RICOH

VOLTAGE REGULATOR FOR LARGE OUTPUT CURRENT

R×5RE SERIES

OUTLINE

The R×5RE Series are voltage regulator ICs with high output voltage accuracy and ultra-low quiescent current by CMOS process. Each of these ICs consists of a voltage reference unit, an error amplifier, a driver transistor, and resistors for setting output voltage, and a current limit circuit. By use of these ICs, a constant voltage power supply circuit with high efficiency can be constructed because the dropout voltage and quiescent current of these ICs are very small. Furthermore, theses ICs have a built-in current limit circuit. The output voltage of these ICs is fixed with high accuracy.

Two types of packages, TO-92 and SOT-89 (Mini-power Mold) are available.

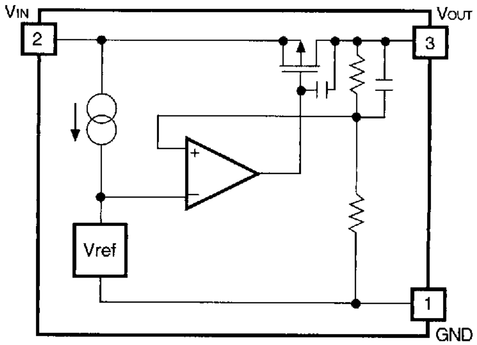
FEATURES

- Ultra-low Quiescent Current ··························TYP. 1.1µA (R×5RE30A, V_{IN}=5.0V)
- Ultra-low Dropout Voltage ·····························TYP. 0.5V (R×5RE50A, I_{OUT}=60mA)
- Large Output Current ··································TYP. 120mA (R×5RE50A)
- Low Temperature-Drift Coefficient of Output Voltage ·························TYP. ±100ppm/°C
- Broad Operating Voltage Range ·····················MAX. 10.0V
- Excellent Line Regulation ······························TYP. 0.1%/V
- High Accuracy Output Voltage ·······················±2.5%
- Output Voltage···Stepwise setting with a step of 0.1V in the range of 2.0V to 6.0V is possible (refer to Selection Guide)
- Two Types of Packages ··································TO-92, SOT-89 (Mini-power Mold)

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 DIAGRAM



SELECTION GUIDE

The package type, the output voltage, the packing type, and the taping type of R×5RE Series can be designated at the user's request by specifying the part number as follows.

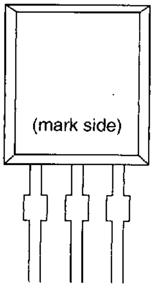
```
R×5RE××××-××  ← Part Number
 ↑    ⌣ ↑↑ ⌣
 a    b c d e
```

Code	Contents
a	Designation of Package Type: E: TO-92 H: SOT-89 (Mini-power Mold)
b	Setting Output Voltage (V_{OUT}): Stepwise setting with a step of 0.1V in the range of 2.0V to 6.0V is possible.
c	A
d	Designation of Packing Type: A: Taping C: Antistatic bag for TO-92 and samples
e	Designation of Taping Type: Ex. TO-92 : RF, RR, TZ SOT-89: T1, T2 (refer to Taping Specifications) "TZ" and "T1" are prescribed as a standard.

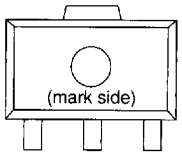
For example, the product with Package Type SOT-89,Output Voltage 5.0V,Version A and Taping Type T1 are designated by Part Number RH5RE50AA-T1.

PIN CONFIGURATION

• TO-92



• SOT-89



PIN DESCRIPTION

• TO-92

Pin No.	Symbol
1	GND
2	V_{IN}
3	V_{OUT}

• SOT-89

Pin No.	Symbol
1	GND
2	V_{IN}
3	V_{OUT}

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	300	mA
P_D	Power Dissipation	300	mW
Topt	Operating Temperature	–30 to +80	°C
Tstg	Storage Temperature	–55 to +25	°C
Tsolder	Lead Temperature (Soldering)	260°C, 10s	

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum ratings are threshold limit values that must not be exceeded even for an instant under any conditions. Moreover, such values for any two items must not be reached simultaneously. Operation above these absolute maximum ratings may cause degradation or permanent damage to the device. These are stress ratings only and do not necessarily imply functional operation below these limits.

