
**VOLTAGE REGULATOR
WITH EXTERNAL POWER TRANSISTOR
RN5RG SERIES**

APPLICATION MANUAL

RN5RG SERIES**OUTLINE**

The RN5RG Series are voltage regulator ICs with an external power transistor with high output voltage accuracy and lowest supply current by CMOS process. Each of these voltage regulator ICs consists of a voltage reference unit, an error amplifier and resistors.

These ICs are suitable for constructing regulators with ultra-low dropout voltage and an output current in the range of several tens mA to several hundreds mA.

Furthermore, these ICs have a chip enable function, so that the supply current on standby can be minimized.

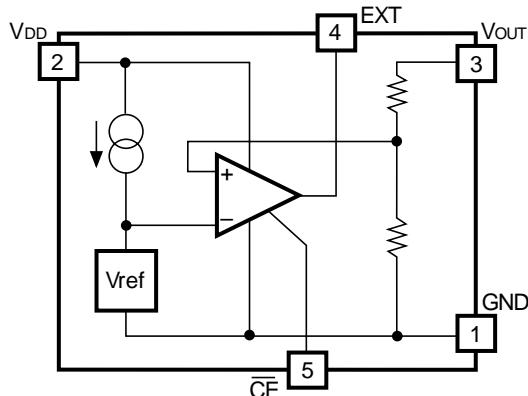
Since the package for these ICs are SOT-23-5 (Mini-mold) package, high density mounting of the ICs on boards is possible.

FEATURES

- Ultra-Low Supply CurrentTYP. 50 μ A
- Standby ModeTYP. 0.2 μ A
- Ultra-Low Dropout VoltageTYP. 0.1V (I_{OUT}=100mA : dependent on External Tr.)
- Low Temperature-Drift Coefficient of Output VoltageTYP. \pm 100 ppm/ $^{\circ}$ C
- Excellent Line RegulationTYP. 0.1%/V
- Output VoltageStepwise setting with a step of 0.1V in the range of 2.0V to 6.0V is possible (refer to Selection Guide).
- High Accuracy Output Voltage \pm 2.5%
- Small PackageSOT-23-5(Mini-Mold)

APPLICATIONS

- Power source for battery-powered equipment.
- Power source for cameras, VCRs, camcorders, hand-held audio instruments, and hand-held communication equipment.
- Power source for domestic appliances.

BLOCK DIAGRAM

SELECTION GUIDE

The output voltage, the version, the packing type, and the taping type for the ICs can be selected at the user's request.

The selection can be made by designating the part number as shown below :

RN5RG $\underset{\uparrow}{X}$ $\underset{\uparrow\uparrow}{X}$ $\underset{\uparrow}{X}$ - $\underset{\uparrow}{X}$ $\underset{\uparrow}{X}$ ← Part Number

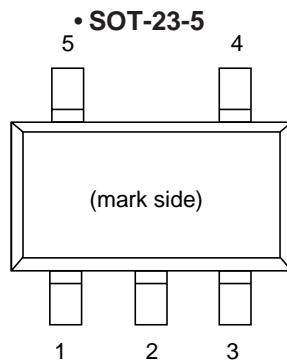
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a b c d

Code	Contents
a	Setting Output Voltage (VOUT): Stepwise setting with a step of 0.1V in the range of 2.0V to 6.0V is possible.
b	A
c	Designation of Packing Type: A: Taping C: Antistatic bag for samples
d	Designation of Taping Type: Ex. TR, TL (refer to Taping Specifications) “TR” is prescribed as a standard.

For example, the product with Output Voltage 5.0V, Version A, and Taping Type TR is designated by Part Number RN5RG50AA-TR.

