OUTLINE

The R1282D002A is a CMOS-based 2-channel PWM Step-up (as Channel 1)/Step-down (as Channel 2) DC/DC converter controller.

The R1282D002A 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 (UVLO) circuit. A high efficiency Step-up/Step-down DC/DC converter can be composed of this IC with inductors, diodes, power MOSFETs, resistors, and capacitors. Each output voltage and maximum duty cycle can be adjustable with external resistors, while soft-start time can be adjustable with external capacitors and resistors.

As for a protection circuit, if Maximum duty cycle of either Step-up DC/DC converter side or Step-down DC/DC converter side is continued for a certain time, the R1280D002A latches both external drivers with their off state by its Latch-type protection circuit. Delay time for protection is internally fixed typically at 100ms. To release the protection circuit, restart with power-on (Voltage supplier is equal or less than UVLO detector threshold level).

FEATURES

- Input Voltage Range ......................... 2.5V to 5.5V
- Built-in Latch-type Protection Function by monitoring duty cycle (Fixed Delay Time Typ. 100ms)
- Oscillator Frequency ....................... 700kHz
- High Accuracy Voltage Reference ............ ±1.5%
- U.V.L.O. Threshold .......................... Typ. 2.2V (Hysteresis: Typ. 0.2V)
- Small Package ...................................... thin SON-10 (package thickness Max. 0.9mm)

APPLICATIONS

- Constant Voltage Power Source for Portable Equipment.
- Constant Voltage Power Source for LCD and CCD.
**BLOCK DIAGRAM**

![Block Diagram of R1282D002A]

**SELECTION GUIDE**

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

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Package</th>
<th>Quantity per Reel</th>
<th>Pb Free</th>
<th>Halogen Free</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1282D002x-TR-FE</td>
<td>SON-10</td>
<td>3,000 pcs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

x: Designation of Mask Option
A version: fosc=700kHz, with External Phase Compensation for Channel 1
PIN CONFIGURATION

![PIN CONFIGURATION Diagram](image)

PIN DESCRIPTION

<table>
<thead>
<tr>
<th>Pin No</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EXT1</td>
<td>External Transistor of Channel 1 Drive Pin (CMOS Output)</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground Pin</td>
</tr>
<tr>
<td>3</td>
<td>AMPOUT1</td>
<td>Amplifier Output Pin of Channel 1</td>
</tr>
<tr>
<td>4</td>
<td>DTC1</td>
<td>Maximum Duty Cycle of Channel 1 Setting Pin</td>
</tr>
<tr>
<td>5</td>
<td>VFB1</td>
<td>Feedback pin of Channel 1</td>
</tr>
<tr>
<td>6</td>
<td>VFB2</td>
<td>Feedback pin of Channel 2</td>
</tr>
<tr>
<td>7</td>
<td>DTC2</td>
<td>Maximum Duty Cycle of Channel 2 Setting Pin</td>
</tr>
<tr>
<td>8</td>
<td>Vrefout</td>
<td>Reference Output Pin</td>
</tr>
<tr>
<td>9</td>
<td>VIN</td>
<td>Voltage Supply Pin of the IC</td>
</tr>
<tr>
<td>10</td>
<td>EXT2</td>
<td>External Transistor of Channel 2 Drive Pin (CMOS Output)</td>
</tr>
</tbody>
</table>

