* 1283Z (WLCSP-11-P2) is the discontinued product as of June, 2016.

RICOH

R1283x SERIES

2ch DC/DC for CCD & OLED

NO.EA-157-160224

OUTLINE

The R1283x 2ch DC/DC converter is designed for CCD & OLED Display power source. It contains a step up DC/DC converter and an inverting DC/DC converter to generate two required voltages by CCD & OLED Display. Step up DC/DC converter generates boosted output voltage up to 20V. Inverting DC/DC converter generates negative voltage up to V_{IN} voltage minus 20V independently. Start up sequence is internally made. Each of the R1283x series consists of an oscillator, a PWM control circuit, a voltage reference, error amplifiers, over current protection circuits, short protection circuits, an under voltage lockout circuit (UVLO), an Nch driver for boost operation, a Pch driver for inverting. A high efficiency boost and inverting DC/DC converter can be composed with external inductors, diodes, capacitors, and resistors.

FEATURES

- Operating Voltage .... 2.5V to 5.5V
- Step Up DC/DC (CH1)
  - Internal Nch MOSFET Driver (R_{ON}=400mΩTyp.)
  - Adjustable V_{OUT} Up to 20V with external resistor
  - Internal Soft start function (Typ. 4.5ms)
  - Over Current Protection
  - Maximum Duty Cycle: 91%(Typ.)
- Inverting DC/DC (CH2)
  - Internal Pch MOSFET Driver (R_{ON}=400mΩ Typ.)
  - Adjustable V_{OUT} Up to Vdd-20V with external resistor
  - Auto Discharge function for negative output
  - Internal Soft start function (Typ. 4.5ms)
  - Over Current Protection
  - Maximum Duty Cycle: 91%(Typ.)

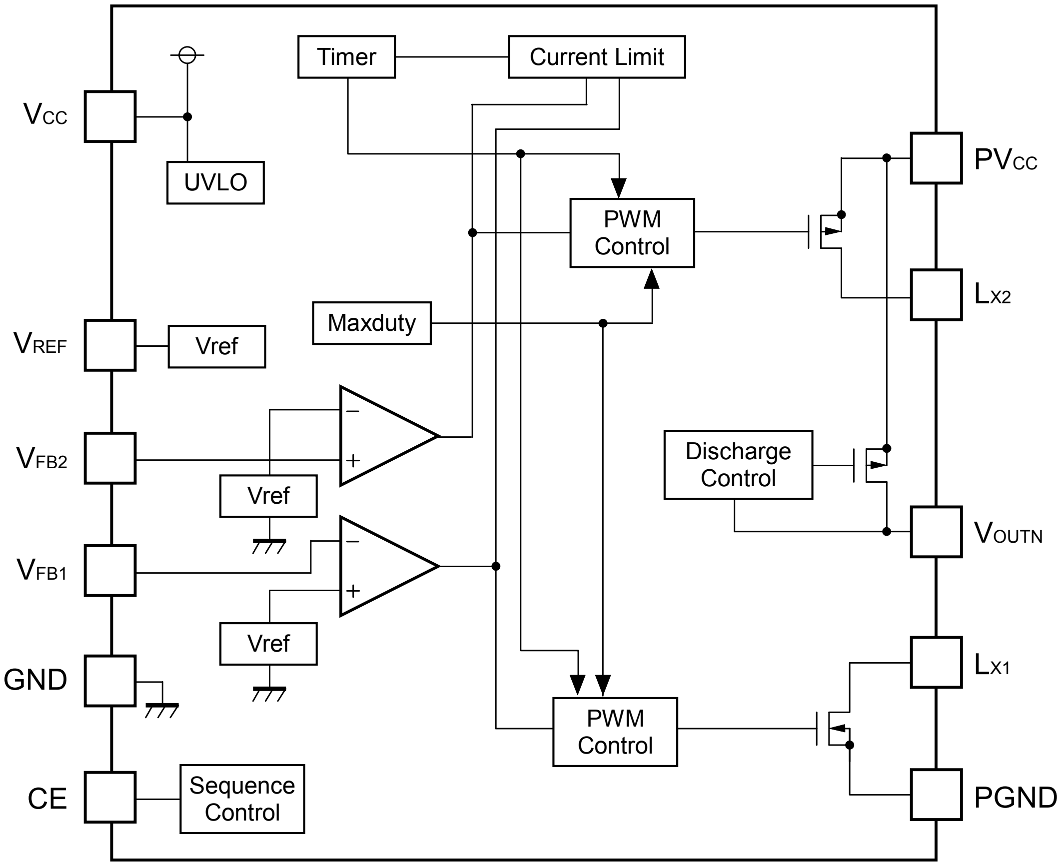
- Short Protection with timer latch function (Typ. 50ms); Short condition for either or both two outputs makes all output drivers off and latches./ If the maximum duty cycle continues for a certain time, these output drivers will be turned off.
  - CE with start up sequence function
  - CH1→CH2 (R1283K001x) / CH2→CH1(R1283K002x) Selectable
  - UVLO function
  - Operating Frequency Selection ....300kHz / 700kHz / 1400kHz

- Packages .... DFN(PLP)2730-12, WLCSP-11-P2

APPLICATION

- Fixed voltage power supply for portable equipment
- Fixed voltage power supply for CCD, OLED, LCD

BLOCK DIAGRAM



SELECTION GUIDE

The start-up sequence, oscillator frequency, and the package for the ICs can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1283Z00x∗-E2-F	WLCSP-11-P2	4,000 pcs	Yes	Yes
R1283K00x∗-TR	DFN(PLP)2730-12	5,000 pcs	Yes	Yes

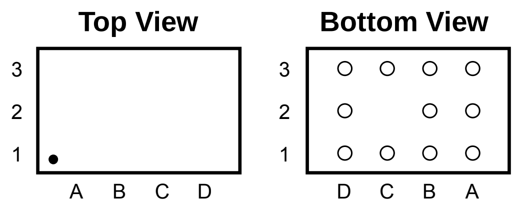
x : The start-up sequence can be designated.
(1) Step-up → Inverting
(2) Inverting → Step-up

∗ : The oscillator frequency is the option as follows.
(A) 300kHz (A Version for 1283Z packaged in WLCSP-11-P2 is not available)
(B) 700kHz
(C) 1400kHz

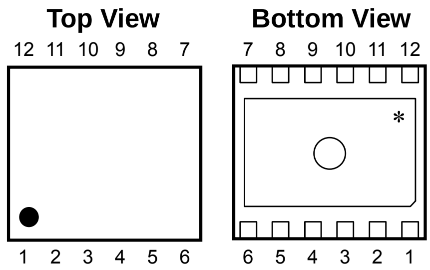
* 1283Z (WLCSP-11-P2) is the discontinued product as of June, 2016.

PIN CONFIGURATIONS

- **WLCSP-11-P2**



- **DFN(PLP)2730-12**



PIN DESCRIPTIONS

- **WLCSP-11-P2**

Pin No	Symbol	Pin Description
A1	PGND	Power GND pin
A2	V_{FB1}	Feedback pin for Step up DC/DC
A3	L_{X1}	Switching pin for Step up DC/DC
B1	PV_{CC}	Power Input pin
B2	CE	Chip Enable pin for the R1283
B3	L_{X2}	Switching pin for Inverting DC/DC
C1	GND	Analog GND pin
C3	V_{OUTN}	Discharge pin for Negative output
D1	V_{CC}	Analog power source Input pin
D2	V_{REF}	Reference Voltage Output pin
D3	V_{FB2}	Feedback pin for Inverting DC/DC

- **DFN(PLP)2730-12**

Pin No	Symbol	Pin Description
1	NC	No Connect
2	L_{X1}	Switching pin for Step up DC/DC
3	L_{X2}	Switching pin for Inverting DC/DC
4	V_{OUTN}	Discharge pin for Negative Output
5	CE	Chip Enable pin for the R1283
6	V_{FB2}	Feedback pin for Inverting DC/DC
7	V_{REF}	Reference Voltage Output pin
8	V_{CC}	Analog power source Input pin
9	V_{FB1}	Feedback pin for Step up DC/DC
10	GND	Analog GND pin
11	PV_{CC}	Power Input pin
12	PGND	Power GND pin

∗) Tab is GND level. (They are connected to the reverse side of this IC.)
The tab is better to be connected to the GND, but leaving it open is also acceptable.

ABSOLUTE MAXIMUM RATINGS

(GND/PGND=0V)

Symbol	Item	Rating	Unit
V_{CC}	V_{CC} / PV_{CC} pin Voltage	6.5	V
V_{DTC}	V_{FB1} pin Voltage	−0.3 to V_{CC}+0.3	V
V_{FB}	V_{FB2} pin Voltage	−0.7(∗1) to V_{CC}+0.3	V
V_{CE}	CE pin Voltage	−0.3 to V_{CC}+0.3	V
V_{REF}	V_{REF} pin Voltage	−0.7(∗1) to V_{CC}+0.3	V
V_{LX1}	L_{X1} pin Voltage	−0.3 to 24	V
I_{LX1}	L_{X1} pin Current	Internally Limited	A
V_{LX2}	L_{X2} pin Voltage	V_{CC}−24 to V_{CC}+0.3	V
I_{LX2}	L_{X2} pin Current	Internally Limited	A
V_{NFB}	V_{OUTN} pin Voltage	V_{CC}−24 to V_{CC}+0.3	V
P_D	Power Dissipation (WLCSP-11-P2) (∗2)	1000	mW
	Power Dissipation (DFN(PLP)2730-12) (∗2)	1000	
Topt	Operating Temperature Range	−40 to 85	°C
Tstg	Storage Temperature Range	−55 to 125	°C

∗1) In case the voltage range is from −0.7V to −0.3V, permissible current is 10mA or less.
∗2) For Power Dissipation, please refer to PACKAGE INFORMATION.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time and safety for both device and system using the device in the field.
The functional operation at or over these absolute maximum ratings is not assured.