ELECTRICAL CHARACTERISTICS

• **R×5RE20A**

Topt=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
VOUT	Output Voltage	VIN=4.0V,IOUT=10mA	1.950	2.000	2.050	V
IOUT	Output Current	VIN=4.0V	40	60		mA
ΔVOUT/ΔIOUT	Load Regulation	VIN=4.0V 1mA≤IOUT≤50mA		40	80	mV
VDIF	Dropout Voltage	IOUT=30mA		0.5	0.7	V
Iss	Quiescent Current	VIN=4.0V		1.0	3.0	μA
ΔVOUT/ΔVIN	Line Regulation	IOUT=10mA VOUT+1.0V≤VIN≤10V		0.1		%/V
VIN	Input Voltage				10	V
Ilim	Current Limit			240		mA
ΔVOUT/ΔTopt	Output Voltage Temperature Coefficient	IOUT=10mA –30°C≤Topt≤80°C		±100		ppm/°C

• **R×5RE30A**

Topt=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
VOUT	Output Voltage	VIN=5.0V,IOUT=10mA	2.925	3.000	3.075	V
IOUT	Output Current	VIN=5.0V	50	80		mA
ΔVOUT/ΔIOUT	Load Regulation	VIN=5.0V 1mA≤IOUT≤60mA		40	80	mV
VDIF	Dropout Voltage	IOUT=40mA		0.5	0.7	V
Iss	Quiescent Current	VIN=5.0V		1.1	3.3	μA
ΔVOUT/ΔVIN	Line Regulation	IOUT=10mA VOUT+1.0V≤VIN≤10V		0.1		%/V
VIN	Input Voltage				10	V
Ilim	Current Limit			240		mA
ΔVOUT/ΔTopt	Output Voltage Temperature Coefficient	IOUT=10mA –30°C≤Topt≤80°C		±100		ppm/°C

• **R×5RE40A**

Topt=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V_{OUT}	Output Voltage	V_{IN}=6.0V, I_{OUT}=10mA	3.900	4.000	4.100	V
I_{OUT}	Output Current	V_{IN}=6.0V	65	100		mA
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	V_{IN}=6.0V 1mA≤I_{OUT}≤70mA		40	80	mV
V_{DIF}	Dropout Voltage	I_{OUT}=50mA		0.5	0.7	V
I_{SS}	Quiescent Current	V_{IN}=6.0V		1.2	3.6	μA
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	I_{OUT}=10mA V_{OUT}+1.0V≤V_{IN}≤10V		0.1		%/V
V_{IN}	Input Voltage				10	V
Ilim	Current Limit			240		mA
$\frac{\Delta V_{OUT}}{\Delta Topt}$	Output Voltage Temperature Coefficient	I_{OUT}=10mA −30°C≤Topt≤80°C		±100		ppm/°C

• **R×5RE50A**

Topt=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V_{OUT}	Output Voltage	V_{IN}=7.0V, I_{OUT}=10mA	4.875	5.000	5.125	V
I_{OUT}	Output Current	V_{IN}=7.0V	80	120		mA
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	V_{IN}=7.0V 1mA≤I_{OUT}≤80mA		40	80	mV
V_{DIF}	Dropout Voltage	I_{OUT}=60mA		0.5	0.7	V
I_{SS}	Quiescent Current	V_{IN}=7.0V		1.3	3.9	μA
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	I_{OUT}=10mA V_{OUT}+1.0V≤V_{IN}≤10V		0.1		%/V
V_{IN}	Input Voltage				10	V
Ilim	Current Limit			240		mA
$\frac{\Delta V_{OUT}}{\Delta Topt}$	Output Voltage Temperature Coefficient	I_{OUT}=10mA −30°C≤Topt≤80°C		±100		ppm/°C

• **R×5RE60A**

Topt=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V_{OUT}	Output Voltage	V_{IN}=8.0V,I_{OUT}=10mA	5.850	6.000	6.150	V
I_{OUT}	Output Current	V_{IN}=8.0V	80	120		mA
$\frac{\Delta V_{OUT}}{\Delta I_{OUT}}$	Load Regulation	V_{IN}=8.0V 1mA≤I_{OUT}≤80mA		40	80	mV
V_{DIF}	Dropout Voltage	I_{OUT}=60mA		0.5	0.7	V
I_{SS}	Quiescent Current	V_{IN}=8.0V		1.4	4.2	µA
$\frac{\Delta V_{OUT}}{\Delta V_{IN}}$	Line Regulation	I_{OUT}=10mA V_{OUT}+1.0V≤V_{IN}≤10V		0.1		%/V
V_{IN}	Input Voltage				10	V
Ilim	Current Limit			240		mA
$\frac{\Delta V_{OUT}}{\Delta Topt}$	Output Voltage Temperature Coefficient	I_{OUT}=10mA −30°C≤Topt≤80°C		±100		ppm/°C

