
LOW RIPPLE VOLTAGE REGULATOR WITH EXTERNAL TRANSISTOR

NO. EA-043-111116

OUTLINE

The RN5RF Series are CMOS-based voltage regulator ICs which control external driver transistors with high ripple rejection, high accuracy output voltage, low supply current. Each of these voltage regulator ICs consists of a voltage reference unit, an error amplifier, output voltage setting resistor, short circuit current limiting circuit and chip enable circuit. These ICs are suitable for constructing regulators with ultra low dropout voltage and an output current in the range of several tens of mA and several hundreds mA. In addition to low supply current by CMOS process, chip enable function can be used to conserve battery life during standby.

Furthermore, a supreme ripple rejection and a transient response are suitable for portable communicator such as cell phones, PDAs, walky talkies. SOT23-5 (Mini Mold) package is available.

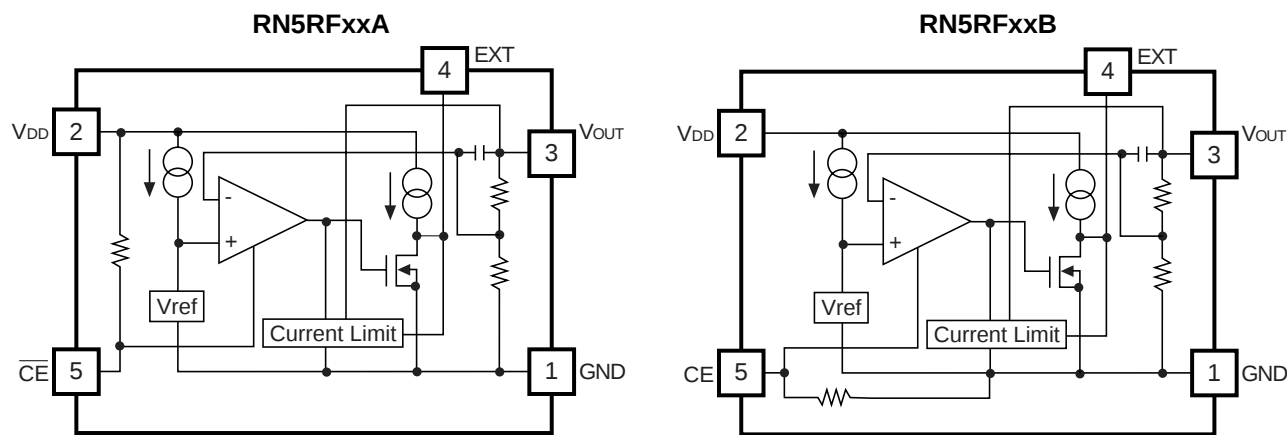
FEATURES

- Supply Current Typ. 30 μ A
- Supply Current (Standby) Typ. 0.1 μ A
- Output Voltage Accuracy $\pm 2\%$
- Ripple Rejection Typ. 60dB (f=1kHz)
- Dropout Voltage Typ. 0.1V ($I_{OUT}=100\text{mA}$, dependent on External Tr.)
- Temperature-Drift Coefficient of Output Voltage Typ. $\pm 100\text{ppm}/^{\circ}\text{C}$
- Line Regulation Typ. 0.05%/V
- Output Voltage Range 1.2V to 6.0V (0.1V steps)
(For other voltages, please refer to MARK INFORMATION.)
- Package SOT-23-5
- Current Limit for external Tr. Current limit Typ. 8mA

APPLICATIONS

- Power source for battery-powered equipment
- Power source for hand-held communication equipment, cameras, and VCRs
- Power source for home appliances

BLOCK DIAGRAMS

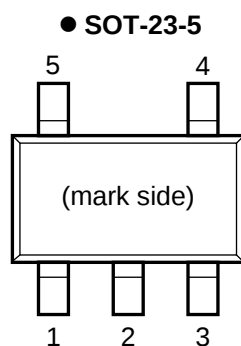


SELECTION GUIDE

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

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
RN5RFxx*A-TR-FE	SOT-23-5	3,000 pcs	Yes	Yes
xx: The output voltage can be designated in the range from 1.2V (12) to 6.0V (60) in 0.1V steps. (For other voltages, please refer to MARK INFORMATION.)				
* : CE pin polarity are options as follows (A) "L" active (B) "H" active				

PIN CONFIGURATION



PIN DESCRIPTION

● SOT-23-5

Pin No	Symbol	Pin Description
1	GND	Ground Pin
2	V _{DD}	Input Pin
3	V _{OUT}	Output Pin
4	EXT	External Transistor Drive Pin (CMOS Output)
5	$\overline{\text{CE}}$ or CE	Chip Enable Pin

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	12.0	V
V_{CE}	Input Voltage ($\overline{CE}$ or CE)	-0.3 to $V_{IN}+0.3$	V
V_{EXT}	EXT Output Voltage	-0.3 to $V_{IN}+0.3$	V
I_{EXT}	EXT Output Current	50	mA
P_D	Power Dissipation* (SOT-23-5)	420	mW
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.

