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PWM/VFM step-down DC/DC Controller

NO.EA-065-181003

OUTLINE

The R1223N Series are CMOS-based PWM step-down DC/DC Converter controllers with low supply current.

Each of these ICs consists of an oscillator, a PWM control circuit, a reference voltage unit, an error amplifier, a soft-start circuit, a protection circuit, a PWM/VFM alternative circuit, a chip enable circuit, and resistors for voltage detection. A low ripple, high efficiency step-down DC/DC converter can be easily composed of this IC with only four external components, or a power-transistor, an inductor, a diode and a capacitor.

With a PWM/VFM alternative circuit, when the load current is small, the operation is automatically switching into the VFM oscillator from PWM oscillator, therefore the efficiency at small load current is improved. The R1223NxxxB type, which is without a PWM/VFM alternative circuit, is also available.

If the term of maximum duty cycle keeps on a certain time, the embedded protection circuit works. There are two types of protection function. One is latch-type protection circuit, and it works to latch an external Power MOSFET with keeping it disable. To release the condition of protection, after disable this IC with a chip enable circuit, enable it again, or restart this IC with power-on. The other is Reset-type protection circuit, and it works to restart the operation with soft-start and repeat this operation until maximum duty cycle condition is released. Either of these protection circuits can be designated by users' request.

FEATURES

- Input Voltage Range .... 2.3V to 13.2V
- Output Voltage Range .... 1.5V to 5.0V (0.1V step)
- Output Voltage Accuracy .... ±2.0%
- Oscillator Frequency 300kHz, 500kHz
- High Efficiency .... Typ. 90%
- Standby Current .... Typ. 0μA
- Temperature-Drift Coefficient of Output Voltage .... Typ. ±100ppm/°C
- Built-in Soft-start Circuit
- Built-in Latch-type or Reset type Protection Circuit
- Package SOT-23-5

APPLICATION

- Power source for hand-held communication equipment, cameras, video instruments such as VCRs, camcorders.
- Power source for battery-powered equipment.
- Power source for household electrical appliances.

BLOCK DIAGRAM
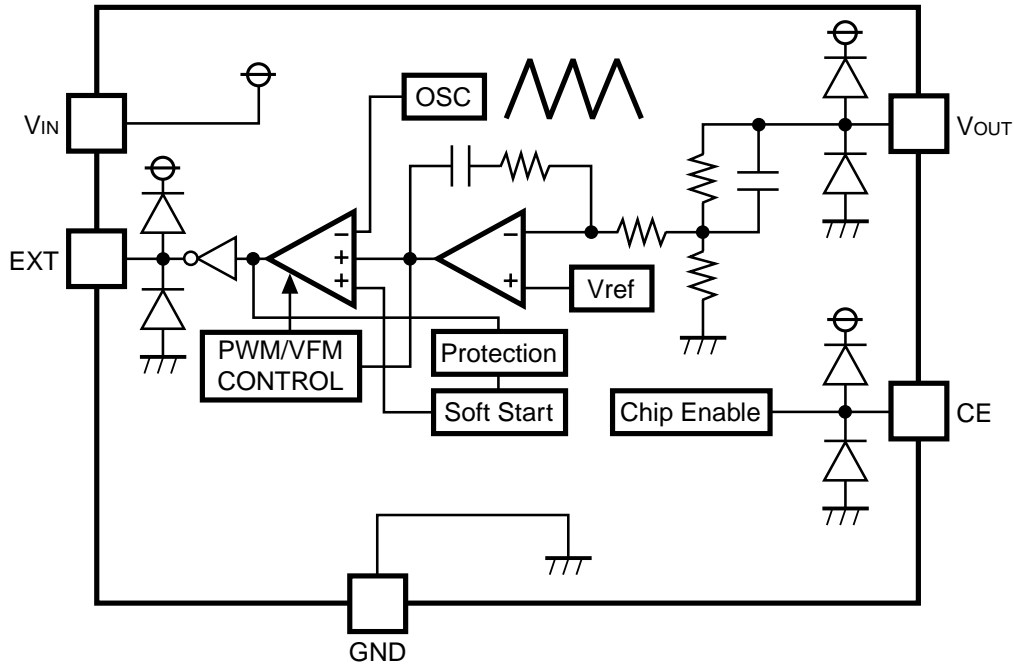
SELECTION GUIDE

In the R1223N Series, the output voltage, the oscillator frequency, switching mode and type of short protection (Latch or Reset) for the IC are selectable at the user's request.
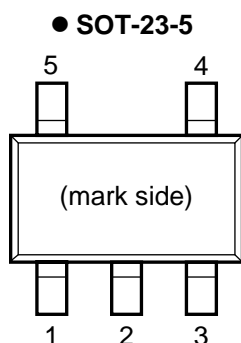
Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1223Nxx2∗-TR-FE	SOT-23-5	3,000pcs	Yes	Yes

xx : The output voltage can be designated in the range from 1.5V(15) to 5.0V(50) in 0.1V[1] steps.

∗ : Designation of the oscillator frequency, switching mode and type of short protection.

   A) 300kHz, with a PWM/VFM alternative circuit, Latch-type protection

   B) 500 kHz, with a PWM/VFM alternative circuit, Latch-type protection

   C) 300kHz, without a PWM/VFM alternative circuit, Latch-type protection

   D) 500kHz, without a PWM/VFM alternative circuit, Latch-type protection

   E) 300kHz, with a PWM/VFM alternative circuit, Reset-type protection

   F) 500 kHz, with a PWM/VFM alternative circuit, Reset-type protection

   G) 300kHz, without a PWM/VFM alternative circuit, Reset-type protection

   H) 500kHz, without a PWM/VFM alternative circuit, Reset-type protection

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PIN CONFIGURATION

● **SOT-23-5**

```
    5        4
   ┌──┐    ┌──┐
  ┌─────────────┐
  │             │
  │ (mark side) │
  │             │
  └─────────────┘
   ┌──┐ ┌──┐ ┌──┐
    1    2    3
```

PIN DESCRIPTION

● **SOT-23-5**

Pin No	Symbol	Pin Description
1	CE	Chip Enable Pin
2	GND	Ground Pin Input Pin
3	V_{OUT}	Pin for Monitoring Output Voltage
4	EXT	External Transistor Drive Pin
5	V_{IN}	Power Supply Pin

ABSOLUTE MAXIMUM RATINGS

(GND=0V)

Symbol	Item	Rating	Unit
V_{IN}	V_{IN} Supply Voltage	15	V
V_{EXT}	EXT Pin Output Voltage	-0.3 to V_{IN} + 0.3	V
V_{CE}	CE Pin Input Voltage	-0.3 to V_{IN} + 0.3	V
V_{OUT}	V_{OUT} Pin Input Voltage	-0.3 to V_{IN} + 0.3	V
I_{EXT}	EXT Pin Inductor Drive Output Current	± 25	mA
P_D	Power Dissipation (Standard Test Land Pattern)[1]	420	mW
T_{opt}	Operating Temperature Range	-40 to 85	°C
T_{stg}	Storage Temperature Range	-55 to 125	°C

[1] For Power Dissipation and Standard Test Land Pattern, 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

- **R1223Nxx2A (,C,E,G) Output Voltage : Vo**

(Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating Input Voltage		2.3		13.2	V
V_{OUT}	Step-down Output Voltage	$V_{IN}=V_{CE}=Vo+1.2V$, $I_{OUT}=-10mA$	$Vo \times 0.98$	Vo	$Vo \times 1.02$	V
$\Delta V_{OUT}/\Delta T$	Step-down Output Voltage Temperature Coefficient	$-40°C \leq Topt \leq 85°C$		± 100		ppm/°C
fosc	Oscillator Frequency	$V_{IN}=V_{CE}=Vo+1.2V$, $I_{OUT}=-100mA$	240	300	360	kHz
$\Delta fosc/\Delta T$	Oscillator Frequency Temperature Coefficient	$-40°C \leq Topt \leq 85°C$		± 0.3		%/°C
I_{DD1}	Supply Current1	$V_{IN}=13.2V$, $V_{CE}=13.2V$, $V_{OUT}=13.2V$		100	160	μA
Istb	Standby Current	$V_{IN}=13.2V$, $V_{CE}=0V$, $V_{OUT}=0V$		0.0	0.5	μA
I_{EXTH}	EXT "H" Output Current	$V_{IN}=8V$, $V_{EXT}=7.9V$, $V_{OUT}=8V$, $V_{CE}=8V$		-10	-6	mA
I_{EXTL}	EXT "L" Output Current	$V_{IN}=8V$, $V_{EXT}=0.1V$, $V_{OUT}=0V$, $V_{CE}=8V$	10	20		mA
I_{CEH}	CE "H" Input Current	$V_{IN}=13.2V$, $V_{CE}=13.2V$, $V_{OUT}=13.2V$		0.0	0.5	μA
I_{CEL}	CE "L" Input Current	$V_{IN}=13.2V$, $V_{CE}=0V$, $V_{OUT}=13.2V$	-0.5	0.0		μA
V_{CEH}	CE "H" Input Voltage	$V_{IN}=8V$, $V_{OUT}=0V \rightarrow 1.5V$		0.8	1.2	V
V_{CEL}	CE "L" Input Voltage	$V_{IN}=8V$, $V_{OUT}=1.5V \rightarrow 0V$	0.3	0.8		V
Maxdty	Oscillator Maximum Duty Cycle		100			%
VFMdty	VFM Duty Cycle	only for A, E version		25		%
Tstart	Delay Time by Soft-Start function	$V_{IN}=Vo+1.2V$, $V_{CE}=0V \rightarrow Vo+1.2V$ specified at 80% for rising edge	5	10	16	ms
Tprot	Delay Time for protection circuit	$V_{IN}=V_{CE}=Vo+1.2V$ $V_{OUT}=Vo+1.2V \rightarrow 0V$	1	3	5	ms

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● **R1223Nxx2B (,D,F,H) Output Voltage : Vo** (Topt

