RICOH

R5212D SERIES

Step-down DC/DC Converter with VR and Reset

NO.EA-128-0510

OUTLINE

The R5212D is CMOS-based PWM step-down DC/DC converter combined with a voltage regulator (VR) and a voltage detector (VD), with low supply current.

Each of these ICs consists of an oscillator, a PWM control circuit, a voltage reference unit, an error amplifier, a soft-start circuit, a current limit circuit, a phase compensation circuit, a resistor net for voltage detect circuit, an output driver transistor, and so on. A low ripple, high efficiency step-down DC/DC converter can be easily composed of this IC with some external components, or an inductor, a diode, and capacitors.

The oscillator frequency is 1.2MHz, therefore small inductor and capacitor can be used with this IC. Further, this IC equips the under voltage lockout function (UVLO). If the input voltage becomes equal or less than 2.35V (Typ.), the output of DC/DC converter turns off. However, in the A/B version, embedded voltage regulator and detector continue to operate. In the C/D version, LDO output also turns off and only the voltage detector is working.

The voltage regulator consists of a voltage reference unit, a resistor net for voltage detect circuit, an error amplifier, an output driver transistor, and so on.

The input source voltage of the built-in voltage regulator is V_{IN} pin (A/B version) or V_{OUT1} pin, the output of DC/DC converter (C/D version).

The built-in voltage detector supervises the input voltage and the output is N-channel open drain.

Power-on reset delay time is also included and internally set typically at 12ms (A/C version) or 50ms(B/D version).

FEATURES

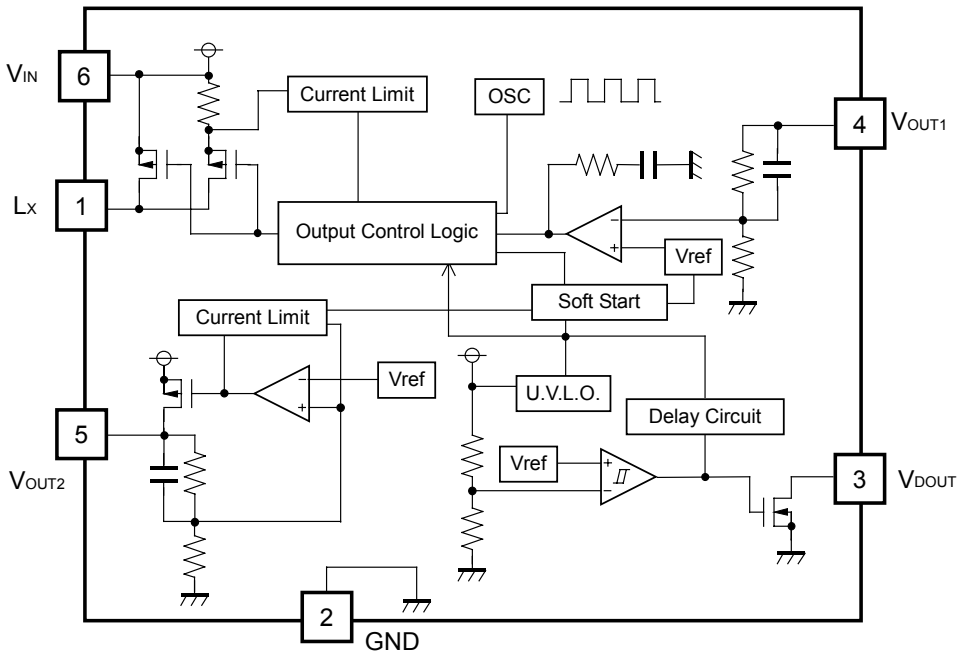
- Range of Input Voltage ..... 3.0V~5.5V
- Built-in Soft-start Function (Typ. 1ms) and built-in power-on reset delay (Typ. 12ms or 50ms)
- Maximum Output Current..... 500mA (DC/DC), 200mA (VR)
- Accuracy Output Voltage ..... ±2.0% (DC/DC and Voltage Regulator Output)
- Accuracy of voltage detector ..... ±2.5%
- Output Voltage (VR)(A/B Version) ..... Stepwise Setting with a step of 0.1V in the range of 2.0V to 3.6V
  (C/D Version) ..... Stepwise Setting with a step of 0.1V in the range of 1.2V to 3.0V
- Output Voltage (DC/DC) (A/B Version)..... Stepwise Setting with a step of 0.1V in the range of 1.2V to 3.6V
  (C/D Version)..... Stepwise Setting with a step of 0.1V in the range of 2.5V to 3.6V
- Output Voltage (VD)..... Stepwise Setting with a step of 0.1V in the range of 3.0V to 4.5V
- Package ..... HSON-6 (t=0.9mm)

APPLICATIONS

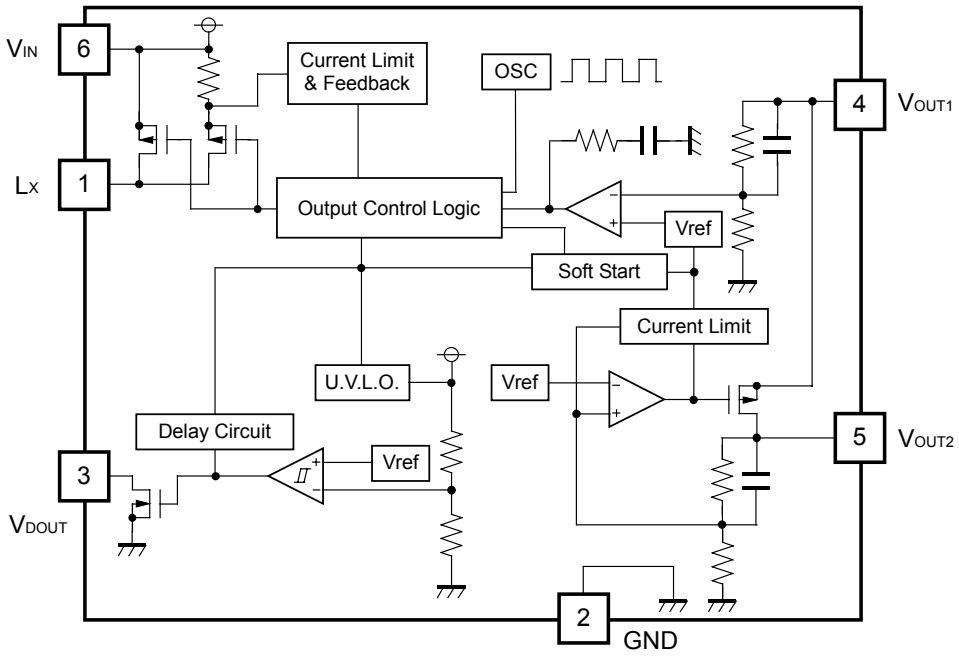
- Power source for hand-held communication equipment, CD or DVD drives.
- Power source for battery-powered equipment.

BLOCK DIAGRAMS

R5212xxxA/B



R5212DxxxC/D



SELECTION GUIDE

In the R5212D Series, the output voltage combination for the ICs can be selected at the user's re-quest. The selection can be made with designating the part number as shown below;

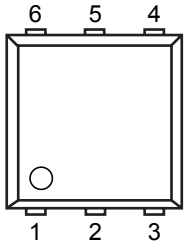
R5212Dxxxx-TR ←Part Number
↑ ↑ ↑
a b c

Code	Contents
a	Output Voltage Combination Code Number
b	Designation of Optional Function A: VR input pin=V_{IN} pin, VD delay=12ms B: VR input pin=V_{IN} pin, VD delay=50ms C: VR input pin=DC/DC Output, VD delay=Typ. 12ms D: VR input pin=DC/DC Output, VD delay=Typ. 50ms
c	Designation of Taping Type: Refer to Taping specification.

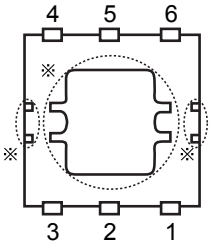
PIN CONFIGURATION

HSON-6

Top View



Bottom View



PIN DESCRIPTIONS

Pin No	Symbol	Pin Description
1	L_X	Switching Pin (P-channel open-drain output type)
2	GND	Ground Pin
3	V_{DOUT}	Output Pin of Voltage Detector (N-channel open-drain out-put type)
4	V_{OUT1}	DC/DC converter Step-down Output monitoring Pin
5	V_{OUT2}	Output Pin of Voltage Regulator
6	V_{IN}	Voltage Supply Pin

∗ 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

(GND=0V)

Symbol	Item	Rating	Unit
V_{IN}	V_{IN} Pin Voltage	6.5	V
V_{LX}	Lx Pin Voltage	−0.3 ~ V_{IN}+0.3	V
V_{OUT1}	V_{OUT1} Pin Voltage	−0.3 ~ V_{IN}+0.3	V
V_{OUT2}	V_{OUT2} Pin Voltage	−0.3 ~ V_{IN}+0.3	V
V_{DOUT}	V_{DOUT} Pin Voltage	−0.3 ~ 6.5	V
I_{LX}	Lx Pin Output Current	800	mA
I_{OUT2}	V_{OUT2} Pin Output Current	400	mA
P_D	Power Dissipation (On Board)[*1]	900	mW
Topt	Operating Temperature Range	−40 ~ +85	°C
Tstg	Storage Temperature Range	−55 ~ +125	°C

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

ELECTRICAL CHARACTERISTICS

- **R5212DxxxA**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating Input Voltage		3.0		5.5	V
I_{DD}	Supply Current	V_{IN}=5.0V, V_{OUT1}=0V		400	800	μA
V_{UVLO2}	UVLO Release Voltage		2.35	2.50	2.65	V
$V_{UVLOHYS}$	UVLO Detector Threshold Voltage Hysteresis		0.05	0.15	0.25	V