ELECTRICAL CHARACTERISTICS BY OUTPUT VOLTAGE

Part Number	Output Voltage V_{OUT}(V) Conditions	MIN.	TYP.	MAX.	OutputCurrent I_{OUT}(mA) Conditions	MIN.	TYP.	Load Regulation $\Delta V_{OUT}/\Delta I_{OUT}$(mV) Conditions	TYP.	MAX.	Dropout Voltage V_{DIF}(V) Conditions	TYP.	MAX.
R×5RE20A	$V_{IN}-V_{OUT}$ =2.0V I_{OUT} =10mA	1.950	2.000	2.050	$V_{IN}-V_{OUT}$ =2.0V	40	60	$V_{IN}-V_{OUT}$ =2.0V 1mA≤ I_{OUT} ≤50mA	40	80	I_{OUT} =30mA	0.5	0.7
R×5RE21A		2.048	2.100	2.152									
R×5RE22A		2.145	2.200	2.255									
R×5RE23A		2.243	2.300	2.357									
R×5RE24A		2.340	2.400	2.460									
R×5RE25A		2.438	2.500	2.562				$V_{IN}-V_{OUT}$ =2.0V 1mA≤ I_{OUT} ≤60mA					
R×5RE26A		2.535	2.600	2.665									
R×5RE27A		2.633	2.700	2.767									
R×5RE28A		2.730	2.800	2.870									
R×5RE29A		2.828	2.900	2.972									
R×5RE30A		2.925	3.000	3.075		50	80				I_{OUT} =40mA		
R×5RE31A		3.023	3.100	3.177									
R×5RE32A		3.120	3.200	3.280									
R×5RE33A		3.218	3.300	3.382									
R×5RE34A		3.315	3.400	3.485									
R×5RE35A		3.413	3.500	3.587				$V_{IN}-V_{OUT}$ =2.0V 1mA≤ I_{OUT} ≤70mA					
R×5RE36A		3.510	3.600	3.690									
R×5RE37A		3.608	3.700	3.792									
R×5RE38A		3.705	3.800	3.895									
R×5RE39A		3.803	3.900	3.997									
R×5RE40A		3.900	4.000	4.100		65	100				I_{OUT} =50mA		
R×5RE41A		3.998	4.100	4.202									
R×5RE42A		4.095	4.200	4.305									
R×5RE43A		4.193	4.300	4.407									
R×5RE44A		4.290	4.400	4.510									
R×5RE45A		4.388	4.500	4.612				$V_{IN}-V_{OUT}$ =2.0V 1mA≤ I_{OUT} ≤80mA					
R×5RE46A		4.485	4.600	4.715									
R×5RE47A		4.583	4.700	4.817									
R×5RE48A		4.680	4.800	4.920									
R×5RE49A		4.778	4.900	5.022									
R×5RE50A		4.875	5.000	5.125		80	120				I_{OUT} =60mA		
R×5RE51A		4.973	5.100	5.227									
R×5RE52A		5.070	5.200	5.330									
R×5RE53A		5.168	5.300	5.432									
R×5RE54A		5.265	5.400	5.535									
R×5RE55A		5.363	5.500	5.637									
R×5RE56A		5.460	5.600	5.740									
R×5RE57A		5.558	5.700	5.842									
R×5RE58A		5.655	5.800	5.945									
R×5RE59A		5.753	5.900	6.047									
R×5RE60A		5.850	6.000	6.150									

Topt=25°C

Quiescent Current			Line Regulation		Input Voltage	Current Limit	Output Voltage Tempco.	
Iss(μA)			ΔVOUT/ΔVIN(%/V)		VIN(V)	Ilim(mA)	ΔVOUT/ΔT(ppm/°C)	
Conditions	TYP.	MAX.	Conditions	TYP.	MAX.	TYP.	Conditions	TYP.
	1.0	3.0						
	1.1	3.3						
VIN−VOUT =2.0V	1.2	3.6	IOUT =10mA VOUT+1.0V≤ VIN ≤10V	0.1	10	240	IOUT =10mA −30°C≤ Topt ≤80°C	±100
	1.3	3.9						
	1.4	4.2						

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OPERATION

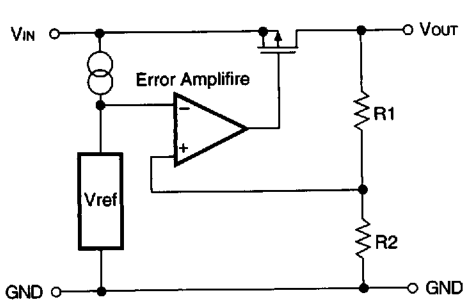


FIG. 1 Brock Diagram

Output Voltage VOUT divided at the node between Registers R1 and R2 is compared with Reference Voltage by Error Amplifier, so that a constant voltage is output.