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

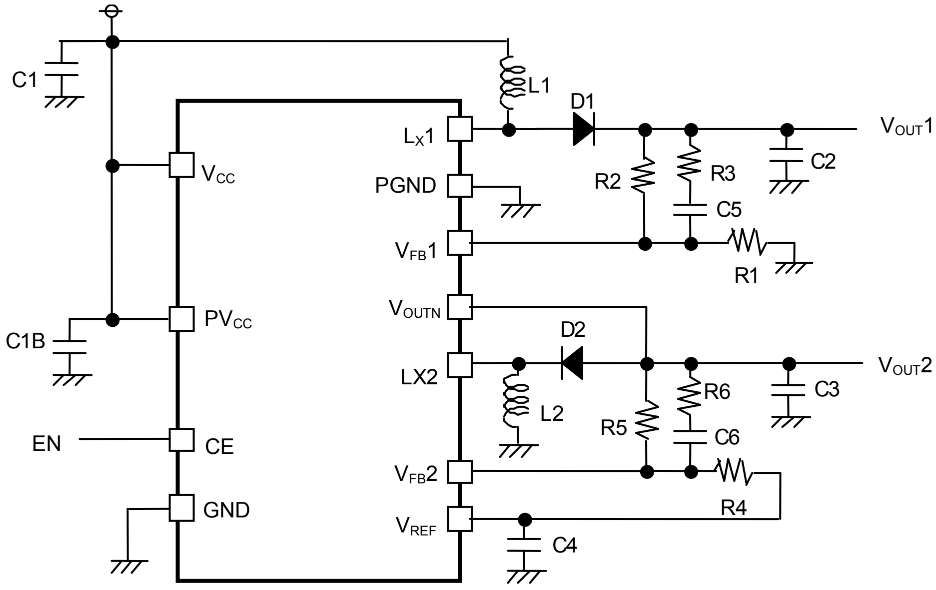
ELECTRICAL CHARACTERISTICS

- **R1283x**

Topt=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit.
V_{CC}	Operating Input Voltage		2.5		5.5	V
I_{CC1}	V_{CC} Consumption Current (Switching)	V_{CC}=5.5V, F_{REQ}=300kHz		2.0		mA
		V_{CC}=5.5V, F_{REQ}=700kHz		4.0		mA
		V_{CC}=5.5V, F_{REQ}=1400kHz		8.0		mA
I_{CC2}	V_{CC} Consumption Current (At no switching)	V_{CC}=5.5V, F_{REQ}=300kHz		250		μA
		V_{CC}=5.5V, F_{REQ}=700kHz		300		μA
		V_{CC}=5.5V, F_{REQ}=1400kHz		350		μA
$I_{standby}$	Standby Current	V_{CC}=5.5V		0.1	3	μA
V_{UVLO1}	UVLO Detect Voltage	Falling	2.05	2.15	2.25	V
V_{UVLO2}	UVLO Released Voltage	Rising		V_{UVLO1} +0.16	2.48	V
V_{REF}	V_{REF} Voltage Tolerance	V_{CC}=3.3V	1.172 $+V_{FB2}$	1.2 $+V_{FB2}$	1.228 $+V_{FB2}$	V
$\Delta V_{REF}/\Delta T_{opt}$	V_{REF} Voltage Temperature Coefficient	V_{CC}=3.3V, −40°C≤Topt≤85°C		±150		ppm/°C
$\Delta V_{REF}/\Delta V_{CC}$	V_{REF} Line Regulation	2.5V≤V_{CC}≤5.5V		5		mV
$\Delta V_{REF}/\Delta I_{OUT}$	V_{REF} Load Regulation	V_{CC}=3.3V, 0.1mA≤I_{OUT}≤2mA		5		mV
I_{LIMREF}	V_{REF} Short Current Limit	V_{CC}=3.3V, V_{REF}=0V		15		mA
V_{FB1}	V_{FB1} Voltage Tolerance	V_{CC}=3.3V	0.985	1.0	1.015	V
$\Delta V_{FB1}/\Delta T_{opt}$	V_{FB1} Voltage Temperature Coefficient	V_{CC}=3.3V, −40°C≤Topt≤85°C		±150		ppm/°C
I_{FB1}	V_{FB1} Input Current	V_{CC}=5.5V, V_{FB1}=0V or 5.5V	−0.1		0.1	μA
V_{FB2}	V_{FB2} Voltage Tolerance	V_{CC}=3.3V	−25	0	25	mV
I_{FB2}	V_{FB2} Input Current	V_{CC}=5.5V, V_{FB2}=0V or 5.5V	−0.1		0.1	μA
fosc	Oscillator Frequency	V_{CC}=3.3V	240	300	360	kHz
		V_{CC}=3.3V	600	700	800	kHz
		V_{CC}=3.3V	1200	1400	1600	kHz
Maxduty1	CH1 Max. Duty Cycle	V_{CC}=3.3V	86	91		%
Maxduty2	CH2 Max. Duty Cycle	V_{CC}=3.3V	86	91		%
t_{SS1}	CH1 Soft-start Time	V_{CC}=3.3V, V_{FB1}=0.9V		4.5		ms
t_{SS2}	CH2 Soft-start Time	V_{CC}=3.3V, V_{FB2}=0.12V		4.5		ms
t_{DLY}	Delay Time for Protection	V_{CC}=3.3V	20	50		ms
R_{LX1}	L_{X1} ON Resistance	V_{CC}=3.3V		400		mΩ
I_{OFFLX1}	L_{X1} Leakage Current	V_{CC}=5.5V, V_{LX1}=20V			5	μA
I_{LIMLX1}	L_{X1} Current limit	V_{CC}=3.3V	1.0	1.5		A
R_{LX2}	L_{X2} ON Resistance	V_{CC}=3.3V		400		mΩ
I_{OFFLX2}	L_{X2} Leakage Current	V_{CC}=5.5V, V_{LX}=−14.5V			5	μA
I_{LIMLX2}	L_{X2} Current limit	V_{CC}=3.3V	1.0	1.5		A
R_{VOUTN}	V_{OUTN} Discharge Resistance	V_{CC}=3.3V, V_{OUTN}=−0.3V		10	25	Ω
V_{CEL}	CE "L" Input Voltage	V_{CC}=2.5V			0.3	V
V_{CEH}	CE "H" Input Voltage	V_{CC}=5.5V	1.5			V
I_{CEL}	CE "L" Input Current	V_{CC}=5.5V	−1.0		1.0	μA
I_{CEH}	CE "H" Input Current	V_{CC}=5.5V	−1.0		1.0	μA

TYPICAL APPLICATION



● Pin Connection

Externally short V_{CC} pin to PV_{CC} pin. Externally short GND pin to PGND pin.

● Step-up DC/DC converter output voltage setting

The output voltage V_{OUT1} of the step-up DC/DC converter is controlled with maintaining the V_{FB1} as 1.0V.

V_{OUT1} can be set with adjusting the values of R1 and R2 as in the next formula. V_{OUT1} can be set equal or less than 20V.

$V_{OUT1} = V_{FB1} \times (R1+R2) / R1$

● Inverting DC/DC converter output voltage setting

The output voltage V_{OUT2} of the inverting DC/DC converter is controlled with maintaining the V_{FB2} as 0V.

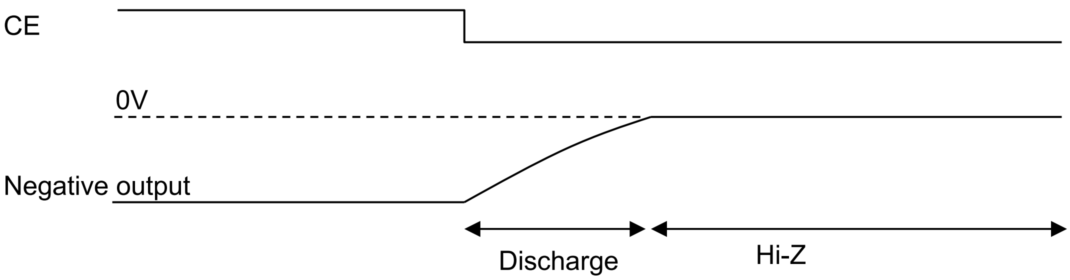
V_{OUT2} can be set with adjusting the values of R4 and R5 as in the next formula.

$V_{OUT2} = V_{FB2} - (V_{REF} - V_{FB2}) \times R5 / R4$

● Auto Discharge Function

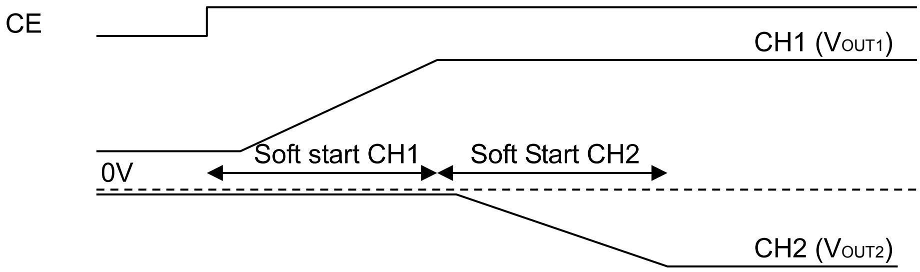
When CE level turns from "H" to "L" level, the R1283x goes into standby mode and switching of the outputs of L_{X1} and L_{X2} will stop. Then dischage Tr. between V_{OUT2} and V_{CC} turns on and discharges the negative output voltage. When the negative output voltage is discharged to 0V, the Tr. turns off and the negative output will be Hi-Z.

When the Auto discharge function is unnecessary, V_{OUTN} connect to V_{CC} or make be Hi-Z.



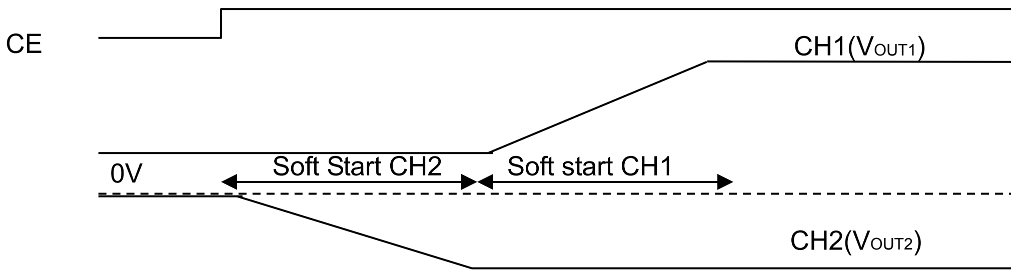
• Start up Sequence (R1283x001x)

When CE level turns from "L" to "H" level, the softstart of CH1 starts the operation. After detecting output voltage of CH1(V_{OUT1}) as the nominal level, the soft start of CH2 starts the operation.



• Start up Sequence (R1283x002x)

When CE level turns from "L" to "H" level, the softstart of CH2 starts the operation. After detecting output voltage of CH2(V_{OUT2}) as the nominal level, the soft start of CH1 starts the operation.



• Short protection circuit timer

In case that the voltage of V_{FB1} drops, the error amplifier of CH1 outputs "H". In case that the voltage of V_{FB2} rises, the error amplifier of CH2 outputs "L". The built-in short protection circuit makes the ineternal timer operate with detecting the output of the error amplifier of CH1 as "H", or the output of the error amplifier of CH2 as "L". After the setting time will pass, the switching of LX1 and LX2 will stop.

To release the latch operatoion, make the V_{CC} set equal or less than UVLO level and restart or set the CE pin as "L" and make it "H" again.

During the softstart operation of CH1 and CH2, the timer operates independently from the outputs of the error amplifiers. Therefore, even if the softstart cannot finish correctly because of the short circuit, the protection timer function will be able to work correctly.

• Phase Compensation

DC/DC converter's phase may lose 180 degree by external components of L and C and load current. Because of this, the phase margin of the system will be less and the stability will be worse. Therefore, the phase must be gained.

A pole will be formed by external components, L and C.

$F_{pole} \sim 1 / \{2 \times \pi \times \sqrt{(L1 \times C2)}\}$ (CH1)

$F_{pole} \sim 1 / \{2 \times \pi \times \sqrt{(L2 \times C3)}\}$ (CH2)

Zero will be formed with R2, C5, R5, and C6.

$F_{zero} \sim 1/(2\times\pi\times R2\times C5)$ (CH1)
$F_{zero} \sim 1/(2\times\pi\times R5\times C6)$ (CH2)
Set the cut-off frequency of the Zero close to the cut off frequency of the pole by L and C.

