RICOH

Rx5RL SERIES

VOLTAGE REGULATOR

NO. EA-022-120404

OUTLINE

The Rx5RL Series are CMOS-based voltage regulator ICs with high accuracy output voltage and ultra-low quiescent current. Each of these ICs consists of a voltage reference unit, an error amplifier, a driver transistor, and resistors for setting output voltage. The output voltage is fixed with high accuracy.

Three types of packages, TO-92 (Discontinued), SOT-89 (Mini-power Mold), SOT-23-5 (Mini-mold), are available.

FEATURES

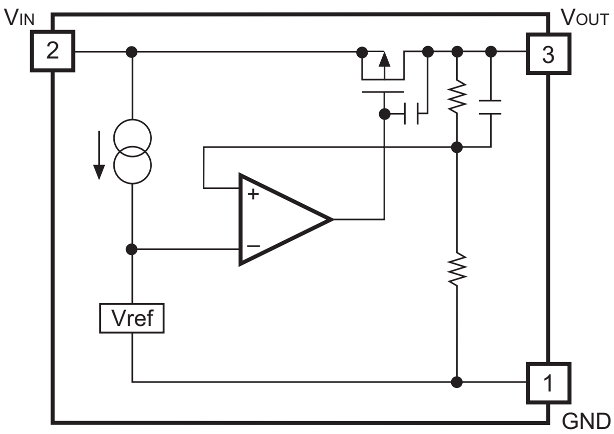
- Supply Current .... Typ. 1.1μA (V_{OUT}=3.0V, V_{IN}=5.0V)
- Dropout Voltage .... Typ. 0.04V (I_{OUT}=1mA, V_{OUT}=2.8V)
- Input Voltage Range .... Max. 10.0V
- Output Voltage Range... 2.0V to 6.0V (0.1V steps)
  (For other voltages, please refer to MARK INFORMATIONS.)
- Output Voltage Accuracy.. ±2.5%
- Temperature-Drift Coefficient of Output Voltage .... Typ. ± 100ppm/°C
- Line Regulation .... Typ. 0.05%/V
- Packages .... SOT-23-5 (Mini-mold), SOT-89 (Mini-power Mold), TO-92 (Discontinued)

APPLICATIONS

- Power source for battery-powered equipment
- Power source for cameras, video instruments such as camcorders, VCRs, and hand- held communication equipment
- Precision voltage references

BLOCK DIAGRAMS

Rx5RL



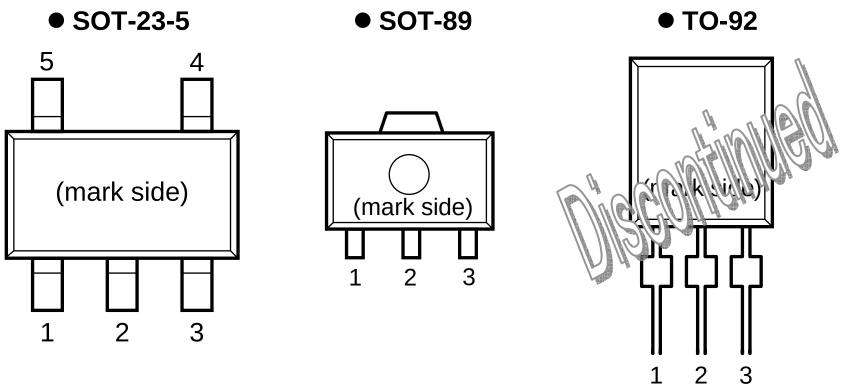
SELECTION GUIDE

The output voltage and package for the ICs can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RN5RLxxAA-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes
RH5RLxxAA-T1-FE	SOT-89	1,000 pcs	Yes	Yes
RE5RLxxAA-TR-F	TO-92 (Discontinued)	2,500 pcs	Yes	No

xx: The output voltage can be designated in the range from 2.0V (20) to 6.0V (60) in 0.1V steps.
(For other voltages, please refer to MARK INFORMATIONS.)

PIN CONFIGURATION



PIN DESCRIPTION

- **SOT-23-5**

Pin No	Symbol	Pin Description
1	GND	Ground Pin
2	V_{IN}	Input Pin
3	V_{OUT}	Output Pin
4	NC	No Connection
5	NC	No Connection

- **SOT-89**

Pin No	Symbol	Pin Description
1	GND	Ground Pin
2	V_{IN}	Input Pin
3	V_{OUT}	Output Pin

- **TO-92 (Discontinued)**

Pin No	Symbol	Pin Description
1	GND	Ground Pin
2	V_{IN}	Input Pin
3	V_{OUT}	Output Pin

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	12	V
V_{OUT}	Output Voltage	–0.3 to V_{IN}+0.3	V
I_{OUT}	Output Current	150	mA
P_D	Power Dissipation* (SOT-23-5)	420	mW
	Power Dissipation* (SOT-89)	900	
	Power Dissipation* (TO-92) (Discontinued)	300	
T_{opt}	Operating Temperature Range	–40 to 85	°C
T_{stg}	Storage Temperature Range	–55 to 125	°C
T_{solder}	Lead Temperature (Soldering)	260°C,10s	

∗) 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

• Rx5RL20A

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
VOUT	Output Voltage	VIN=4.0V 10μA≤IOUT≤10mA	1.950	2.000	2.050	V
IOUT	Output Current	VIN=4.0V	25	35		mA
ΔVOUT/ΔIOUT	Load Regulation	VIN=4.0V 1mA≤IOUT≤35mA		30	45	mV
VDIF	Dropout Voltage	IOUT=1mA		60	90	mV
ISS	Quiescent Current	VIN=4.0V		1.0	3.0	μA
ΔVOUT/ΔVIN	Line Regulation	IOUT=1mA VOUT+0.5V≤VIN≤10V		0.05	0.20	%/V
VIN	Input Voltage				10	V
ΔVOUT/ΔTopt	Output Voltage Temperature Coefficient	IOUT=10mA –40°C≤Topt≤85°C		±100		ppm/°C