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIN</td>
<td>VIN Pin Voltage</td>
<td>6.5</td>
<td>V</td>
</tr>
<tr>
<td>VEXT1,2</td>
<td>VEXT1,2 Pin Output Voltage</td>
<td>−0.3~VIN+0.3</td>
<td>V</td>
</tr>
<tr>
<td>VAMPOUT1</td>
<td>AMPOUT1 Pin Voltage</td>
<td>−0.3~VIN+0.3</td>
<td>V</td>
</tr>
<tr>
<td>VDTC1,2</td>
<td>DTC1,2 Pin Voltage</td>
<td>−0.3~VIN+0.3</td>
<td>V</td>
</tr>
<tr>
<td>Vrefout</td>
<td>VREFOUT Pin Voltage</td>
<td>−0.3~VIN+0.3</td>
<td>V</td>
</tr>
<tr>
<td>VFB1,2</td>
<td>VFB1, VFB2 Pin Voltage</td>
<td>−0.3~VIN+0.3</td>
<td>V</td>
</tr>
<tr>
<td>IEXT1,2</td>
<td>EXT1,2 Pin Output Current</td>
<td>±50</td>
<td>mA</td>
</tr>
<tr>
<td>P0</td>
<td>Power Dissipation</td>
<td>250</td>
<td>mW</td>
</tr>
<tr>
<td>Topt</td>
<td>Operating Temperature Range</td>
<td>−40 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>Tstg</td>
<td>Storage Temperature Range</td>
<td>−55 to +125</td>
<td>°C</td>
</tr>
</tbody>
</table>
# ELECTRICAL CHARACTERISTICS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>Operating Input Voltage</td>
<td>$V_{IN}=3.3V$, $I_{OUT}=1mA$</td>
<td>2.5</td>
<td>5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{REFOUT}$</td>
<td>$V_{REFOUT}$ Voltage Tolerance</td>
<td>$V_{IN}=3.3V$, $I_{OUT}=1mA$</td>
<td>1.478</td>
<td>1.500</td>
<td>1.522</td>
<td>V</td>
</tr>
<tr>
<td>$I_{OUT}$</td>
<td>$V_{REFOUT}$ Output Current</td>
<td>$V_{IN}=3.3V$</td>
<td>20</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>$\Delta V_{REFOUT}/\Delta V_{IN}$</td>
<td>$V_{REFOUT}$ Line Regulation</td>
<td>$2.5V \leq V_{IN} \leq 5.5V$</td>
<td>2</td>
<td>6</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>$\Delta V_{REFOUT}/\Delta I_{OUT}$</td>
<td>$V_{REFOUT}$ Load Regulation</td>
<td>$1mA \leq I_{OUT} \leq 10mA$</td>
<td>6</td>
<td>12</td>
<td>mV</td>
<td></td>
</tr>
<tr>
<td>$I_{LIM}$</td>
<td>$V_{REFOUT}$ Short Current Limit</td>
<td>$V_{IN}=3.3V$, $V_{REFOUT}=0V$</td>
<td>25</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>$\Delta V_{REFOUT}/\Delta T$</td>
<td>$V_{REFOUT}$ Voltage Temperature Coefficient</td>
<td>$-40^\circ C \leq Topt \leq 85^\circ C$</td>
<td>±150</td>
<td></td>
<td>ppm/°C</td>
<td></td>
</tr>
<tr>
<td>$V_{FB1}$</td>
<td>$V_{FB1}$ Voltage</td>
<td>$V_{IN}=3.3V$</td>
<td>0.985</td>
<td>1.000</td>
<td>1.015</td>
<td>V</td>
</tr>
<tr>
<td>$\Delta V_{FB1}/\Delta T$</td>
<td>$V_{FB1}$ Voltage Temperature Coefficient</td>
<td>$-40^\circ C \leq Topt \leq 85^\circ C$</td>
<td>±150</td>
<td></td>
<td>ppm/°C</td>
<td></td>
</tr>
<tr>
<td>$\Delta V_{FB2}/\Delta T$</td>
<td>$V_{FB2}$ Voltage Temperature Coefficient</td>
<td>$-40^\circ C \leq Topt \leq 85^\circ C$</td>
<td>±150</td>
<td></td>
<td>ppm/°C</td>
<td></td>
</tr>
<tr>
<td>$I_{FB1,2}$</td>
<td>$V_{FB1,2}$ Input Current</td>
<td>$V_{IN}=5.5V$, $V_{FB1}$ or $V_{FB2}=0V$ or $5.5V$</td>
<td>-0.1</td>
<td>0.1</td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>$f_{OSC}$</td>
<td>Oscillator Frequency</td>
<td>EXT1,2 Pins at no load, $V_{IN}=3.3V$</td>
<td>595</td>
<td>700</td>
<td>805</td>
<td>kHz</td>
</tr>
<tr>
<td>$I_{OD1}$</td>
<td>Supply Current</td>
