PWM STEP-DOWN DC/DC CONVERTER WITH SYNCHRONOUS RECTIFIER

OUTLINE

The R1232D Series are CMOS-based PWM step-down DC/DC converters with synchronous rectifier, low supply current. As an output capacitor, a 10μF or more ceramic capacitor can be used with the R1232D.

Each of these ICs consists of an oscillator, a PWM control circuit, a voltage reference unit, an error amplifier, a soft-start circuit, protection circuits, a protection against miss operation under low voltage (UVLO), a chip enable circuit, a synchronous rectifier, Nch. driver transistor, and so on. A low ripple, high efficiency step-down DC/DC converter can be easily composed of this IC with only a few kinds of external components, or an inductor and capacitors. (As for R1232D001x type, divider resistors are also necessary.) In terms of the output voltage, it is fixed internally in the R1232Dxx1x types. While in the R1232D001x types, the output voltage is adjustable with external divider resistors.

As protection circuits, current limit circuit which limits peak current of L_X at each clock cycle, and latch type protection circuit exist. The latch protection works if the term of the over-current condition keeps on a certain time. Latch-type protection circuit works to latch an internal driver 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 or make the supply voltage at UVLO detector threshold level or lower than UVLO.

FEATURES

- Two choices of Oscillator Frequency 1MHz, 2.25MHz
  (Small inductors can be used. 4.7μH for 1MHz/2.2μH for 2.25MHz)
- Built-in Driver ON Resistance .... P-channel 0.2Ω (at V_{IN}=5.0V)
- Built-in Soft-start Function .... Typ. 1.0ms (fosc=1MHz type)
- Output Voltage .... 0.9V to 3.3V (xx1x Type)
  0.8V to V_{IN} (001x Type)
- High Accuracy Output Voltage .... ±2.0%
- Built-in Current Limit Circuit .... Typ. 1.4A
- Package .... SON-8 (t=0.9mm)

APPLICATIONS
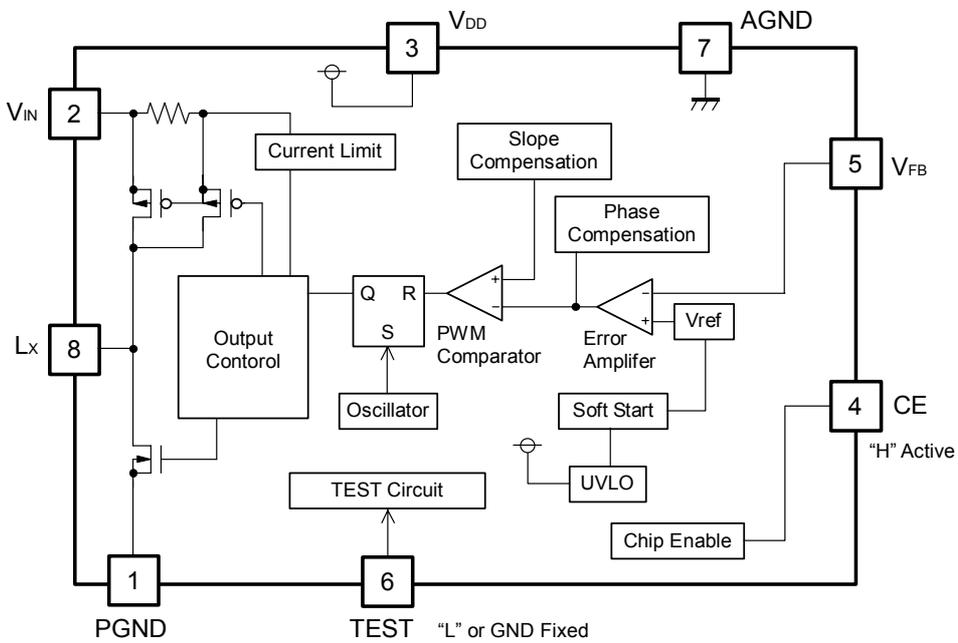
- Power source for portable equipment such as PDA, DSC, Notebook PC.
- Power source for HDD

BLOCK DIAGRAMS

R1232Dxx1A/B

R1232D001C/D

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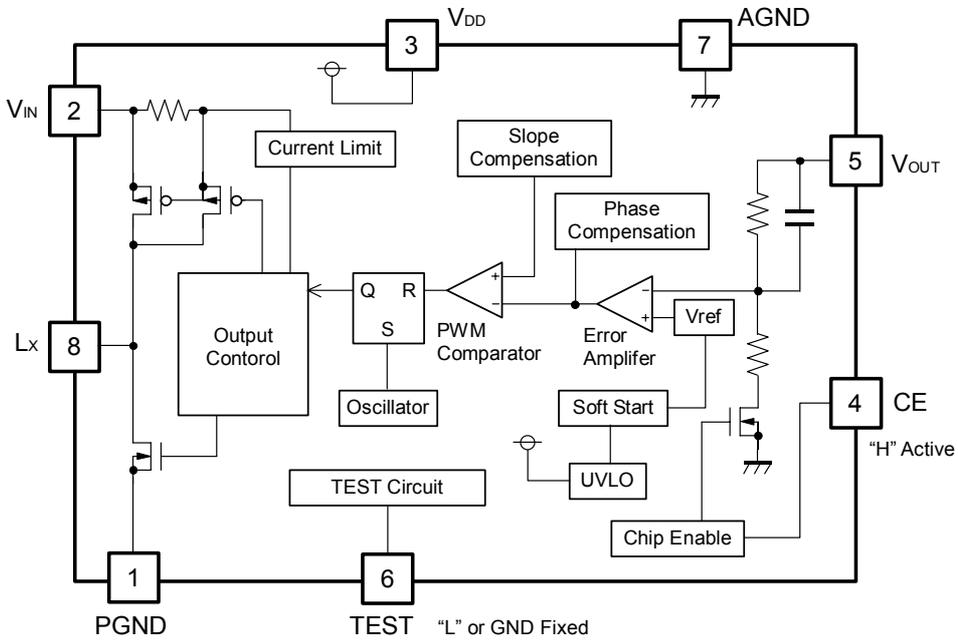
SELECTION GUIDE

In the R1232D Series, the output voltage, the oscillator frequency, and the taping type for the ICs can be selected at the user's request.

The selection can be made with designating the part number as shown below;

R1232D<u>xx</u>1<u>x</u>-<u>xx</u>-<u>x</u> ←Part Number
　　　↑ ↑↑　↑　↑
　　　a bc　d　e

Code	Contents
a	Setting Output Voltage(V_{OUT}): Stepwise setting with a step of 0.1V in the range of 0.9V to 3.3V is possible for fixed output version."00" is for Output Voltage Adjustable version (0.8V as the feedback voltage.)
b	1: fixed
c	Designation of Optional Function A: 1MHz, Fixed Output Voltage B: 2.25MHz, Fixed Output Voltage C: 1MHz, Adjustable Output Voltage D: 2.25MHz, Adjustable Output Voltage
d	Designation of Taping Type; (Refer to Taping Specification)"TR" is prescribed as a standard.
e	Designation of Composition of pin plating -F : Lead free plating

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PIN CONFIGURATION

SON-8

Top View

8 7 6 5

1 2 3 4

Bottom View

5 6 7 8

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*

*

4 3 2 1
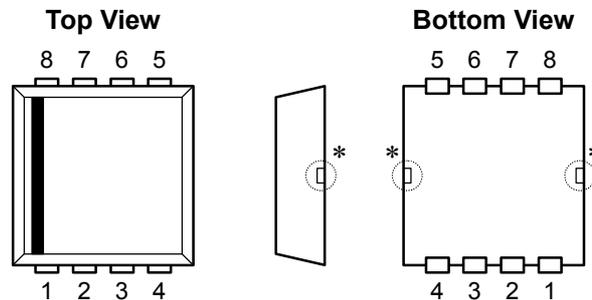
PIN DESCRIPTIONS

Pin No	Symbol	Pin Description
1	PGND	Ground Pin
2	V_{IN}	Voltage Supply Pin
3	V_{DD}	Voltage Supply Pin
4	CE	Chip Enable Pin (active with "H")
5	V_{OUT}/V_{FB}	Output/Feedback Pin
6	TEST	Test Pin (Forced to the "L" or GND level.)
7	AGND	Ground Pin
8	L_X	L_X Switching Pin (CMOS Output)

∗ Tab in the ⋯ parts have GND level. (They are connected to the reverse side of this IC.)
Do not connect to other wires or land patterns.