• Rx5RL30A

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
VOUT	Output Voltage	VIN=5.0V 10μA≤IOUT≤10mA	2.925	3.000	3.075	V
IOUT	Output Current	VIN=5.0V	35	50		mA
ΔVOUT/ΔIOUT	Load Regulation	VIN=5.0V 1mA≤IOUT≤50mA		40	60	mV
VDIF	Dropout Voltage	IOUT=1mA		40	60	mV
ISS	Quiescent Current	VIN=5.0V		1.1	3.3	μA
ΔVOUT/ΔVIN	Line Regulation	IOUT=1mA VOUT+0.5V≤VIN≤10V		0.05	0.20	%/V
VIN	Input Voltage				10	V
ΔVOUT/Δ Topt	Output Voltage Temperature Coefficient	IOUT=10mA –40°C≤Topt≤85°C		±100		ppm/°C

• **Rx5RL40A**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN}=6.0V 10μA≤I_{OUT}≤10mA	3.900	4.000	4.100	V
I_{OUT}	Output Current	V_{IN}=6.0V	45	65		mA
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	V_{IN}=6.0V 1mA≤I_{OUT}≤65mA		50	75	mV
V_{DIF}	Dropout Voltage	I_{OUT}=1mA		25	38	mV
I_{SS}	Quiescent Current	V_{IN}=6.0V		1.2	3.6	μA
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	I_{OUT}=1mA V_{OUT}+0.5V≤V_{IN}≤10V		0.05	0.20	%/V
V_{IN}	Input Voltage				10	V
$\frac{\Delta V_{OUT}}{\Delta Topt}$	Output Voltage Temperature Coefficient	I_{OUT}=10mA –40°C≤Topt≤85°C		±100		ppm/°C

• **Rx5RL50A**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN}=7.0V 10μA≤I_{OUT}≤10mA	4.875	5.000	5.125	V
I_{OUT}	Output Current	V_{IN}=7.0V	55	80		mA
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	V_{IN}=7.0V 1mA≤I_{OUT}≤80mA		60	90	mV
V_{DIF}	Dropout Voltage	I_{OUT}=1mA		25	38	mV
I_{SS}	Quiescent Current	V_{IN}=7.0V		1.3	3.9	μA
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	I_{OUT}=1mA V_{OUT}+0.5V≤V_{IN}≤10V		0.05	0.20	%/V
V_{IN}	Input Voltage				10	V
$\frac{\Delta V_{OUT}}{\Delta Topt}$	Output Voltage Temperature Coefficient	I_{OUT}=10mA –40°C≤Topt≤85°C		±100		ppm/°C

• **Rx5RL60A**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN}=8.0V 10μA≤I_{OUT}≤10mA	5.850	6.000	6.150	V
I_{OUT}	Output Current	V_{IN}=8.0V	55	80		mA
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	V_{IN}=8.0V 1mA≤I_{OUT}≤80mA		60	90	mV
V_{DIF}	Dropout Voltage	I_{OUT}=1mA		25	38	mV
I_{SS}	Quiescent Current	V_{IN}=8.0V		1.3	3.9	μA
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	I_{OUT}=1mA V_{OUT}+0.5V≤V_{IN}≤10V		0.05	0.20	%/V
V_{IN}	Input Voltage				10	V
$\frac{\Delta V_{OUT}}{\Delta Topt}$	Output Voltage Temperature Coefficient	I_{OUT}=10mA –40°C≤Topt≤85°C		±100		ppm/°C

