RICOH

R1114N Series

Low Noise 150 mA LDO Regulator for Automotive Applications

NO.EC-094-131219

OUTLINE

The R1114x Series are CMOS-based voltage regulator ICs with high output voltage accuracy, low supply current, low ON-resistance, and high ripple rejection. Each of these ICs consists of a voltage reference unit, an error amplifier, resistor-net for voltage setting, a current limit circuit, and a chip enable circuit.

These ICs perform with low dropout voltage and a chip enable function. The line transient response and load transient response of the R1114x Series are excellent, thus these ICs are very suitable for the power supply for hand-held communication equipment.

The output voltage of these ICs is fixed with high accuracy. Since the package for these ICs is SOT-23-5, the high density mounting of the ICs on boards is possible.

FEATURES

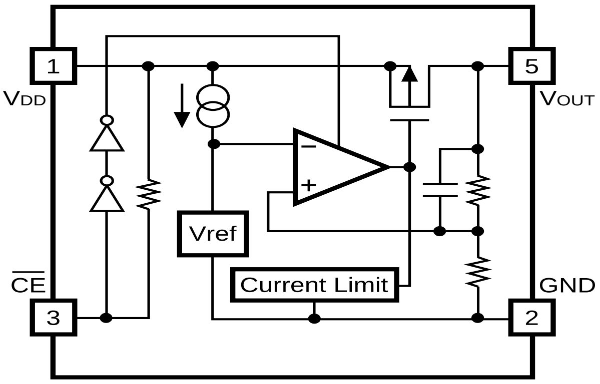
- Input Voltage Range (Maximum Rating) .... 2.0V to 6V (6.5V)
- Supply Current .... Typ. 75μA
- Standby Mode .... Typ. 0.1μA
- Dropout Voltage .... Typ. 0.22V (I_{OUT}=150mA 3.0V Output type)
- Ripple Rejection.. Typ. 70dB (f=1kHz 3.0V Output type)
  Typ. 60dB (f=10kHz)
- Output Voltage Range.. 1.5V to 4.0V (0.1V steps)
  (For other voltages, please refer to *MARK SPECIFICATION TABLE*)
- Output Voltage Accuracy.. ±2.0%
- Temperature-Drift Coefficient of Output Voltage .... Typ. ±100ppm/°C
- Line Regulation .... Typ. 0.02%/V
- Output Noise .... TYP. 30μVrms (BW=10Hz~100kHz)
- Packages SOT-23-5
- Built-in Fold Back Protection Circuit .... Typ. 40mA (Current at short mode)
- Ceramic capacitors are recommended to be used with this IC ... C_{IN}=C_{OUT}=1μF (V_{OUT}<2.5V)
  C_{IN}=1μF, C_{OUT}=0.47μF (V_{OUT} ≧ 2.5V)

APPLICATIONS

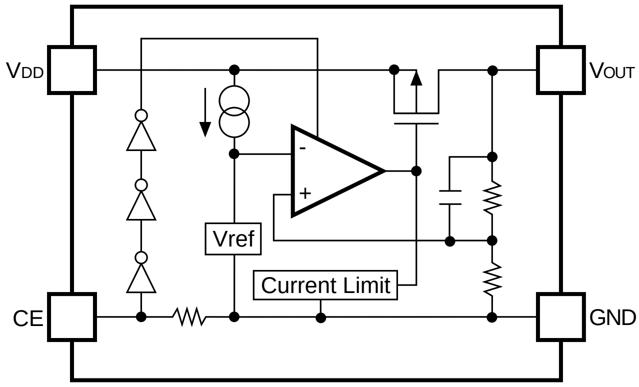
- Power source for accessories such as car audios, car navigation systems, and ETC systems

BLOCK DIAGRAMS

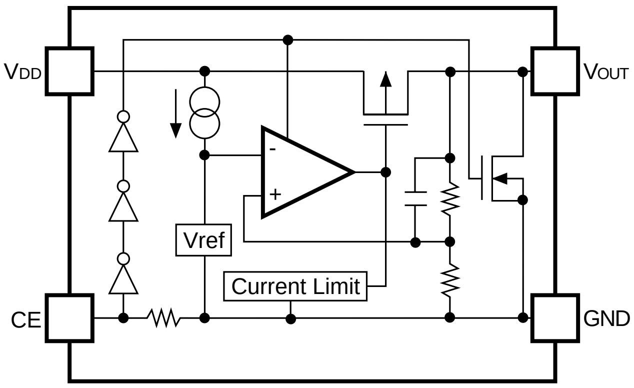
R1114xxx1A



R1114xxx1B



R1114xxx1D



SELECTION GUIDE

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

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1114Nxx1∗-TR-#E	SOT-23-5	3,000 pcs	Yes	Yes

xx: The output voltage can be designated in the range from 1.5V(15) to 4.0V(40) in 0.1V steps.
(For other voltages, please refer to *MARK SPECIFICATION TABLE*)

∗ : CE pin polarity and auto discharge function at off state are options as follows.
(A) "L" active, without auto discharge function at off state
(B) "H" active, without auto discharge function at off state
(D) "H" active, with auto discharge function at off state

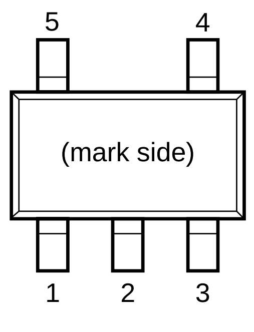
: Specify Automotive Class Code

	Operating Temperature Range	Guaranteed Specs Temperature Range	Screening
A	-40°C to 85°C	25°C	High Temperature

* Auto-discharge function quickly lowers the output voltage to 0V, when the chip enable signal is switched from the active mode to the standby mode, by releasing the electrical charge accumulated in the external capacitor.

PIN DESCRIPTIONS

● **SOT-23-5**



● **R1114N**

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

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	6.5	V
V_{CE}	Input Voltage ($\overline{CE}$ or CE Pin)	6.5	V
V_{OUT}	Output Voltage	-0.3~$V_{IN}+0.3$	V
I_{OUT}	Output Current	200	mA
P_D	Power Dissipation (SOT-23-5) *	420	mW
Tj	Junction Temperature	–40~125	°C
Tstg	Storage Temperature Range	–55~125	°C

*) Refer to *PACKAGE INFORMATION* for detailed 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 RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	2.0 to 6	V
Ta	Operating Temperature Range	−40 to 85	°C

RECOMMENDED OPERATING RATINGS

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating ratings. The semiconductor devices cannot operate normally over the recommended operating ratings, even if when they are used over such ratings by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating ratings.

ELECTRICAL CHARACTERISTICS

- **R1114xxx1A**

(Ta=25°C)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN} = Set V_{OUT}+1V 1mA ≦ I_{OUT} ≦ 30mA	×0.980		×1.020	V
I_{OUT}	Output Current	V_{IN}–V_{OUT} = 1.0V	150			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	V_{IN} = Set V_{OUT}+1V 1mA ≦ I_{OUT} ≦ 150mA		22	40	mV
V_{DIF}	Dropout Voltage	I_{OUT} = 150mA	Refer to the *Product-specific Electrical Characteristics*			
I_{SS}	Supply Current	V_{IN} = Set V_{OUT}+1V, I_{OUT} = 0mA		75	95	µA
Istandby	Supply Current (Standby)	V_{IN} = Set V_{OUT}+1V V_{CE} = V_{DD}		0.1	1.0	µA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{OUT} > 1.7V, Set V_{OUT}+0.5V ≦ V_{IN} ≦ 6.0V (V_{OUT} ≦ 1.7V, 2.2V ≤ V_{IN} ≦ 6.0V) I_{OUT} = 30mA		0.02	0.10	%/V
I_{SC}	Short Current Limit	V_{OUT} = 0V		40		mA
R_{PU}	$\overline{CE}$ Pull-up Resistance		0.7	2.0	8.0	MΩ
V_{CEH}	$\overline{CE}$ Input Voltage "H"		1.5		6.0	V
V_{CEL}	$\overline{CE}$ Input Voltage "L"		0.0		0.3	V

- **R1114xxx1B/D**

(Ta=25°C)

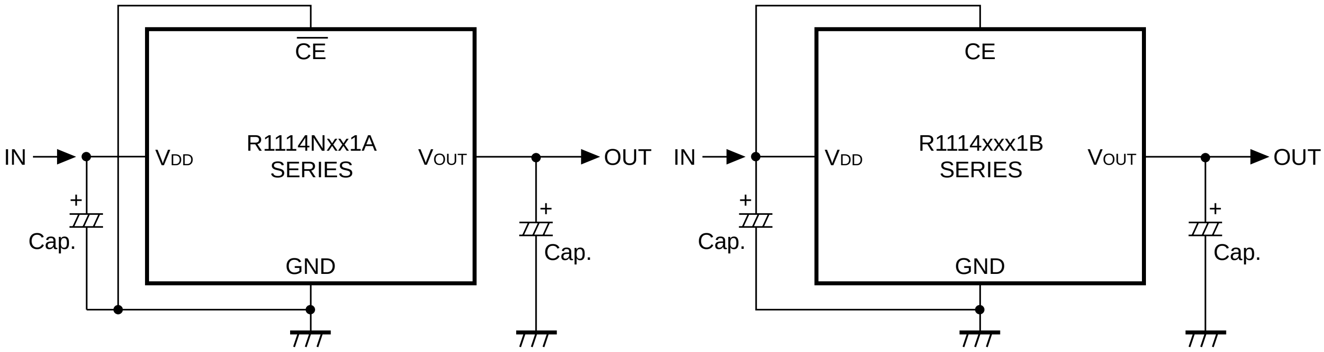
Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN} = Set V_{OUT}+1V 1mA ≦ I_{OUT} ≦ 30mA	×0.980		×1.020	V
I_{OUT}	Output Current	V_{IN}–V_{OUT} = 1.0V	150			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	V_{IN} = Set V_{OUT}+1V 1mA ≦ I_{OUT} ≦ 150mA		22	40	mV
V_{DIF}	Dropout Voltage	I_{OUT} = 150mA	Refer to the *Product-specific Electrical Characteristics*			
I_{SS}	Supply Current	V_{IN} = Set V_{OUT}+1V, I_{OUT} = 0mA		75	95	μA
Istandby	Supply Current (Standby)	V_{IN} = Set V_{OUT}+1V V_{CE} = GND		0.1	1.0	μA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	V_{OUT} > 1.7V, Set V_{OUT}+0.5V ≦ V_{IN} ≦ 6.0V (V_{OUT} ≦ 1.7V, 2.2V ≦ V_{IN} ≦ 6.0V) I_{OUT} = 30mA		0.02	0.10	%/V
I_{SC}	Short Current Limit	V_{OUT} = 0V		40		mA
R_{PD}	CE Pull-down Resistance		0.7	2.0	8.0	MΩ
V_{CEH}	CE Input Voltage “H”		1.5		6.0	V
V_{CEL}	CE Input Voltage “L”		0.0		0.3	V
R_{LOW}	On Resistance of Nch for auto-discharge (Only for D version)	V_{CE} = 0V		60		Ω