TEST CIRCUITS

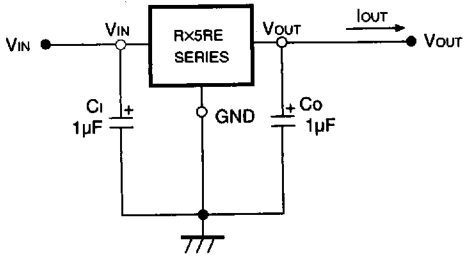


FIG. 2 Test Circuit

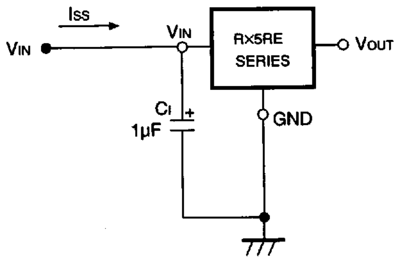


FIG. 3 Quiescent Current Test Circuit

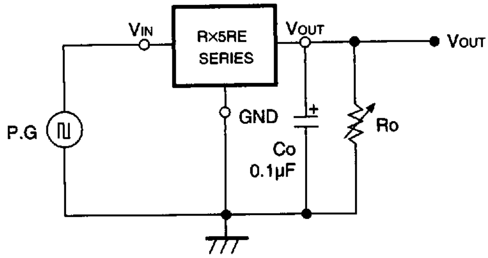
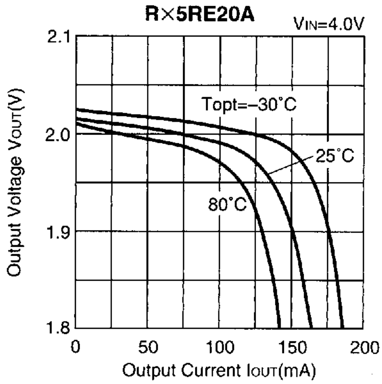
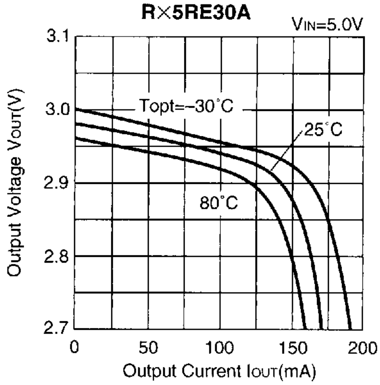


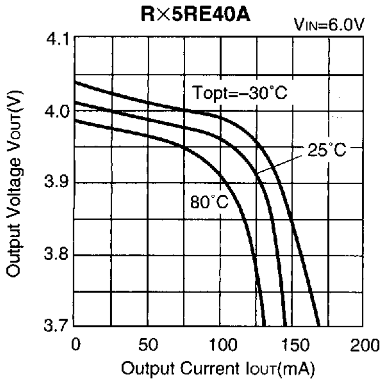
FIG. 4 Line Transient Response Test Circuit

