The R1285L 2ch DC/DC converter is designed for OLED Display power source. It contains a step up DC/DC converter and an inverting DC/DC converter to generate two required voltages by OLED Display. Step up DC/DC converter generates boosted output voltage to 4.6V ~ 5.0V. Inverting DC/DC converter generates negative voltage –2.0V ~ -6.0V independently. Each of the R1285 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), a complete shutdown switch and 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. Start up sequence is internally made.

FEATURES

- Operating Voltage • • • • • 2.3V ~ 4.8V
- Step Up DC/DC (CH1)
  - Internal Pch MOSFET for complete shutdown (Ron=300mΩTyp.)
  - Internal Nch MOSFET Driver (Ron=300mΩTyp.)
  - Output Voltage (V_{OUTP}) • • • • • 4.6V ~ 5.0V (0.2VStep)
  - Auto Discharge function for positive output
  - Internal Soft start function (Typ. 4.5ms)
  - Over Current Protection
  - Maximum Duty Cycle: 85%(Typ.)
- Inverting DC/DC (CH2)
  - Internal Pch MOSFET Driver (Ron=600mΩTyp.)
  - Output Voltage (V_{OUTN}) • • • • • -2V ~ -6V (0.1VStep) [R1285LxxxA]
  - Adjustable Vout Up to -6V with external resistors [R1285L00x0]
  - Auto Discharge function for negative output
  - Internal Soft start function (Typ. 4.5ms)
  - Over Current Protection
  - Maximum Duty Cycle: 90%(Typ.)
- Control
  - 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. This function prevents irregular current from overheating the R1285.
  - CE with start up sequence function (CH1→CH2)
  - UVLO function.
  - Operating Frequency • • • • • 1400kHz
- Small package • • • • • DFN2730-12

APPLICATION

- Fixed voltage power supply for portable equipment
- Fixed voltage power supply for OLED
BLOCK DIAGRAM

R1285LxxxA

PVCC
LXN
VOUTN
TST1
TST2
CE

PWM Control
Current Limit
Maxduty
PWM Control
Timer
Short Protect
Discharge Control
Soft start2
Sequence Control
Enable Control

Vref3
Vref1

R1285L00xB

PVCC
LXN
VOUTN
VFB
VREF
CE

PWM Control
Current Limit
Maxduty
PWM Control
Timer
Short Protect
Discharge Control
Soft start2
Sequence Control
Enable Control

Vref3
Vref1

Limited Product
SELECTION GUIDE

The mask option for the ICs can be selected at the user's request. 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>R1285Lxx+$-TR</td>
<td>DFN2730-12</td>
<td>5,000 pcs</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

xx : Setting inverting output voltage (\(V_{\text{OUTN}}\))
Stepwise setting with a step of 0.1V in the range of -2.0V(20) to -6.0(60)V is possible for fixed output version.
"00" is for Output Voltage Adjustable version.

*: Setting positive output voltage (\(V_{\text{OUTP}}\))
(1) 4.6V
(2) 4.8V
(3) 5.0V

$: Designation of method of setting Inverting Voltage
(A) Fixed output version
(B) Adjustable version
PIN configuration

DFN 2730-12

Top View

Bottom View

PIN DESCRIPTIONS

**R1285LxxxA**

<table>
<thead>
<tr>
<th>PIN No.</th>
<th>NAME</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PGND</td>
<td>Power GND pin</td>
</tr>
<tr>
<td>2</td>
<td>VOUTP</td>
<td>Output Voltage feedback pin for Step up DC/DC</td>
</tr>
<tr>
<td>3</td>
<td>PVCC</td>
<td>Power input pin</td>
</tr>
<tr>
<td>4</td>
<td>VCC</td>
<td>Analog power source input pin</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Analog GND pin</td>
</tr>
<tr>
<td>6</td>
<td>CE</td>
<td>Chip enable pin</td>
</tr>
<tr>
<td>7</td>
<td>TST2</td>
<td>TEST pin</td>
</tr>
<tr>
<td>8</td>
<td>TST1</td>
<td>TEST pin</td>
</tr>
<tr>
<td>9</td>
<td>VOUTN</td>
<td>Output Voltage feedback pin for Inverting DC/DC</td>
</tr>
<tr>
<td>10</td>
<td>LXXN</td>
<td>Switching pin for Inverting DC/DC</td>
</tr>
<tr>
<td>11</td>
<td>LXPN1</td>
<td>Shutdown switch output pin</td>
</tr>
<tr>
<td>12</td>
<td>LXPN2</td>
<td>Switching pin for Step up DC/DC</td>
</tr>
</tbody>
</table>