Product-specific Electrical Characteristics

(Ta=25°C)

Product Name	V_{OUT} [V]			V_{DIF} [V]	
	MIN.	TYP.	MAX.	TYP.	MAX.
R1114N151x	1.470	1.500	1.530	0.38	0.70
R1114N161x	1.568	1.600	1.632	0.36	0.65
R1114N171x	1.666	1.700	1.734	0.34	0.60
R1114N181x	1.764	1.800	1.836	0.32	0.55
R1114N181x5	1.813	1.850	1.887		
R1114N191x	1.862	1.900	1.938		
R1114N201x	1.960	2.000	2.040		
R1114N211x	2.058	2.100	2.142	0.28	0.50
R1114N221x	2.156	2.200	2.244		
R1114N231x	2.254	2.300	2.346		
R1114N241x	2.352	2.400	2.448		
R1114N251x	2.450	2.500	2.550		
R1114N261x	2.548	2.600	2.652		
R1114N271x	2.646	2.700	2.754		
R1114N281x	2.744	2.800	2.856	0.22	0.35
R1114N281x5	2.793	2.850	2.907		
R1114N291x	2.842	2.900	2.958		
R1114N301x	2.940	3.000	3.060		
R1114N311x	3.038	3.100	3.162		
R1114N321x	3.136	3.200	3.264		
R1114N331x	3.234	3.300	3.366		
R1114N341x	3.332	3.400	3.468		
R1114N351x	3.430	3.500	3.570		
R1114N361x	3.528	3.600	3.672		
R1114N371x	3.626	3.700	3.774		
R1114N381x	3.724	3.800	3.876		
R1114N391x	3.822	3.900	3.978		
R1114N401x	3.920	4.000	4.080		

TYPICAL APPLICATIONS



(External Components)
Output Capacitor; Ceramic 0.47µF (Set Output Voltage in the range from 2.5 to 4.0V)
Ceramic 1.0µF (Set Output Voltage in the range from 1.5 to 2.4V)
Input Capacitor; Ceramic 1.0µF

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 C_{OUT} with good frequency characteristics and ESR (Equivalent Series Resistance).

Recommended C2 Values

Output Voltage	RecommendedC2 values
$V_{OUT} \leq 2.4V$	1.0µF or more
$2.5V \leq V_{OUT}$	0.47µF or more

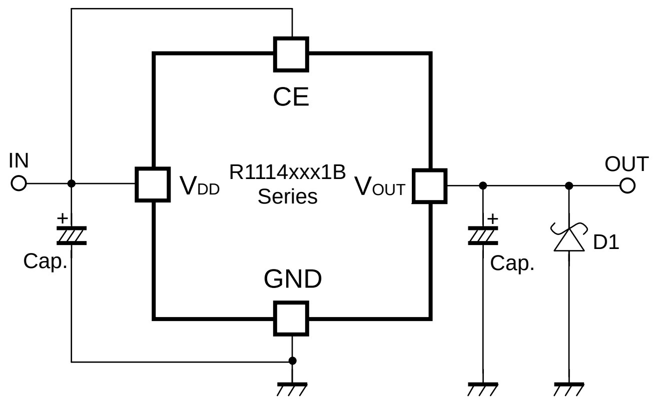
When using a tantalum type capacitor and the ESR value of the capacitor is large, the output might be unstable. Evaluate a circuit including consideration of frequency characteristics.

PCB Layout

Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor with a capacitance value as much as 1.0µF or more between V_{DD} and GND pin, and as close as possible to the pins.

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

TYPICAL APPLICATION FOR IC CHIP BREAKDOWN PREVENTION



(External Components)

Output Capacitor; Ceramic 0.47μF (Set Output Voltage in the range from 2.5 to 4.0V)
Ceramic 1.0μF (Set Output Voltage in the range from 1.5 to 2.4V)

Input Capacitor; Ceramic 1.0μF

When a sudden surge of electrical current travels along the V_{OUT} pin and GND due to a short-circuit, electrical resonance of a circuit involving an output capacitor and a short circuit inductor generates a negative voltage and may damage the device or the load devices. Connecting a schottky diode (D1) between the V_{OUT} pin and GND has the effect of preventing damage to them.

PACKAGE INFORMATION

POWER DISSIPATION (SOT-23-5)

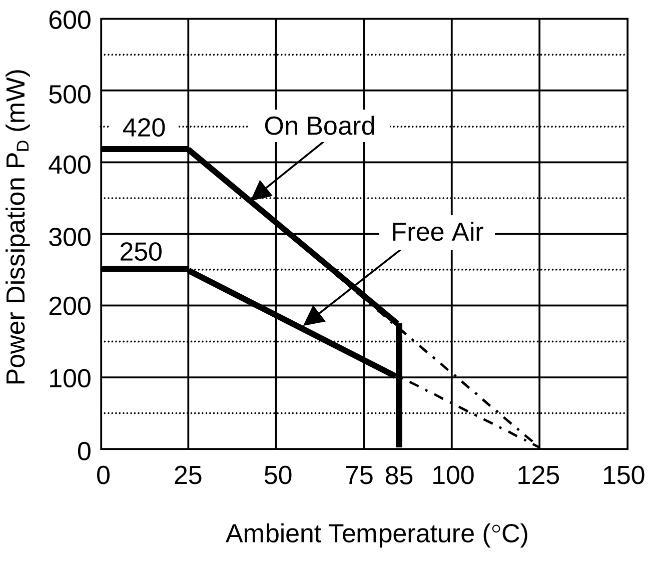
Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:
(Power Dissipation (SOT-23-5) is substitution of SOT-23-6.)

* Measurement Conditions

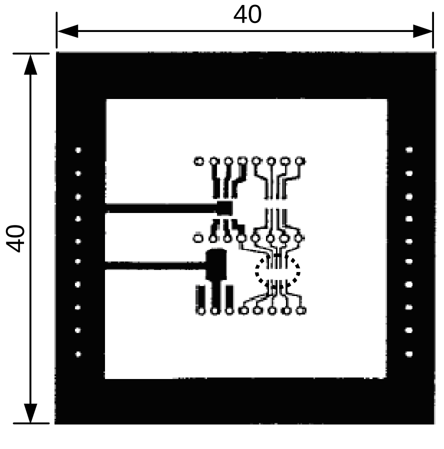
	Standard Test Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plastic (Double sided)
Board Dimensions	40mm x 40mm x 1.6mm
Copper Ratio	Top side: Approx. 50%, Back side: Approx. 50%
Through-holes	ϕ 0.5mm x 44pcs

* Measurement Result: (Ta=25°C, Tjmax=125°C)

	Standard Land Pattern	Free Air
Power Dissipation	420mW	250mW
Thermal Resistance	θja = (125-25°C)/0.42W= 238°C/W	400°C/W



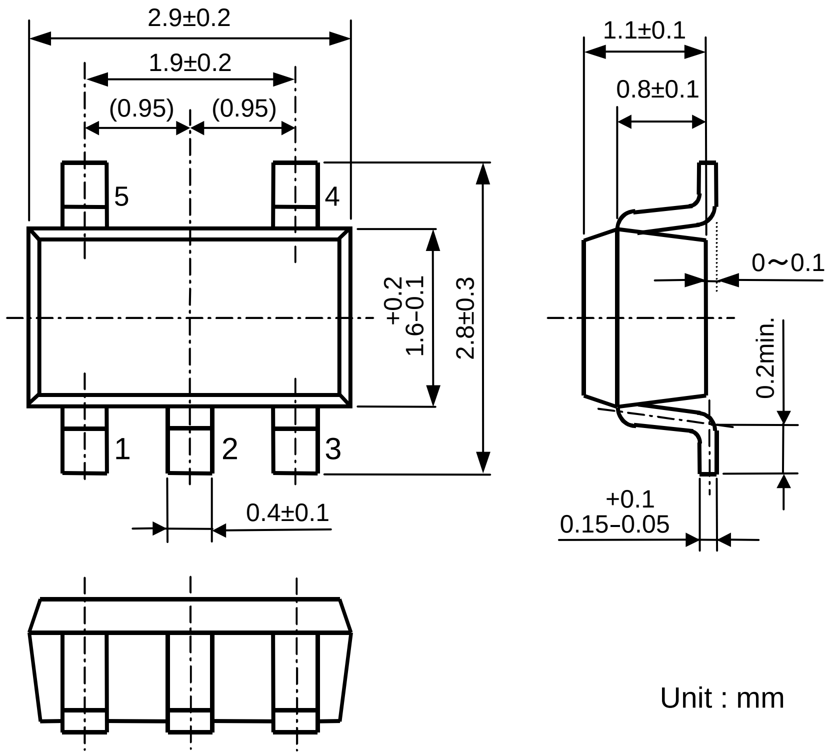
Power Dissipation



Measurement Board Pattern

IC Mount Area (Unit: mm)

PACKAGE DIMENSIONS (SOT-23-5)

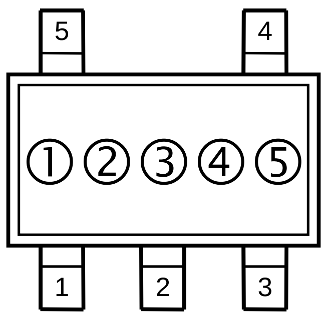


SOT-23-5 Package Dimensions

MARK SPECIFICATION (SOT-23-5)

①②③: Product Code … **Refer to *MARK SPECIFICATION TABLE (SOT-23-5)***

④⑤: Lot Number … Alphanumeric Serial Number



SOT-23-5 Mark Specification

MARK SPECIFICATION TABLE (SOT-23-5)