PIN CONFIGURATION



PIN DESCRIPTION

Pin No.	Symbol	Description
1	GND	Ground Pin
2	VDD	Input Pin
3	VOUT	Output Pin
4	EXT	External Transistor Drive Pin (Nch Open Drain Output)
5	$\overline{\text{CE}}$	Chip Enable Pin

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V _{IN}	Input Voltage	+12	V
V _{CE}	Input Voltage ($\overline{\text{CE}}$ Pin)	-0.3 to V _{IN} +0.3	V
V _{EXT}	EXT Output Voltage	+12	V
I _{EXT}	EXT Output Current	50	mA
P _D	Power Dissipation	150	mW
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	

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

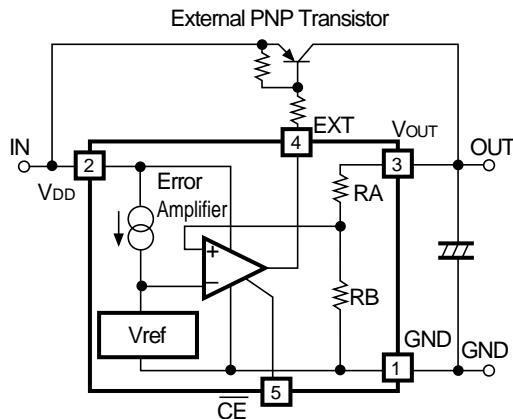
Topt=25°C

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit	Note
VOUT	Output Voltage	VIN=8.0V IOUT=50mA	VOUT ×0.975		VOUT ×1.025	V	
IOUT	Output Current	VIN-VOUT=1.0V		1000		mA	Note
IEXT	EXT Current	VIN=4.0V, VEXT=2.0V	10			mA	
$\frac{\Delta V_{\text{OUT}}}{\Delta I_{\text{OUT}}}$	Load Regulation	VIN-VOUT=1.0V 1mA≤IOUT≤100mA	-60		60	mV	
VDIF	Dropout Voltage	IOUT=100mA		100	200	mV	
ISS	Supply Current	VIN-VOUT=1.0V IOUT=0mA (at no load)		50	80	µA	
Istandby	Supply Current (Standby)	VIN=8V	0.01	0.2	1.0	µA	
IEXTleak	EXT Leakage Current				0.5	µA	
$\frac{\Delta V_{\text{OUT}}}{\Delta V_{\text{IN}}}$	Line Regulation	IOUT=50mA VOUT+0.5V≤VIN≤8V	0	0.1	0.3	%/V	
VIN	Input Voltage				8	V	
VEXT	EXT Output Voltage				8	V	
$\frac{\Delta V_{\text{OUT}}}{\Delta T_{\text{opt}}}$	Output Voltage Temperature Coefficient	IOUT=10mA -40°C≤Topt≤85°C		±100		ppm/°C	
VCEH	\overline{CE} Input Voltage "H"		1.5			V	
VCEL	\overline{CE} Input Voltage "L"				0.25	V	
ICEH	\overline{CE} Input Current "H"			0	0.1	µA	
ICEL	\overline{CE} Input Current "L"		-5	-3	-0.1	µA	

(Note) The output current depends upon the performance of External PNP Transistor. Use External PNP Transistor of a low saturation type, with an hFE of 100 or more.

*) With respect to Test Circuits, refer to the Typical Application.

OPERATION



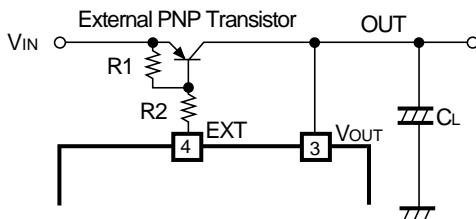
In these ICs, Output Voltage VOUT is detected by Feed-back Registers RA, RB, and the detected Output Voltage is compared with a reference voltage by Error Amplifier, so that the base current of External PNP Transistor is adjusted and Output Voltage VOUT is regulated.

SELECTION GUIDE FOR EXTERNAL COMPONENTS

1.External PNP Transistor

Select External PNP Transistor from the viewpoints of output current, input voltage and power dissipation.

Generally External PNP Transistor with low VCE (SAT) and high hFE is suitable.



