

LOW ON RESISTANCE / LOW VOLTAGE 1A LDO

NO.EA-174-090507

OUTLINE

The RP131x Series are voltage-regulators with a built-in low ON-resistance transistor and output current is 1A capability. These ICs are capable of the low input voltage (Min.1.6V) and also the minimum output voltage can be set from 0.8V. (The output voltage is fixed in the IC.)

Each of these ICs consists of a voltage reference unit, an error amplifier, resistor net for setting output voltage, a current limit circuits for over-current and thermal-shutdown circuits.

A standby mode with ultra low supply current can be realized with the chip enable function.

Since the packages for these ICs are DFN(PLP)1820-6, SOT-89-5, HSOP-6J and TO-252-5-P2 with high power dissipation, high density mounting of the ICs on boards is possible.

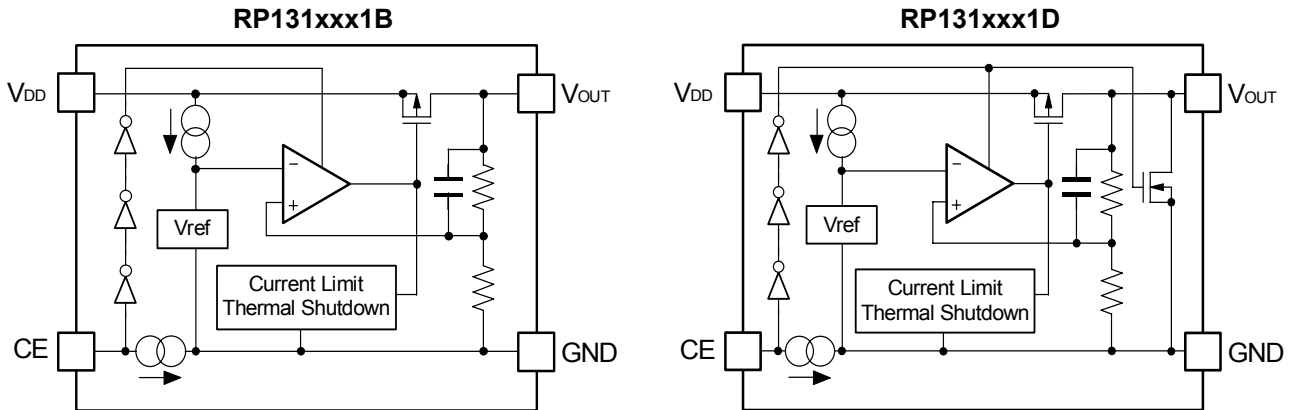
FEATURES

- Output Current Min. 1A
- Supply Current Typ. 65 μ A
- Standby Current Typ. 0.15 μ A
- Input Voltage Range 1.6V to 6.5V
- Output Voltage..... Stepwise setting with a step of 0.1V in the range of 0.8V to 5.0V
- Dropout Voltage..... Typ. 0.5V ($V_{OUT}=2.8V$, $I_{OUT}=1A$)
- Ripple Rejection Typ. 70dB ($f=1kHz$, $V_{OUT}=2.8V$)
- Output Voltage Accuracy $\pm 1.0\%$
- Temperature-Drift Coefficient of Output Voltage Typ. $\pm 100ppm/^{\circ}C$
- Line Regulation Typ. 0.05%/V
- Load Regulation Typ. 20mV at $I_{OUT}=300mA$, Typ. 80mV at $I_{OUT}=1A$
- Packages DFN(PLP)1820-6, SOT-89-5, HSOP-6J, TO-252-5-P2
- Built-in Inrush current limit circuit Typ. 500mA
- Built-in Fold-Back Protection Circuit Typ. 250mA (Current at short mode)
- Built-in Thermal Shutdown Circuit Thermal Shutdown Temperature ; Typ. 165 $^{\circ}C$
Released Temperature ; Typ. 135 $^{\circ}C$
- Built-in Auto Discharge Function D version
- Ceramic capacitors are recommended to be used with this IC 2.2 μ F or more ($V_{OUT} \leq 3.6V$)
4.7 μ F or more ($V_{OUT} > 3.6V$)

APPLICATIONS

- Power source for battery-powered equipment.
- Power source for portable communication equipment.
- Power source for electrical appliances such as cameras, VCRs and camcorders.
- Power source for Notebook PC.
- Power source for home appliances.

BLOCK DIAGRAMS



SELECTION GUIDE

The output voltage, auto discharge function*, and the taping type for the ICs can be selected at the user's request.

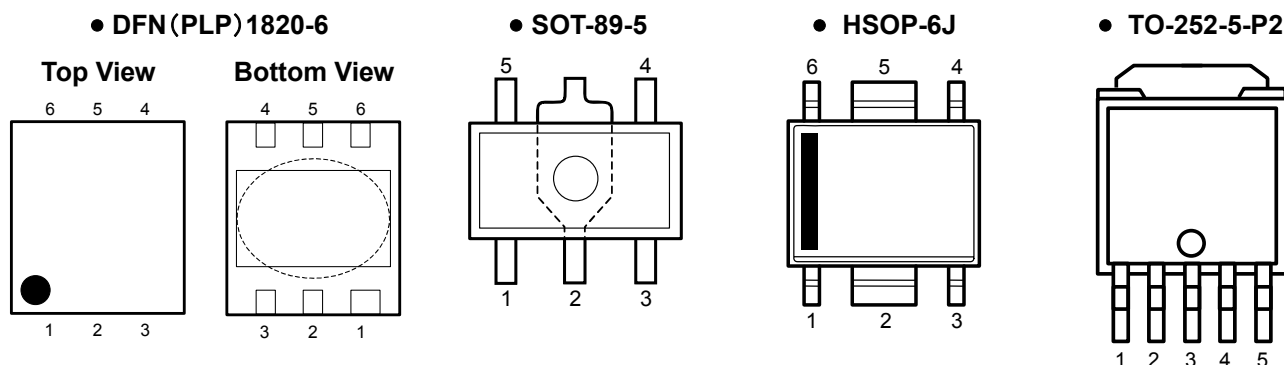
The selection can be made with designating the part number as shown below;

RP131xxx1x-xx-x ← Part Number
 ↑ ↑ ↑ ↑ ↑
 a b c d e

Code	Contents
a	Designation of Package Type; K : DFN(PLP)1820-6 H : SOT-89-5 S : HSOP-6J J : TO-252-5-P2
b	Setting Output Voltage (V_{OUT}); Stepwise setting with a step of 0.1V in the range of 0.8V to 5.0V is possible. Exceptions: 1.05V=RP131x101x5-xx-x 1.25V=RP131x121x5-xx-x 1.85V=RP131x181x5-xx-x 2.85V=RP131x281x5-xx-x
c	Designation of Mask Option; B : active high, without auto discharge function* at OFF state. D : active high, with auto discharge function* at OFF state.
d	Designation of Taping Type; T1 : SOT-89-5, TO-252-5-P2 TR : DFN(PLP)1820-6 E2 : HSOP-6J Refer to Taping Specifications.
e	Designation of composition of pin plating; -F : Lead free solder plating (SOT-89-5, HSOP-6J, TO-252-5-P2) None : Au plating (DFN(PLP)1820-6)

*) When the mode is into standby with CE signal, auto discharge transistor turns on, and it makes the turn-off speed faster than normal type.

PIN CONFIGURATIONS



PIN DESCRIPTIONS

• DFN(PLP)1820-6*

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

*) Tab in the  parts have GND level. (They are connected to the back side of this IC.)

Do not connect to other wires or land patterns.

When you use this IC, please make sure be wired with 1pin with 2pin and 5pin with 6pin.

• HSOP-6J*

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

*) When you use this IC, please make sure be wired with 2pin and 5pin.

• SOT-89-5

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

• TO-252-5-P2*

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

*) When you use this IC, please make sure be wired with 2pin and 3pin.

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	7.0	V
V_{CE}	Input Voltage (CE Pin)	-0.3 to 7.0	V
V_{OUT}	Output Voltage	-0.3 to $V_{IN}+0.3$	V
I_{OUT}	Output Current (DC)	1.4	A
P_D	Power Dissipation (DFN(PLP)1820-6)*	880	mW
	Power Dissipation (SOT-89-5)*	900	
	Power Dissipation (HSOP-6J)*	1700	
	Power Dissipation (TO-252-5-P2)*	1900	
T_{opt}	Operating Temperature Range	-40 to 85	°C
T_{stg}	Storage Temperature Range	-55 to 125	°C

*) For Power Dissipation, please refer to PACKAGE INFORMATION.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field.
The functional operation at or over these absolute maximum ratings is not assured.

ELECTRICAL CHARACTERISTICS

$V_{IN} = \text{Set } V_{OUT} + 1V$

The specification in is checked and guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_{opt} \leq 85^{\circ}\text{C}$, unless otherwise noted.