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	V_{IN} Supply Voltage	6.5	V
V_{DD}	V_{DD} Pin Voltage	6.5	V
V_{LX}	L_X Pin Voltage	−0.3 to V_{IN} + 0.3	V
V_{CE}	CE Pin Input Voltage	−0.3 to V_{IN} + 0.3	V
V_{TEST}	TEST Pin Input Voltage	−0.3 to V_{IN} + 0.3	V
V_{FB}	V_{FB} Pin Input Voltage	−0.3 to V_{IN} + 0.3	V
I_{LX}	L_X Pin Output Current	±1.5	V
P_D	Power Dissipation (SON-8)[1]	480	mW
Topt	Operating Temperature Range	−40 to 85	°C
Tstg	Storage Temperature Range	−55 to 125	°C

∗1) For the power dissipation, refer to the package information on the website.

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ELECTRICAL CHARACTERISTICS

● **R1232DxxxA/C**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating Input Voltage		2.6		5.5	V
V_{OUT}	Step-down Output Voltage	$V_{IN}=V_{CE}=5.0V$, $I_{OUT}=10mA$	×0.980		×1.020	V
V_{FB}	Feedback Voltage	$V_{IN}=V_{CE}=5.0V$, $I_{OUT}=10mA$	0.784	0.800	0.816	V
$\Delta V_{OUT}/\Delta Topt$	Step-down Output Voltage Temperature Coefficient	$-40°C \leq Topt \leq 85°C$		±150		ppm/°C
fosc	Oscillator Frequency	$V_{IN}=V_{CE}=V_{SET}+1.5V$	0.75	1.00	1.25	MHz
I_{DD}	Supply Current	$V_{IN}=V_{CE}=5.5V$, $V_{OUT}=5.5V$	70	140	190	μA
Istandby	Standby Current	$V_{CE}=V_{OUT}=0V$, $V_{IN}=5.5V$		0.0	5.0	μA
I_{LXleak}	Lx Leakage Current	$V_{IN}=5.5V$, $V_{CE}=0V$ $V_{LX}=0V/5.5V$	−5.0	0.0	5.0	μA
R_{ONP}	ON Resistance of Pch Transistor	$V_{IN}=5.0V$, $I_{LX}=200mA$		0.20	0.35	Ω
R_{ONN}	ON Resistance of Nch Transistor	$V_{IN}=5.0V$, $I_{LX}=200mA$		0.20	0.35	Ω
Maxduty	Oscillator Maximum Duty Cycle		100			%
tstart	Soft-start Time	$V_{IN}=V_{CE}=5.0V$, at no load	0.5	1.0	1.4	ms
tprot	Protection Delay Time	$V_{IN}=V_{CE}=5.0V$	0.1	2.0	10.0	ms
$I_{LX}limit$	Lx Current Limit	$V_{IN}=V_{CE}=5.0V$	1.0	1.4		A
V_{UVLO1}	UVLO Detector Threshold	$V_{IN}=V_{CE}=2.6V->1.5V$	2.10	2.25	2.40	V
V_{UVLO2}	UVLO Released Voltage	$V_{IN}=V_{CE}=1.5V->2.6V$	2.20	V_{UVLO1} +0.10	2.50	V
I_{CE}	CE Input Current	$V_{IN}=5.5V$, $V_{CE}=5.5V/0V$	−0.1	0.0	0.1	μA
I_{VOUT}	V_{OUT} Leakage Current	$V_{IN}=5.5V$, $V_{CE}=0V$, $V_{OUT}=5.5V/0V$	−0.1	0.0	0.1	μA
V_{CEH}	CE "H" Input Voltage	$V_{IN}=5.5V$	1.5			V
V_{CEL}	CE "L" Input Voltage	$V_{IN}=3.0V$			0.3	V
V_{TESTL}	TEST pin "L" Input Voltage	$V_{IN}=3.0V$			0.3	V

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● **R1232DxxxB/D**

Topt=25°C

| Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating Input Voltage		2.6		5.5	V
V_{OUT}	Step-down Output Voltage	$V_{IN}=V_{CE}=5.0V$, $I_{OUT}=10mA$	×0.980		×1.020	V
V_{FB}	Feedback Voltage	$V_{IN}=V_{CE}=5.0V$, $I_{OUT}=10mA$	0.784	0.800	0.816	V
$\Delta V_{OUT}/\Delta Topt$	Step-down Output Voltage Temperature Coefficient	$-40°C \leq Topt \leq 85°C$		±150		ppm/°C
fosc	Oscillator Frequency	$V_{IN}=V_{CE}=V_{SET}+1.5V$	1.91	2.25	2.58	MHz
I_{DD}	Supply Current	$V_{IN}=V_{CE}=5.5V$, $V_{OUT}=5.5V$	170	240	310	μA
Istandby	Standby Current	$V_{CE}=V_{OUT}=0V$, $V_{IN}=5.5V$		0.0	5.0	μA
I_{LXleak}	L_X Leakage Current	$V_{IN}=5.5V$, $V_{CE}=0V$, $V_{LX}=0V/5.5V$	−5.0	0.0	5.0	μA
R_{ONP}	ON Resistance of Pch Transistor	$V_{IN}=5.0V$, $I_{LX}=200mA$		0.20	0.35	Ω
R_{ONN}	ON Resistance of Nch Transistor	$V_{IN}=5.0V$, $I_{LX}=200mA$		0.20	0.35	Ω
Maxduty	Oscillator Maximum Duty Cycle		100			%
tstart	Soft-start Time	$V_{IN}=V_{CE}=5.0V$, at no load	0.15	0.4	0.7	ms
tprot	Protection Delay Time	$V_{IN}=V_{CE}=5.0V$	0.1	2.0	10.0	ms
I_{LX}limit	L_X Current Limit	$V_{IN}=V_{CE}=5.0V$	1.0	1.4		A
V_{UVLO1}	UVLO Detector Threshold	$V_{IN}=V_{CE}=2.6V \rightarrow 1.5V$	2.10	2.25	2.40	V
V_{UVLO2}	UVLO Released Voltage	$V_{IN}=V_{CE}=1.5V \rightarrow 2.6V$	2.20	V_{UVLO1} +0.10	2.50	V
I_{CE}	CE Input Current	$V_{IN}=5.5V$, $V_{CE}=5.5V/0V$	−0.1	0.0	0.1	μA
I_{VOUT}	V_{OUT} Leakage Current	$V_{IN}=5.5V$, $V_{CE}=0V$, $V_{OUT}=5.5V/0V$	−0.1	0.0	0.1	μA
V_{CEH}	CE "H" Input Voltage	$V_{IN}=5.5V$	1.5			V
V_{CEL}	CE "L" Input Voltage	$V_{IN}=3.0V$			0.3	V
V_{TESTL}	TEST "L" Input Voltage	$V_{IN}=3.0V$			0.3	V

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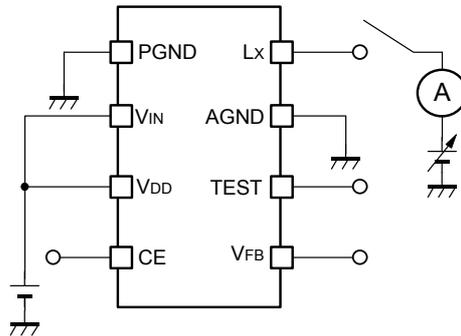
TEST CIRCUIT