R1114Nxx1A

Product Name	①	②	③	V_{SET}
R1114N151A	4	1	5	1.5 V
R1114N161A	4	1	6	1.6 V
R1114N171A	4	1	7	1.7 V
R1114N181A	4	1	8	1.8 V
R1114N191A	4	1	9	1.9 V
R1114N201A	4	2	0	2.0 V
R1114N211A	4	2	1	2.1 V
R1114N221A	4	2	2	2.2 V
R1114N231A	4	2	3	2.3 V
R1114N241A	4	2	4	2.4 V
R1114N251A	4	2	5	2.5 V
R1114N261A	4	2	6	2.6 V
R1114N271A	4	2	7	2.7 V
R1114N281A	4	2	8	2.8 V
R1114N291A	4	2	9	2.9 V
R1114N301A	4	3	0	3.0 V
R1114N311A	4	3	1	3.1 V
R1114N321A	4	3	2	3.2 V
R1114N331A	4	3	3	3.3 V
R1114N341A	4	3	4	3.4 V
R1114N351A	4	3	5	3.5 V
R1114N361A	4	3	6	3.6 V
R1114N371A	4	3	7	3.7 V
R1114N381A	4	3	8	3.8 V
R1114N391A	4	3	9	3.9 V
R1114N401A	4	4	0	4.0 V
R1114N281A5	4	4	1	2.85 V
R1114N181A5	4	4	2	1.85 V

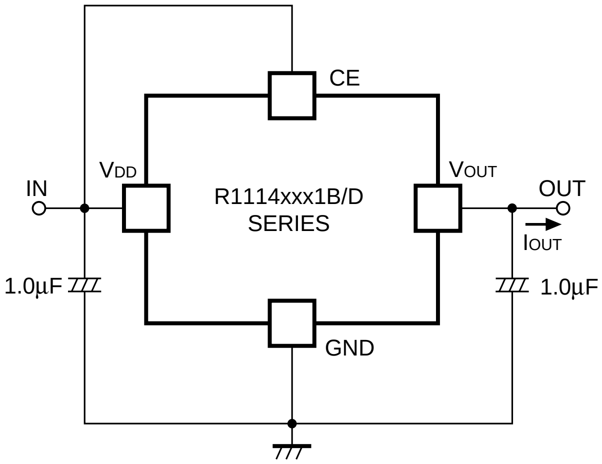
R1114Nxx1B

Product Name	①	②	③	V_{SET}
R1114N151B	5	1	5	1.5 V
R1114N161B	5	1	6	1.6 V
R1114N171B	5	1	7	1.7 V
R1114N181B	5	1	8	1.8 V
R1114N191B	5	1	9	1.9 V
R1114N201B	5	2	0	2.0 V
R1114N211B	5	2	1	2.1 V
R1114N221B	5	2	2	2.2 V
R1114N231B	5	2	3	2.3 V
R1114N241B	5	2	4	2.4 V
R1114N251B	5	2	5	2.5 V
R1114N261B	5	2	6	2.6 V
R1114N271B	5	2	7	2.7 V
R1114N281B	5	2	8	2.8 V
R1114N291B	5	2	9	2.9 V
R1114N301B	5	3	0	3.0 V
R1114N311B	5	3	1	3.1 V
R1114N321B	5	3	2	3.2 V
R1114N331B	5	3	3	3.3 V
R1114N341B	5	3	4	3.4 V
R1114N351B	5	3	5	3.5 V
R1114N361B	5	3	6	3.6 V
R1114N371B	5	3	7	3.7 V
R1114N381B	5	3	8	3.8 V
R1114N391B	5	3	9	3.9 V
R1114N401B	5	4	0	4.0 V
R1114N281B5	5	4	1	2.85 V
R1114N181B5	5	4	2	1.85 V

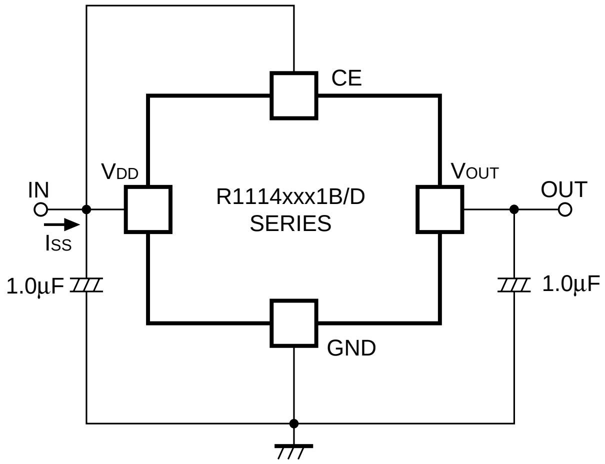
R1114Nxx1D

Product Name	①	②	③	V_{SET}
R1114N151D	6	1	5	1.5 V
R1114N161D	6	1	6	1.6 V
R1114N171D	6	1	7	1.7 V
R1114N181D	6	1	8	1.8 V
R1114N191D	6	1	9	1.9 V
R1114N201D	6	2	0	2.0 V
R1114N211D	6	2	1	2.1 V
R1114N221D	6	2	2	2.2 V
R1114N231D	6	2	3	2.3 V
R1114N241D	6	2	4	2.4 V
R1114N251D	6	2	5	2.5 V
R1114N261D	6	2	6	2.6 V
R1114N271D	6	2	7	2.7 V
R1114N281D	6	2	8	2.8 V
R1114N291D	6	2	9	2.9 V
R1114N301D	6	3	0	3.0 V
R1114N311D	6	3	1	3.1 V
R1114N321D	6	3	2	3.2 V
R1114N331D	6	3	3	3.3 V
R1114N341D	6	3	4	3.4 V
R1114N351D	6	3	5	3.5 V
R1114N361D	6	3	6	3.6 V
R1114N371D	6	3	7	3.7 V
R1114N381D	6	3	8	3.8 V
R1114N391D	6	3	9	3.9 V
R1114N401D	6	4	0	4.0 V
R1114N281D5	6	4	1	2.85 V
R1114N181D5	6	4	2	1.85 V

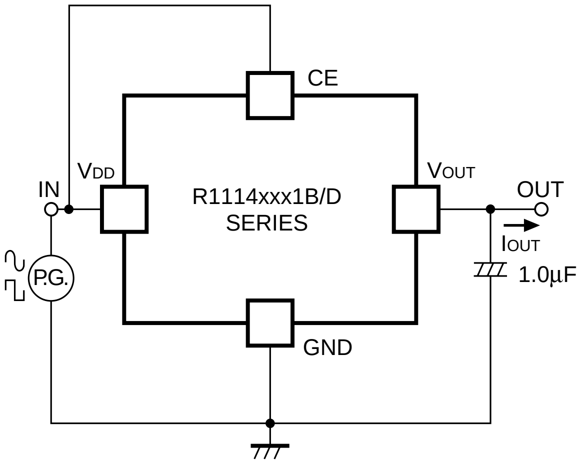
TEST CIRCUITS



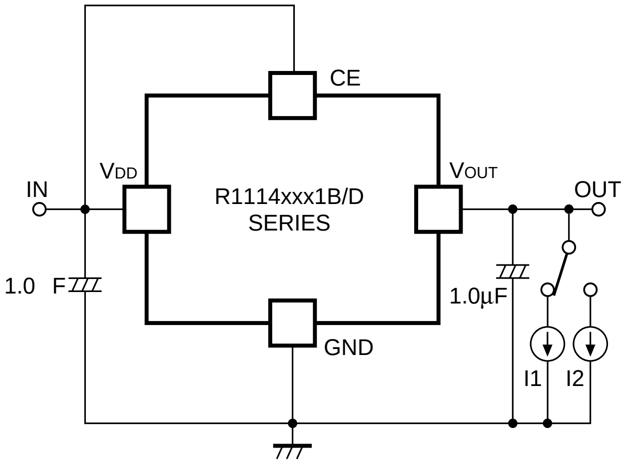
Standard test Circuit



Supply Current Test Circuit



Ripple Rejection, Line Transient Response Test Circuit

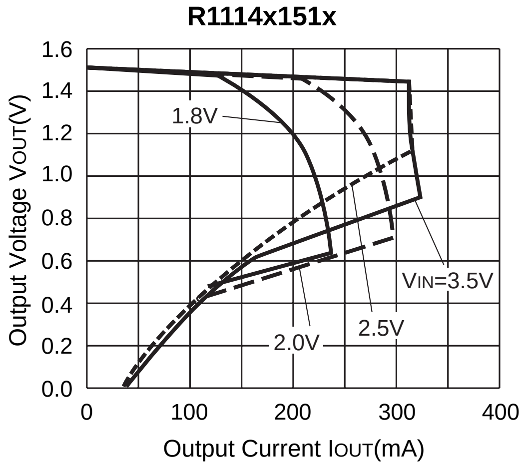


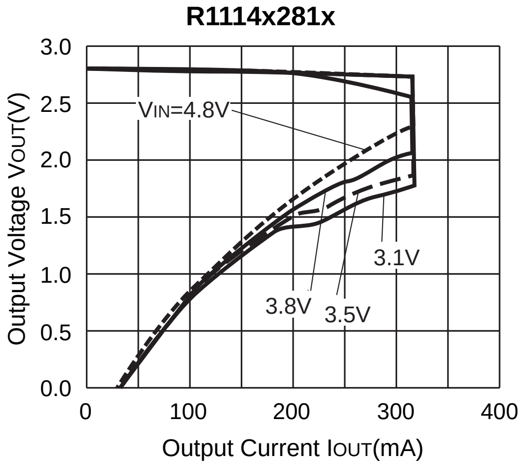
Load Transient Response Test Circuit

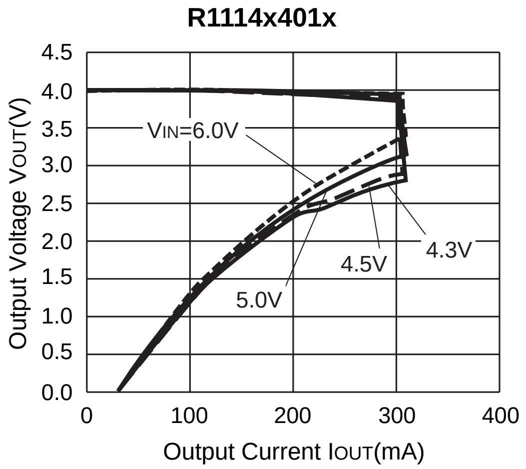
TYPICAL CHARACTERISTICS

Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

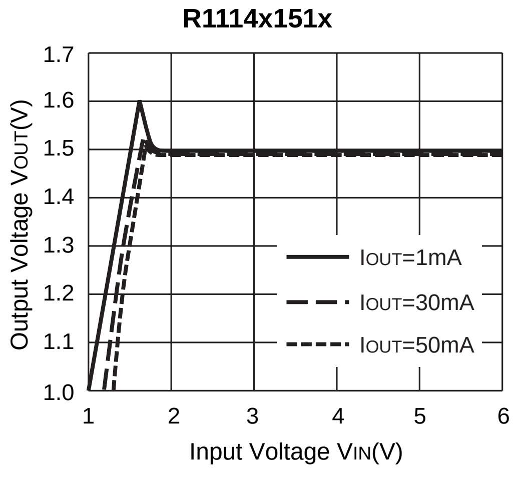
1) Output Voltage vs. Output Current (Ta=25°C)