ELECTRICAL CHARACTEISTICS BY OUTPUT VOLTAGE

<table>
<tr><th rowspan="3">Part Number</th><th colspan="4">Output Voltage</th><th colspan="3">OutputCurrent</th><th colspan="3">Load Regulation</th><th colspan="3">Dropout Voltage</th></tr>
<tr><th colspan="4">V_{OUT}(V)</th><th colspan="3">I_{OUT}(mA)</th><th colspan="3">ΔV_{OUT}(mV)</th><th colspan="3">V_{DIF} (mV)</th></tr>
<tr><th>Conditions</th><th>Min.</th><th>Typ.</th><th>Max.</th><th>Conditions</th><th>Min.</th><th>Typ.</th><th>Conditions</th><th>Typ.</th><th>Max.</th><th>Conditions</th><th>Typ.</th><th>Max.</th></tr>
<tr><td>Rx5RL20A</td><td rowspan="41">$V_{IN}-V_{OUT}$ =2.0V
$10\mu A \le I_{OUT} \le 10mA$</td><td>1.950</td><td>2.000</td><td>2.050</td><td rowspan="41">$V_{IN}-V_{OUT}$ =2.0V</td><td rowspan="10">25</td><td rowspan="10">35</td><td rowspan="10">$V_{IN}-V_{OUT}$ =2.0V
$1mA \le I_{OUT} \le 35mA$</td><td rowspan="10">30</td><td rowspan="10">45</td><td rowspan="41">I_{OUT} =1mA</td><td rowspan="4">60</td><td rowspan="4">90</td></tr>
<tr><td>Rx5RL21A</td><td>2.048</td><td>2.100</td><td>2.152</td></tr>
<tr><td>Rx5RL22A</td><td>2.145</td><td>2.200</td><td>2.255</td></tr>
<tr><td>Rx5RL23A</td><td>2.243</td><td>2.300</td><td>2.357</td></tr>
<tr><td>Rx5RL24A</td><td>2.340</td><td>2.400</td><td>2.460</td><td rowspan="4">50</td><td rowspan="4">75</td></tr>
<tr><td>Rx5RL25A</td><td>2.438</td><td>2.500</td><td>2.562</td></tr>
<tr><td>Rx5RL26A</td><td>2.535</td><td>2.600</td><td>2.665</td></tr>
<tr><td>Rx5RL27A</td><td>2.633</td><td>2.700</td><td>2.767</td></tr>
<tr><td>Rx5RL28A</td><td>2.730</td><td>2.800</td><td>2.870</td><td rowspan="4">40</td><td rowspan="4">60</td></tr>
<tr><td>Rx5RL29A</td><td>2.828</td><td>2.900</td><td>2.972</td></tr>
<tr><td>Rx5RL30A</td><td>2.925</td><td>3.000</td><td>3.075</td><td rowspan="10">35</td><td rowspan="10">50</td><td rowspan="10">$V_{IN}-V_{OUT}$ =2.0V
$1mA \le I_{OUT} \le 50mA$</td><td rowspan="10">40</td><td rowspan="10">60</td></tr>
<tr><td>Rx5RL31A</td><td>3.023</td><td>3.100</td><td>3.177</td></tr>
<tr><td>Rx5RL32A</td><td>3.120</td><td>3.200</td><td>3.280</td><td rowspan="4">35</td><td rowspan="4">53</td></tr>
<tr><td>Rx5RL33A</td><td>3.218</td><td>3.300</td><td>3.382</td></tr>
<tr><td>Rx5RL34A</td><td>3.315</td><td>3.400</td><td>3.485</td></tr>
<tr><td>Rx5RL35A</td><td>3.413</td><td>3.500</td><td>3.587</td></tr>
<tr><td>Rx5RL36A</td><td>3.510</td><td>3.600</td><td>3.690</td><td rowspan="4">30</td><td rowspan="4">45</td></tr>
<tr><td>Rx5RL37A</td><td>3.608</td><td>3.700</td><td>3.792</td></tr>
<tr><td>Rx5RL38A</td><td>3.705</td><td>3.800</td><td>3.895</td></tr>
<tr><td>Rx5RL39A</td><td>3.803</td><td>3.900</td><td>3.997</td></tr>
<tr><td>Rx5RL40A</td><td>3.900</td><td>4.000</td><td>4.100</td><td rowspan="10">45</td><td rowspan="10">65</td><td rowspan="10">$V_{IN}-V_{OUT}$ =2.0V
$1mA \le I_{OUT} \le 65mA$</td><td rowspan="10">50</td><td rowspan="10">70</td><td rowspan="21">25</td><td rowspan="21">38</td></tr>
<tr><td>Rx5RL41A</td><td>3.998</td><td>4.100</td><td>4.202</td></tr>
<tr><td>Rx5RL42A</td><td>4.095</td><td>4.200</td><td>4.305</td></tr>
<tr><td>Rx5RL43A</td><td>4.193</td><td>4.300</td><td>4.407</td></tr>
<tr><td>Rx5RL44A</td><td>4.290</td><td>4.400</td><td>4.510</td></tr>
<tr><td>Rx5RL45A</td><td>4.388</td><td>4.500</td><td>4.612</td></tr>
<tr><td>Rx5RL46A</td><td>4.485</td><td>4.600</td><td>4.715</td></tr>
<tr><td>Rx5RL47A</td><td>4.583</td><td>4.700</td><td>4.817</td></tr>
<tr><td>Rx5RL48A</td><td>4.680</td><td>4.800</td><td>4.920</td></tr>
<tr><td>Rx5RL49A</td><td>4.778</td><td>4.900</td><td>5.022</td></tr>
<tr><td>Rx5RL50A</td><td>4.875</td><td>5.000</td><td>5.125</td><td rowspan="11">55</td><td rowspan="11">80</td><td rowspan="11">$V_{IN}-V_{OUT}$ =2.0V
$1mA \le I_{OUT} \le 80mA$</td><td rowspan="11">60</td><td rowspan="11">90</td></tr>
<tr><td>Rx5RL51A</td><td>4.973</td><td>5.100</td><td>5.227</td></tr>
<tr><td>Rx5RL52A</td><td>5.070</td><td>5.200</td><td>5.330</td></tr>
<tr><td>Rx5RL53A</td><td>5.168</td><td>5.300</td><td>5.432</td></tr>
<tr><td>Rx5RL54A</td><td>5.265</td><td>5.400</td><td>5.535</td></tr>
<tr><td>Rx5RL55A</td><td>5.363</td><td>5.500</td><td>5.637</td></tr>
<tr><td>Rx5RL56A</td><td>5.460</td><td>5.600</td><td>5.740</td></tr>
<tr><td>Rx5RL57A</td><td>5.558</td><td>5.700</td><td>5.842</td></tr>
<tr><td>Rx5RL58A</td><td>5.655</td><td>5.800</td><td>5.945</td></tr>
<tr><td>Rx5RL59A</td><td>5.753</td><td>5.900</td><td>6.047</td></tr>
<tr><td>Rx5RL60A</td><td>5.850</td><td>6.000</td><td>6.150</td></tr>
</table>

Topt=25°C

Quiescent Current			Line Regulation			Input Voltage	Output Voltage Tempco.	
Iss(μA)			ΔVOUT/ΔVIN(%/V)			VIN(V)	ΔVOUT/ΔT(ppm/°C)	
Conditions	Typ.	Max.	Conditions	Typ.	Max.	Max.	Conditions	Typ.
V_{IN} V_{OUT} =2.0V	1.0	3.0	I_{OUT} =1mA V_{OUT}+ 0.5V≤ V_{IN}≤ ≤10V	0.05	0.2	10	I_{OUT} =10mA −40°C≤ Topt 85°C	±100
	1.1	3.3						
	1.2	3.6						
	1.3	3.9						

OPERATION

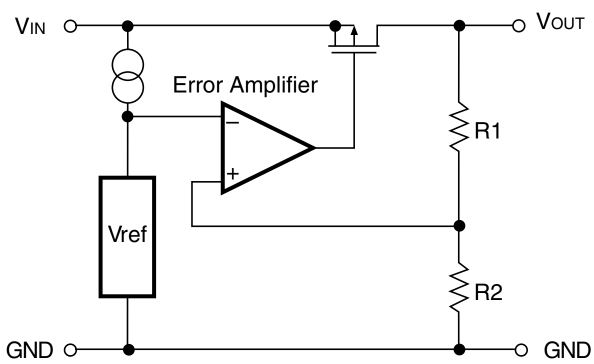


FIG. 1 Brock Diagram

Output voltage, VOUT divided at the node between Registers R1 and R2 is compared with the reference voltage by the error amplifier, so that a constant voltage is output.