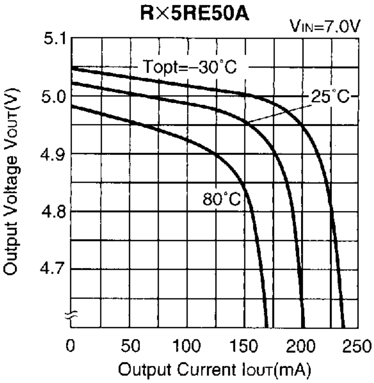
TYPICAL CHARACTERISTICS

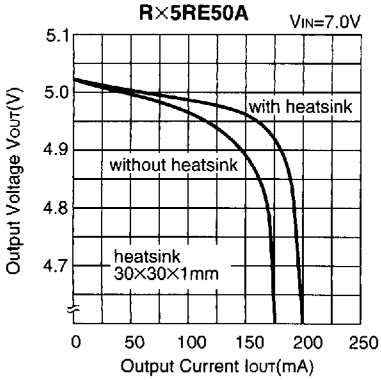
1) Output Voltage vs. Output Current



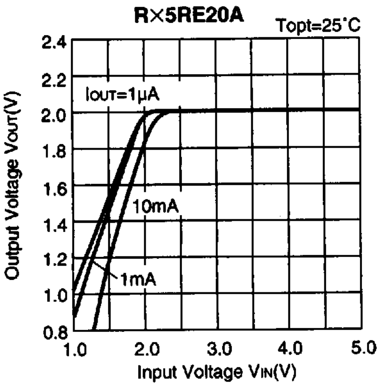


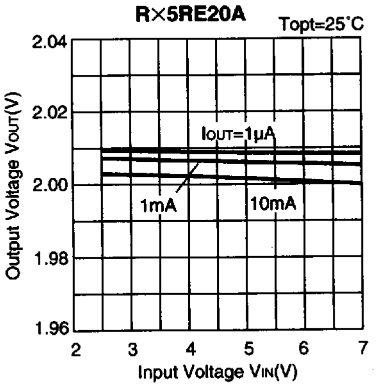


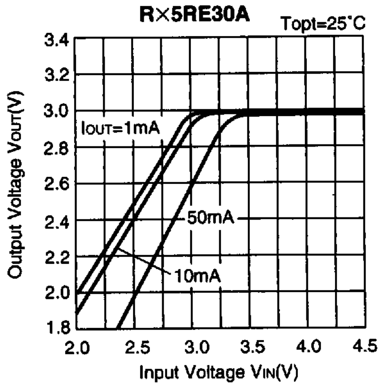


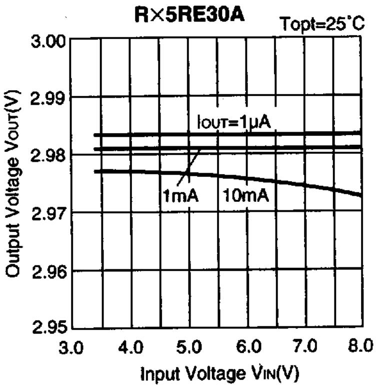


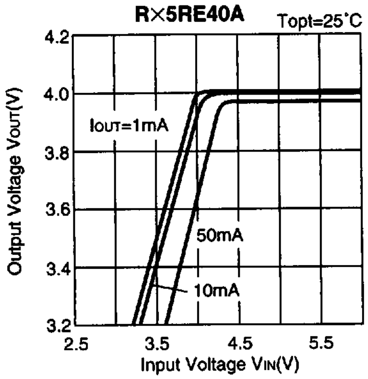
2) Output Voltage vs. Input Voltage

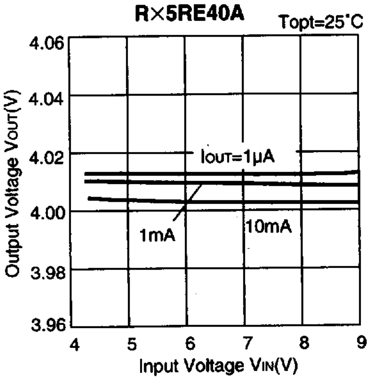




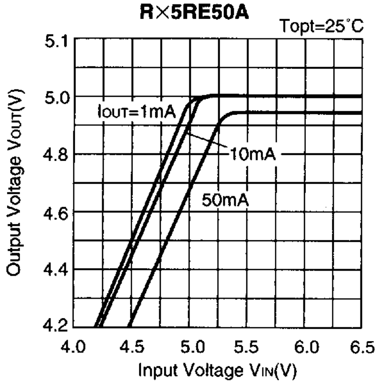








R×5RE50A



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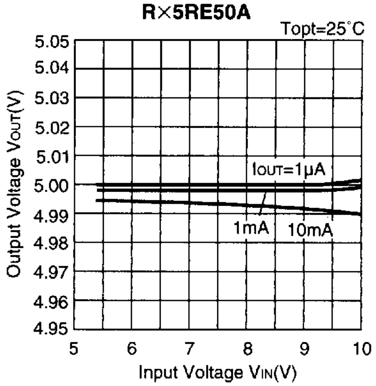
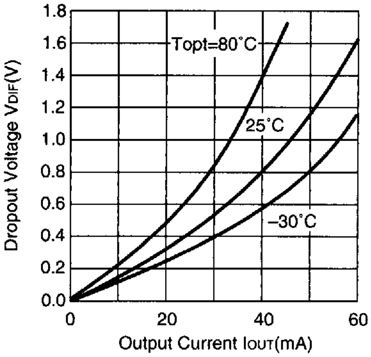


3) Dropout Voltage vs. Output Curret

R×5RE20A



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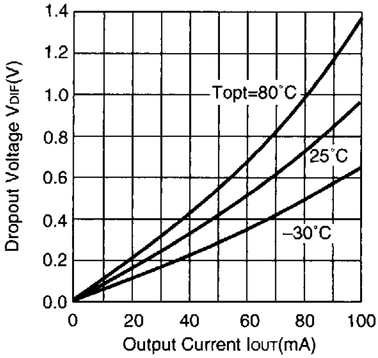
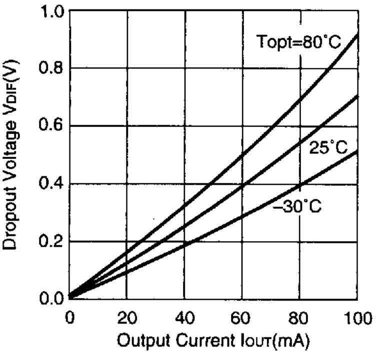
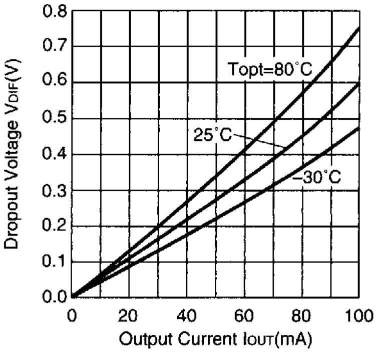