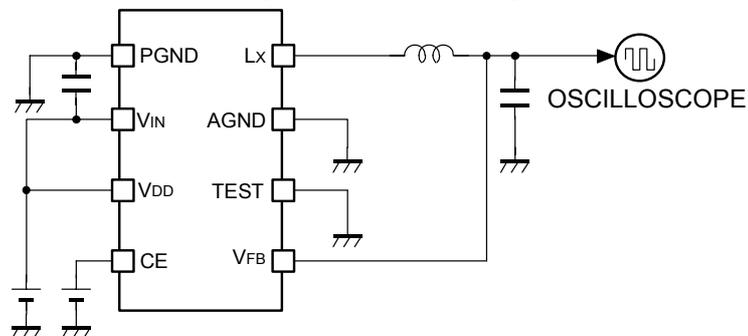**Test Circuit for Input Current and Leakage Current**
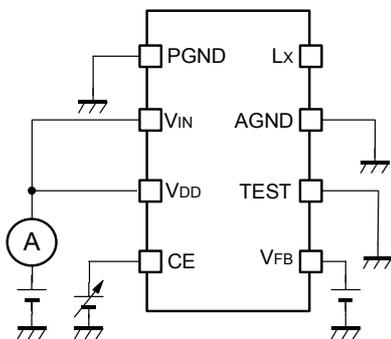
Test Circuit for Supply Current and Standby Current
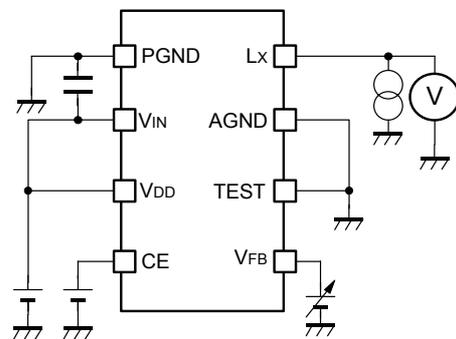
Test Circuit for ON resistance of Lx
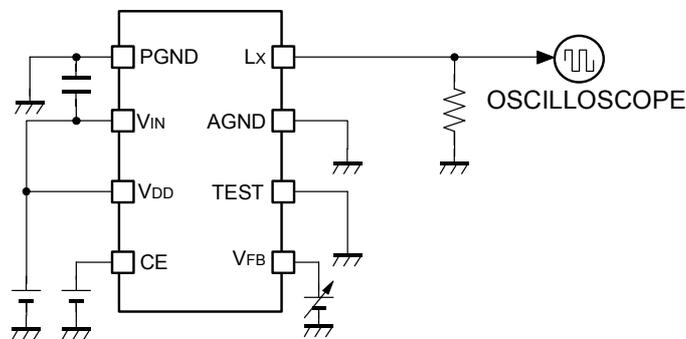
**Input Voltage, Output Voltage, Frequency, Lx Current Limit,
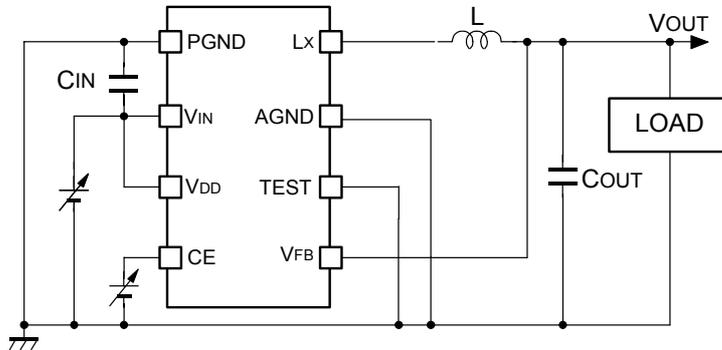Protection Delay Time, UVLO Voltage Test Circuit**
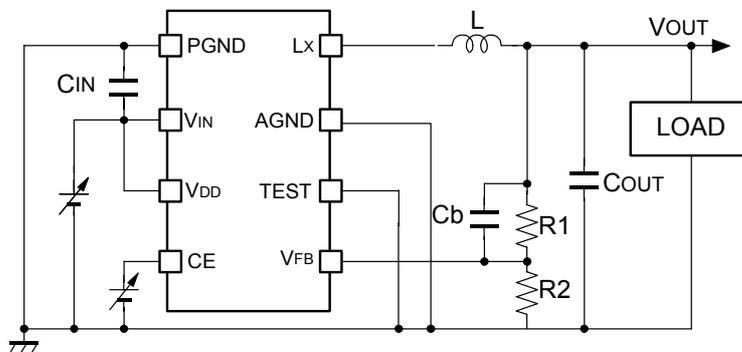

Soft Start Time Test Circuit

The bypass capacitor between power supply and GND is a ceramic capacitor 10μF.

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TYPICAL APPLICATION AND TECHNICAL NOTES

● **Fixed Output Voltage Type**

● **Adjustable Output Type**

C_{IN}	10μF C2012JB0J106MT (TDK), 10μF CM21B106M06AB (Kyocera)
C_{OUT}	10μF C2012JB0J106MT (TDK), 10μF CM21B106M06AB (Kyocera)
L	4.7μH/2.7μH VLP5610-4R7MR90, VLP5610-2R7M1R0 (TDK) *2.2μH is also suitable for B version.

In terms of setting R1, R2, Cb, refer to the technical notes.

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When you use these ICs, consider the following issues;

- Input the same voltage into power supply pins, V_{IN} and V_{DD}. Set the same level as AGND and PGND.
- When you control the CE pin by another power supply, do not make its "H" level more than the voltage level of V_{IN} / V_{DD} pin.
- Set external components such as an inductor, C_{IN}, C_{OUT} as close as possible to the IC, in particular, minimize the wiring to V_{IN} pin and PGND pin.
- At stand by mode, (CE="L"), the L_X output is Hi-Z, or both P-channel transistor and N-channel transistor of L_X pin turn off.
- In terms of the protection circuits, current limit for the peak current of each cycle of Lx, and the latch protection circuit, which works if the over-limit current flows continuously for a certain time exist. To release the protection, once make this IC into be standby mode with chip enable pin, or make the supply voltage be down to UVLO threshold level or less.
- Reinforce the V_{IN}, PGND, and V_{OUT} lines sufficiently. Large switching current may flow in these lines. If the impedance of V_{IN} and PGND lines is too large, the internal voltage level in this IC may shift caused by the switching current, and the operation might be unstable.
- Connect the TEST Pin to the "L" or GND level.

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 that the values such as voltage, current, and power of each component, PCB patterns and the IC do not exceed their 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 L_x transistor is ON, and discharges the energy from the inductor when L_x transistor is OFF and controls with less energy loss, so that a lower output voltage than the input voltage is obtained. The operation will be explained with reference to the following diagrams:

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<Basic Circuits>   **<Current through L>**

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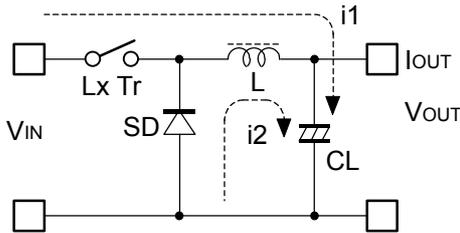
Step 1: P-channel Tr. turns on and current IL (=i1) flows, and energy is charged into C_L. At this moment, IL increases from Ilmin (=0) to reach ILmax in proportion to the on-time period (ton) of P-channel Tr.

Step 2: When P-channel Tr. turns off, Synchronous rectifier N-channel Tr. turns on in order that L maintains IL at ILmax, and current IL (=i2) flows.

Step 3: IL (=i2) decreases gradually and reaches IL=ILmin=0 after a time period of topen, and N-channel Tr. Turns off. Provided that in the continuous mode, next cycle starts before IL becomes to 0 because toff time is not enough. In this case, IL value increases from this Ilmin (>0).

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

● **Continuous Conduction Mode**

The maximum value (ILmax) and the minimum value (ILmin) of the current flowing through the inductor are the same as those when P-channel Tr. turns on and off.
The difference between ILmax and ILmin, which is represented by ΔI;

$$\Delta I = ILmax - ILmin = V_{OUT} \times topen/L = (V_{IN} - V_{OUT}) \times ton/L \quad\text{...Equation 1}$$

Where, t=1/fosc=ton+toff
duty (%)=ton/t×100=ton×fosc×100
topen ≦ toff

In Equation 1, $V_{OUT} \times topen/L$ and $(V_{IN} - V_{OUT}) \times ton/L$ are respectively shown the change of the current at ON, and the change of the current at OFF.

Even if the output current (I_{OUT}) is, topen < toff as illustrated in the above diagram is not realized with this IC. At least, topen is equal toff (topen=toff), and when I_{OUT} is further increased, ILmin becomes larger than zero (ILmin>0). The mode is referred to as the continuous mode.

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

$$tonc = t \times V_{OUT}/V_{IN} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\text{Equation 2}$$

When the ton=tonc, the mode is the continuous mode.

OUTPUT CURRENT AND SELECTION OF EXTERNAL COMPONENTS

When P-channel Tr. of L_X is ON:

(Wherein, Ripple Current P-P value is described as I_{RP}, ON resistance of P-channel Tr. and N-channel Tr. of L_X are respectively described as R_{ONP} and R_{ONN}, and the DC resistor of the inductor is described as R_L.)

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

When P-channel Tr. of L_X is "OFF"(N-channel Tr. is "ON"):

$$L \times I_{RP}/toff = V_F + V_{OUT} + R_{ONN} \times I_{OUT} \dots\dots\dots\dots\dots\dots\dots\dots\text{Equation 4}$$

Put Equation 4 to Equation 3 and solve for ON duty of P-channel transistor, Don=ton/(toff+ton),

$$D_{ON} = (V_{OUT} - R_{ONN} \times I_{OUT} + R_L \times I_{OUT})/(V_{IN} + R_{ONN} \times I_{OUT} - R_{ONP} \times I_{OUT}) \dots\dots\dots\dots\text{Equation 5}$$

Ripple Current is as follows;

$$I_{RP} = (V_{IN} - V_{OUT} - R_{ONP} \times I_{OUT} - R_L \times I_{OUT}) \times D_{ON}/fosc/L \dots\dots\dots\dots\dots\dots\text{Equation 6}$$

wherein, peak current that flows through L, and L_X Tr. is as follows;

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

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

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

How to Adjust Output Voltage and about Phase Compensation

As for Adjustable Output type, feedback pin (V_{FB}) voltage is controlled to maintain 0.8V.
Output Voltage, V_{OUT} is as following equation;

V_{OUT} R1+R2=V_{FB}:R2
V_{OUT}=V_{FB}×(R1+R2)/R2

Thus, with changing the value of R1 and R2, output voltage can be set in the specified range.