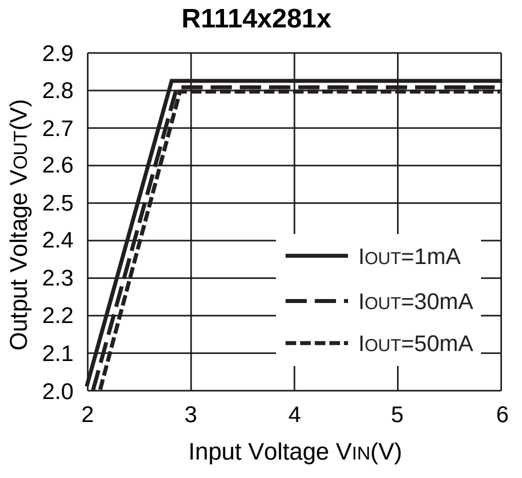






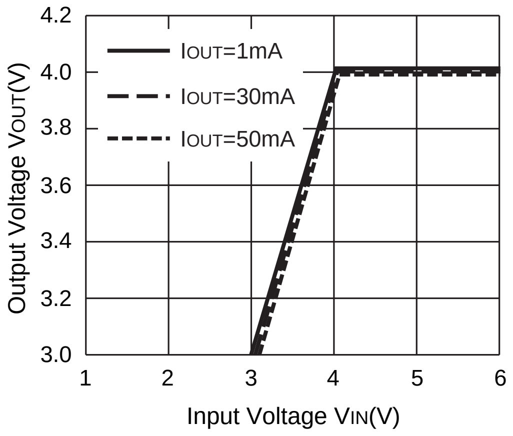
2) Output Voltage vs. Input Voltage (Ta=25°C)





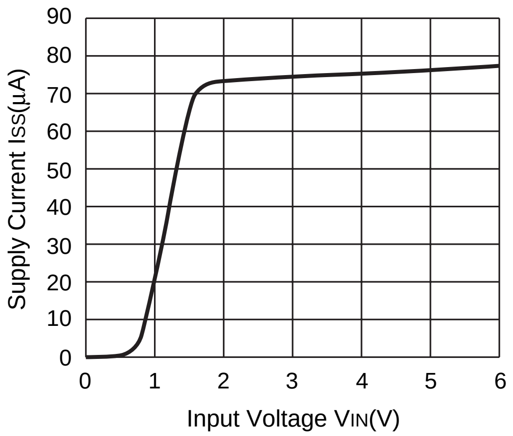
RICOH

R1114x401x

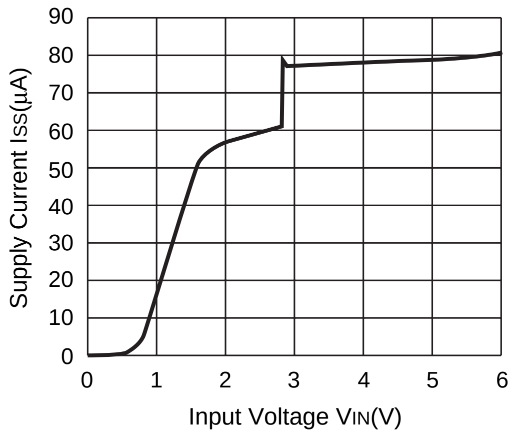


3) Supply Current vs. Input Voltage (Ta=25°C)