**R1285L00xB**

<table>
<thead>
<tr>
<th>PIN No.</th>
<th>NAME</th>
<th>FUNCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PGND</td>
<td>Power GND pin</td>
</tr>
<tr>
<td>2</td>
<td>VOUTP</td>
<td>Output Voltage feedback pin for Step up DC/DC</td>
</tr>
<tr>
<td>3</td>
<td>PVCC</td>
<td>Power input pin</td>
</tr>
<tr>
<td>4</td>
<td>VCC</td>
<td>Analog power source input pin</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Analog GND pin</td>
</tr>
<tr>
<td>6</td>
<td>CE</td>
<td>Chip enable pin</td>
</tr>
<tr>
<td>7</td>
<td>VREF</td>
<td>Reference voltage output pin for Inverting DC/DC</td>
</tr>
<tr>
<td>8</td>
<td>VFBN</td>
<td>Feedback pin for Inverting DC/DC</td>
</tr>
<tr>
<td>9</td>
<td>VOUTN</td>
<td>Output Voltage feedback pin for Inverting DC/DC</td>
</tr>
<tr>
<td>10</td>
<td>LXXN</td>
<td>Switching pin for Inverting DC/DC</td>
</tr>
<tr>
<td>11</td>
<td>LXPN1</td>
<td>Shutdown switch output pin</td>
</tr>
<tr>
<td>12</td>
<td>LXPN2</td>
<td>Switching pin for Step up DC/DC</td>
</tr>
</tbody>
</table>

*) 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

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V\text{CC} / PV\text{CC} pin Voltage</td>
<td>V\text{CC}</td>
<td>-0.3 ~ 6.0</td>
<td>V</td>
</tr>
<tr>
<td>V\text{OUTP} pin Voltage</td>
<td>V\text{OUTP}</td>
<td>-0.3 ~ 6.0</td>
<td>V</td>
</tr>
<tr>
<td>CE pin Voltage</td>
<td>V\text{CE}</td>
<td>-0.3 ~ V\text{CC}+0.3</td>
<td>V</td>
</tr>
<tr>
<td>L\text{XP}1 pin Voltage</td>
<td>V\text{LXP}1</td>
<td>-0.3 ~ V\text{CC}+0.3</td>
<td>V</td>
</tr>
<tr>
<td>L\text{XP}2 pin Voltage</td>
<td>V\text{LXP}2</td>
<td>-0.3 ~ 6.0</td>
<td>V</td>
</tr>
<tr>
<td>L\text{XN} pin Voltage</td>
<td>V\text{LXN}</td>
<td>V\text{CC}-14 ~ V\text{CC}+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V\text{OUTN} pin Voltage</td>
<td>V\text{OUTN}</td>
<td>V\text{CC}-14 ~ V\text{CC}+0.3</td>
<td>V</td>
</tr>
<tr>
<td>TST1/TST2 pin Voltage [R1285LxxxA]</td>
<td>V\text{TST}</td>
<td>-0.3 ~ V\text{CC}+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V\text{FBN} pin Voltage [R1285L00xB]</td>
<td>V\text{FBN}</td>
<td>-0.7 ~ V\text{CC}+0.3</td>
<td>V</td>
</tr>
<tr>
<td>V\text{REF} pin Voltage [R1285L00xB]</td>
<td>V\text{REF}</td>
<td>-0.7 ~ V\text{CC}+0.3</td>
<td>V</td>
</tr>
<tr>
<td>Power Dissipation</td>
<td>PD</td>
<td>1000 mW</td>
<td>mW</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>Ta</td>
<td>-40 ~ +85 °C</td>
<td>°C</td>
</tr>
<tr>
<td>Storage Temperature Range</td>
<td>Tstg</td>
<td>-55 ~ +125 °C</td>
<td>°C</td>
</tr>
</tbody>
</table>

*1) In case the voltage range is from –0.7V to –0.3V, permissible current is 10mA or less.