TEST CIRCUITS

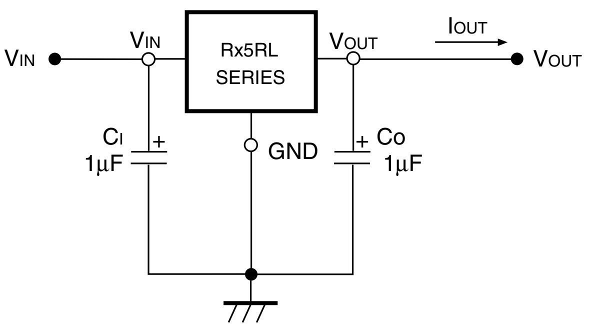


FIG. 2 Test Circuit

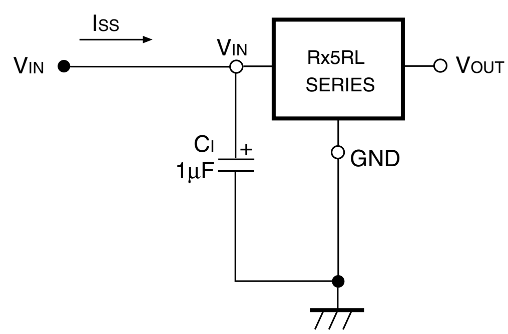


FIG. 3 Quiescent Current Test Circuit

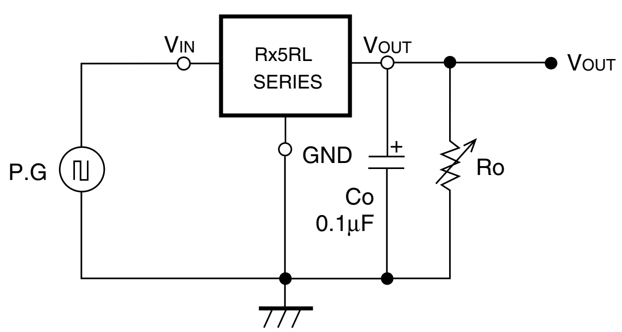
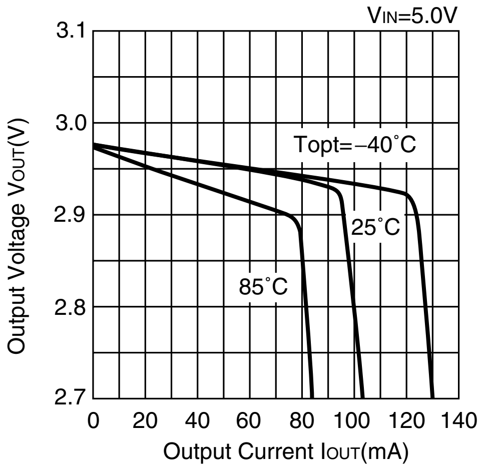


FIG. 4 Line Transient Response Test Circuit

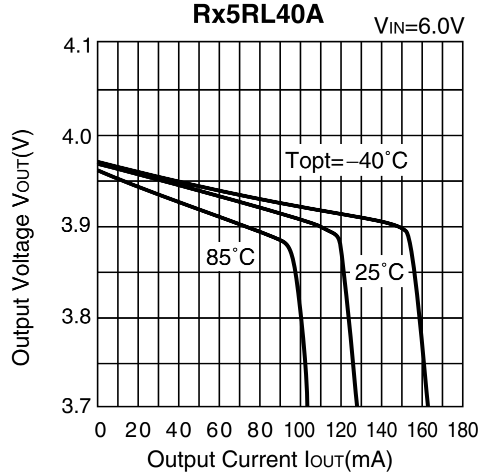
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current

