RICOH

RN5RK SERIES

VFM STEP-UP DC/DC CONVERTER

NO.EA-045-0602

OUTLINE

The RN5RKxx1A/xx1B/xx2A Series are CMOS-based VFM (Chopper) Step-up DC/DC converter ICs with ultra low supply current and high output voltage accuracy.

Each of the RN5RKxx1A/xx1B consists of an oscillator, a VFM control circuit, a driver transistor to have low ON resistance (Lx switch), a reference voltage unit, a high speed comparator, resistors for voltage detection, an Lx switch protection circuit and an internal chip enable circuit. A low ripple, high efficiency step-up DC/DC converter can be composed of this RN5RKxx1A/xx1B with only three external components: an inductor, a diode and a capacitor.

The RN5RKxx2A uses the same chip as what is employed in the RN5RKxx1A/1B IC and has a drive pin (EXT) for an external transistor instead of an Lx pin. As it is possible to load a large output current with a power transistor which has a low saturation voltage, RN5RKxx2A IC is recommendable to users who need an output current as large as between several tens mA and several hundreds mA.

Using the chip enable function, it is possible to make the supply current on standby minimized.

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

FEATURES

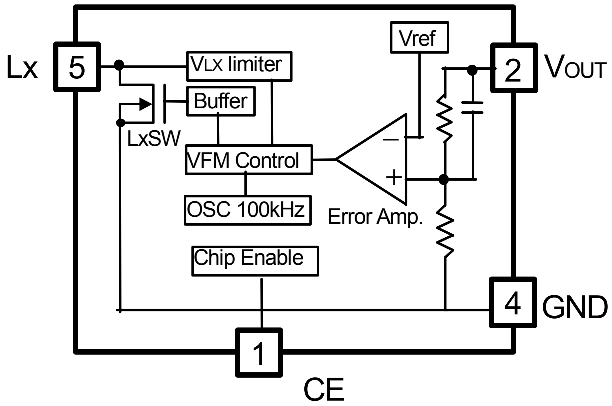
- Small Number of External Components .... Only an inductor, a diode and a capacitor (RN5RKxx1A/xx1B)
- Standby Current .... Typ. 0μA
- High Output Voltage Accuracy .... ±2.5%
- Low Ripple and Low Noise
- Low Start-up Voltage Max.0.9V
- High Efficiency .... Typ. 80%
- Including a Driver Transistor with Low ON Resistance........ Only RN5RKxx1A/xx1B
- Two Kinds of Duty Ratio... 77% (xx1A, xx2A)/ 55% (xx1B)
- Output Voltage Range... 2.0V to 5.5V
- Low Temperature-Drift Coefficient of Output Voltage........... Typ. ±100ppm/°C
- Small Packages .... SOT-23-5 (Mini-Mold)

APPLICATIONS

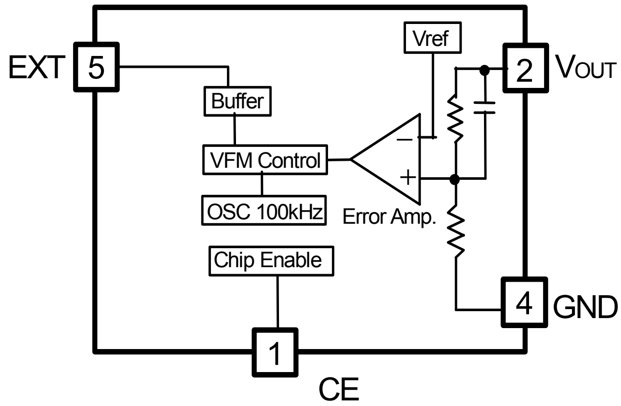
- Power source for battery-powered equipment.
- Power source for cameras, camcorders, VCRs, and hand-held communication equipment.
- Power source for those appliances which require higher cell voltage than that of batteries.

OUTLINE DIAGRAM

RN5RKxx1x



RN5RKxx2A



SELECTION GUIDE

The output voltage, the driver type, the duty cycle and the taping type for the ICs can be selected at the user's request.

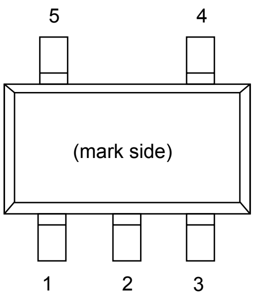
The selection can be made by designating the part number as shown below:

RN5RKxxxx-xx ←Part Number
↑ ↑↑ ↑
a bc d

Code	Contents
a	Setting Output Voltage (V_{OUT}) : Stepwise setting with a step of 0.1V in the range of 2.0V to 5.5V is possible.
b	Designation of Driver 1: Internal Lx Tr. Driver 2: External Tr. Driver
c	Designation of Duty Cycle A: 77% B: 55%
d	Designation of Taping type Ex. TR, TL (refer to Taping Specifications, TR type is prescribed as a standard.)

PIN CONFIGURATIONS

- **SOT-23-5**



PIN DISCRIPTION

- **RN5RKxx1x**

Pin No.	Symbol	Description
1	CE	Chip Enable Pin
2	V_{OUT}	Step-up Output Monitoring Pin, Power Supply (for device itself)
3	NC	No Connection
4	GND	Ground Pin
5	L_X	Switching Pin (Nch Open Drain)

- **RN5RKxx2x**

Pin No.	Symbol	Description
1	CE	Chip Enable Pin
2	V_{OUT}	Step-up Output Monitoring Pin, Power Supply (for device itself)
3	NC	No Connection
4	GND	Ground Pin
5	EXT	External Tr. Drive Pin (CMOS Output)

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{OUT}	Step-up Output Pin Voltage	9.0	V
V_{LX}	LX Pin Voltage	9.0	V
V_{EXT}	EXT Pin Voltage	-0.3 to V_{OUT}+0.3	V
V_{CE}	CE Pin Voltage	-0.3 to V_{OUT}+0.3	V
I_{LX}	Lx Pin Output Current	500	mA
I_{EXT}	EXT Pin Output Current	±30	mA
P_D	Power Dissipation (SOT-23-5)*[1]	420	mW
Topt	Operating Temperature Range	-40 to +85	°C
Tstg	Storage Temperature Range	-55 to +125	°C

*1)For Power Dissipation, please refer to PACKAGE INFORMATION to be described.

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

- **RN5RKxx1A/xx1B**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN}=Set V_{OUT}×0.6, I_{OUT}=1mA	×0.975		×1.025	V
V_{IN}	Input Voltage				8.0	V
ΔV_{OUT}/ ΔTopt	Output Voltage Temperature Coefficient	–40°C ≦ Topt ≦ 85°C		±100		ppm /°C
Vstart	Start-Up Voltage	V_{IN}=0V→2V*[1]		0.75	0.90	V
ΔVstart/ ΔTopt	Start-Up Voltage Temperature Coefficient	-40°C ≦ Topt ≦ 85°C V_{IN}=0V→2V*[1]		-1.6		mV/ °C
Vhold	Hold-on Voltage (xx1A)	V_{IN}=2V→0V*[1]	0.7			V
Vhold	Hold-on Voltage (xx1B)	V_{IN}=2V→0V*[1]	0.9			V
I_{DD2}	Supply Current2	V_{OUT}=V_{CE}=Set V_{OUT}+0.5V		2	5	µA
Istandby	Supply Current (Standby)	V_{OUT}=6V, V_{CE}=0V			0.5	µA
I_{LXleak}	Lx Leakage Current	V_{OUT}=V_{LX}=8V			1	µA
fosc	Maximum Oscillator Frequency	V_{OUT}=V_{CE}=Set V_{OUT}×0.96	80	100	120	kHz
Δfosc/ ΔTopt	Frequency Temperature Coefficient	-40°C ≦ Topt ≦ 85°C		0.41		kHz/ °C
Duty	Oscillator Duty Cycle (xx1A)	V_{OUT}=V_{CE}=Set V_{OUT}×0.96, ON (V_{LX} "L" side)	70	77	85	%
	Oscillator Duty Cycle (xx1B)		47	55	63	%
Vlxlim	V_{LX} Voltage Limit	V_{OUT}=V_{CE}=1.95, Lx Switch ON	0.4	0.6	0.8	V
V_{CEH}	CE "H" Input Voltage	V_{OUT}=V_{CE}=Set V_{OUT}×0.96, Judgment is made by the Lx waveform	0.9			V
V_{CEL}	CE "L" Input Voltage				0.3	V
I_{CEH}	CE "H" Input Current	V_{OUT}=6.0V, V_{CE}=6.0V	-0.5	0.0	0.5	µA
I_{CEL}	CE "L" Input Current	V_{OUT}=6.0V, V_{CE}=0.0V	-0.5	0.0	0.5	µA
I_{DD1}	Supply Current1 *[2]	2.0V ≦ V_{OUT} ≦ 2.4V		25	50	µA
		2.5V ≦ V_{OUT} ≦ 2.9V		30	55	µA
		3.0V ≦ V_{OUT} ≦ 3.4V		35	60	
		3.5V ≦ V_{OUT} ≦ 3.9V		40	65	
		4.0V ≦ V_{OUT} ≦ 4.4V		45	75	
		4.5V ≦ V_{OUT} ≦ 4.9V		50	80	
		5.0V ≦ V_{OUT} ≦ 5.5V		60	90	

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
I_{LX}	Lx Switching Current	2.0V ≦ V_{OUT} ≦ 2.4V, V_{LX}=0.4V	80			mA
		2.5V ≦ V_{OUT} ≦ 2.9V, V_{LX}=0.4V	100			
		3.0V ≦ V_{OUT} ≦ 3.4V, V_{LX}=0.4V	120			
		3.5V ≦ V_{OUT} ≦ 3.9V, V_{LX}=0.4V	140			
		4.0V ≦ V_{OUT} ≦ 4.4V, V_{LX}=0.4V	160			
		4.5V ≦ V_{OUT} ≦ 4.9V, V_{LX}=0.4V	180			
		5.0V ≦ V_{OUT} ≦ 5.5V, V_{LX}=0.4V	200			

*1)Condition: An Output load resistor R_L is connected between V_{OUT} and GND.
Note that the resistor R_L has a resistance which makes an output current 1mA after step-up operation.