Symbol	Item	Conditions	Min.	Typ.	Max.	
V_{IN}	Operating Input Voltage		2.3		13.2	
V_{OUT}	Step-down Output Voltage	$V_{IN}=V_{CE}=Vo+1.2V$, $I_{OUT}=-10mA$	Vo× 0.98	Vo	Vo× 1.02	
$\Delta V_{OUT}/\Delta T$	Step-down Output Voltage Temperature Coefficient	$-40°C \leq Topt \leq 85°C$		±100		p
Fosc	Oscillator Frequency	$V_{IN}=V_{CE}=Vo+1.2V$, $I_{OUT}=-100mA$	400	500	600	
$\Delta fosc/\Delta T$	Oscillator Frequency Temperature Coefficient	$-40°C \leq Topt \leq 85°C$		±0.3		
I_{DD1}	Supply Current1	$V_{IN}=13.2V$, $V_{CE}=13.2V$, $V_{OUT}=13.2V$		140	200	
Istb	Standby Current	$V_{IN}=13.2V$, $V_{CE}=0V$, $V_{OUT}=0V$		0.0	0.5	
I_{EXTH}	EXT "H" Output Current	$V_{IN}=8V$, $V_{EXT}=7.9V$, $V_{OUT}=8V$, $V_{CE}=8V$		-10	-6	
I_{EXTL}	EXT "L" Output Current	$V_{IN}=8V$, $V_{EXT}=0.1V$, $V_{OUT}=0V$, $V_{CE}=8V$	10	20		
I_{CEH}	CE "H" Input Current	$V_{IN}=13.2V$, $V_{CE}=13.2V$, $V_{OUT}=13.2V$		0.0	0.5	
I_{CEL}	CE "L" Input Current	$V_{IN}=13.2V$, $V_{CE}=0V$, $V_{OUT}=13.2V$	-0.5	0.0		
V_{CEH}	CE "H" Input Voltage	$V_{IN}=8V$, $V_{OUT}=0V{\rightarrow}1.5V$		0.8	1.2	
V_{CEL}	CE "L" Input Voltage	$V_{IN}=8V$, $V_{OUT}=1.5V{\rightarrow}0V$	0.3	0.8		
Maxdty	Oscillator Maximum Duty Cycle		100			
VFMdty	VFM Duty Cycle	only for B, F version		25		
Tstart	Delay Time by Soft-Start function	$V_{IN}=Vo+1.2V$, $V_{CE}=0V{\rightarrow}Vo+1.2V$ specified at 80% for rising edge	3	6	10	
Tprot	Delay Time for protection circuit	$V_{IN}=V_{CE}=Vo+1.2V$ $V_{OUT}=Vo+1.2V{\rightarrow}0V$	1	2	4	

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TEST CIRCUITS

A)

B)

C)

D)

E)

F)

OSCILLOSCOPE

G)
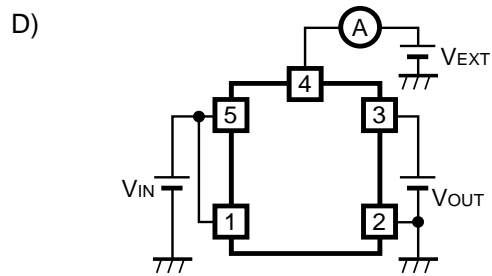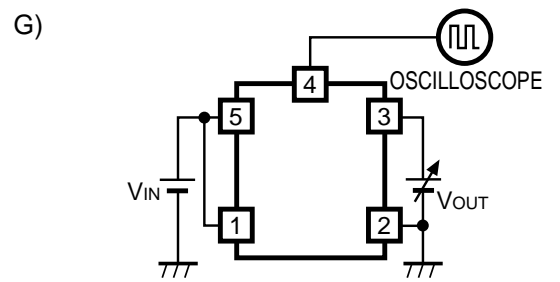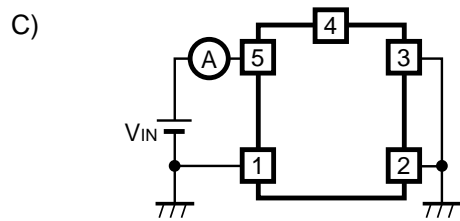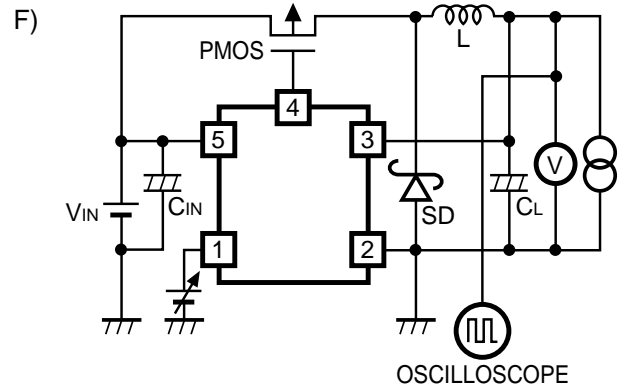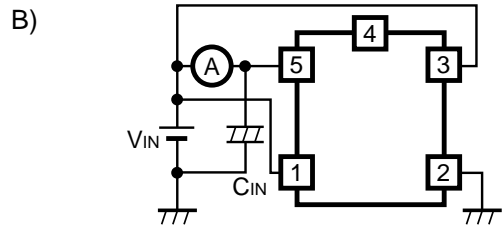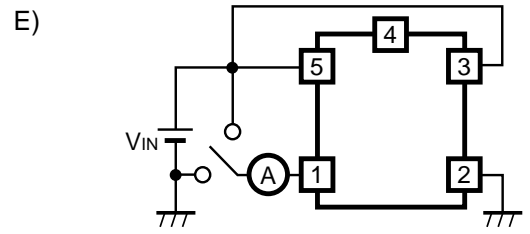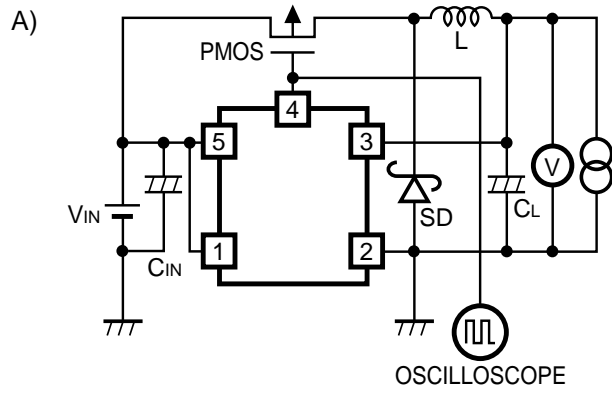
The typical characteristics were obtained by use of these test circuits.

Test Circuit A : Typical characteristics 1), 2), 3), 4), 5), 6), 7)
Test Circuit B : Typical characteristics 8)

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Test Circuit C : Standby Current
Test Circuit D : Typical characteristics 12), 13)
Test Circuit E : CE input current "H" and "L"
Test Circuit F : Typical characteristics 9)
Test Circuit G : Typical characteristics 10), 11)

TYPICAL APPLICATIONS AND APPLICATION HINTS
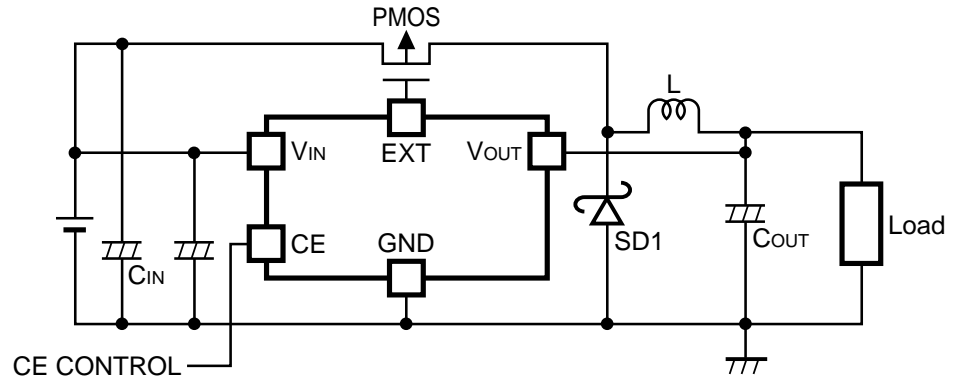
PMOS : HAT1020R (Hitachi), Si3443DV (Siliconix)   L   : CD104NP (Sumda, 27μH)

SD1   : RB491D (Rohm) C_{OUT} : 47μF (Tantalum Type)

C_{IN} : 10μF×2 (Tantalum Type)

When you use these ICs, consider the following issues;

- As shown in the block diagram, a parasitic diode is formed in each terminal, each of these diodes is not formed fo[r] load current, therefore do not use it in such a way. When you control the CE pin by another power supply, do no[t] make its "H" level more than the voltage level of V_{IN} pin.
- The operation of latch-type protection circuit is as follows;
  When the maximum duty cycle continues longer than the delay time for protection circuit, (Refer to the Electrica[l] Characteristics) the protection circuit works to shut-down Power MOSFET with its latching operation. Therefor[e] when an input/output voltage difference is small, the protection circuit may work with small load current.
  To release the protection latch state, after disable this IC with a chip enable circuit, enable it again, or restart this I[C] with power-on. However, in the case of restarting this IC with power-on, after the power supply is turned off, if [a] certain amount of charge remains in C_{IN}, or some voltage is forced to V_{IN} from C_{IN}, this IC might not be restarte[d] even after power-on.
  If rising transition speed of supply voltage is too slow, or the time which is required for V_{IN} voltage to reach Outpu[t] voltage of DC/DC converter is longer than soft-starting time plus delay time for protection circuit, protection circui[t] works before V_{IN} voltage reaches Output voltage of DC/DC converter. To prevent this action, while power suppl[y] voltage is not ready, make this IC be standby mode (CE="L"), and when the power supply is ready (the voltage leve[l] of V_{IN} is equal or more than the voltage level of V_{OUT}), make it enable (CE="H").
- The operation of Reset-type protection circuit is as follows;
  When the maximum duty cycle continues longer than the delay time for protection circuit, (Refer to the Electrica[l] Characteristics) the protection circuit works to restart with soft-start operation. Therefore when an input/outpu[t] voltage difference is small, the protection circuit may work with small load current.
- Set external components as close as possible to the IC and minimize the connection between the components an[d] the IC. In particular, a capacitor should be connected to V_{OUT} pin with the minimum connection. And make sufficien[t] grounding and reinforce supplying. A large switching current flows through the connection of power supply, an in[-] ductor and the connection of V_{OUT}. If the impedance of the connection of power supply is high, the voltage level o[f] power supply of the IC fluctuates with the switching current. This may cause unstable operation of the IC.
- Use capacitors with a capacity of $22\mu F$ or more for V_{OUT} pin, and with good high frequency characteristics such a[s] tantalum capacitors. We recommend you to use capacitors with an allowable voltage which is at least twice as muc[h] as setting output voltage. This is because there may be a case where a spike-shaped high voltage is generated by a[n] inductor when an external transistor is on and off.
- Choose an inductor that has sufficiently small DC resistance and large allowable current and is hard to reach mag[-] netic saturation. And if the value of inductance of an inductor is extremely small, the I_{LX} may exceed the absolute maximum rating at the maximum loading.
  Use an inductor with appropriate inductance.
- Use a diode of a Schottky type with high switching speed, and also pay attention to its current capacity.
- Do not use this IC under the condition at V_{IN} voltage less than minimum operating voltage.