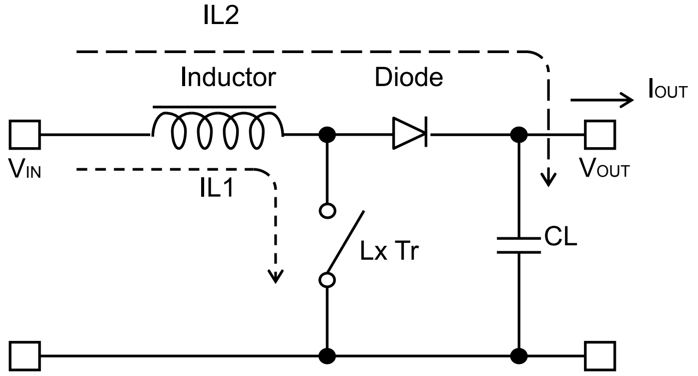
● To reduce the noise of Feedback voltage

If the noise of the system is large, the output noise affects the feedback and the operation may be unstable. In that case, resistor values, R1, R2, R4, and R5 should be set lower and make the noise into the feedback pin reduce. Another method is set R3 and R6 . The appropriate value range is from 1kΩ to 5kΩ.

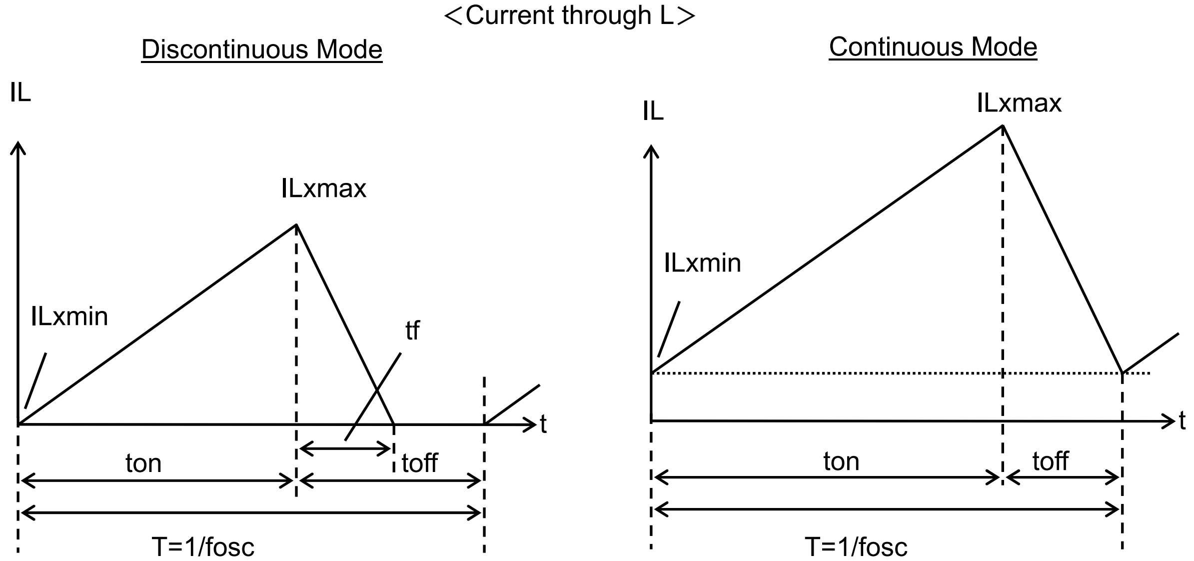
- Set a ceramic 1μF or more capacitor as C1B between V_{CC} pin and GND. Set another 4.7μF or more capacitor between PV_{CC} and GND as C1.
- Set a ceramic 1μF or more capacitor between V_{OUT1} and GND, and between V_{OUT2} and GND for each as C2 and C3. Recommendation value range is from 4.7μF to 22μF.
- Set a ceramic capacitor between VREF and GND as C4. Recommendation value range is from 0.1μF to 2.2μF.

Operation of Step-up DC/DC Converter and Output Current

<Basic Circuit>



<Current through L>



There are two operation modes for the PWM control step-up switching regulator, that is the continuous mode and the discontinuous mode.

When the Lx Tr. is on, the voltage for the inductor L will be V_{IN}. The inductor current (IL1) will be;

$IL1 = V_{IN} \times ton / L$ Formula1

When the Lx transistor turns off, power will supply continuously. The inductor current at off (IL2) will be;

$IL2 = (V_{OUT} - V_{IN}) \times tf / L$ Formula2

In terms of the PWM control, when the tf=toff, the inductor current will be continuous, the operation of the switching regulator will be continuous mode.

In the continuous mode, the current variation of IL1 and IL2 are same, therefore

$V_{IN} \times ton / L = (V_{OUT} - V_{IN}) \times toff / L$ Formula3

In the continuous mode, the duty cycle will be

$DUTY = ton / (ton + toff) = (V_{OUT} - V_{IN}) / V_{OUT}$ Formula4

If the input power equals to output power,

$I_{OUT} = V_{IN}^2 \times ton / (2 \times L \times V_{OUT})$ Formula5

When I_{OUT} becomes more then Formula5, it will be continuous mode.

In this moment, the peak current, ILxmax flowing through the inductor is described as follows:

$ILxmax = I_{OUT} \times V_{OUT} / V_{IN} + V_{IN} \times ton / (2 \times L)$ Formula6

$ILxmax = I_{OUT} \times V_{OUT} / V_{IN} + V_{IN} \times T \times (V_{OUT} - V_{IN}) / (2 \times L \times V_{OUT})$ Formula7

Therefore, peak current is more than I_{OUT}. Considering the value of ILxmax, the condition of input and output, and external components should be selected.

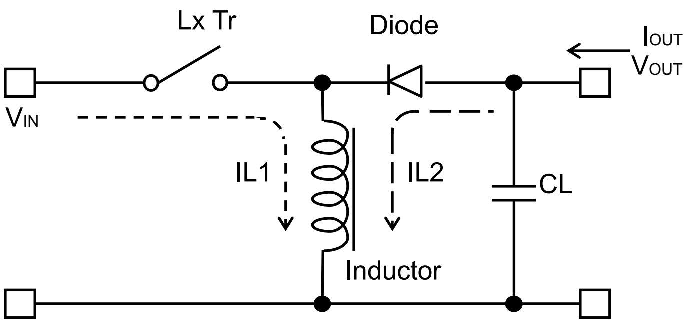
The explanation above is based on the ideal calculation, and the loss caused by Lx switch and external components is not included.

The actual maximum output current is between 50% and 80% of the calculation.

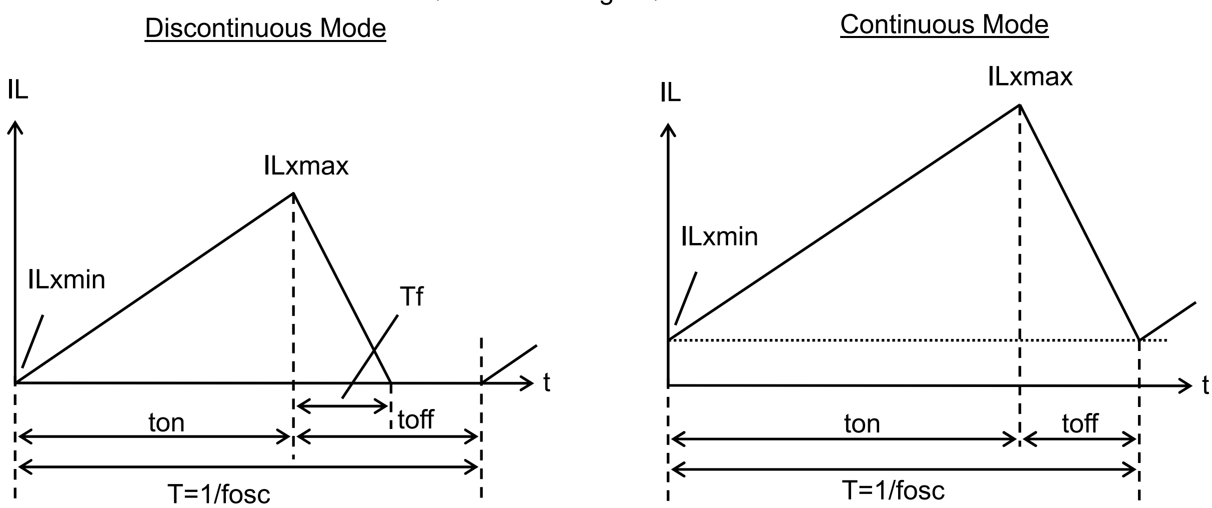
Especially, when the IL is large, or V_{IN} is low, the loss of V_{IN} is generated with on resistance of the switch. As for V_{OUT}, V_F(as much as 0.3V) of the diode should be considered.

Operation of Inverting DC/DC Converter and Output Current

<Basic Circuit>



<Current through L>



There are also two operation modes for the PWM control inverting switching regulator, that is the continuous mode and the discontinuous mode.

When the Lx Tr. is on, the voltage for the inductor L will be V_{IN}. The inductor current (IL1) will be;

$IL1 = V_{IN} \times ton / L$ Formula8

Inverting circuit saves energy during on time of Lx Tr, and supplies the energy to output during off time, output voltage opposed to input voltage is obtained. The inductor current at off (IL2) will be;

$IL2 = |V_{OUT}| \times tf / L$ Formula9

In terms of the PWM control, when the tf=toff, the inductor current will be continuous, the operation of the switching regulator will be continuous mode.

In the continuous mode, the current variation of IL1 and IL2 are same, therefore

$V_{IN} \times ton / L = |V_{OUT}| \times toff / L$ Formula10

In the continuous mode, the duty cycle will be:

$DUTY = ton / (ton + toff) = |V_{OUT}| / (|V_{OUT}| + V_{IN})$ Formula11

If the input power equals to output power,

$I_{OUT} = V_{IN}^2 \times ton / (2 \times L \times |V_{OUT}|)$ Formula12

When I_{OUT} becomes more then Formula12, it will be continuous mode.

In this moment, the peak current, IL_{xmax} flowing through the inductor is described as follows:

$IL_{xmax} = I_{OUT} \times |V_{OUT}| / V_{IN} + V_{IN} \times ton / (2 \times L)$ Formula13

$IL_{xmax} = I_{OUT} \times |V_{OUT}| / V_{IN} + V_{IN} \times |V_{OUT}| \times T / \{ 2 \times L \times (|V_{OUT}| + V_{IN}) \}$..........................Formula14

Therefore, peak current is more than I_{OUT}. Considering the value of IL_{xmax}, the condition of input and output, and external components should be selected.

The explanation above is based on the ideal calculation, and the loss caused by Lx switch and external components is not included.

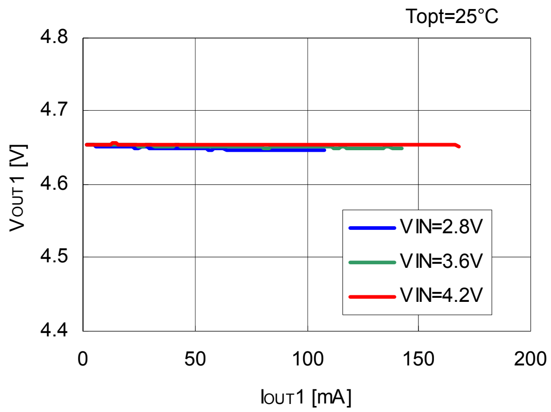
The actual maximum output current is between 50% and 80% of the calculation.

Especially, when the IL is large, or V_{IN} is low, the loss of V_{IN} is generated with on resistance of the switch. As for V_{OUT}, V_F (as much as 0.3V) of the diode should be considered.