<td>EXT1,2 pins at no load</td>
<td>1.4</td>
<td>3.0</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>$R_{EXTH1}$</td>
<td>EXT1 &quot;H&quot; ON Resistance</td>
<td>$V_{IN}=3.3V$, $I_{EXT}=20mA$</td>
<td>4.0</td>
<td>8.0</td>
<td>Ω</td>
<td></td>
</tr>
<tr>
<td>$R_{EXTL1}$</td>
<td>EXT1 &quot;L&quot; ON Resistance</td>
<td>$V_{IN}=3.3V$, $I_{EXT}=20mA$</td>
<td>2.7</td>
<td>5.0</td>
<td>Ω</td>
<td></td>
</tr>
<tr>
<td>$R_{EXTH2}$</td>
<td>EXT2 &quot;H&quot; ON Resistance</td>
<td>$V_{IN}=3.3V$, $I_{EXT}=20mA$</td>
<td>4.0</td>
<td>8.0</td>
<td>Ω</td>
<td></td>
</tr>
<tr>
<td>$R_{EXTL2}$</td>
<td>EXT2 &quot;L&quot; ON Resistance</td>
<td>$V_{IN}=3.3V$, $I_{EXT}=20mA$</td>
<td>3.7</td>
<td>8.0</td>
<td>Ω</td>
<td></td>
</tr>
<tr>
<td>$T_{DL}$</td>
<td>Delay Time for Protection</td>
<td>$V_{IN}=3.3V$, $V_{FB1}=1.1V\rightarrow0V$</td>
<td>60</td>
<td>100</td>
<td>140</td>
<td>ms</td>
</tr>
<tr>
<td>$V_{UVLO}$</td>
<td>UVLO Detector Threshold</td>
<td>EXT1,2 Pins at no load, $V_{IN}=3.3V$</td>
<td>2.10</td>
<td>2.20</td>
<td>2.35</td>
<td>V</td>
</tr>
<tr>
<td>$V_{UVLO}$</td>
<td>UVLO Released Voltage</td>
<td>$V_{IN}=5.5V$, EXT1,2 pins at no load</td>
<td>2.48</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>$V_{DTC10}$</td>
<td>CH1 Duty=0%</td>
<td>$V_{IN}=3.3V$</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td>$V_{DTC1100}$</td>
<td>CH1 Duty=100%</td>
<td>$V_{IN}=3.3V$</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>V</td>
</tr>
<tr>
<td>$V_{DTC20}$</td>
<td>CH2 Duty=0%</td>
<td>$V_{IN}=3.3V$</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>V</td>
</tr>
<tr>
<td>$V_{DTC2100}$</td>
<td>CH2 Duty=100%</td>
<td>$V_{IN}=3.3V$</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>V</td>
</tr>
<tr>
<td>$A_{V1}$</td>
<td>CH1 Open Loop Gain</td>
<td>$V_{IN}=3.3V$</td>
<td>110</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$F_{11}$</td>
<td>CH1 Single Gain Frequency Band</td>
<td>$V_{IN}=3.3V$, $A_{V1}=0dB$</td>
<td>1.9</td>
<td></td>
<td></td>
<td>MHz</td>
</tr>
<tr>
<td>$V_{ICR1}$</td>
<td>CH1 Input Voltage Range</td>
<td>$V_{IN}=3.3V$</td>
<td>0.7</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$I_{AMP}$</td>
<td>CH1 Sink Current</td>
<td>$V_{IN}=3.3V$, $V_{AMPIN}=-1.0V$, $V_{FB1}=V_{FB1}+0.1V$</td>
<td>70</td>
<td>115</td>
<td></td>
<td>μA</td>
</tr>
<tr>
<td>$I_{AMPH}$</td>
<td>CH1 Source Current</td>
<td>$V_{IN}=3.3V$, $V_{AMPIN}=-1.0V$, $V_{FB1}=V_{FB1}+0.1V$</td>
<td>-1.4</td>
<td>-0.7</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>$A_{V2}$</td>
<td>CH2 Open Loop Gain</td>
<td>$V_{IN}=3.3V$</td>
<td>60</td>
<td></td>
<td></td>
<td>dB</td>
</tr>
<tr>
<td>$F_{21}$</td>
<td>CH2 Single Gain Frequency Band</td>
<td>$V_{IN}=3.3V$, $A_{V2}=0dB$</td>
<td>600</td>
<td></td>
<td></td>
<td>kHz</td>
</tr>
<tr>
<td>$V_{ICR2}$</td>
<td>CH2 Input Voltage Range</td>
<td>$V_{IN}=3.3V$</td>
<td>-0.2</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{FB2}$</td>
<td>CH2 Reference Voltage</td>
<td>$V_{IN}=3.3V$</td>
<td>0.985</td>
<td>1.000</td>
<td>1.015</td>
<td>V</td>
</tr>
</tbody>
</table>
Output Current and Selection of External Components

