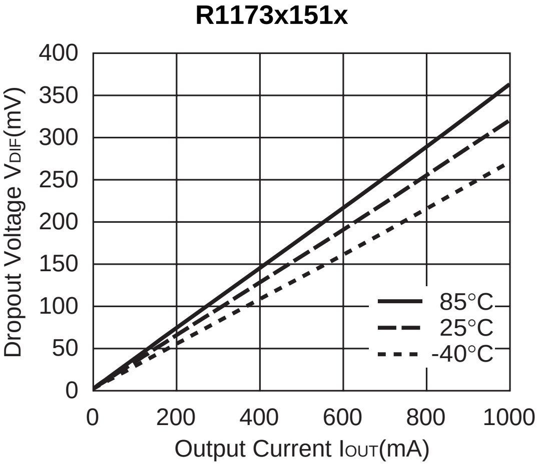


6) Dropout Voltage vs. Output Current

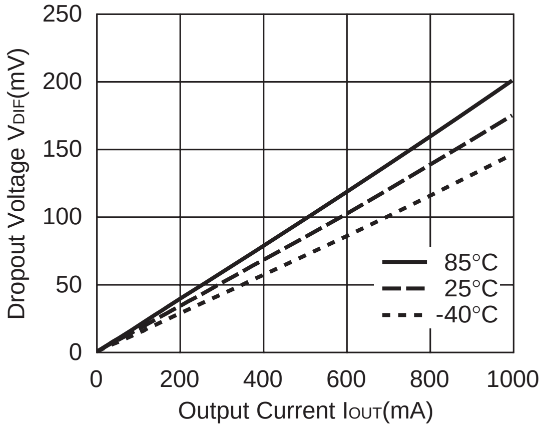




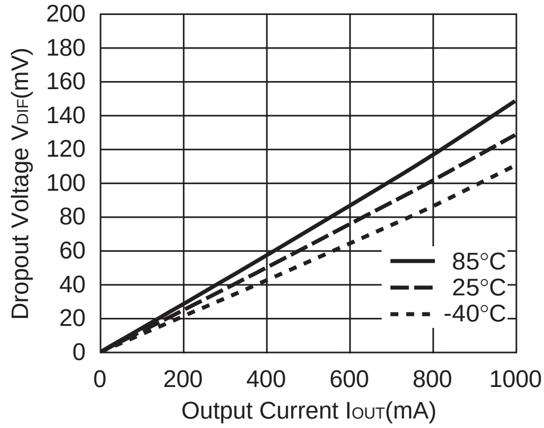




R1173x301x

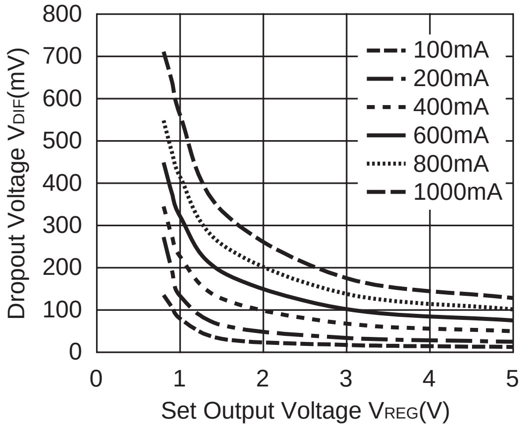


R1173x501x



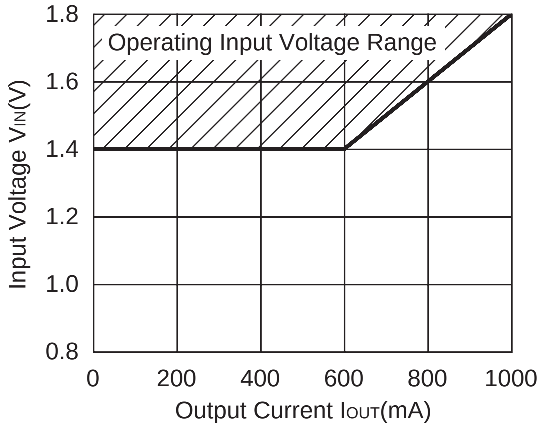
7) Dropout Voltage vs. Set Output Voltage