2.Base Resistor R2

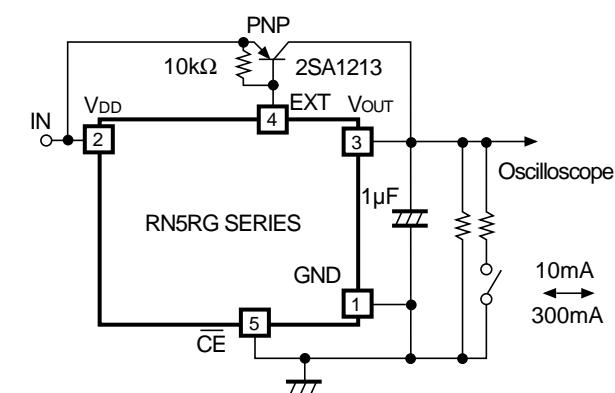
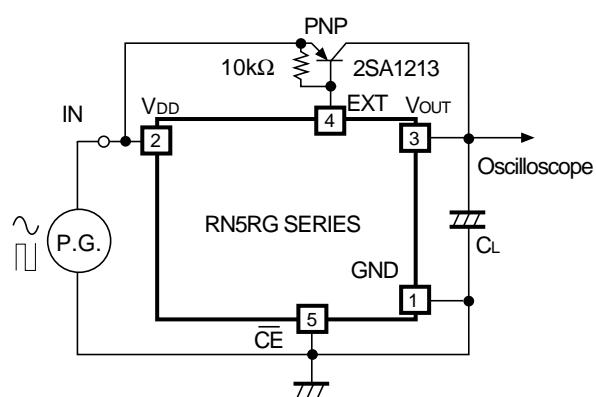
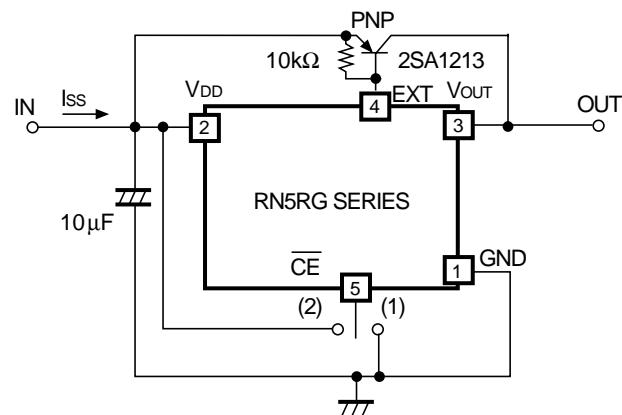
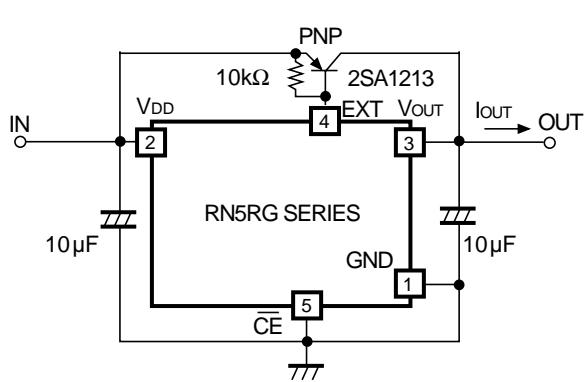
EXT Pin of these ICs is protected by a current limit circuit from the destruction caused by excess current. However, since this current limit circuit is provided for the purpose of protecting the IC, use a resistor R2 for the protection of the External Transistor, although this IC can be operated without such a resistor. It is required that the resistance of the Resistor R2 be determined with the input voltage, output voltage, output current, temperature, and the hFE value taken into consideration and the dispersion of these values. Before making such a determination, check the characteristics by calculating the respective values by using the following formula :

$$\frac{V_{IN} [\text{MIN.}]-1.2(\text{V})}{R_2} - \frac{0.7(\text{V})}{R_1} > \frac{I_{OUT} [\text{MAX.}]}{hFE}$$