*2)The Supply Current 1 (I_{DD1}) for IC itself is measured when the internal oscillator works continuously.
If the oscillator works intermittently, the supply current becomes smaller than the value which is written on the above table.
Measurement condition: V_{OUT}=V_{CE}=Setting Output Voltage×0.96

● RN5RKxx2A

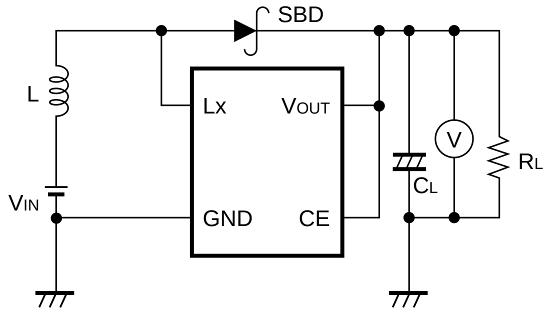
Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	V_{IN}=Set V_{OUT}×0.6, I_{OUT}=1mA	×0.975		×1.025	V
V_{IN}	Input Voltage				8.0	V
ΔV_{OUT}/ ΔTopt	Output Voltage Temperature Coefficient	–40°C ≦ Topt ≦ 85°C		±100		ppm /°C
Vstart	Start-Up Voltage	V_{IN}=0V→2V*1		0.7	0.8	V
ΔVstart/ ΔTopt	Start-Up Voltage Temperature Coefficient	-40°C ≦ Topt ≦ 85°C V_{IN}=0V→2V*1	-1.6			mV/ °C
I_{DD2}	Supply Current2	V_{OUT}=V_{CE}=Set V_{OUT}+0.5V		2	5	μA
Istandby	Supply Current (Standby)	V_{OUT}=6V, V_{CE}=0V			0.5	μA
fosc	Maximum Oscillator Frequency	V_{OUT}=V_{CE}=Set V_{OUT}×0.96	80	100	120	kHz
Δfosc/ ΔTopt	Frequency Temperature Coefficient	-40°C ≦ Topt ≦ 85°C		0.41		kHz/ °C
Duty	Oscillator Duty Cycle	V_{OUT}=V_{CE}=Set V_{OUT}×0.96, ON (V_{LX} “H” side)	70	77	85	%
V_{CEH}	CE “H” Input Voltage	V_{OUT}=V_{CE}=Set V_{OUT}×0.96, Judgment is made by the EXT waveform			0.3	V
V_{CEL}	CE “L” Input Voltage			0.7	0.8	V
I_{CEH}	CE “H” Input Current	V_{OUT}=6.0V, V_{CE}=6.0V	-0.5	0.0	0.5	μA
I_{CEL}	CE “L” Input Current	V_{OUT}=6.0V, V_{CE}=0.0V	-0.5	0.0	0.5	μA
I_{DD1}	Supply Current1 *2	2.0V ≦ V_{OUT} ≦ 2.9V,EXT no load		20	40	μA
		3.0V ≦ V_{OUT} ≦ 3.9V,EXT no load		25	50	μA
		3.0V ≦ V_{OUT} ≦ 3.4V,EXT no load		30	60	
		3.5V ≦ V_{OUT} ≦ 3.9V,EXT no load		35	70	
I_{EXTH}	EXT “H” Output Current	2.0V ≦ V_{OUT} ≦ 2.4V, V_{EXT}=0.4V			-1.0	mA
		2.5V ≦ V_{OUT} ≦ 2.9V, V_{EXT}=0.4V			-1.5	
		4.0V ≦ V_{OUT} ≦ 5.5V, V_{EXT}=0.4V			-2.0	
	EXT “L” Output Current	2.0V ≦ V_{OUT} ≦ 2.9V, V_{EXT}=0.4V	1.0			
		3.0V ≦ V_{OUT} ≦ 3.9V, V_{EXT}=0.4V	1.5			
		4.0V ≦ V_{OUT} ≦ 5.5V, V_{EXT}=0.4V	2.0			

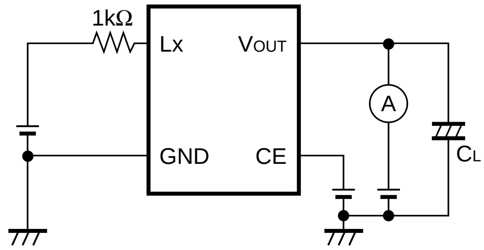
*1)Condition: An Output load resistor R_L is connected between V_{OUT} and GND.
Note that the resistor R_L has a resistance which makes an output current 1mA after step-up operation.

*2)The Supply Current 1 (I_{DD1}) for IC itself is measured when the internal oscillator works continuously.
If the oscillator works intermittently, the supply current becomes smaller than the value which is written on the above table. Measurement condition: V_{OUT}=V_{CE}=Setting Output Voltage×0.96

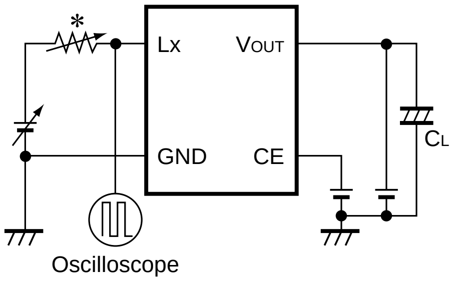
TEST CIRCUITS



Test Circuit 1



Test Circuit 2



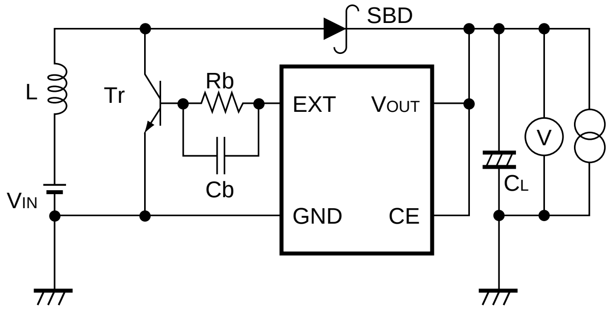
Test Circuit 3

*)When V_{LX}lim and I_{LX} are measured, the 5Ω resistor is used. Otherwise 1kΩ is used.

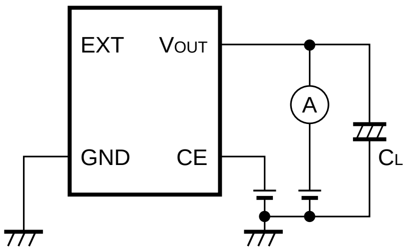
Components Inductor	(L)	: 100μH, 220μH (Sumida Electric Co., Ltd; CD-54)
Diode	(SBD)	: MA721 (Matsushita Electronics Corporation; Schottky Type)
Capacitor	(C_L)	: 47μF (Tantalum Type)

Using these test circuits characteristics data has been obtained as shown on the following pages.

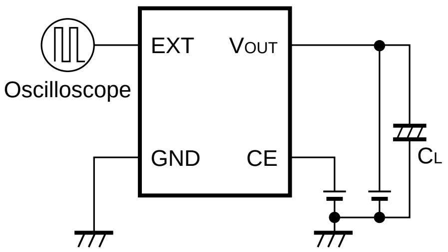
Test Circuit 1: Typical Characteristics (1)-(7)
Test Circuit 2: Typical Characteristics (9)-(11)
Test Circuit 3: Typical Characteristics (8), (12)-(16)



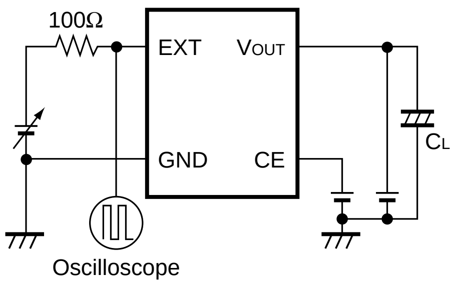
Test Circuit 1



Test Circuit 2



Test Circuit 3



Test Circuit 4

Components Inductor	(L)	: 27μH (Sumida Electric Co., Ltd; CD-104)
Diode	(SBD)	: RB111C (Rohm Co., Ltd; Schottky Type)
Capacitor	(CL)	: 47μF×2(Tantalum Type)
Transistor	(Tr)	: 2SD1628G
Base Resistor	(Rb)	: 300W Base Capacitor (Cb): 0.01μF

The typical characteristics were obtained with using these test circuits.

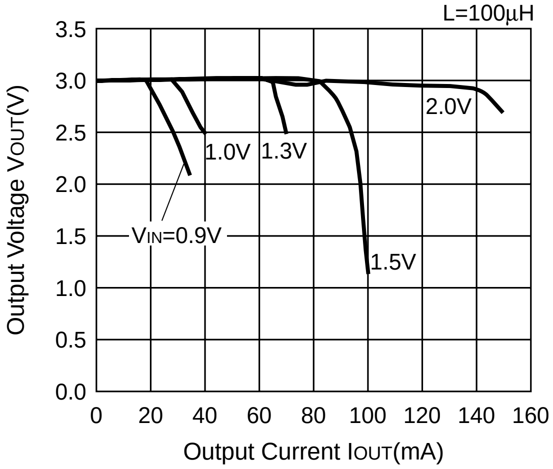
Test Circuit 1: Typical Characteristics (1)-(5)
Test Circuit 2: Typical Characteristics (8)-(10)
Test Circuit 3: Typical Characteristics (11)-(14)
Test Circuit 4: Typical Characteristics (6), (7)

TYPICAL CHARACTERISTICS

● RN5RKxx1A/B

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

RN5RK301A



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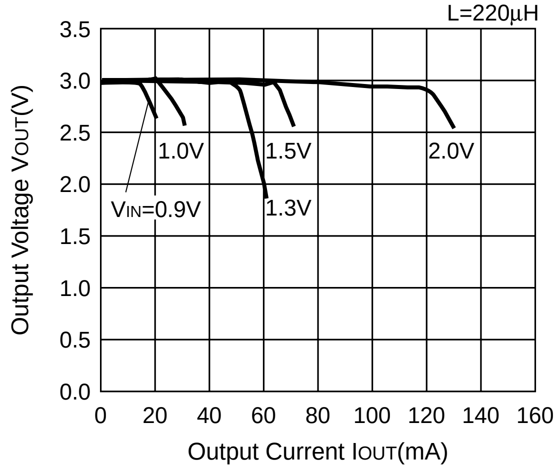
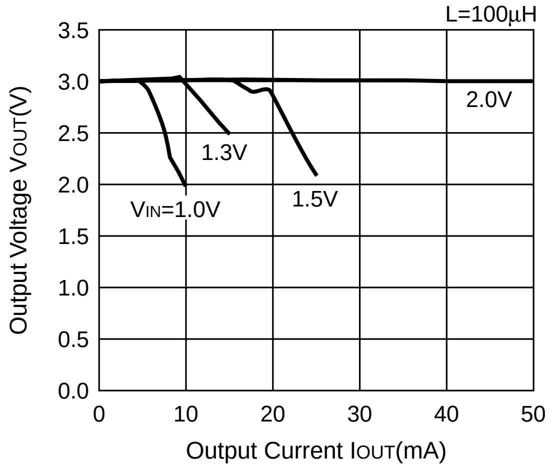