R1173xxx1x



8) 0.8V Output type, Operating Input Voltage Range

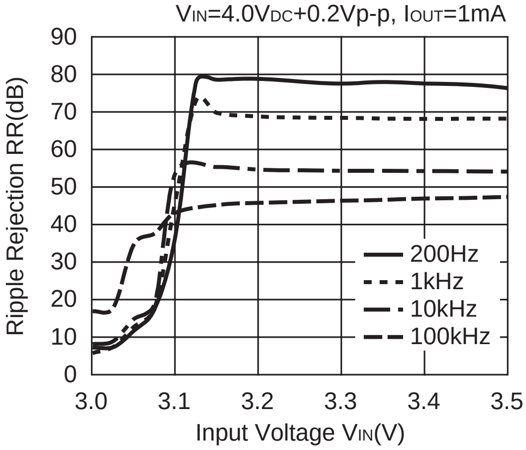
R1173x081x



9) Ripple Rejection vs. Input Bias

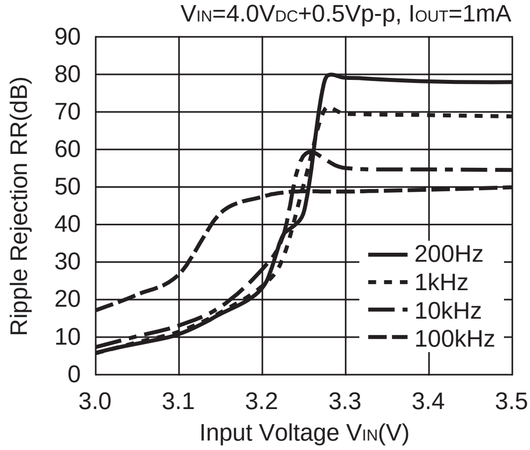
R1173x301x

V_{IN}=4.0V_{DC}+0.2Vp-p, I_{OUT}=1mA



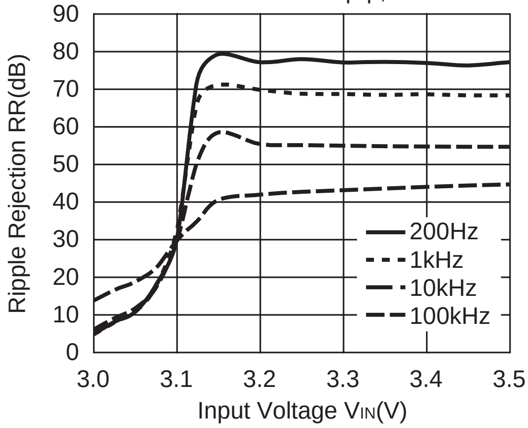
R1173x301x

V_{IN}=4.0V_{DC}+0.5Vp-p, I_{OUT}=1mA



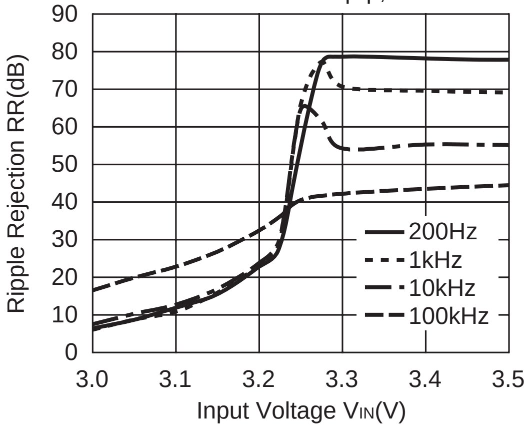
R1173x301x

V_{IN}=4.0V_{DC}+0.2Vp-p, I_{OUT}=10mA



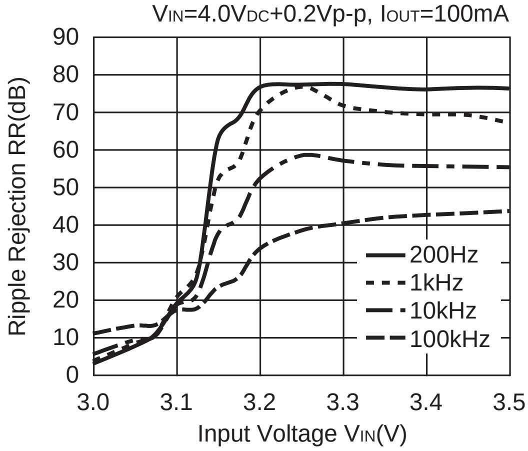
R1173x301x

V_{IN}=4.0V_{DC}+0.5Vp-p, I_{OUT}=10mA



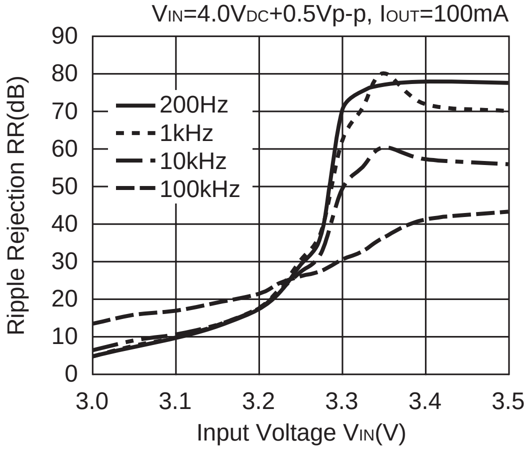
R1173x301x

V_{IN}=4.0V_{DC}+0.2Vp-p, I_{OUT}=100mA



R1173x301x

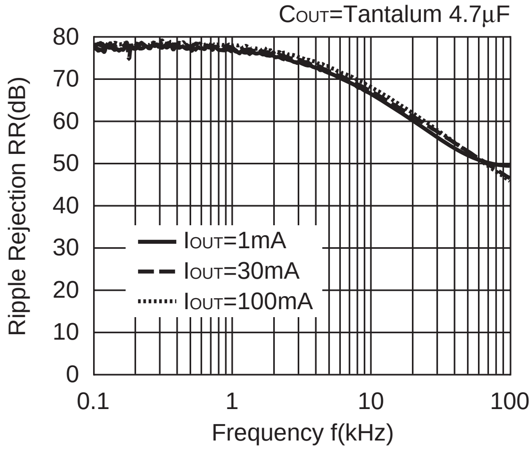
V_{IN}=4.0V_{DC}+0.5Vp-p, I_{OUT}=100mA



10) Ripple Rejection vs. Frequency