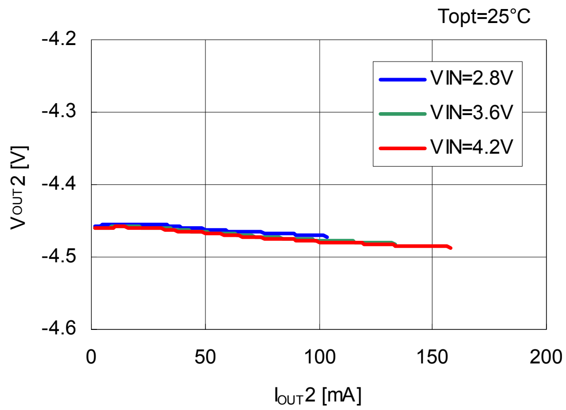
TYPICAL CHARACTERISTICS

1) Output Voltage VS. Output Current

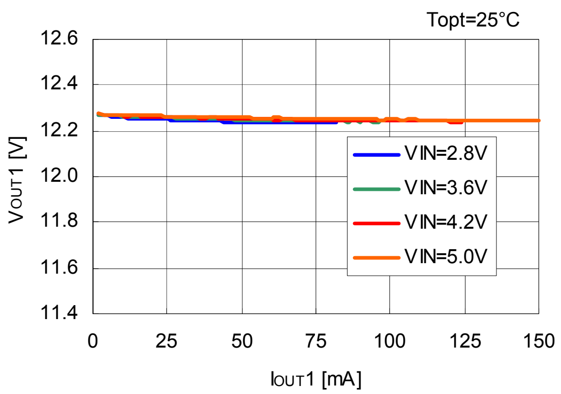
R1283x001A



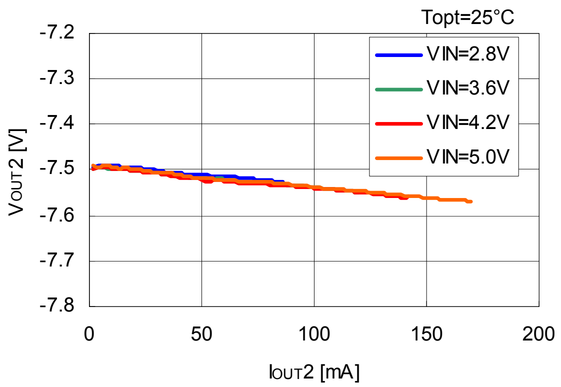
R1283x001A



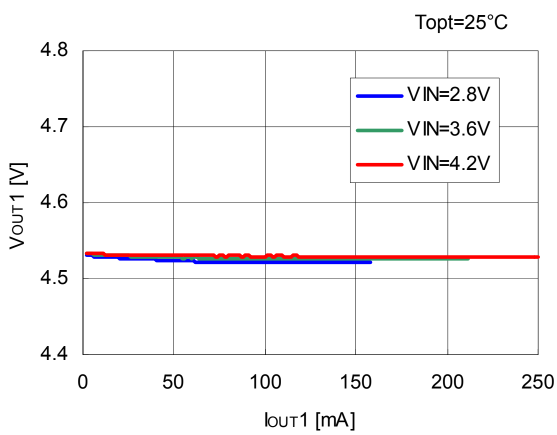
R1283x001A



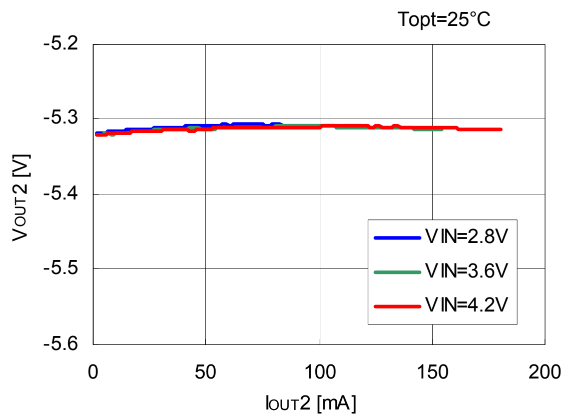
R1283x001A



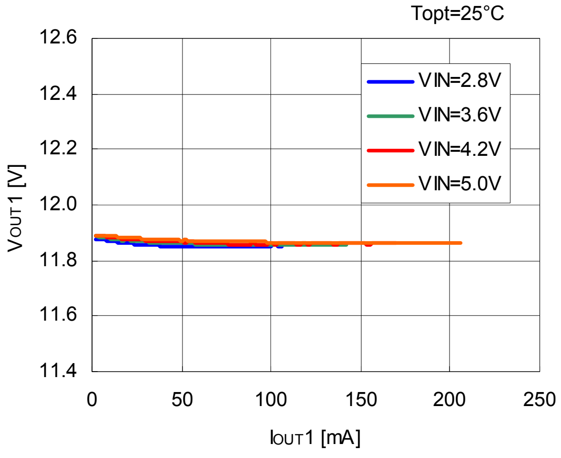
R1283x001B



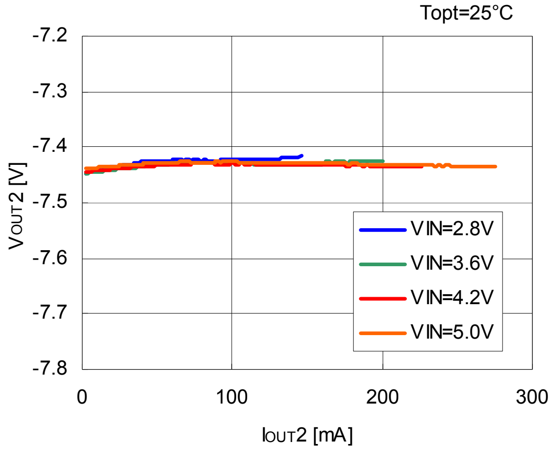
R1283x001B



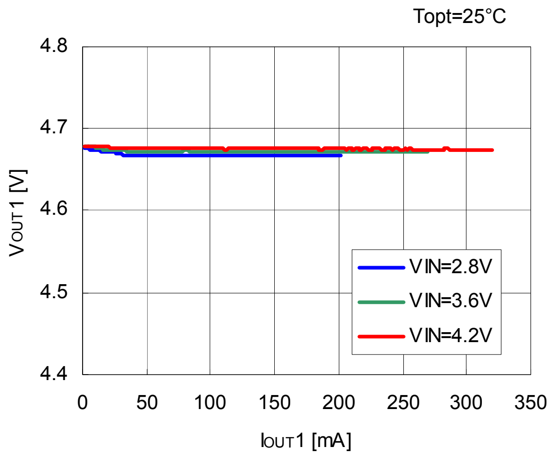
R1283x001B



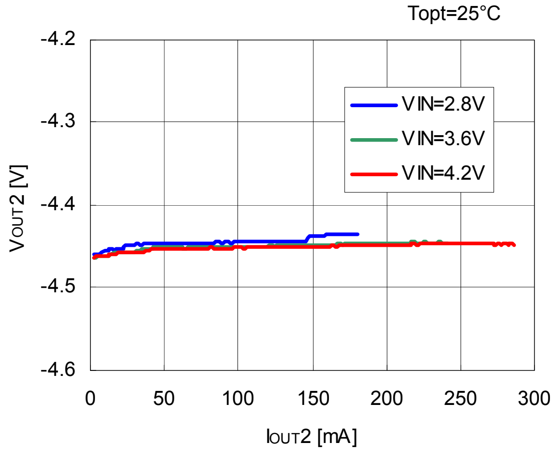
R1283x001B



R1283x001C



R1283x001C



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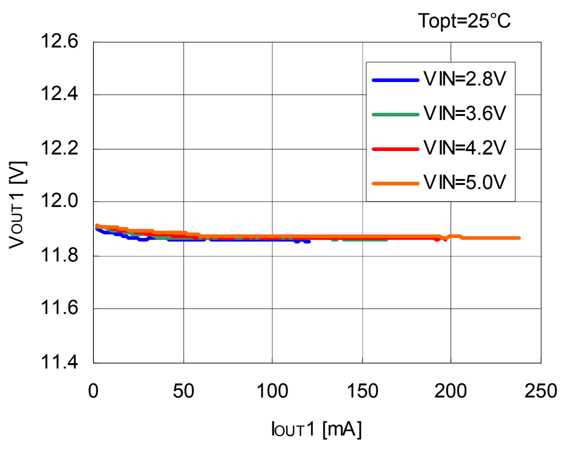

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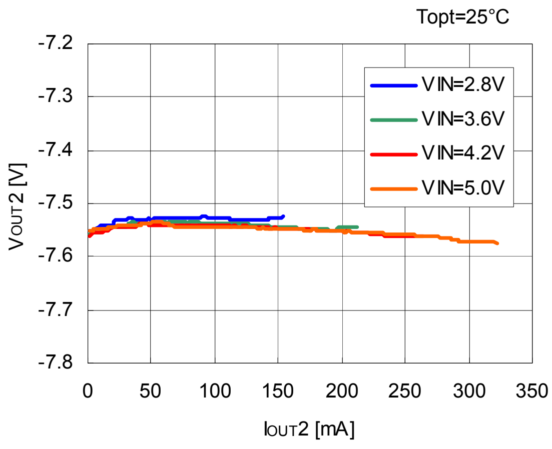
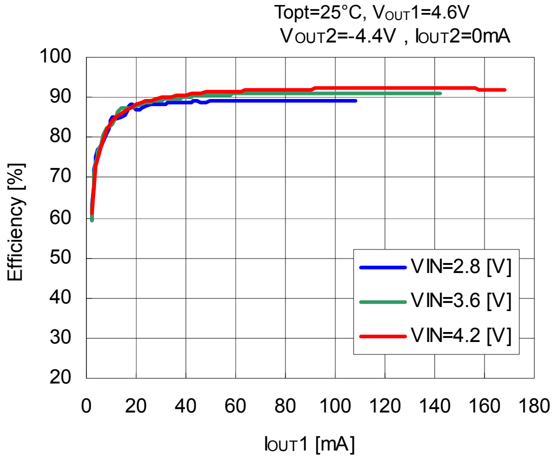


2) Efficiency vs. Output Current

R1283x001A



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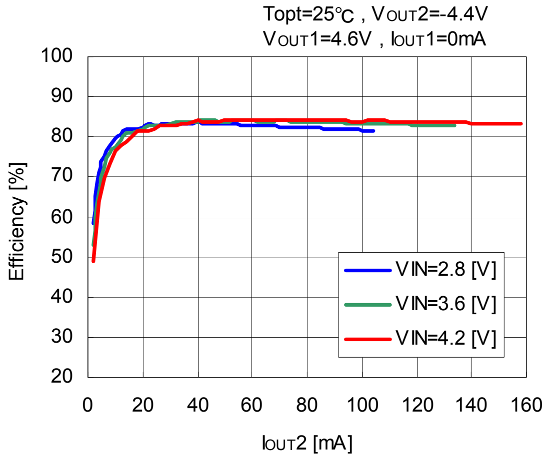

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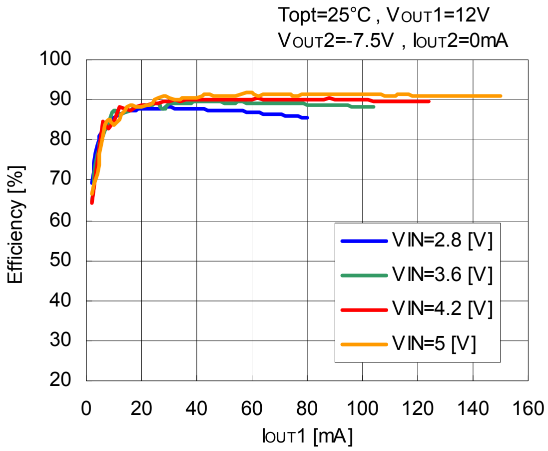

