Step-up DC/DC Controller

R1211X Series

■ OUTLINE

The R1211X Series are PWM step-up DC/DC converter controllers with low supply current by CMOS process.

Each of the R1211X Series consists of an oscillator, a PWM control circuit, a reference voltage unit, an error amplifier, a reference current unit, a protection circuit, and an under voltage lockout circuit. A low ripple, high efficiency step-up DC/DC converter can be composed of this IC with some external components, or an inductor, a diode, a power MOSFET, divider resisters, and capacitors.

Phase compensation has been made internally in the R1211XB Series, while phase compensation can be made externally as for R1211XA Series. B version has stand-by mode. Max duty cycle is internally fixed typically at 90%. Soft start function is built-in, and Soft-starting time is set typically at 9ms(700kHz version) or 10.5ms(300kHz version). As for the protection circuit, after the soft-starting time, if the maximum duty cycle is continued for a certain time, the R1211X Series latch the external driver with its off state, or Latch-type protection circuit. The delay time for latch the state can be set with an external capacitor.

To release the protection circuit, restart with power-on (Voltage supplier is equal or less than UVLO detector threshold level), or once after making the circuit be stand-by with chip enable pin and enable the circuit again.

■ FEATURES

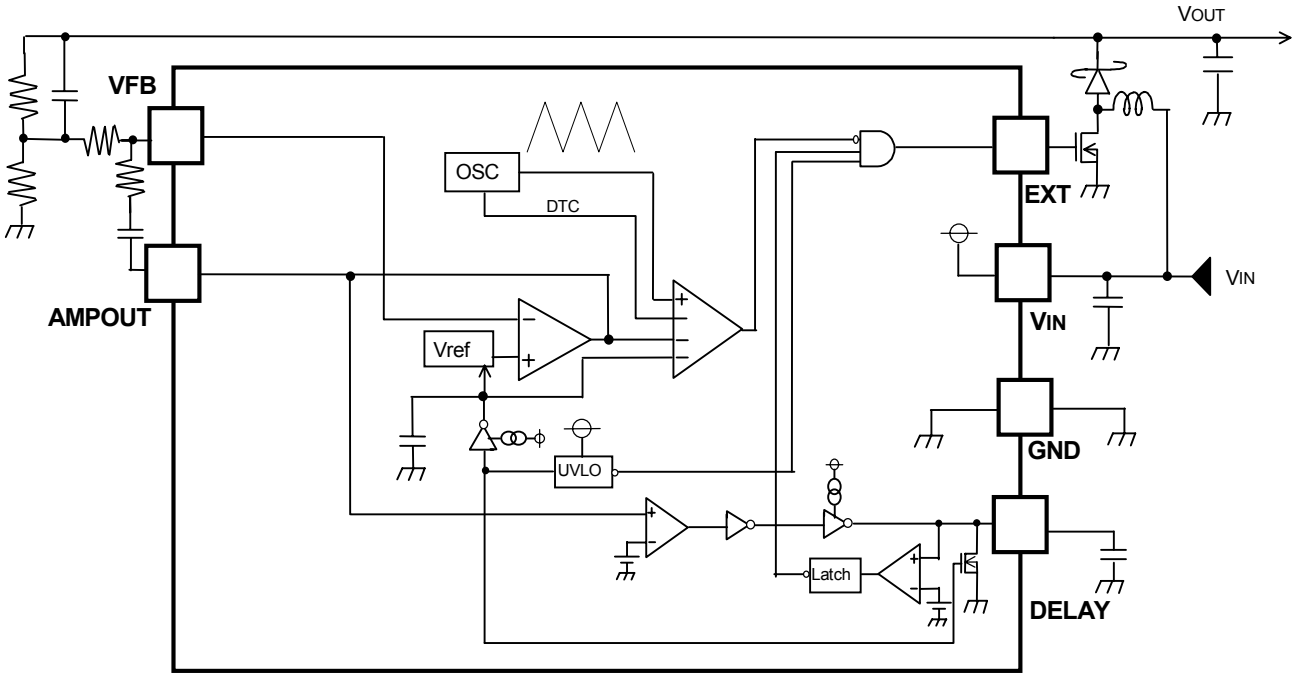
- Standby Current • • • • • • • • • • • • • • • • • • TYP. 0μA (for B version)
- Input Voltage Range • • • • • • • • • • • • • • • • 2.5V to 6.0V
- Built-in Latch-type Protection Function (Output Delay Time can be set with an external capacitor)
- Two choices of Basic Oscillator Frequency • • 300kHz, 700kHz
- Max Duty Cycle • • • • • • • • • • • • • • • • • • • TYP. 90%
- High Reference Voltage Accuracy • • • • • • • ±1.5%
- U.V.L.O. Threshold level • • • • • • • • • • • • • • TYP. 2.2V (Hysteresis TYP. 0.13V)
- Small Package • • • • • SOT-23-6W or thin (package thickness MAX. 0.85mm) SON-6 (Under Development)