☆ The performance of power source circuits using these ICs extremely depends upon the peripheral circuits.
  Pay attention in the selection of the peripheral circuits. In particular, design the peripheral circuits in a way tha[t]

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the values such as voltage, current, and power of each component, PCB patterns and the IC do not exce[ed]
respected rated values.

OPERATION of step-down DC/DC converter and Output Current

The step-down DC/DC converter charges energy in the inductor when Lx transistor is ON, and discharges
ergy from the inductor when Lx transistor is OFF and controls with less energy loss, so that a lower output
than the input voltage is obtained. The operation will be explained with reference to the following diagrams :

<Basic Circuits>   <Current through L>
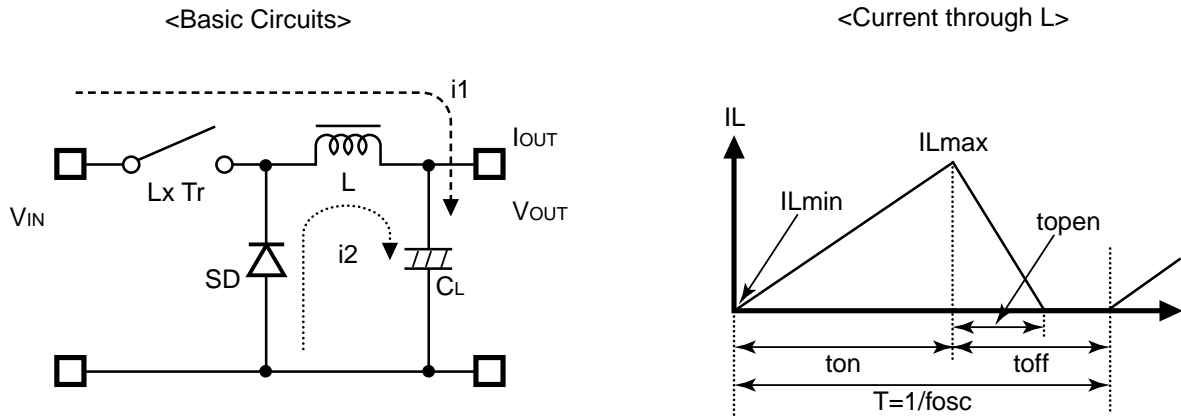
Step 1 : LxTr turns on and current IL (=i1) flows, and energy is charged into CL. At this moment, IL increase[s]
ILmin (=0) to reach ILmax in proportion to the on-time period (ton) of LxTr.

Step 2 : When LxTr turns off, Schottky diode (SD) turns on in order that L maintains IL at ILmax, and current I[L]
flows.

Step 3 : IL decreases gradually and reaches ILmin after a time period of topen, and SD turns off, provided tha[t in]
continuous mode, next cycle starts before IL becomes to 0 because toff time is not enough. In this c[ase]
value increases from this ILmin (>0).

In the case of PWM control system, the output voltage is maintained by controlling the on-time period (to[n])
the oscillator frequency (fosc) being maintained constant.

- **Discontinuous Conduction Mode and Continuous Conduction Mode**

The maximum value (ILmax) and the minimum value (ILmin) of the current which flows through the indu[ctor]
the same as those when LxTr is ON and when it is off.

The difference between ILmax and ILmin, which is represented by ΔI ;

$\Delta I = ILmax - ILmin = V_{OUT} \times topen/L = (V_{IN} - V_{OUT}) \times ton/L$ .... Equ[ation]

wherein $T = 1/fosc = ton + toff$

duty (%) = ton/T×100 = ton×fosc×100

topen ≤ toff

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In Equation 1, $V_{OUT} \times topen/L$ and $(V_{IN}-V_{OUT}) \times ton/L$ respectively show the change of the current at on state, and the change of the current at off state.

When the output current (I_{OUT}) is relatively small, topen<toff as illustrated in the above diagram. In this case, the energy is charged in the inductor during the time period of ton and is discharged in its entirely during the time period of toff, therefore ILmin becomes to zero (ILmin=0). When I_{OUT} is gradually increased, eventually, topen becomes to toff (topen=toff), and when I_{OUT} is further increased, ILmin becomes larger than zero (ILmin>0). The former mode is referred to as the discontinuous mode and the latter mode is referred to as continuous mode.

In the continuous mode, when Equation 1 is solved for ton and assumed that the solution is tonc,

$$tonc = T \times V_{OUT}/V_{IN} \dotfill \text{Equation 2}$$

When ton<tonc, the mode is the discontinuous mode, and when ton=tonc, the mode is the continuous mode.

Output Current and Selection of External Components

When LxTr is ON:

(Wherein, Ripple Current P-P value is described as I_{RP}, ON resistance of LXTr is described as R_P the direct current resistance of the inductor is described as R_L.)

$$V_{IN} = V_{OUT} + (R_P + R_L) \times I_{OUT} + L \times I_{RP}/ton \dotfill \text{Equation 3}$$

When LxTr is OFF:

$$L \times I_{RP}/toff = V_F + V_{OUT} + R_L \times I_{OUT} \dotfill \text{Equation 4}$$

Put Equation 4 to Equation 3 and solve for ON duty, ton/(toff+ton)=D_{ON},

$$D_{ON} = (V_{OUT} + V_F + R_L \times I_{OUT})/(V_{IN} + V_F - R_P \times I_{OUT}) \dotfill \text{Equation 5}$$

Ripple Current is as follows;

$$I_{RP} = (V_{IN} - V_{OUT} - R_P \times I_{OUT} - R_L \times I_{OUT}) \times D_{ON}/f/L \dotfill \text{Equation 6}$$

wherein, peak current that flows through L, LxTr, and SD is as follows;

$$ILmax = I_{OUT} + I_{RP}/2 \dotfill \text{Equation 7}$$

Consider ILmax, condition of input and output and select external components.

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★ The above explanation is directed to the calculation in an ideal case in continuous mode.

External Components

1. Inductor

    Select an inductor that peak current does not exceed ILmax. If larger current than allowable current flow netic saturation occurs and make transform efficiency worse.

    When the load current is same, the smaller value of L is used, the larger the ripple current is.

    Provided that the allowable current is large in that case and DC current is small, therefore, for large output efficiency is better than using an inductor with a large value of L and vice versa.

2. Diode

    Use a diode with low V_F (Schottky type is recommended.) and high switching speed.

    Reverse voltage rating should be more than V_{IN} and current rating should be equal or more than ILmax.

3. Capacitor

    As for C_{IN}, use a capacitor with low ESR (Equivalent Series Resistance) and a capacity of at least $10\mu F$ fo operation.

    C_{OUT} can reduce ripple of Output Voltage, therefore 47 to $100\mu F$ tantalum type is recommended.

4. Lx Transistor

    Pch Power MOS FET is required for this IC.

    Its breakdown voltage between gate and source should be a few volt higher than Input Voltage.

    In the case of Input Voltage is low, to turn on MOS FET completely, select a MOS FET with low threshold v

    If a large load current is necessary for your application and important, choose a MOS FET with low ON res for good efficiency.

    If a small load current is mainly necessary for your application, choose a MOS FET with low gate capacity f efficiency.

    Maximum continuous drain current of MOS FET should be larger than peak current, ILmax.

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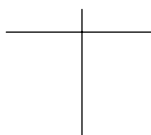
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current

R1223N332H   L=27µH

Output Voltage VOUT(V) vs Output Current IOUT(A)
- 12V
- 8V
- 4.5V

R1223N152H   L=27µH

Output Voltage VOUT(V) vs Output Current IOUT(A)
- 13.2V
- 8V
- 5V
- 2.3V
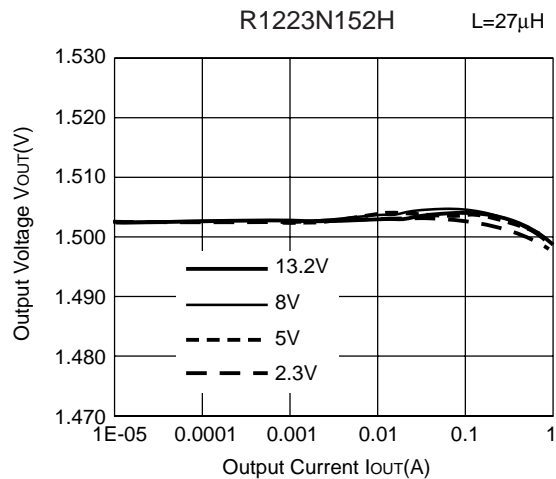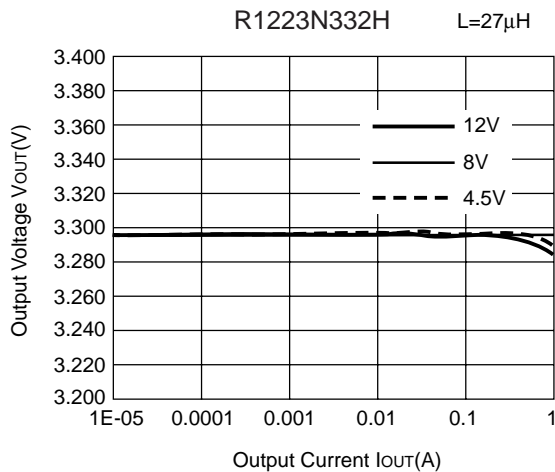
2) Efficiency vs. Output Current