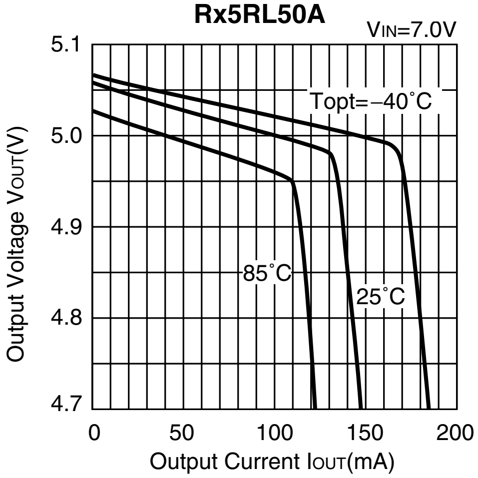
Rx5RL30A



Rx5RL40A

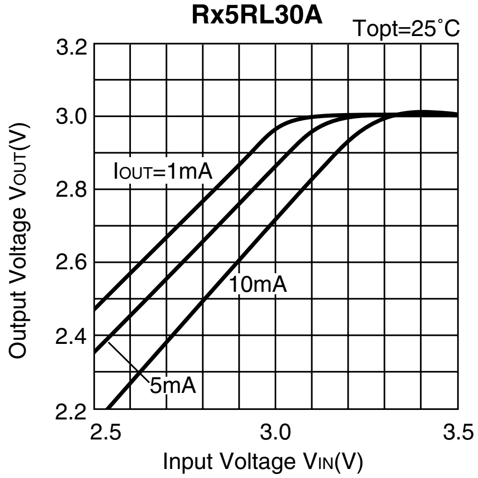


Rx5RL50A

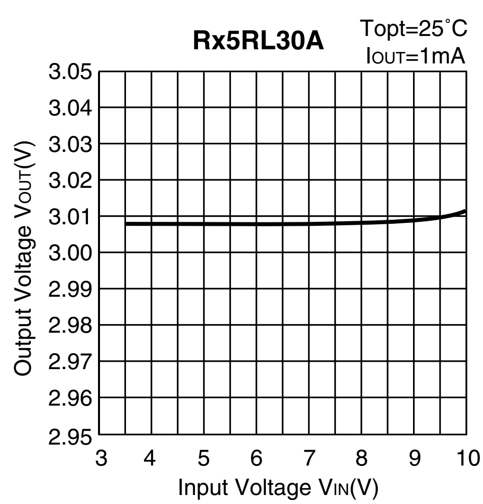


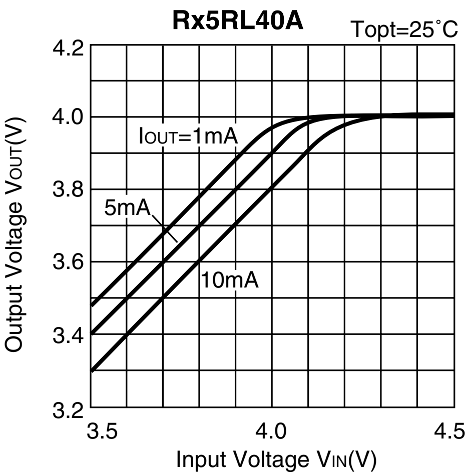
2) Output Voltage vs. Input Voltage

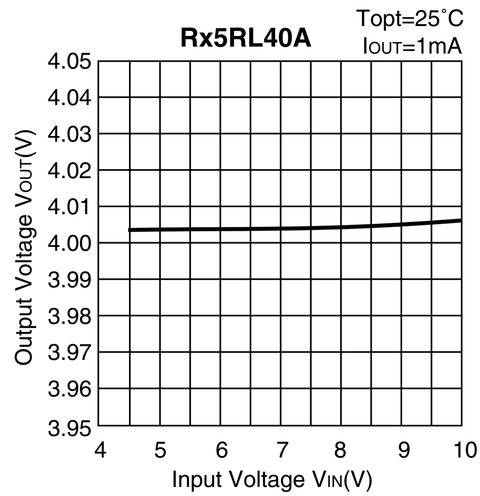
Rx5RL30A

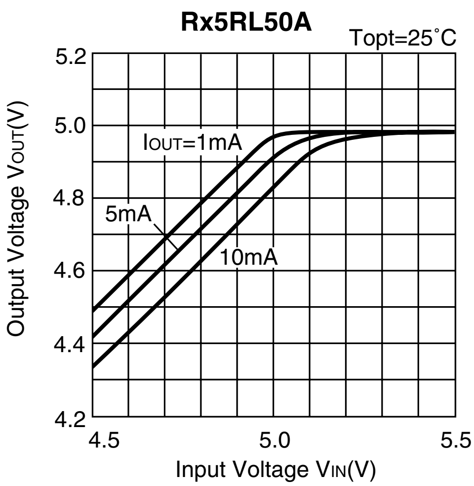


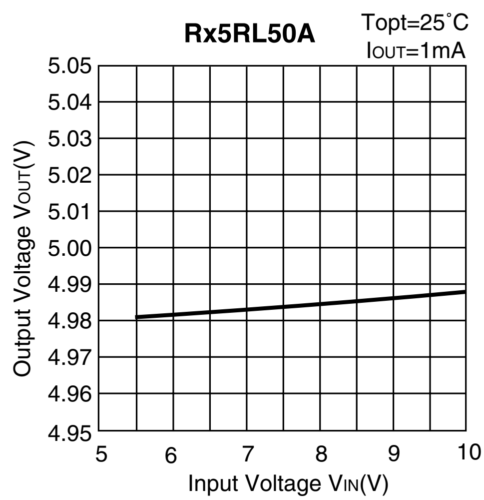
Rx5RL30A



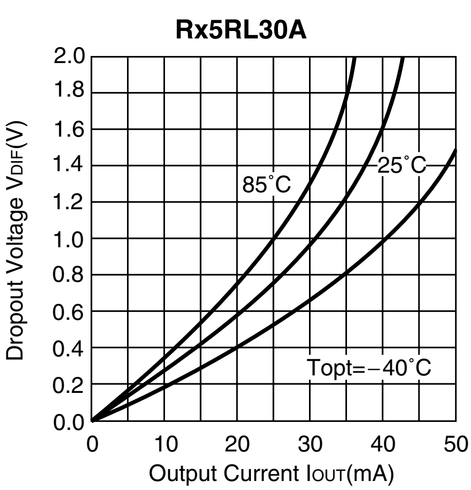