There are two modes, or discontinuous mode and continuous mode for the PWM step-up switching regulator depending on the continuous characteristic of inductor current.

During on time of the transistor, when the voltage added on to the inductor is described as $V_{IN}$, the current is $V_{IN} \times t/L$.

Therefore, the electric power, $P_{ON}$, which is supplied with input side, can be described as in next formula.

$$P_{ON} = \int_{0}^{Ton} V_{IN}^2 \times t/L \ dt \ ...................................................... \text{Formula 1}$$

With the step-up circuit, electric power is supplied from power source also during off time. In this case, input current is described as $(V_{OUT} - V_{IN}) \times t/L$, therefore electric power, $P_{OFF}$ is described as in next formula.

$$P_{OFF} = \int_{0}^{Tf} V_{IN} \times (V_{OUT} - V_{IN})t/L \ dt \ ...................................................... \text{Formula 2}$$

In this formula, $Tf$ means the time of which the energy saved in the inductance is being emitted. Thus average electric power, $P_{AV}$ is described as in the next formula.

$$P_{AV} = \frac{1}{(Ton + Toff)} \left( \int_{0}^{Ton} V_{IN}^2 \times t/L \ dt + \int_{0}^{Tf} V_{IN} \times (V_{OUT} - V_{IN})t/L \ dt \right) \ ......................... \text{Formula 3}$$
In PWM control, when \( T_f = T_{off} \) is true, the inductor current becomes continuous, then the operation of switching regulator becomes continuous mode.

In the continuous mode, the deviation of the current is equal between on time and off time.

\[
V_{IN} \times Ton/L = (V_{OUT} - V_{IN}) \times T_{off}/L \quad \text{Formula 4}
\]

Further, the electric power, \( P_{AV} \) is equal to output electric power, \( V_{OUT} \times I_{OUT} \), thus,

\[
I_{OUT} = f_{OSC} \times \frac{V_{IN}^2 \times Ton^2}{(2 \times L \times (V_{OUT} - V_{IN}))} = \frac{V_{IN}^2 \times Ton}{(2 \times L \times V_{OUT})} \quad \text{Formula 5}
\]

When \( I_{OUT} \) becomes more than \( V_{IN} \times Ton \times T_{off} / (2 \times L \times (Ton + T_{off})) \), the current flows through the inductor, then the mode becomes continuous. The continuous current through the inductor is described as \( I_{const} \), then,

\[
I_{OUT} = f_{OSC} \times V_{IN}^2 \times Ton^2 / (2 \times L \times (V_{OUT} - V_{IN})) + V_{IN} \times I_{const} / V_{OUT} \quad \text{Formula 6}
\]

In this moment, the peak current, \( I_{LX_{max}} \) flowing through the inductor and the driver \( Tr. \) is described as follows:

\[
I_{LX_{max}} = I_{const} + V_{IN} \times Ton / L \quad \text{Formula 7}
\]

With the formula 4, 6, and \( I_{LX_{max}} \) is,

\[
I_{LX_{max}} = \frac{V_{OUT}}{V_{IN}} \times I_{OUT} + V_{IN} \times Ton / (2 \times L) \quad \text{Formula 8}
\]

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

In the formula 7, peak current \( I_{LX_{max}} \) at discontinuous mode can be calculated. Put \( I_{const} = 0 \) in the formula.

The explanation above is based on the ideal calculation, and the loss caused by \( L_x \) switch and external components is not included. The actual maximum output current is between 50% and 80% of the calculation. Especially, when the \( I_{LX} \) is large, or \( V_{IN} \) is low, the loss of \( V_{IN} \) is generated with the on resistance of the switch. As for \( V_{OUT} \), \( V_f \) (as much as 0.3V) of the diode should be considered.
There are also two modes, or discontinuous mode and continuous mode for the PWM step-down switching regulator depending on the continuous characteristic of inductor current.

During on time of the transistor, when the voltage added on to the inductor is described as \( V_{IN} - V_{OUT} \) the current is \( (V_{IN} - V_{OUT}) \times t/L \).