R×5RE40A

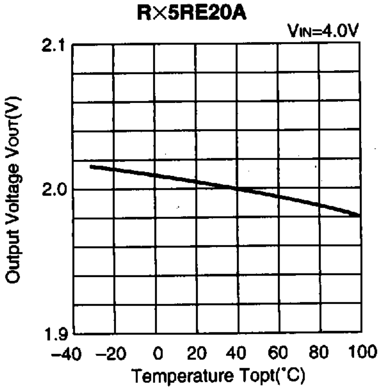


R×5RE50A

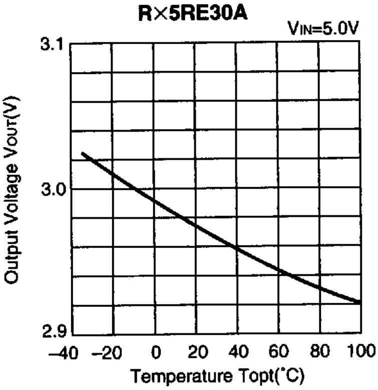


4) Output Voltage vs.Temperature

R×5RE20A



R×5RE30A



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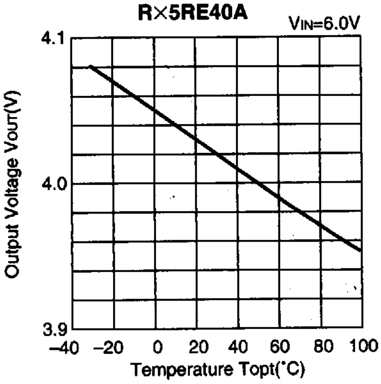
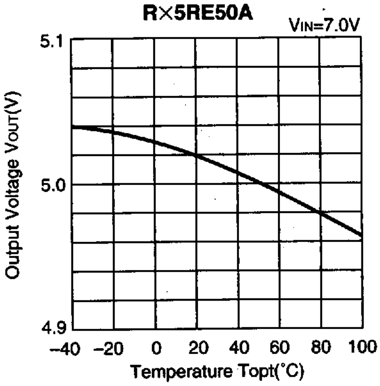
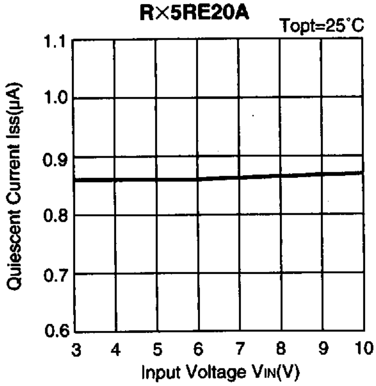