■ APPLICATIONS

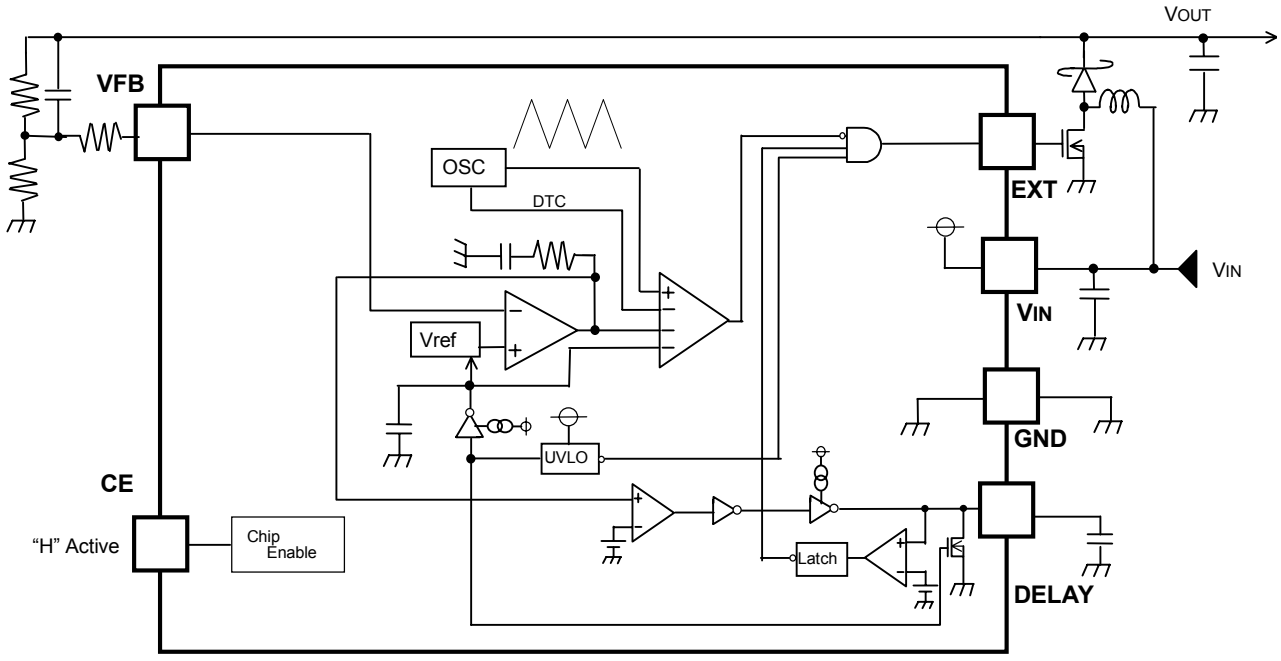
- Constant Voltage Power Source for portable equipment.
- Constant Voltage Power Source for LCD and CCD.

■ BLOCK DIAGRAM

Version A



Version B



■ SELECTION GUIDE

In the R1211X Series, the oscillator frequency, the optional function, and the package 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;