- **DC/DC Part**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT1}	DC/DC Output Voltage	V_{IN}=5.0V, at no load OPEN LOOP	V_{OUT1} ×0.98		V_{OUT1} ×1.02	V
$\Delta V_{OUT1}/\Delta Topt$	DC/DC Output Voltage Temperature Coefficient	40°C ≦ Topt ≦ 85°C		±100		ppm /°C
fosc	Oscillator Frequency	V_{IN}=5.0V	960	1200	1440	kHz
R_{LX}	Lx on Resistance	V_{IN}=5.0V, I_{LX}=100mA		0.4	0.8	Ω
I_{LXleak}	Lx Leakage Current	V_{IN}=V_{OUT1}=5.5V, V_{LX}=0V		0.01	5.00	μA
I_{LXLIM}	Lx Current Limit	V_{IN}=5.0V	600	800		mA
Maxduty	Maximum duty cycle		100			%
tstart	Soft-start Time	V_{IN}=5.0V	0.35	1.00	3.00	ms

- **VR Part**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT2}	VR Output Voltage	V_{IN}=5.0V, I_{OUT2}=10mA	V_{OUT2} ×0.98		V_{OUT2} ×1.02	V
I_{OUT2}	Maximum Output Current of VR	V_{IN}=5.0V	200			mA
V_{REG2}	VR Load Regulation	V_{IN}–V_{OUT2}=0V 1mA ≦ I_{OUT2} ≦ 80mA		20	60	mV
V_{DIF2}	Dropout Voltage	I_{OUT2}=100mA		0.2	0.3	V
I_{LIM2}	Short Current Limit	V_{OUT2}=0V		50		mA
$\Delta V_{OUT2}/\Delta Topt$	VR Output Voltage Temperature Coefficient	40°C ≦ Topt ≦ 85°C		±100		ppm /°C

- **VD Part**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
$-V_{DET}$	VD Detector Threshold		$-V_{DET}$ ×0.975		$-V_{DET}$ ×1.025	V
$\Delta -V_{DET}/\Delta Topt$	VD Detector Threshold Temperature Coefficient	40°C ≦ Topt ≦ 85°C		±100		ppm /°C
V_{HYS}	Hysteresis Range			$-V_{DET}$ ×0.05		V
t_{PLH}	VD Output Delay Time for Release	V_{IN}=V_{DOUT}=$-V_{DET}$×0.9 to 5.0	3	12	30	ms
I_{DOUTL}	V_{DOUT} "L" Output Current	V_{IN}=2.0V, I_{OUT}=0.1V	2	7	20	mA

- **R5212DxxxB**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating Input Voltage		3.0		5.5	V
I_{DD}	Supply Current	V_{IN}=5.0V, V_{OUT1}=0V		400	800	μA
V_{UVLO2}	UVLO Release Voltage		2.35	2.50	2.65	V
$V_{UVLOHYS}$	UVLO Detector Threshold Voltage Hysteresis		0.05	0.15	0.25	V

- **DC/DC Part**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT1}	DC/DC Output Voltage	V_{IN}=5.0V, at no load OPEN LOOP	V_{OUT1} ×0.98		V_{OUT1} ×1.02	V
$\Delta V_{OUT1}/\Delta Topt$	DC/DC Output Voltage Temperature Coefficient	40°C ≦ Topt ≦ 85°C		±100		ppm /°C
fosc	Oscillator Frequency	V_{IN}=5.0V	960	1200	1440	kHz
R_{LX}	Lx on Resistance	V_{IN}=5.0V, I_{LX}=100mA		0.4	0.8	Ω
I_{LXleak}	Lx Leakage Current	V_{IN}=V_{OUT1}=5.5V, V_{LX}=0V		0.01	5.00	μA
I_{LXLIM}	Lx Current Limit	V_{IN}=5.0V	600	850		mA
Maxduty	Maximum duty cycle		100			%
tstart	Soft-start Time	V_{IN}=5.0V	0.35	1.00	3.00	ms

- **VR Part**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT2}	VR Output Voltage	V_{IN}=5.0V, I_{OUT2}=10mA	V_{OUT2} ×0.98		V_{OUT2} ×1.02	V
I_{OUT2}	Maximum Output Current of VR	V_{IN}=5.0V	200			mA
V_{REG2}	VR Load Regulation	V_{IN}–V_{OUT2}=0V 1mA ≦ I_{OUT2} ≦ 80mA		20	60	mV
V_{DIF2}	Dropout Voltage	I_{OUT2}=100mA		0.2	0.3	V
I_{LIM2}	Short Current Limit	V_{OUT2}=0V		50		mA
$\Delta V_{OUT2}/\Delta Topt$	VR Output Voltage Temperature Coefficient	40°C ≦ Topt ≦ 85°C		±100		ppm /°C

- **VD Part**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
$-V_{DET}$	VD Detector Threshold		$-V_{DET}$ ×0.975		$-V_{DET}$ ×1.025	V
$\Delta -V_{DET}/\Delta Topt$	VD Detector Threshold Temperature Coefficient	40°C ≦ Topt ≦ 85°C		±100		ppm /°C
V_{HYS}	Hysteresis Range			$-V_{DET}$ ×0.05		V
t_{PLH}	VD Output Delay Time for Release	V_{IN}=V_{DOUT}=$-V_{DET}$×0.9 to 5.0	3	12	30	ms
I_{DOUTL}	V_{DOUT} "L" Output Current	V_{IN}=2.0V, V_{DOUT}=0.1V	2	7	20	mA

- **R5212DxxxC**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating Input Voltage		3.0		5.5	V
I_{DD}	Supply Current	V_{IN}=5.0V, V_{OUT1}=0V		400	800	μA
V_{UVLO2}	UVLO Release Voltage		2.35	2.50	2.65	V
$V_{UVLOHYS}$	UVLO Detector Threshold Voltage Hysteresis		0.05	0.15	0.25	V

- **DC/DC Part**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT1}	DC/DC Output Voltage	V_{IN}=5.0V, at no load OPEN LOOP	V_{OUT1} ×0.98		V_{OUT1} ×1.02	V
$\Delta V_{OUT1}/\Delta Topt$	DC/DC Output Voltage Temperature Coefficient	40°C ≦ Topt ≦ 85°C		±100		ppm /°C
fosc	Oscillator Frequency	V_{IN}=5.0V	960	1200	1440	kHz
R_{LX}	Lx on Resistance	V_{IN}=5.0V, I_{LX}=100mA		0.4	0.8	Ω
I_{LXleak}	Lx Leakage Current	V_{IN}=V_{OUT1}=5.5V, V_{LX}=0V		0.01	5.00	μA
I_{LXLIM}	Lx Current Limit	V_{IN}=5.0V	600	850		mA
Maxduty	Maximum duty cycle		100			%
tstart	Soft-start Time	V_{IN}=5.0V	0.35	1.00	3.00	ms

- **VR Part**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT2}	VR Output Voltage	V_{OUT1}=3.3V I_{OUT2}=10mA	V_{OUT2} ×0.98		V_{OUT2} ×1.02	V
I_{OUT2}	Maximum Output Current of VR	V_{IN}=5.0V	200			mA
V_{REG2}	VR Load Regulation	V_{IN}–V_{OUT2}=0V 1mA ≦ I_{OUT2} ≦ 80mA		20	60	mV
V_{DIF2}	Dropout Voltage	I_{OUT2}=100mA		0.2	0.3	V
I_{LIM2}	Short Current Limit	V_{OUT2}=0V		50		mA
$\Delta V_{OUT2}/\Delta Topt$	VR Output Voltage Temperature Coefficient	40°C ≦ Topt ≦ 85°C		±100		ppm /°C

- **VD Part**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
$-V_{DET}$	VD Detector Threshold		$-V_{DET}$ ×0.975		$-V_{DET}$ ×1.025	V
$\Delta-V_{DET}/\Delta Topt$	VD Detector Threshold Temperature Coefficient	40°C ≦ Topt ≦ 85°C		±100		ppm /°C
V_{HYS}	Hysteresis Range			$-V_{DET}$ ×0.05		V
t_{PLH}	VD Output Delay Time for Release	V_{IN}=V_{DOUT}=$-V_{DET}$×0.9 to 5.0	3	12	30	ms
I_{DOUTL}	V_{DOUT} "L" Output Current	V_{IN}=2.0V, V_{DOUT}=0.1V	2	7	20	mA

- **R5212DxxxD**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating Input Voltage		3.0		5.5	V
I_{DD}	Supply Current	V_{IN}=5.0V, V_{OUT1}=0V		400	800	μA
V_{UVLO2}	UVLO Release Voltage		2.35	2.50	2.65	V
$V_{UVLOHYS}$	UVLO Detector Threshold Voltage Hysteresis		0.05	0.15	0.25	V

- **DC/DC Part**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT1}	DC/DC Output Voltage	V_{IN}=5.0V, at no load OPEN LOOP	V_{OUT1} ×0.98		V_{OUT1} ×1.02	V
$\Delta V_{OUT1}/\Delta Topt$	DC/DC Output Voltage Temperature Coefficient	40°C ≦ Topt ≦ 85°C		±100		ppm /°C
fosc	Oscillator Frequency	V_{IN}=5.0V	960	1200	1440	kHz
R_{LX}	Lx on Resistance	V_{IN}=5.0V, I_{LX}=100mA		0.4	0.8	Ω
I_{LXleak}	Lx Leakage Current	V_{IN}=V_{OUT1}=5.5V, V_{LX}=0V		0.01	5.00	μA
I_{LXLIM}	Lx Current Limit	V_{IN}=5.0V	600	850		mA
Maxduty	Maximum duty cycle		100			%
tstart	Soft-start Time	V_{IN}=5.0V	0.35	1.00	3.00	ms