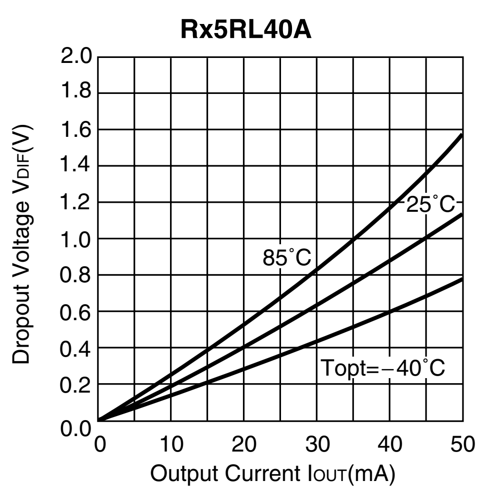


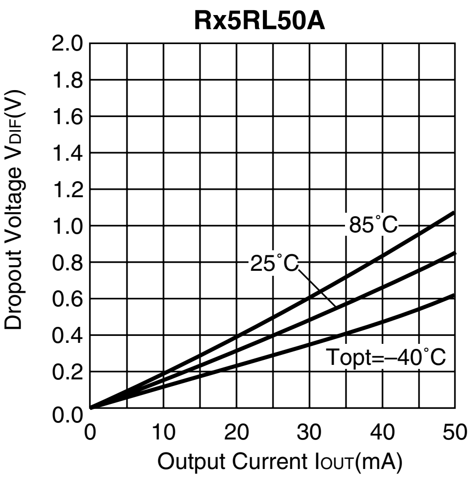




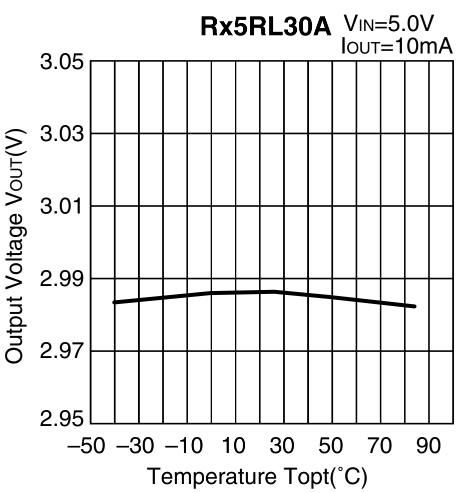
3) Dropout Voltage vs. Output Curret

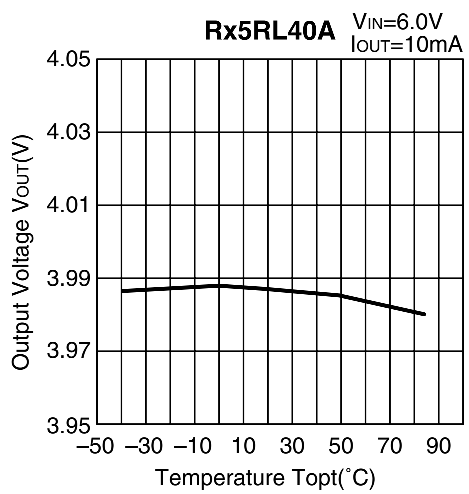


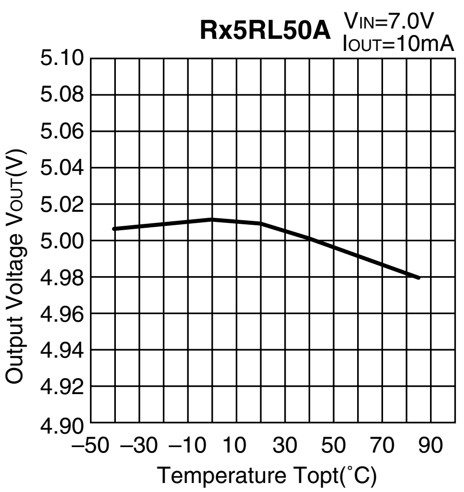




4) Output Voltage vs.Temperature

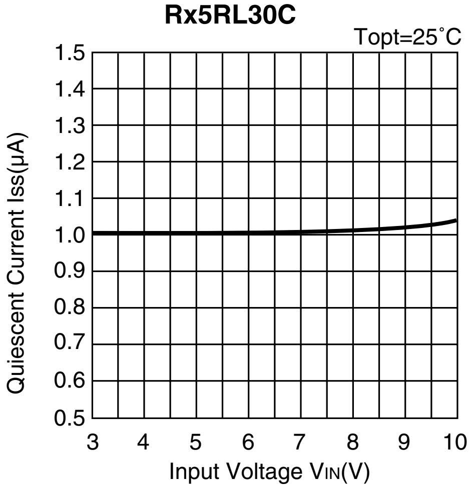




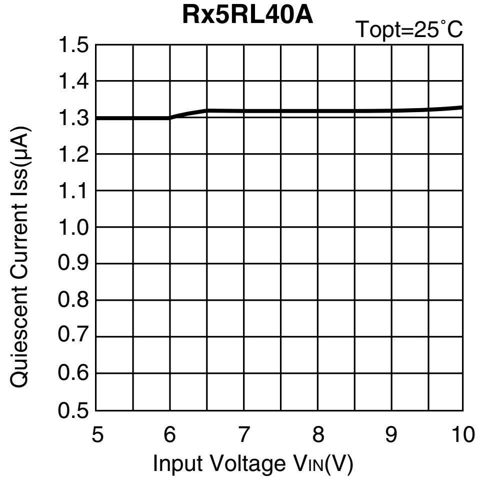


5) Quiescent Current vs. Input Voltage