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

• RN5RFxxA

T_{opt}=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V _{OUT}	Output Voltage	V _{IN} -V _{OUT} =1.0V I _{OUT} =50mA	V _{OUT} ×0.98		V _{OUT} ×1.02	V
I _{OUT}	Output Current	V _{IN} -V _{OUT} =1.0V		1.0 ^{*1}		A
I _{EXT}	EXT Current	V _{IN} =4.0V, V _{EXT} =2.0V	5	8	15	mA
ΔV _{OUT} /ΔI _{OUT}	Load Regulation	V _{IN} -V _{OUT} =1.0V 1mA≤I _{OUT} ≤100mA	-60		60	mV
V _{DIF}	Dropout Voltage	I _{OUT} =100mA, I _{OUT} =0mA		0.1	0.2	V
I _{SS}	Supply Current	V _{IN} -V _{OUT} =1.0V		30	50	μA
I _{standby}	Standby Current	V _{IN} =10.0V	0.01	0.10	1.00	μA
I _{EXTleak}	EXT Leakage Current				0.5	μA
ΔV _{OUT} /ΔV _{IN}	Line Regulation	I _{OUT} =50mA V _{OUT} +0.5V≤V _{IN} ≤10V	0.00	0.05	0.30	%/V
R _R	Ripple Rejection	f=1kHz, sinusoidal 0.5Vp-p V _{IN} -V _{OUT} =1.0V		60		dB
V _{IN}	Input Voltage				10	V
V _{EXT}	EXT Output Voltage				10	V
ΔV _{OUT} /ΔT _{opt}	Output Voltage Temperature Coefficient	I _{OUT} =10mA -40°C≤T _{opt} ≤85°C		±100		ppm/°C
R _{PU}	Pull up resistance for CE pin			4		MΩ
V _{CEH}	$\overline{\text{CE}}$ Input Voltage “H”		1.5		V _{IN}	V
V _{CEL}	$\overline{\text{CE}}$ Input Voltage “L”		0.00		0.25	V

*1) The output current depends on the performance of external PNP transistor. Use External PNP transistor of a low saturation type, with an h_{FE} between 100 and 300.

*) With respect to Test Circuit, refer to Typical Application.

• RN5RFxxB

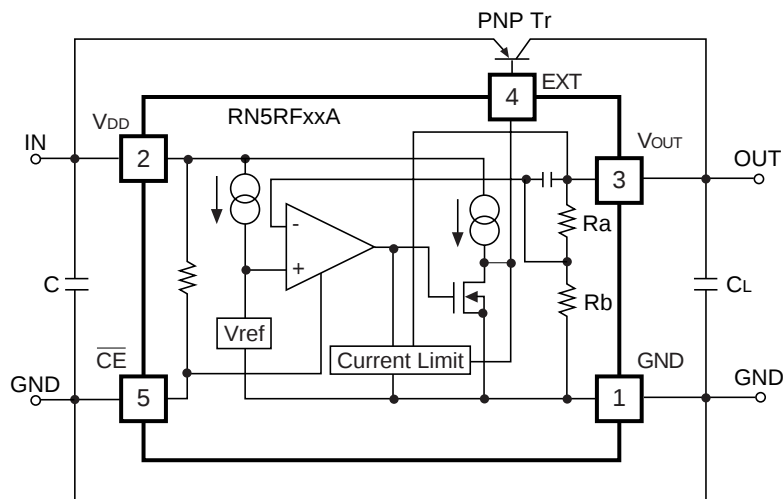
T_{opt} = 25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V _{OUT}	Output Voltage	V _{IN} -V _{OUT} =1.0V I _{OUT} =50mA	V _{OUT} ×0.98		V _{OUT} ×1.02	V
I _{OUT}	Output Current	V _{IN} -V _{OUT} =1.0V		1.0 ^{*1}		A
I _{EXT}	EXT Current	V _{IN} =4.0V, V _{EXT} =2.0V	5	8	15	mA
ΔV _{OUT} /ΔI _{OUT}	Load Regulation	V _{IN} -V _{OUT} =1.0V 1mA≤I _{OUT} ≤100mA	-60		60	mV
V _{DIF}	Dropout Voltage	I _{OUT} =100mA		0.1	0.2	V
I _{SS}	Supply Current	V _{IN} -V _{OUT} =1.0V I _{OUT} =0mA		30	50	μA
I _{standby}	Standby Current	V _{IN} =10.0V	0.01	0.10	1.00	μA
I _{EXTleak}	EXT Leakage Current				0.5	μA
ΔV _{OUT} /ΔV _{IN}	Line Regulation	I _{OUT} =50mA V _{OUT} +0.5V≤V _{IN} ≤10V	0.00	0.05	0.30	%/V
R _R	Ripple Rejection	f=1kHz, sinusoidal 0.5Vp-p V _{IN} -V _{OUT} =1.0V		60		dB
V _{IN}	Input Voltage				10	V
V _{EXT}	EXT Output Voltage				10	V
ΔV _{OUT} /ΔT _{opt}	Output Voltage Temperature Coefficient	I _{OUT} =10mA -40°C≤T _{opt} ≤85°C		±100		ppm/°C
R _{PD}	Pull down resistance for CE pin			4		MΩ
V _{CEH}	CE Input Voltage “H”		1.5		V _{IN}	V
V _{CEL}	CE Input Voltage “L”		0.00		0.25	V