Therefore, the electric power, \( P \), which is supplied from the input side, can be described as in next formula.

\[
P = \int_{0}^{\text{Ton}} V_{IN} \cdot (V_{IN} - V_{OUT}) \cdot t/ L \, dt \tag{Formula 9}
\]

Thus average electric power in one cycle, \( P_{AV} \) is described as in the next formula.

\[
P_{AV} = 1/(\text{Ton}+\text{Toff}) \int_{0}^{\text{Ton}} V_{IN} \cdot (V_{IN} - V_{OUT}) \cdot t/ L \, dt = V_{IN} \cdot (V_{IN} - V_{OUT}) \cdot \text{Ton}^2 / (2 \cdot L \cdot (\text{Ton}+\text{Toff})) \tag{Formula 10}
\]

This electric power \( P_{AV} \) equals to output electric power \( V_{OUT} \times I_{OUT} \), thus,

\[
I_{OUT} = V_{IN} / V_{OUT} \cdot (V_{IN} - V_{OUT}) \cdot \text{Ton}^2/(2 \cdot L \cdot (\text{Ton}+\text{Toff})) \tag{Formula 11}
\]

When \( I_{OUT} \) increases and the current flows through the inductor continuously, then the mode becomes continuous. In the continuous mode, the deviation of the current equals between \( \text{Ton} \) and \( \text{Toff} \), therefore,

\[
(V_{IN} - V_{OUT}) \times \text{Ton}/L = V_{OUT} \times \text{Toff}/L \tag{Formula 12}
\]

In this moment, the current flowing continuously through \( L \), is assumed as \( I_{const} \), \( I_{OUT} \) is described as in the next formula:
\[ I_{\text{out}} = I_{\text{const}} + V_{\text{out}} \times T_{\text{off}} / (2 \times L) \] Formula 13

In this moment, the peak current, \( I_{LX\text{max}} \) flowing through the inductor and the driver \( Tr. \) is described as follows:

\[ I_{LX\text{max}} = I_{\text{out}} + V_{\text{out}} \times T_{\text{off}} / (2 \times L) \] Formula 14

With the formula 12, 13, \( I_{LX\text{max}} \) is,

\[ T_{\text{off}} = (1 - V_{\text{out}} / V_{\text{in}}) / f_{\text{osc}} \] Formula 15

Therefore, peak current is more than \( I_{\text{out}} \). Considering the value of \( I_{LX\text{max}} \), the condition of input and output, and external components should be selected.

In the formula 14, peak current \( I_{LX\text{max}} \) at discontinuous mode can be calculated. Put \( I_{\text{const}} = 0 \) in the formula.

The explanation above is based on the ideal calculation, and the loss caused by \( L_X \) switch and external components is not included.
TEST CIRCUITS

Test Circuit 1

Test Circuit 2

Test Circuit 3

Test Circuit 4

Test Circuit 5

Test Circuit 6
Typical Characteristics shown in the following pages are obtained with test circuits shown above.

Test Circuit 1,2 : Typical Characteristic 4)
Test Circuit 3 : Typical Characteristic 5)
Test Circuit 4 : Typical Characteristic 5)
Test Circuit 5 : Typical Characteristic 6)
Test Circuit 6 : Typical Characteristics 7) 8)
Test Circuit 7 : Typical Characteristic 9)
Test Circuit 8 : Typical Characteristic 10)
Test Circuit 9 : Typical Characteristics 10)
Test Circuit 10 : Typical Characteristics 11) 12)

Note) Capacitors’ values of test circuits
Capacitors: Ceramic Type:
C1=4.7μF, C2=1.0μF

Efficiency $\eta(\%)$ can be calculated with the next formula:

$$\eta = \frac{(V_{OUT1}\times I_{OUT1} + V_{OUT2}\times I_{OUT2})}{(V_{IN}\times I_{IN})} \times 100$$
TYPICAL CHARACTERISTICS

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

2) Efficiency vs. Output Current (VIN=3.3V, Topt=25°C)

3) Output Voltage vs. Temperature (VIN=3.3V)
4) Frequency vs. Temperature

5) Feedback Voltage vs. Temperature (VIN=3.3V)

6) Vrefout Voltage vs. Temperature (VIN=3.3V)

7) Vrefout Output Voltage vs. Output Current
8) Vrefout Output Voltage vs. Output Current

9) Protection Delay Time vs. Temperature (Vin=3.3V)

10) Maximum Duty Cycle vs. DTC Voltage (Vin=3.3V)

11) Output Sink Current vs. Temperature (Vin=3.3V)

12) Output Source Current vs. Temperature
13) Load Transient Response (Step-up Side) $V_{IN}=3.3V$, $L_1=6.8\mu H$

14) Load Transient Response (Step-down Side) $V_{IN}=3.3V$, $L_2=6.8\mu H$
TYPICAL APPLICATION AND TECHNICAL NOTES