• RP131xxx1B/D

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

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit	
V_{OUT}	Output Voltage	$T_{opt} = 25^{\circ}\text{C}$	$V_{OUT} > 1.5V$	$\times 0.99$		$\times 1.01$	V
			$V_{OUT} \leq 1.5V$	-15		15	mV
		$-40^{\circ}\text{C} \leq T_{opt} \leq 85^{\circ}\text{C}$	$V_{OUT} > 1.5V$	<input type="checkbox"/> 0.974		<input type="checkbox"/> 1.018	V
			$V_{OUT} \leq 1.5V$	<input type="checkbox"/> -40		<input type="checkbox"/> 27	mV
I_{OUT}	Output Current		<input type="checkbox"/> 1			A	
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	$0.1\text{mA} \leq I_{OUT} \leq 300\text{mA}$		20	<input type="checkbox"/> 40	mV	
		$0.1\text{mA} \leq I_{OUT} \leq 1A$		80	<input type="checkbox"/> 120		
V_{DIF}	Dropout Voltage	Refer to the following table					
I_{SS}	Supply Current	$I_{OUT} = 0\text{mA}$ ($V_{IN} = 6.5V$)		65	<input type="checkbox"/> 90	μA	
$I_{standby}$	Standby Current	$V_{CE} = 0V$, $V_{IN} = 6.5V$		0.15	0.60	μA	
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	Set $V_{OUT} + 0.5V \leq V_{IN} \leq 6.5V$ *If $V_{OUT} \leq 1.1V$, $V_{IN} = 1.6V$		0.05	<input type="checkbox"/> 0.1	$\%/V$	
RR	Ripple Rejection	Ripple 0.2Vp-p $I_{OUT} = 100\text{mA}$	$f = 1\text{kHz}$ ($V_{OUT} \leq 3.3V$)		70	dB	
			$f = 1\text{kHz}$ ($V_{OUT} > 3.3V$)		60		
V_{IN}	Input Voltage		<input type="checkbox"/> 1.6		<input type="checkbox"/> 6.5	V	
$\frac{\Delta V_{OUT}}{\Delta T_{opt}}$	Output Voltage Temperature Coefficient	$-40^{\circ}\text{C} \leq T_{opt} \leq 85^{\circ}\text{C}$		± 100		ppm/ $^{\circ}\text{C}$	
I_{lim}	Short Current Limit	$V_{OUT} = 0V$		250		mA	
I_{PD}	CE Pull-down Current			0.3		μA	
V_{CEH}	CE Input Voltage "H"		<input type="checkbox"/> 1.0			V	
V_{CEL}	CE Input Voltage "L"				<input type="checkbox"/> 0.4	V	
e_n	Output Noise	$BW = 10\text{Hz to } 100\text{kHz}$, $I_{OUT} = 1\text{mA}$		45		μV_{rms}	
T_{TSD}	Thermal Shutdown Temperature	Junction Temperature		165		$^{\circ}\text{C}$	
T_{TSR}	Thermal Shutdown Released Temperature	Junction Temperature		135		$^{\circ}\text{C}$	
R_{LOW}	Low Output Nch Tr. ON Resistance (of D version)	$V_{IN} = 4.0V$, $V_{CE} = 0V$		30		Ω	

The specification in is checked and guaranteed by design engineering at $-40^{\circ}\text{C} \leq T_{opt} \leq 85^{\circ}\text{C}$, unless otherwise noted.

All of unit are tested and specified under load conditions such that $T_j \approx T_{opt} = 25^{\circ}\text{C}$ except for Output Noise, Ripple Rejection, Output Voltage Temperature Coefficient, Dropout Voltage at 1A Output Current and Thermal Shutdown items.

• Dropout Voltage by Output Voltage

T_{opt}=25°C

Output Voltage V _{OUT} (V)	Dropout Voltage V _{DIF} (V)					
	Condition	Typ.	Max.	Condition	Typ.	Max.
0.8 ≤ V _{OUT} < 0.9	I _{OUT} =300mA	0.600	0.780	I _{OUT} =1A	1.100	1.650
0.9 ≤ V _{OUT} < 1.0		0.550	0.690		1.050	1.500
1.0 ≤ V _{OUT} < 1.1		0.450	0.610		1.000	1.450
1.1 ≤ V _{OUT} < 1.2		0.340	0.540		0.930	1.420
1.2 ≤ V _{OUT} < 1.5		0.290	0.500		0.900	1.380
1.5 ≤ V _{OUT} < 2.6		0.230	0.310		0.700	1.100
2.6 ≤ V _{OUT} < 3.3		0.150	0.180		0.500	0.750
3.3 ≤ V _{OUT} ≤ 5.0		0.140	0.170		0.450	0.650

The specification in is checked and guaranteed by design engineering at -40°C ≤ T_{opt} ≤ 85°C, unless otherwise noted.

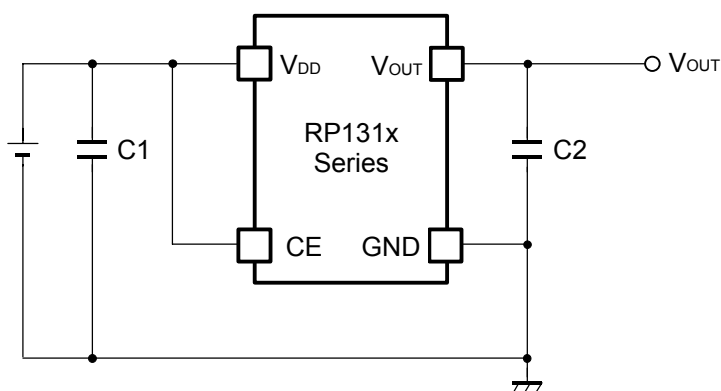
All of unit are tested and specified under load conditions such that T_j≈T_{opt}=25°C except for Output Noise, Ripple Rejection, Output Voltage Temperature Coefficient, Dropout Voltage at 1A Output Current and Thermal Shutdown items.

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge.

And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

TYPICAL APPLICATION



Recommendation value of the external capacitors

V_{OUT}	Capacitors	
$V_{OUT} \leq 3.6V$	C1	Kyocera 2.2 μ F (size:1005) [CM05X5R225M04AB]
	C2	Kyocera 2.2 μ F (size:1608) [CM105X5R225K06AB]
$V_{OUT} > 3.6V$	C1	Kyocera 2.2 μ F (size:1608) [CM105X5R225K06AB]
	C2	Kyocera 4.7 μ F (size:1608) [CM105X5R475M06AB]

TECHNICAL NOTES

When using these ICs, consider the following points:

Phase Compensation

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

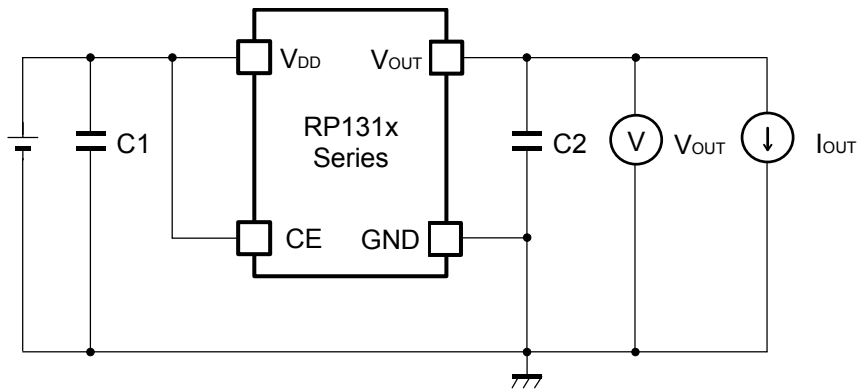
If a tantalum capacitor is used, and its ESR of C2 is large, the loop oscillation may result. Because of this, select C2 carefully considering its frequency characteristics.

PCB Layout

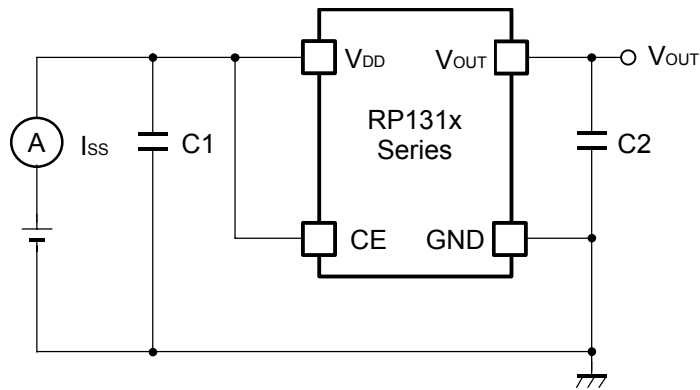
Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 between V_{DD} and GND pin with a capacitance value as "Recommendation value of the external capacitors" above or more, and as close as possible to the pins.