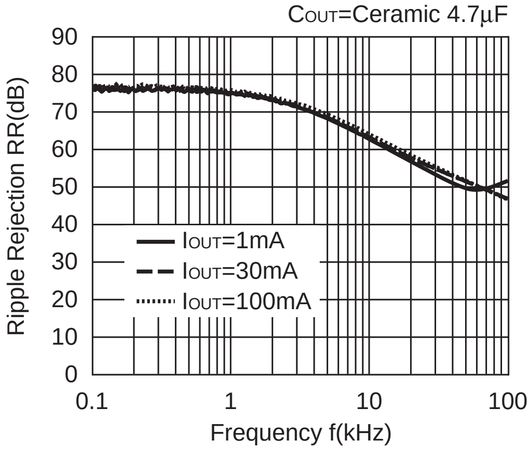
R1173x081x

V_{IN}=1.8V_{DC}+0.5Vp-p,
C_{OUT}=Tantalum 4.7µF



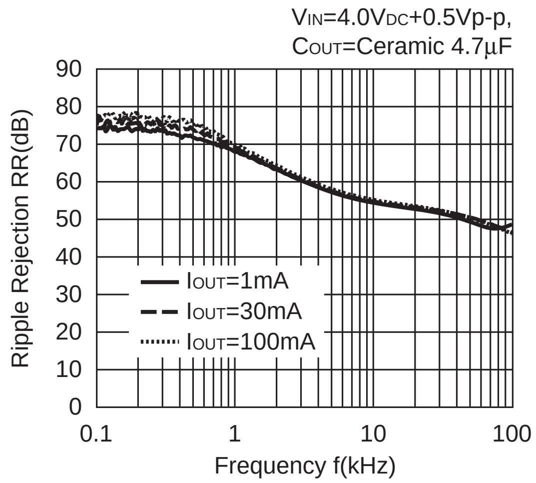
R1173x101x

V_{IN}=2.0V_{DC}+0.5Vp-p,
C_{OUT}=Ceramic 4.7µF

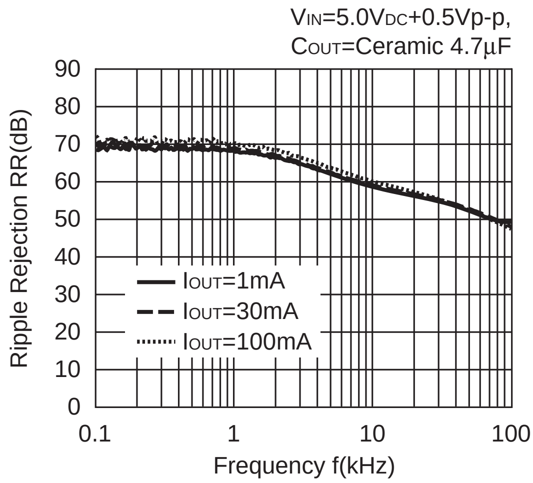


RICOH

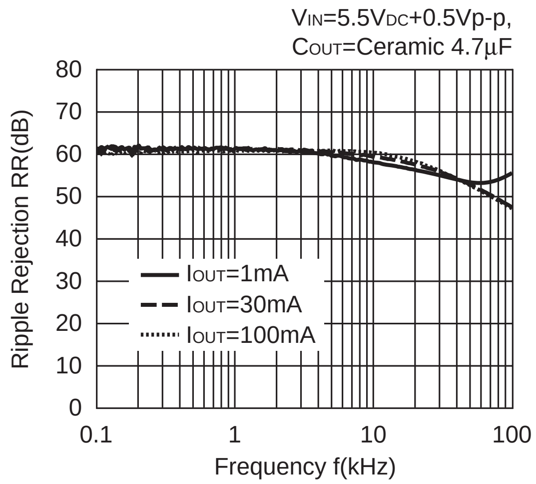
R1173x301x



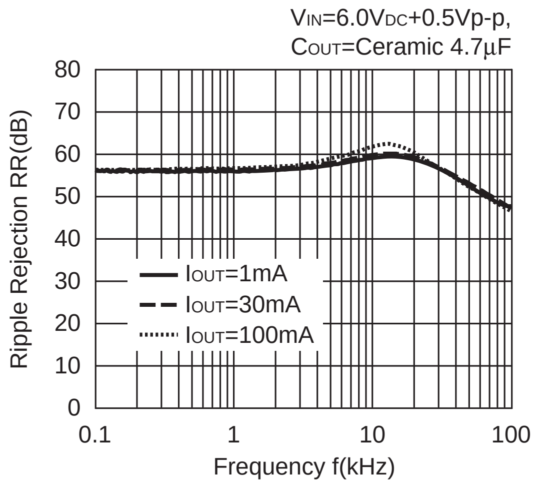
R1173x401x



R1173x451x

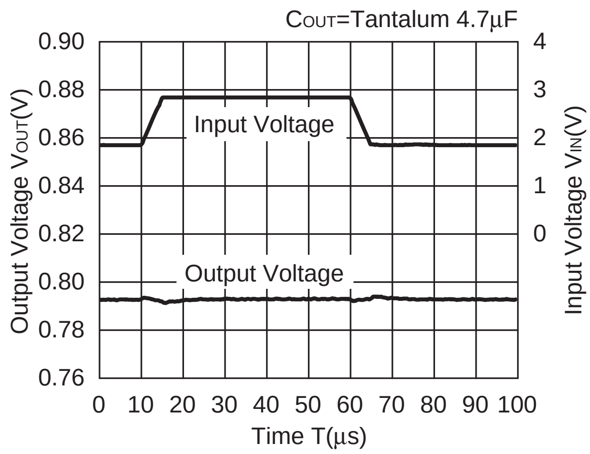


R1173x501x

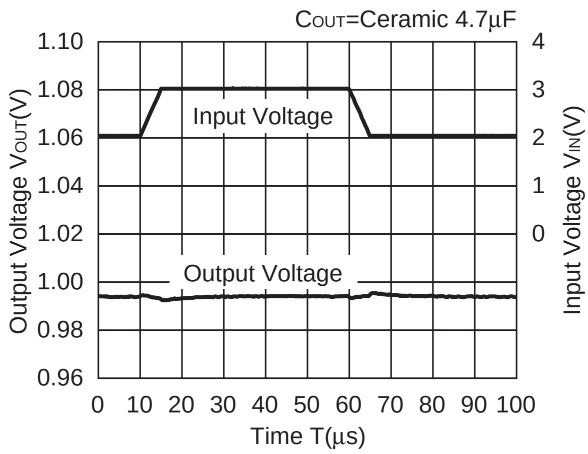


11) Line Transient Response (Tr=Tf=5µs, IOUT=100mA)

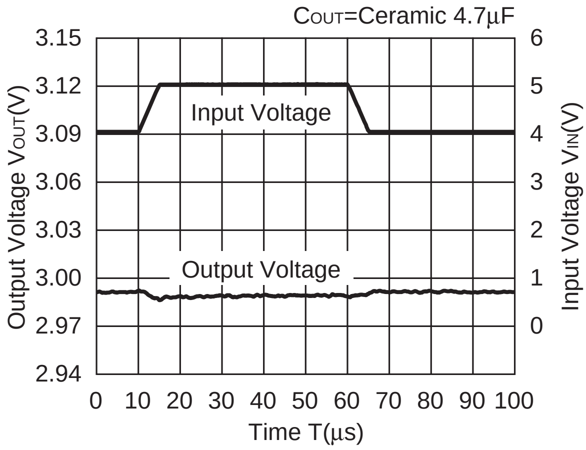
R1173x081x



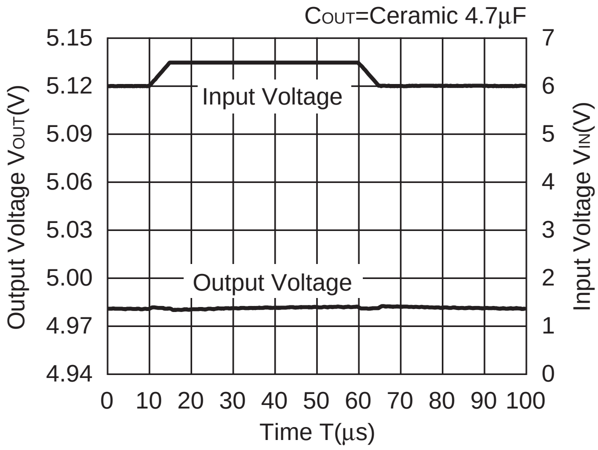
R1173x101x



R1173x301x

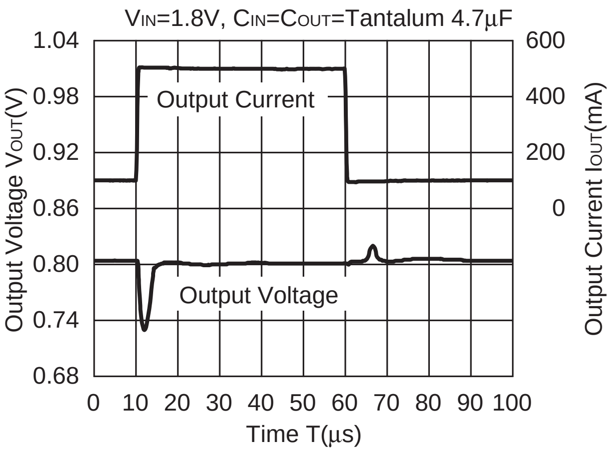


R1173x501x

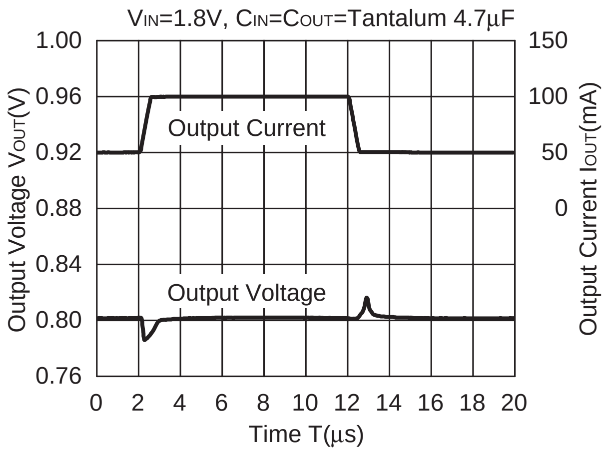


12) Load Transient Response (Tr=Tf=500ns)