- **VR Part**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{OUT2}	VR Output Voltage	V_{OUT1}=3.3V I_{OUT2}=10mA	V_{OUT2} ×0.98		V_{OUT2} ×1.02	V
I_{OUT2}	Maximum Output Current of VR	V_{IN}=5.0V, V_{OUT1}=3.3V	200			mA
V_{REG2}	VR Load Regulation	V_{IN}–V_{OUT2}=0V 1mA ≦ I_{OUT2} ≦ 80mA		20	60	mV
V_{DIF2}	Dropout Voltage	I_{OUT2}=100mA		0.2	0.3	V
I_{LIM2}	Short Current Limit	V_{OUT2}=0V		50		mA
$\Delta V_{OUT2}/\Delta Topt$	VR Output Voltage Temperature Coefficient	40°C ≦ Topt ≦ 85°C		±100		ppm /°C

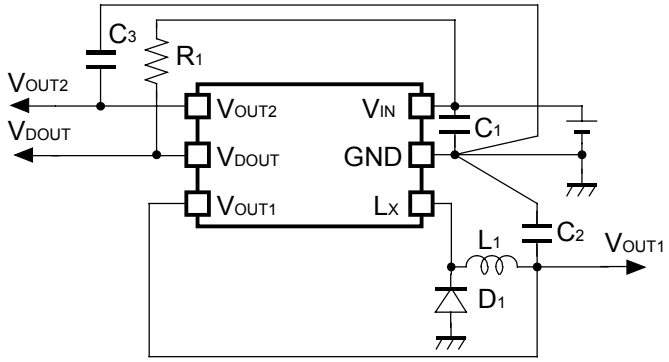
- **VD Part**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
$-V_{DET}$	VD Detector Threshold		$-V_{DET}$ ×0.975		$-V_{DET}$ ×1.025	V
$\Delta-V_{DET}/\Delta Topt$	VD Detector Threshold Temperature Coefficient	40°C ≦ Topt ≦ 85°C		±100		ppm /°C
V_{HYS}	Hysteresis Range			$-V_{DET}$ ×0.05		V
t_{PLH}	VD Output Delay Time for Release	V_{IN}=V_{DOUT}=$-V_{DET}$×0.9 to 5.0	10	50	120	ms
I_{DOUTL}	V_{DOUT} "L" Output Current	V_{IN}=2.0V, V_{DOUT}=0.1V	2	7	20	mA

TYPICAL APPLICATION AND APPLICATION HINTS

R5212Dxxxx



Examples of Components

Symbol	Item			
L_1	($V_{OUT1} \leqq 1.6V$)	4.7μH	LQH43C Series	Murata
		4.7μH	VLP5610 Series	TDK
	($V_{OUT1} > 1.6V$)	6.8μH	LQH43C Series	Murata
		6.8μH	VLP5610 Series	TDK
D_1	RB491D(ROHM) or EP05Q03 (Nihon Inter)			
R_1	50kΩ			
C_1	10μF Ceramic Capacitor			
C_2	10μF Ceramic Capacitor			
C_3	2.2μF Ceramic Capacitor			

When you use these ICs, consider the following issues;

Set external components as close as possible to the IC and minimize the connection between the components and the IC. In particular, a capacitor should be connected to between V_{IN} and GND with the minimum connection. Make sufficient grounding, and reinforce supplying. A large switching current may flow through the connection of power supply, an inductor and the connection of V_{OUT1}. If the impedance of the connection of power supply or ground is high, the voltage level of power supply of the IC fluctuates with the switching current. This may cause unstable operation of the IC.

Use a capacitor with a capacity of 10μF or more for V_{IN} and GND, and with low ESR ceramic type. In terms of V_{OUT1}, use a ceramic capacitor with a capacity of 10μF or more. For V_{OUT2} pin, use a ceramic capacitor with a capacitance of 2.2μF or around.

Choose an inductor that has a small D.C. resistance and large allowable current and which is hard to reach magnetic saturation. If the value of inductance of an inductor is extremely small, the IL_X , which flows through Lx transistor and an inductor, 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.

If the spike noise of Lx pin is too large, make snub circuit (such as serial connection of CR) between Lx and GND, then the noise will be reduced. The time constant of the CR depends on the actual PCB, so evaluate it on the actual PCB.

If the load current of the voltage regulator is small, because of the switching noise of DC/DC converter, the output voltage of V_{OUT2} may be large. To avoid this, use the voltage regulator with a load current at least 0.5mA.

In terms of LDO, the difference between the set output voltage and input voltage should be 0.5V or more,

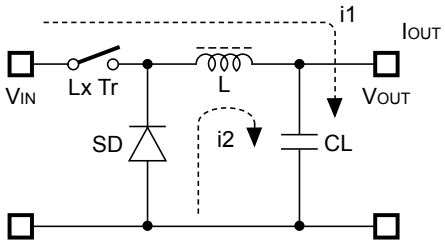
The performance of power source circuits using these ICs extremely depends upon the peripheral circuits.

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.

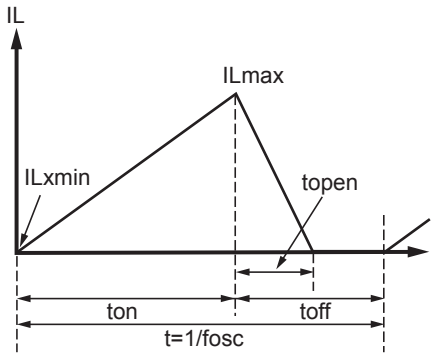
OPERATION of step-down DC/DC converter and Output Current

The step-down DC/DC converter charges energy in the inductor when Lx transistor is ON, and discharges the energy from the inductor when Lx 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:

<Basic Circuits>



<Current through L>



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

Step 2 : When Lx Tr. turns off, Schottky diode (SD) turns on in order that L maintains IL at ILmax, and current IL (=i2) flows.

Step 3 : IL decreases gradually and reaches ILmin after a time period of topen, and SD 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 is 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.

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

The maximum value (ILmax) and the minimum value (ILmin) current which flow through the inductor is the same as those when Lx Tr. turns on and when it turns 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 (%) $= ton/t \times 100 = ton \times fosc \times 100$
topen ≦ toff

In Equation A, $V_{OUT} \times topen/L$ 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.

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

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

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 Lx Tr. is “ON”:

(Wherein, Ripple Current P-P value is described as I_{RP}, ON resistance of Lx Tr. is described as R_P the direct current of the inductor is described as R_L. The threshold level of Shottky diode is described as V_F.)

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

When Lx Tr. is “OFF”:

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

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

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

Ripple Current is as follows;

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

Wherein, peak current that flows through L, Lx Tr., and SD is as follows;

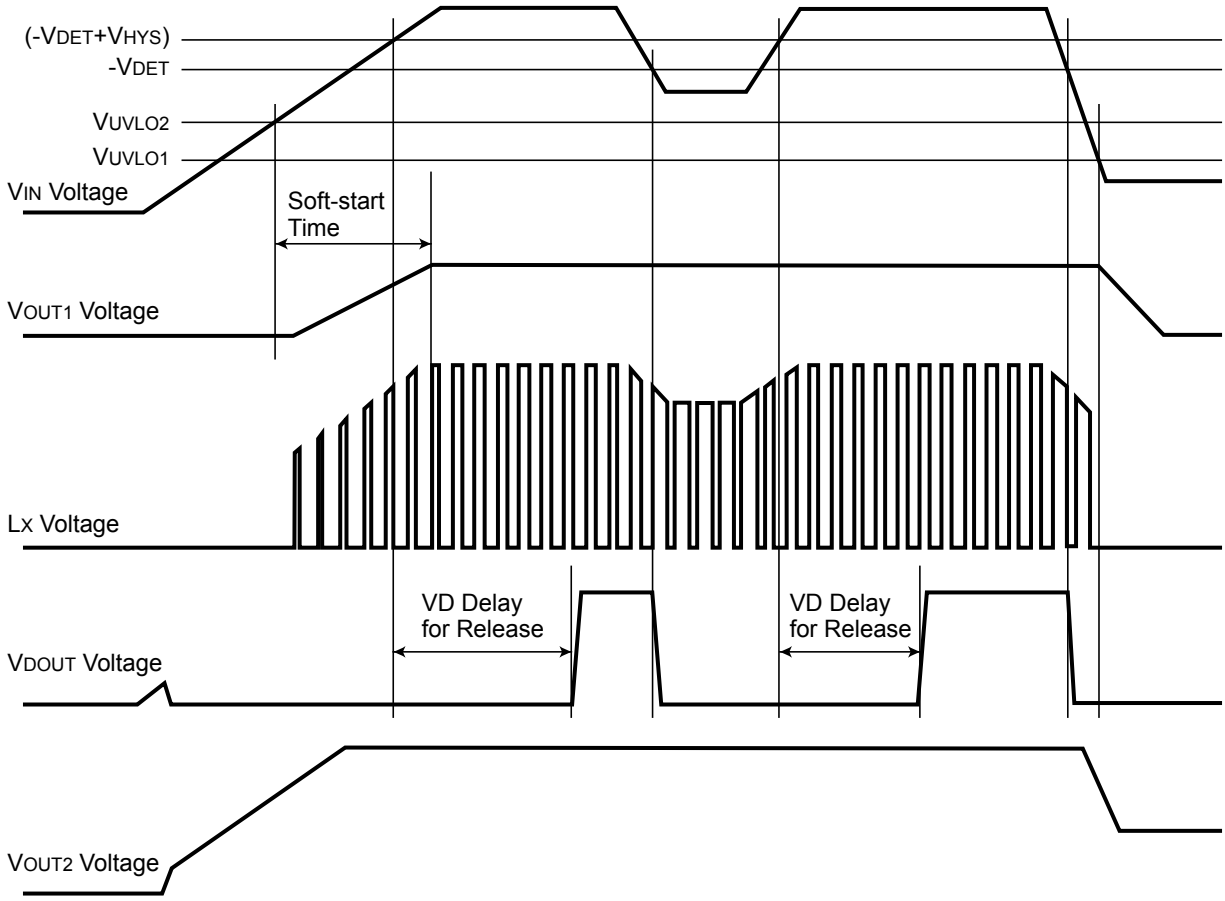
$$ILmax = I_{OUT} + I_{RP}/2 \quad \text{Equation 7}$$