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.
**ELECTRICAL CHARACTERISTICS** *(Ta=25ºC)*

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item Description</th>
<th>Conditions</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>Unit.</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>Operating Input Voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=4.8V</td>
<td>2.3</td>
<td>4.8</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;CC1&lt;/sub&gt;</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; Consumption Current (switching)</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=4.8V</td>
<td>4.0</td>
<td>9.1</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;CC2&lt;/sub&gt;</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt; Consumption Current (at no switching)</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=4.8V</td>
<td>350</td>
<td>730</td>
<td>uA</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;STB&lt;/sub&gt;</td>
<td>Standby Current</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=4.8V</td>
<td>0.1</td>
<td>3</td>
<td>uA</td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;UVLO1&lt;/sub&gt;</td>
<td>UVLO Detect Voltage</td>
<td>Falling</td>
<td>1.95</td>
<td>2.05</td>
<td>2.15</td>
<td>V</td>
</tr>
<tr>
<td>V&lt;sub&gt;UVLO2&lt;/sub&gt;</td>
<td>UVLO Released Voltage</td>
<td>Rising</td>
<td>V&lt;sub&gt;UVLO1&lt;/sub&gt; +0.10</td>
<td>2.28</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>F&lt;sub&gt;OSC&lt;/sub&gt;</td>
<td>Oscillator Frequency</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=3.7V</td>
<td>1200</td>
<td>1400</td>
<td>1600 kHz</td>
<td></td>
</tr>
<tr>
<td>T&lt;sub&gt;DLY&lt;/sub&gt;</td>
<td>Delay Time for Protection</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=3.7V</td>
<td>14</td>
<td>50</td>
<td>162 ms</td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;CEL&lt;/sub&gt;</td>
<td>CE “L” Input Voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=2.3V</td>
<td>0.3</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;CEH&lt;/sub&gt;</td>
<td>CE “H” Input Voltage</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=4.8V</td>
<td>1.5</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>R&lt;sub&gt;CE&lt;/sub&gt;</td>
<td>CE pin Pulldown Resistance</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=3.7V</td>
<td>300</td>
<td>600</td>
<td>900 kΩ</td>
<td></td>
</tr>
</tbody>
</table>