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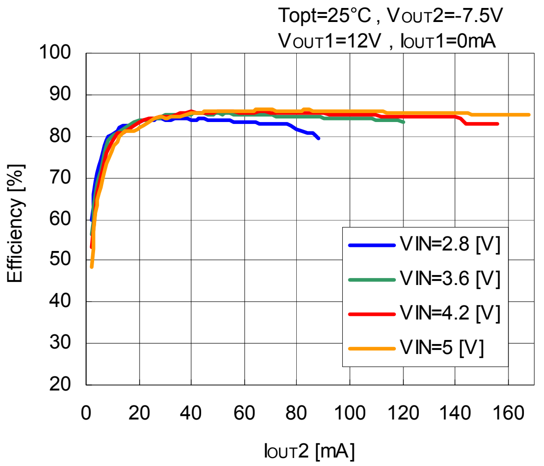
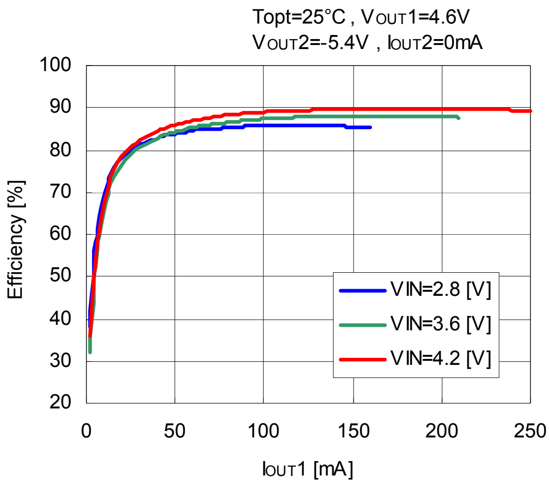


R1283x001B



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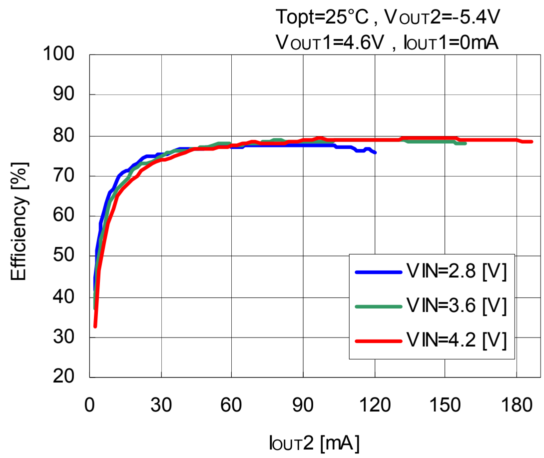

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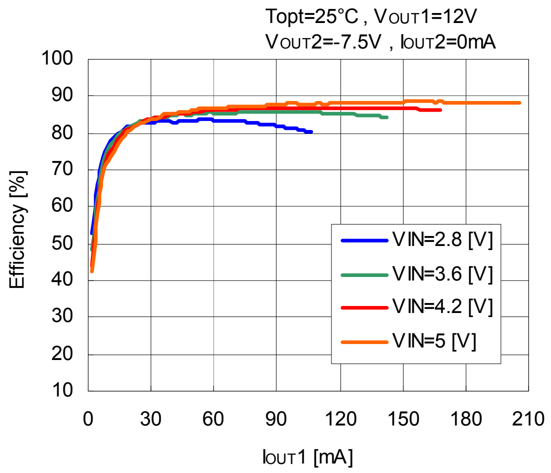

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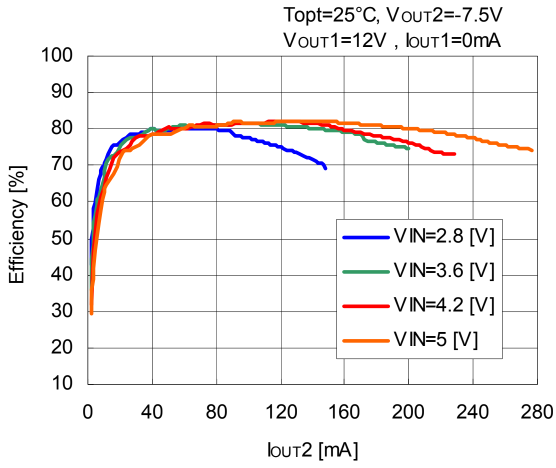
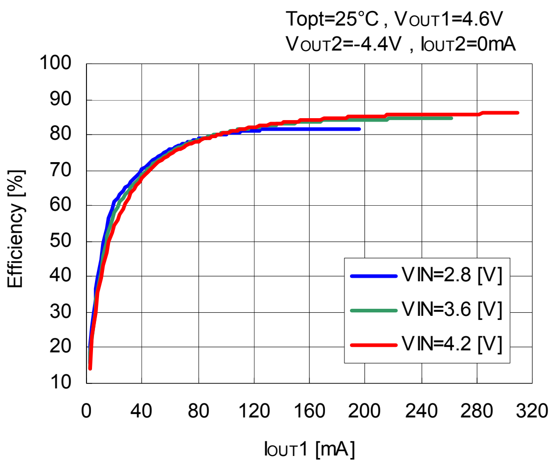


R1283x001C



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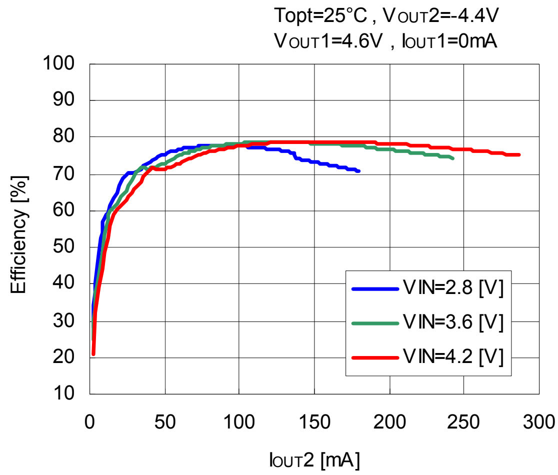

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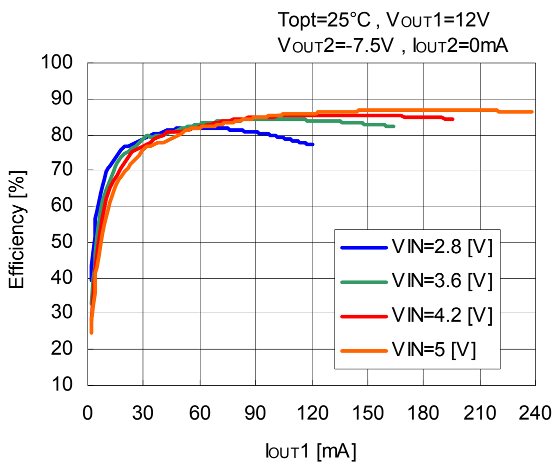

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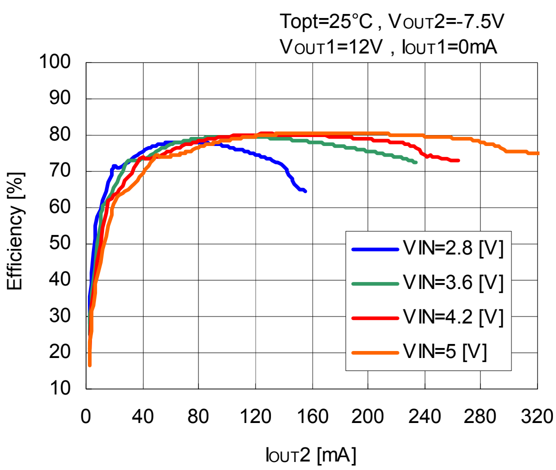
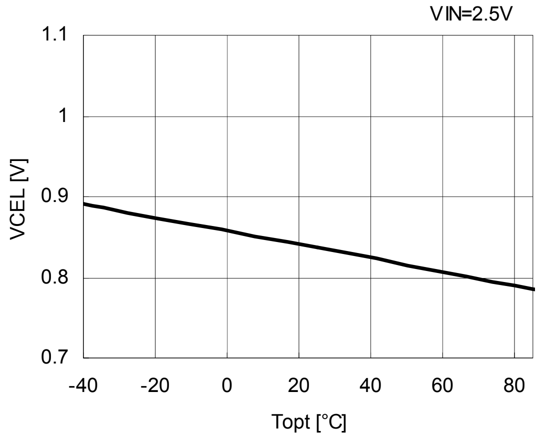