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

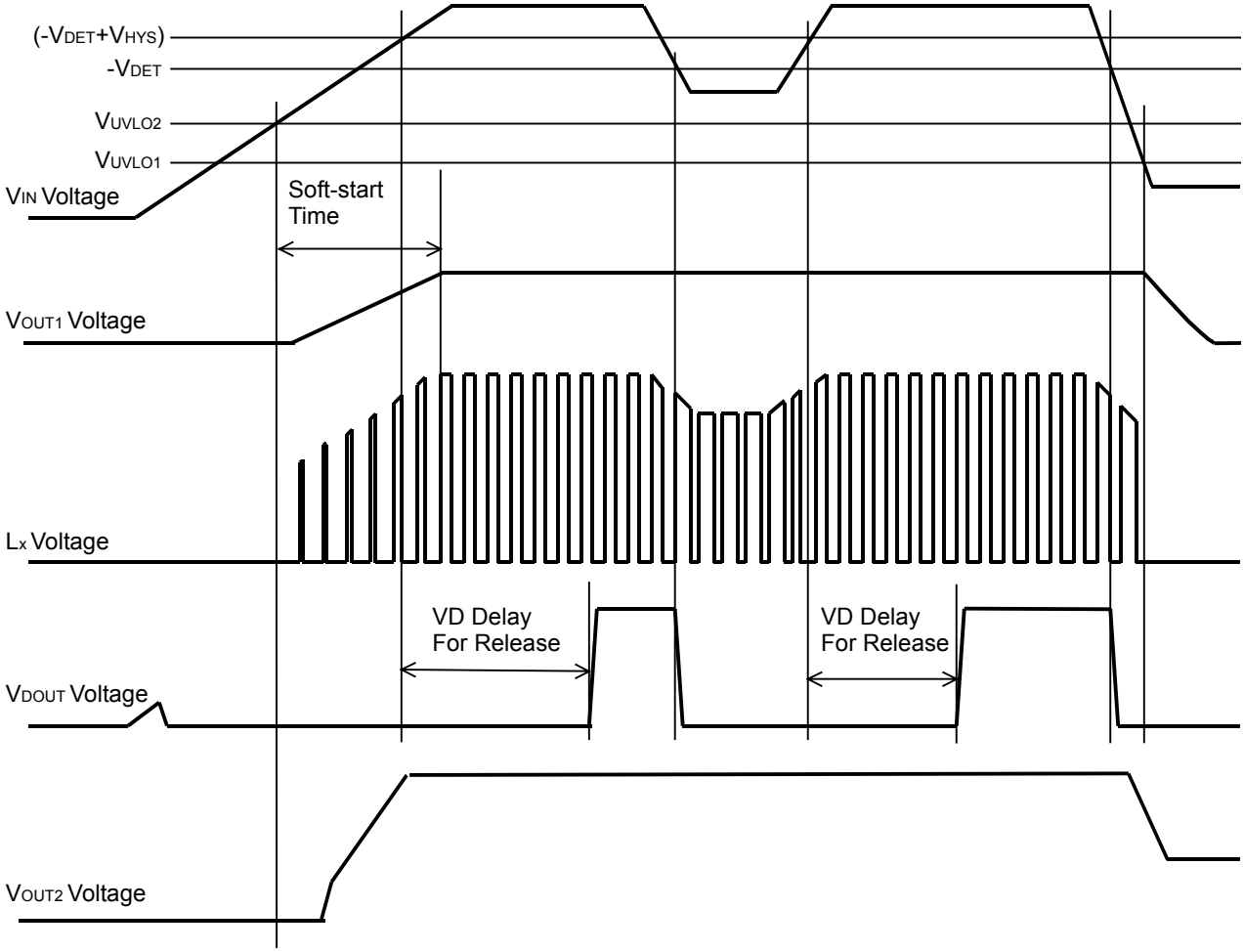
★The above explanation is directed to the calculation in an ideal case in continuous mode.

Timing Chart

- **R5212DxxxA/B**



- **R5212DxxxC/D**



The timing chart which is shown in the previous page describes the relation of supply voltage changes with time and each output of DC/DC converter, voltage detector, and voltage regulator.

(1) DC/DC converter

When the power turns on and in the case of rising the V_{IN} voltage, while the V_{IN} voltage is at UVLO release level (V_{UVLO2}) or less, the operation of the DC/DC converter stops and does not make switching, therefore V_{OUT1} voltage does not rise.

When the V_{IN} voltage becomes UVLO release level or more, the DC/DC converter starts soft-start operation, and start switching, then V_{OUT1} will rise. After the soft-start time, if V_{IN} voltage becomes set V_{OUT1} level or more, V_{OUT1} will be settled at V_{OUT1} set output voltage. If V_{IN} voltage becomes UVLO detector threshold level (V_{UVLO1}) or less, the DC/DC converter stops switching then Lx transistor in the IC turns off.

(2) Voltage Detector

If the V_{IN} voltage is at VD detector threshold level or less, the N-channel transistor of V_{DOUT} pin turns on and outputs “L” to V_{DOUT} pin. Then, when the V_{IN} voltage becomes VD detector threshold level + its hysteresis range ($-V_{DET}+V_{HYS}$) or more, after VD delay for release (t_{PLH}) passing, the N-channel transistor inside the IC turns off, V_{DOUT} pin voltage reaches to the pull-up voltage. Besides, the release circuit for VD starts from when V_{IN} voltage reaches ($-V_{DET}+V_{HYS}$).

(3)Voltage Regulator

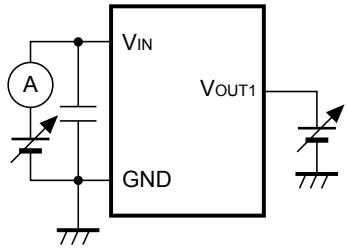
- **R5212DxxxA/B**

The voltage regulator always operates even if UVLO function would work. Therefore, V_{OUT2} voltage is nearly equal to V_{IN} voltage. Actual value depends on the load current. When the V_{IN} voltage becomes set V_{OUT2} voltage or more, V_{OUT2} voltage will be the set output voltage. The short current limit can operate after soft-start time.

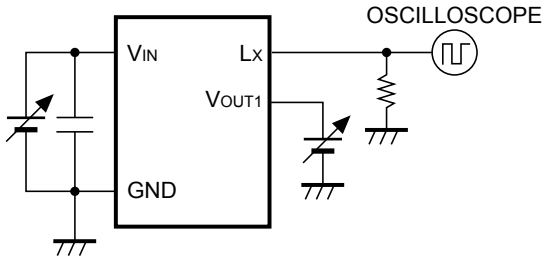
- **R5212DxxxC/D**

V_{OUT1} voltage is the input voltage for the built-in LDO, when the V_{OUT1} voltage is equal or less than V_{OUT2} set voltage, V_{OUT2} voltage is depending on the load current for V_{OUT2}, however almost same as V_{OUT1} Voltage. When the V_{OUT1} voltage is equal or more than set V_{OUT2} voltage, V_{OUT2} voltage becomes the set output voltage. Short Current Limit works after soft-start operation.

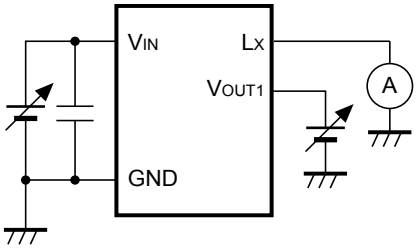
TEST CIRCUITS



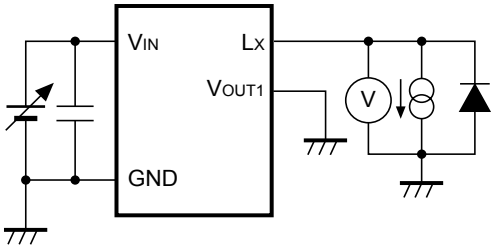
Supply Current



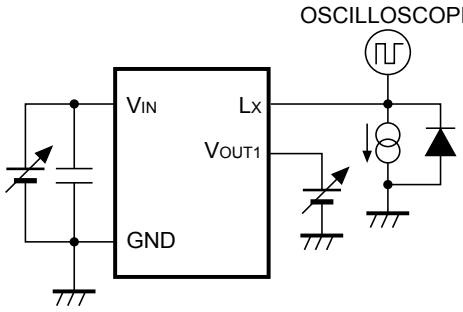
UVLO Detector Threshold/ Released Voltage