*1) The output current depends on the performance of external PNP transistor. Use External PNP transistor of a low saturation type, with an h_{FE} between 100 and 300.

*) With respect to Test Circuit, refer to Typical Application.

OPERATION



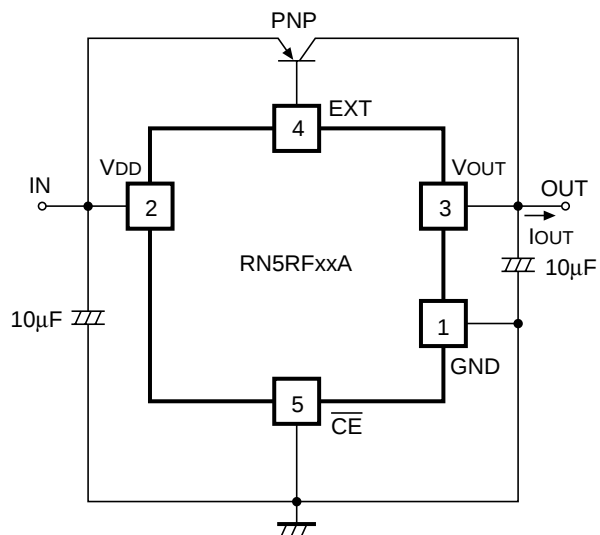
In these ICs, Output Voltage V_{OUT} is detected by feed-back resistors, R_A and R_B and the detected output voltage is compared with a reference voltage by the error amplifier so that the base current of an external PNP Transistor can be adjusted and the output voltage V_{OUT} is able to be regulated.

The base current of an external Tr. is monitored and controlled by an internal base current limit circuit to keep current within a proper range. Furthermore, the other current limit circuit prevents a problem which is that a base current increases sharply when an input voltage, V_{IN} becomes lower than set output voltage.

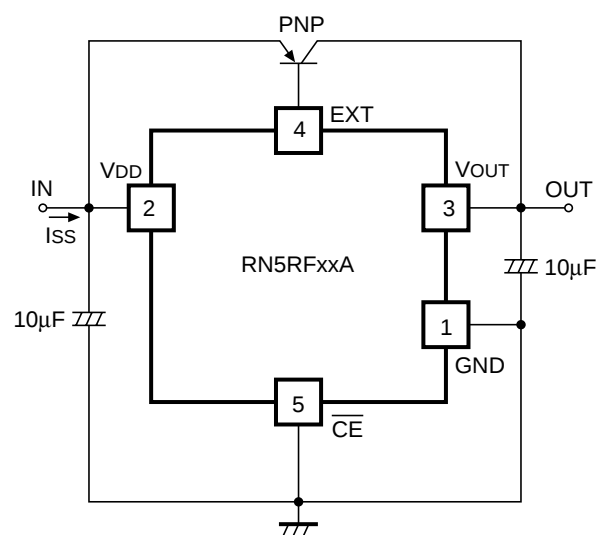
Notes on selecting external components

- (1) On external PNP transistor
Be careful of output current, input voltage and power dissipation of an external PNP Transistor.
External PNP Transistor with a low $V_{CE}(\text{sat})$ and an h_{FE} between 100 and 300 is suitable.
- (2) On phase compensation in these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, be sure to use a capacitor C_L (tantalum type) with a capacitance of $10\mu\text{F}$ or more. There may be the case the loop oscillation takes place when a tantalum capacitor C_L with a large ESR is used, so select the C_L carefully with considering the frequency characteristics also.