3.Phase Compensation

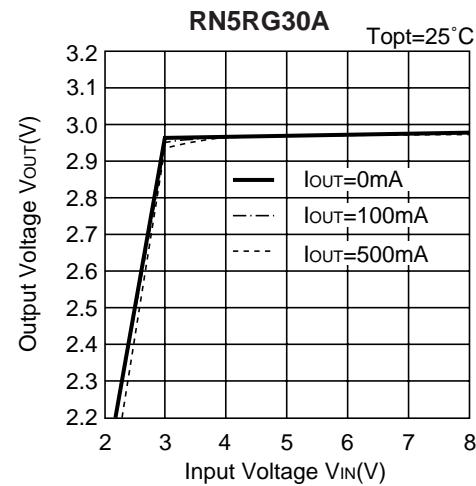
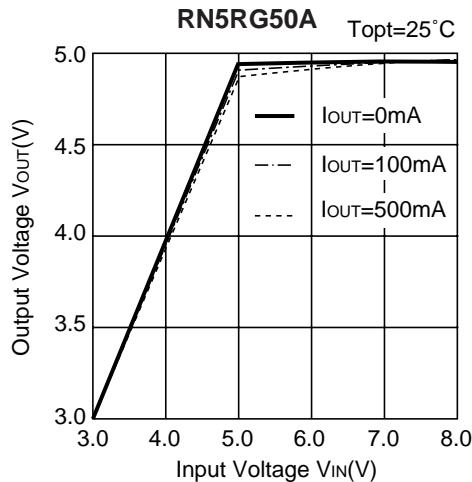
In these ICs, phase compensation is made for securing stable operation even when the load current is varied. For this purpose, be sure to use a capacitor CL (tantalum type) with a capacitance of 10μF or more and a resistor R1 with a resistance of about 10kΩ between the base and the emitter. There may be the case the loop oscillation takes place when a tantalum capacitor CL with a large ESR is used, so select the CL carefully including the frequency characteristics.

TEST CIRCUITS

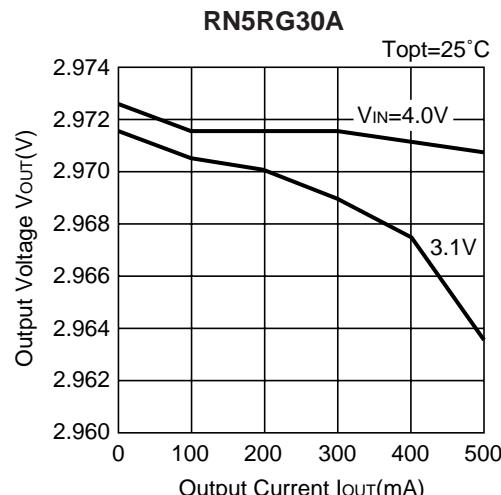
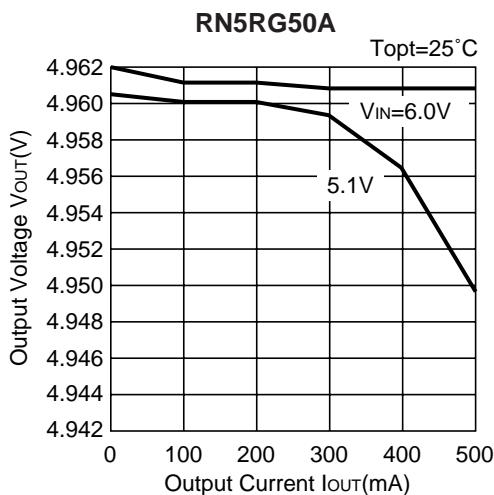