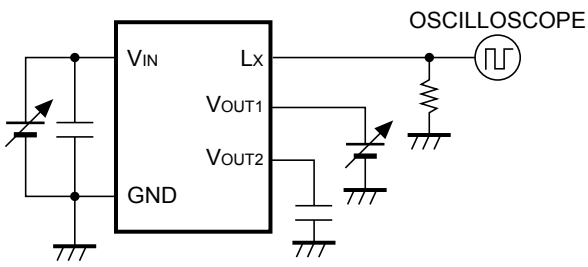
Lx Leakage Current



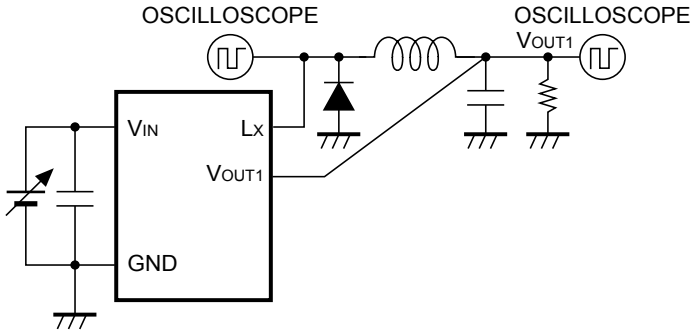
Lx On Resistance



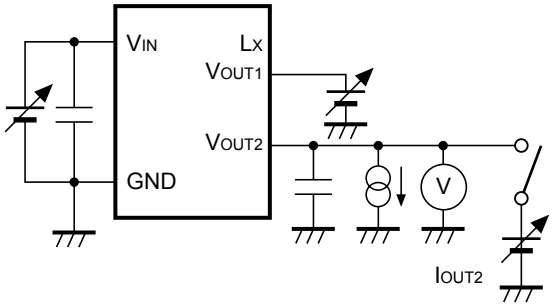
Lx Current Limit



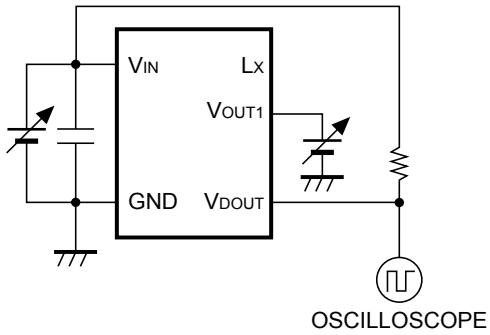
V_{OUT1} Output Voltage



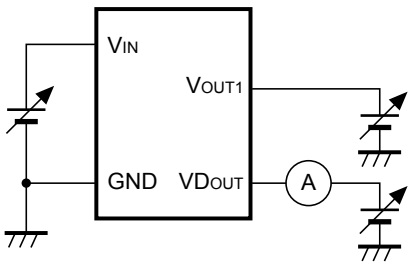
Oscillator Frequency, Soft-start Time



V_{OUT2} Output Voltage, Load Regulation, Dropout Voltage, Current Limit, Short Current Limit



V_{DOUT} Detector Threshold, Hysteresis Range, VD Output Delay Time for Release

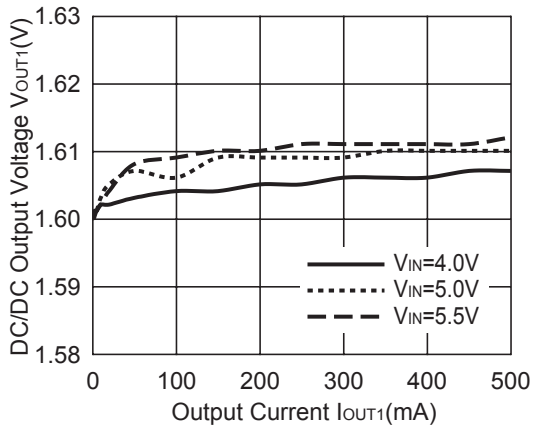


V_{DOUT} "L" Output Current

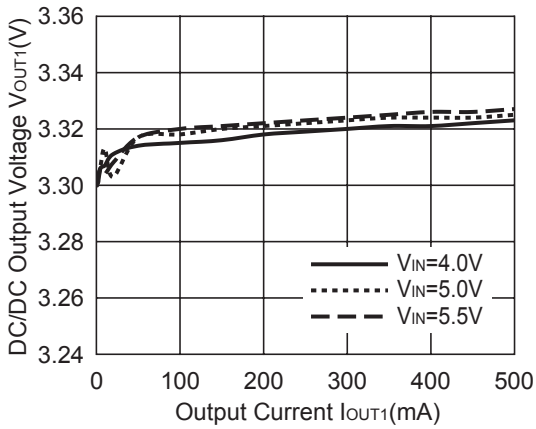
TYPICAL CHARACTERISTICS

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

R5212D011A

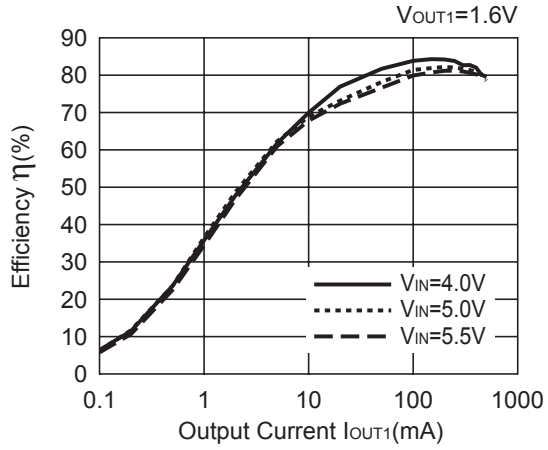


R5212D014C

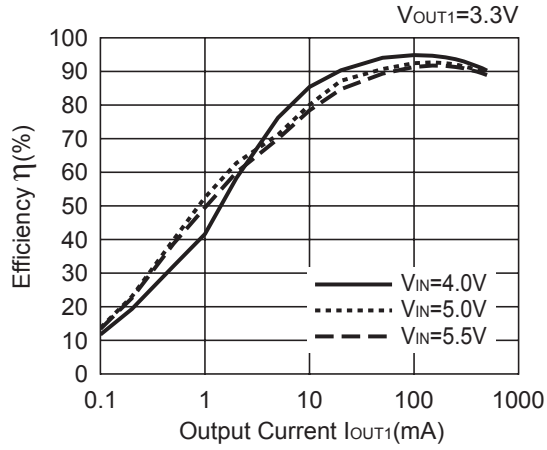


2) Efficiency vs. Output Current (Topt=25°C)

R5211D011A

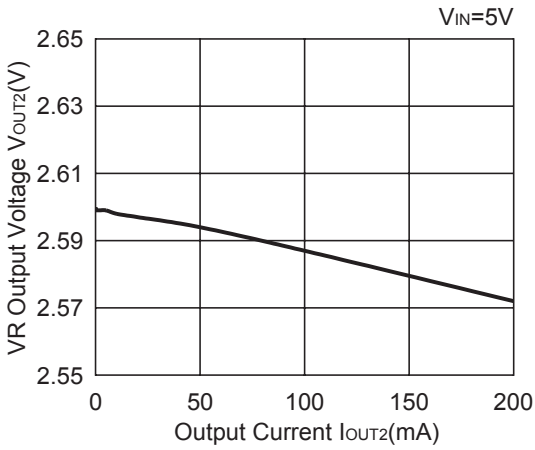


R5211D014C

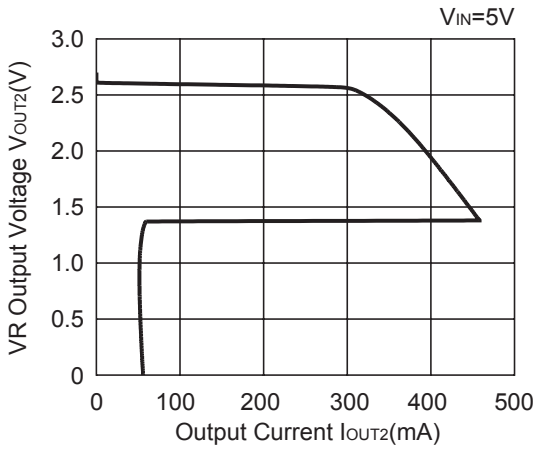


3) VR Output Voltage vs. Output Current (Topt=25°C)

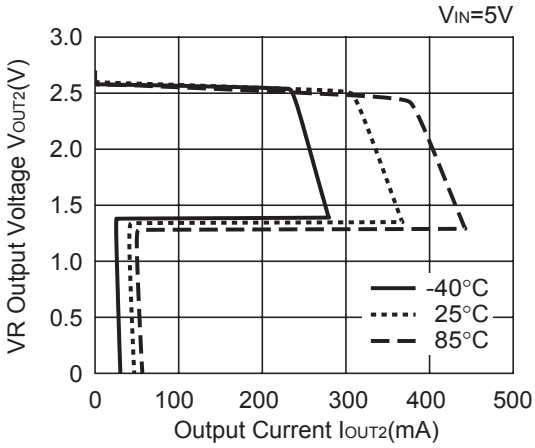
R5212D011A



R5212D011A

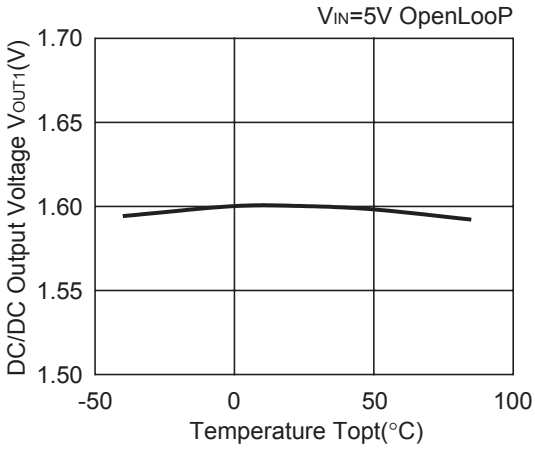


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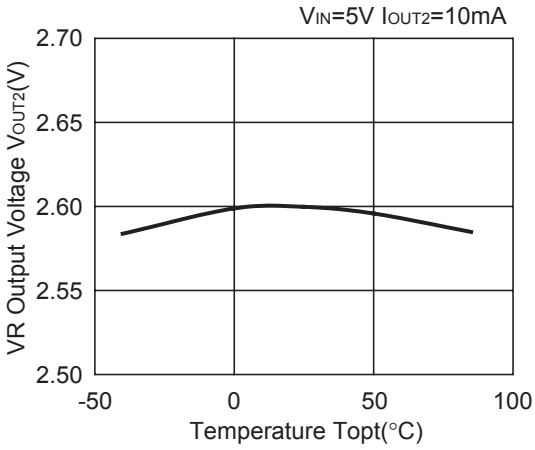
4) DC/DC Output Voltage vs. Temperature