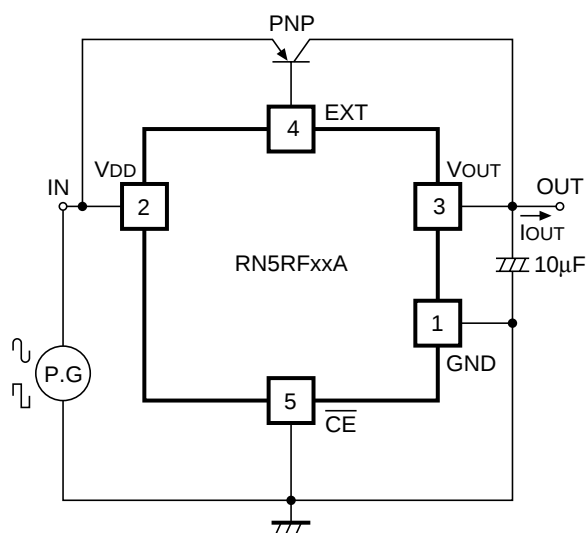
TEST CIRCUITS



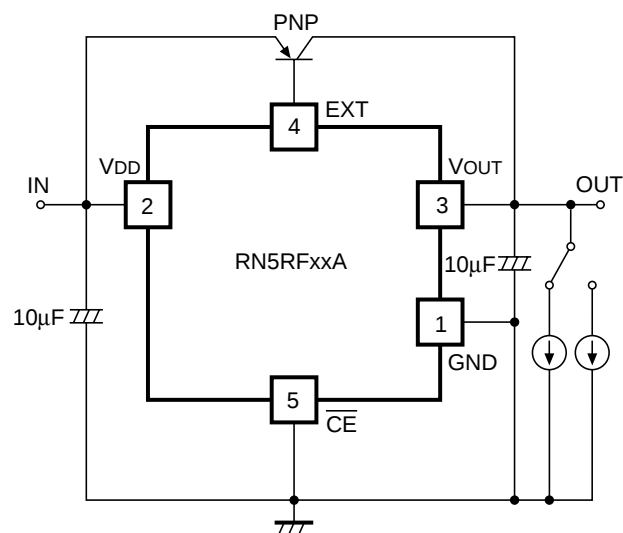
Basic Test Circuit



Test Circuit for Supply Current



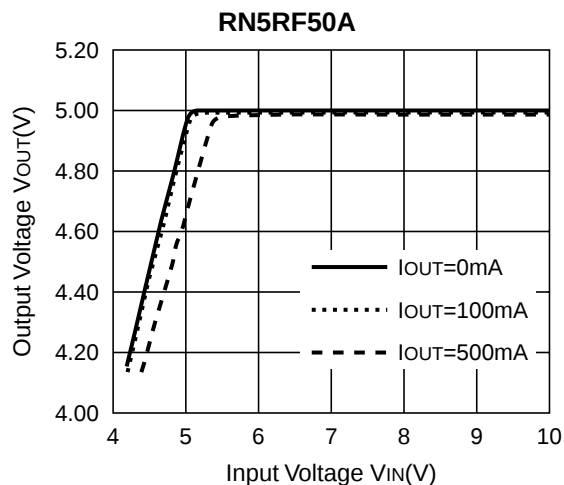
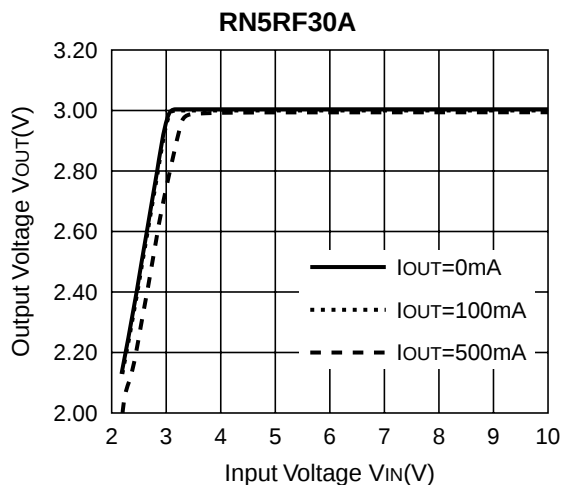
Test Circuit for Ripple Rejection and Line Transient Response