In the DC/DC converter, with the load current and external components such as L and C, phase might be behind 180 degree. In this case, the phase margin of the system will be less and stability will be worse. To prevent this, phase margin should be secured with proceeding the phase. A pole is formed with external components L and C_{OUT}.

$$fpole \sim 1/2\pi\sqrt{LC_{OUT}}$$

A zero (signal back to zero) is formed with R1 and Cb.

$$\cong fzero \sim 1/(2p \times R1 \times Cb)$$

First, choose the appropriate value of R1, R2 and Cb.
Set R1+R2 value 100kΩ or less.

For example, if L=4.7μH, C_{OUT}=10μF, the cut off frequency of the pole is approximately 23kHz.
To make the cut off frequency of the zero by R1, R2, and Cb be higher than 23kHz,
set R1=33kΩ and Cb=100pF.If V_{OUT} is set at 2.0V, R2=22kΩ is appropriate.

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External Components

1.Inductor

Select an inductor that peak current does not exceed ILmax. If larger current than allowable current flows, magnetic saturation occurs and makes transform efficiency be worse.

Supposed that the load current is at the 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 current, efficiency is better than using an inductor with a large value of L and vice versa.

2.Capacitor

As for C_{IN}, use a capacitor with low ESR (Equivalent Series Resistance) Ceramic type of a capacity at least 10μF for stable operation.

C_{OUT} can reduce ripple of the output voltage, therefore as much as 10μF ceramic type is recommended.

TIMING CHART

CE pin Voltage

Output Short   Output Short

Intemal Opertional   Intemal Soft-start
Amplifier Output   Set Voltage

Intemal Oscillator Waveform

Lx Pin Output

Latched

Soft-start Time   Stable   Delay Time of Protection
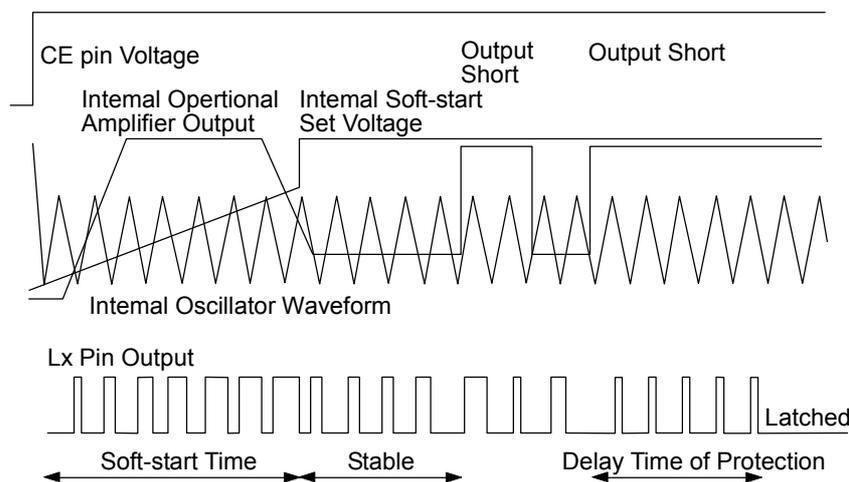
The timing chart as shown above describes the waveforms starting from the IC is enabled with CE and latched with protection. During the soft-start time, until the level is rising up to the internal soft-start set voltage, the duty cycle of L_x is gradually wider and wider to prevent the over-shoot of the voltage. During the term, the output of amplifier is "H". After the output voltage reaches the set output voltage, they are balanced well. Herein, if the output pin would be short circuit, the output of amplifier would become "H" again, and the condition would continue for 2.0ms (Typ.), latch circuit would work and the output of L_x would be latched with "OFF". (Output ="High-Z")

If the output short is released before the latch circuit works (within 2ms after output shorted), the output of amplifier is balanced in the stable state again.
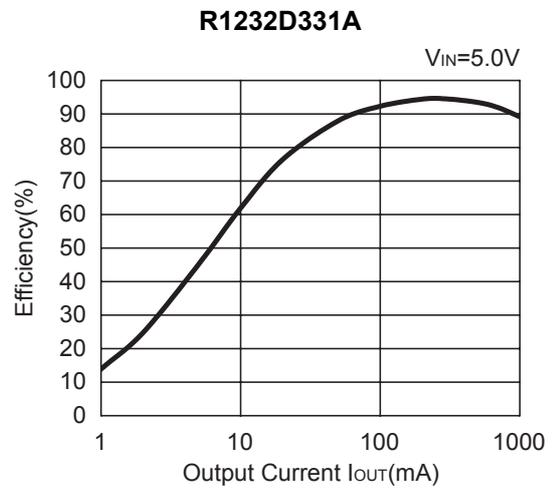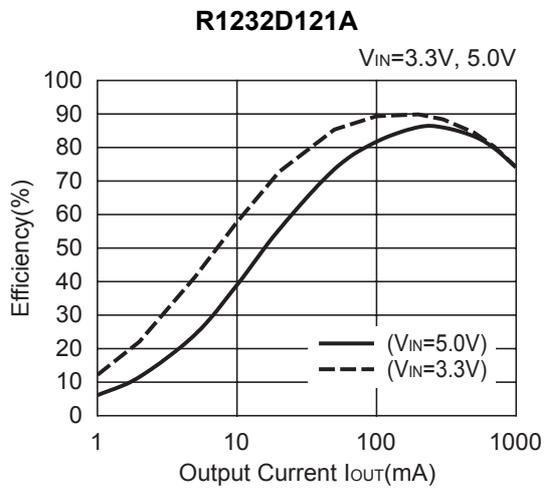
Once the IC is latched, to release the protection, input "L" with CE pin, or make the supply voltage at UVLO level or less.

TYPICAL CHARACTERISTICS

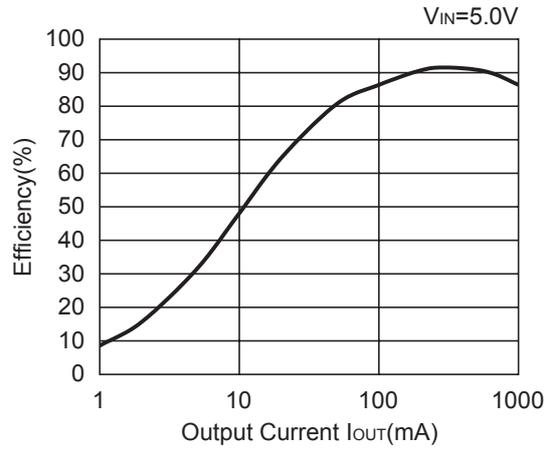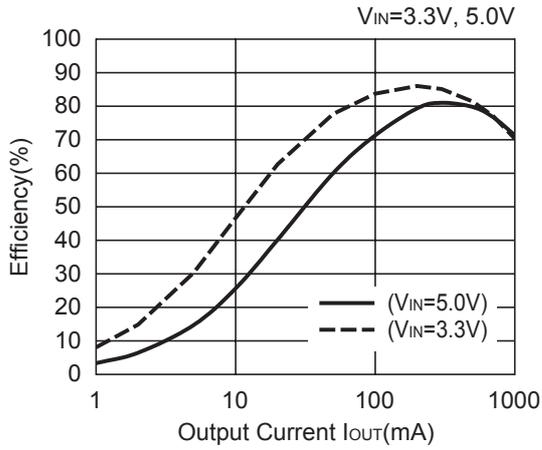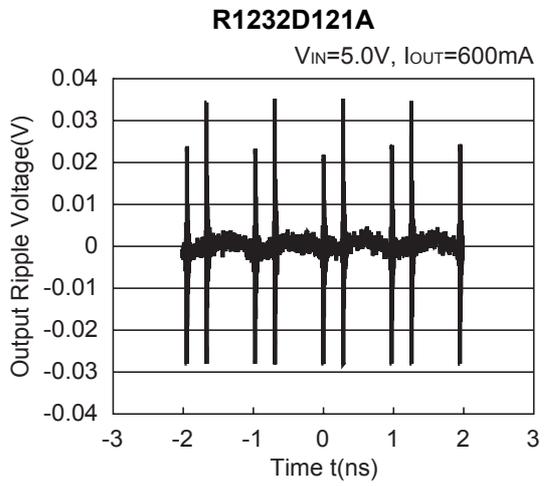## 1) Output Voltage vs. Output Current ($C_{IN} = 10\mu F$, $C_{OUT} = 10\mu F$)