R1223N332A(VIN=4.5V)   CD104-27µH Si3443DV

Efficiency η(%) vs Output Current IOUT(mA)

R1223N332A(VIN=12V)   CD104-27µH Si3443DV

Efficiency η(%) vs Output Current IOUT(mA)

R1223N332B(VIN=4.5V)   CD104-27µH Si3443DV

Efficiency η(%) vs Output Current IOUT(mA)

R1223N332B(VIN=12V)   CD104-27µH Si3443DV

Efficiency η(%) vs Output Current IOUT(mA)

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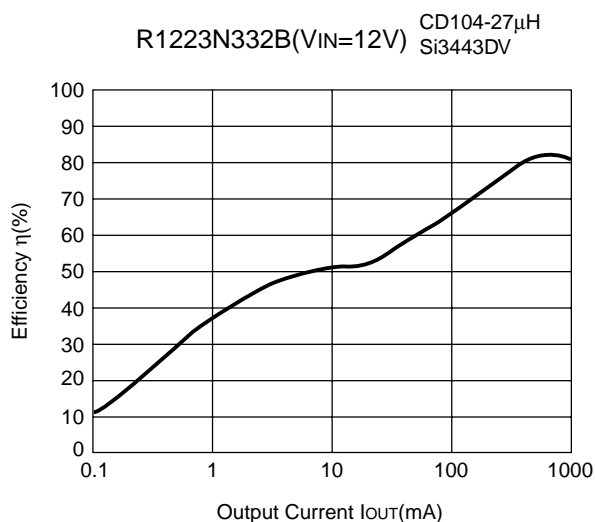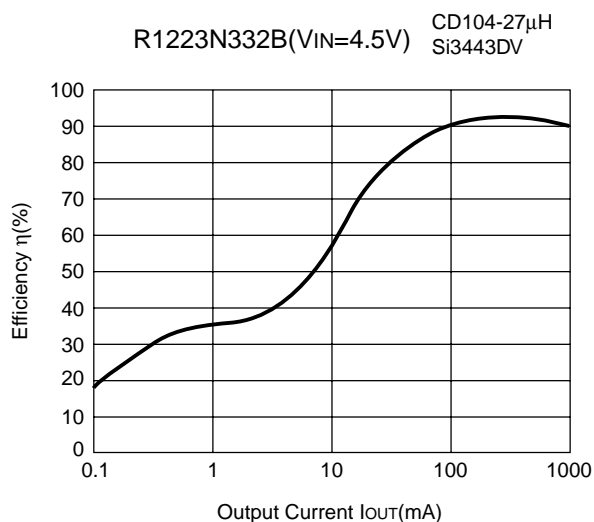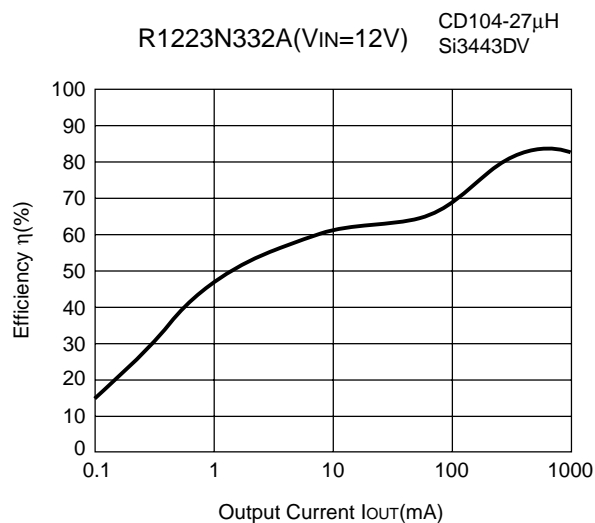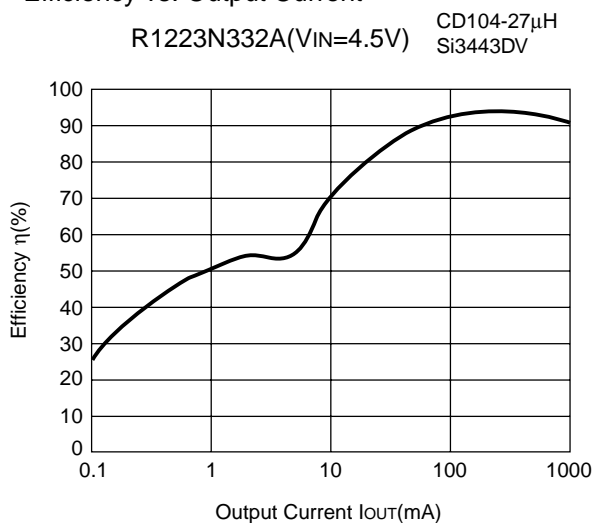
R1223N332C(VIN=4.5V) CD104-27µH Si3443DV

Efficiency η(%) vs Output Current IOUT(mA)
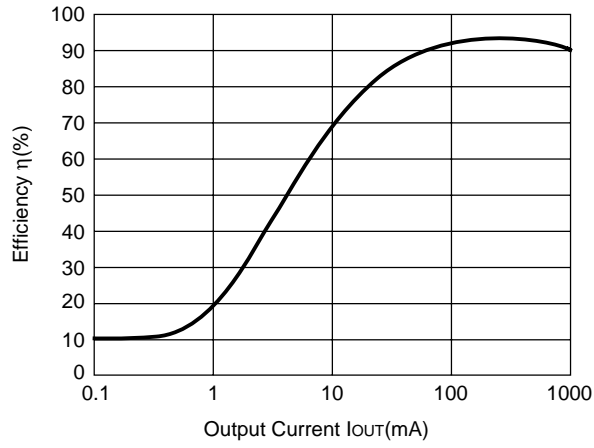
R1223N332C(VIN=12V) CD104-27µH Si3443DV

Efficiency η(%) vs Output Current IOUT(mA)
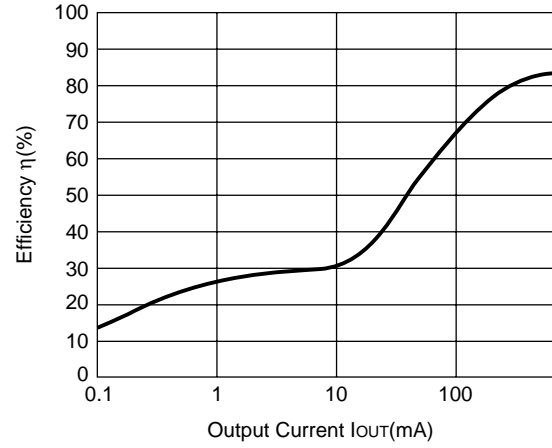
R1223N502A(VIN=6.0V) CD104-27µH Si3443DV

Efficiency η(%) vs Output Current IOUT(mA)
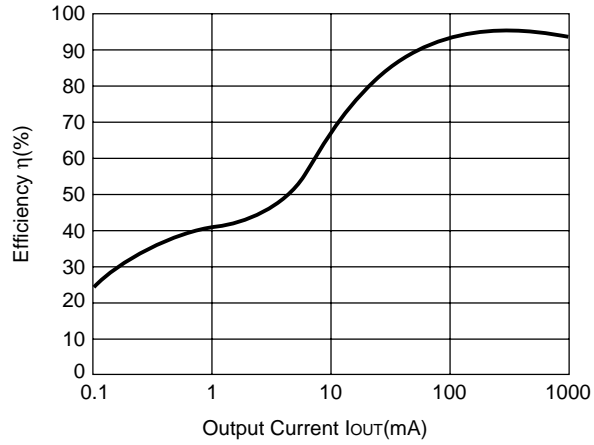
R1223N502A(VIN=12V) CD104-27µH Si3443DV

Efficiency η(%) vs Output Current IOUT(mA)
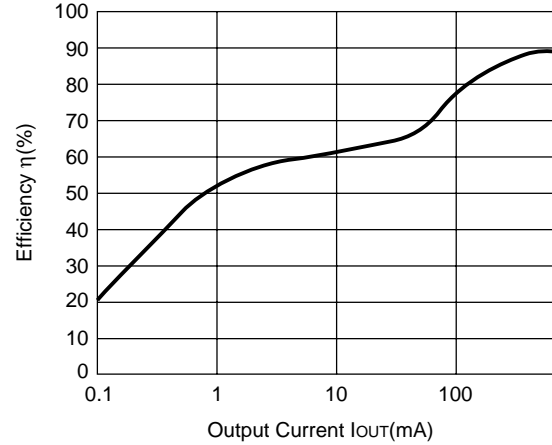
R1223N502B(VIN=6.0V) CD104-27µH Si3443DV

Efficiency η(%) vs Output Current IOUT(mA)
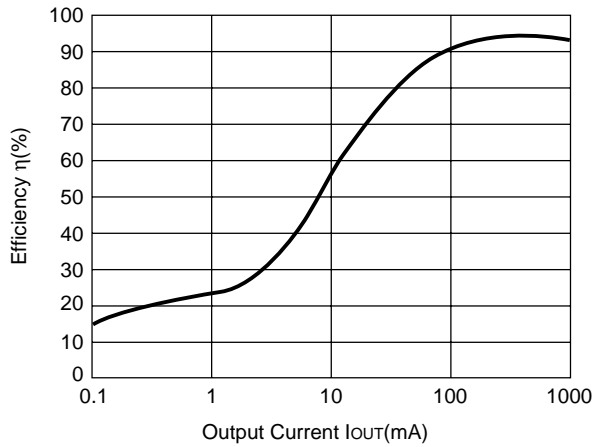
R1223N502B(VIN=12V) CD104-27µH Si3443DV

Efficiency η(%) vs Output Current IOUT(mA)

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R1223N502C(V$_{IN}$=6.0V)　CD104-27μH
Si3443DV