TYPICAL CHARACTERISTICS

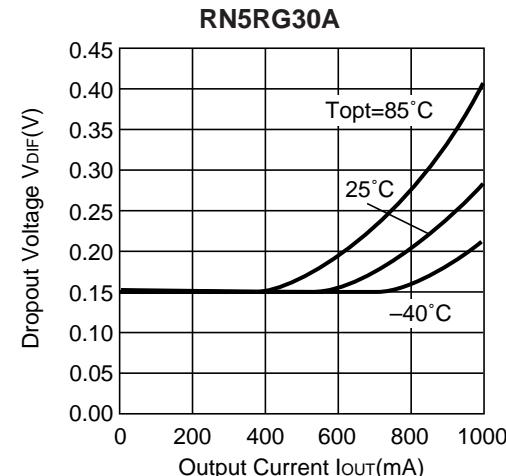
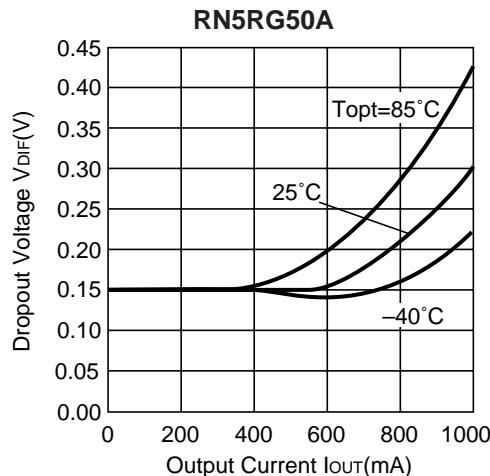
1) Output Voltage vs. Input Voltage



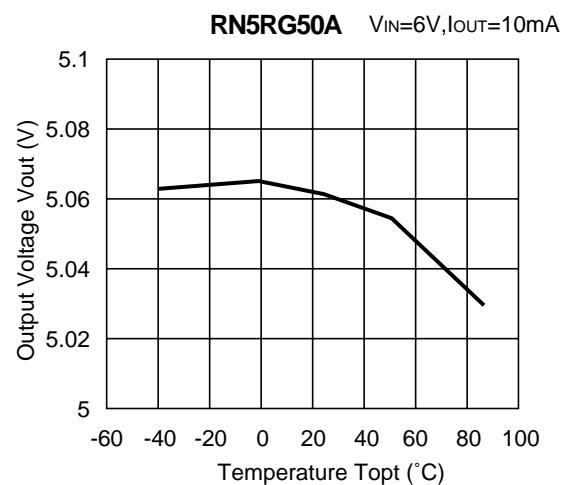
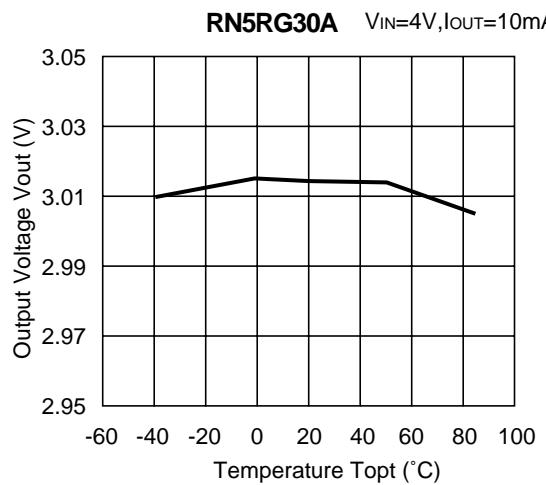
2) Output Voltage vs. Output Current



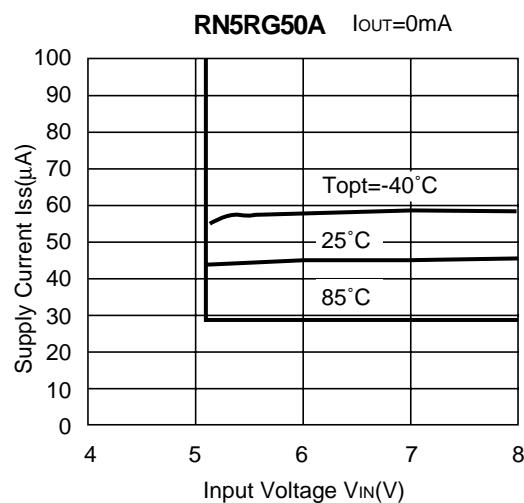
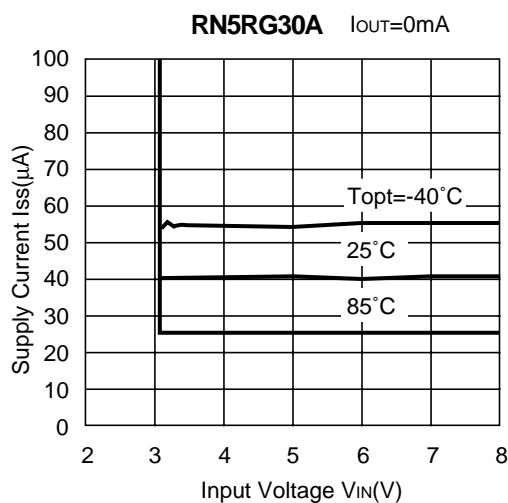
3) Dropout Voltage vs. Output Current