R1232D121A

$V_{IN}=5.0V$

Output Voltage $V_{OUT}(V)$ vs. Output Current $I_{OUT}(mA)$

R1232D331A

$V_{IN}=5.0V$

Output Voltage $V_{OUT}(V)$ vs. Output Current $I_{OUT}(mA)$

R1232D121B

$V_{IN}=5.0V$

Output Voltage $V_{OUT}(V)$ vs. Output Current $I_{OUT}(mA)$

R1232D331B

$V_{IN}=5.0V$

Output Voltage $V_{OUT}(V)$ vs. Output Current $I_{OUT}(mA)$

2) Efficiency vs. Output Current ($C_{IN} = 10\mu F$, $C_{OUT} = 10\mu F$)

R1232D121A

$V_{IN}=3.3V$, 5.0V

Efficiency(%) vs. Output Current $I_{OUT}(mA)$

— ($V_{IN}=5.0V$)
-- ($V_{IN}=3.3V$)

R1232D331A

$V_{IN}=5.0V$

Efficiency(%) vs. Output Current $I_{OUT}(mA)$

R1232D121B

R1232D331B

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Efficiency charts (top): V$_{IN}$=3.3V, 5.0V and V$_{IN}$=5.0V, Efficiency(%) vs Output Current I$_{OUT}$(mA)

Legend: (V$_{IN}$=5.0V), (V$_{IN}$=3.3V)

3) Output Waveform

R1232D121A V$_{IN}$=5.0V, I$_{OUT}$=600mA — Output Ripple Voltage(V) vs Time t(ns)

R1232D331A V$_{IN}$=5.0V, I$_{OUT}$=600mA — Output Ripple Voltage(V) vs Time t(ns)

R1232D121B V$_{IN}$=5.0V, I$_{OUT}$=600mA — Output Ripple Voltage(V) vs Time t(ns)

R1232D331B V$_{IN}$=5.0V, I$_{OUT}$=600mA — Output Ripple Voltage(V) vs Time t(ns)

4) Load Transient Response

R1232D121A

V_IN=5.0V

Output Current 10mA→600mA

Output Voltage

Time t (μs)

R1232D121A

V_IN=5.0V

Output Current 600mA→10mA

Output Voltage

Time t (μs)

R1232D121B

V_IN=5.0V

Output Current 10mA→600mA

Output Voltage

Time t (μs)

R1232D121B

V_IN=5.0V

Output Current 600mA→10mA

Output Voltage

Time t (μs)
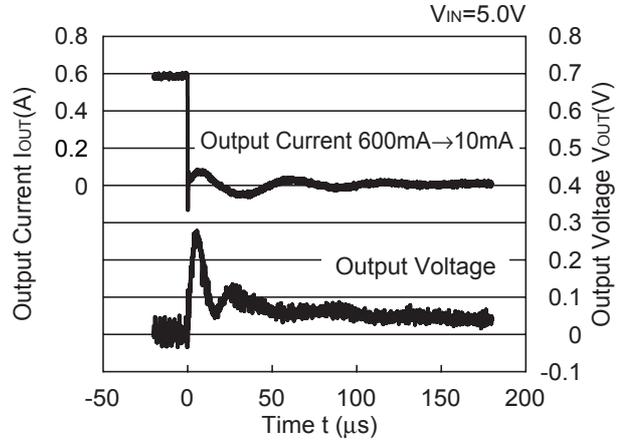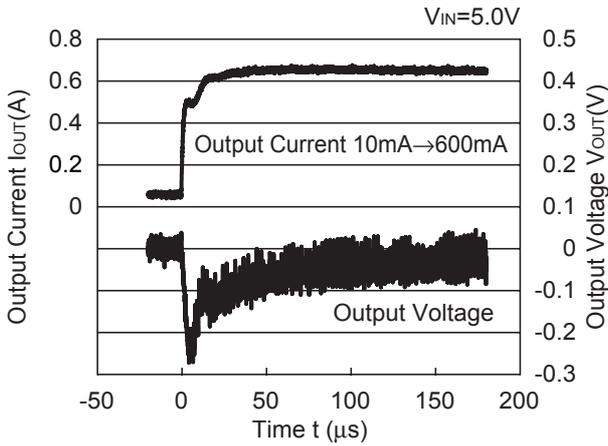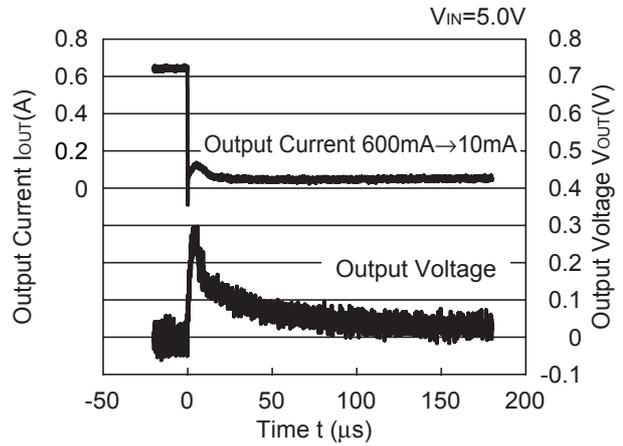
5) Output Voltage vs. Input Voltage

R1232D121A

I_OUT=600mA

Input Voltage V_IN(V)

R1232D331A

I_OUT=600mA
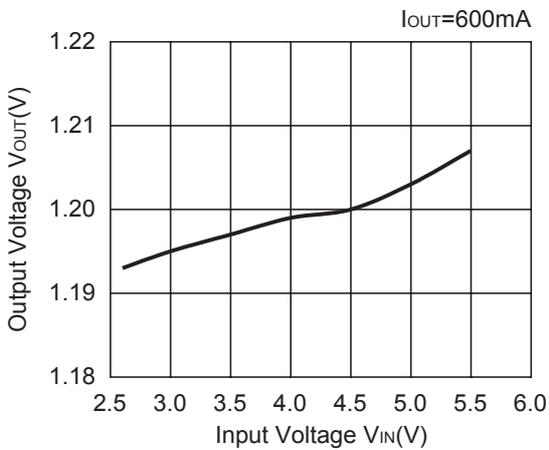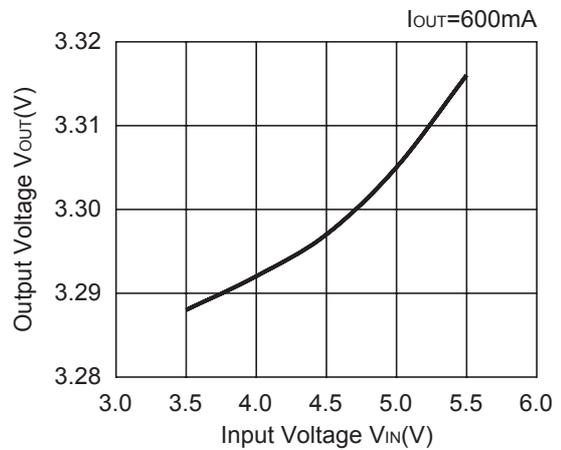
Input Voltage V_IN(V)

6) Oscillator Frequency vs. Input Voltage

R1232D121A   **R1232D121B**

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Iout=600mA

Iout=600mA

[Graph: Frequency fosc(MHz) vs Input Voltage VIN(V), Y-axis 0.90 to 1.10]

[Graph: Frequency fosc(MHz) vs Input Voltage VIN(V), Y-axis 2.0 to 2.4]
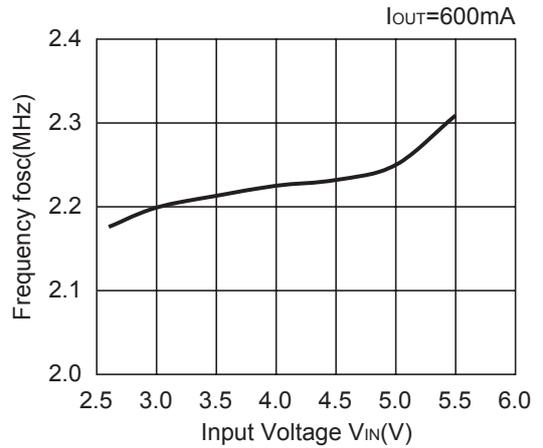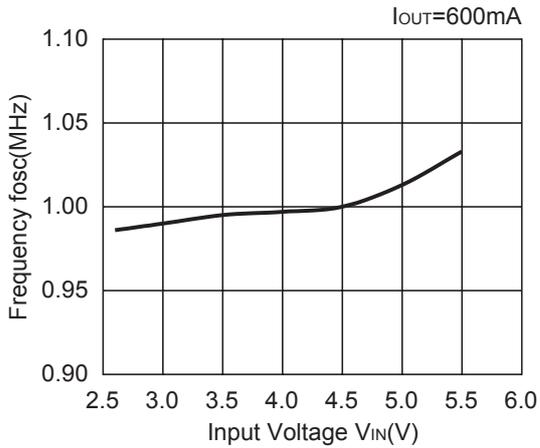
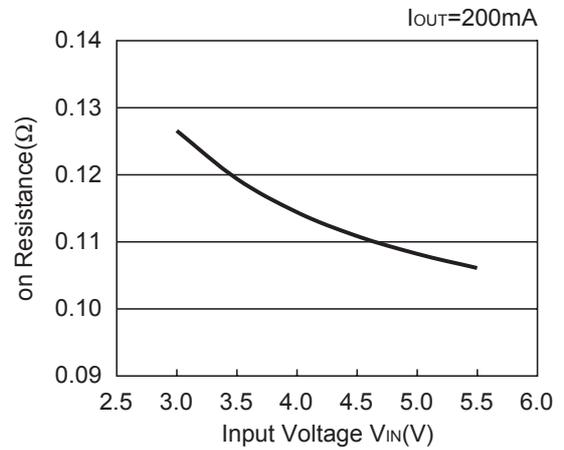## 7) Lx Transistor On Resistance vs. Input Voltage