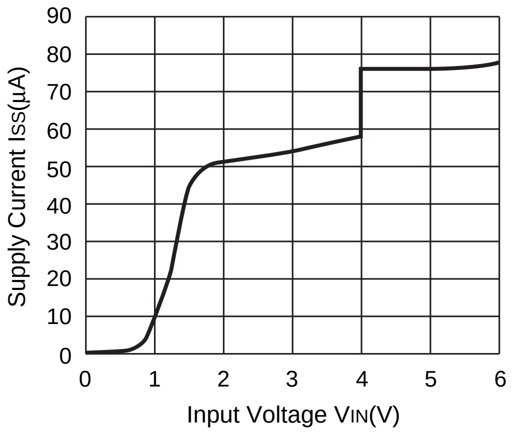
R1114x151x



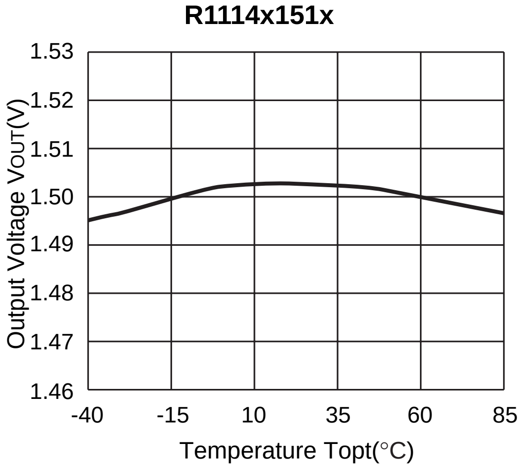
R1114x281x

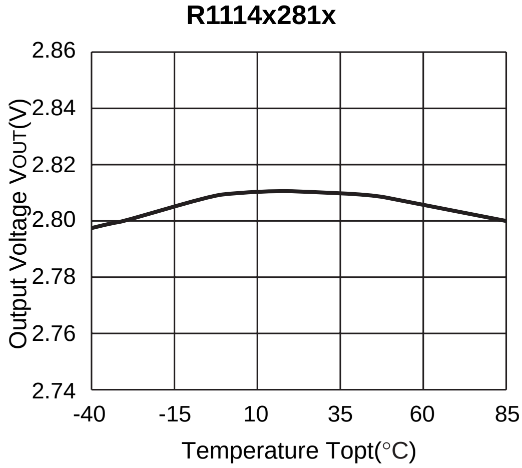


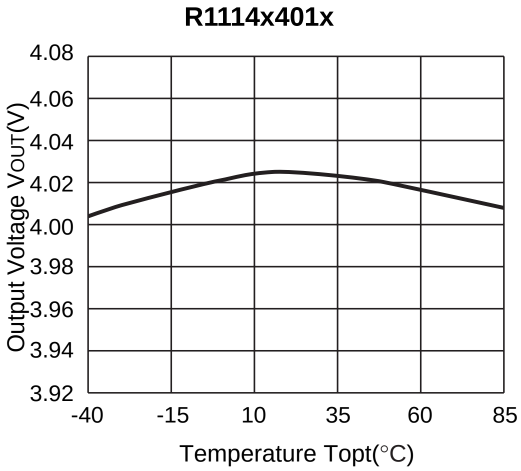
R1114x401x



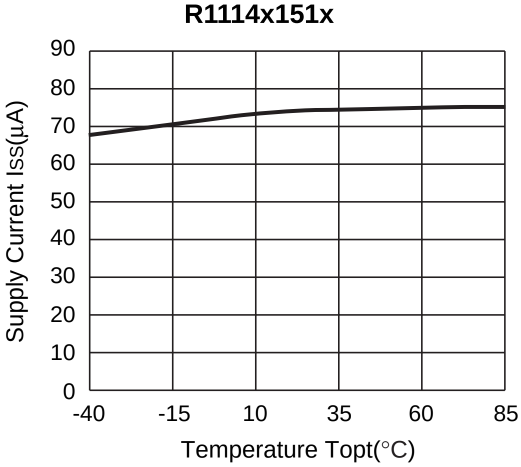
4) Output Voltage vs. Temperature

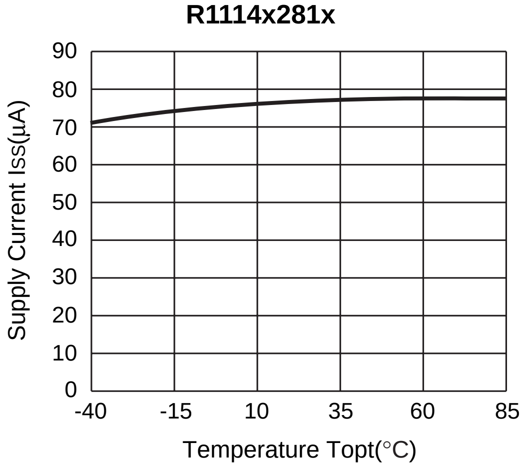




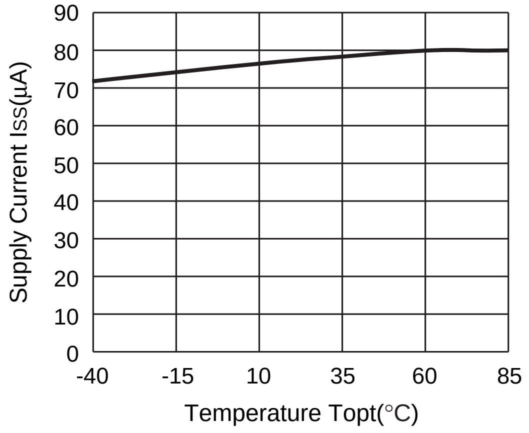


5) Supply Current vs. Temperature



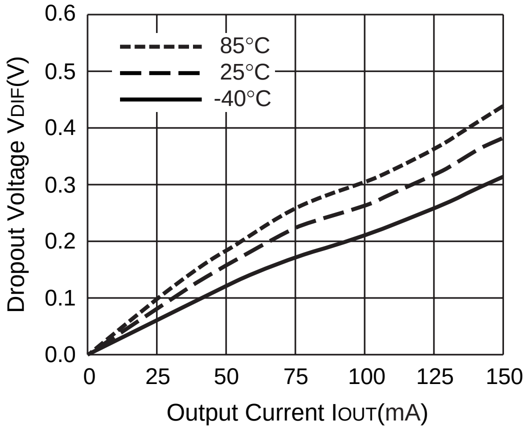


R1114x401x

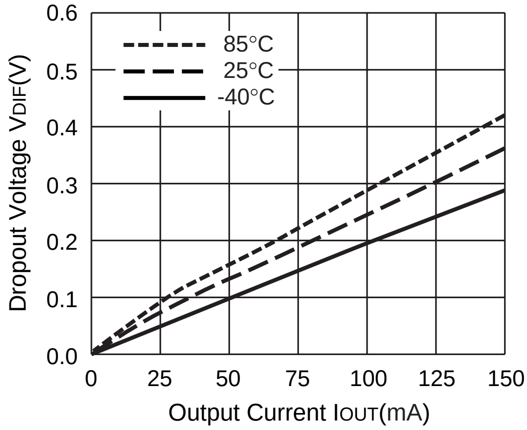


6) Dropout Voltage vs. Temperature

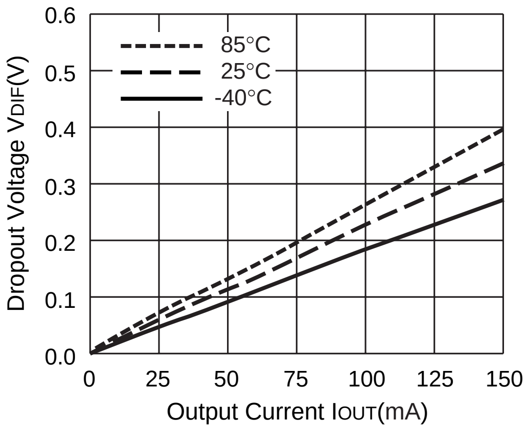
R1114x151x

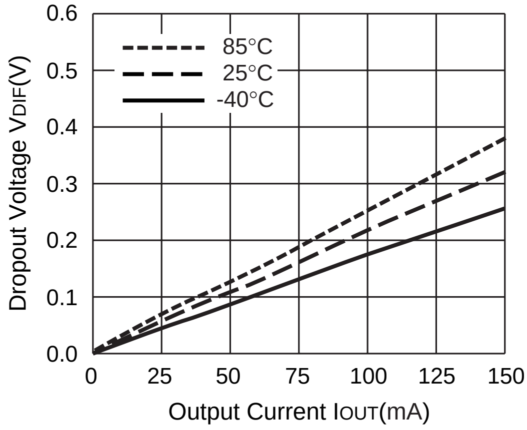


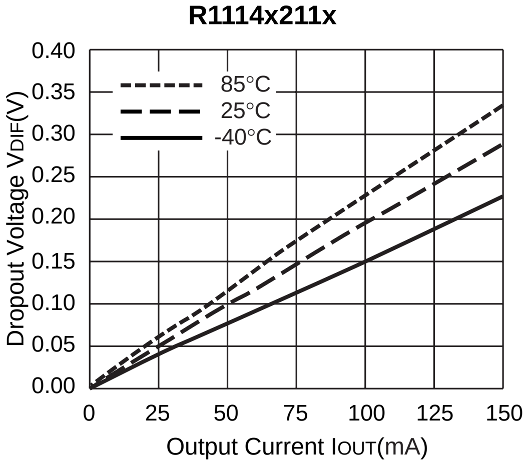
R1114x161x

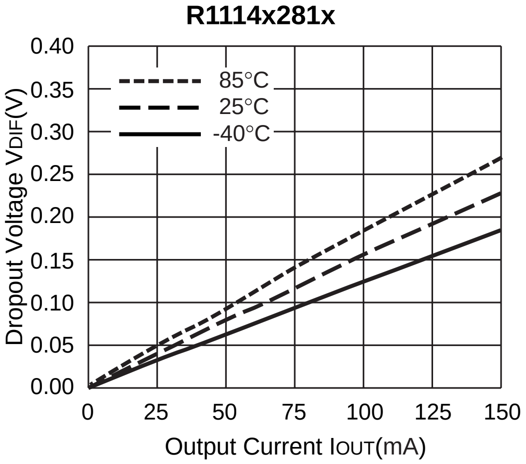


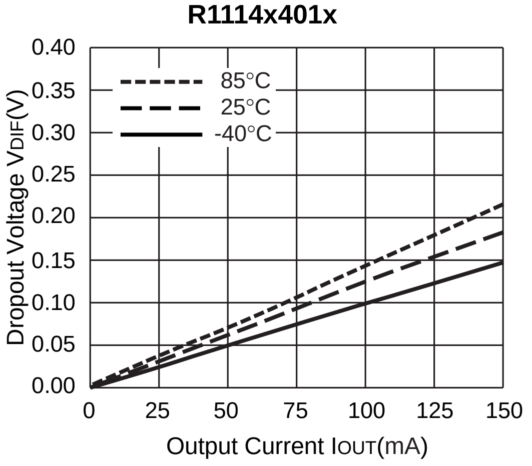
R1114x171x R1114x181x



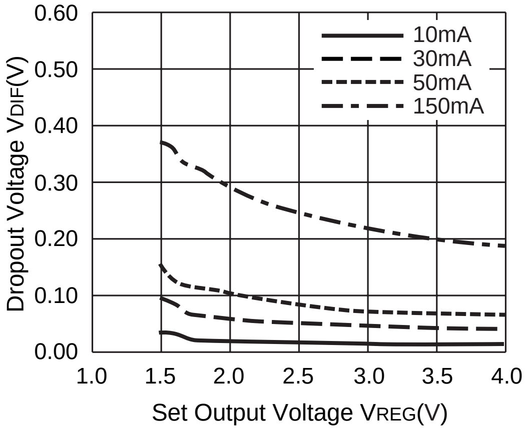








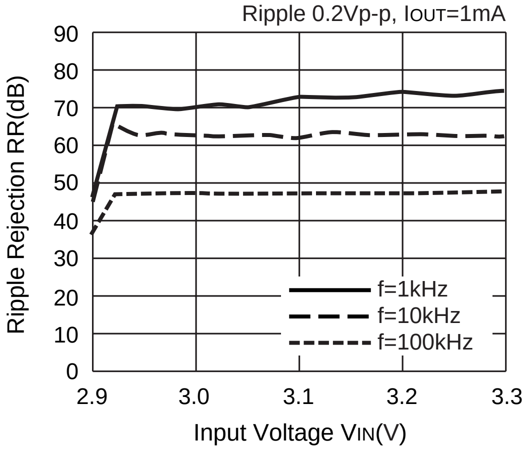
7) Dropout Voltage vs. Set Output Voltage (Ta=25°C)



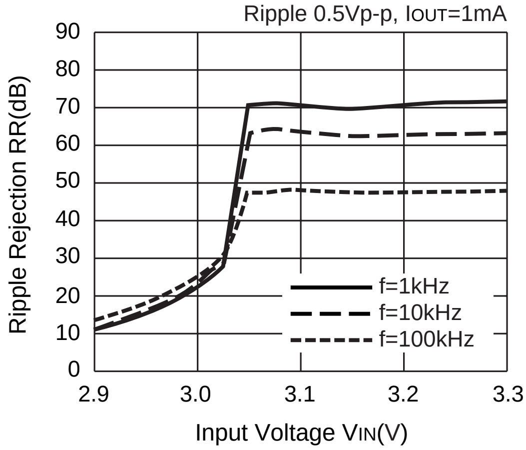
RICOH

8) Ripple Rejection vs. Input Bias Voltage (Ta=25°C, C_{IN}=none, C_{OUT}=ceramic0.47μF)

R1114x281x



R1114x281x



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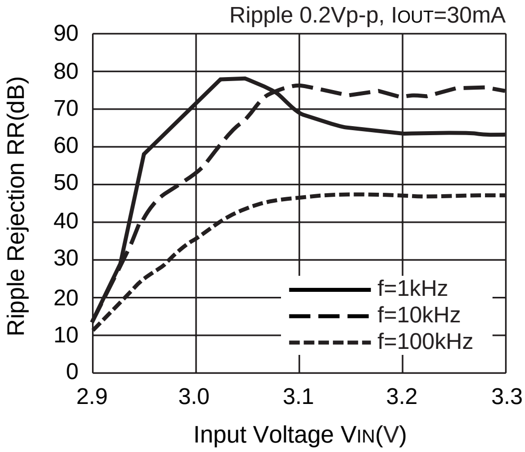

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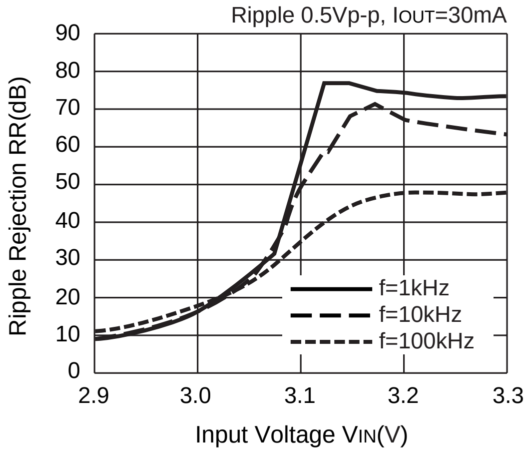
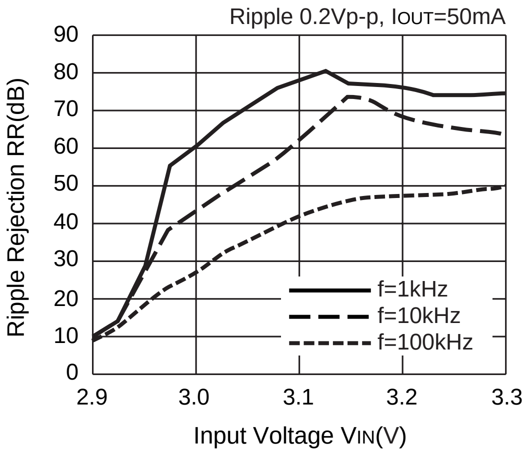
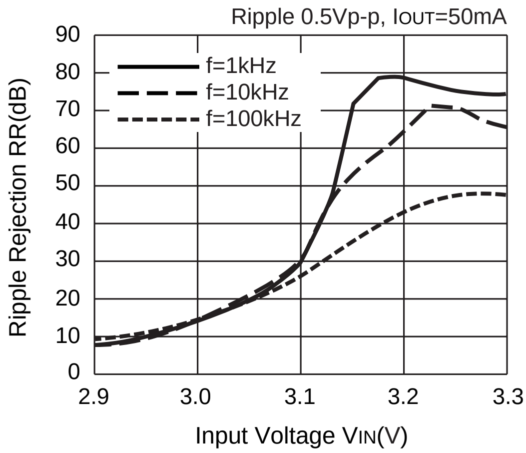