R5212D011A



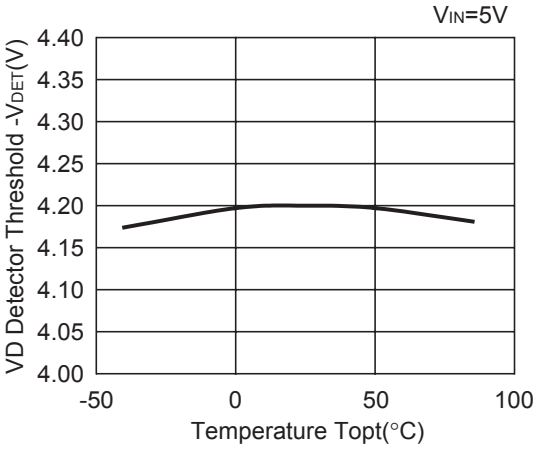
5) VR Output Voltage vs. Temperature

R5212D011A



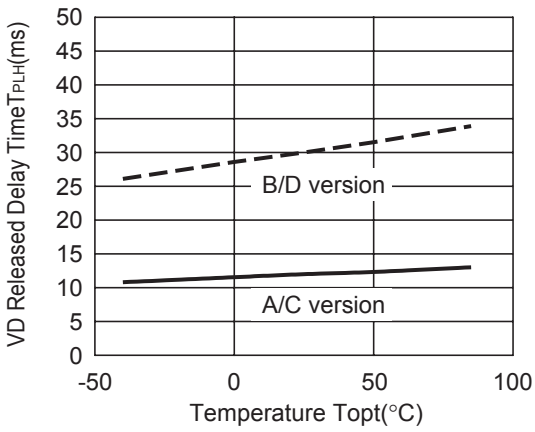
6) VD Detector Threshold vs. Temperature

R5212D011A



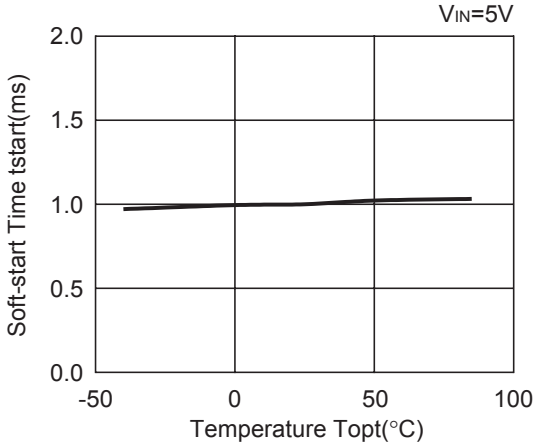
7) VD Released Delay Time vs. Temperature

R5212D



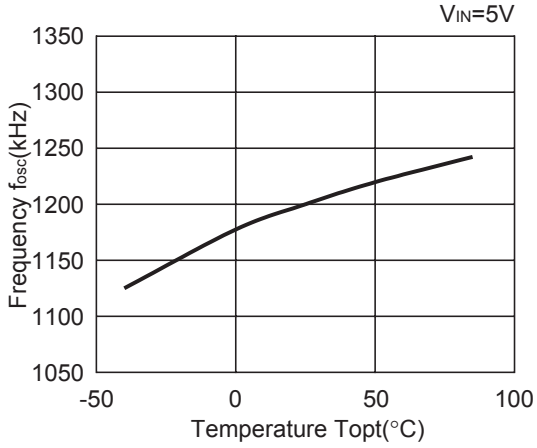
8) Soft-start time vs. Temperature

R5212D011A



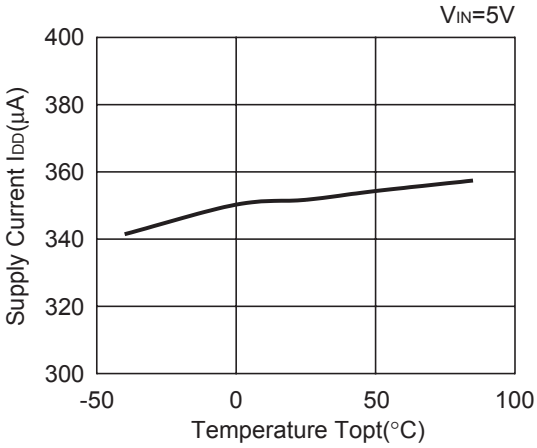
9)Frequency vs. Temperature

R5212D011A



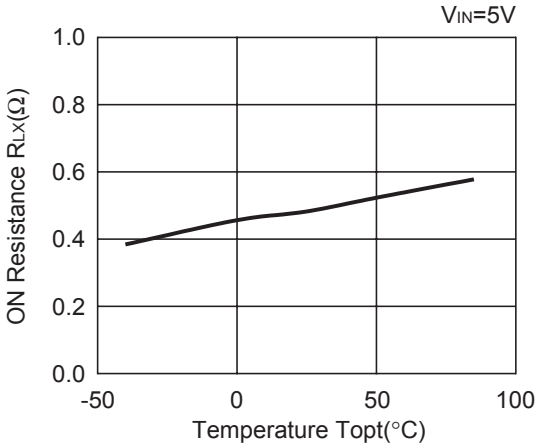
10) Supply Current vs. Temperature

R5212D011A



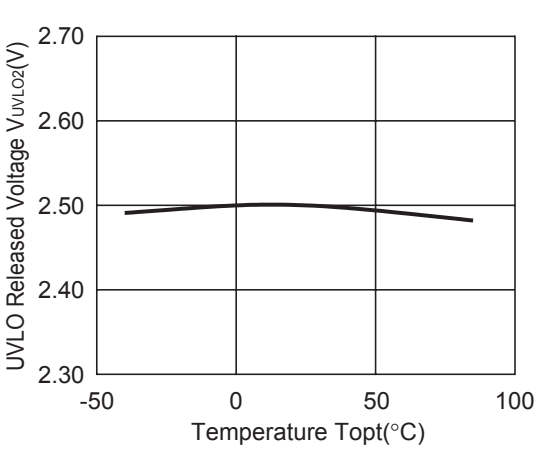
11) ON Resistance vs. Temperature

R5212D011A



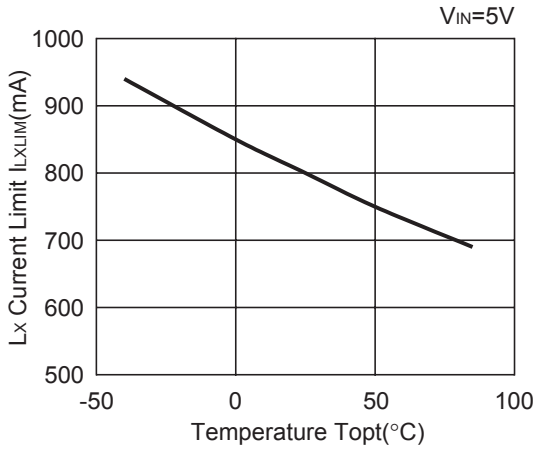
12) UVLO Released Voltage vs. Temperature

R5212D011A



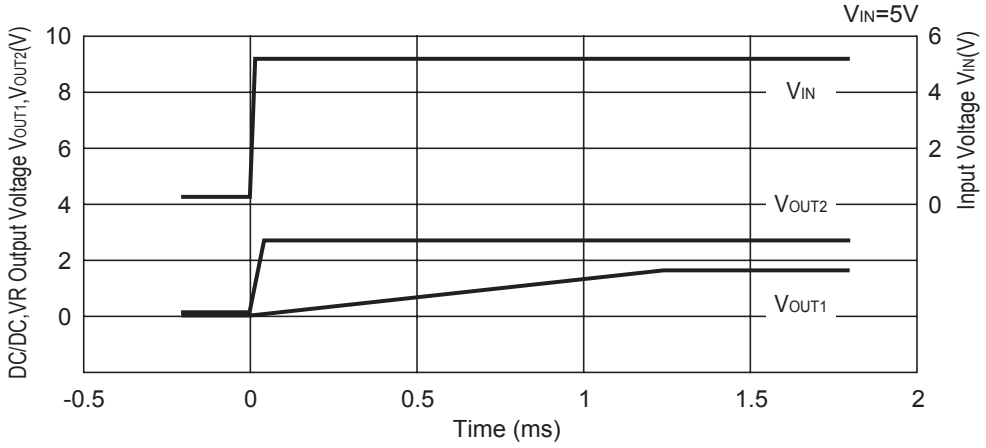
13) Lx Current Limit vs. Temperature

R5212D011A



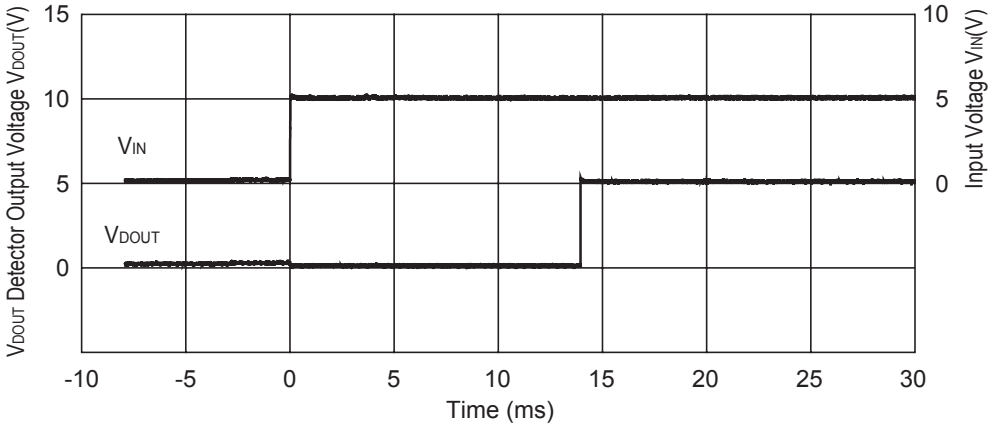
14) Soft-start Output Waveform (Topt=25°C)