Switching Tr. Pch on Resistance
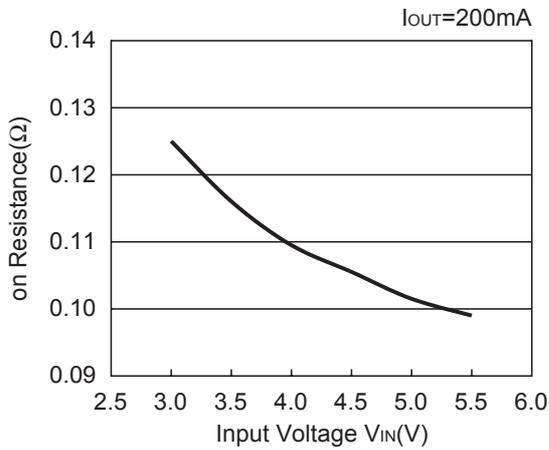
Synchronous Rectifier Tr. Nch on Resistance

Iout=200mA

Iout=200mA

[Graph: on Resistance(Ω) vs Input Voltage VIN(V), Y-axis 0.09 to 0.14]

[Graph: on Resistance(Ω) vs Input Voltage VIN(V), Y-axis 0.09 to 0.14]
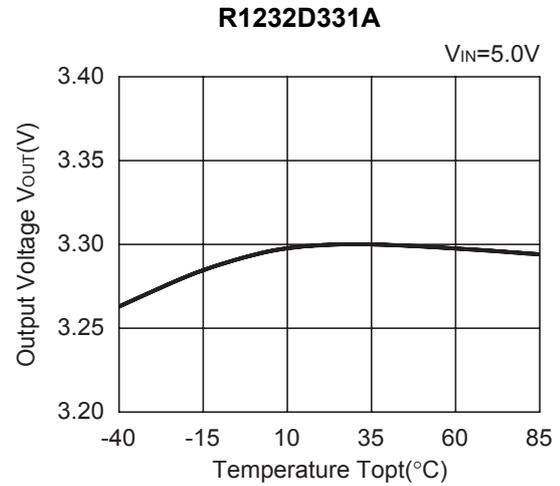
8) Turn-on speed by CE pin

R1232D121A

R1232D121A

VIN=5.0V, L=4.7μH Rload=0Ω

VIN=5.0V, L=4.7μH Rload=12Ω

CE
5V/div

VOUT
1V/div

IL
200mA/div

200μs/div

CE
5V/div

VOUT
1V/div

IL
200mA/div

200μs/div

R1232D331B

R1232D331B

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V$_{IN}$=5.0V, L=2.7µH Rload=0Ω

CE
5V/div

V$_{OUT}$
1V/div

IL
200mA/div

100µs/div

V$_{IN}$=5.0V, L=2.7µH Rload=33Ω

CE
5V/div

V$_{OUT}$
1V/div

IL
200mA/div

100µs/div
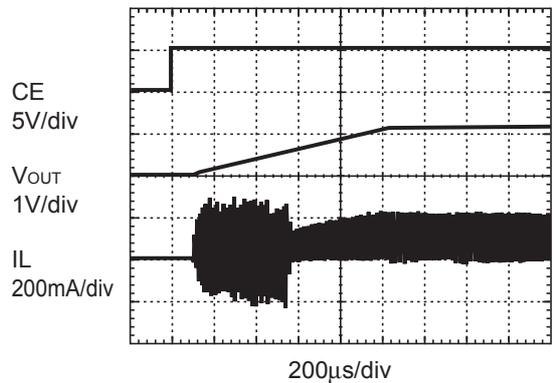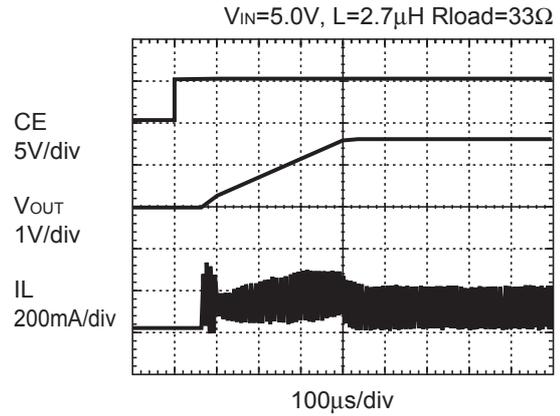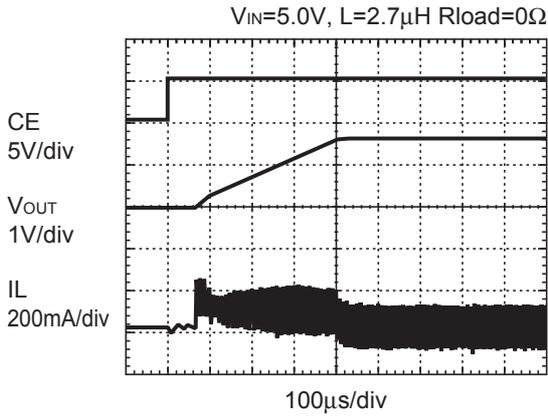
9) Output Voltage vs. Temperature

R1232D121A

V$_{IN}$=5.0V

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

R1232D331A

V$_{IN}$=5.0V

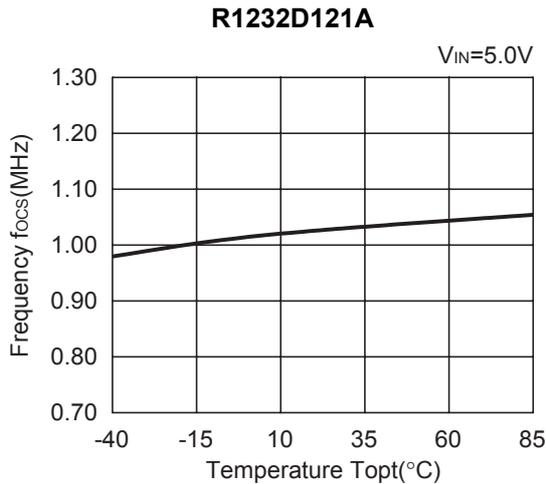Output Voltage V$_{OUT}$(V) vs Temperature Topt(°C)
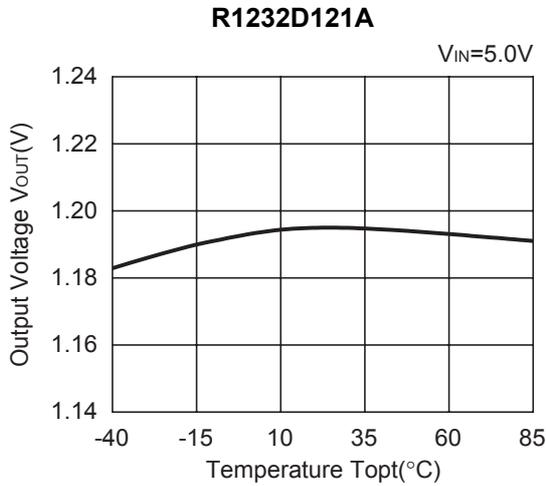
10) Oscillator Frequency vs. Temperature

R1232D121A

V$_{IN}$=5.0V

Frequency f$_{OCS}$(MHz) vs Temperature Topt(°C)

R1232D331B

V$_{IN}$=5.0V

Frequency f$_{OCS}$(MHz) vs Temperature Topt(°C)