R1223N502C(V$_{IN}$=12V)　CD104-27μH
Si3443DV
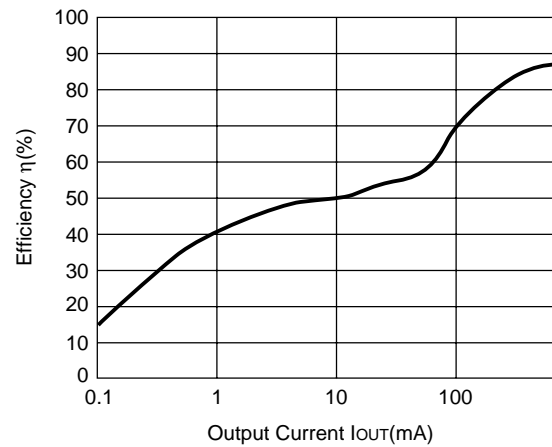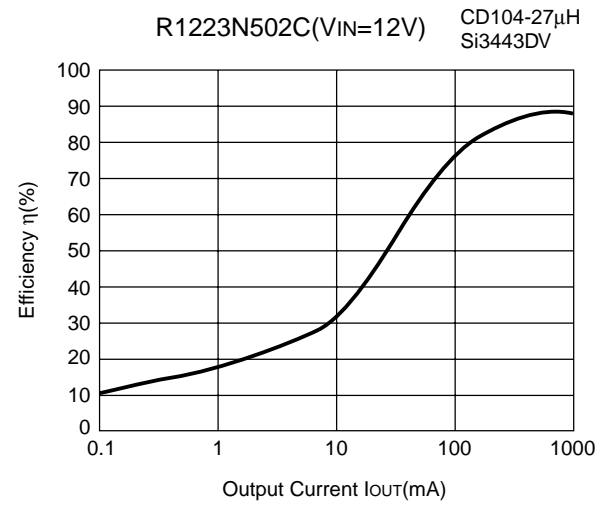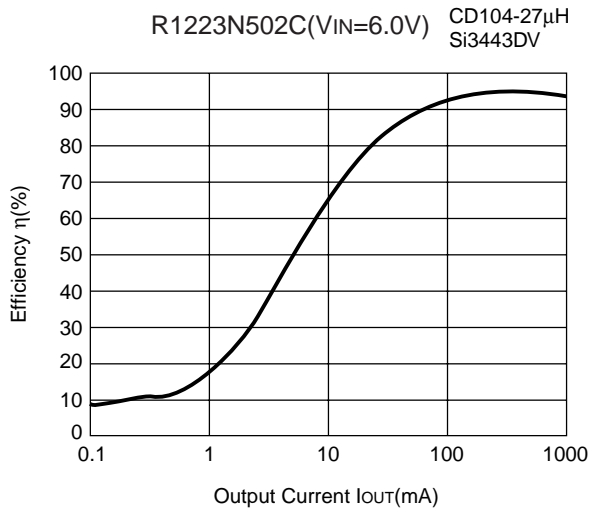
3)　Ripple Voltage vs. Output Current

R1223N332A　L=27μH

R1223N502A　L=27μH

R1223N332B　L=27μH

R1223N332H　L=27μH

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R1223N332C L=27μH

Ripple Voltage V_{RPP}(mV)

- V_{IN}4.5V
- V_{IN}8V
- V_{IN}12V

Output Current I_{OUT}(mA)

R1223N502C L=27μH

Ripple Voltage V_{RPP}(mV)

- V_{IN}6V
- V_{IN}8V
- V_{IN}12V

Output Current I_{OUT}(mA)
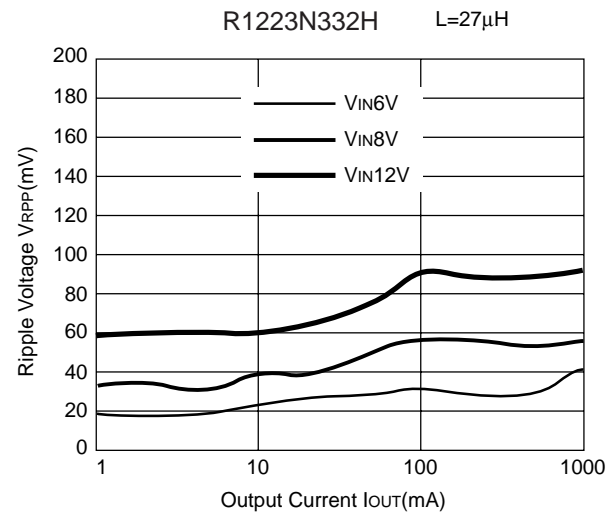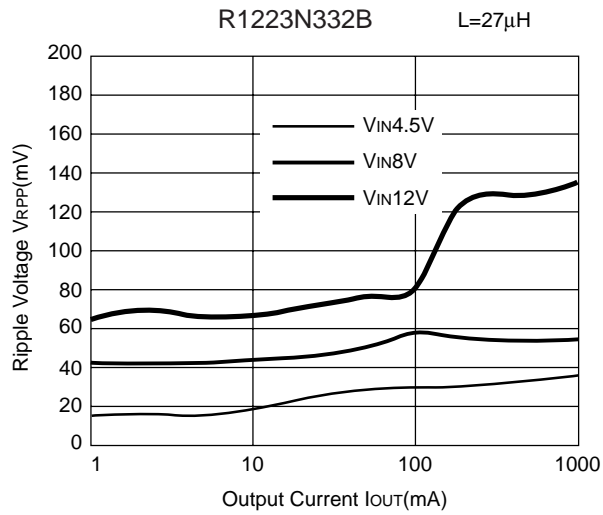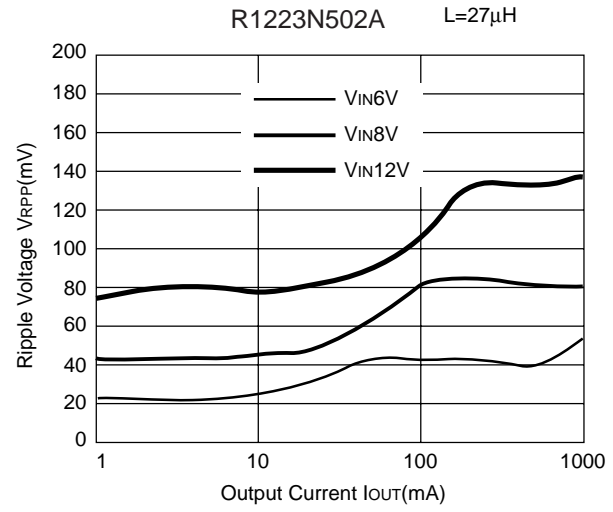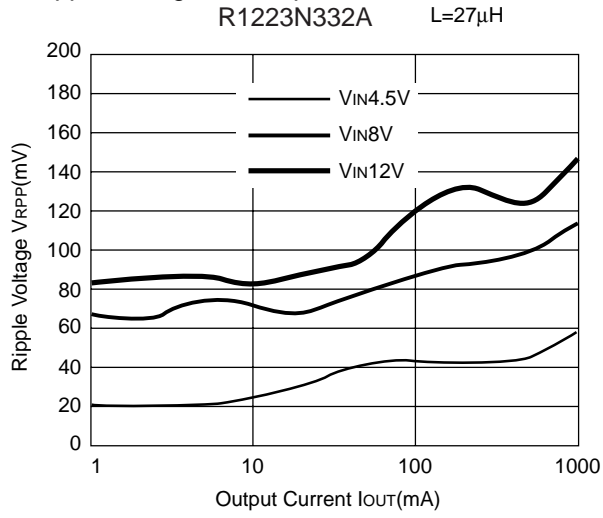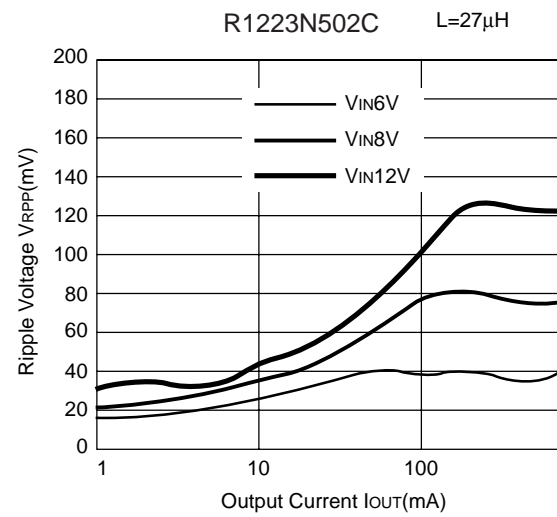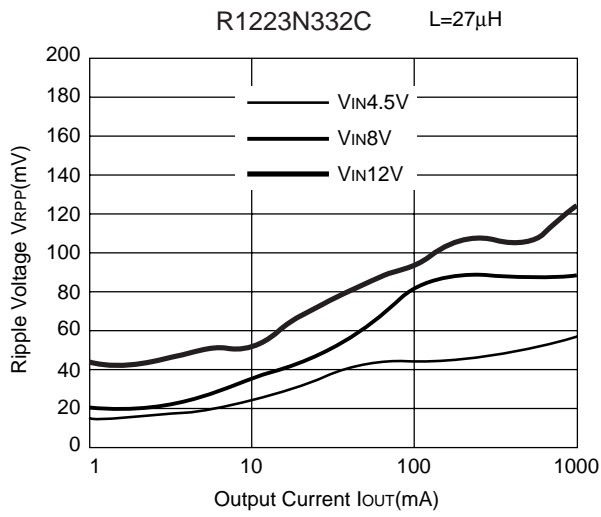
4) Oscillator Frequency vs. Input Voltage

R1223N152B L=27μH

Oscillator Frequency f_{osc}(kHz)

Intput Voltage V_{IN}(V)

R1223N152A L=27μH

Oscillator Frequency f_{osc}(kHz)