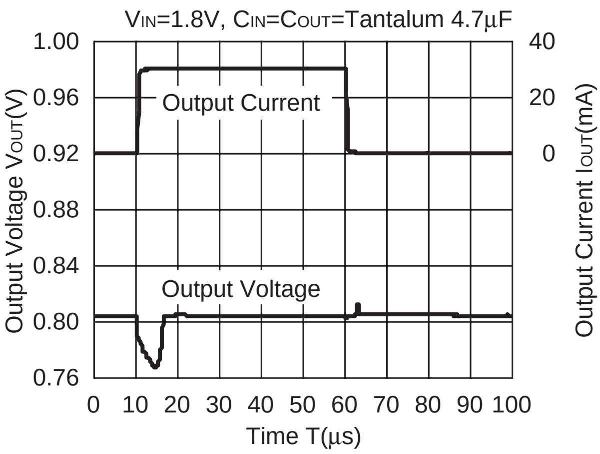
R1173x081x



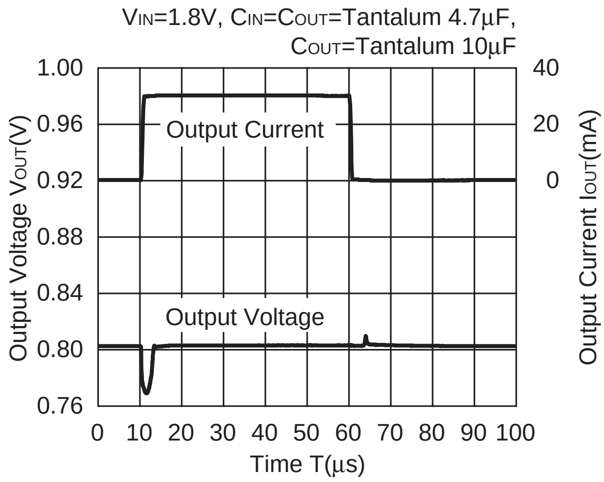
R1173x081x



R1173x081x



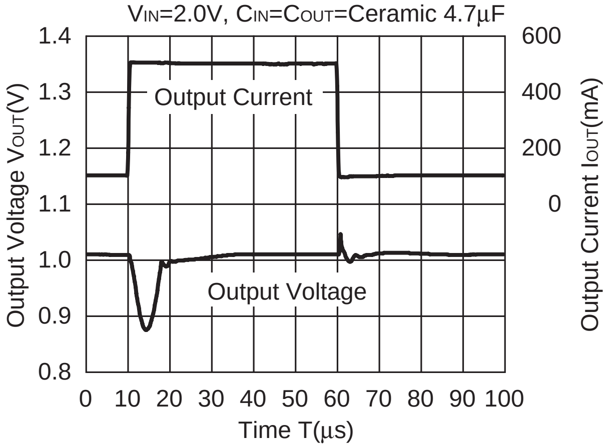
R1173x081x



RICOH

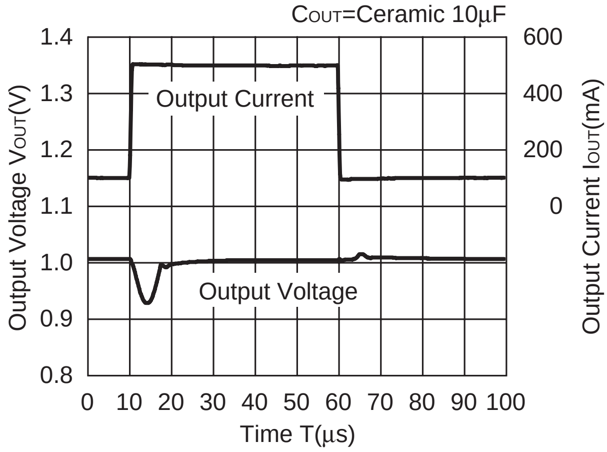
R1173x101x

VIN=2.0V, CIN=COUT=Ceramic 4.7µF



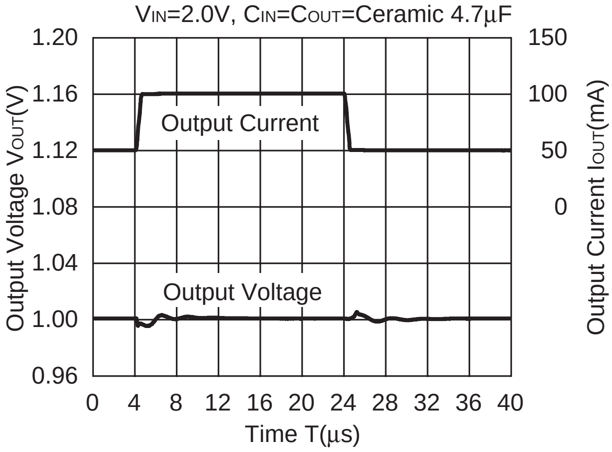
R1173x101x

VIN=2.0V, CIN=Ceramic 4.7µF,
COUT=Ceramic 10µF



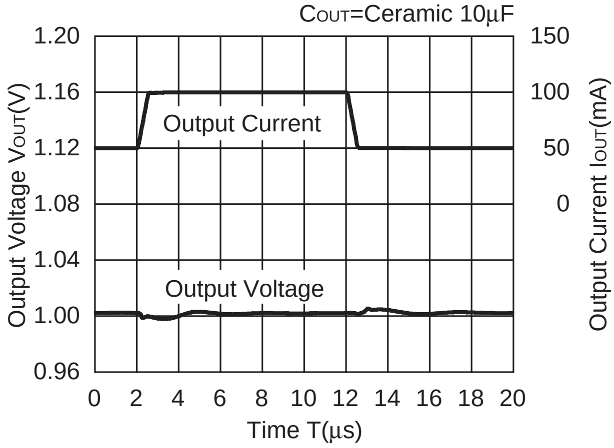
R1173x101x

VIN=2.0V, CIN=COUT=Ceramic 4.7µF



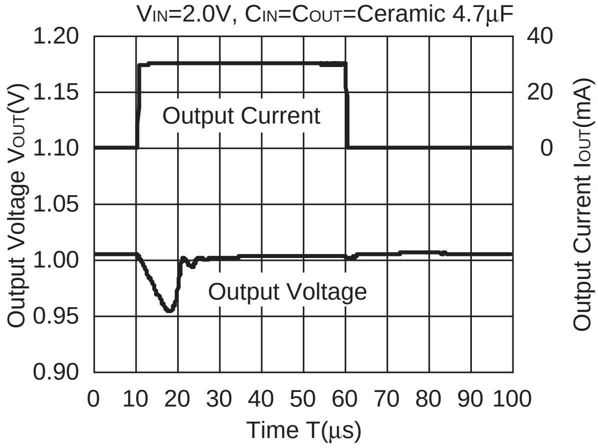
R1173x101x

VIN=2.0V, CIN=Ceramic 4.7µF,
COUT=Ceramic 10µF



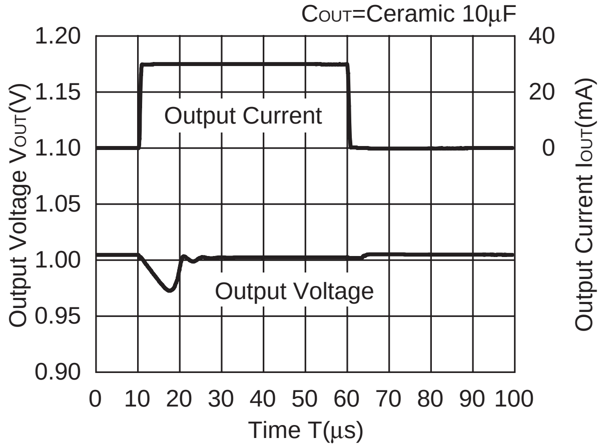
R1173x101x

VIN=2.0V, CIN=COUT=Ceramic 4.7µF



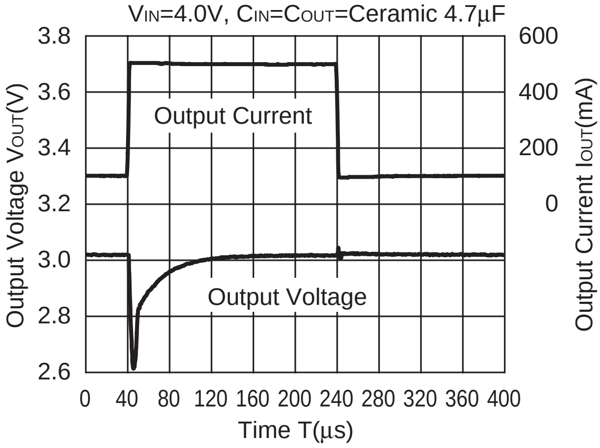