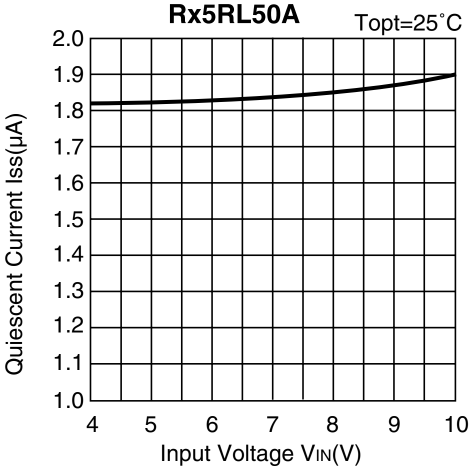
Rx5RL30C



Rx5RL40A

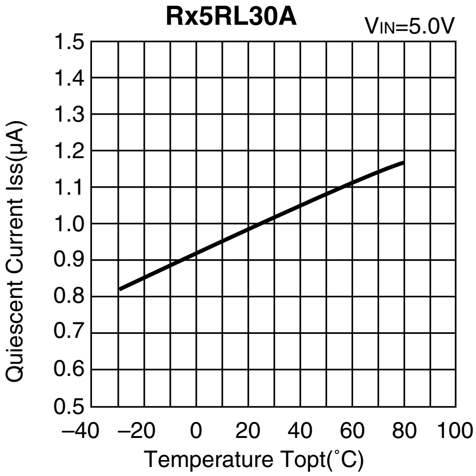


Rx5RL50A

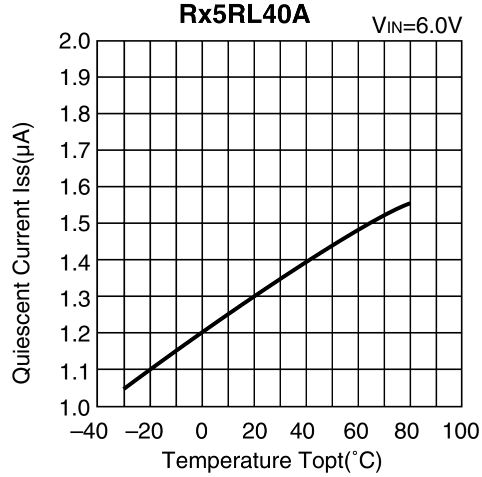


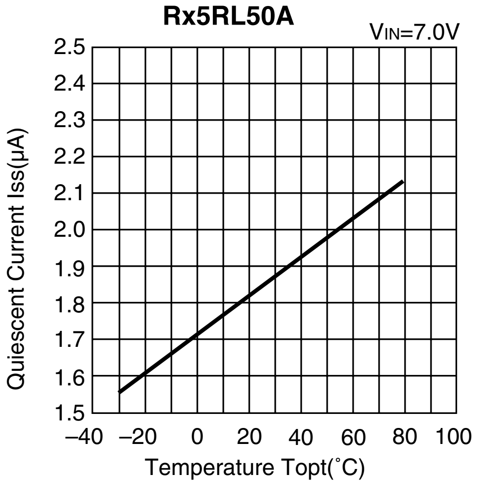
6) Quiescent Current vs. Temperature

Rx5RL30A

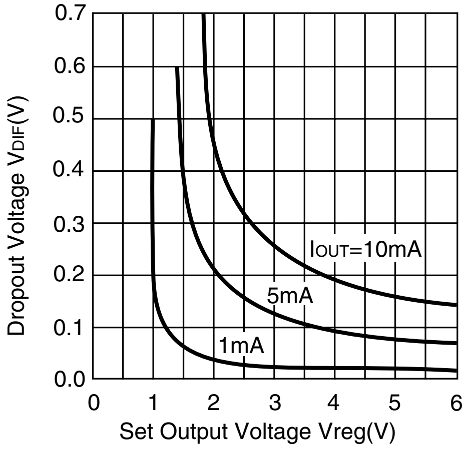


Rx5RL40A

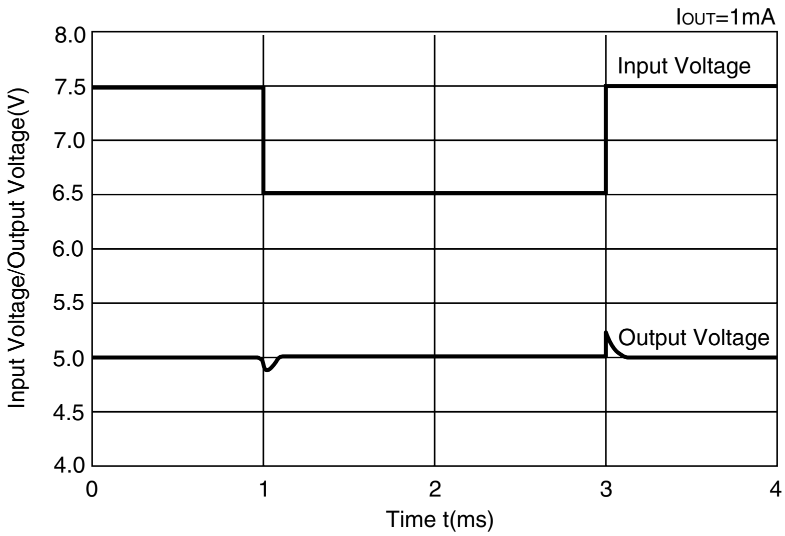




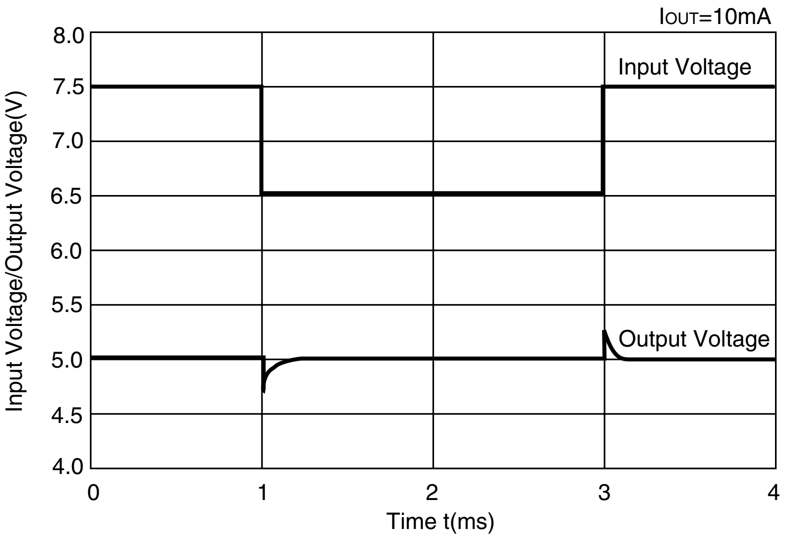
7) Dropout Voltage vs. Set Output Voltage