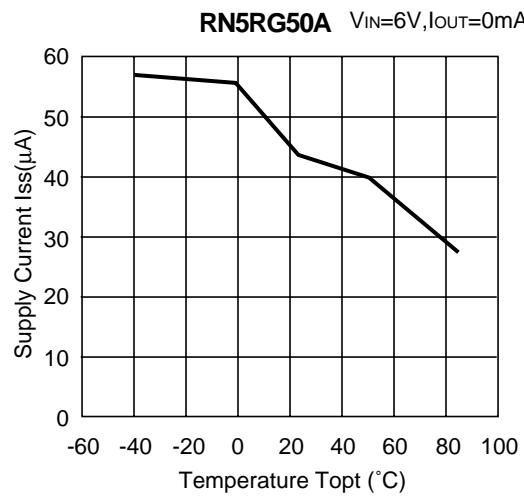
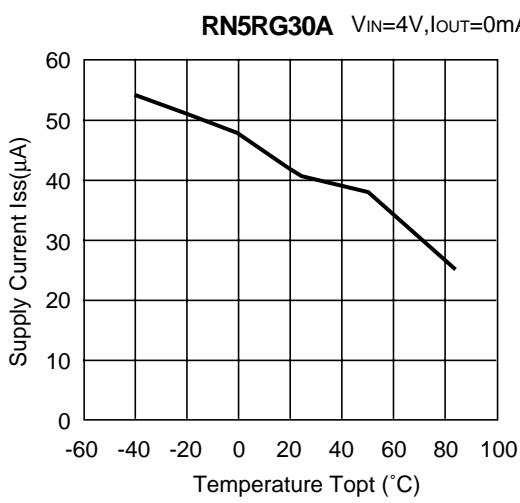
4) Output Voltage vs. Temperature