R×5RE50A

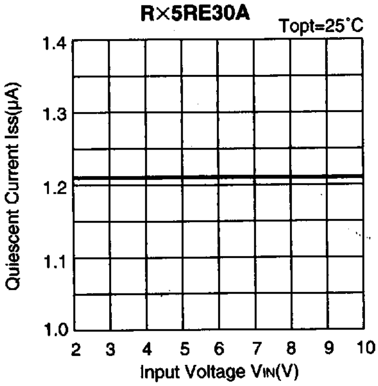


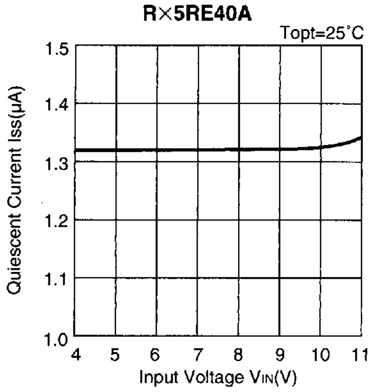
5) Quiescent Current vs. Input Voltage

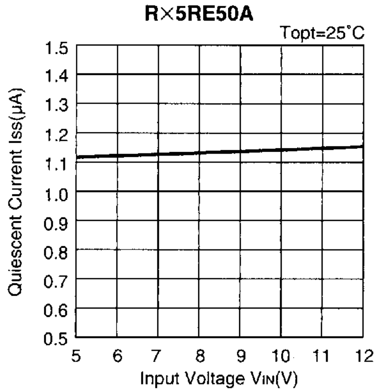
R×5RE20A



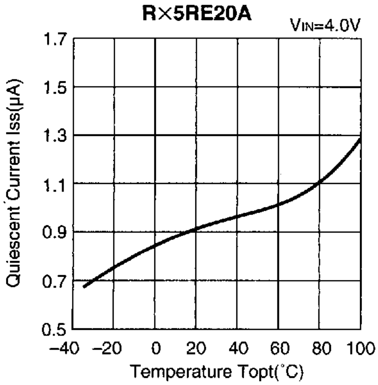
R×5RE30A

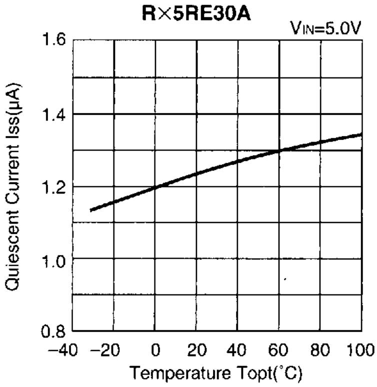


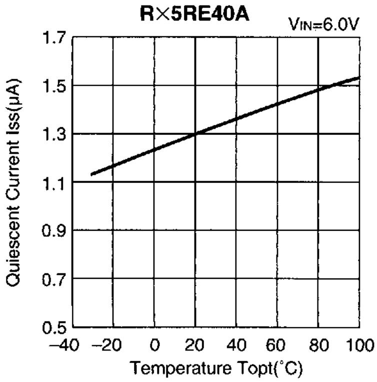


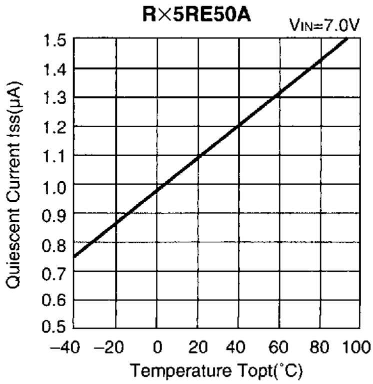


6) Quiescent Current vs. Temperature

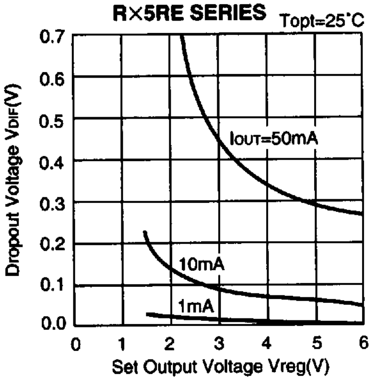




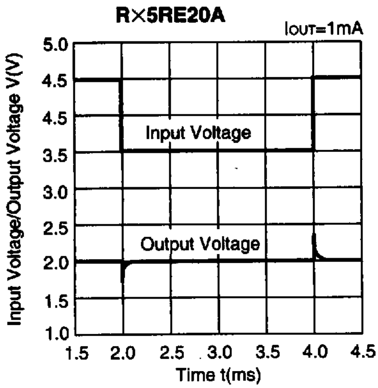


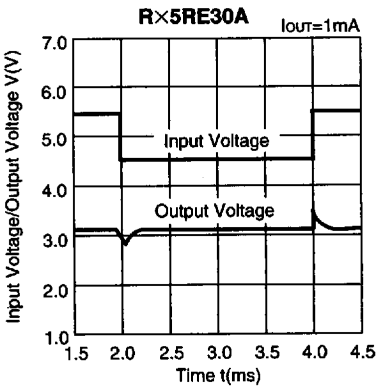


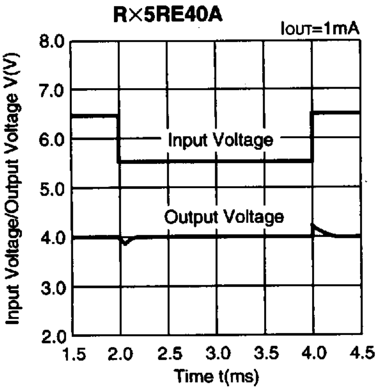
7) Dropout Voltage vs. Set Output Voltage

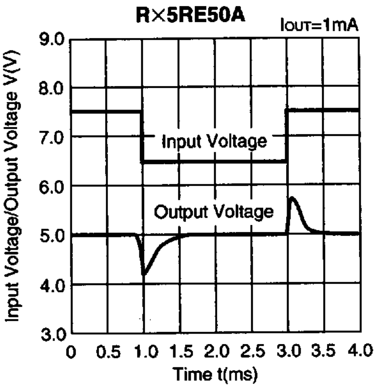


8) Line Transient Response (1)