R1114x281x R1114x281x

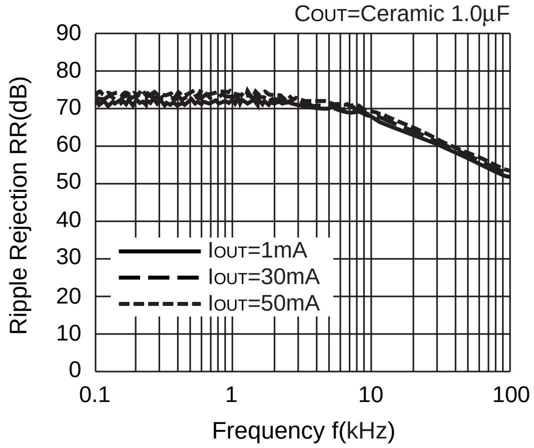




9) Ripple Rejection vs. Frequency (C_{IN}=none)

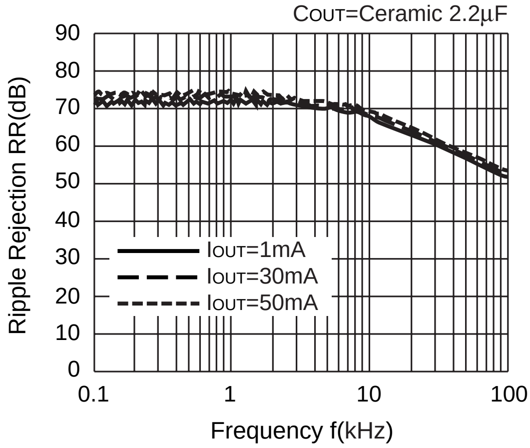
R1114x151x

V_{IN}=2.5V_{DC}+0.5Vp-p,
C_{OUT}=Ceramic 1.0µF



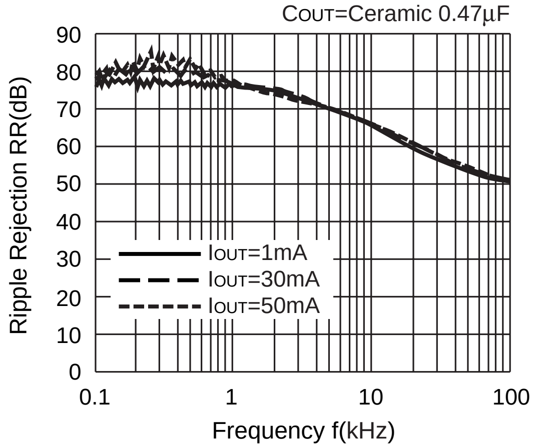
R1114x151x

V_{IN}=2.5V_{DC}+0.5Vp-p,
C_{OUT}=Ceramic 2.2µF



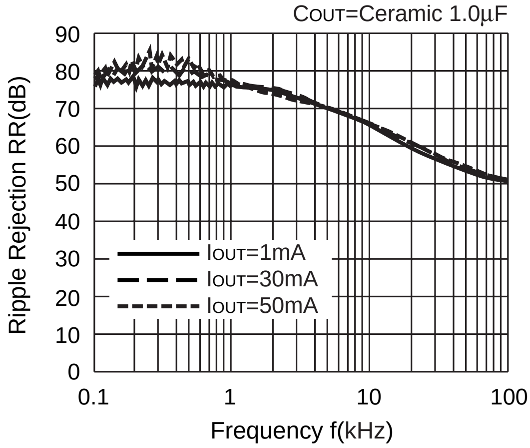
R1114x281x

V_{IN}=3.8V_{DC}+0.5Vp-p,
C_{OUT}=Ceramic 0.47µF



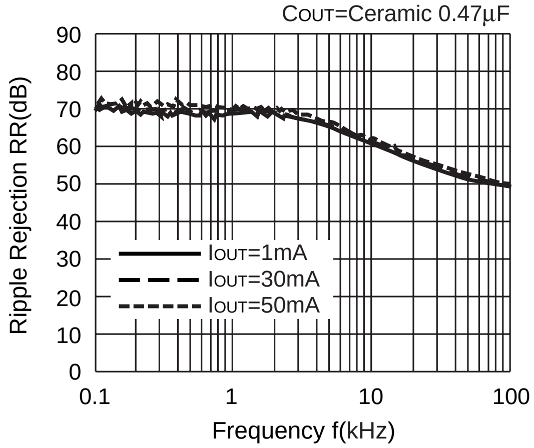
R1114x281x

V_{IN}=3.8V_{DC}+0.5Vp-p,
C_{OUT}=Ceramic 1.0µF

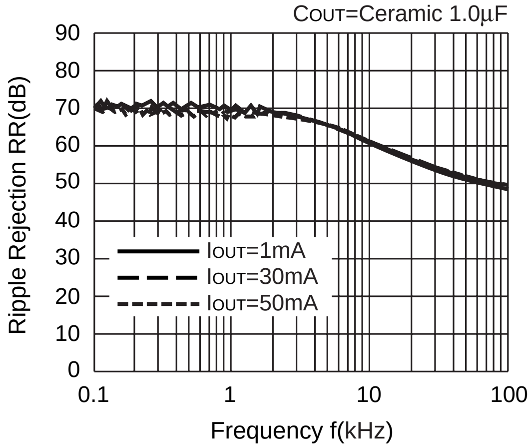


R1114x401x R1114x401x

V_{IN}=5.0V_{DC}+0.5Vp-p,
C_{OUT}=Ceramic 0.47µF

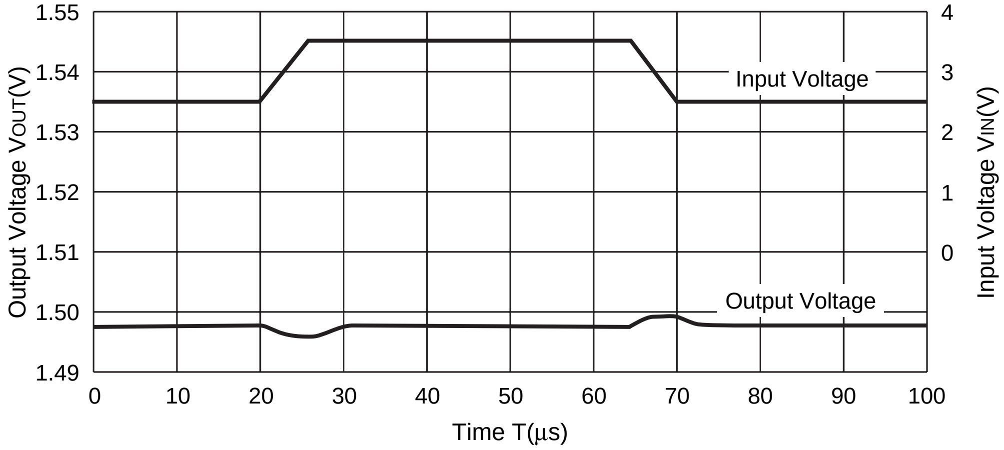


V_{IN}=5.0V_{DC}+0.5Vp-p,
C_{OUT}=Ceramic 1.0µF

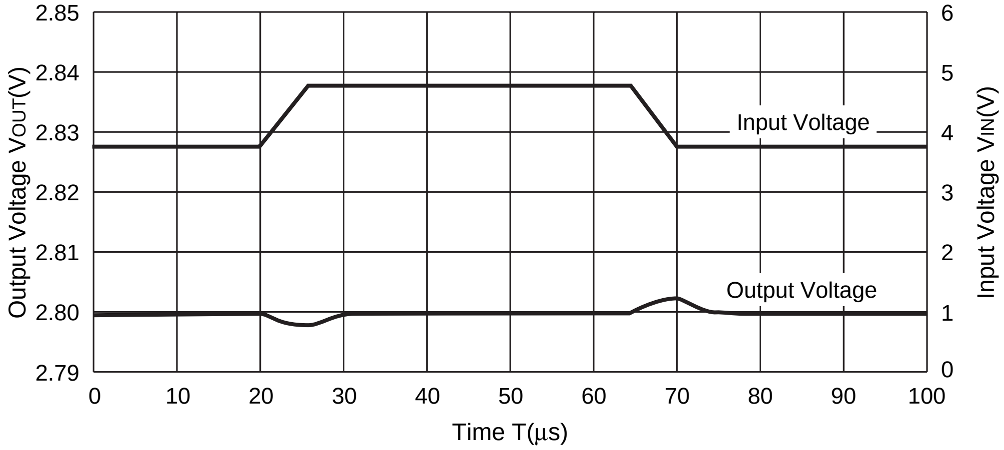


10) Input Transient Response (I_{OUT}=30mA, C_{IN}=none, tr=tf=5µs, C_{OUT}=Ceramic 0.47µF)