RN5RK301B



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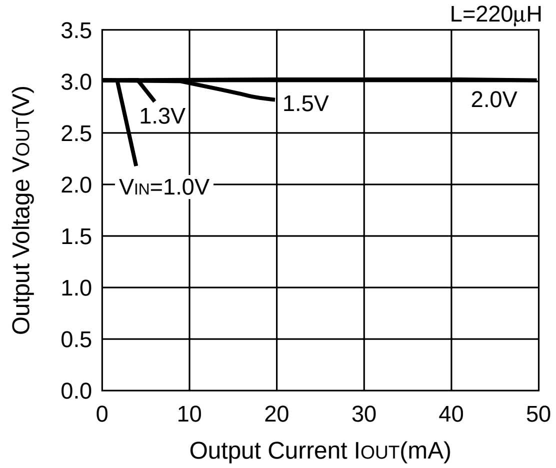

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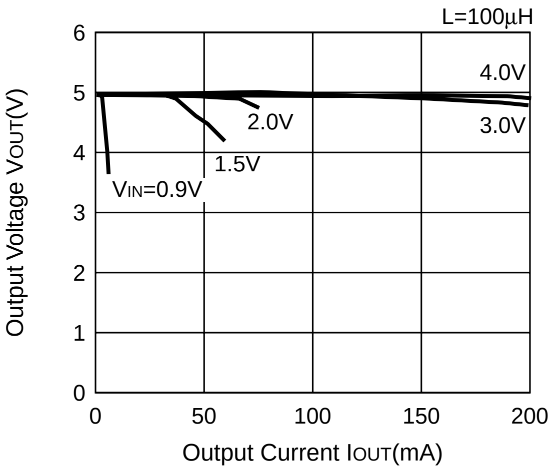

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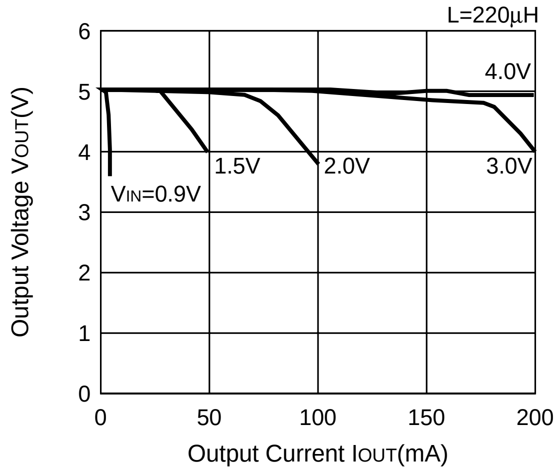

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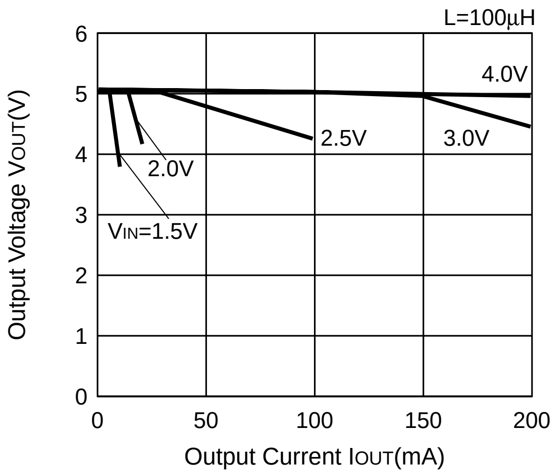

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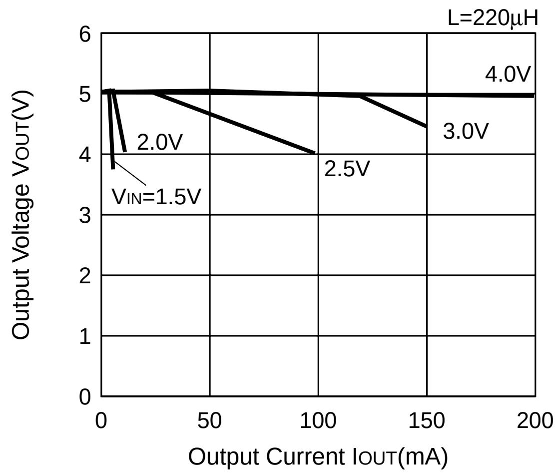
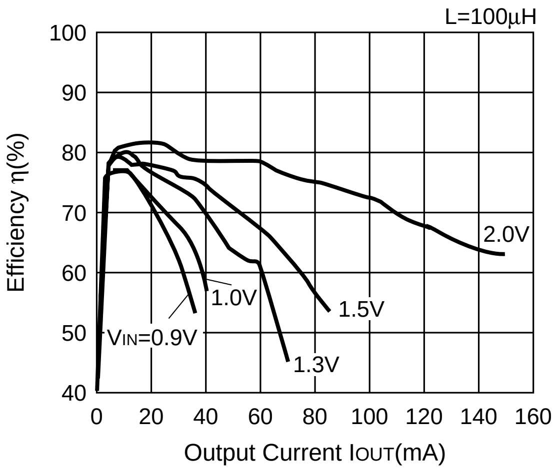


2) Efficiency vs. Output Current (Topt=25°C)

RN5RK301A



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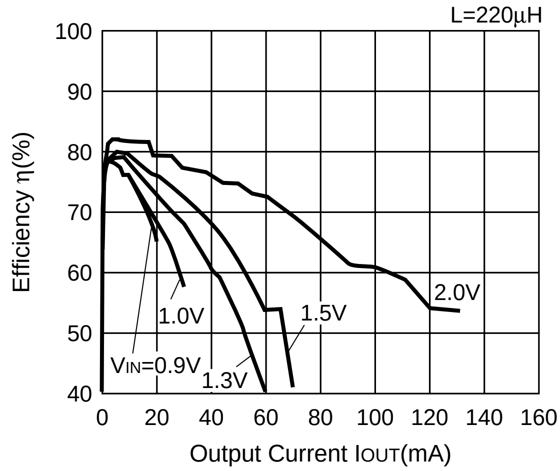

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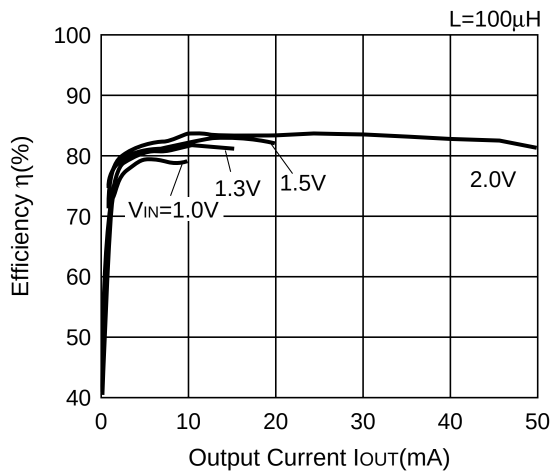

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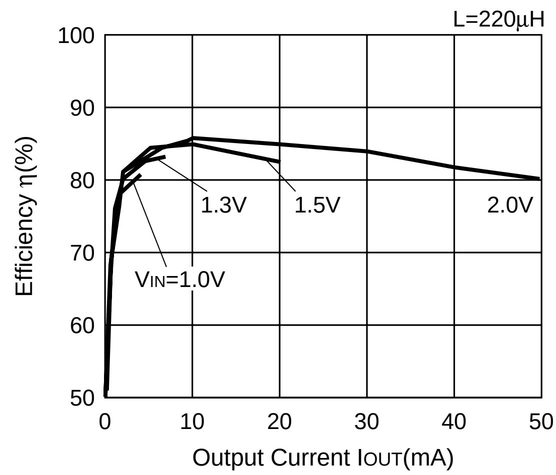

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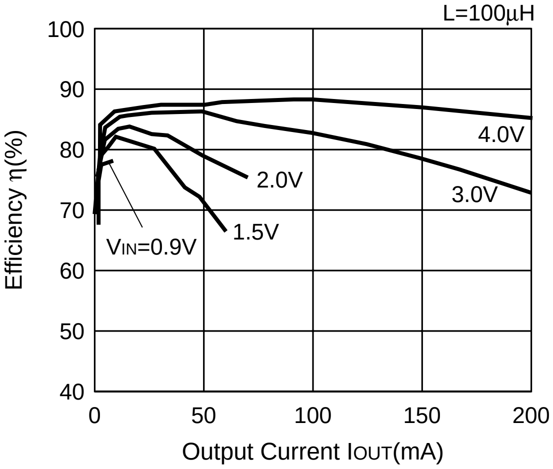

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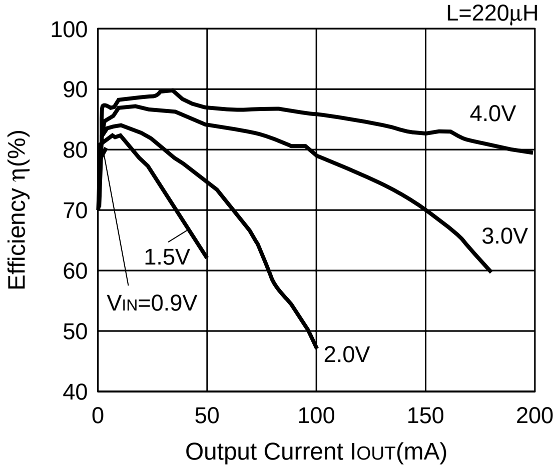

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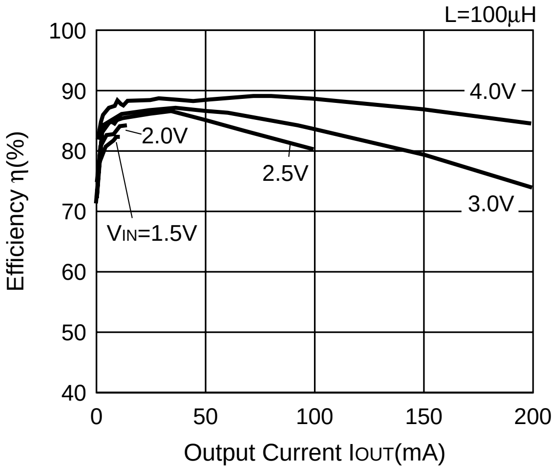

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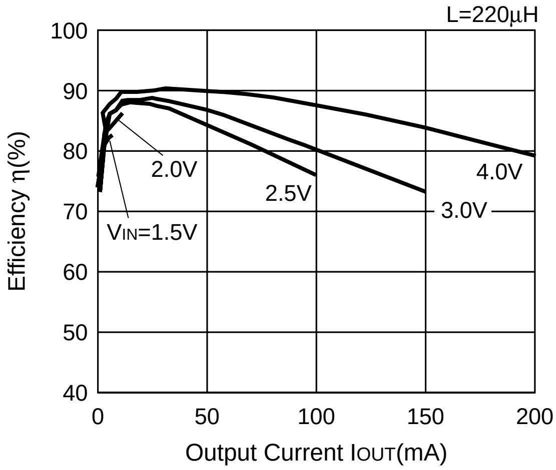
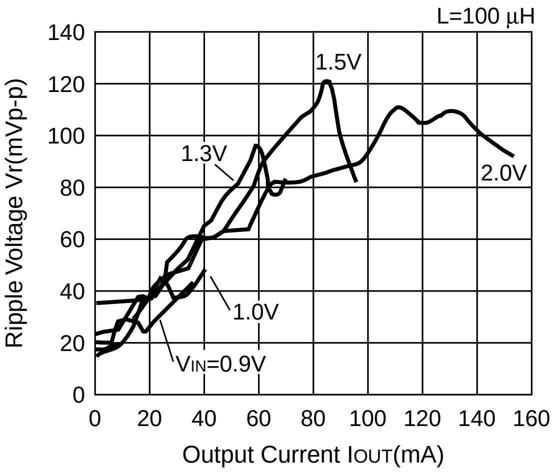