R1173x101x

VIN=2.0V, CIN=Ceramic 4.7µF,
COUT=Ceramic 10µF



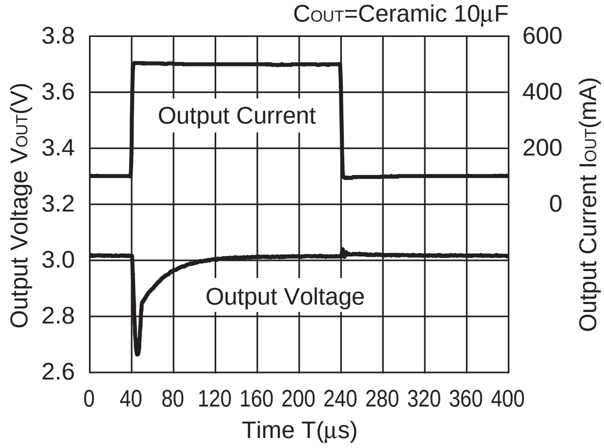
R1173x301x

VIN=4.0V, CIN=COUT=Ceramic 4.7µF



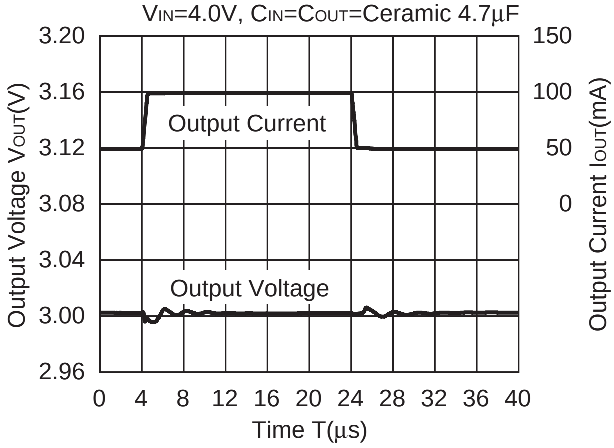
R1173x301x

VIN=4.0V, CIN=Ceramic 4.7µF,
COUT=Ceramic 10µF



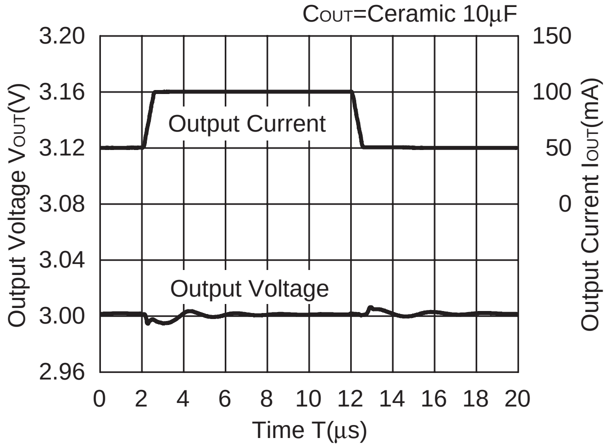
R1173x301x

VIN=4.0V, CIN=COUT=Ceramic 4.7µF



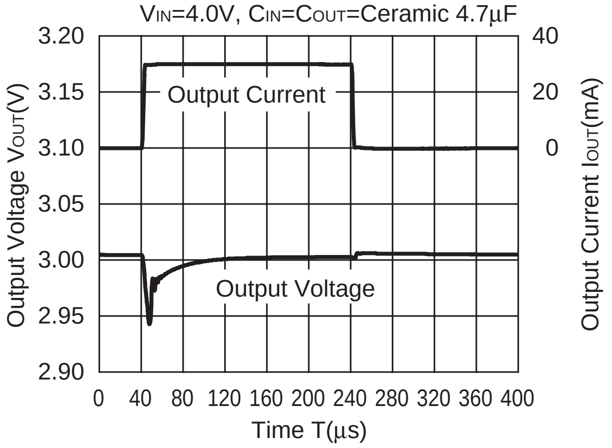
R1173x301x

VIN=4.0V, CIN=Ceramic 4.7µF,
COUT=Ceramic 10µF



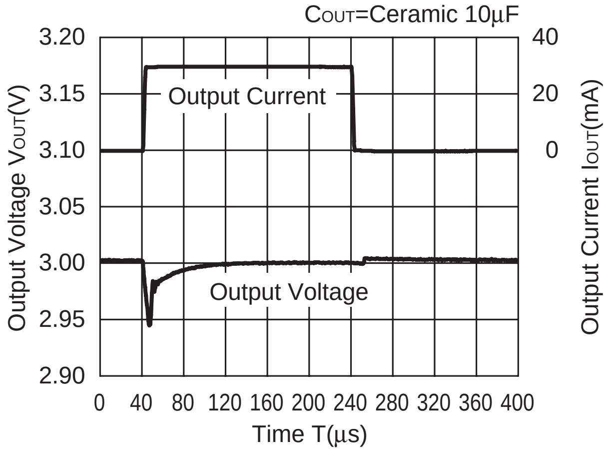
R1173x301x

VIN=4.0V, CIN=COUT=Ceramic 4.7µF



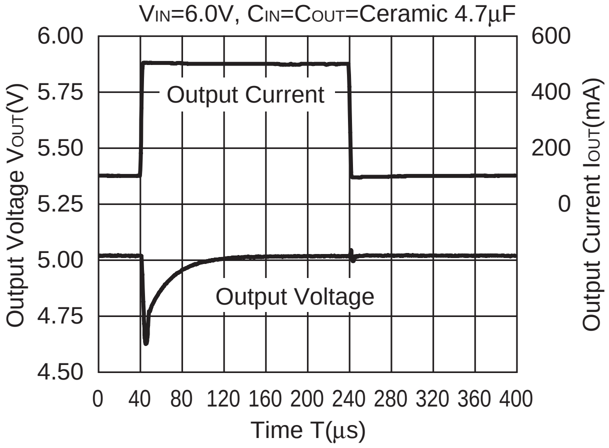
R1173x301x

VIN=4.0V, CIN=Ceramic 4.7µF,
COUT=Ceramic 10µF



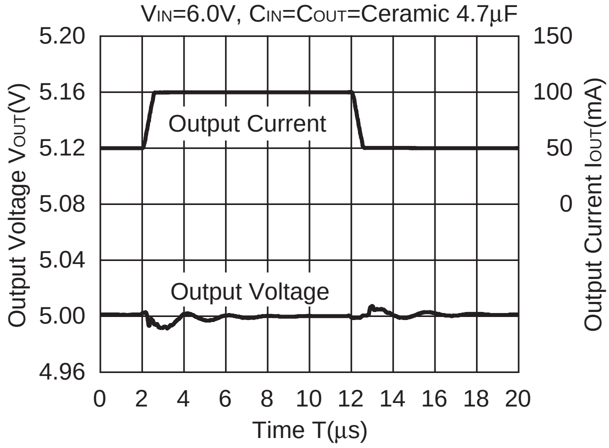
R1173x501x