R1211X002X-TR

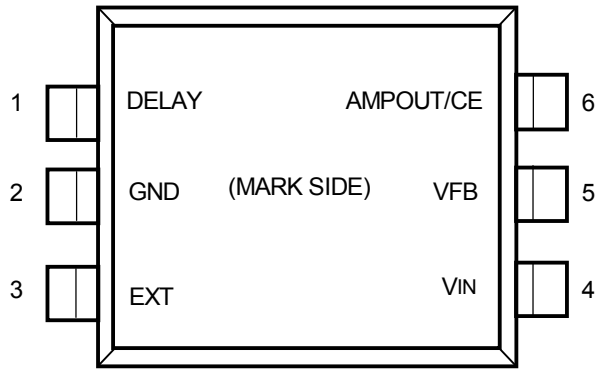
↑ ↑

a b

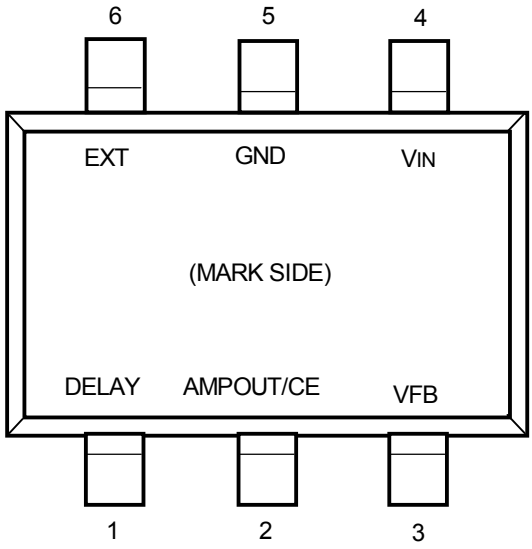
Code	Contents
a	Designation of Package Type: D: SON-6 N: SOT23-6W
b	Designation of Optional Function A : 700kHz, with AMPOUT pin B : 700 kHz, with CE pin C : 300kHz, with AMPOUT pin D : 300kHz, with CE pin

■ PIN CONFIGURATION

SON-6



SOT-23-6W



■ PIN DESCRIPTION

Pin No.		Symbol	Description
SON6	SOT23-6W		
1	1	DELAY	Pin for External Capacitor (for Setting Output Delay of Protection)
2	5	GND	Ground Pin
3	6	EXT	External FET Drive Pin (CMOS Output)
4	4	V_{IN}	Power Supply Pin
5	3	V_{FB}	Feedback Pin for monitoring Output Voltage
6	2	AMPOUT or CE	Amp Output Pin(A/C Version) or Chip Enable Pin(B/D Version)

■ ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	V_{IN} Pin Voltage	6.5	V
V_{EXT}	EXT Pin Output Voltage	-0.3~V_{IN}+0.3	V
V_{DLY}	DELAY Pin Voltage	-0.3~V_{IN}+0.3	V
V_{AMP}	AMPOUT Pin Voltage	-0.3~V_{IN}+0.3	V
V_{CE}	CE Pin Input Voltage	-0.3~V_{IN}+0.3	V
V_{FB}	VFB Pin Voltage	-0.3~V_{IN}+0.3	V
I_{AMP}	AMPOUT Pin Current	±10	mA
I_{EXT}	EXT Pin Inductor Drive Output Current	±50	mA
P_D	Power Dissipation	250	mW
Topt	Operating Temperature Range	-40~+85	°C
Tstg	Storage Temperature Range	-55~+125	°C

■ ELECTRICAL CHARACTERISTICS

●R1211X002A (Topt=25°C)