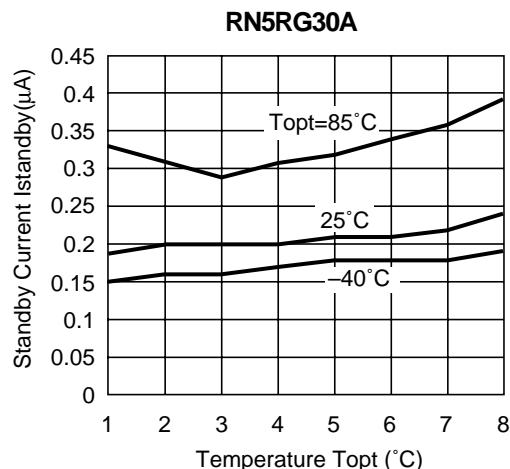
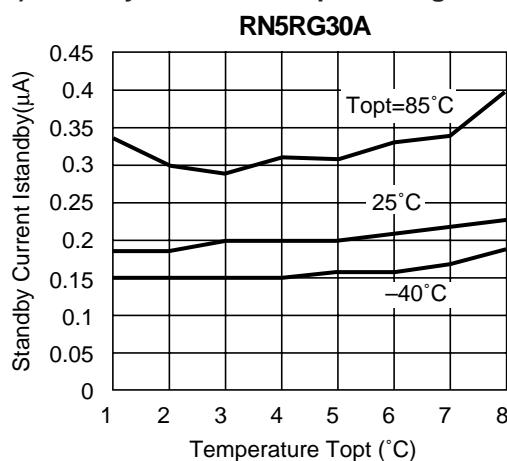
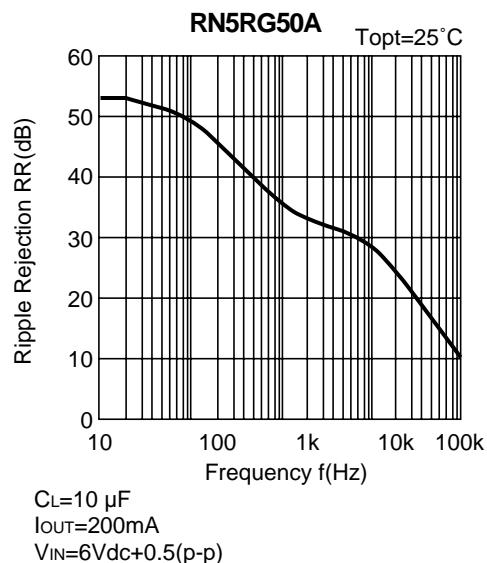
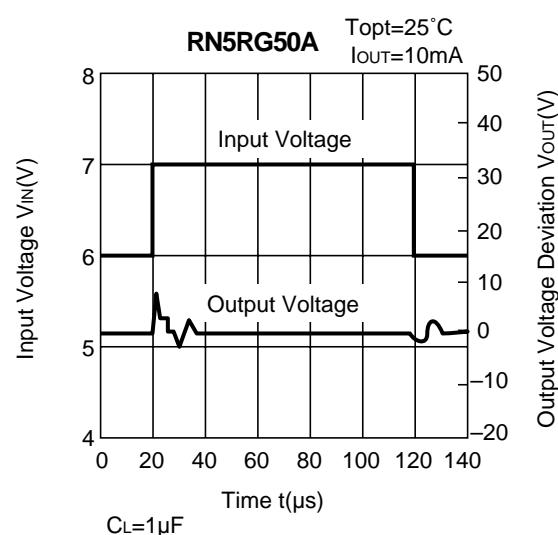
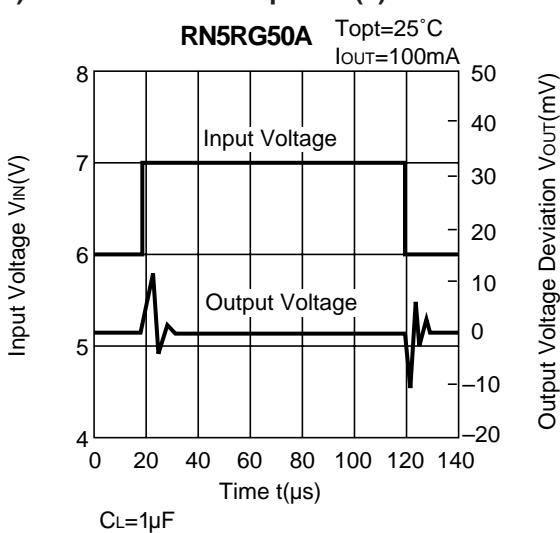
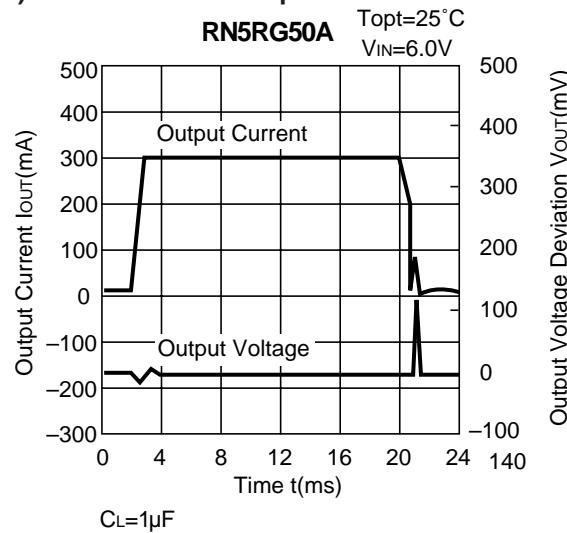


5) Supply Current vs. Input Voltage



6) Supply Current vs. Temperature



7) Standby Current vs. Input Voltage**8) Ripple Rejection****9) Line Transient Response (1)****10) Line Transient Response (2)****11) Load Transient Response**

TYPICAL APPLICATION