R5212D011A



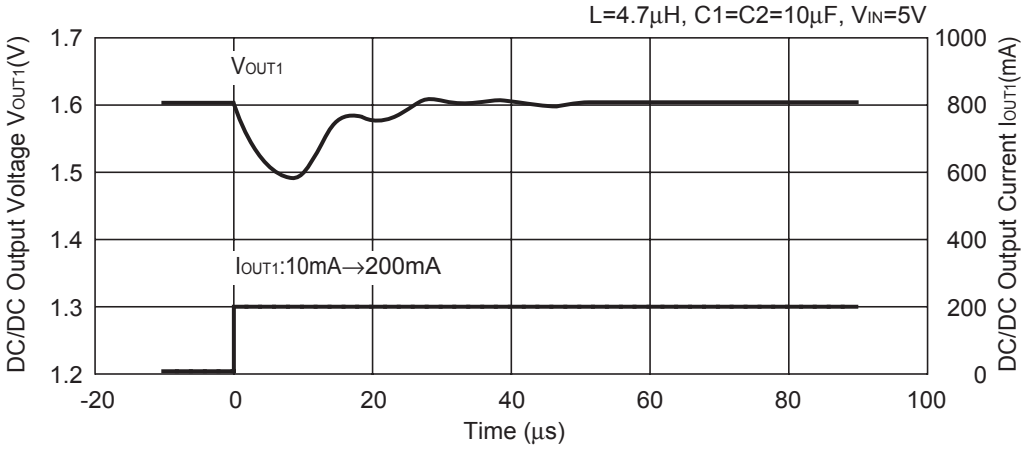
15) VD Released Delay Waveform (Topt=25°C)

R5212D011A

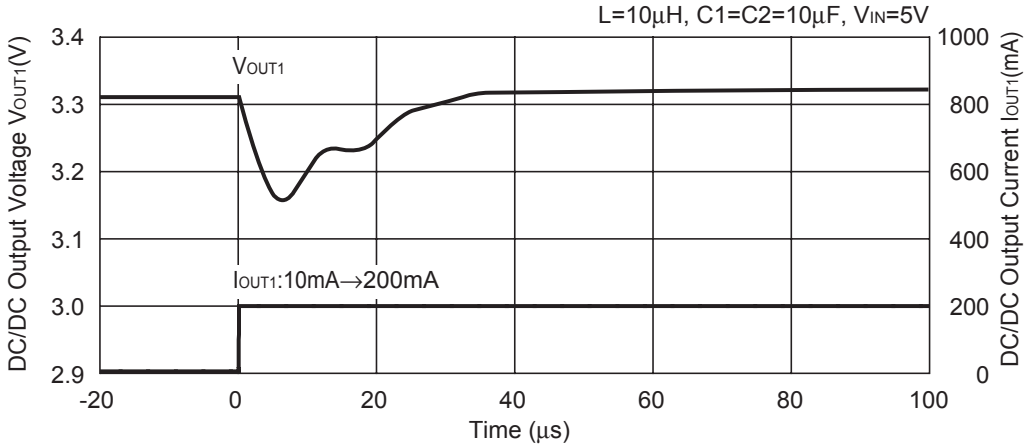


16) DC/DC Load Transient Response 1 (Topt=25°C)

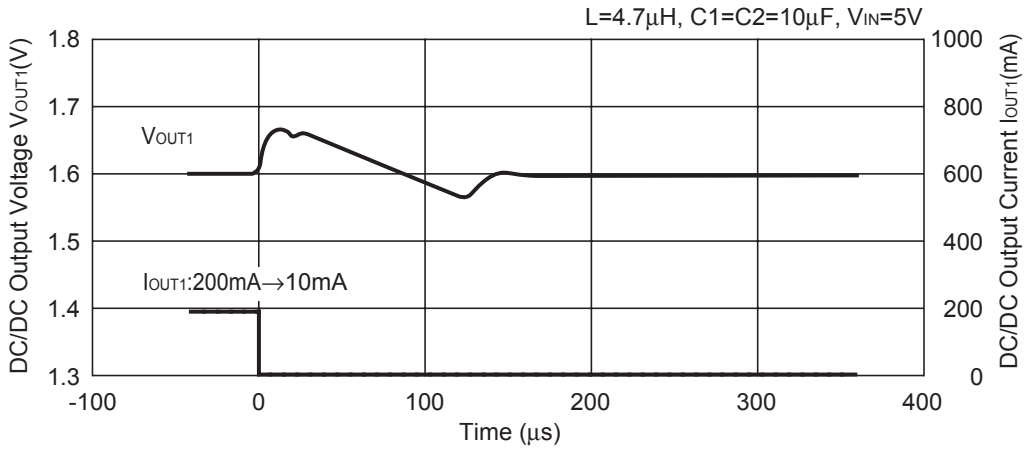
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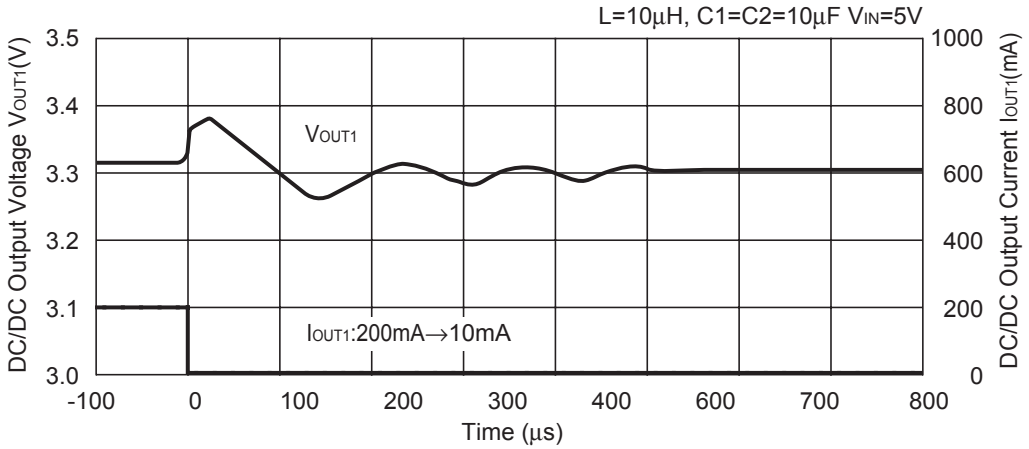
R5212D014C



R5212D011A

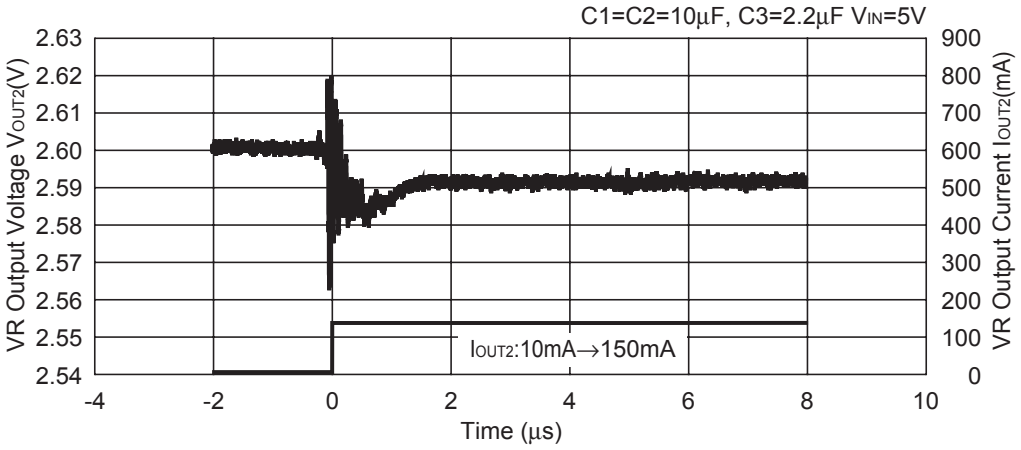


R5212D014C



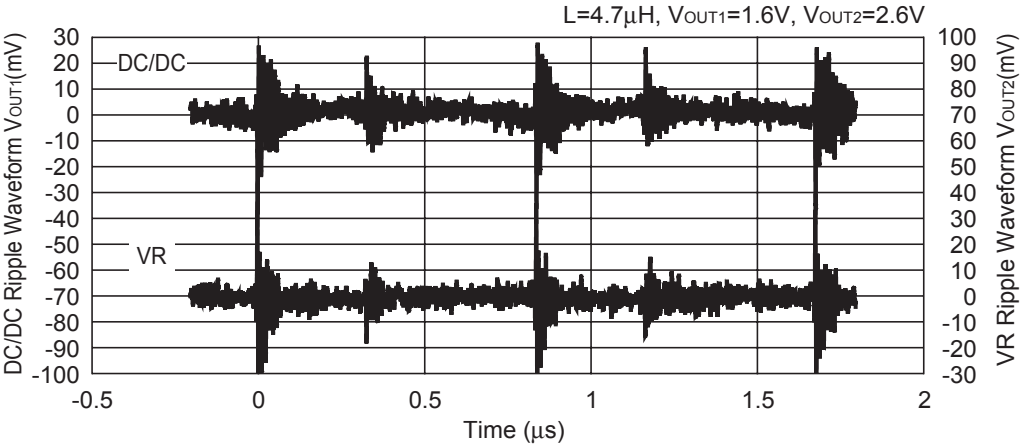
17) VR Load Transient Response (Topt=25°C)