V_{IN}=6.0V, C_{IN}=C_{OUT}=Ceramic 4.7µF



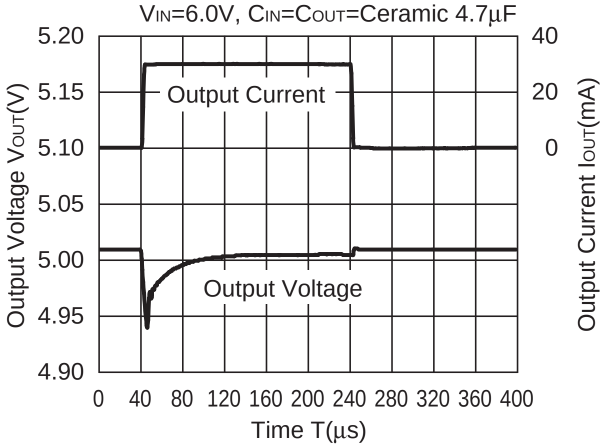
R1173x501x

V_{IN}=6.0V, C_{IN}=C_{OUT}=Ceramic 4.7µF



R1173x501x

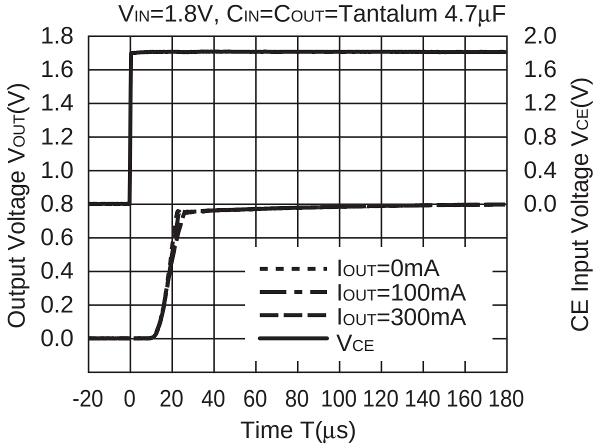
V_{IN}=6.0V, C_{IN}=C_{OUT}=Ceramic 4.7µF



13) Turn-on speed with CE pin control

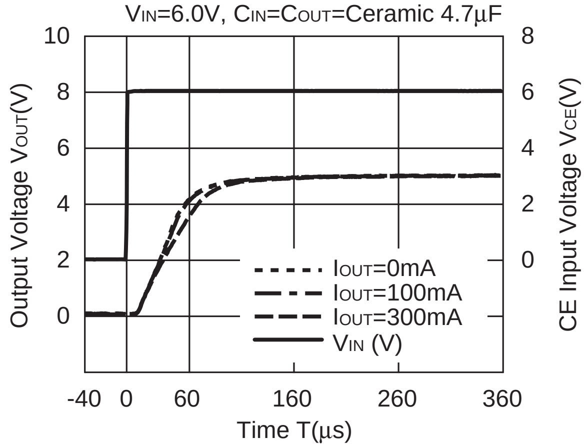
R1173x081x

V_{IN}=1.8V, C_{IN}=C_{OUT}=Tantalum 4.7µF



R1173x501x

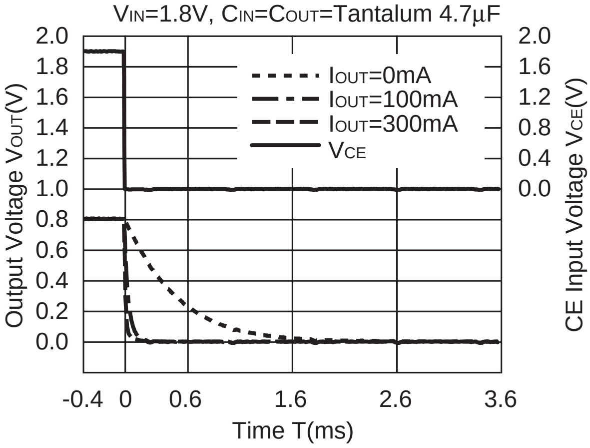
V_{IN}=6.0V, C_{IN}=C_{OUT}=Ceramic 4.7µF



14) Turn-off speed with CE pin control

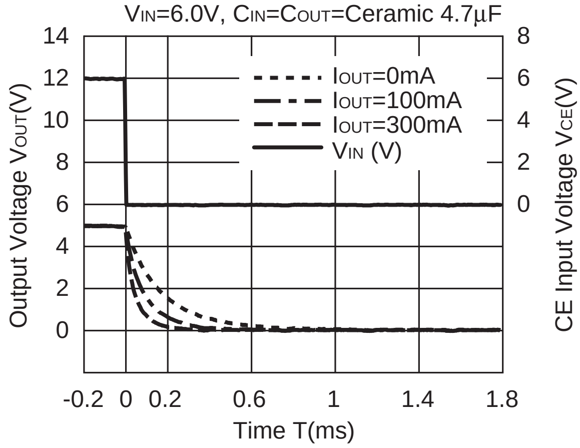
R1173x081D

V_{IN}=1.8V, C_{IN}=C_{OUT}=Tantalum 4.7µF



R1173x501D

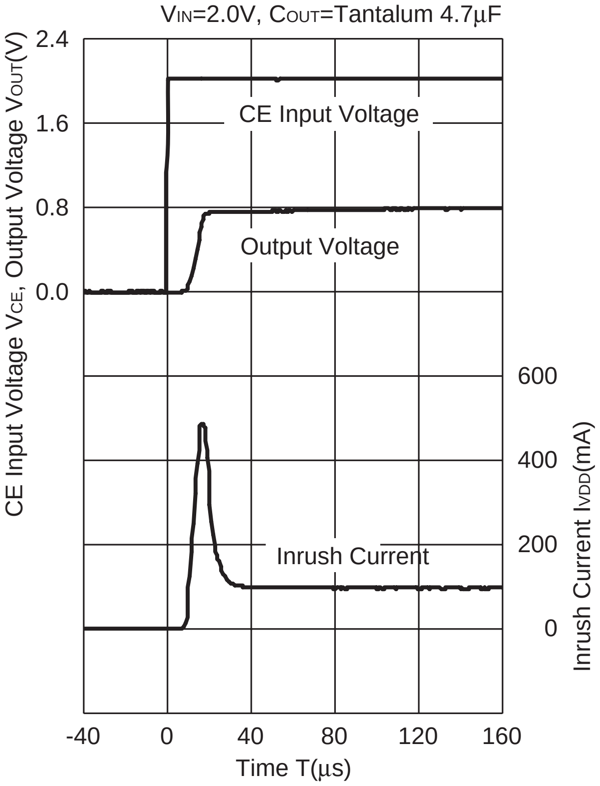
V_{IN}=6.0V, C_{IN}=C_{OUT}=Ceramic 4.7µF