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V_{IN}	Operating Input Voltage		2.5		6.0	V
V_{FB}	V_{FB} Voltage Tolerance	V_{IN}=3.3V	0.985	1.000	1.015	V
$\Delta V_{FB}/\Delta T$	V_{FB} Voltage Temperature Coefficient	-40°C≤ Topt ≤ 85°C		±150		ppm/°C
I_{FB}	V_{FB} Input Current	V_{IN}=6V, V_{FB}=0V or 6V	-0.1		0.1	μA
f_{OSC}	Oscillator Frequency	V_{IN}=3.3V, V_{DLY}=V_{FB}=0V	595	700	805	kHz
$\Delta f_{OSC}/\Delta T$	Oscillator Frequency Temperature Coefficient	-40°C≤ Topt ≤ 85°C		±1.4		kHz/°C
I_{DD1}	Supply Current 1	V_{IN}=6V, V_{DLY}=V_{FB}=0V, EXT at no load		600	900	μA
maxdty	Maximum Duty Cycle	V_{IN}=3.3V, EXT “H” side	82	90	94	%
R_{EXTH}	EXT “H” ON Resistance	V_{IN}=3.3V, I_{EXT}=-20mA		5	10	Ω
R_{EXTL}	EXT “L” ON Resistance	V_{IN}=3.3V, I_{EXT}=20mA		3	6	Ω
I_{DLY1}	Delay Pin Charge Current	V_{IN}=3.3V, V_{DLY}=V_{FB}=0V	2.5	5.0	7.5	μA
I_{DLY2}	Delay Pin Discharge Current	V_{IN}=V_{FB}=2.5V, V_{DLY}=0.1V	2.5	5.5	9.0	mA
V_{DLY}	Delay Pin Detector Threshold	V_{IN}=3.3V, V_{FB}=0V, V_{DLY}=0V→2V	0.95	1.00	1.05	V
T_{START}	Soft-start Time	V_{IN}=3.3V at 90% of rising edge	4.5	9.0	13.5	ms
V_{UVLO1}	UVLO Detector Threshold	V_{IN}=3.3V→0V, V_{DLY}=V_{FB}=0V	2.1	2.2	2.3	V
V_{UVLO2}	UVLO Detector Hysteresis	V_{IN}=0V→3.3V, V_{DLY}=V_{FB}=0V	0.08	0.13	0.18	V
I_{AMP1}	AMP “H” Output Current	V_{IN}=3.3V, V_{AMP}=1V, V_{FB}=0.9V	0.45	0.90	1.50	mA
I_{AMP2}	AMP “L” Output Current	V_{IN}=3.3V, V_{AMP}=1V, V_{FB}=1.1V	30	60	90	μA

●R1211X002B

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V_{IN}	Operating Input Voltage		2.5		6.0	V
V_{FB}	V_{FB} Voltage Tolerance	V_{IN}=3.3V	0.985	1.000	1.015	V
$\Delta V_{FB}/\Delta T$	V_{FB} Voltage Temperature Coefficient	-40°C≤ Topt ≤ 85°C		±150		ppm/°C
I_{FB}	V_{FB} Input Current	V_{IN}=6V, V_{FB}=0V or 6V	-0.1		0.1	μA
f_{OSC}	Oscillator Frequency	V_{IN}=3.3V, V_{DLY}=V_{FB}=0V	595	700	805	kHz
$\Delta f_{OSC}/\Delta T$	Oscillator Frequency Temperature Coefficient	-40°C≤ Topt ≤ 85°C		±1.4		kHz/°C
I_{DD1}	Supply Current 1	V_{IN}=6V, V_{DLY}=V_{FB}=0V, EXT at no load		600	900	μA
maxdty	Maximum Duty Cycle	V_{IN}=3.3V, EXT “H” side	84	90	94	%
R_{EXTH}	EXT “H” ON Resistance	V_{IN}=3.3V, I_{EXT}=-20mA		5	10	Ω
R_{EXTL}	EXT “L” ON Resistance	V_{IN}=3.3V, I_{EXT}=20mA		3	6	Ω
I_{DLY1}	Delay Pin Charge Current	V_{IN}=3.3V, V_{DLY}=V_{FB}=0V	2.5	5.0	7.5	μA
I_{DLY2}	Delay Pin Discharge Current	V_{IN}=V_{FB}=2.5V, V_{DLY}=0.1V	2.5	5.5	9.0	mA
V_{DLY}	Delay Pin Detector Threshold	V_{IN}=3.3V, V_{FB}=0V, V_{DLY}=0V→2V	0.95	1.00	1.05	V
T_{START}	Soft-start Time	V_{IN}=3.3V	4.5	9.0	13.5	ms
V_{UVLO1}	UVLO Detector Threshold	V_{IN}=3.3V→0V, V_{DLY}=V_{FB}=0V	2.1	2.2	2.3	V
V_{UVLO2}	UVLO Detector Hysteresis	V_{IN}=0V→3.3V, V_{DLY}=V_{FB}=0V	0.08	0.13	0.18	V
I_{STB}	Standby Current	V_{IN}=6V, V_{CE}=0V		0	1	μA
I_{CEH}	CE “H” Input Current	V_{IN}=6V, V_{CE}=6V	-0.5		0.5	μA
I_{CEL}	CE “L” Input Current	V_{IN}=6V, V_{CE}=0V	-0.5		0.5	μA
V_{CEH}	CE “H” Input Voltage	V_{IN}=6V, V_{CE}=0V→6V	1.5			V
V_{CEL}	CE “L” Input Voltage	V_{IN}=2.5V, V_{CE}=2V→0V			0.3	V