3) Ripple Voltage vs. Output Current (Topt=25°C)

RN5RK301A



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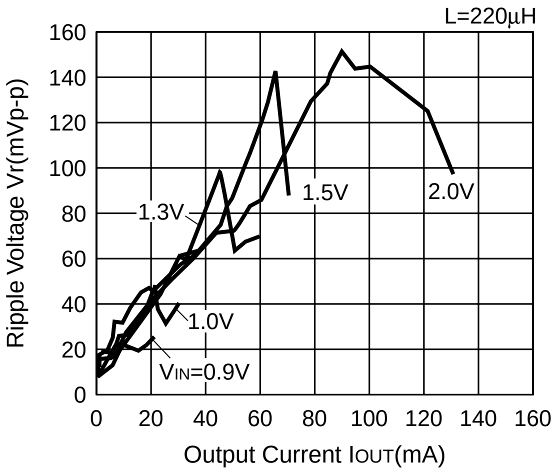

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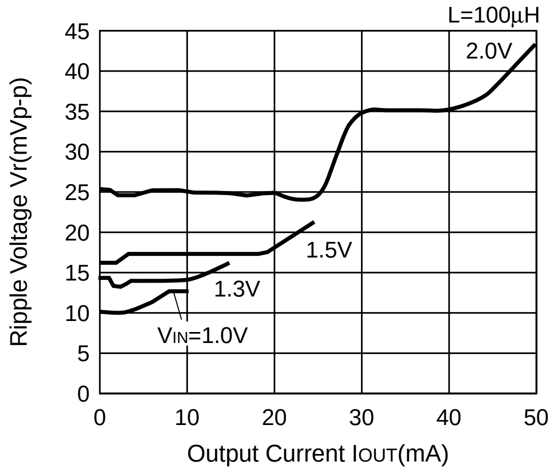

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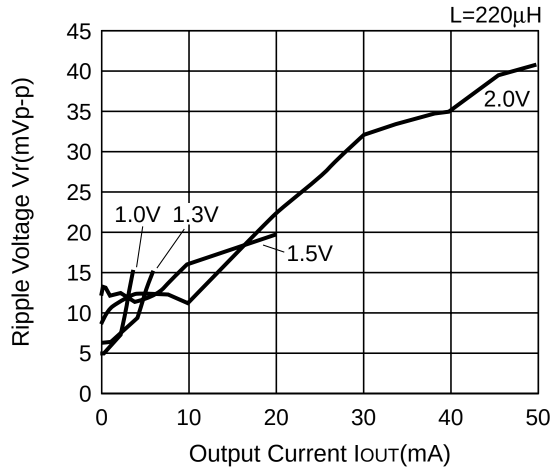

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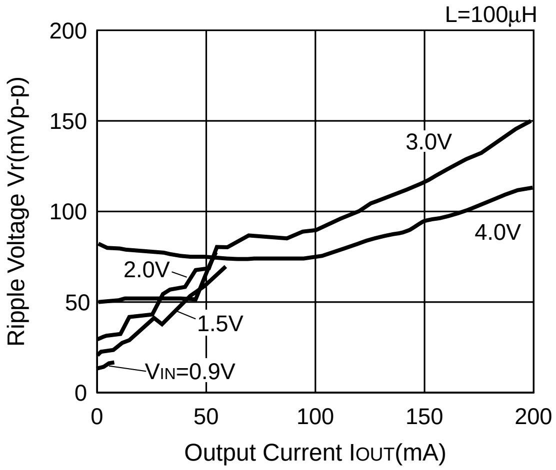

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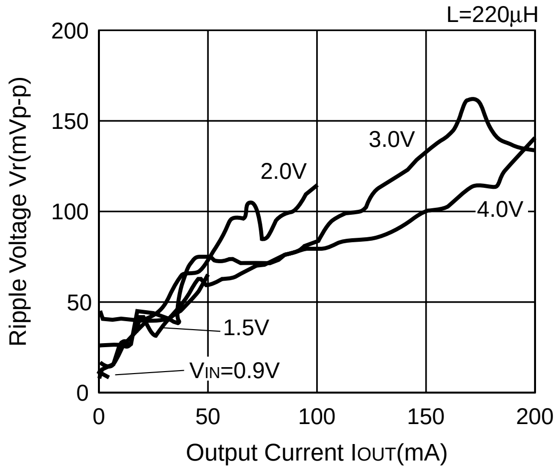

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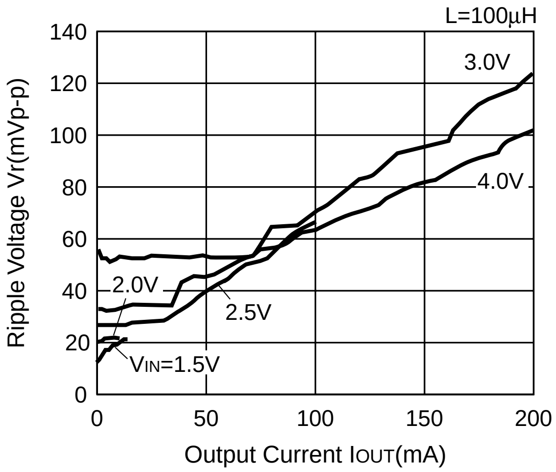

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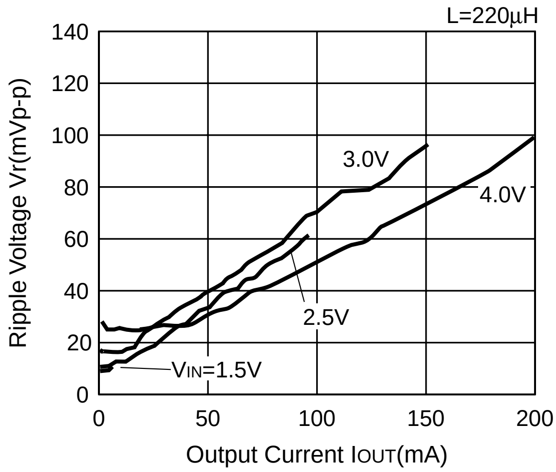
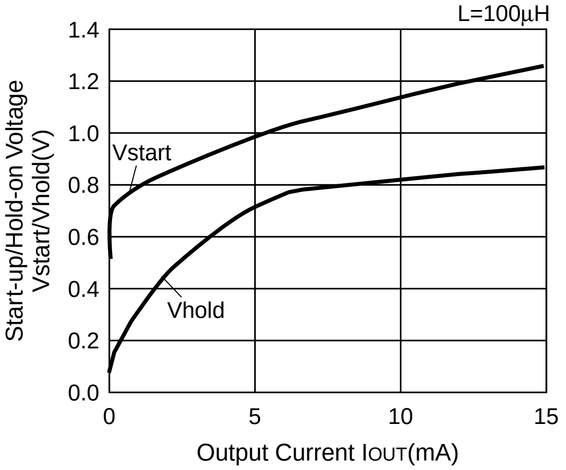
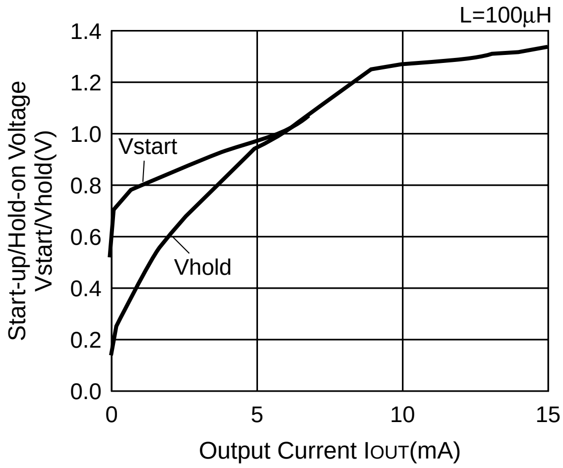


4) Start-up/Hold-on Voltage vs. Output Current (Topt=25 °C)

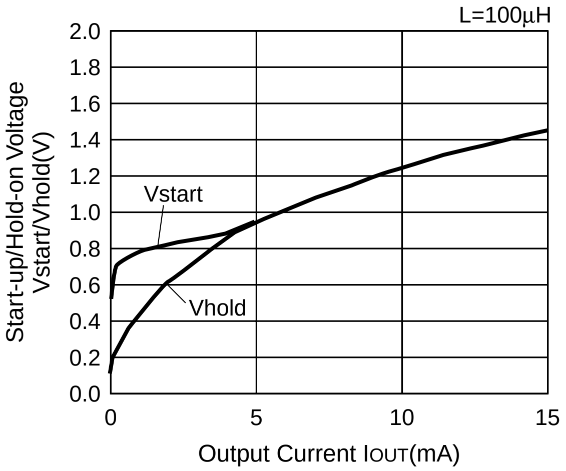
RN5RK301A



RN5RK501A



RN5RK301B



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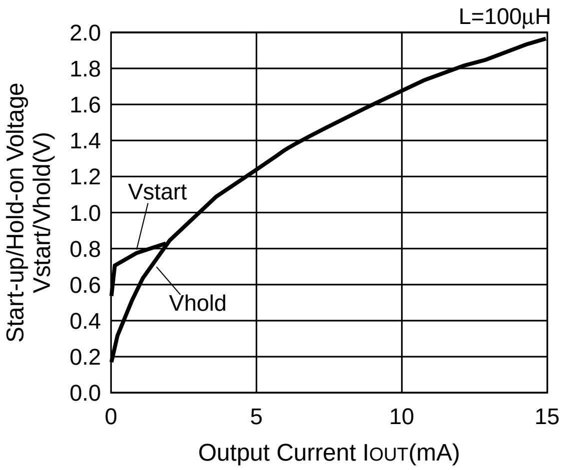
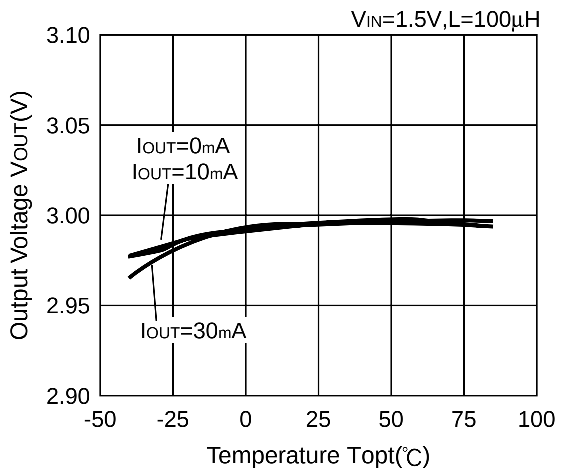
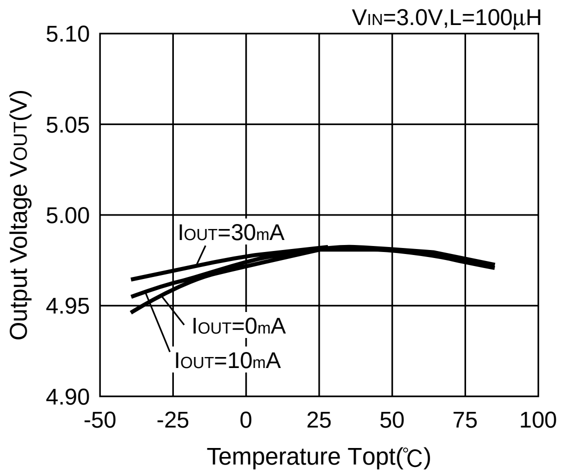