15) Inrush Current

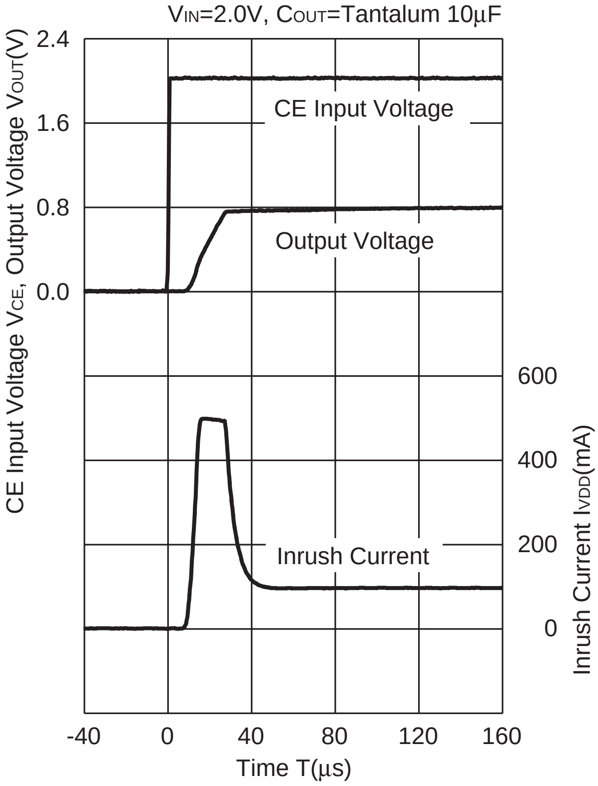
R1173x081x

V_{IN}=2.0V, C_{OUT}=Tantalum 4.7µF



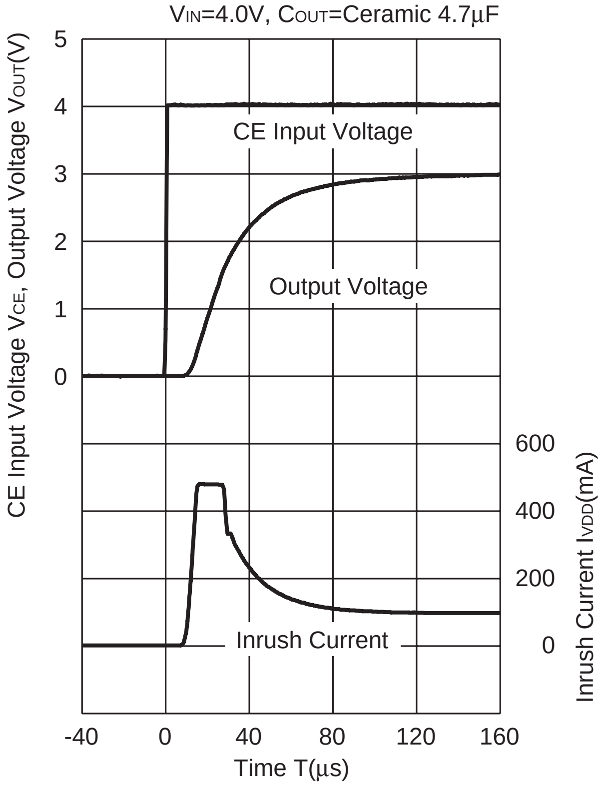
R1173x081x

V_{IN}=2.0V, C_{OUT}=Tantalum 10µF



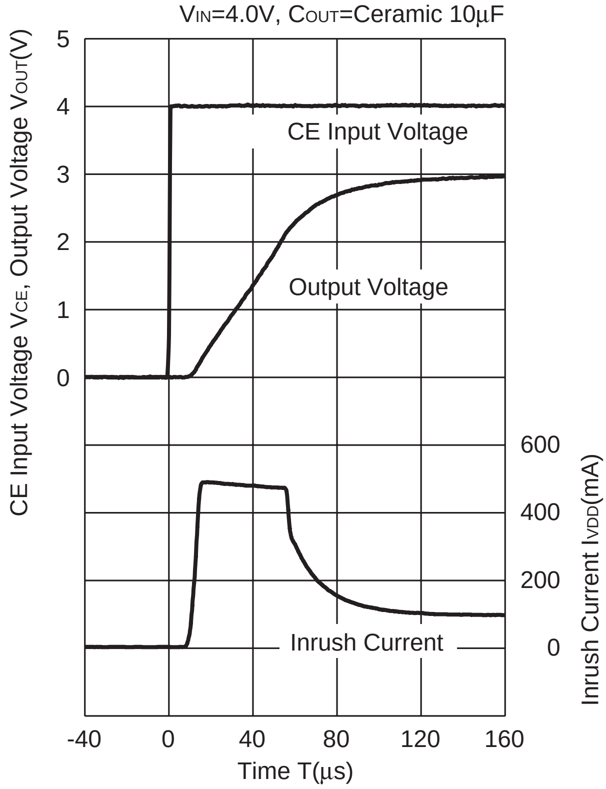
R1173x301x

V_{IN}=4.0V, C_{OUT}=Ceramic 4.7µF



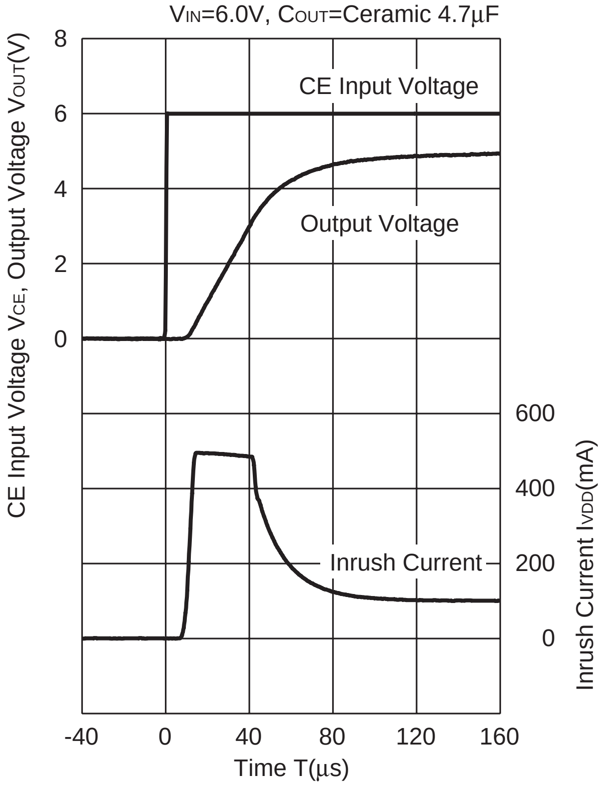
R1173x301x

V_{IN}=4.0V, C_{OUT}=Ceramic 10µF



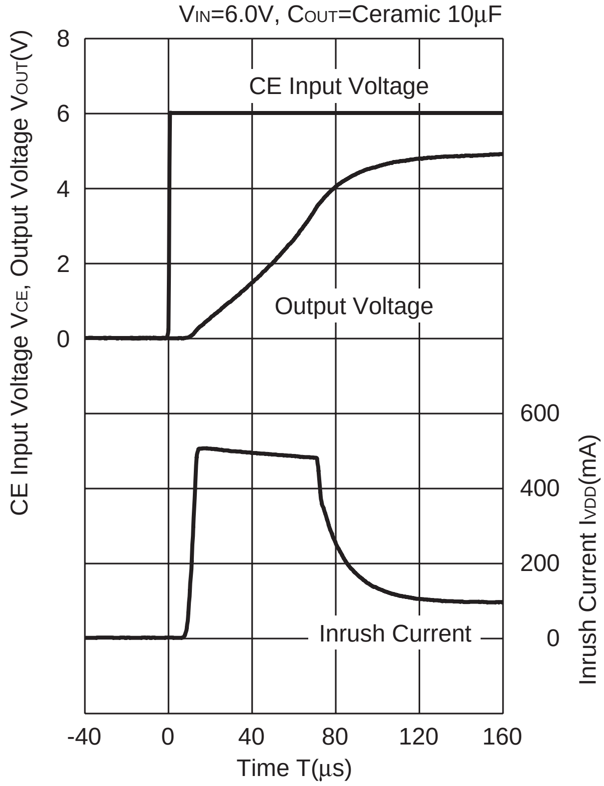
R1173x501x

V_{IN}=6.0V, C_{OUT}=Ceramic 4.7µF



R1173x501x

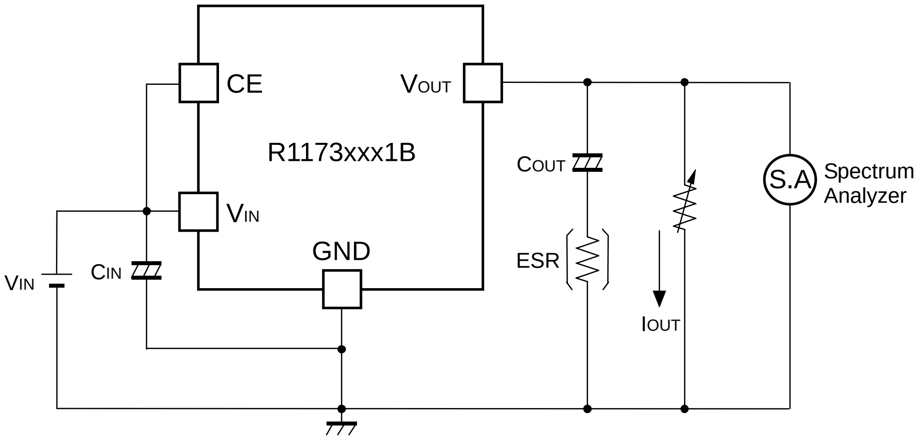
V_{IN}=6.0V, C_{OUT}=Ceramic 10µF



16) Stable Area: ESR limit vs. Load current

0.8V to 3.3V Output type : C_{OUT}=4.7μF (Kyocera CM105X5R475M06AB)

5.0V Output type : C_{OUT}=4.7μF(Kyocera CT21X5R475K06AB)

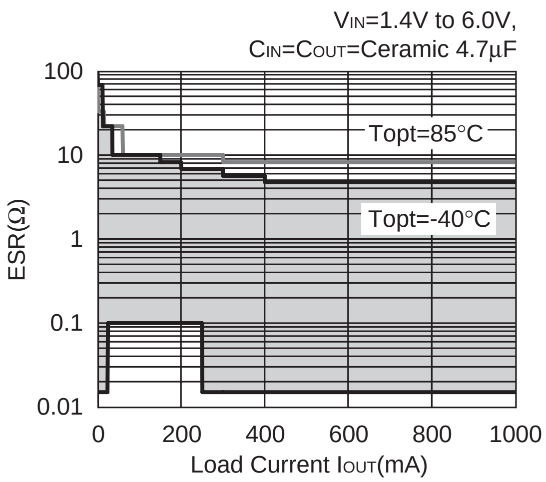


Measurement Conditions
- V_{IN}=V_{OUT}+1V
- Freguency=10Hz to 1MHz
- Topt=25°C

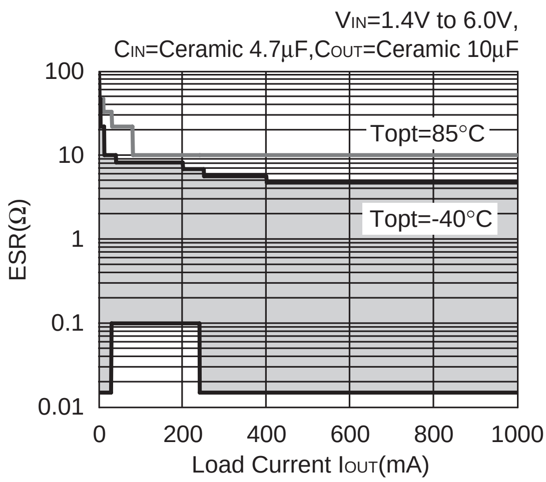
As an output capacitor for this IC, Ceramic capacitor is recommendable. However, other low ESR type capacitor can be used with this IC.

For your reference, noise level is tested, and if the noise level is 40μV or less than 40μV, 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.)