●R1211X002C (Topt=25°C)

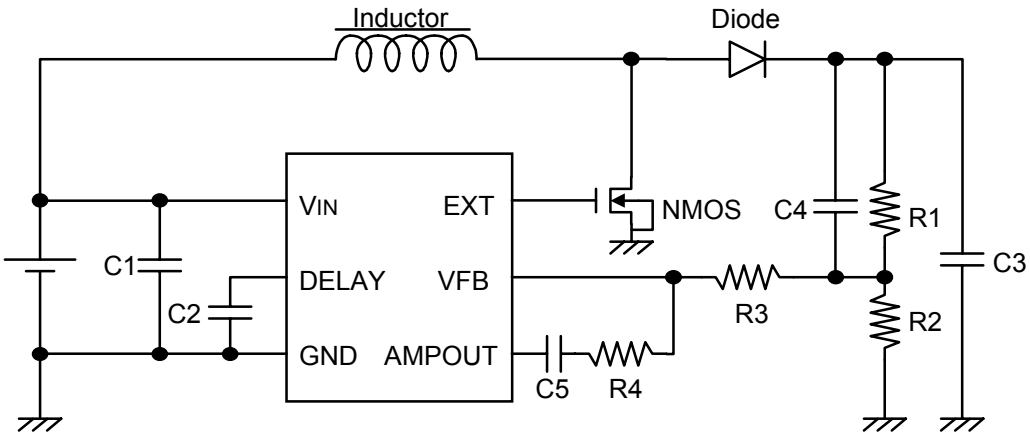
Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V_{IN}	Operating Input Voltage		2.5		6.0	V
V_{FB}	V_{FB} Voltage Tolerance	V_{IN}=3.3V	0.985	1.000	1.015	V
$\Delta V_{FB}/\Delta T$	V_{FB} Voltage Temperature Coefficient	-40°C≤ Topt ≤ 85°C		±150		ppm/°C
I_{FB}	V_{FB} Input Current	V_{IN}=6V, V_{FB}=0V or 6V	-0.1		0.1	μA
f_{OSC}	Oscillator Frequency	V_{IN}=3.3V, V_{DLY}=V_{FB}=0V	240	300	360	kHz
$\Delta f_{OSC}/\Delta T$	Oscillator Frequency Temperature Coefficient	-40°C≤ Topt ≤ 85°C		±0.6		kHz/°C
I_{DD1}	Supply Current 1	V_{IN}=6V, V_{DLY}=V_{FB}=0V, EXT at no load		300	500	μA
maxdty	Maximum Duty Cycle	V_{IN}=3.3V, EXT “H” side	84	90	94	%
R_{EXTH}	EXT “H” ON Resistance	V_{IN}=3.3V, I_{EXT}=-20mA		5	10	Ω
R_{EXTL}	EXT “L” ON Resistance	V_{IN}=3.3V, I_{EXT}=20mA		3	6	Ω
I_{DLY1}	Delay Pin Charge Current	V_{IN}=3.3V, V_{DLY}=V_{FB}=0V	2.0	4.5	7.0	μA
I_{DLY2}	Delay Pin Discharge Current	V_{IN}=V_{FB}=2.5V, V_{DLY}=0.1V	2.5	5.5	9.0	mA
V_{DLY}	Delay Pin Detector Threshold	V_{IN}=3.3V, V_{FB}=0V, V_{DLY}=0V→2V	0.95	1.00	1.05	V
T_{START}	Soft-start Time	V_{IN}=3.3V	5.0	10.5	16.0	ms
V_{UVLO1}	UVLO Detector Threshold	V_{IN}=3.3V→0V, V_{DLY}=V_{FB}=0V	2.1	2.2	2.3	V
V_{UVLO2}	UVLO Detector Hysteresis	V_{IN}=0V→3.3V, V_{DLY}=V_{FB}=0V	0.08	0.13	0.18	V
I_{AMP1}	AMP “H” Output Current	V_{IN}=3.3V, V_{AMP}=1V, V_{FB}=0.9V	0.45	0.90	1.50	mA
I_{AMP2}	AMP “L” Output Current	V_{IN}=3.3V, V_{AMP}=1V, V_{FB}=1.1V	25	50	75	μA