5) Output Voltage vs. Temperature

RN5RK301A

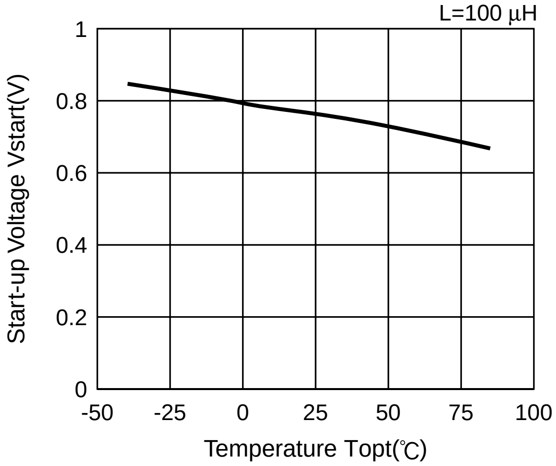


RN5RK501A

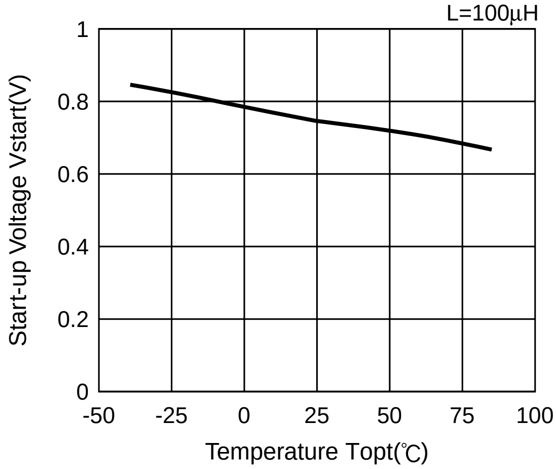


6) Start-up Voltage vs. Temperature

RN5RK501A

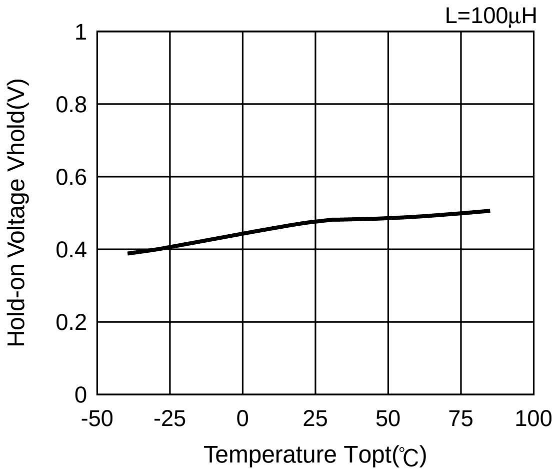


RN5RK501B

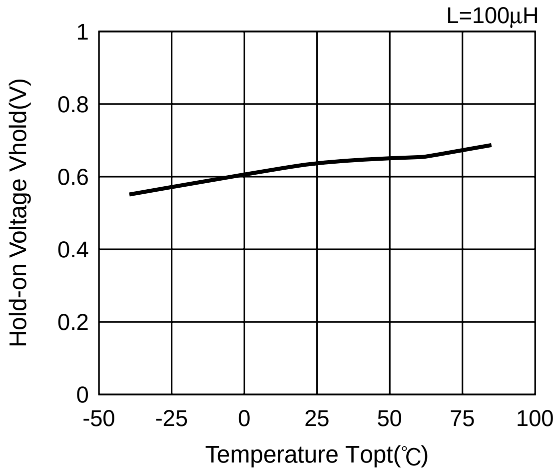


7) Hold-on Voltage vs. Temperature

RN5RK501A

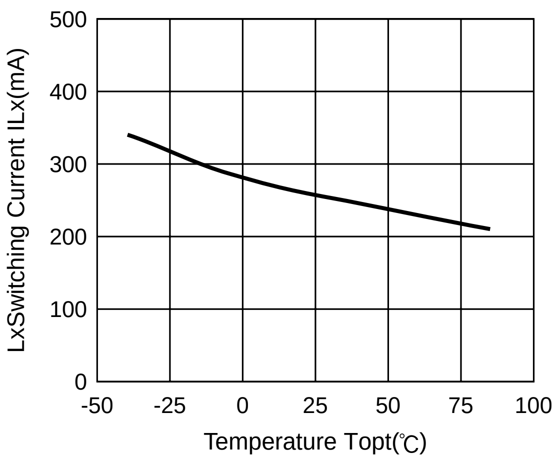


RN5RK501B



8) Lx Switching Current vs. Temperature

RN5RK301A



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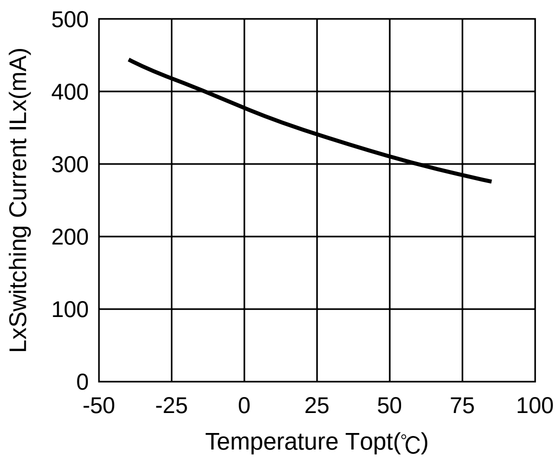
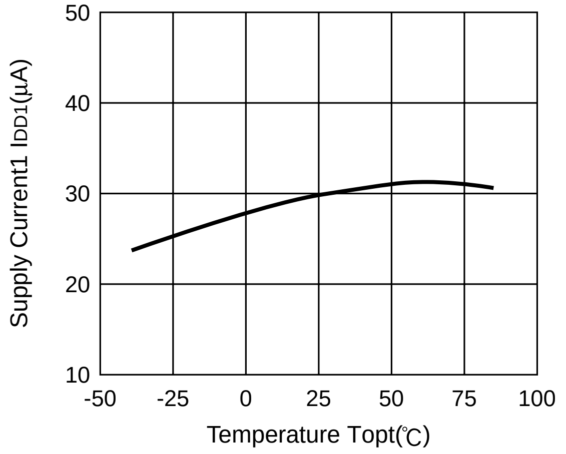


9) Supply Current 1 vs. Temperature

RN5RK301A



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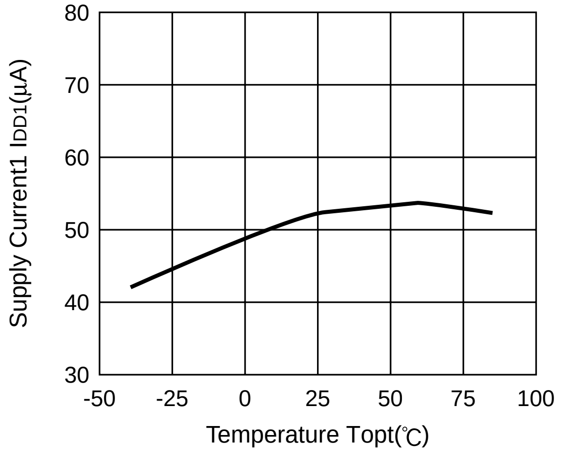
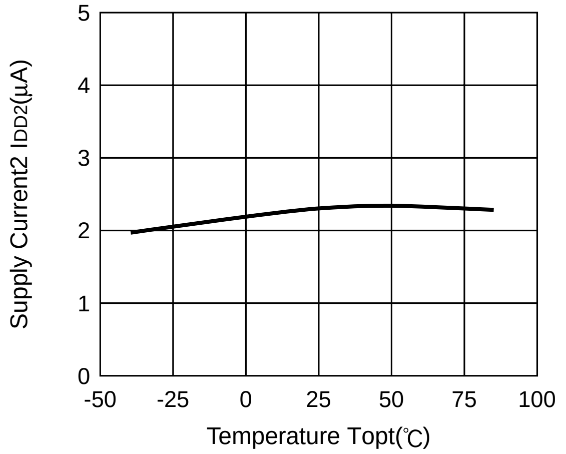