R1114x151x

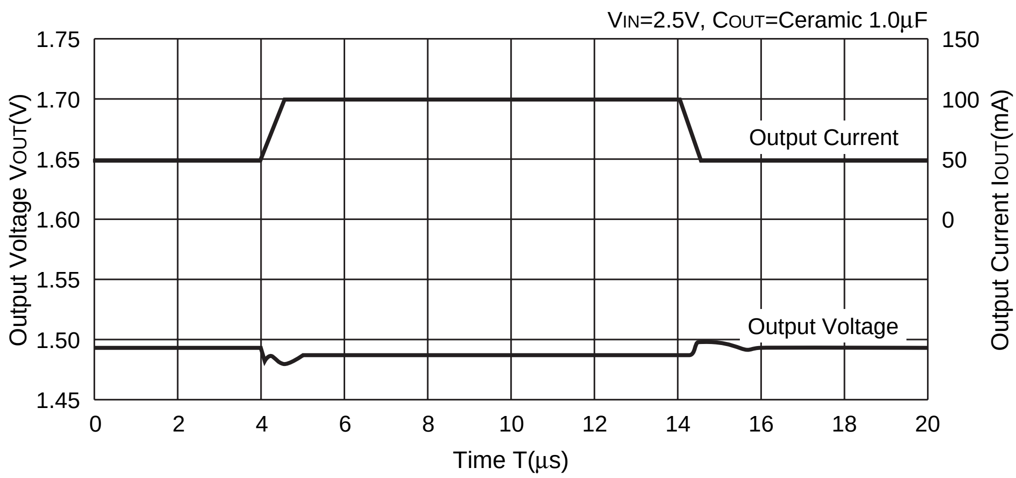


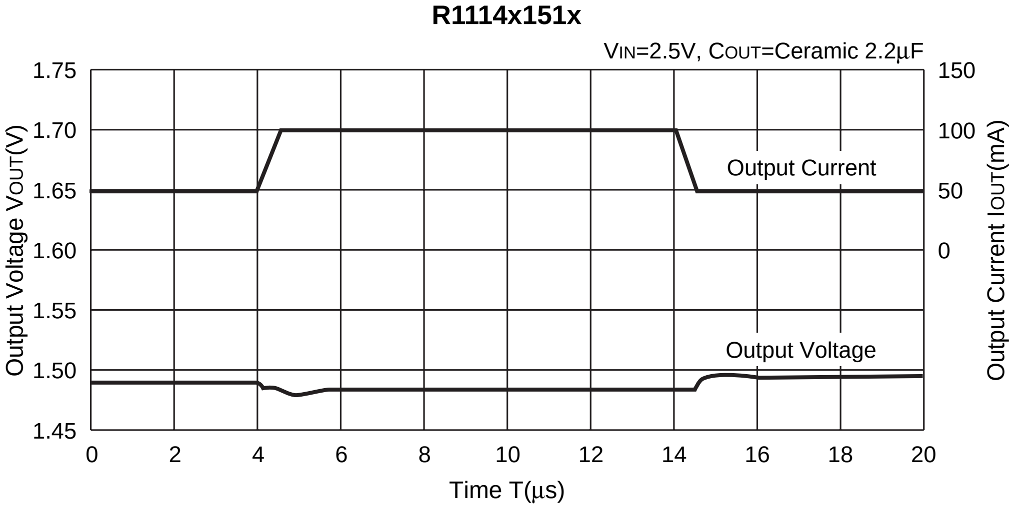
R1114x281x

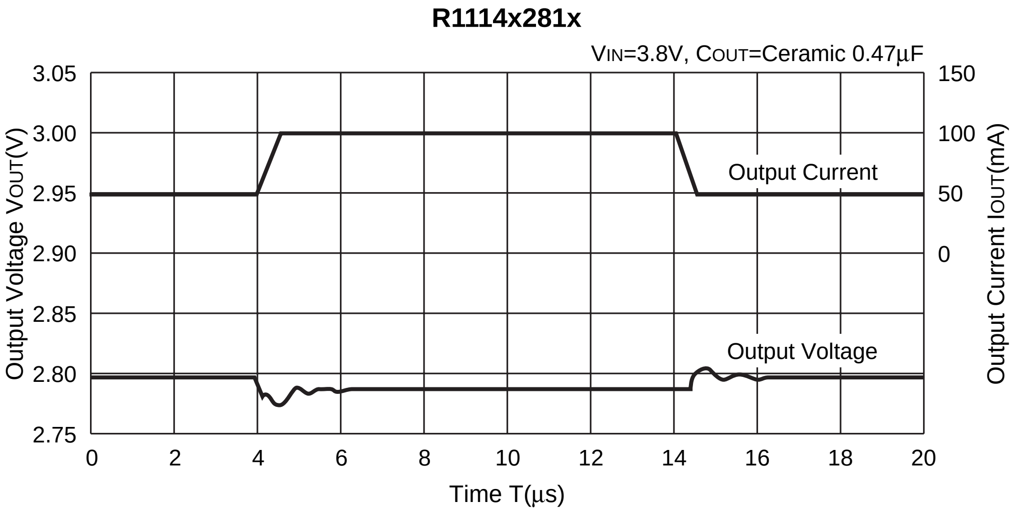


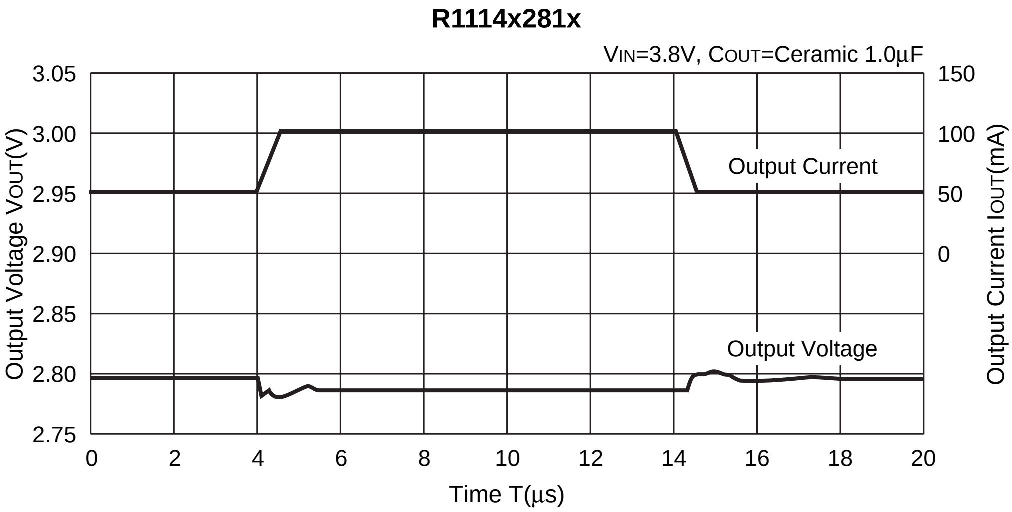
11) Load Transient Response (tr=tf=0.5µs, C_{IN}=Ceramic 1.0µF)

R1114x151x

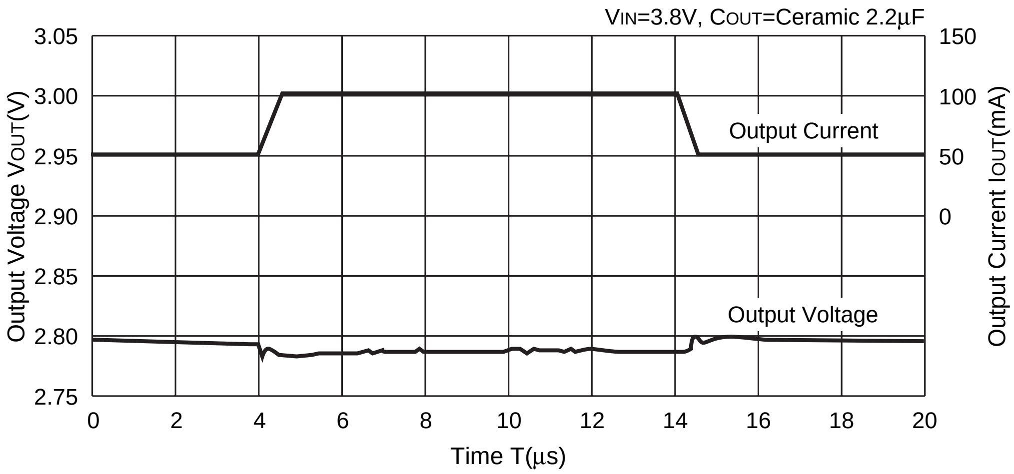



R1114x151x
VIN=2.5V, COUT=Ceramic 2.2µF
Output Voltage VOUT(V)
1.75
1.70
1.65
1.60
1.55
1.50
1.45
Output Current IOUT(mA)
150
100
50
0
Output Current
Output Voltage
0
2
4
6
8
10
12
14
16
18
20
Time T(µs)


R1114x281x
VIN=3.8V, COUT=Ceramic 0.47µF
Output Voltage VOUT(V)
3.05
3.00
2.95
2.90
2.85
2.80
2.75
Output Current IOUT(mA)
150
100
50
0
Output Current
Output Voltage
0
2
4
6
8
10
12
14
16
18
20
Time T(µs)

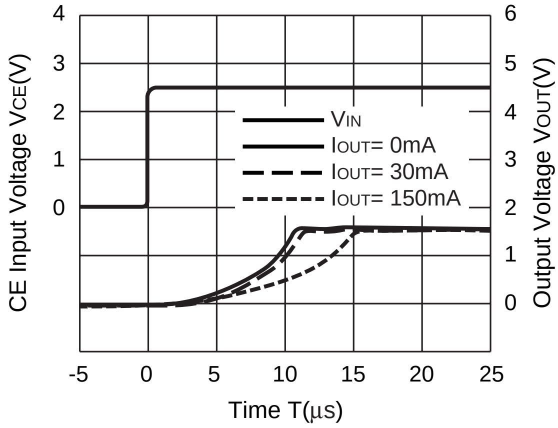

R1114x281x
VIN=3.8V, COUT=Ceramic 1.0µF
Output Voltage VOUT(V)
3.05
3.00
2.95
2.90
2.85
2.80
2.75
Output Current IOUT(mA)
150
100
50
0
Output Current
Output Voltage
0
2
4
6
8
10
12
14
16
18
20
Time T(µs)