●R1211X002D

Symbol	Item	Conditions	MIN.	TYP.	MAX.	Unit
V_{IN}	Operating Input Voltage		2.5		6.0	V
V_{FB}	V_{FB} Voltage Tolerance	V_{IN}=3.3V	0.985	1.000	1.015	V
$\Delta V_{FB}/\Delta T$	V_{FB} Voltage Temperature Coefficient	-40°C≤ Topt ≤ 85°C		±150		ppm/°C
I_{FB}	V_{FB} Input Current	V_{IN}=6V, V_{FB}=0V or 6V	-0.1		0.1	μA
f_{OSC}	Oscillator Frequency	V_{IN}=3.3V, V_{DLY}=V_{FB}=0V	240	300	360	kHz
$\Delta f_{OSC}/\Delta T$	Oscillator Frequency Temperature Coefficient	-40°C≤ Topt ≤ 85°C		±0.6		kHz/°C
I_{DD1}	Supply Current 1	V_{IN}=6V, V_{DLY}=V_{FB}=0V, EXT at no load		300	500	μA
maxdty	Maximum Duty Cycle	V_{IN}=3.3V, EXT “H” side	84	90	94	%
R_{EXTH}	EXT “H” ON Resistance	V_{IN}=3.3V, I_{EXT}=-20mA		5	10	Ω
R_{EXTL}	EXT “L” ON Resistance	V_{IN}=3.3V, I_{EXT}=20mA		3	6	Ω
I_{DLY1}	Delay Pin Charge Current	V_{IN}=3.3V, V_{DLY}=V_{FB}=0V	2.0	4.5	7.0	μA
I_{DLY2}	Delay Pin Discharge Current	V_{IN}=V_{FB}=2.5V, V_{DLY}=0.1V	2.5	5.5	9.0	mA
V_{DLY}	Delay Pin Detector Threshold	V_{IN}=3.3V, V_{FB}=0V, V_{DLY}=0V→2V	0.95	1.00	1.05	V
T_{START}	Soft-start Time	V_{IN}=3.3V	5.0	10.5	16.0	ms
V_{UVLO1}	UVLO Detector Threshold	V_{IN}=3.3V→0V, V_{DLY}=V_{FB}=0V	2.1	2.2	2.3	V
V_{UVLO2}	UVLO Detector Hysteresis	V_{IN}=0V→3.3V, V_{DLY}=V_{FB}=0V	0.08	0.13	0.18	V
I_{STB}	Standby Current	V_{IN}=6V, V_{CE}=0V		0	1	μA
I_{CEH}	CE “H” Input Current	V_{IN}=6V, V_{CE}=6V	-0.5		0.5	μA
I_{CEL}	CE “L” Input Current	V_{IN}=6V, V_{CE}=0V	-0.5		0.5	μA
V_{CEH}	CE “H” Input Voltage	V_{IN}=6V, V_{CE}=0V→6V	1.5			V
V_{CEL}	CE “L” Input Voltage	V_{IN}=2.5V, V_{CE}=2V→0V			0.3	V