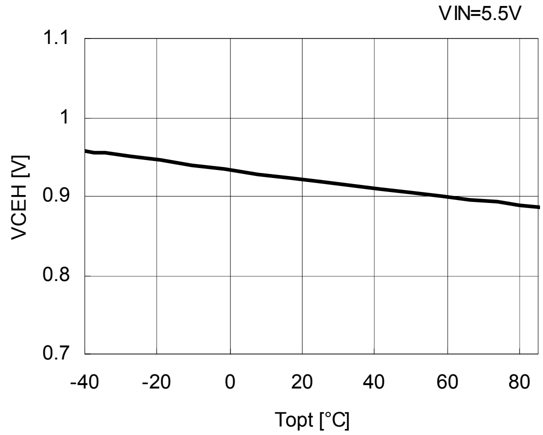
3) CE "L" Input Voltage vs. Temperature

R1283x00xx



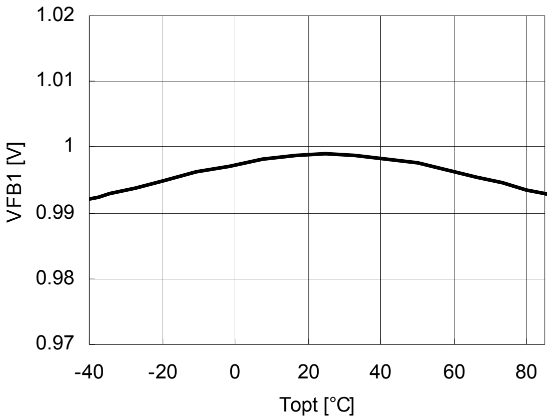
4) CE "H" Input Voltage vs. Temperature

R1283x00xx



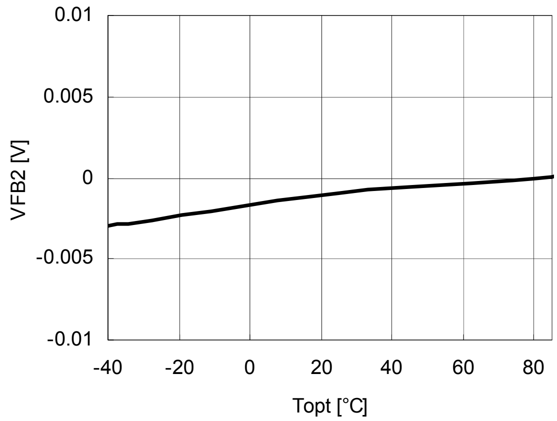
5) VFB1 Voltage vs. Temperature

R1283x00xx



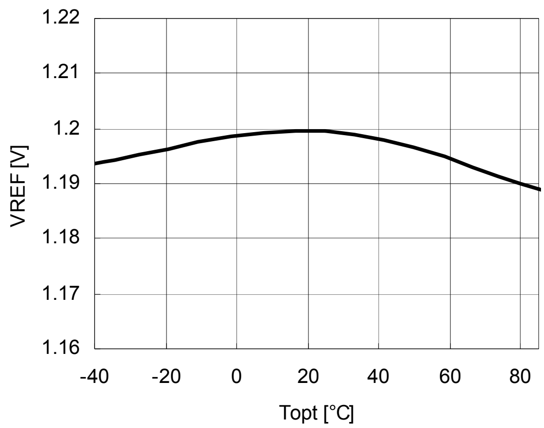
6) VFB2 Voltage vs. Temperature

R1283x00xx



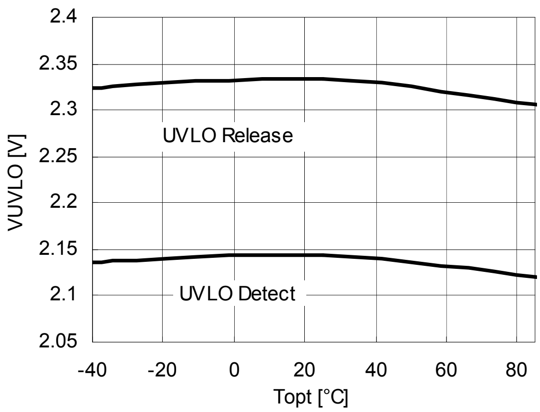
7) VREF Voltage vs. Temperature

R1283x00xx



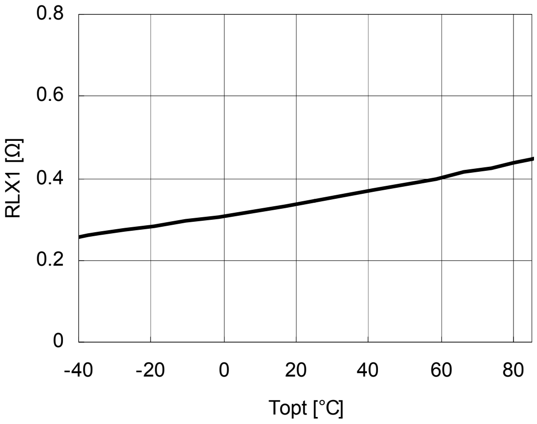
8) UVLO Voltage vs. Temperature

R1283x00xx



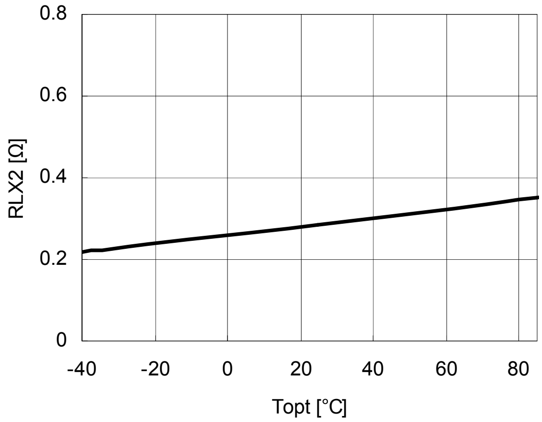
9) LX1 ON Resistance vs. Temperature

R1283x00xx



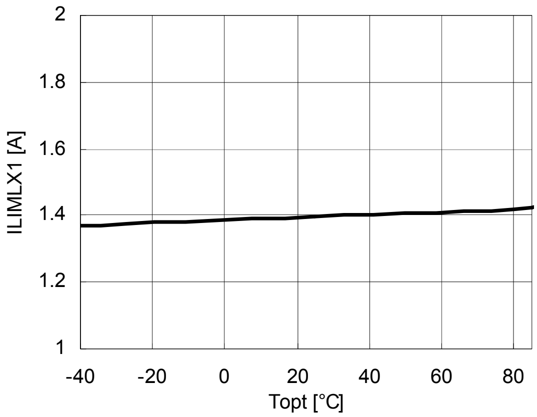
10) LX2 ON Resistance vs. Temperature

R1283x00xx



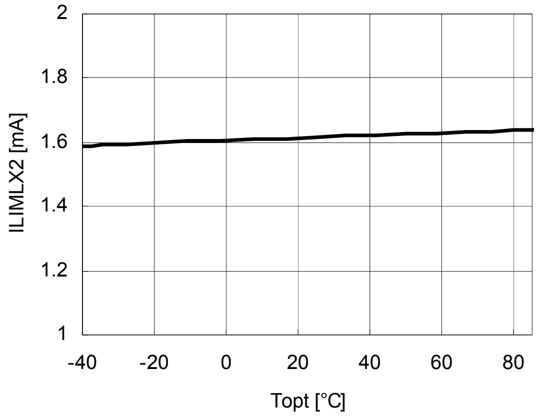
11) LX1 Limit Current vs. Temperature

R1283x00xx



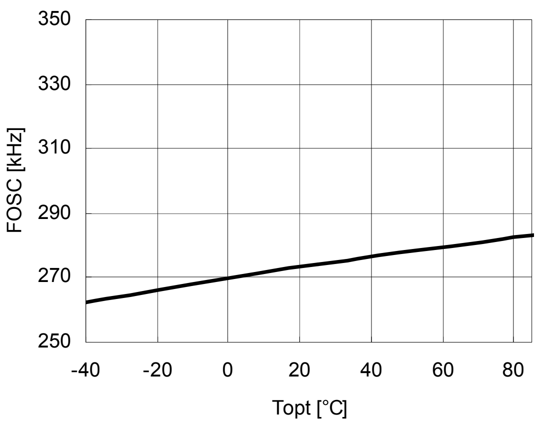
12) LX2 Limit Current vs. Temperature

R1283x00xx

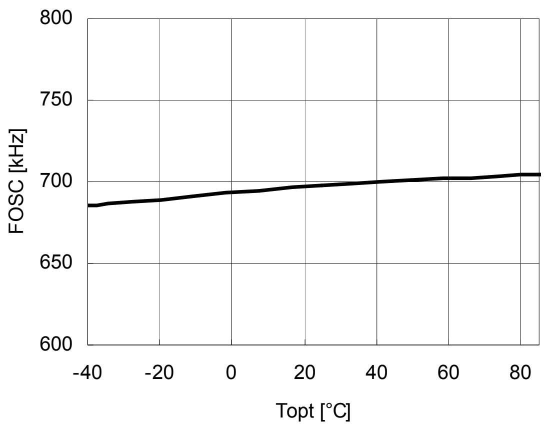


13) Oscillator Frequency vs. Temperature

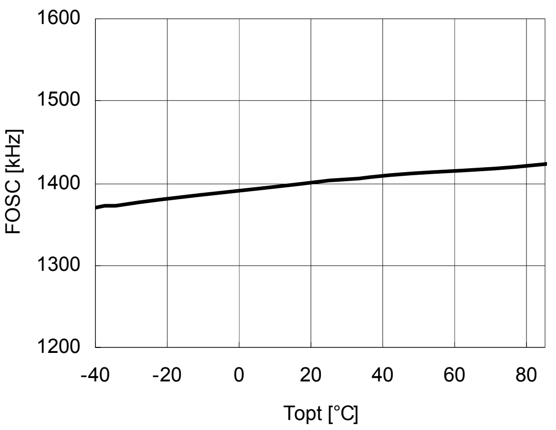
R1283x00xA



R1283x00xB

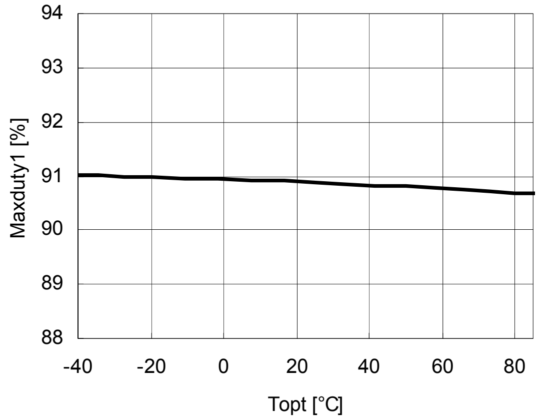


R1283x00xC

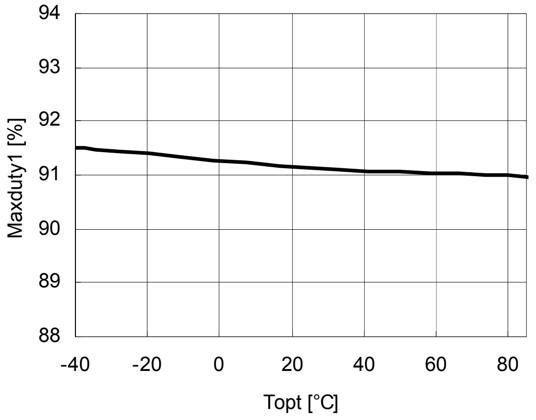


14) Maxduty1 vs. Temperature

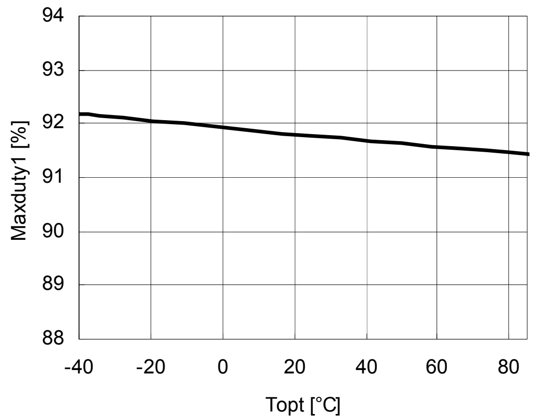
R1283x00xA



R1283x00xB

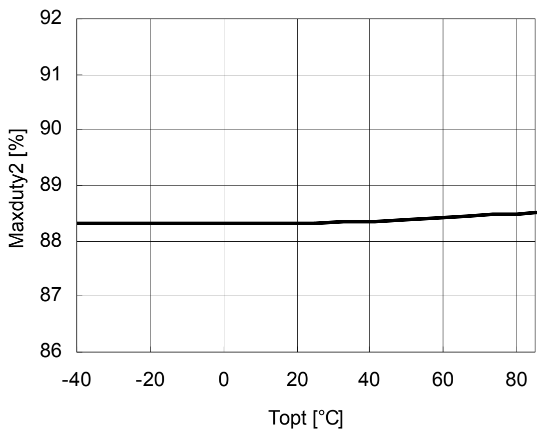


R1283x00xC

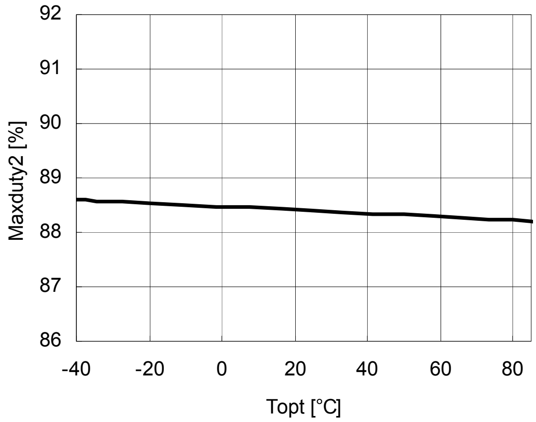


15) Maxduty2 vs. Temperature

R1283x00xA



R1283x00xB



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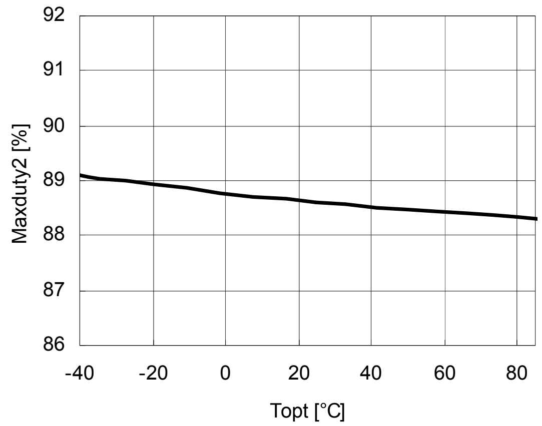
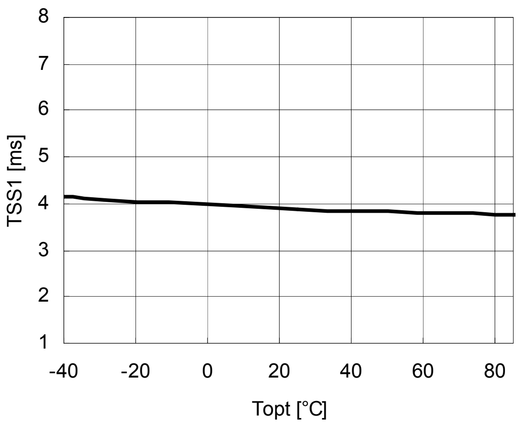