R1173x081x

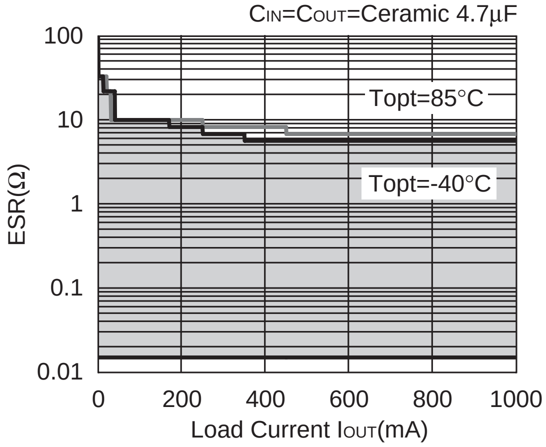


R1173x081x



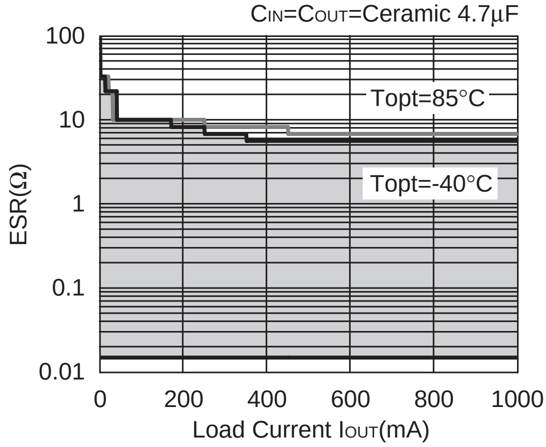
R1173x101x

V_{IN}=1.4V to 6.0V,
C_{IN}=C_{OUT}=Ceramic 4.7µF



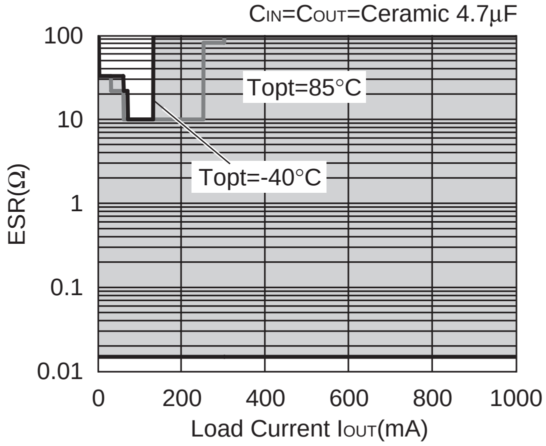
R1173x301x

V_{IN}=3.1V to 6.0V,
C_{IN}=C_{OUT}=Ceramic 4.7µF



R1173x501x

V_{IN}=3.1V to 6.0V,
C_{IN}=C_{OUT}=Ceramic 4.7µF



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8. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
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10. There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact Ricoh sales or our distributor before attempting to use AOI.
11. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.

RoHS Compliant
Halogen Free

Ricoh is committed to reducing the environmental loading materials in electrical devices with a view to contributing to the protection of human health and the environment.
Ricoh has been providing RoHS compliant products since April 1, 2006 and Halogen-free products since April 1, 2012.

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