Components examples
Inductor L1,2  6.8µH  VLF504012MT (TDK)
Diode  CRS10I30A  (Toshiba)
PMOS        Si3443DV  (Siliconix)
NMOS           IRF7601  (International Rectifier)

Resistance As setting resistors total value for the output voltage, R1+R2, R3+R4 recommendation value is 100kW or less.
R1=47kΩ  R2=5.1kΩ  R3=30kΩ  R4=20kΩ
R5=43kΩ  R6=10kWΩ
R7=R9=22kΩ  R8=R10=43kΩ  R11=220kΩ

Capacitors Ceramic Type
C1=C2=10µF  C3=4.7µF  C4=0.22µF  C5=0.47µF  C6=120pF
C7=50pF  C8=1µF  C9=1000pF

Note) Consider the ratings of external components including voltage tolerance. With the transistor in the circuit above, VOUT=15V is the voltage setting limit.
EXTERNAL COMPONENTS

1. How to set the output voltages
   As for step-up side, feedback (VFB1) pin voltage is controlled to maintain 1V, therefore,
   \[ V_{OUT1} = \frac{R1}{R1+R2} \times V_{FB1} \]

   Thus, \[ V_{OUT1} = \frac{V_{FB1} \times (R1+R2)}{R2} \]
   Output Voltage is adjustable with R1 and R2.
   As for Step-down side, Feedback (VFB2) pin voltage follows the next formula,
   \[ V_{OUT2} = \frac{R3}{R3+R4} \times V_{FB2} \]

   Thus, \[ V_{OUT2} = \frac{V_{FB2} \times (R3+R4)}{R4} \]
   Output Voltage is adjustable with R3 and R4.

2. How to set Soft-Start Time and Maximum Duty Cycle
   Soft-start time is adjustable with connecting resistors and a capacitor to DTC pin.
   Soft starting time, TSS1 and TSS2 are adjustable. Soft-start time can be set with the time constant of RC.
   Soft-start time can be described as in next formula.
   \[ TSS1 = R_{O1} \times C4 \]

   If R10=0Ω, then,
   \[ TSS2 = R_9 \times C5 \times \ln\left(\frac{V_{refout} - V_{DTC2}}{V_{refout}}\right) \]

   Maximum Duty Cycle is set with the voltage to DTC1 and DTC2.
   Maximum duty cycle is described as follows;
   CH1 (Step-up side)
   \[ \text{Maxduty1} = \frac{R8(R7+R8) \times V_{refout} - 0.2}{(1.2-0.2) \times 100} \%
   \]
   Step-up side maximum duty cycle should be set equal or less than 90%. If the maximum duty cycle is set at high percentage, operation will be unstable.
TECHNICAL NOTES on EXTERNAL COMPONENTS

- External components should be set as close to this IC as possible. Especially, wiring of the capacitor connected to VIN pin should be as short as possible.
- Enforce the ground wire. Large current caused by switching operation flows through GND pin. If the impedance of ground wire is high, internal voltage level of this IC might fluctuate and operation could be unstable.
- Recommended capacitance value of C3 is equal or more than 4.7µF.
- If the spike noise of VOUT1 is too large, the noise is feedback from VFB1 pin and operation might be unstable.
  In that case, use the resistor ranging from 10kΩ to 50kΩ as R5 and try to reduce the noise level. In the case of VOUT2, use the resistor as much as 10kΩ as R6.
- Select an inductor with low D.C. current, large permissible current, and uneasy to cause magnetic saturation. If the inductance value is too small, ILx might be beyond the absolute maximum rating at the maximum load.
- Select a Schottky diode with fast switching speed and large enough permissible current.
- Recommended capacitance value of C1 and C2 is as much as Ceramic 10µF. In case that the operation with the system of DC/DC converter would be unstable, add a series resister less than 0.5Ω to each output capacitor or use tantalum capacitors with appropriate ESR. If you choose too large ESR, ripple noise may be forced to VFB1 and VFB2, and unstable operation may result. Use a capacitor with fully large voltage tolerance of the capacitor.
- this IC, for the test efficiency, latch release function is included. By forcing (VIN−0.3)V or more voltage to DTC1 pin or DTC2 pin, Latch release function works.
- Performance of the power controller with using this IC depends on external components. Each component, layout should not be beyond each absolute maximum rating such as voltage, current, and power dissipation.
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