RICOH
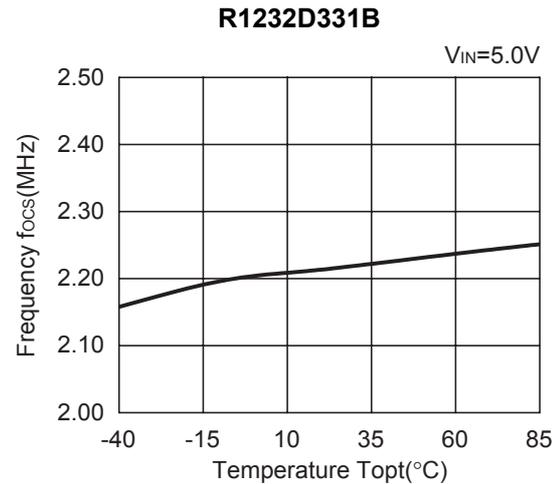
11) Supply Current vs. Temperature

R1232D121A

V_{IN}=5.0V

R1232D331B

V_{IN}=5.0V
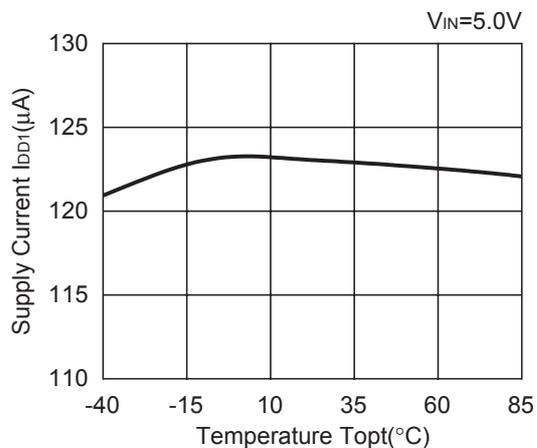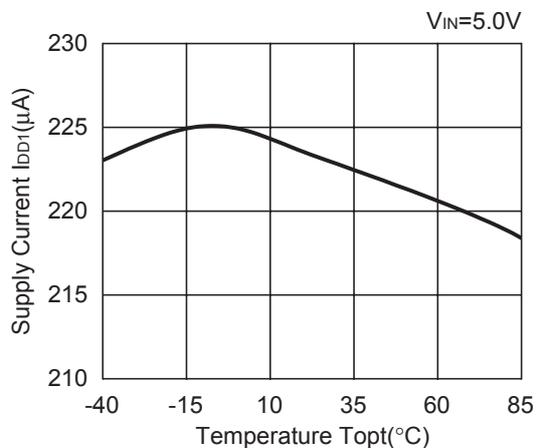
12) Soft-start time vs. Temperature

R1232D121A

V_{IN}=5.0V, Rload=0Ω

R1232D331B

V_{IN}=5.0V, Rload=0Ω
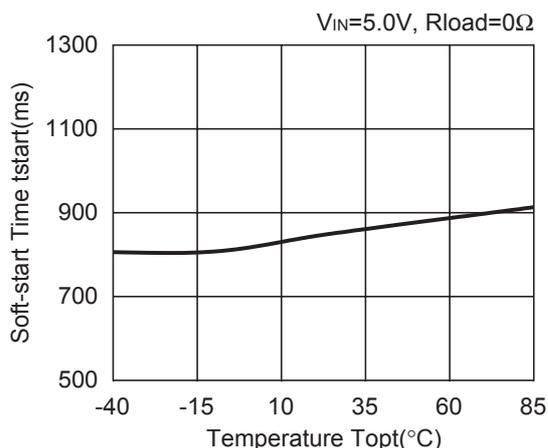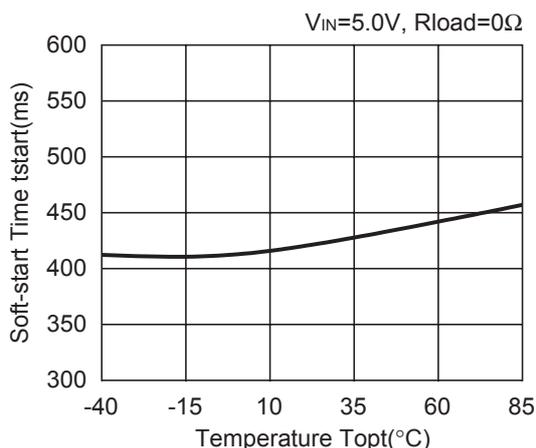
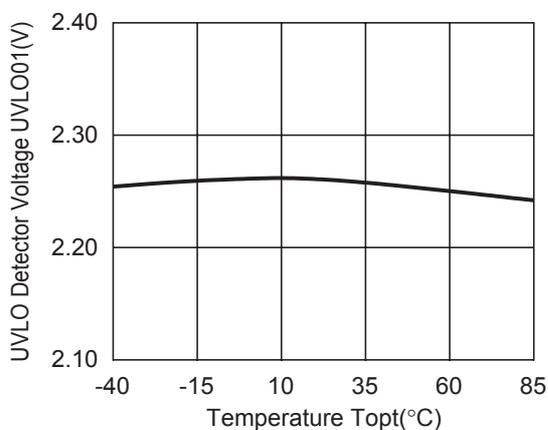## 13) UVLO Voltage vs. Temperature

R1232D121A

R1232D121A

14) CE Input Voltage vs. Temperature

R1232D121A

V_{IN}=5.0V, CE=H Threshold

R1232D121A

V_{IN}=5.0V, CE=L Threshold
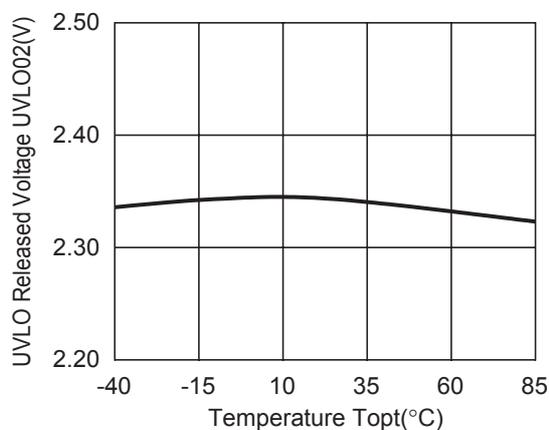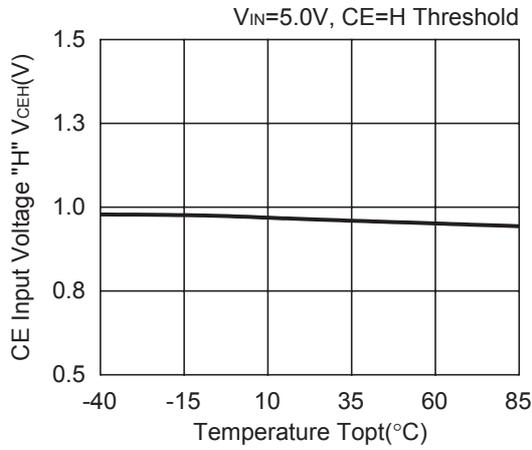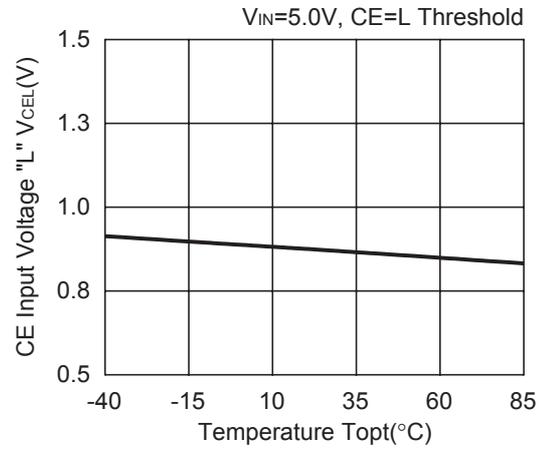
15) TEST Input Voltage vs. Temperature

R1232D121A

V_{IN}=5.0V
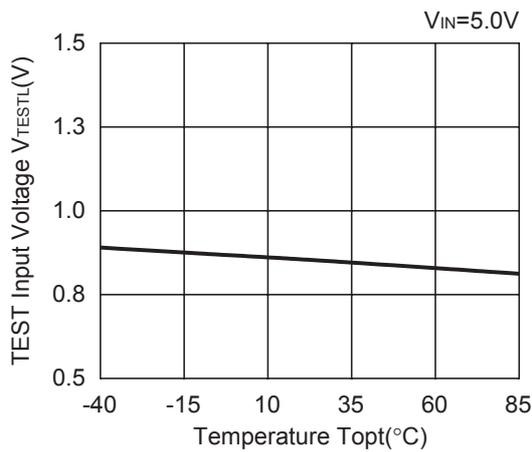
16) Lx Transistor On Resistance vs. Temperature