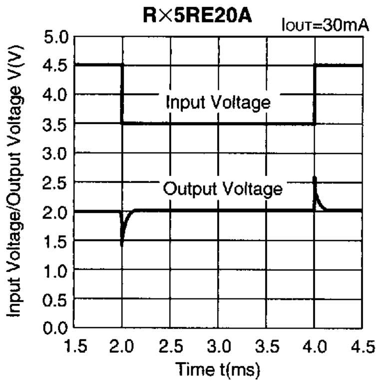


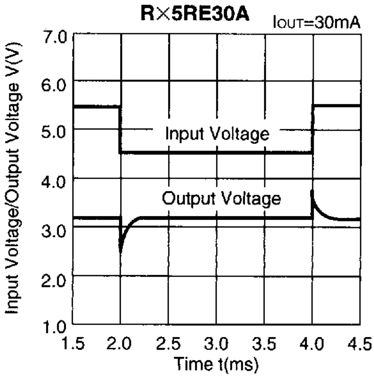


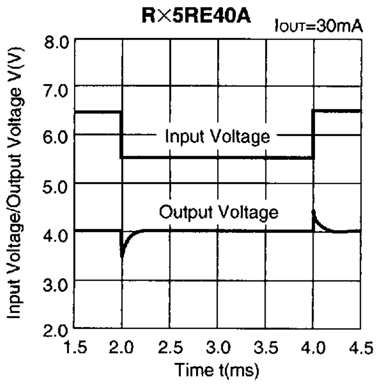


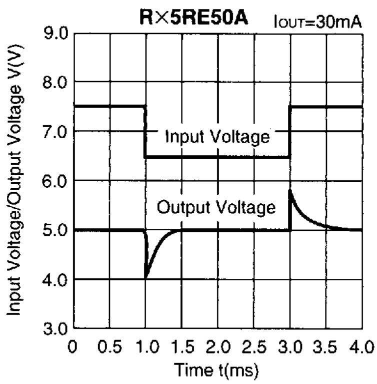


9) Line Transient Response (2)

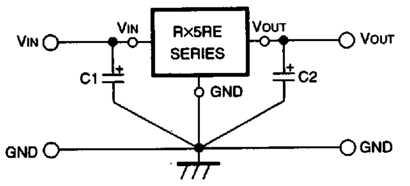








TYPICAL APPLICATION

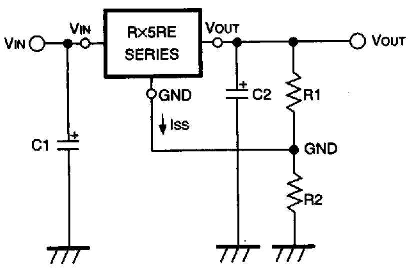


In R×5RE Series, a constant voltage can be obtained without using Capacitors C1 and C2. However, when the wire connected to VIN is long, use Capacitor C1. Output noise can be reduced by using Capacitor C2.

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 :

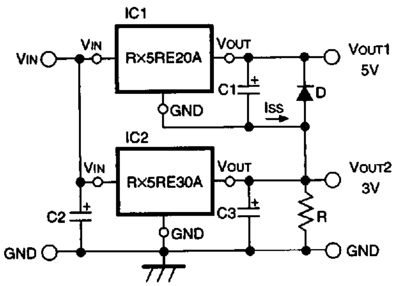
$$V_{OUT}=V_{reg}^{*1} \cdot (1+R2/R1) + I_{SS} \cdot R2$$

Since the quiescent current of R×5RE 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 R×5RE 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 R×5RE Series.

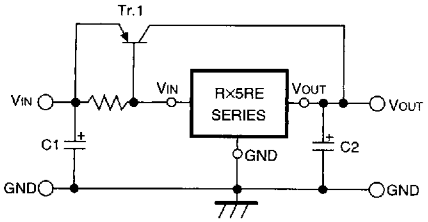
• DUAL POWER SUPPLY CIRCUIT



As shown in the circuit diagram, a dual power supply circuit can be constructed by using two R×5RE Series.

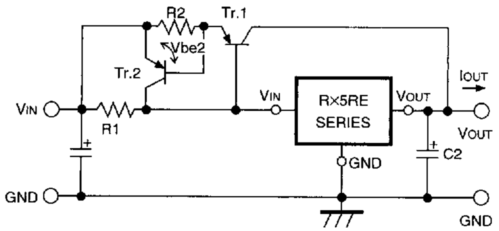
This circuit diagram shows a dual power supply circuit with an output of 3V and an output of 5V. When the minimum output current of IC2 is larger than Iss of IC1, Resistor R is unnecessary. Diode D is a protection diode for the case where VOUT2 becomes larger than VOUT1.

• CURRENT BOOST CIRCUIT



Output current of 120mA or more can be obtained by the current boost circuit constructed as shown in this circuit diagram.

• CURRENT BOOST CIRCUIT WITH OVERCURRENT LIMIT CIRCUIT



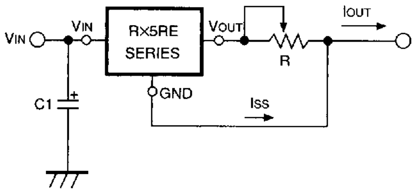
A circuit for protecting Tr.1 from the destruction caused by output short-circuit or overcurrent is shown in this circuit diagram.

When the voltage reduction caused by the current ($\fallingdotseq$ IOUT) 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 IOUT is obtained as follows :

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

Take care that Output Current IOUT does not exceed its allowable current.

*1) Vreg : Set Output Voltage of RX5RE Series.