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

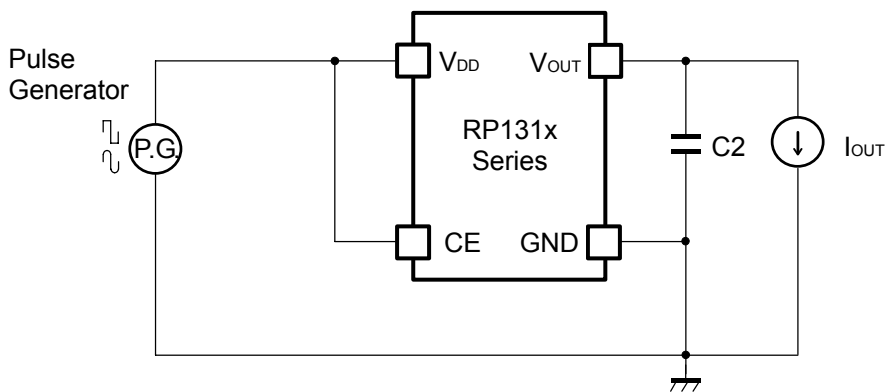
TEST CIRCUITS



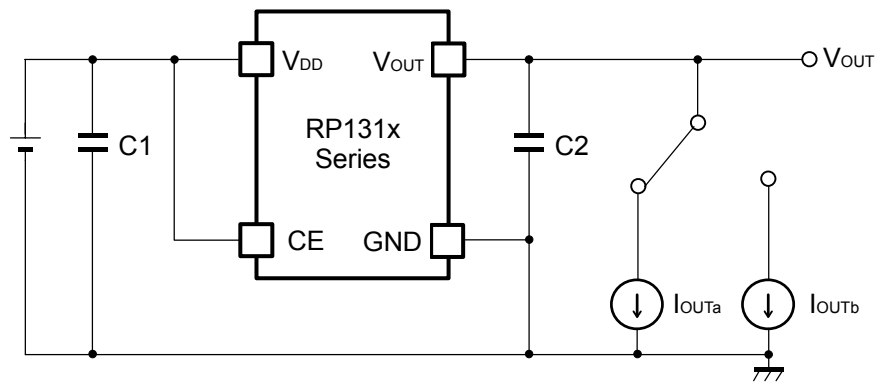
Basic Test Circuit



Test Circuit for Supply Current



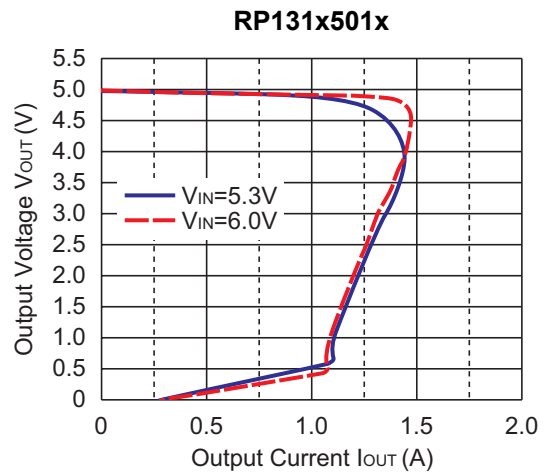
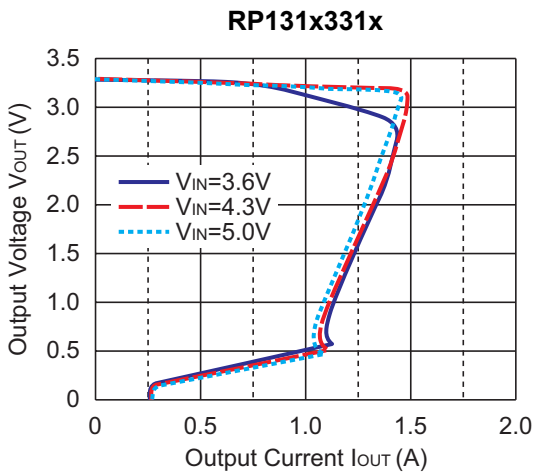
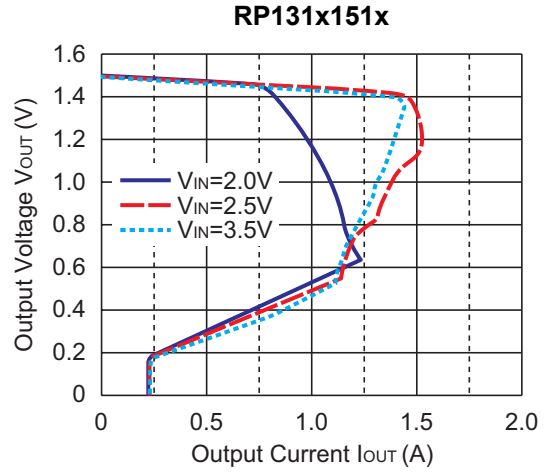
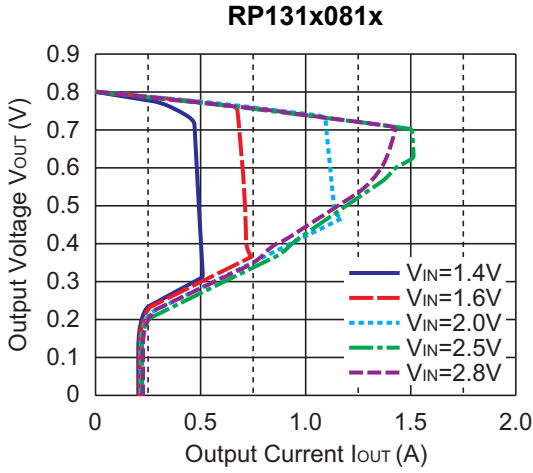
Test Circuit for Ripple Rejection



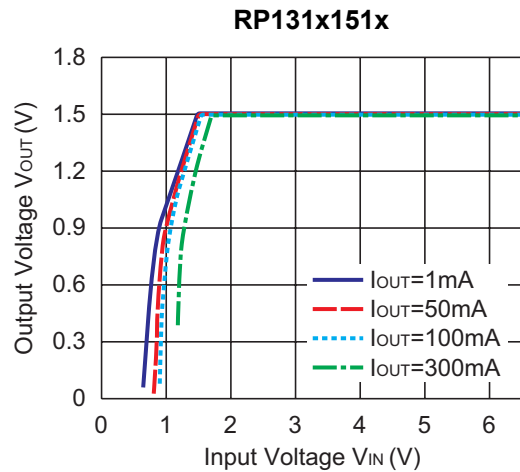
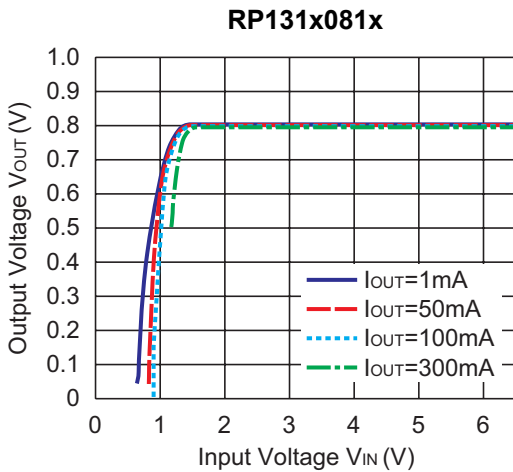
Test Circuit for Load Transient Response

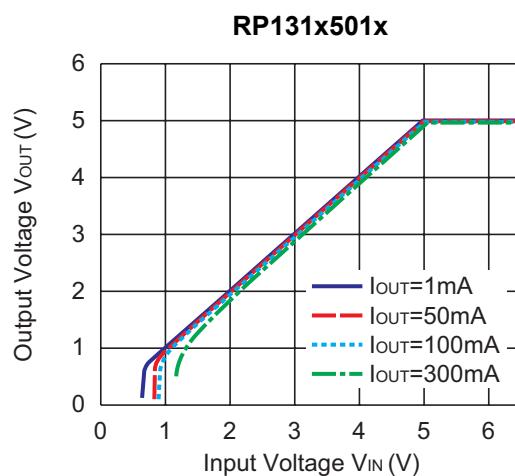
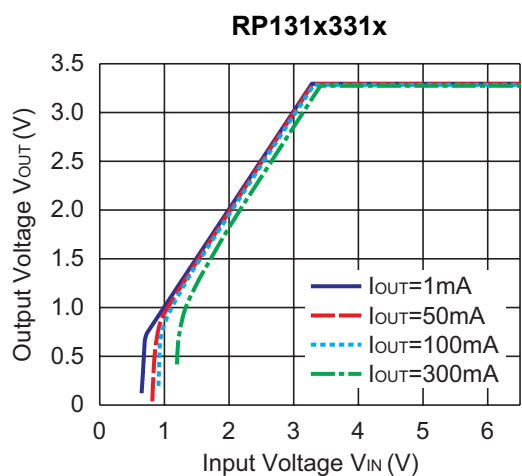
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current (T_{opt}=25°C)