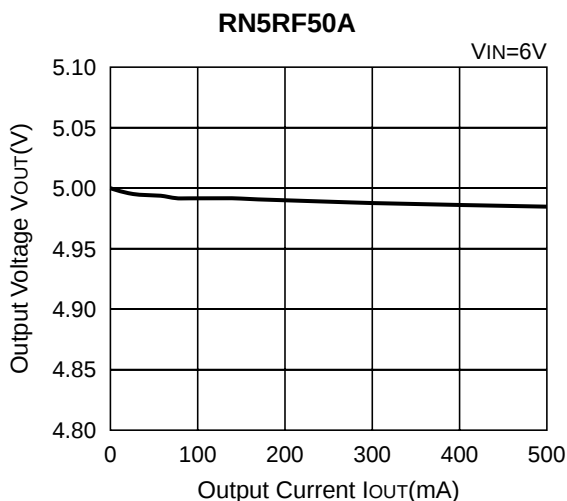
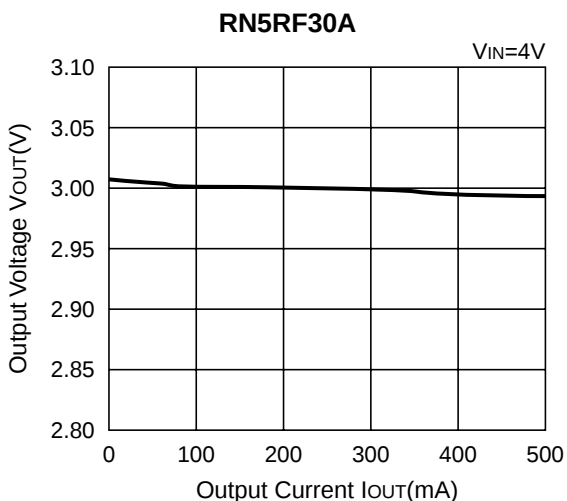
Test Circuit for Load Transient Response

TYPICAL CHARACTERISTICS

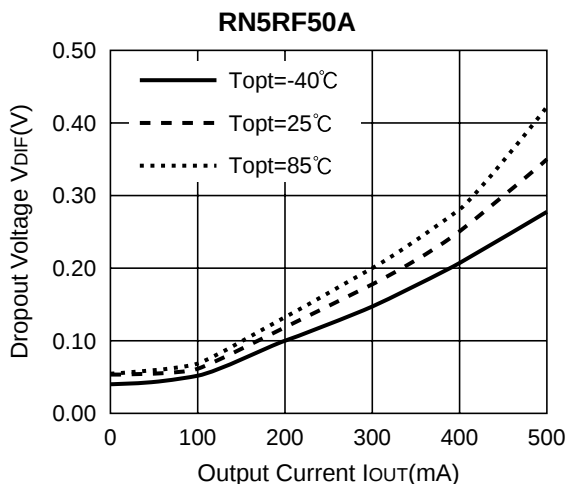
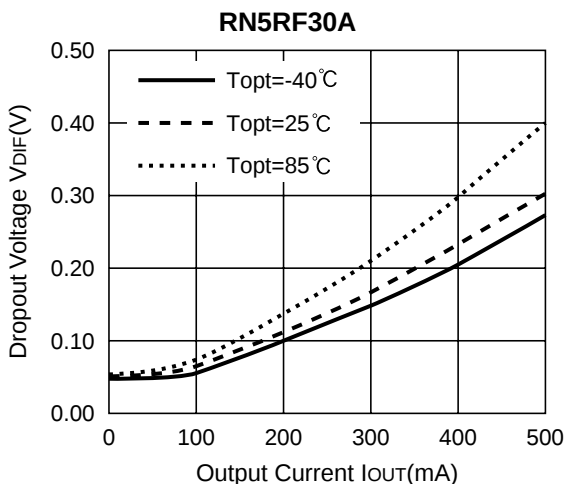
1) Output Voltage vs. Input Voltage (T_{opt}=25°C)