R5212D011A

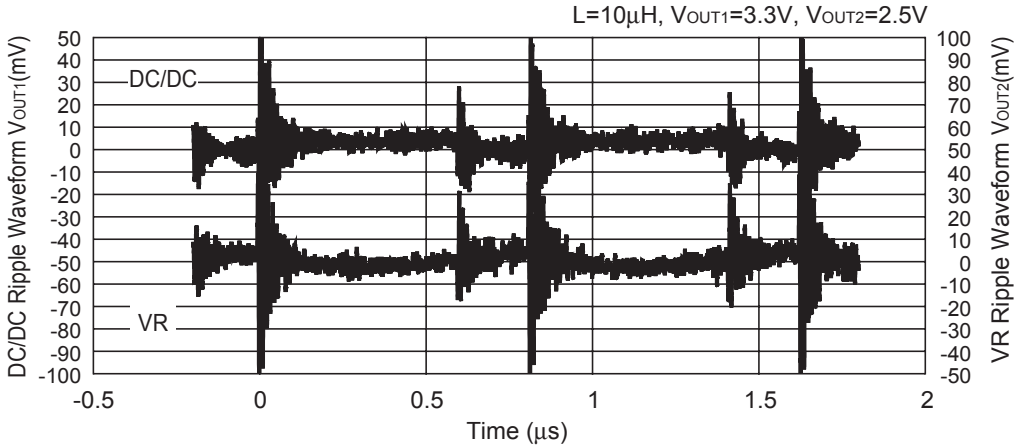


18) DC/DC, VR Ripple Waveform (C=10µF, V_{IN}=5V, I_{OUT1}=280mA, I_{OUT2}=150mA, Topt=25°C)

R5212D011A

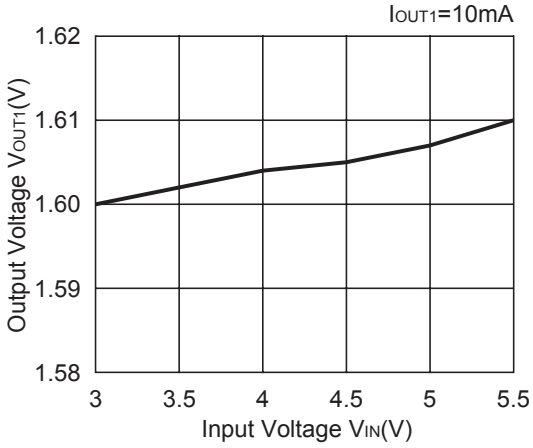


R5212D014C

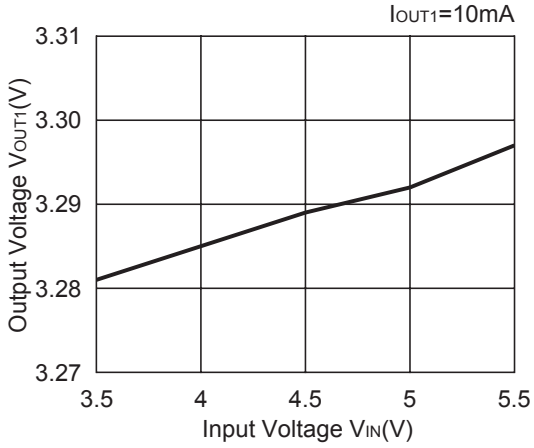


19) DC/DC Output Voltage vs. Input Voltage (Topt=25°C)

R5212D011A

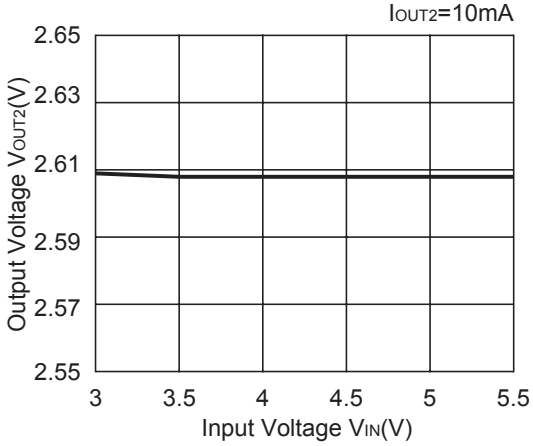


R5212D014C



20) VR Output Voltage vs. Input Voltage (Topt=25°C)

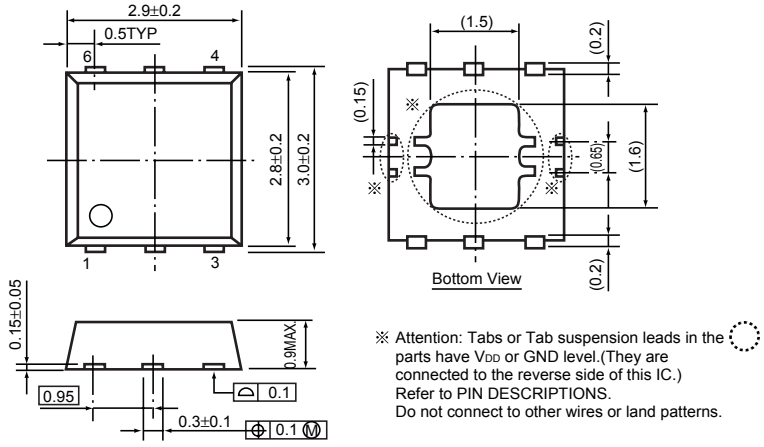
R5212D011A



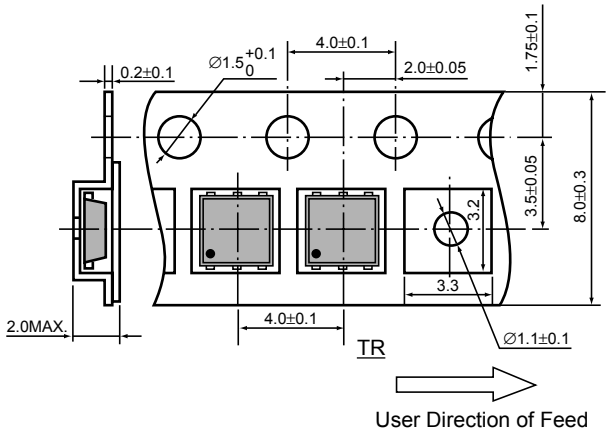
- **HSON-6**

Unit: mm

PACKAGE DIMENSIONS

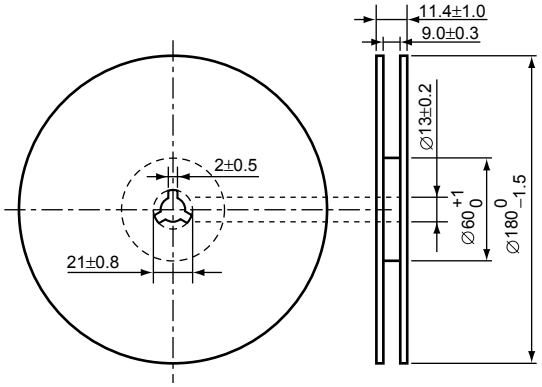


TAPING SPECIFICATION



TAPING REEL DIMENSIONS

(1reel=3000pcs)



POWER DISSIPATION (HSON-6)

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:

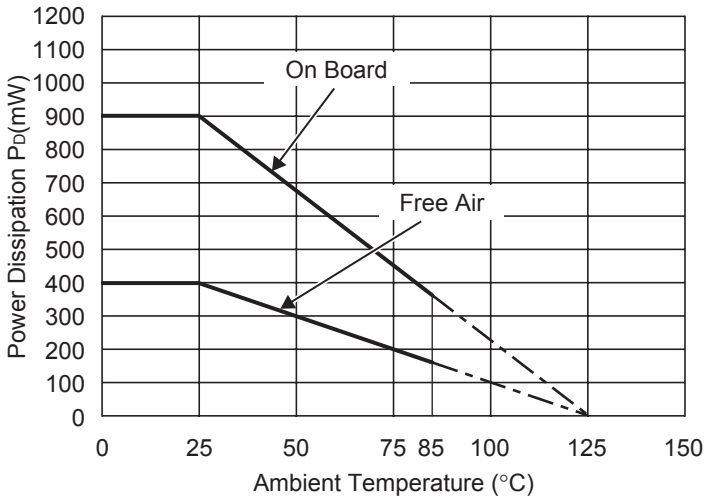
Measurement Conditions

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

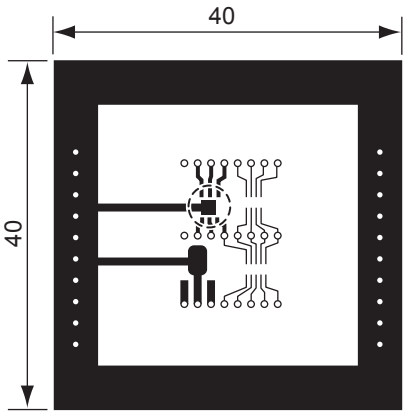
Measurement Result

(Topt=25°C,Tjmax=125°C)

	Standard Land Pattern	Free Air
Power Dissipation	900mW	400mW
Thermal Resistance	θja=(125−25°C)/0.9W=111°C/W	250°C/W



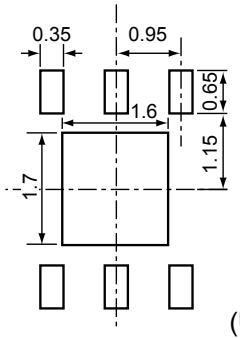
Power Dissipation



Measurement Board Pattern

IC Mount Area Unit : mm

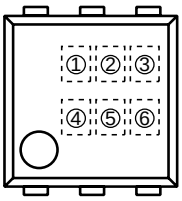
RECOMMENDED LAND PATTERN



(Unit: mm)

R5212D SERIES MARK SPECIFICATION

- **HSON-6**



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
R5212D011A	D	1	1	A
R5212D014C	D	1	4	C
R5212D017A	D	1	7	A
R5212D016B	D	1	6	B