■ TYPICAL APPLICATION AND TECHNICAL NOTES

<A/C Version>

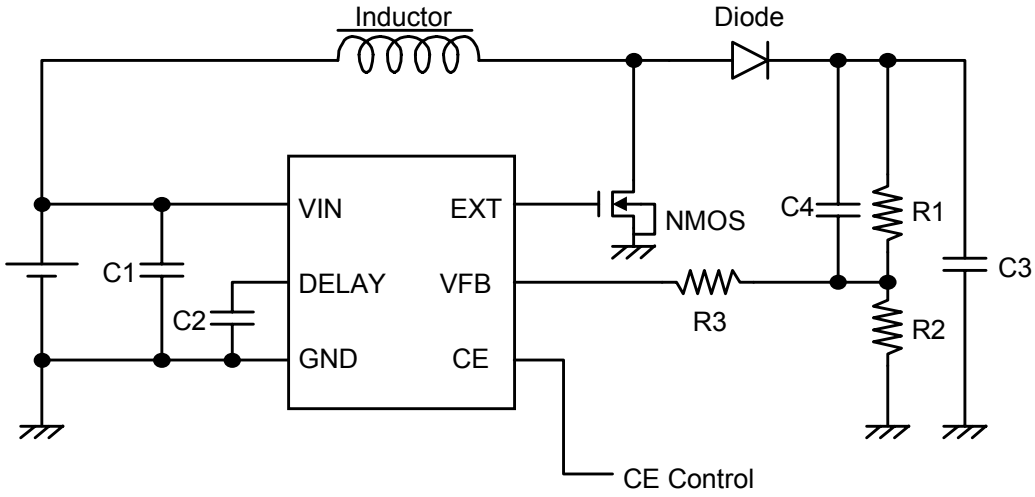


NMOS: IRF7601 (International Rectifier)
Inductor:10 μH (TDK, LDR Series)
Diode: CRS02 (Toshiba)

C1: 4.7μF(Ceramic)
C2: 0.22μF(Ceramic)
C3: 22μF(Tantalum)
C4: 680pF(Ceramic)
C5: 2200pF(Ceramic)

R1: Output Voltage Setting Resistor 1
R2: Output Voltage Setting Resistor 2
R3: 30kΩ
R4: 30kΩ

<B/D Version>



NMOS: IRF7601 (International Rectifier)
Inductor: 10μH (TDK, LDR Series)
Diode: CRS02 (Toshiba)

C1: 4.7μF (Ceramic)
C2: 0.22μF (Ceramic)
C3: 22μF (Tantalum)
C4: 680pF(Ceramic)

R1 : Setting Output Voltage Resistor1
R2 : Setting Output Voltage Resistor2
R3 : 30kΩ

When you use these ICs, consider the following issues;

● Use a 1μF or more capacitance value of bypass capacitor between VIN pin and GND, C1 as shown in the typical applications above.

● In terms of the capacitor for setting delay time of the latch protection, C2 as shown in typical applications of the previous page, connect between Delay pin and GND pin of the IC with the minimum wiring distance.

● Connect a 1μF or more value of capacitor between V_{OUT} and GND, C3 as shown in typical applications of the previous page. (Recommended value is from 10μF to 22μF.)

● Connect a capacitor between V_{OUT} and the dividing point, C4 as shown in typical applications of the previous page. The capacitance value of C4 depends on divider resistors for output voltage setting. Typical value is between 100pF and 1000pF.

● Output Voltage can be set with divider resistors for voltage setting, R1 and R2 as shown in typical applications of the previous page. Refer to the next formula.

Output Voltage = $V_{FB} \times (R1+R2)/R2$

R1+R2=100kΩ is recommended range of resistance.

● We recommend adding a resistor with resistance value from 20kΩ to 100kΩ between divider point of voltage setting and V_{FB} pin, R3 as shown in typical applications of the previous page. If R3 is not connected as shown, the noise of V_{OUT} could be transmitted to V_{FB} input and accuracy of output voltage could be worse.

● The operation of Latch protection circuit is as follows: When the IC detects maximum duty cycle, charge to an external capacitor, C2 of DELAY pin starts. And maximum duty cycle continues and the voltage of DELAY pin reaches delay voltage detector threshold, V_{DLY}, outputs "L" to EXT pin and turns off the external power MOSFET.

To release the latch protection operation, make the IC be standby mode with CE pin and make it active in terms of B/D version. Otherwise, restart with power on.

The delay time of latch protection can be calculated with C2, V_{DLY}, and Delay Pin Charge Current, I_{DLY1}, as in the next formula.

$t=C2 \times V_{DLY}/I_{DLY1}$

Once after the maximum duty is detected and released before delay time, charge to the capacitor is halt and delay pin outputs "L".

● As for A/C version, connect a capacitor between AMPOUT pin and V_{FB} pin and a resistor for phase compensation, C5 and R4 as shown in typical applications of the previous page. The resistance value of R4 is as same as R3. The recommended capacitance value of C5 is between 1nF and 10nF.

Recommended value of R3 is from 20kΩ to 100kΩ.

● As for B/D version, EXT pin outputs GND level at standby mode.

● Select the Power MOSFET, the diode, and the inductor within ratings (Voltage, Current, Power) of this IC. Choose the power MOSFET with low threshold voltage depending on Input Voltage. Choose the diode with low V_F such as Shottky type, and with low I_R.