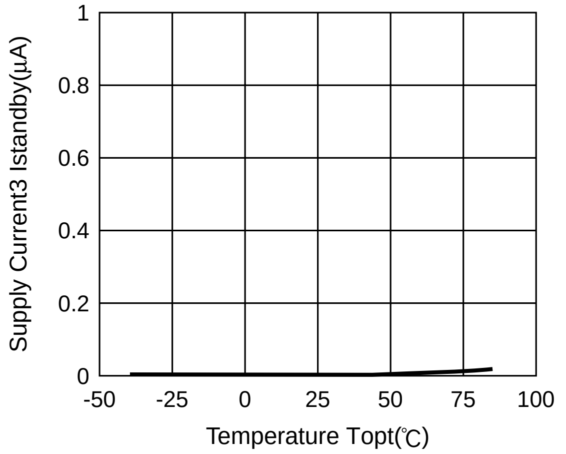
10) Supply Current 2 vs. Temperature

RN5RK301A



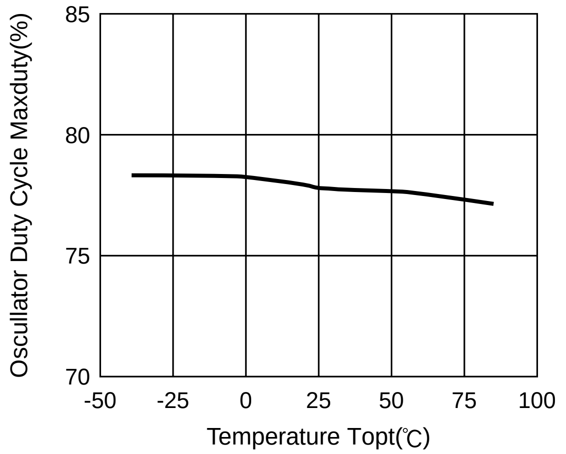
11) Standby Current 3 vs. Temperature

RN5RK301A



12) Oscillator Duty Cycle vs. Temperature

RN5RK301A



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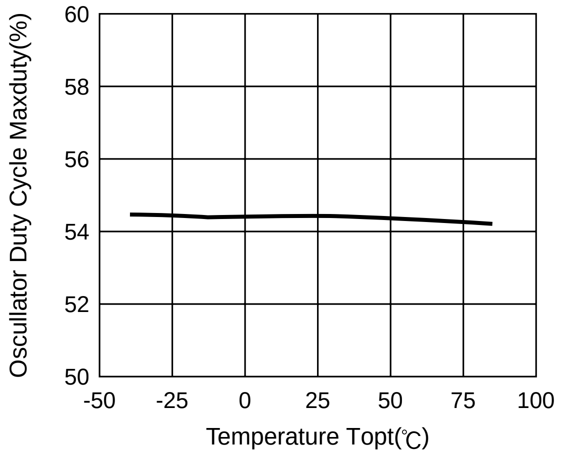
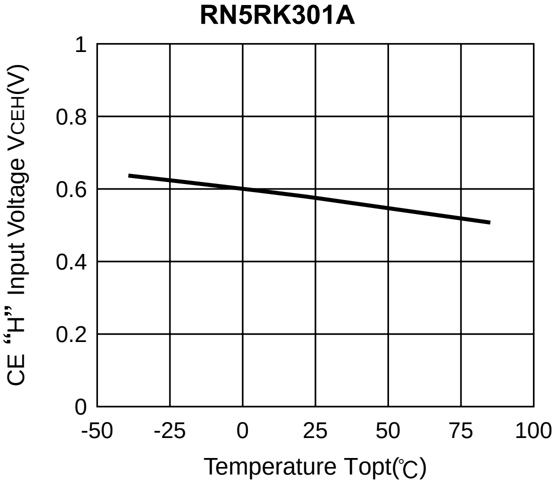
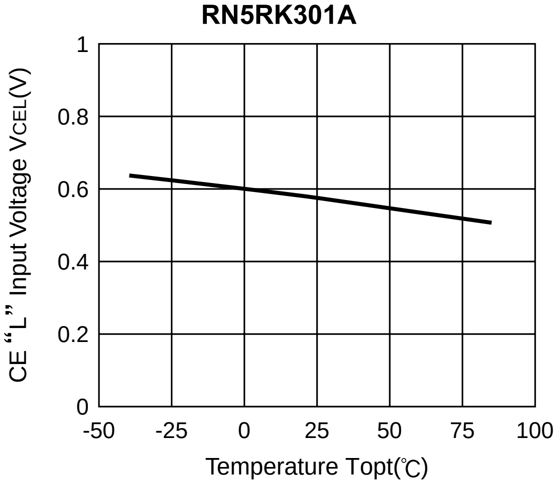


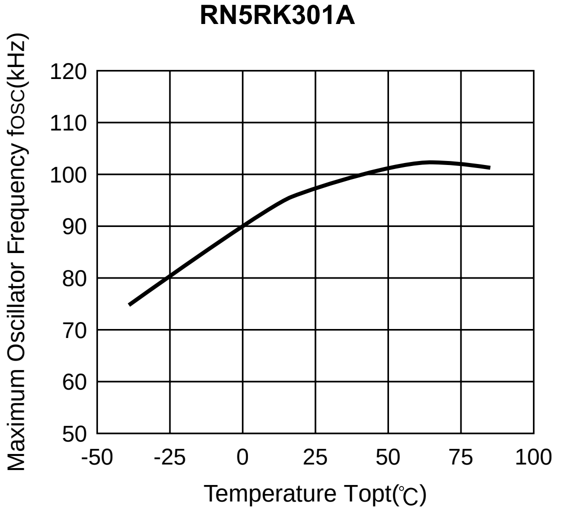
13) CE "H" Input Voltage vs. Temperature



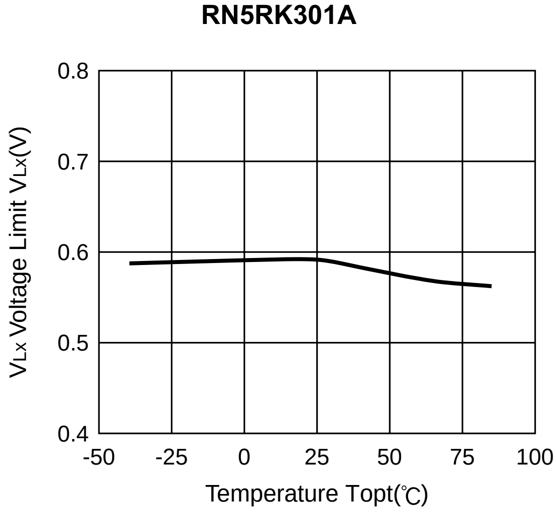
14) CE "L" Input Voltage vs. Temperature



15) Maximum Oscillator Frequency vs. Temperature



16) V_{LX} Voltage Limit vs. Temperature

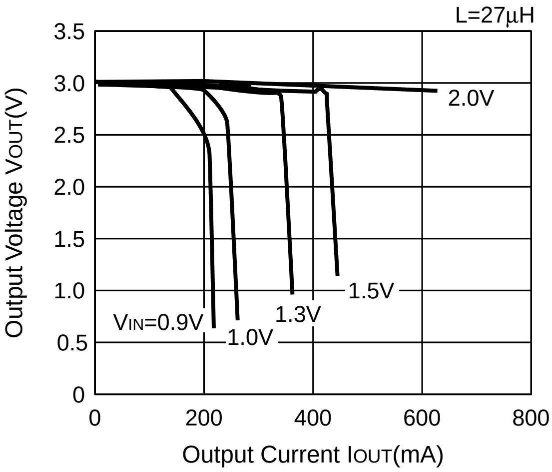


RICOH

● **RN5RKxx2A**

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

RN5RK302A



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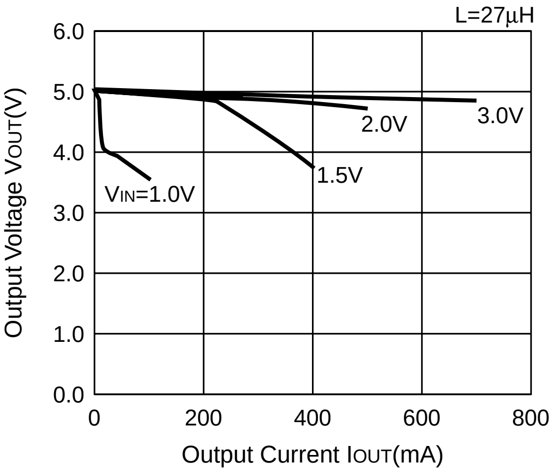
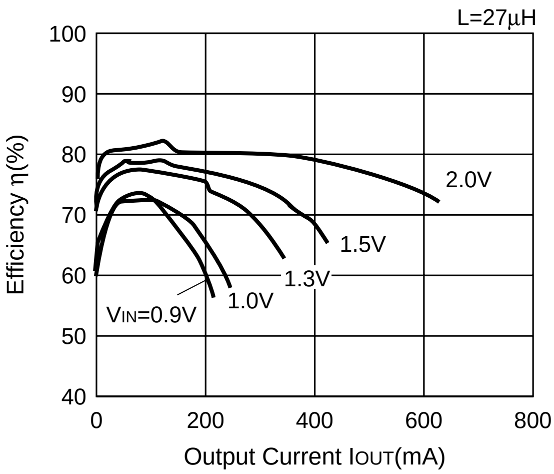


2) Efficiency vs. Output Current (Topt=25°C)

RN5RK302A



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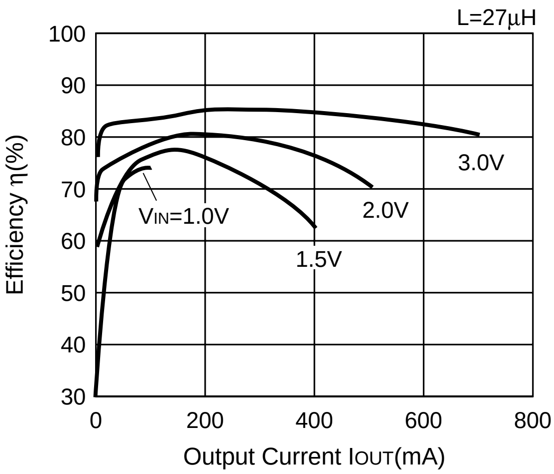
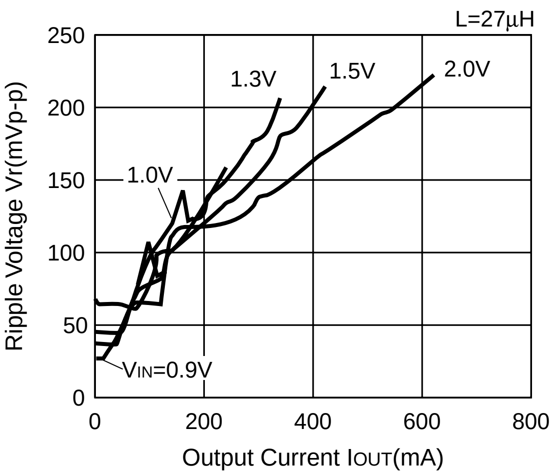
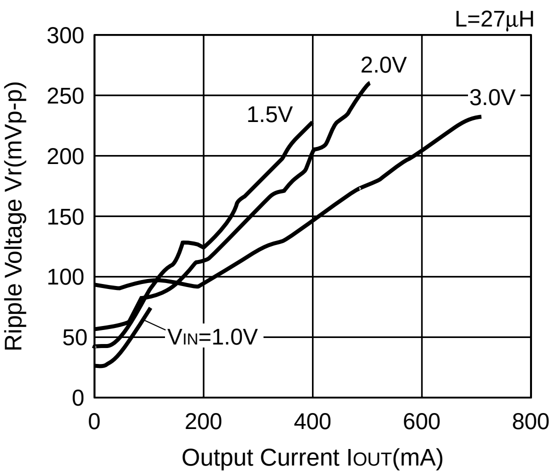


3) Ripple Voltage vs. Output Current (Topt=25°C)