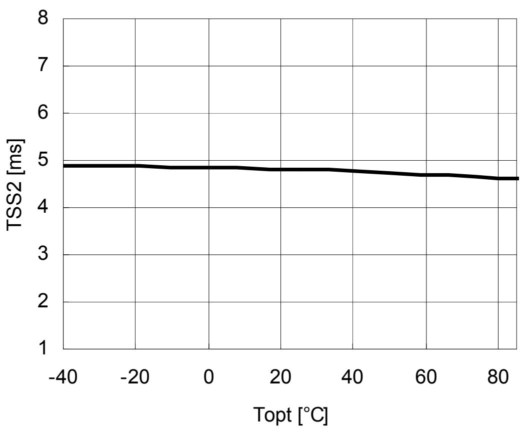
16) CH1 Soft-start Time vs. Temperature

R1283x00xx



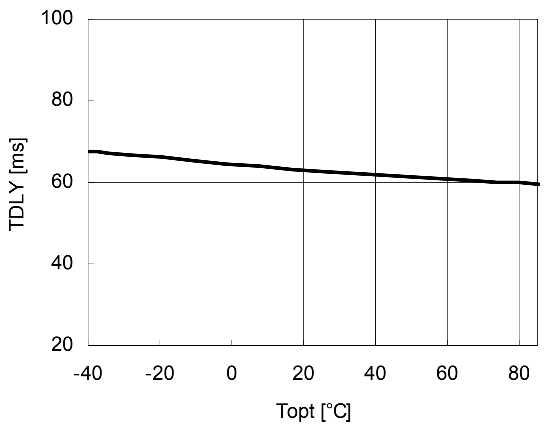
17) CH2 Soft-start Time vs. Temperature

R1283x00xx



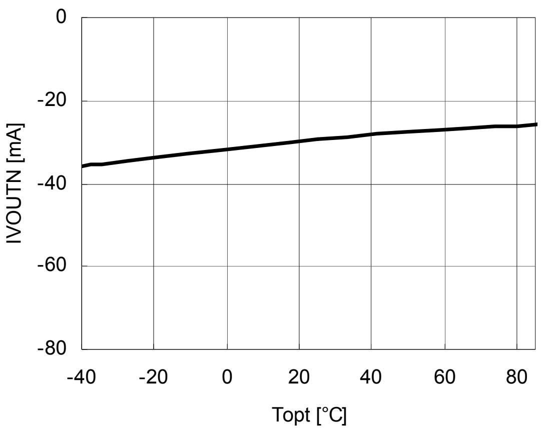
18) Timer Latch Delay Time vs. Temperature

R1283x00xx

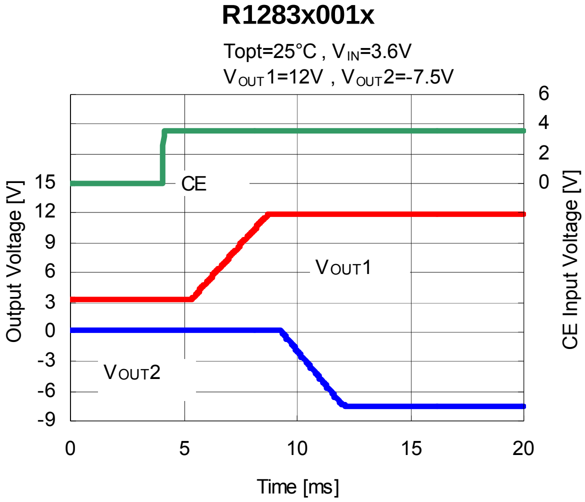


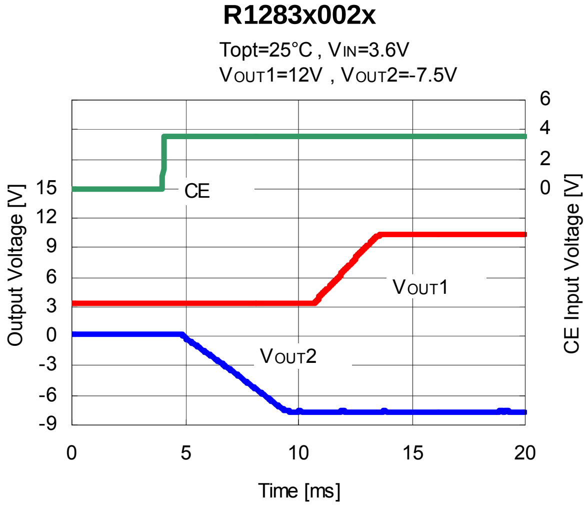
19) VOUTN Discharge Current vs. Temperature