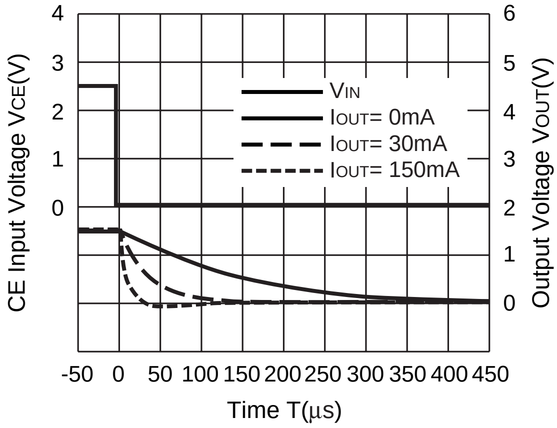
R1114x281x



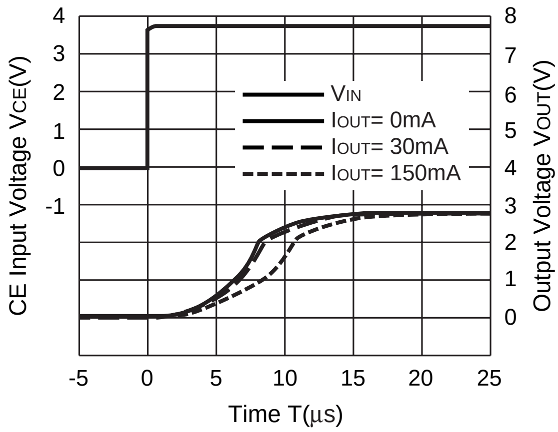
12) Turn-on/off speed with CE pin (D version)

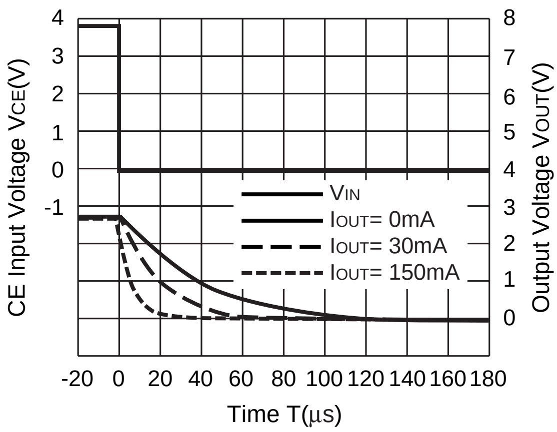
R1114x151D (VIN=2.5V, CIN=Ceramic 1.0µF, COUT=Ceramic 1.0µF)



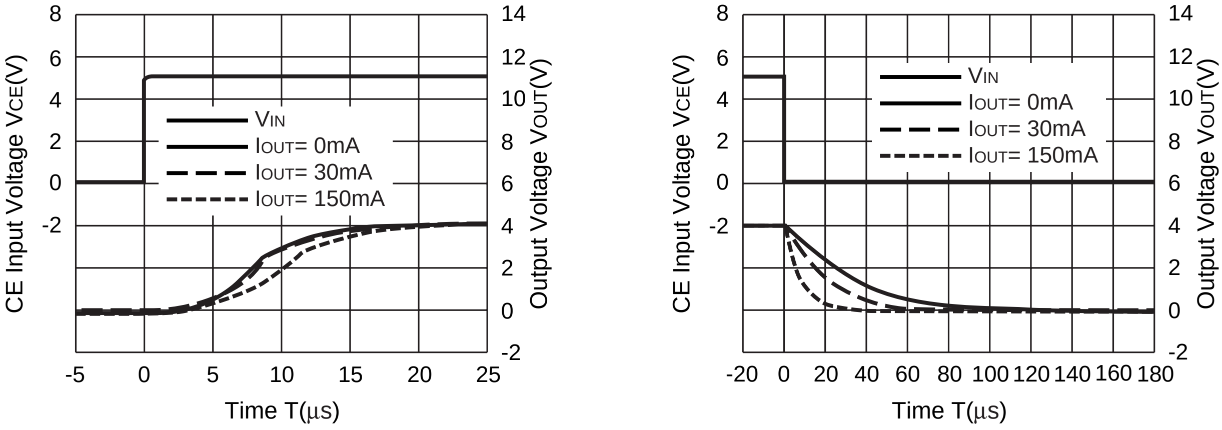


R1114x281D (VIN=3.8V, CIN=Ceramic 0.47µF, COUT=Ceramic 0.47µF)





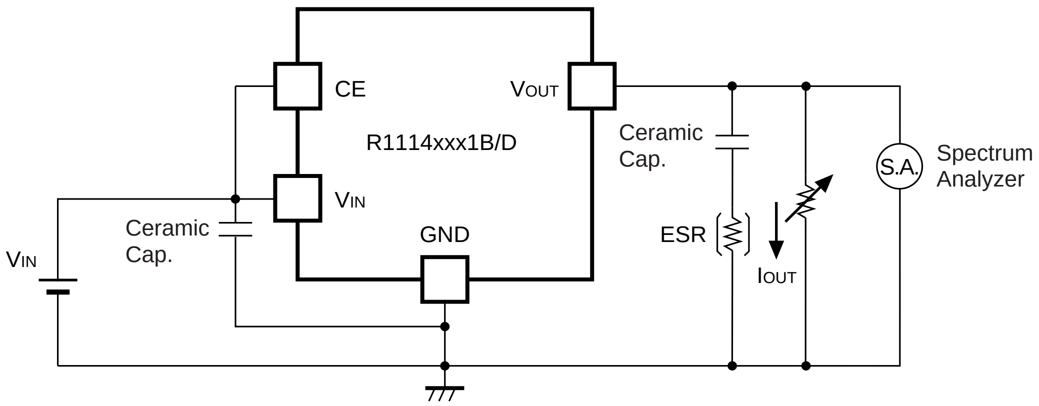
R1114x401D (V_{IN}=5.0V, C_{IN}=Ceramic 0.47μF, C_{OUT}=Ceramic 0.47μF)



ESR vs. Output Current

When using these ICs, consider the following points:

In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, use a capacitor C_{OUT} with good frequency characteristics and ESR (Equivalent Series Resistance) of which is in the range described as follows:



Measuring Circuit for white noise; R1114xxx1B/D

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 40μV (Avg.) are marked as the hatched area in the graph.

(Note: If additional ceramic capacitors are connected to the Output Pin with Output capacitor for phase compensation, the operation might be unstable. Because of this, test these ICs with as same external components as ones to be used on the PCB.)

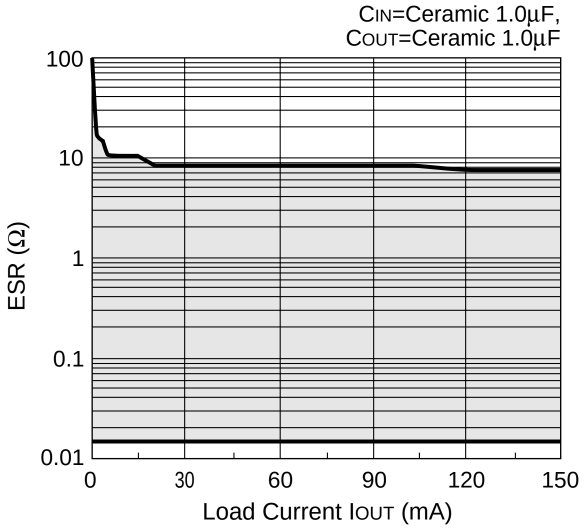
<Measurement conditions>

(1) V_{IN}=V_{OUT}+1V

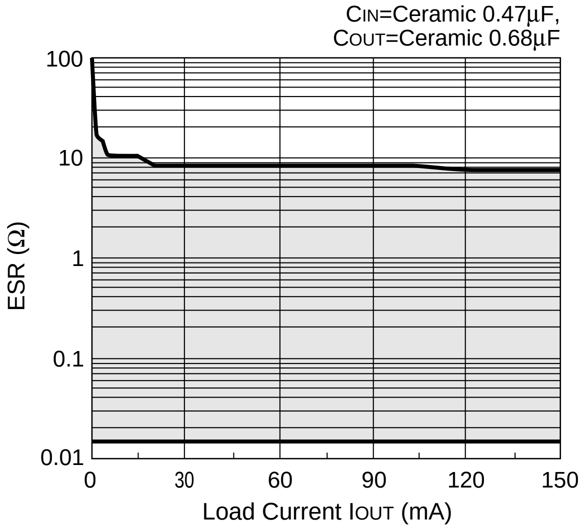
(2) Frequency Band: 10Hz to 2MHz

(3) Temperature: –40°C to 25°C

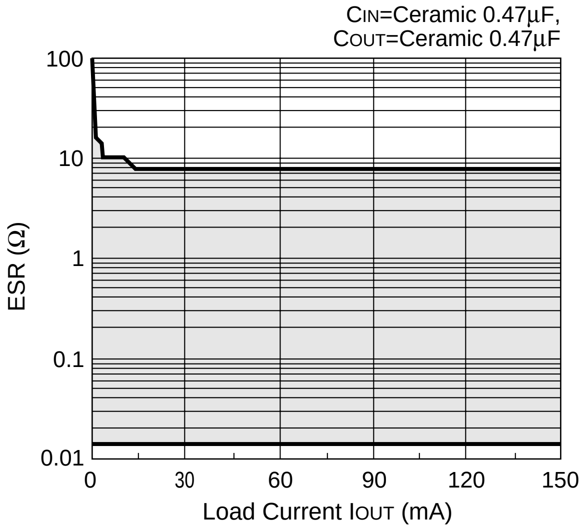
R1114x151x



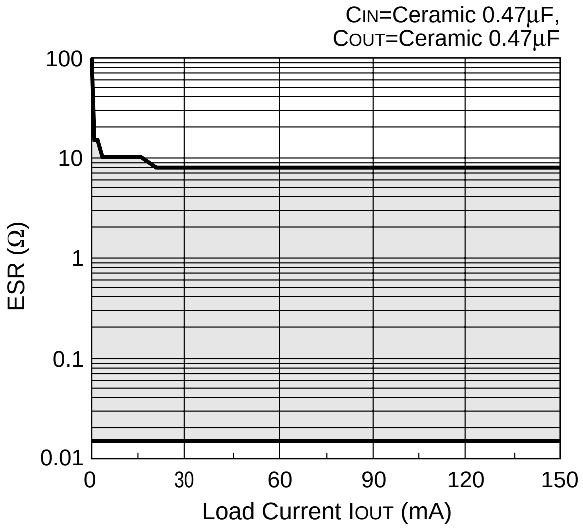
R1114x161x



R1114x211x



R1114x281x



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