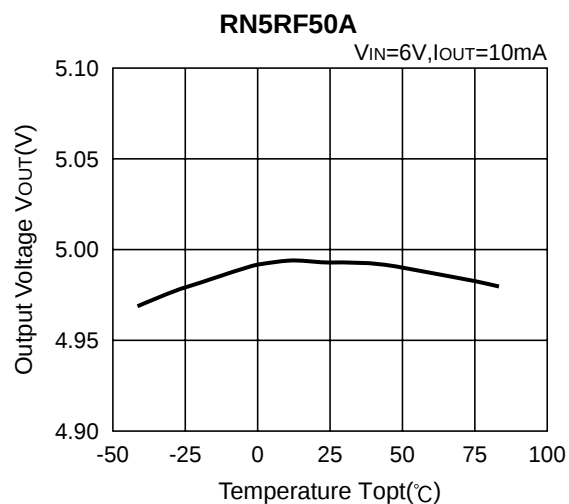
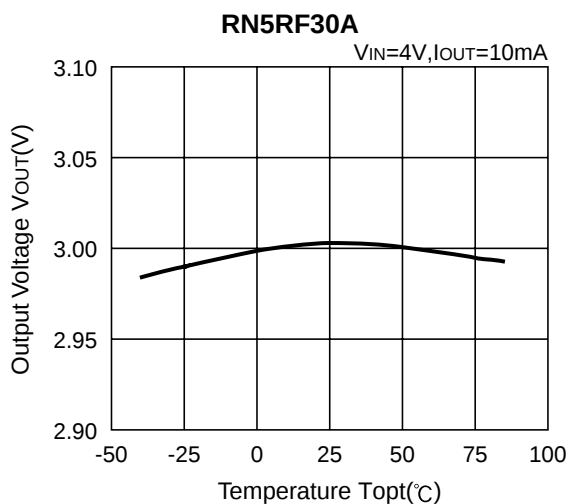
2) Output Voltage vs. Output Current (T_{opt}=25°C)



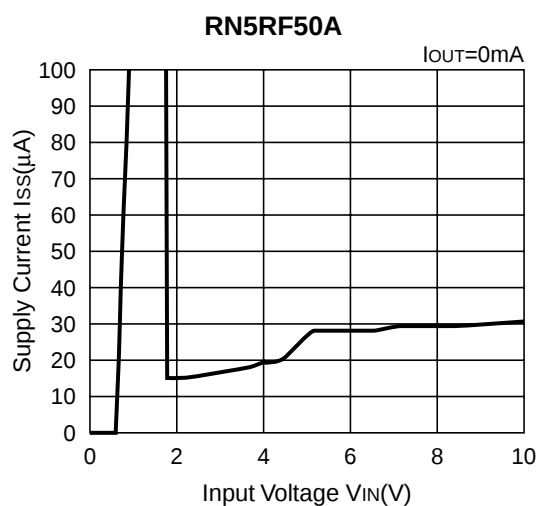
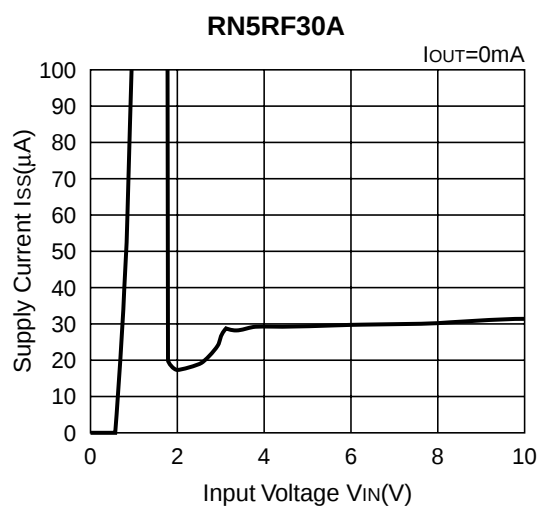
3) Dropout Voltage vs. Output Current