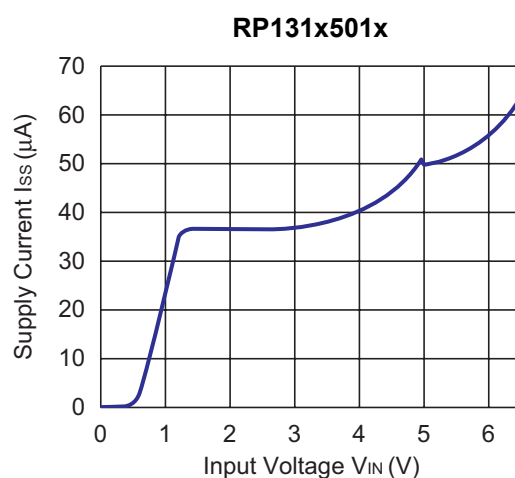
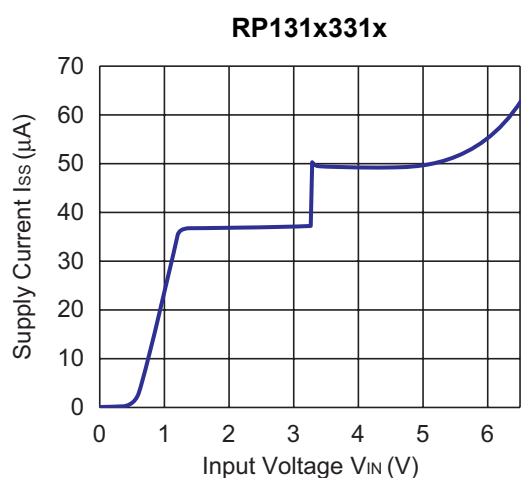
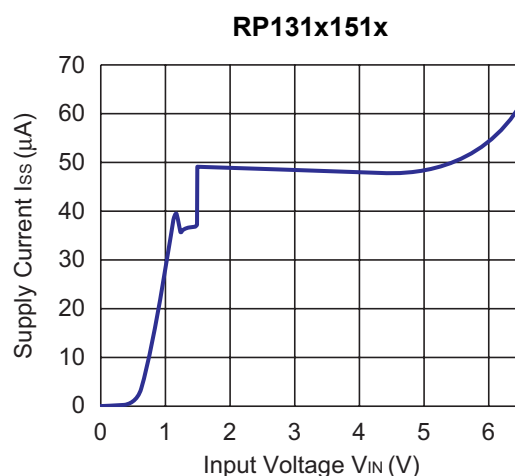
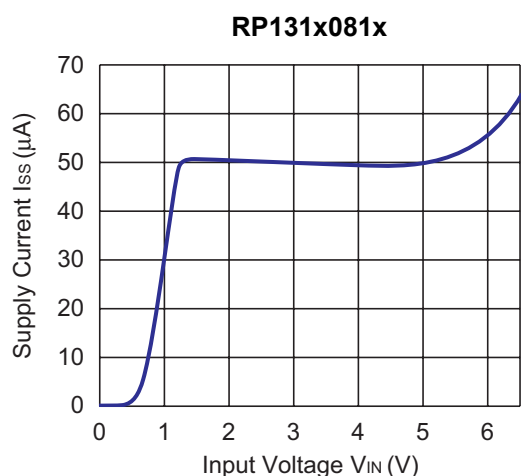


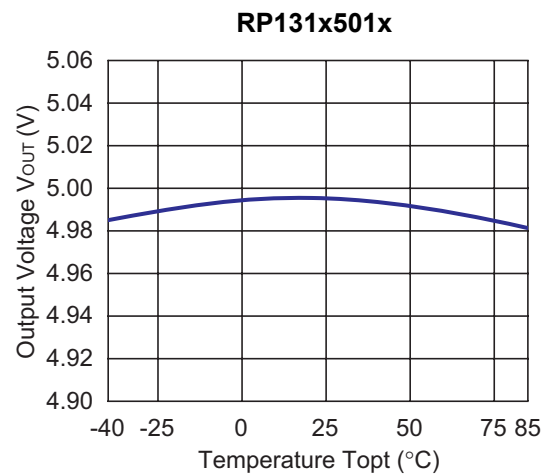
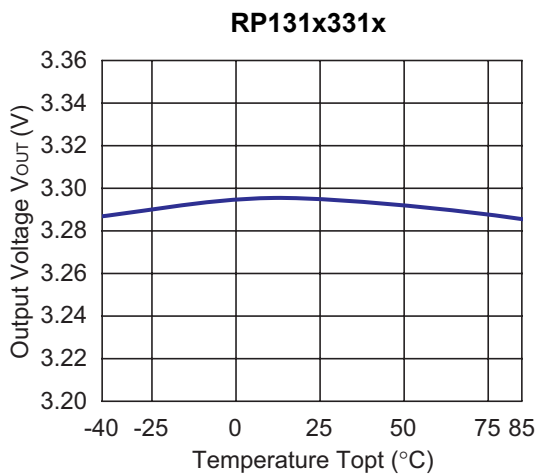
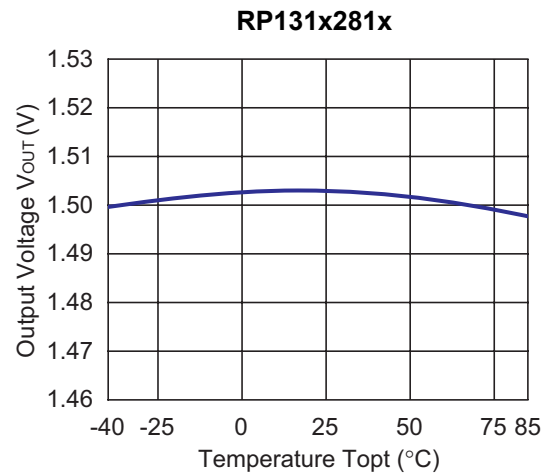
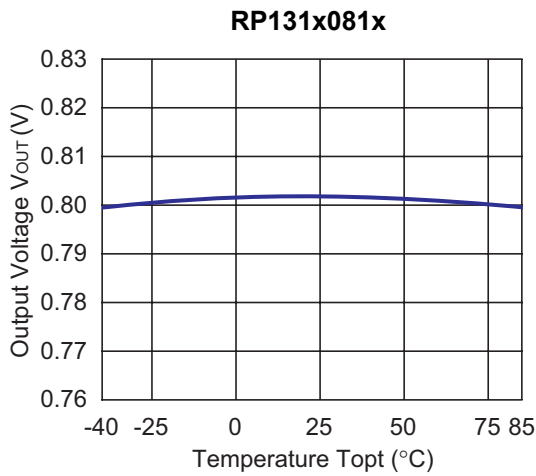
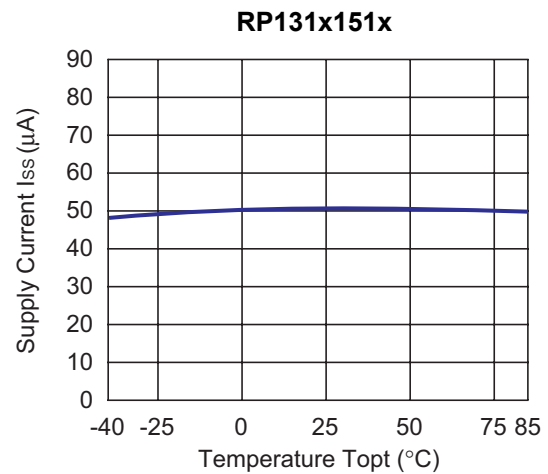
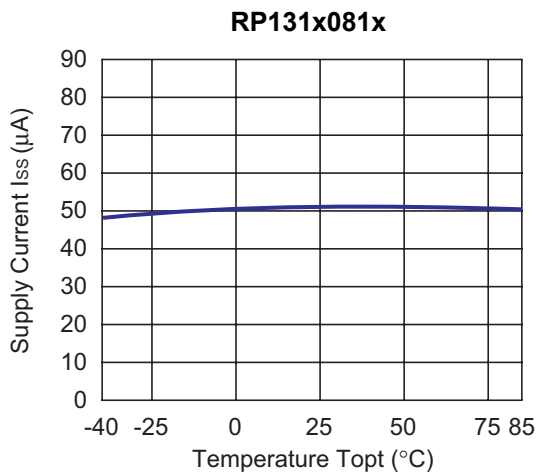
2) Output Voltage vs. Input Voltage (T_{opt}=25°C)

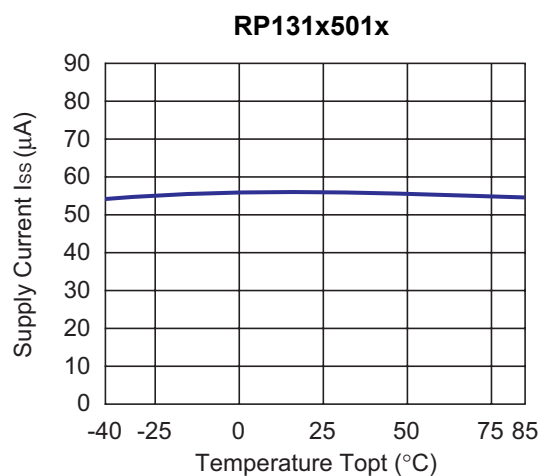
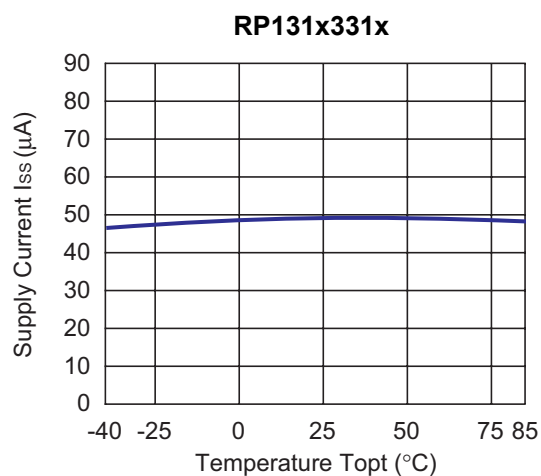