R1283x00xx

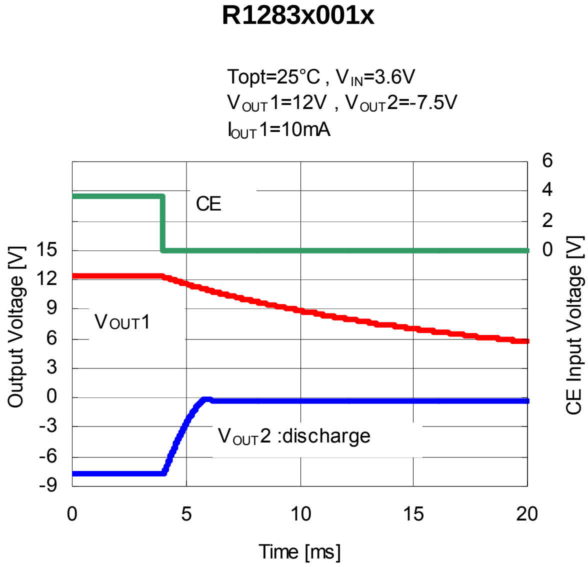


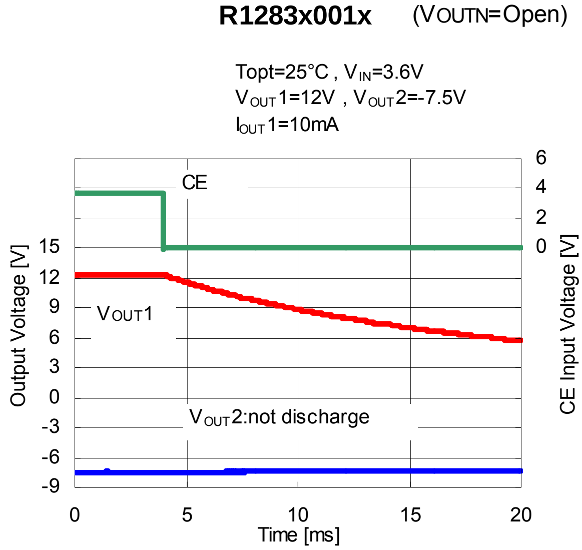
20) Startup Response

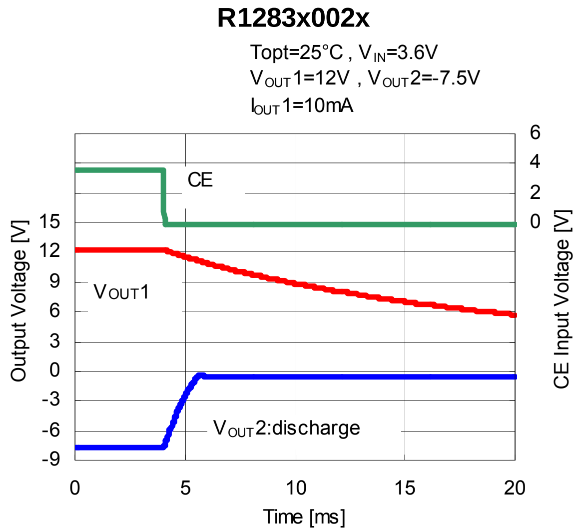


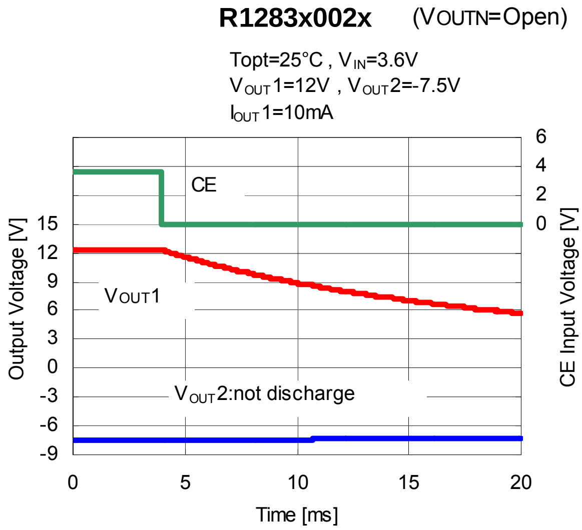


21)Shut down Response



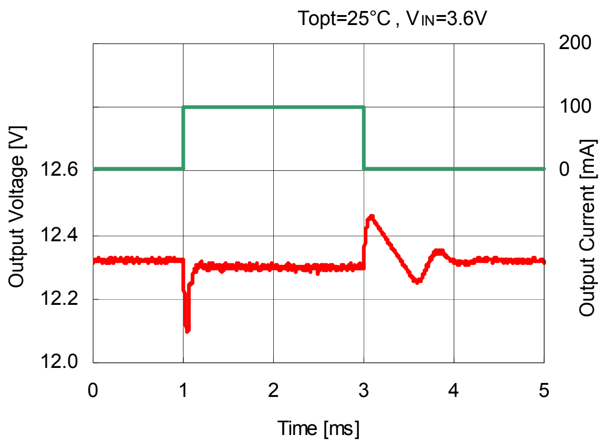




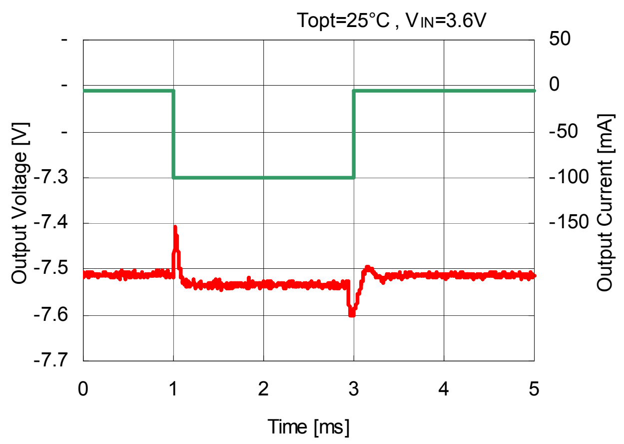


22) Load Transient Response

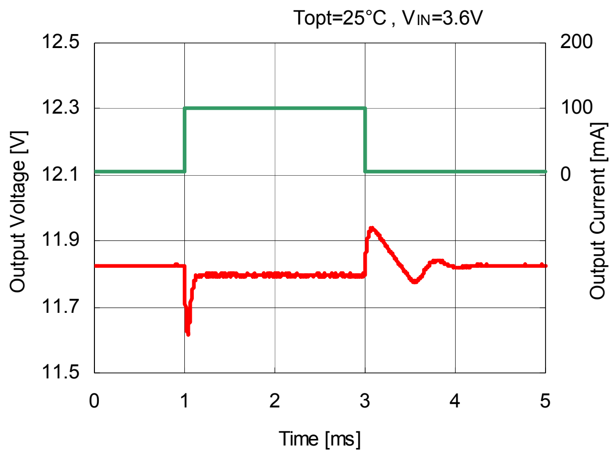
R1283x00xA



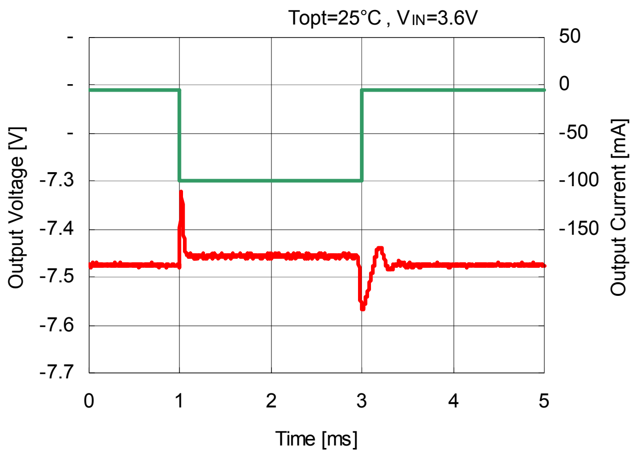
R1283x00xA



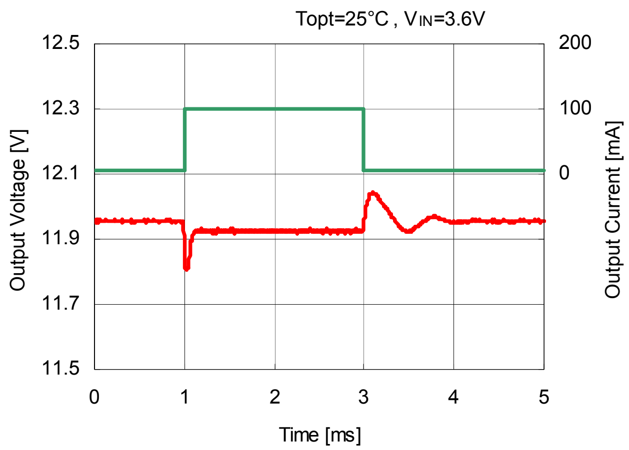
R1283x00xB



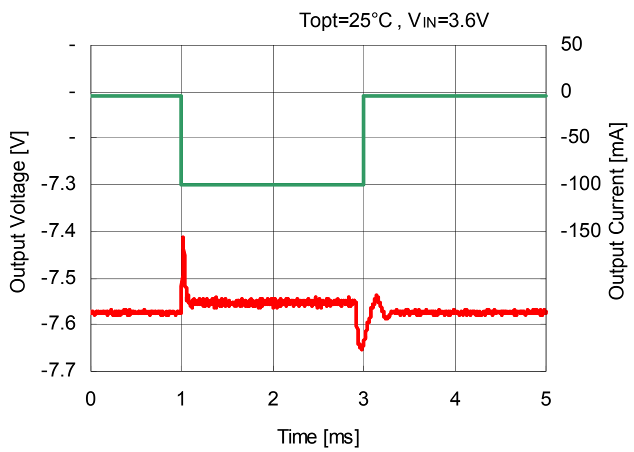
R1283x00xB



R1283x00xC

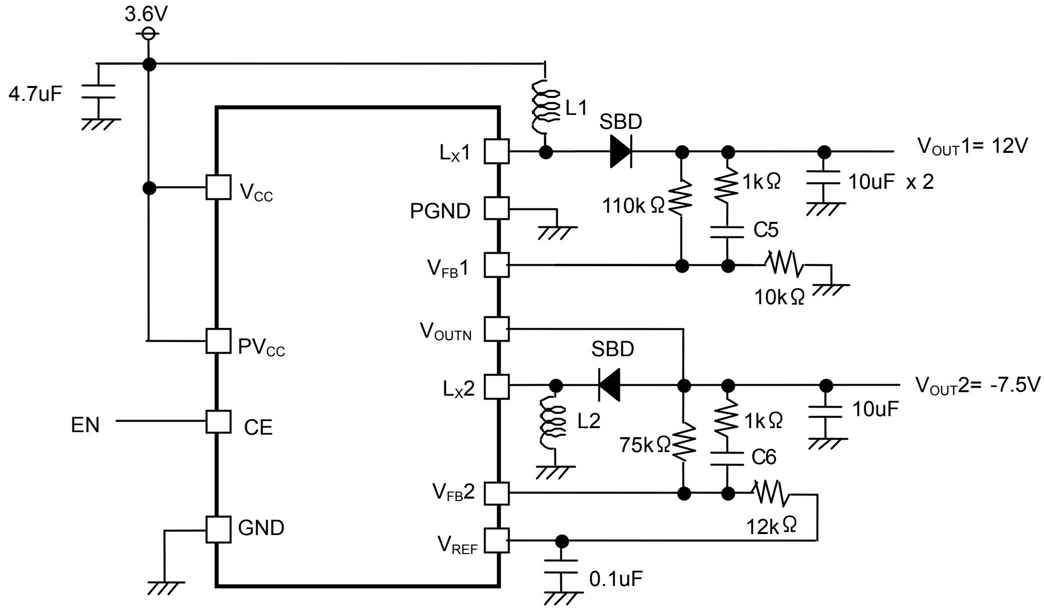


R1283x00xC



APPLIED CIRCUIT

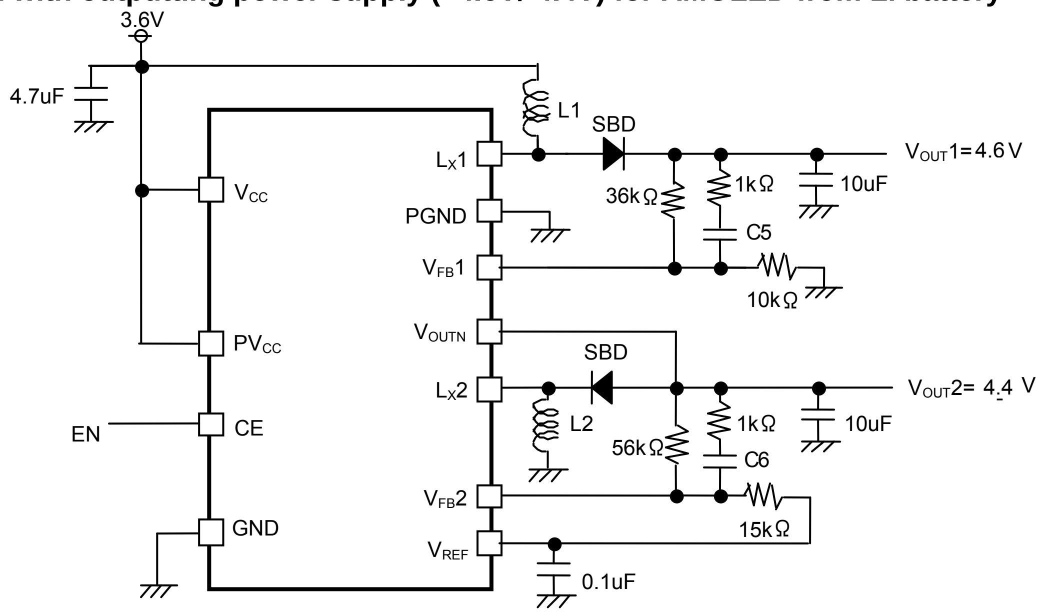
1) Application with outputting power supply (+12V/-7.5V) for CCD from Li battery



	L1	L2	C5	C6
R1283x00xA	15µH	10µH	220pF	220pF
R1283x00xB	6.8µH	6.8µH	150pF	150pF
R1283x00xC	4.7µH	4.7µH	120pF	120pF

Inductor	VLF3010 (TDK)
SBD	CRS10I30A (TOSHIBA)

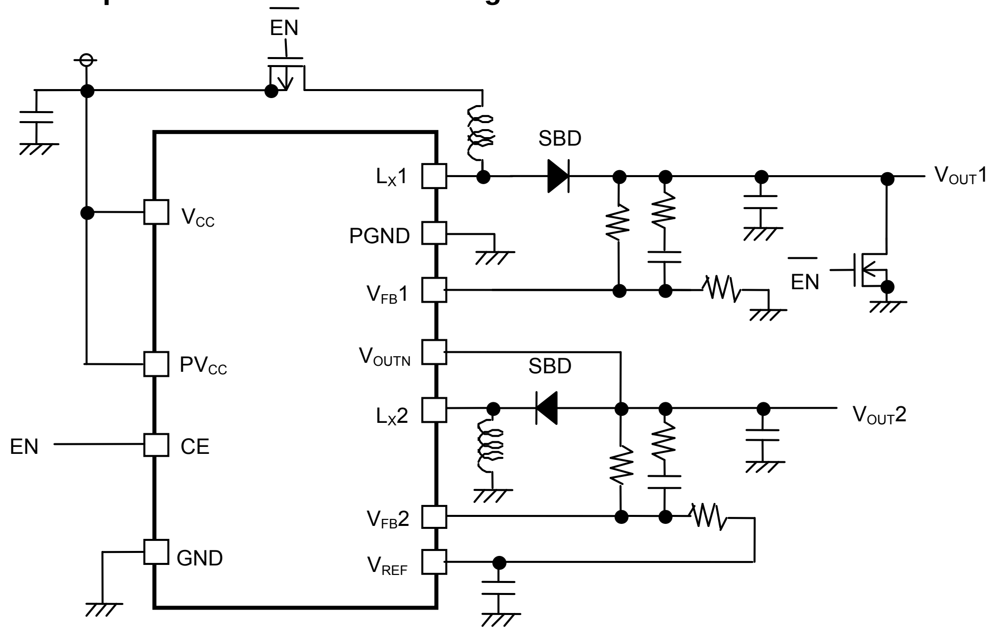
2) Application with outputting power supply (+4.6V/-4.4V) for AMOLED from Li battery



	L1	L2	C5	C6
R1283x00xA	15µH	10µH	100pF	100pF
R1283x00xB	4.7µH	4.7µH	47pF	33pF
R1283x00xC	4.7µH	4.7µH	68pF	47pF

Inductor	VLF3010 (TDK)
SBD	CRS10I30A (TOSHIBA)

3) Application with output disconnect and discharge.



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