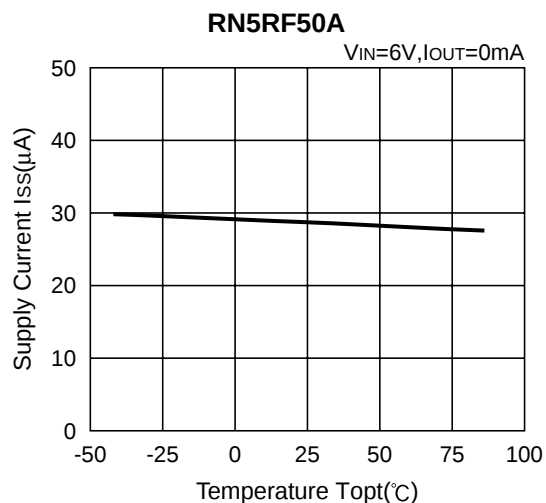
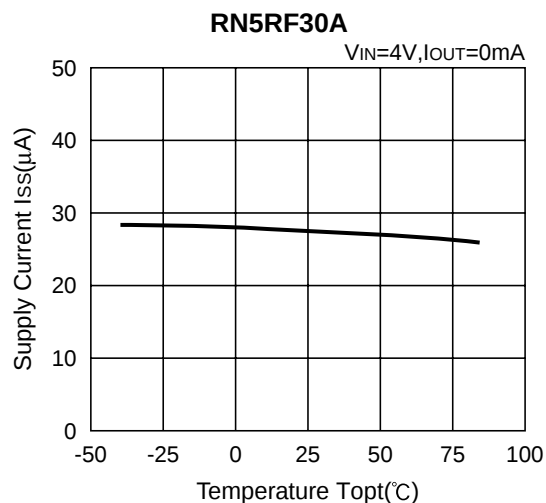
4) Output Voltage vs. Temperature



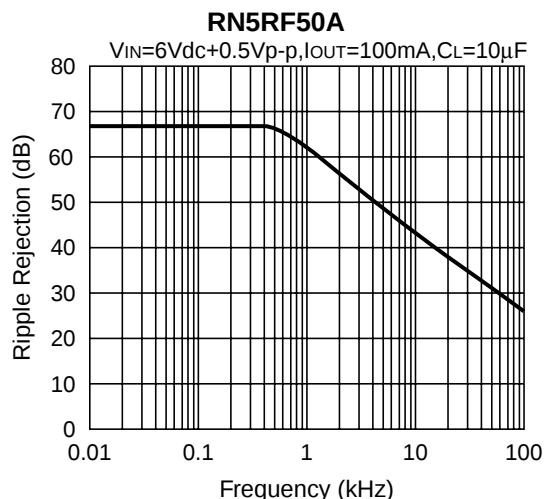
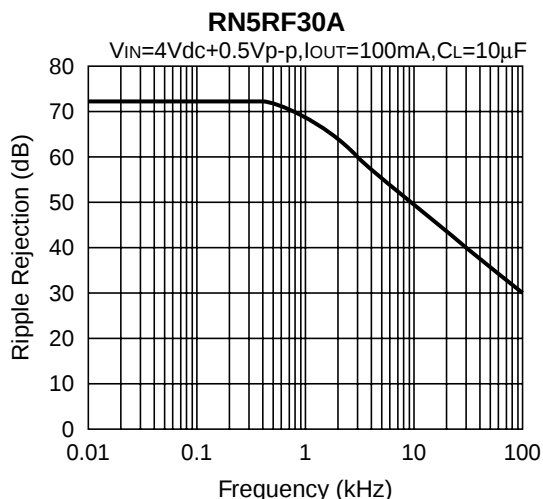
5) Supply Current vs. Input Voltage (Topt=25°C)



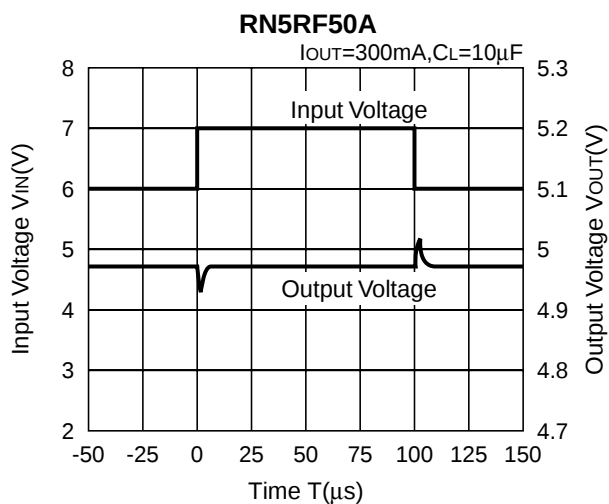
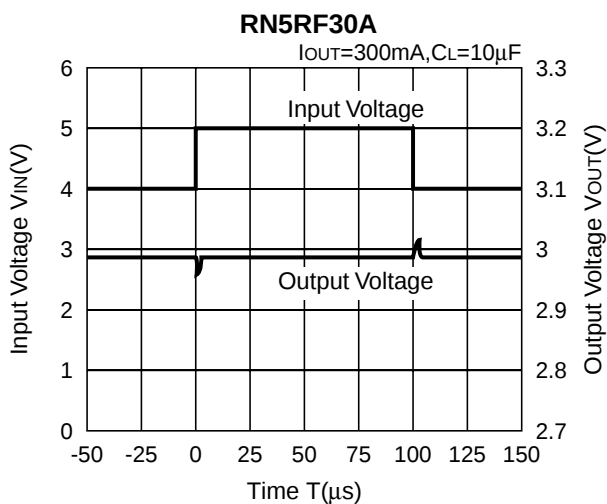
6) Supply Current vs. Temperature