Intput Voltage V_{IN}(V)
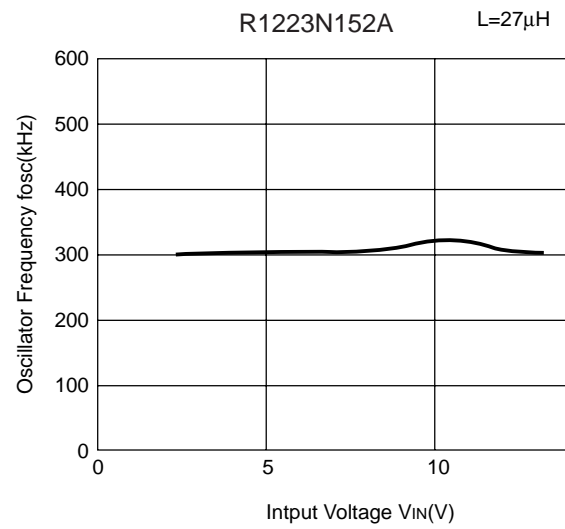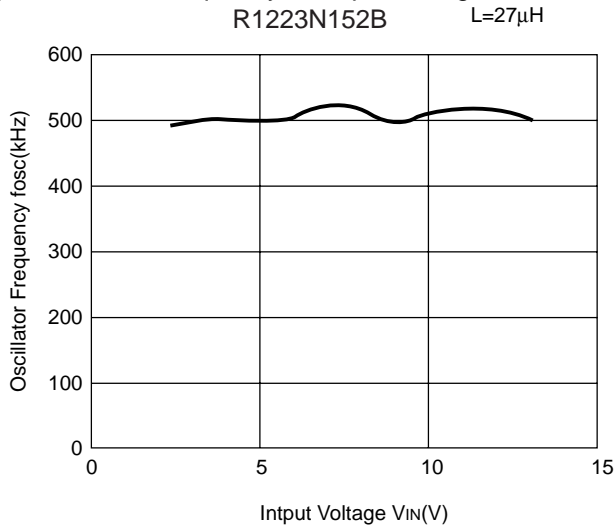
5) Output Voltage vs. Input Voltage

R1223N152B L=27μH

Output Voltage V_{OUT}(V)

Intput Voltage V_{IN}(V)

R1223N152A L=27μH

Output Voltage V_{OUT}(V)

Intput Voltage V_{IN}(V)

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R1223N332B L=27μH

Output Voltage V$_{OUT}$(V) vs. Intput Voltage VIN(V)

R1223N332A L=27μH

Output Voltage V$_{OUT}$(V) vs. Intput Voltage VIN(V)
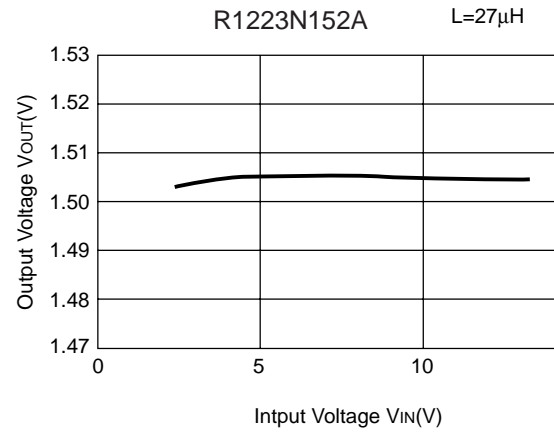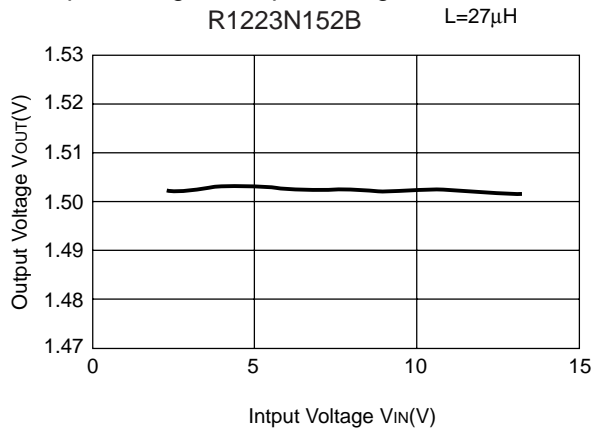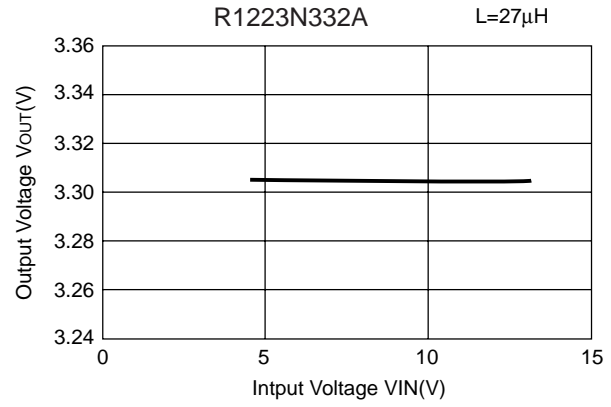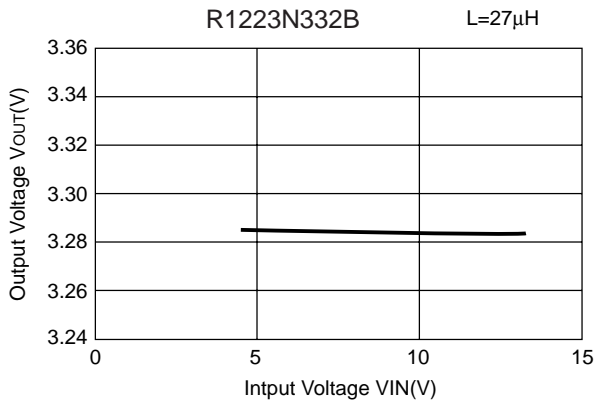
6) Output Voltage vs. Temperature

R1223N332H L=27μH VIN=4.5V

Output Voltage V$_{OUT}$(V) vs. Temperature Topt (°C)

R1223N152B L=27μH VIN=2.7V

Output Voltage V$_{OUT}$(V) vs. Temperature Topt (°C)
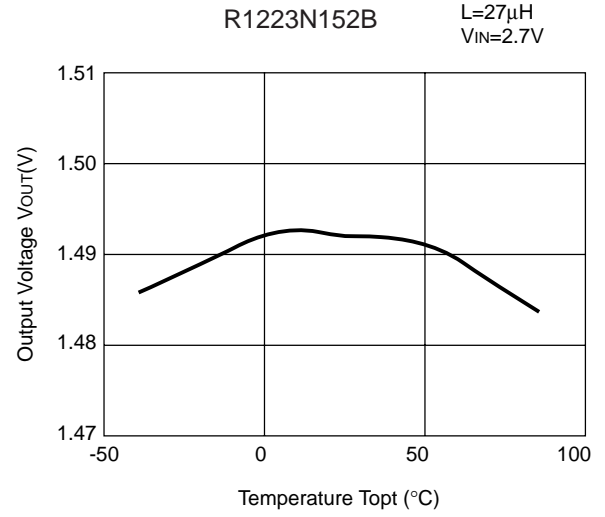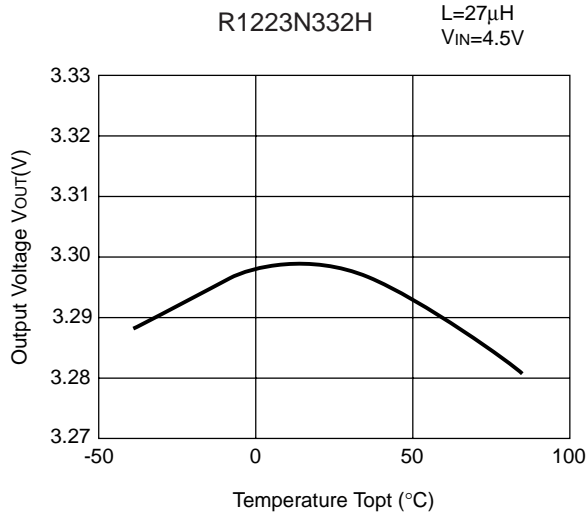
7) Oscillator Frequency vs. Temperature

R1223N252A L=27μH VIN=3.7V

Oscillator Frequency fosc(kHz) vs. Temperature Topt (°C)

R1223N332B L=27μH VIN=4.5V

Oscillator Frequency fosc(kHz) vs. Temperature Topt (°C)
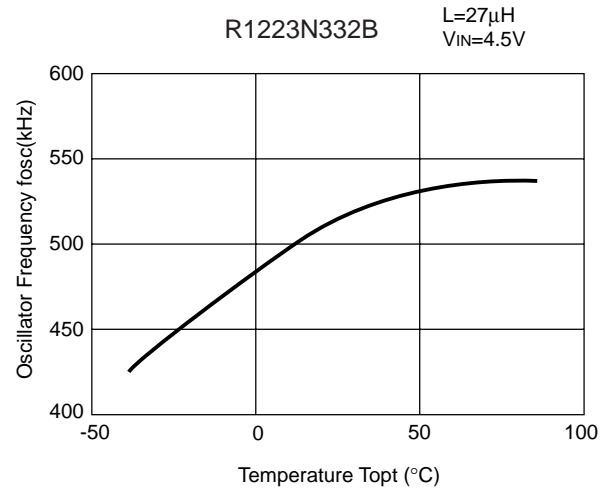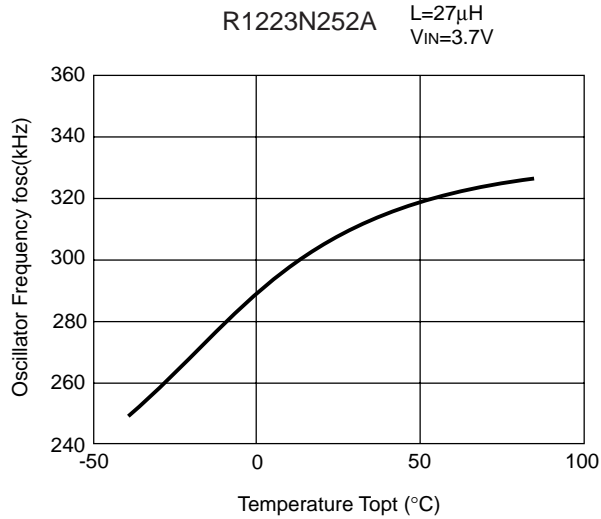
RICOH