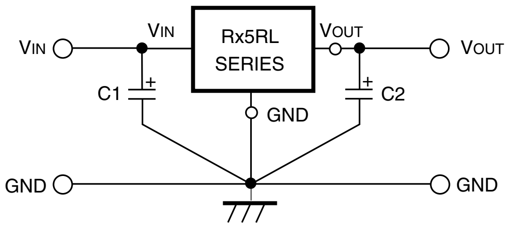
8) Line Transient Response (1)



9) Line Transient Response (2)



TYPICAL APPLICATION

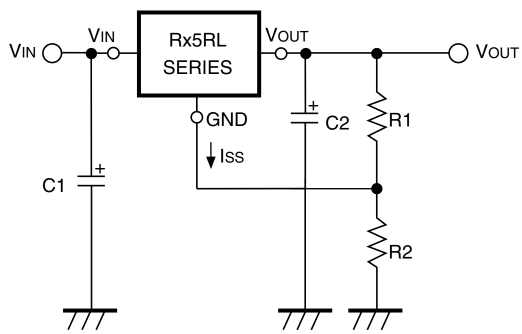


In Rx5RL Series, a constant voltage can be obtained without using Capacitors C1 and C2. However, when the wire connected to Vin is long, use Capacitor C1. Output noise can be reduced by using Capacitor C2.

Insert Capacitors C1 and C2 with the capacitance of 0.1µF to 2.0µF between Input/Output Pins and GND Pin with minimum wiring.

APPLICATION CIRCUITS

• VOLTAGE BOOST CIRCUIT



The output voltage can be obtained by the following formula :

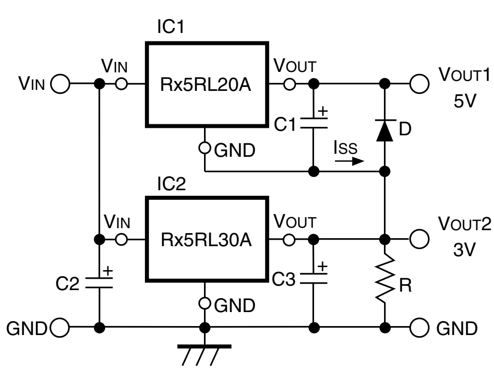
$$V_{OUT}=Vreg^{*1}\cdot(1+R2/R1)+I_{SS}\,R\cdot 2$$

Since the quiescent current of Rx5RE Series is so small that the resistances of R1 and R2 can be set as large as several hundreds kΩ and therefore the supply current of “Voltage Boost Circuit” itself can be reduced.

Furthermore, since Rx5RL Series are operated by a constant voltage, the supply current of “Voltage Boost Circuit” is not substantially affected by the input voltage.

*1) Vreg : Set Output Voltage of Rx5RL Series.

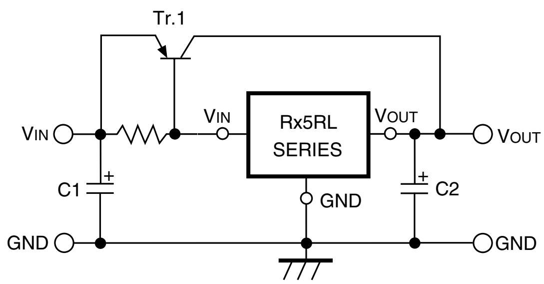
• DUAL POWER SUPPLY CIRCUIT



As shown in the circuit diagram, a dual power supply circuit can be constructed by using two Rx5RL Series.

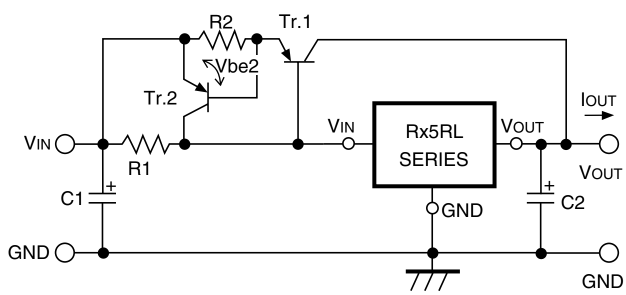
This circuit diagram shows a dual power supply circuit with an output of 3V and an output of 5V. When the minimum output current of IC2 is larger than I_{SS} of IC1, Resistor R is unnecessary. Diode D is a protection diode for the case where $V_{OUT}2$ becomes larger than $V_{OUT}1$.

• CURRENT BOOST CIRCUIT



Output current of 60mA or more can be obtained by the current boost circuit constructed as shown in this circuit diagram.

• CURRENT BOOST CIRCUIT WITH OVERCURRENT LIMIT CIRCUIT



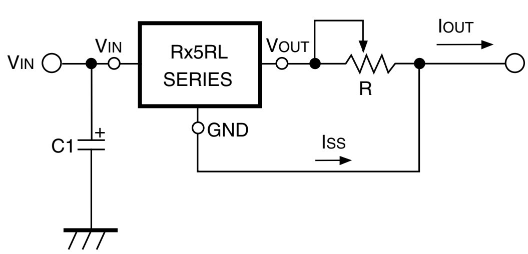
A circuit for protecting Tr.1 from the destruction caused by output short-circuit or overcurrent is shown in this circuit diagram.

When the voltage reduction caused by the current ($\fallingdotseq$ I_{OUT}) which flows through R2 reaches Vbe2 of Tr.2 by additionally providing the current boost circuit with Tr.2 and R2, Tr.2 is turned on and the base current of Tr.1 is increased, so that the output current is limited.

Current limit of overcurrent limit circuit is obtained as follows :

$$I_{OUT} \fallingdotseq Vbe2/R2$$

• CURRENT SOURCE



A current source with the structure as shown in this circuit diagram can be used. Output Current I_{OUT} is obtained as follows :

$$I_{OUT} = Vreg^{*1}/R + I_{SS}$$

Output current, I_{OUT} should not exceed its allowable current.

*1) Vreg : Set output voltage of Rx5RL Series.

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