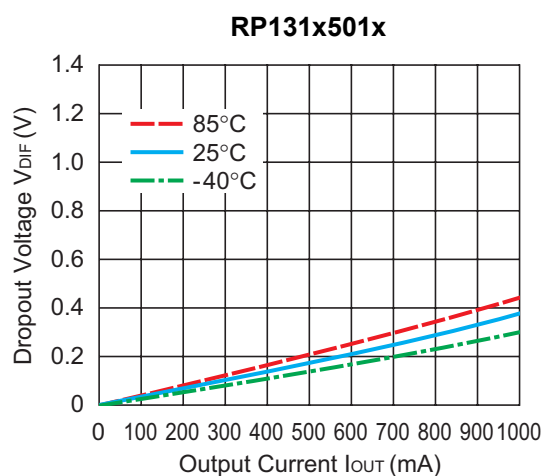
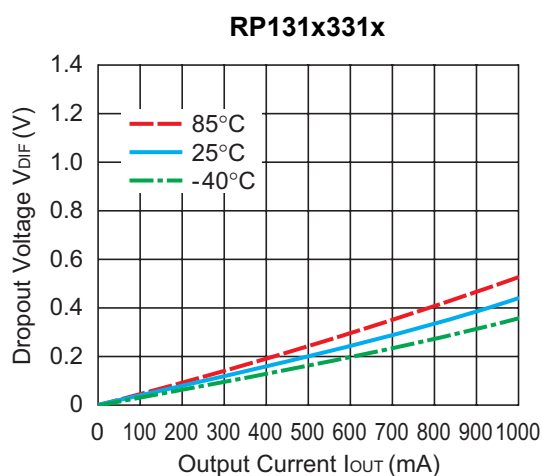
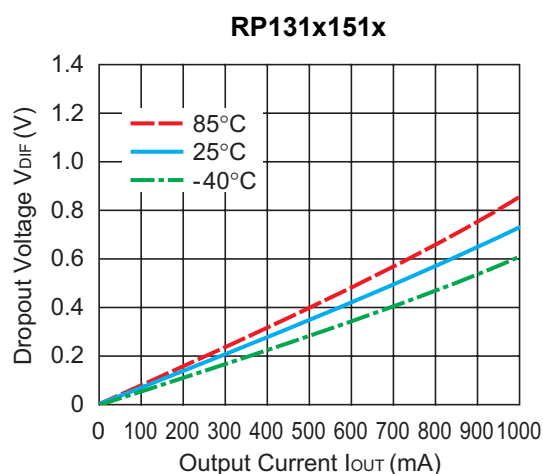
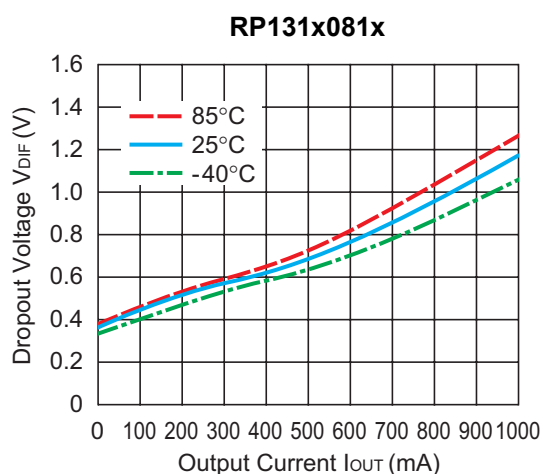
3) Supply Current vs. Input Voltage (Topt=25°C)



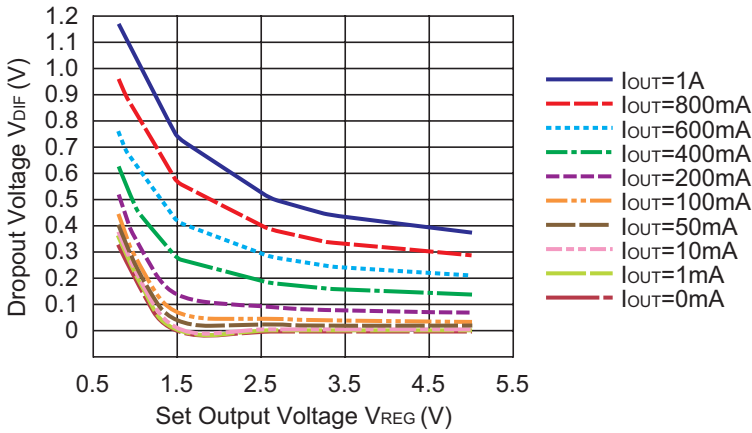
4) Output Voltage vs. Temperature**5) Supply Current vs. Temperature**



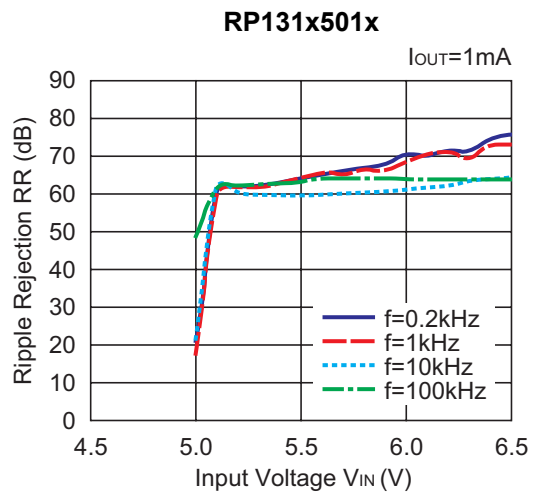
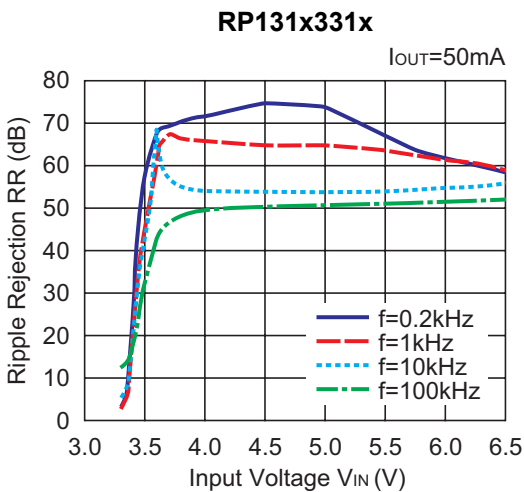
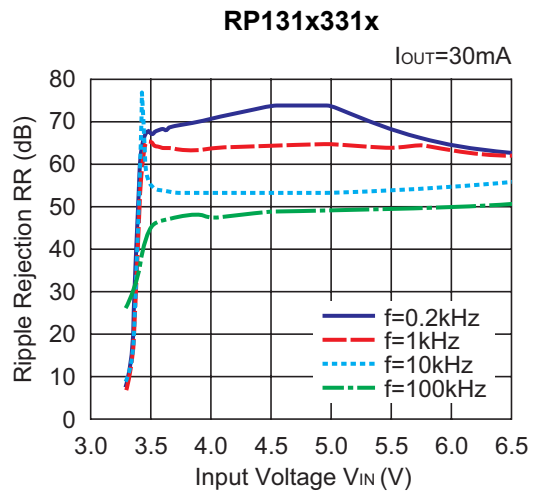
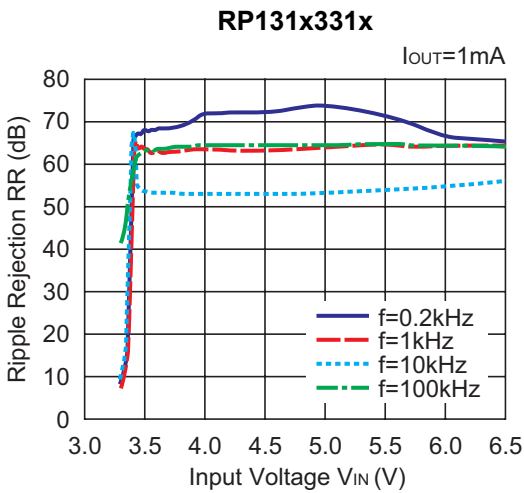
6) Dropout Voltage vs. Output Current

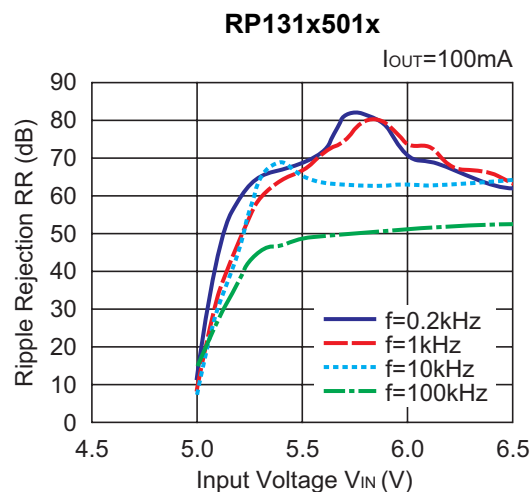
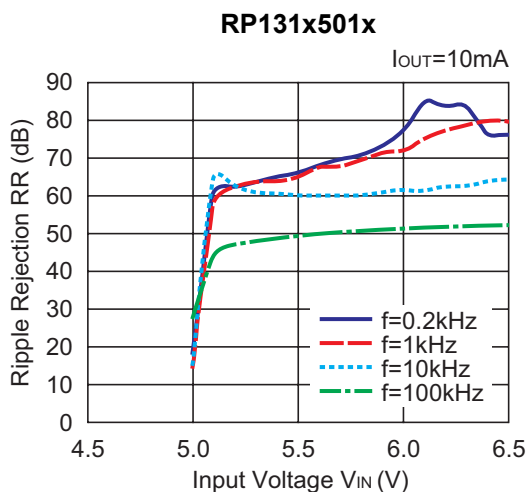