8) Supply Current vs. Temperature

R1223N332G

Supply Current1(μA) vs Temperature Topt (°C)

VIN15V
VIN13.2V
VIN8V

R1223N332H

Supply Current1(μA) vs Temperature Topt (°C)

VIN15V
VIN13.2V
VIN8V
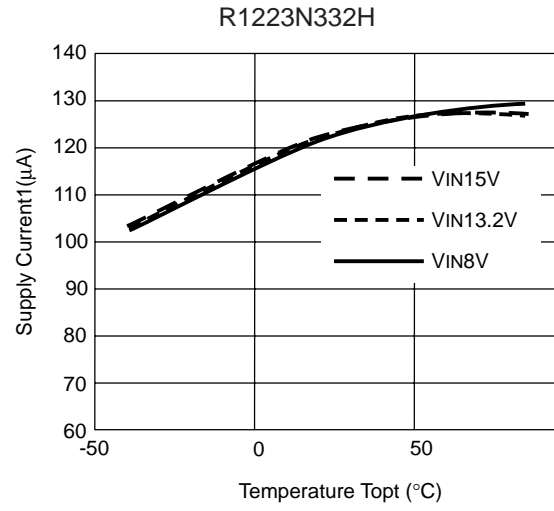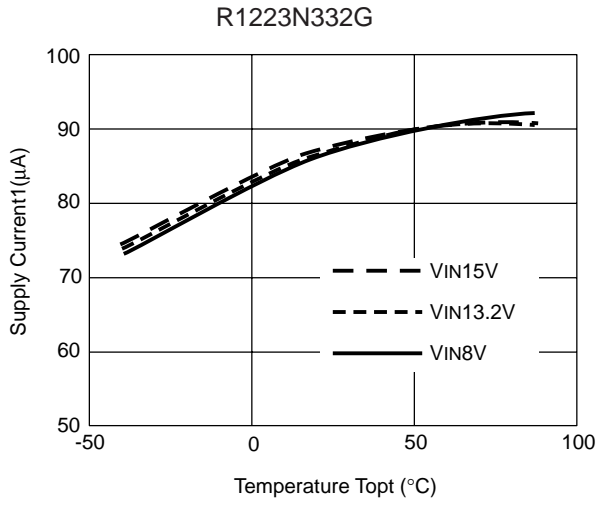
9) Soft-start time vs. Temperature

R1223N252A   L=27μH
VIN=3.7V

Soft-start Time (msec) vs Temperature Topt (°C)

R1223N332B   L=27μH
VIN=4.5V

Soft-start Time (msec) vs Temperature Topt (°C)

10) Delay Time for Latch-type protection vs. Temperature

R1223N252A   VIN=3.7V

Delay Time for Latch-type Protection(msec) vs Temperature Topt (°C)

R1223N332B   VIN=4.5V
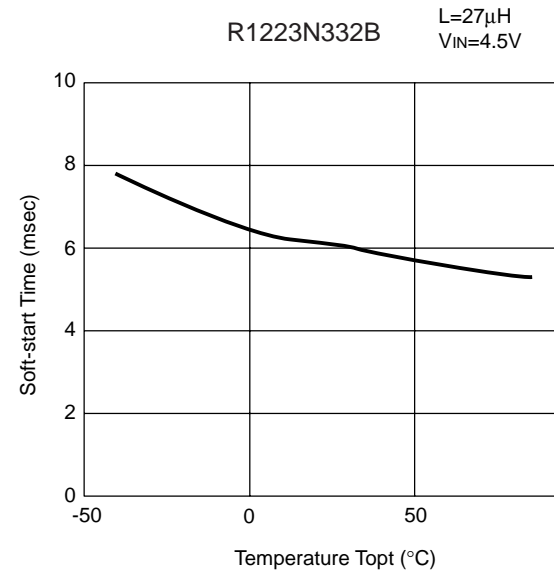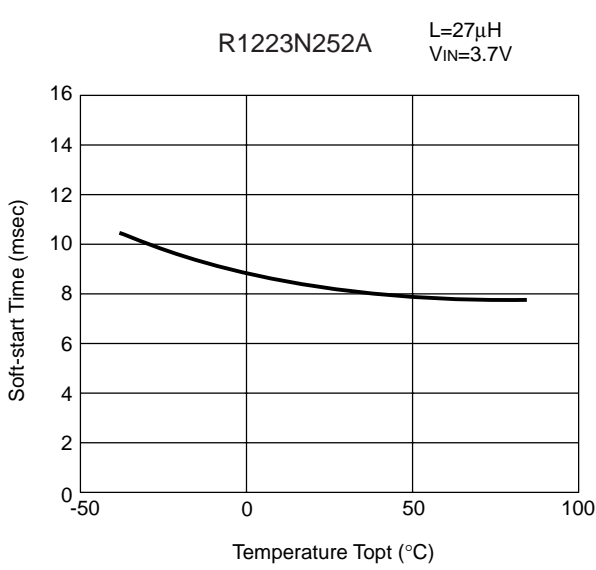
Delay Time for Latch-type Protection(msec) vs Temperature Topt (°C)
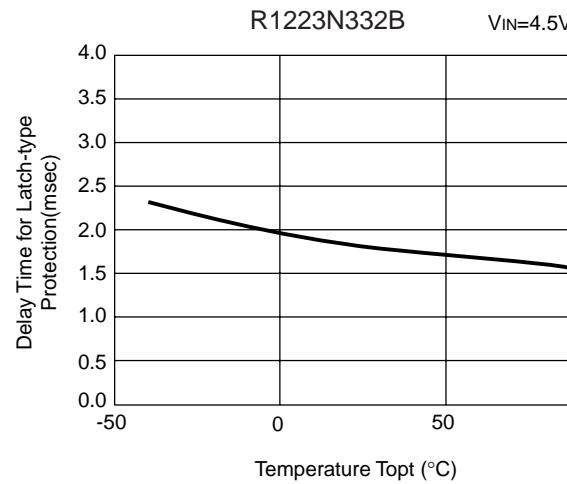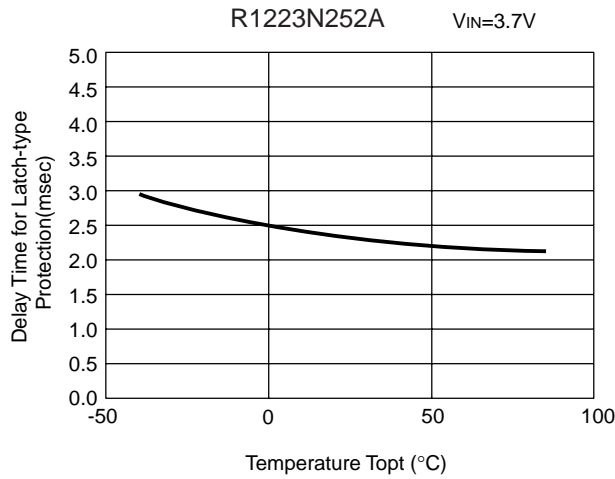
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11) Delay Time for Reset-type Protection vs. Temperature

R1223N332G V_{IN}=4.5V

Temperature Topt (°C)
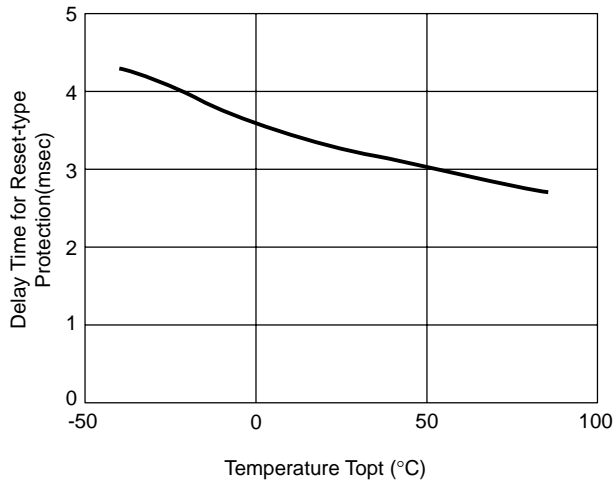
R1223N332H V_{IN}=4.5V
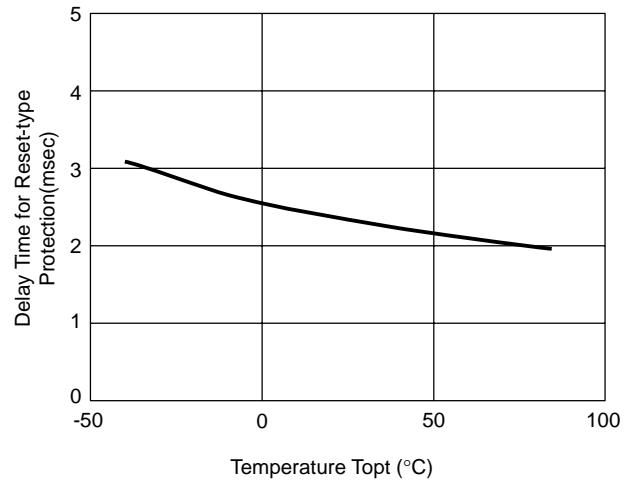
Temperature Topt (°C)

12) EXT "H" Output Current vs. Temperature

R1223N332B
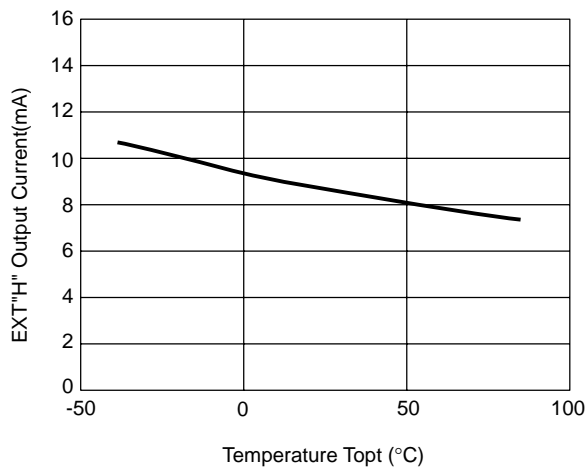
Temperature Topt (°C)