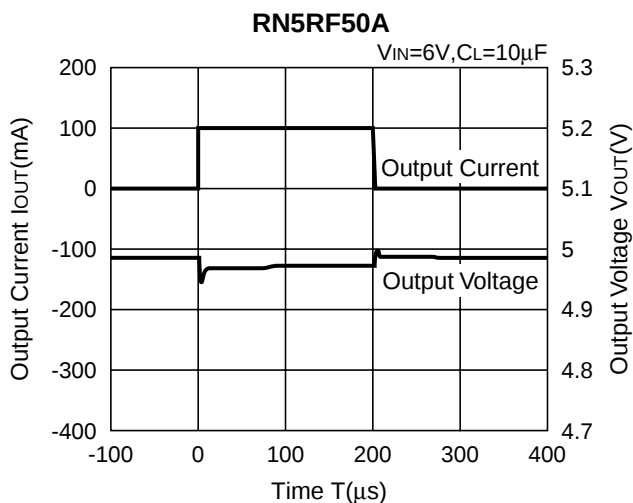
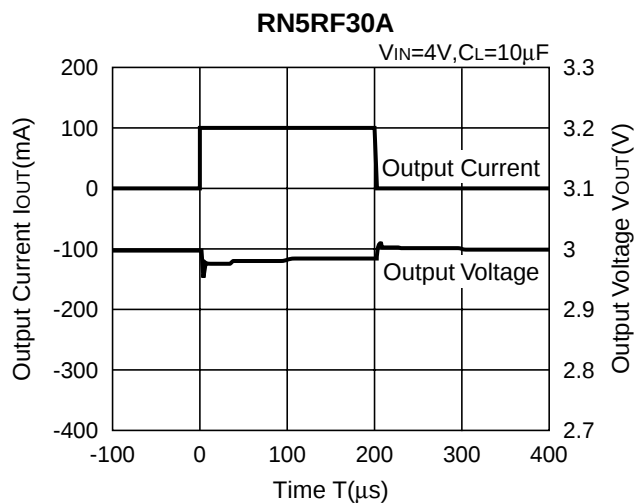
7) Ripple Rejection vs. Frequency (T_{opt}=25°C)



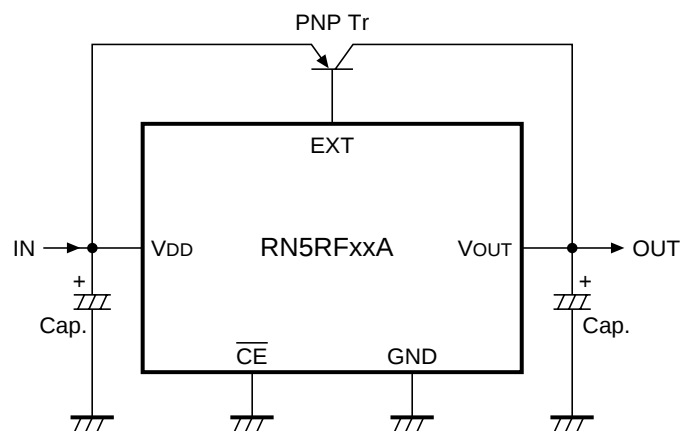
8) Line Transient Response (T_{opt}=25°C)



9) Load Transient Response (T_{opt}=25°C)



TYPICAL APPLICATION



Components

Transistor: 2SB766A

Capacitor: 10µF (Tantalum type)



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<u>RN5RF45AA-TR-FE</u>	<u>RN5RF45BA-TR-FE</u>	<u>RN5RF51AA-TR-FE</u>	<u>RN5RF52AA-TR-FE</u>	<u>RN5RF35BA-TR-FE</u>
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<u>RN5RF12BA-TR-FE</u>	<u>RN5RF13BA-TR-FE</u>	<u>RN5RF15AA-TR-FE</u>	<u>RN5RF15BA-TR-FE</u>	<u>RN5RF16BA-TR-FE</u>