7) Dropout Voltage vs. Set Output Voltage

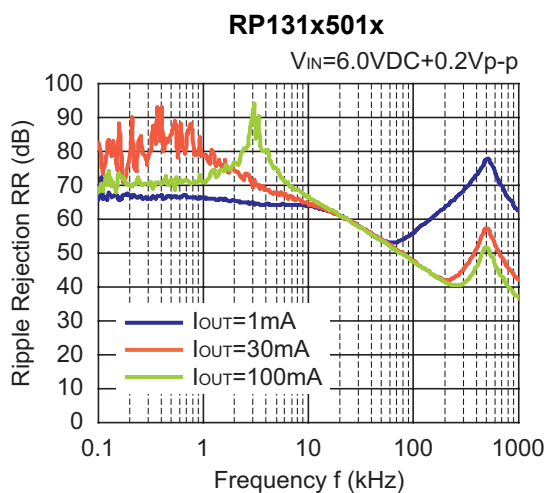
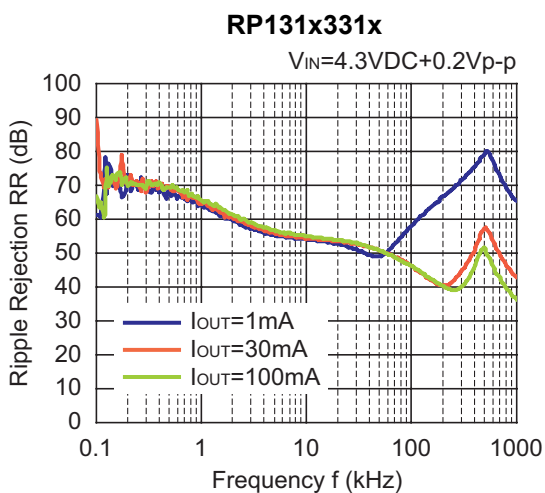
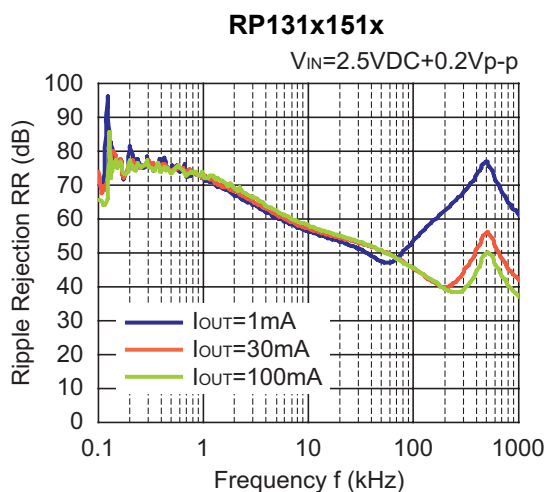
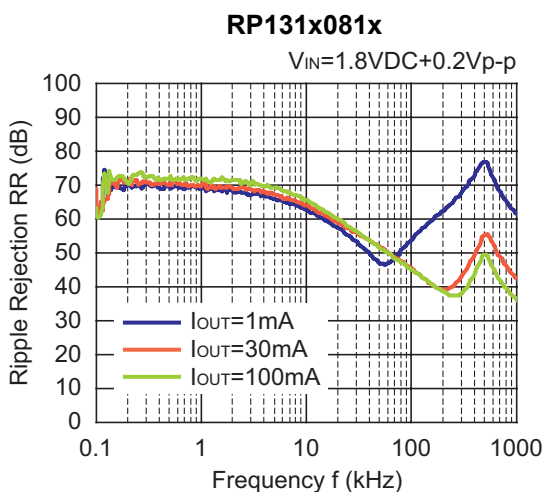


8) Ripple Rejection vs. Input Bias Voltage ($C1=none$, $C2=Ceramic\ 1.0\mu F$, Ripple= $0.2V_{pp}$, $T_{opt}=25^{\circ}C$)

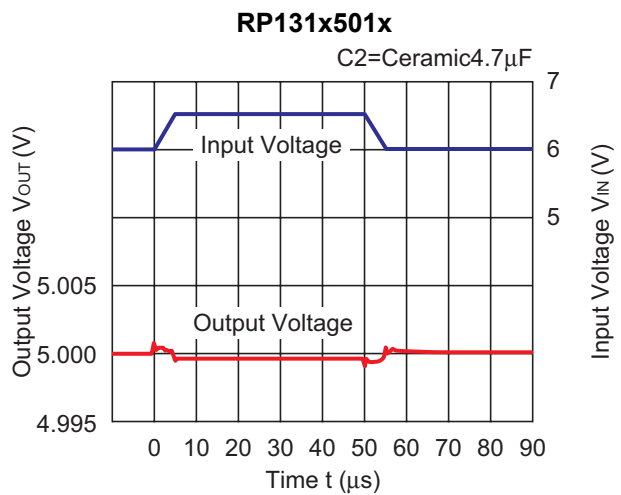
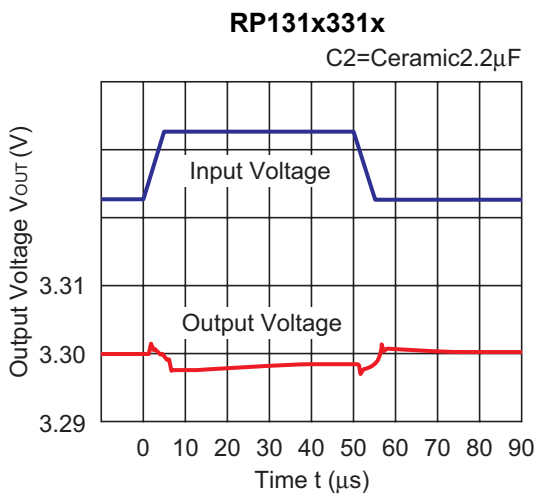
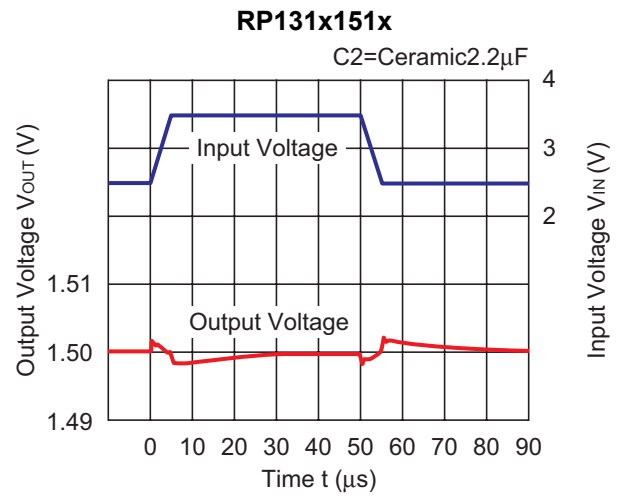
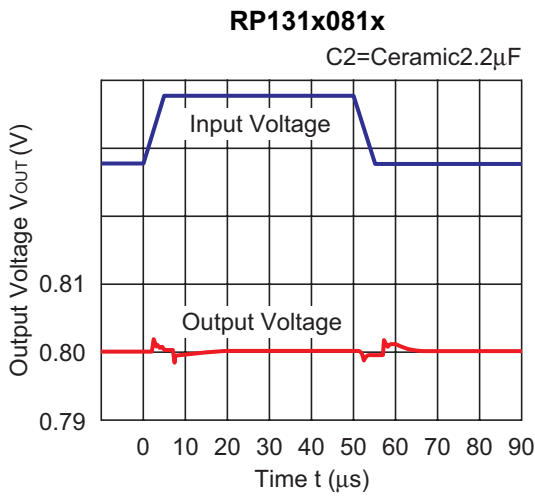




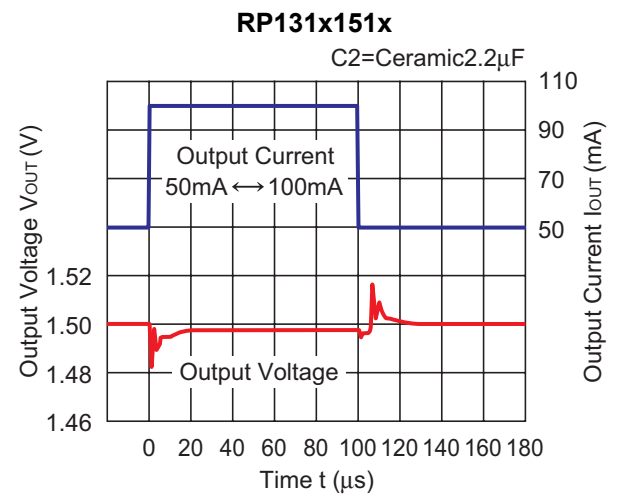
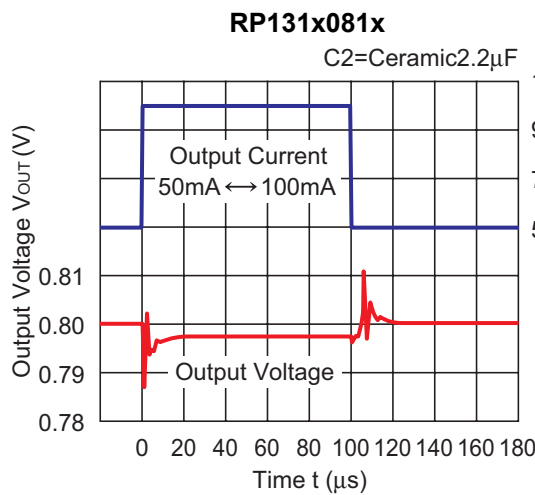
9) Ripple Rejection vs. Frequency ($C1=none$, $C2=Ceramic\ 4.7\mu F$, $T_{opt}=25^{\circ}C$)