13) EXT "L" Output Current vs. Temperature

R1223N332B

Temperature Topt (°C)
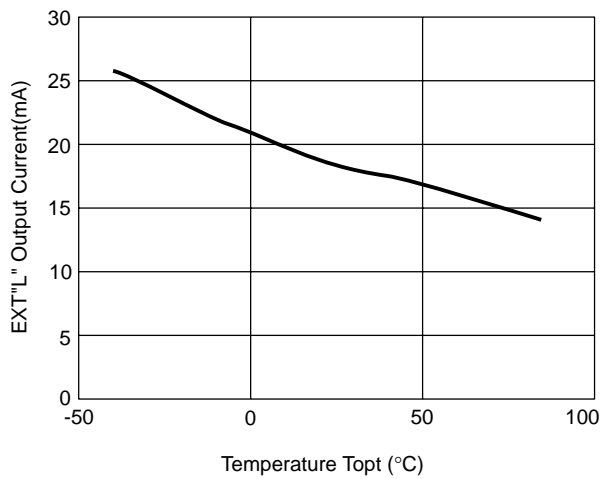
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14) Load Transient Response

R1223N332A $V_{IN}=5V$ $L=27\mu H$

R1223N332A $V_{IN}=5V$ $L=27\mu H$

R1223N332B $V_{IN}=5V$ $L=27\mu H$

R1223N332B $V_{IN}=5V$ $L=27\mu H$

R1223N332C $V_{IN}=5V$ $L=27\mu H$

R1223N332C $V_{IN}=5V$ $L=27\mu H$

Output Voltage V_{OUT}(V)

Output Current I_{OUT}(mA)

Time (sec)

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R1223N332D

VIN=5V
L=27µH

Output Voltage VOUT(V)

3.4
3.3
3.2
3.1
3
2.9

Output Current IOUT(mA)

500

0.1

0   0.0002   0.0004   0.0006   0.0008   0.001
Time (sec)

R1223N332C

VIN=5V
L=27µH

Output Voltage VOUT(V)

3.6
3.5
3.4
3.3
3.2

Output Current IOUT(mA)

500

0.1

0   0.05   0.1
Time (sec)

15) Turn-on Waveform

R1223N332A(VIN=10V,IOUT=0mA)

L=27µH

Output Voltage VOUT(V)

3.5
3
2.5
2
1.5
1
0.5
0

CE Voltage(V)

10

0

-0.01   0   0.01   0.02
Time (sec)
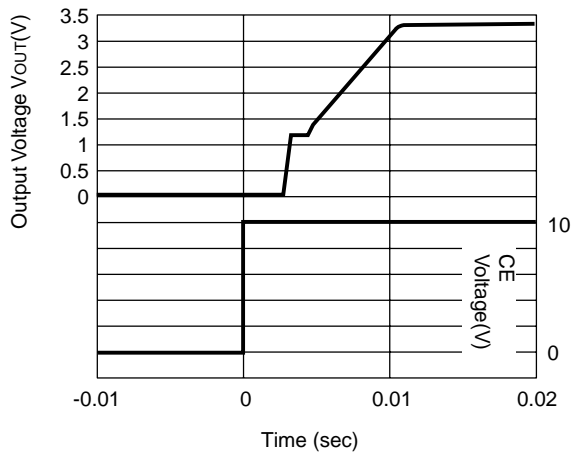
R1223N332A(VIN=5V,IOUT=0mA)

L=27µH

Output Voltage VOUT(V)

3.5
3
2.5
2
1.5
1
0.5
0

CE Voltage(V)

5

0

-0.01   0   0.01   0.02
Time (sec)

R1223N332B(VIN=10V, IOUT=0mA)

L=27µH

Output Voltage VOUT(V)

3.5
3
2.5
2
1.5
1
0.5
0

CE Voltage(V)

10

0

-0.01   0   0.01   0.02
Time (sec)
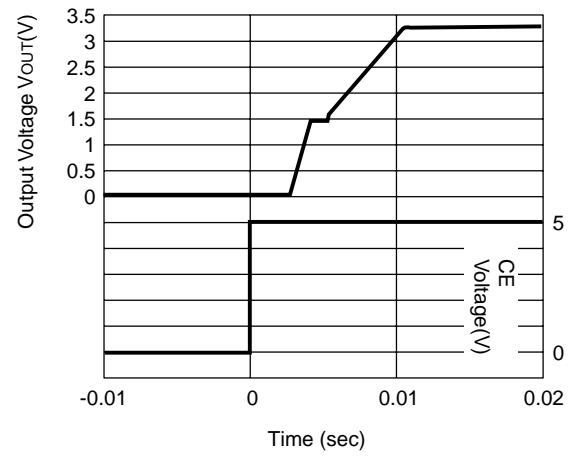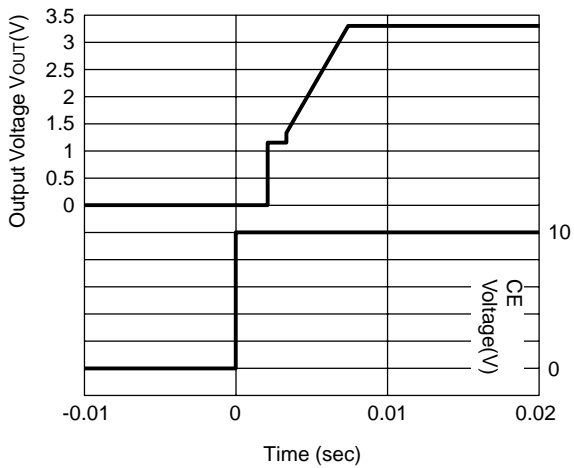
R1223N332B(VIN=5V, IOUT=0mA)

L=27µH

Output Voltage VOUT(V)

3.5
3
2.5
2
1.5
1
0.5
0

CE Voltage(V)

5

0

-0.01   0   0.01   0.02
Time (sec)

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R1223N332A(V$_{IN}$=10V, I$_{OUT}$=100mA)

L=27μH

Output Voltage V$_{OUT}$(V) / CE Voltage(V) vs Time (sec)
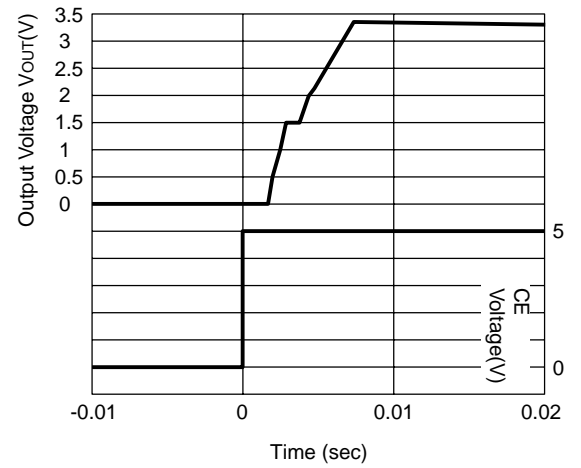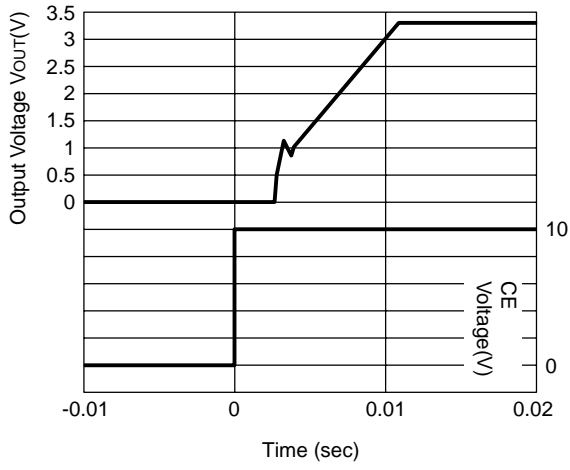
R1223N332A(V$_{IN}$=5V, I$_{OUT}$=100mA)

L=27μH

Output Voltage V$_{OUT}$(V) / CE Voltage(V) vs Time (sec)

R1223N332B(V$_{IN}$=10V, I$_{OUT}$=100mA)

L=27μH

Output Voltage V$_{OUT}$(V) / CE Voltage(V) vs Time (sec)
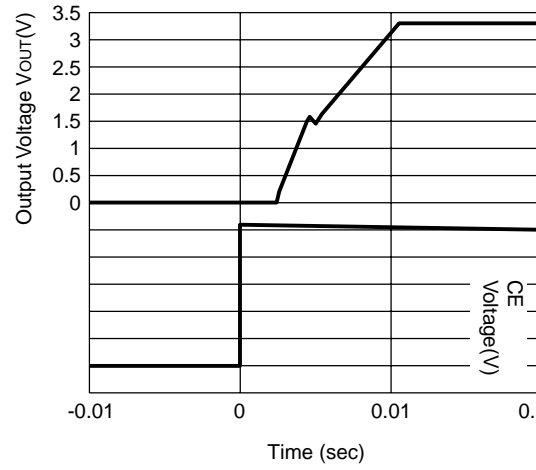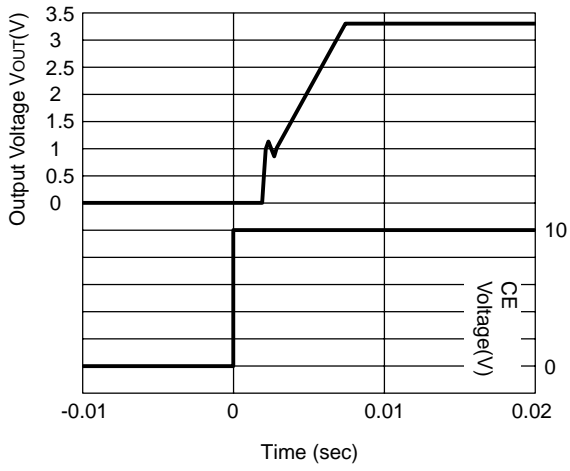
R1223N332B(V$_{IN}$=5V, I$_{OUT}$=100mA)

L=27μH

Output Voltage V$_{OUT}$(V) / CE Voltage(V) vs Time (sec)

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