Driver Tr. Pch ON Resistance

V_{IN}=5.0V

Rectifier Tr.Nch ON Resistance

V_{IN}=5.0V

RICOH
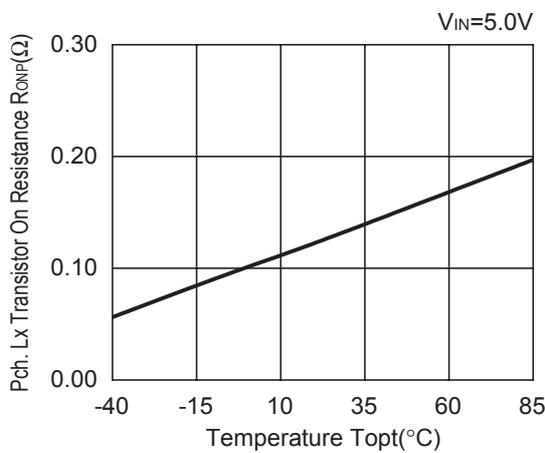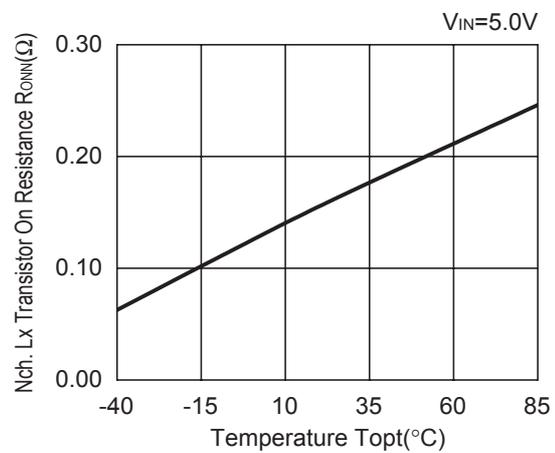
17) Current Limit vs. Temperature

R1232D121A

V_{IN}=5.0V

Lx Current Limit $I_{Lxlimit}$(A) vs. Temperature Topt(°C)

R1232D331B

V_{IN}=5.0V

Lx Current Limit $I_{Lxlimit}$(A) vs. Temperature Topt(°C)
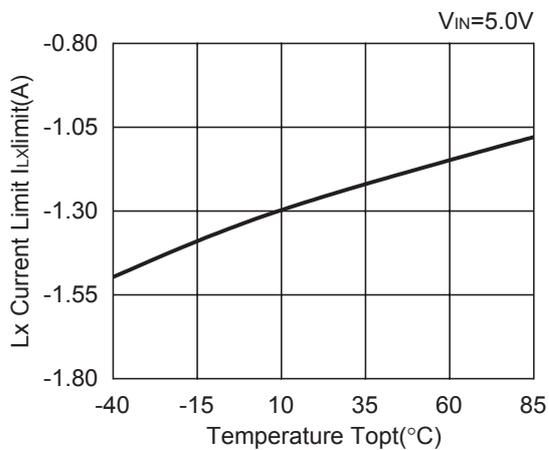
18) Protection Delay Time vs. Temperatures

R1232D121A

V_{IN}=5.0V

Protection Delay Time tprot(ms) vs. Temperature Topt(°C)

R1232D331B

V_{IN}=5.0V

Protection Delay Time tprot(ms) vs. Temperature Topt(°C)

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● **SON-8**   Unit: mm

PACKAGE DIMENSIONS

※ Attention : Tab suspension leads in the parts have V_{DD} or GND level. (They are connected to the reverse side of this IC.) Refer to PIN DISCRIPTION. Do not connect to other wires or land patterns.

Bottom View

TAPING SPECIFICATION

TR

User Direction of Feed

TAPING REEL DIMENSIONS

(1reel=3000pcs)

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POWER DISSIPATION (SON-8)

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:

Measurement Conditions

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

Measurement Result

(Topt=25°C,Tjmax=125°C)

	Standard Land Pattern	Free Air
Power Dissipation	480mW	300mW
Thermal Resistance	θja=(125$-$25°C)/0.48W=208°C/W	333°C/W
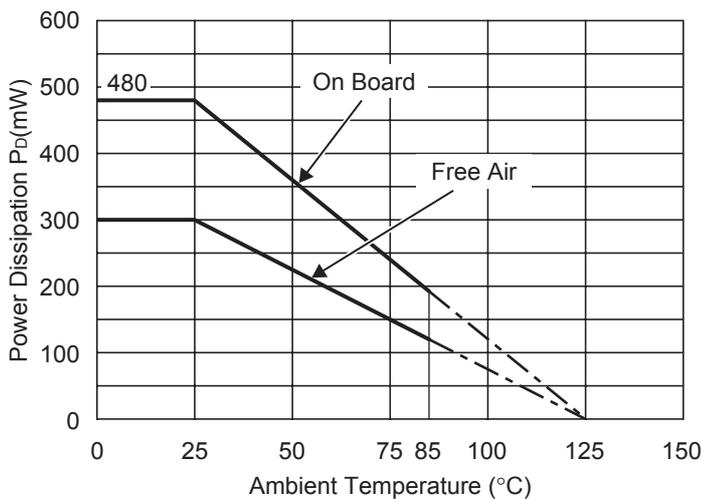
Power Dissipation
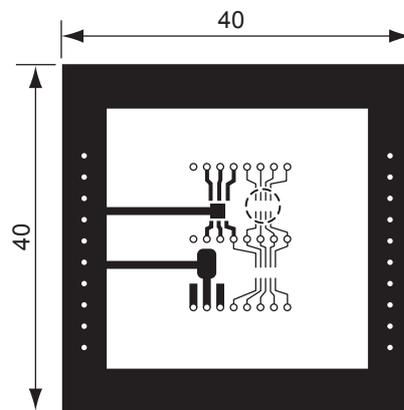
Measurement Board Pattern

⬚ IC Mount Area (Unit : mm)

RECOMMENDED LAND PATTERN

(Unit: mm)

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R1232D SERIES MARK SPECIFICATION

● **SON-8**

① to ④   : Product Code (refer to Part Number vs. Product Code)

⑤, ⑥   : Lot Number

● **Part Number vs. Product Code**

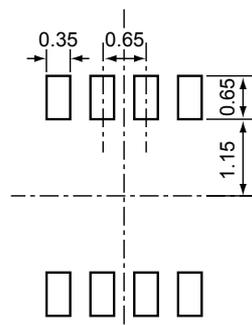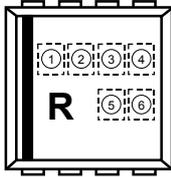| Part Number	Product Code			
	①	②	③	④
R1232D091A	K	0	9	A
R1232D101A	K	1	0	A
R1232D111A	K	1	1	A
R1232D121A	K	1	2	A
R1232D131A	K	1	3	A
R1232D141A	K	1	4	A
R1232D151A	K	1	5	A
R1232D161A	K	1	6	A
R1232D171A	K	1	7	A
R1232D181A	K	1	8	A
R1232D191A	K	1	9	A
R1232D201A	K	2	0	A
R1232D211A	K	2	1	A
R1232D221A	K	2	2	A
R1232D231A	K	2	3	A
R1232D241A	K	2	4	A
R1232D251A	K	2	5	A
R1232D261A	K	2	6	A
R1232D271A	K	2	7	A
R1232D281A	K	2	8	A
R1232D291A	K	2	9	A
R1232D301A	K	3	0	A
R1232D311A	K	3	1	A
R1232D321A	K	3	2	A
R1232D331A	K	3	3	A

Part Number	Product Code			
	①	②	③	④
R1232D091B	K	0	9	B
R1232D101B	K	1	0	B
R1232D111B	K	1	1	B
R1232D121B	K	1	2	B
R1232D131B	K	1	3	B
R1232D141B	K	1	4	B
R1232D151B	K	1	5	B
R1232D161B	K	1	6	B
R1232D171B	K	1	7	B
R1232D181B	K	1	8	B
R1232D191B	K	1	9	B
R1232D201B	K	2	0	B
R1232D211B	K	2	1	B
R1232D221B	K	2	2	B
R1232D231B	K	2	3	B
R1232D241B	K	2	4	B
R1232D251B	K	2	5	B
R1232D261B	K	2	6	B
R1232D271B	K	2	7	B
R1232D281B	K	2	8	B
R1232D291B	K	2	9	B
R1232D301B	K	3	0	B
R1232D311B	K	3	1	B
R1232D321B	K	3	2	B
R1232D331B	K	3	3	B

Part Number	Product Code			
	①	②	③	④
R1232D001C	K	0	1	C
R1232D001D	K	0	1	D

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Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits,General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.

Как с нами связаться

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Факс: 8 (812) 320-02-42
Электронная почта: org@eplast1.ru
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