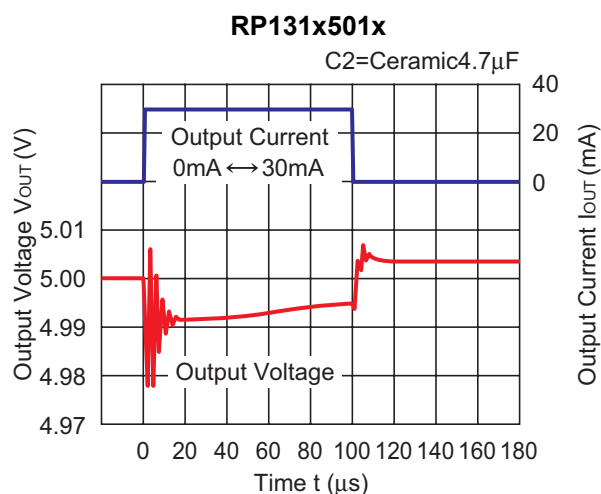
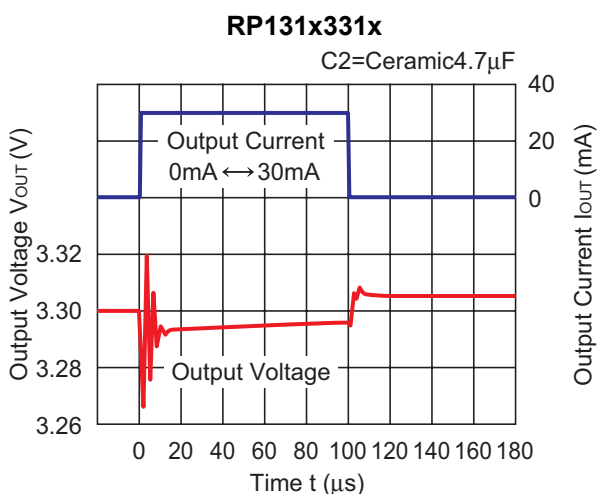
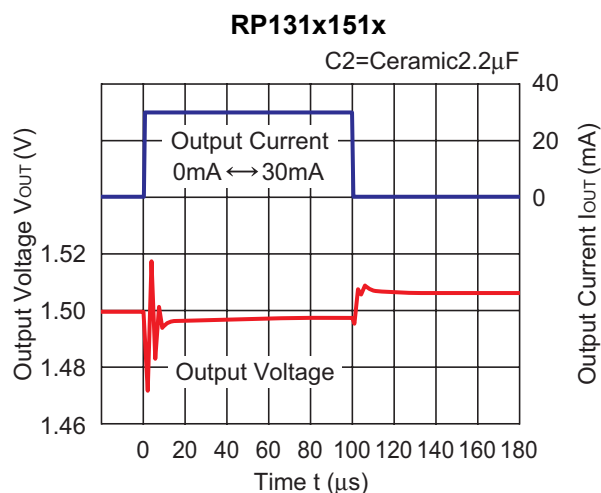
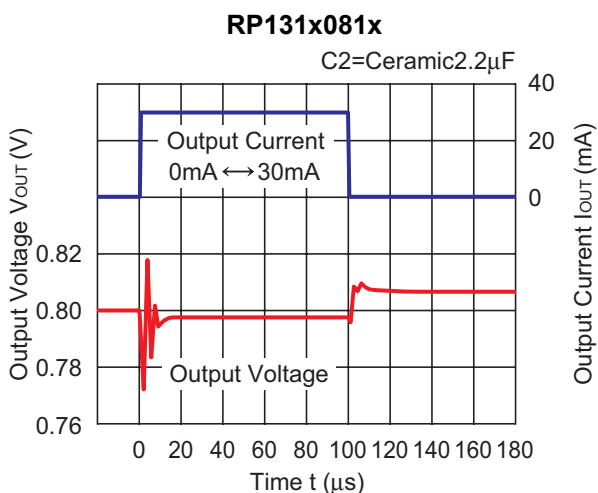
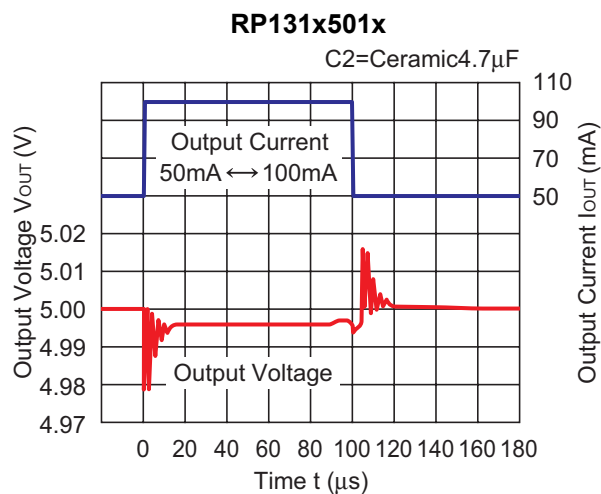
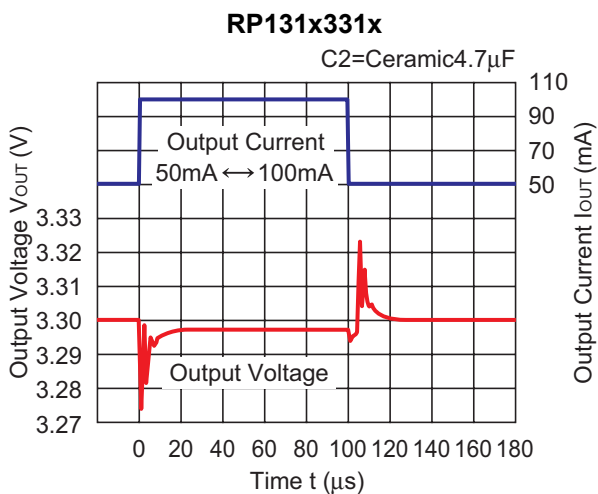


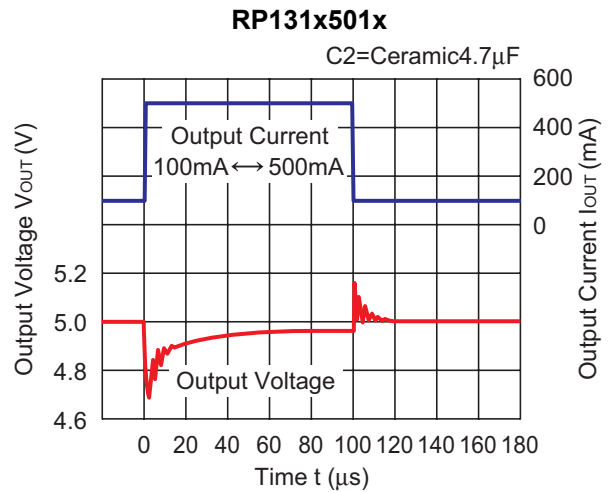
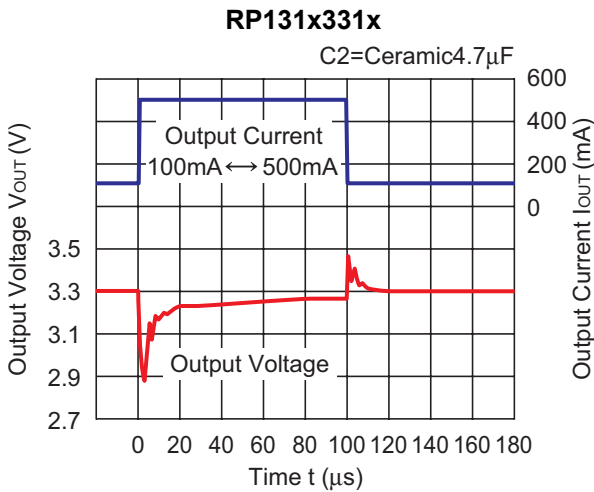
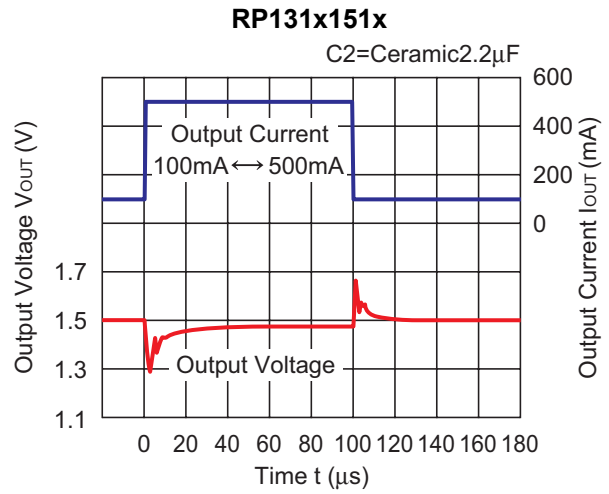
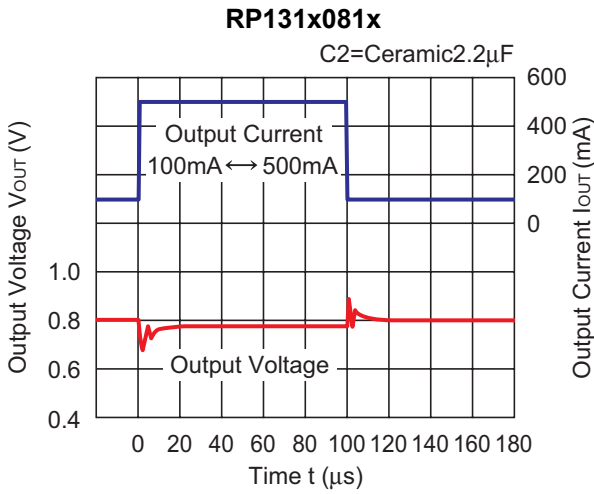
10) Input Transient Response ($I_{OUT}=100mA$, $t_r=t_f=5\mu s$, $C_1=none$, $T_{opt}=25^\circ C$)