RN5RK302A

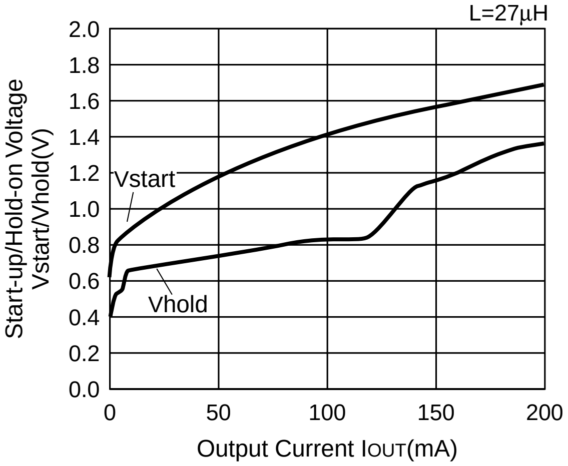


RN5RK502A

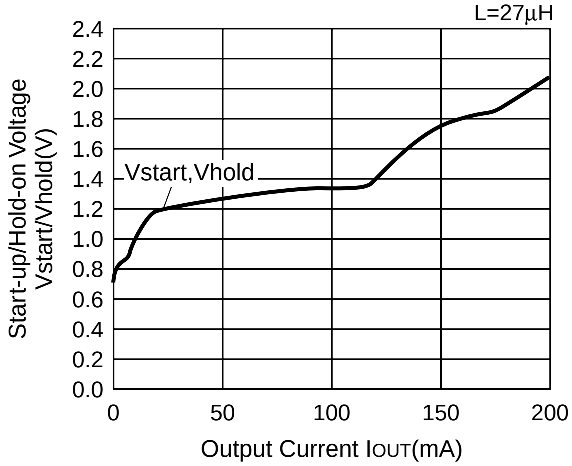


4) Start-up/Hold-on Voltage vs. Output Current (Topt=25°C)

RN5RK302A

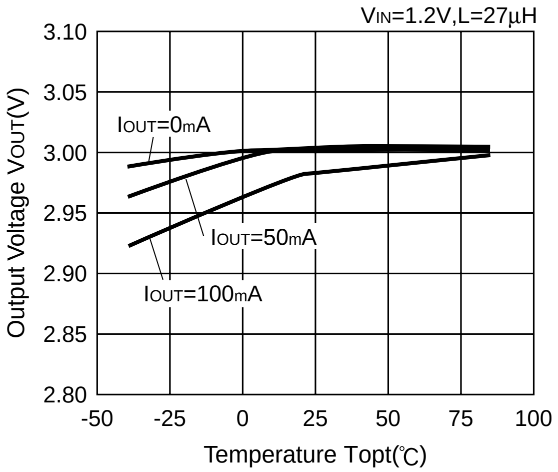


RN5RK502A



5) Output Voltage vs. Temperature

RN5RK302A



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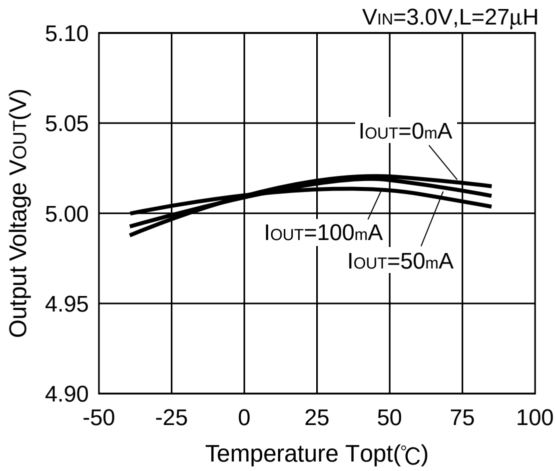
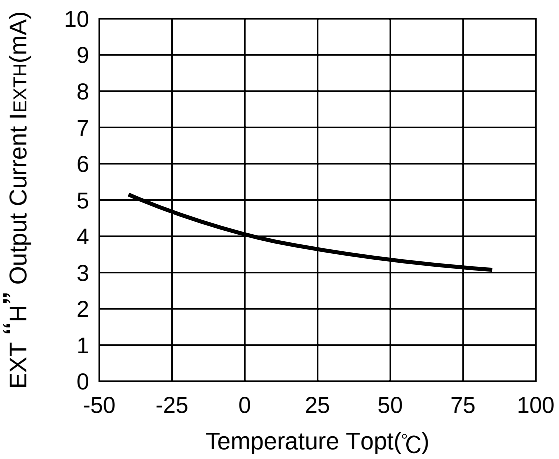


6) EXT “H” Output Current vs. Temperature

RN5RK302A



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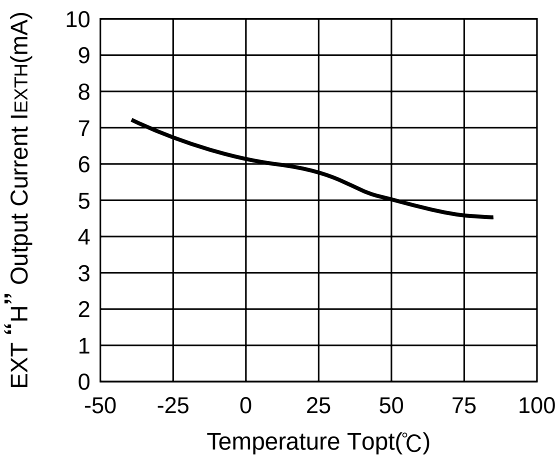
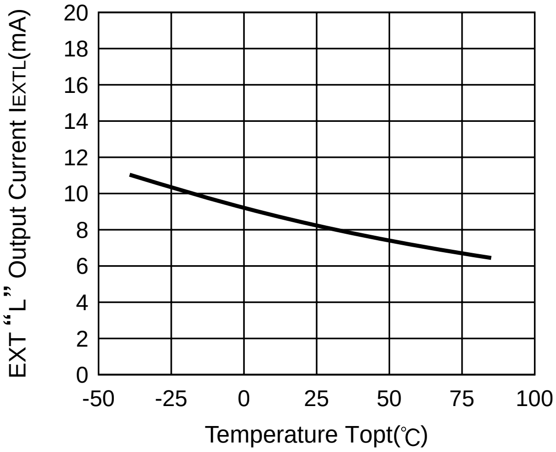
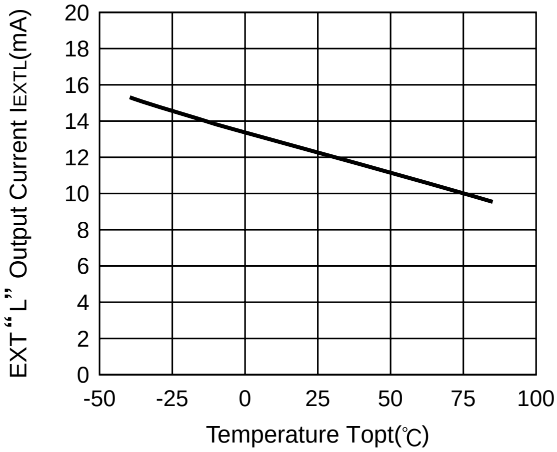


7) EXT "L" Output Current vs. Temperature

RN5RK302A

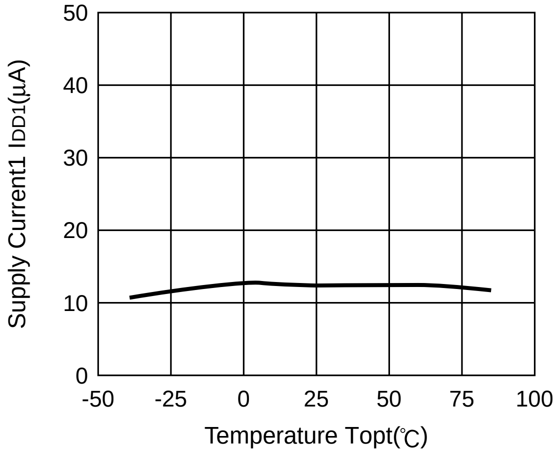


RN5RK502A



8) Supply Current 1 vs. Temperature

RN5RK302A



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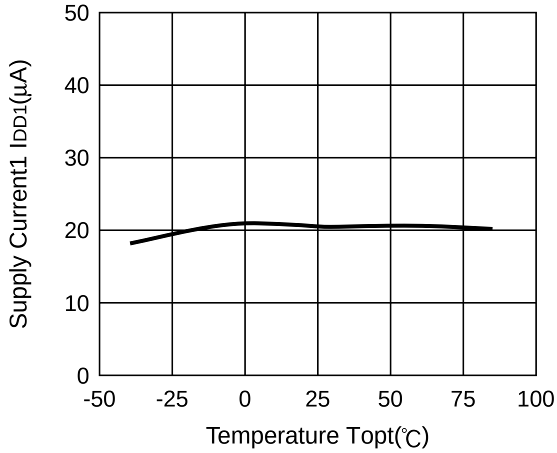
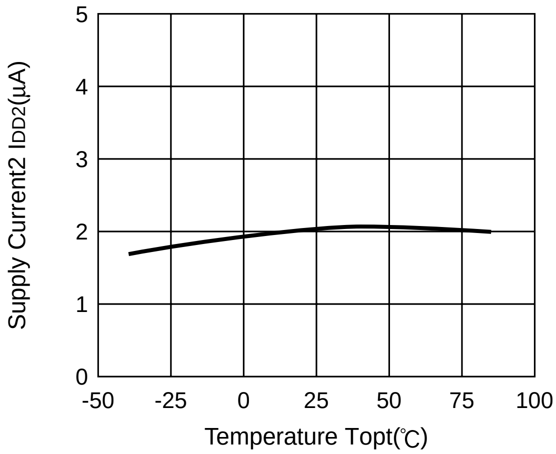


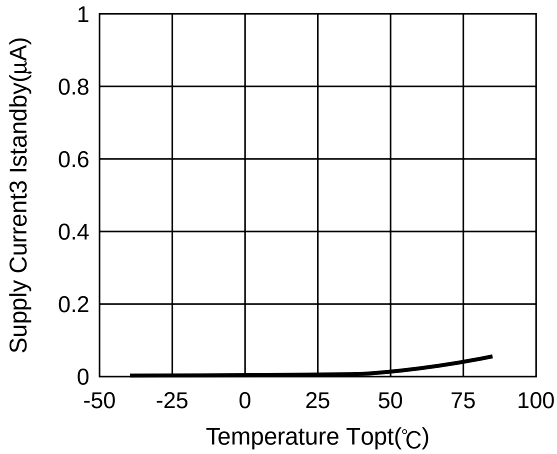
9) Supply Current 2 vs. Temperature

RN5RK302A



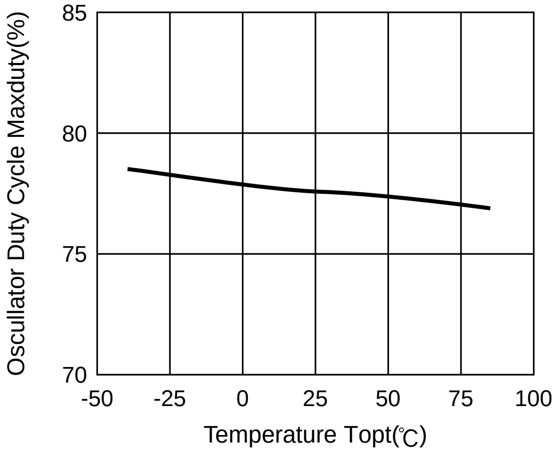
10) Standby Current vs. Temperature

RN5RK302A



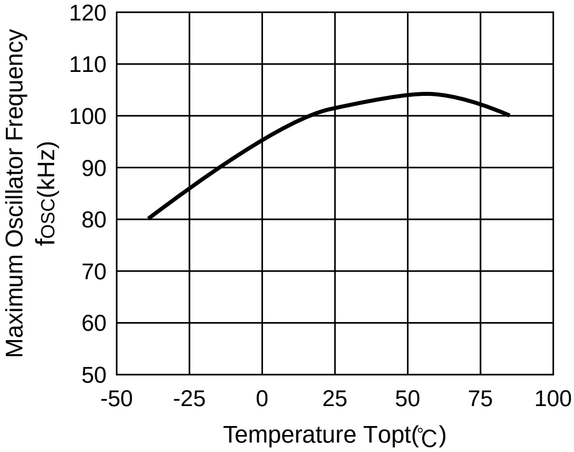
11) Oscillator Duty Cycle vs. Temperature

RN5RK302A



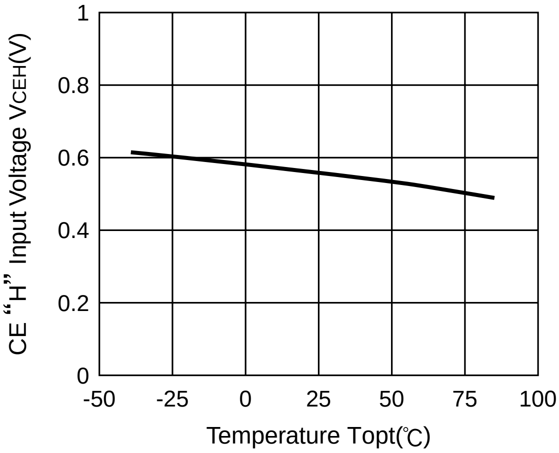
12) Maximum Oscillator Frequency vs. Temperature

RN5RK302A



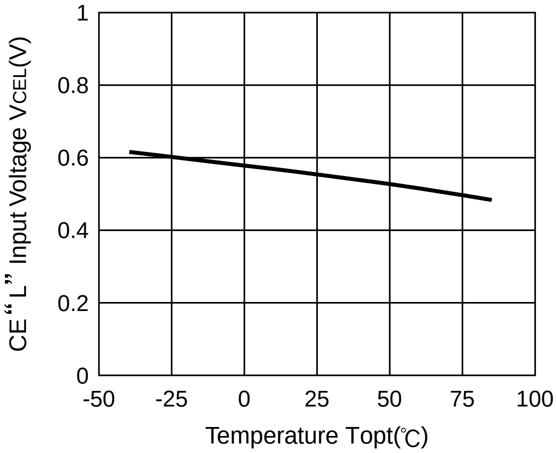
13) CE "H" Input Voltage vs. Temperature

RN5RK302A



14) CE "L" Input Voltage vs. Temperature

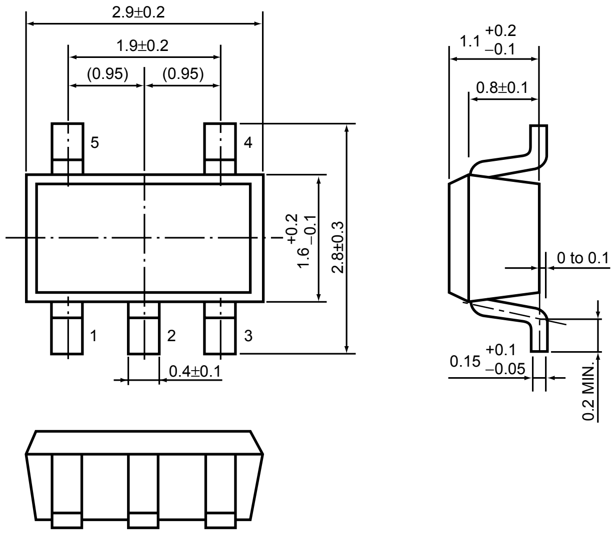
RN5RK302A



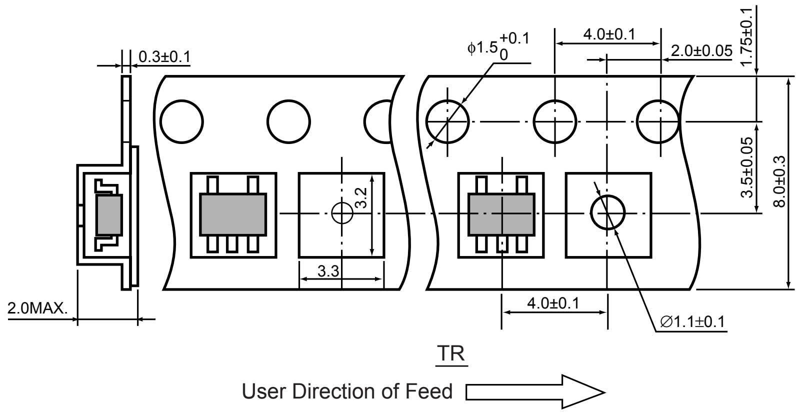
- **SOT-23-5 (SC-74A)**

Unit: mm

PACKAGE DIMENSIONS

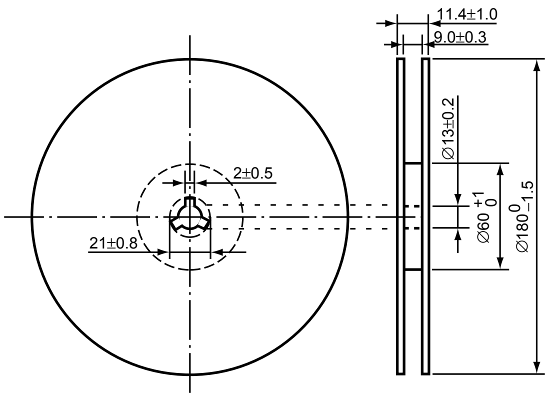


TAPING SPECIFICATION



TAPING REEL DIMENSIONS

(1reel=3000pcs)



POWER DISSIPATION (SOT-23-5)

This specification is at mounted on board. 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.)

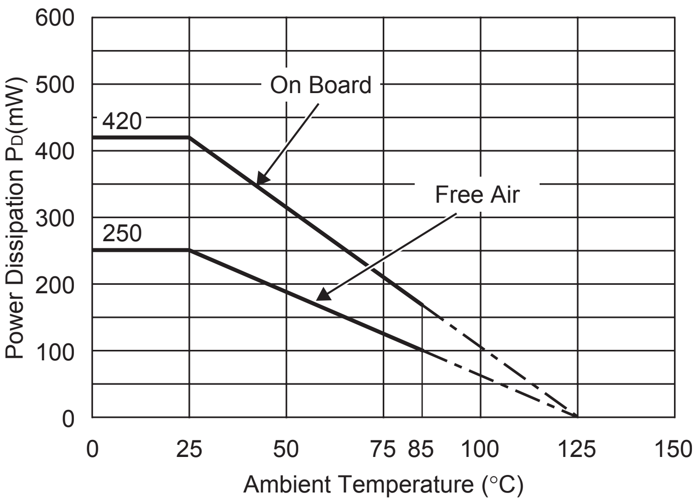
Measurement Conditions

	Standard Land Pattern
Environment	Mounting on Board (Wind velocity=0m/s)
Board Material	Glass cloth epoxy plactic (Double sided)
Board Dimensions	40mm × 40mm × 1.6mm
Copper Ratio	Top side : Approx. 50% , Back side : Approx. 50%
Through-hole	ϕ0.5mm × 44pcs

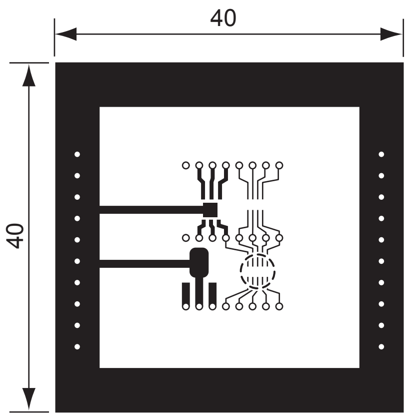
Measurement Result

(Topt=25°C,Tjmax=125°C)

	Standard Land Pattern	Free Air
Power Dissipation	420mW	250mW
Thermal Resistance	θja=(125−25°C)/0.42W=263°C/W	400°C/W



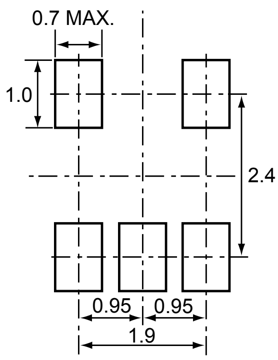
Power Dissipation



Measurement Board Pattern

IC Mount Area Unit : mm

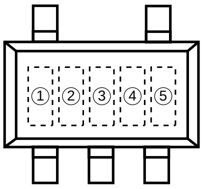
RECOMMENDED LAND PATTERN



(Unit: mm)

RN5RK SERIES MARK SPECIFICATION

• SOT-23-5 (SC-74A)



①, ② : Product Code (refer to Part Number vs. Product Code)

③, ④ : Lot Number

• Part Number vs. Product Code

Part Number	Product Code	
	①	②
RN5RK301A	W	A
RN5RK241A	W	B
RN5RK501A	W	C
RN5RK201A	W	D
RN5RK251A	W	E
RN5RK331A	W	F
RN5RK551A	W	G
RN5RK221A	W	H
RN5RK271A	W	J

Part Number	Product Code	
	①	②
RN5RK361A	W	K
RN5RK261A	W	L
RN5RK281A	W	M
RN5RK321A	W	N
RN5RK371A	W	P
RN5RK391A	W	Q
RN5RK271B	X	A
RN5RK201B	X	B
RN5RK221B	X	C

Part Number	Product Code	
	①	②
RN5RK251B	X	D
RN5RK301B	X	E
RN5RK331B	X	F
RN5RK361B	X	G
RN5RK501B	X	H
RN5RK551B	X	J
RN5RK391B	X	K
RN5RK202A	Y	A
RN5RK252A	Y	B

Part Number	Product Code	
	①	②
RN5RK272A	Y	C
RN5RK302A	Y	D
RN5RK332A	Y	E
RN5RK502A	Y	F
RN5RK552A	Y	G
RN5RK522A	Y	H
RN5RK222A	Y	J
RN5RK452A	Y	K