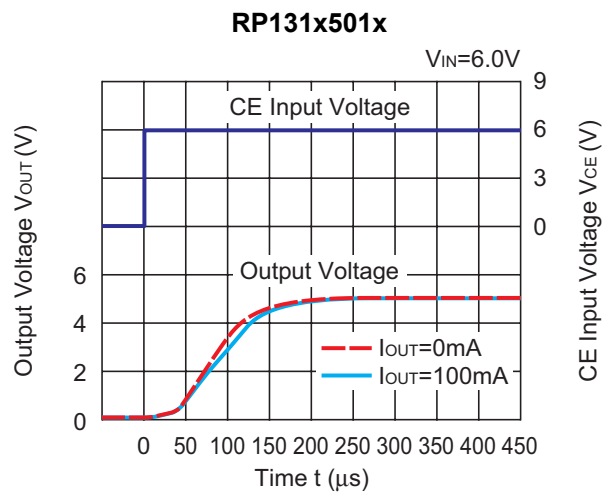
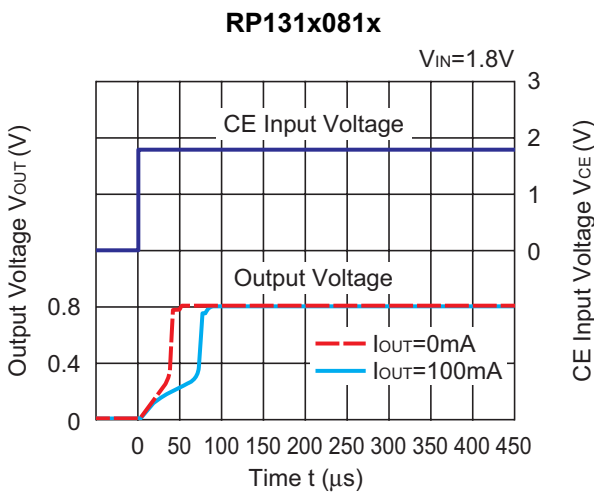
11) Load Transient Response ($t_r=t_f=0.5\mu s$, $C_1=Ceramic\ 2.2\mu F$, $V_{IN}=V_{OUT}+1.0V$, $T_{opt}=25^\circ C$)



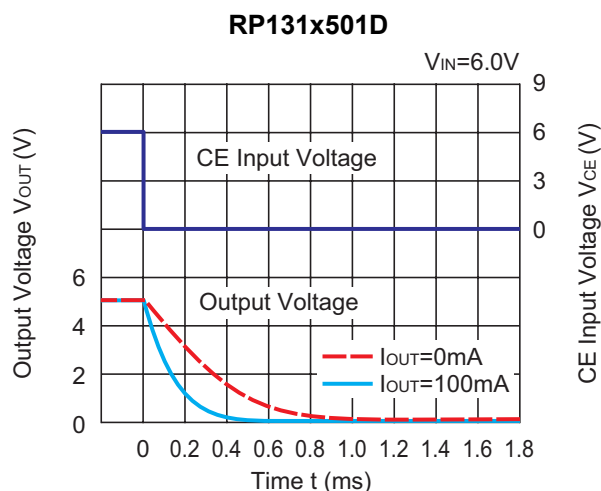
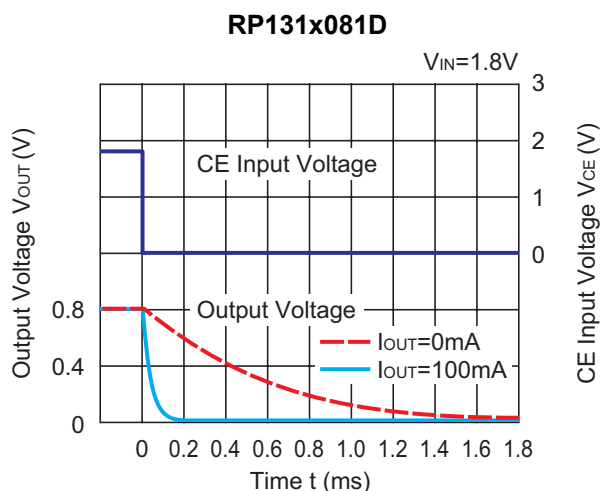




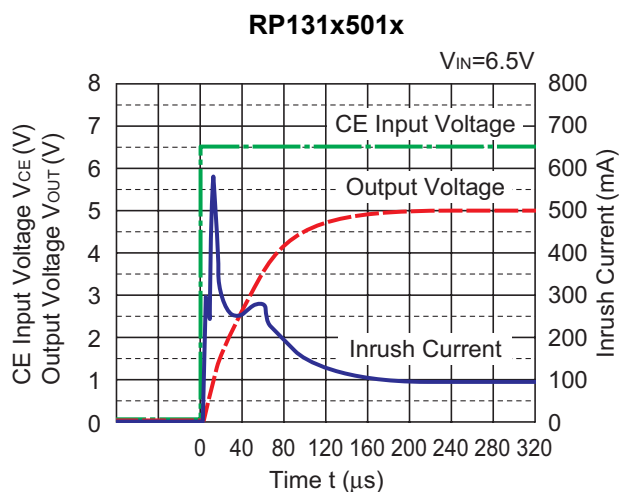
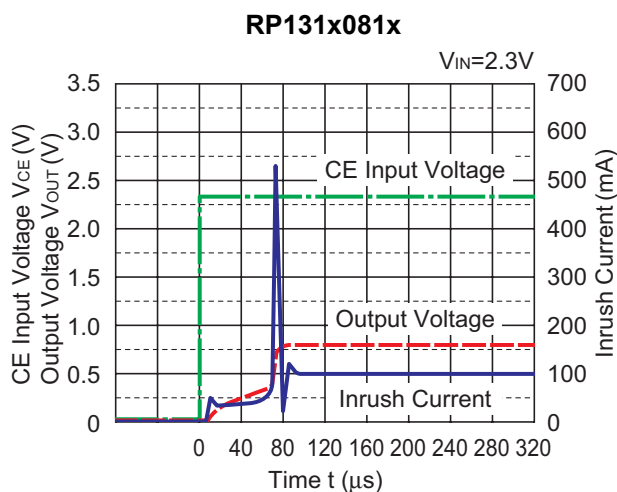
12) Turn On Speed with CE pin (C1=Ceramic 2.2 μ F, C2=Ceramic 4.7 μ F, T_{opt}=25 $^{\circ}$ C)



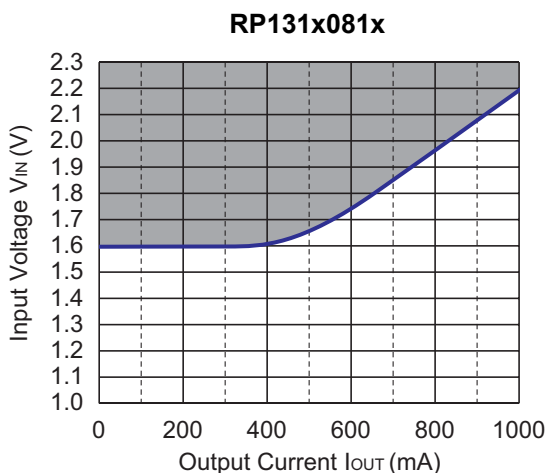
13) Turn Off Speed with CE pin (D Version) (C1=Ceramic 2.2μF, C2=Ceramic 4.7μF, Topt=25°C)



14) Inrush Current at turning on (C1=Ceramic 2.2μF, C2=Ceramic 4.7μF, Topt=25°C)



15) Minimum Operating Voltage



Hatched area is available for 0.8V output.

ESR vs. Output Current

When using these ICs, consider the following points:

The relations between I_{OUT} (Output Current) and ESR of an output capacitor are shown below.

The conditions when the white noise level is under $40\mu\text{V}$ (Avg.) are marked as the hatched area in the graph.

Measurement conditions

Frequency Band : 10Hz to 3MHz

Temperature : -40°C to 85°C

C1 : $2.2\mu\text{F}$ (Kyocera, CM05X5R225M04AD)

C2 : $2.2\mu\text{F}$ (Kyocera, CM105X5R225K06AE)

$4.7\mu\text{F}$ (Kyocera, CM105X5R475M06AB)