**Step-up DC/DC**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item Description</th>
<th>Conditions</th>
<th>MIN.</th>
<th>TYP.</th>
<th>MAX.</th>
<th>Unit.</th>
</tr>
</thead>
<tbody>
<tr>
<td>V&lt;sub&gt;OUTP&lt;/sub&gt;</td>
<td>V&lt;sub&gt;OUTP&lt;/sub&gt; Voltage Tolerance</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=3.7V</td>
<td>x0.985</td>
<td>x1.015</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>ΔV&lt;sub&gt;OUTP&lt;/sub&gt; /ΔT</td>
<td>V&lt;sub&gt;OUTP&lt;/sub&gt; Voltage Temperature Coefficient</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=3.7V , -40ºC ≤ Ta ≤ 85ºC</td>
<td>±150 ppm /ºC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔV&lt;sub&gt;OUTP&lt;/sub&gt; /ΔV&lt;sub&gt;CC&lt;/sub&gt;</td>
<td>V&lt;sub&gt;OUTP&lt;/sub&gt; Voltage Line Regulation</td>
<td>2.9V ≤ V&lt;sub&gt;CC&lt;/sub&gt; ≤ 3.4, I&lt;sub&gt;OUT&lt;/sub&gt; = 0mA</td>
<td>±4 mV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔV&lt;sub&gt;OUTP&lt;/sub&gt; /ΔI&lt;sub&gt;OUT&lt;/sub&gt;</td>
<td>V&lt;sub&gt;OUTP&lt;/sub&gt; Voltage Load Regulation</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=3.7V , 10mA ≤ I&lt;sub&gt;OUT&lt;/sub&gt; ≤ 100mA</td>
<td>±10 mV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔV&lt;sub&gt;OUTP_TR&lt;/sub&gt;</td>
<td>V&lt;sub&gt;OUTP&lt;/sub&gt; Voltage Line Transient Response</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=2.9V ↔ 3.4V , T&lt;sub&gt;R&lt;/sub&gt;=T&lt;sub&gt;F&lt;/sub&gt;=50us I&lt;sub&gt;OUT&lt;/sub&gt; = 100mA</td>
<td>±10 mV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxduty1</td>
<td>CH1 Max. Duty Cycle</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=3.7V</td>
<td>78</td>
<td>85</td>
<td>91  %</td>
<td></td>
</tr>
<tr>
<td>T&lt;sub&gt;SS1&lt;/sub&gt;</td>
<td>CH1 Soft-Start Time</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=3.7V</td>
<td>1.6</td>
<td>4.5</td>
<td>10 ms</td>
<td></td>
</tr>
<tr>
<td>R&lt;sub&gt;LXP1&lt;/sub&gt;</td>
<td>LXP1 ON Resistance</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=3.7V</td>
<td>300</td>
<td></td>
<td>mΩ</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;OFF_LXP1&lt;/sub&gt;</td>
<td>LXP1 Leakage Current</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=4.8V , LXP1=0V</td>
<td>5 uA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R&lt;sub&gt;LXP2&lt;/sub&gt;</td>
<td>LXP2 ON Resistance</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=3.7V</td>
<td>300</td>
<td></td>
<td>mΩ</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;OFF_LXP2&lt;/sub&gt;</td>
<td>LXP2 Leakage Current</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=4.8V , LXP2=5V</td>
<td>5 uA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;LMLXP2&lt;/sub&gt;</td>
<td>LXP2 Current Limit</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=3.7V</td>
<td>0.61</td>
<td>1.0</td>
<td>1.68 A</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;VOUTP&lt;/sub&gt;</td>
<td>V&lt;sub&gt;OUTP&lt;/sub&gt; Discharge Current</td>
<td>V&lt;sub&gt;CC&lt;/sub&gt;=3.7V , V&lt;sub&gt;OUTP&lt;/sub&gt;=0.1V</td>
<td>2.8</td>
<td>5</td>
<td>10.3 mA</td>
<td></td>
</tr>
</tbody>
</table>
### Inverting DC/DC [R1285LxxxA]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta V_{OUTN}/\Delta T$</td>
<td>$V_{CC}=3.7V$, $-40^\circ C \leq Ta \leq 85^\circ C$</td>
<td>$\pm 150$ ppm/°C</td>
</tr>
<tr>
<td>$\Delta V_{OUTN}/\Delta V_{CC}$</td>
<td>$2.9V \leq V_{CC} \leq 3.4V$, $I_{OUT} = 0mA$</td>
<td>$\pm 6$ mV</td>
</tr>
<tr>
<td>$\Delta V_{OUTN}/\Delta I_{OUT}$</td>
<td>$V_{CC}=3.7V$, $10mA \leq I_{OUT} \leq 100mA$</td>
<td>$\pm 15$ mV</td>
</tr>
<tr>
<td>$\Delta V_{OUTN_{TR}}/\Delta V_{OUTN}$</td>
<td>$V_{CC}=2.9V \leftrightarrow 3.4V$, $T_R=T_F=50us$, $I_{OUT} = 100mA$</td>
<td>$\pm 25$ mV</td>
</tr>
<tr>
<td>$\Delta V_{OUTN}/\Delta V_{CC}$</td>
<td>$2.9V \leftrightarrow 3.4V$, $V_{CC} = 3.7V$, $I_{OUT} = 0mA$</td>
<td>$\pm 6$ mV</td>
</tr>
<tr>
<td>$\Delta V_{OUTN}/\Delta I_{OUT}$</td>
<td>$V_{CC}=3.7V$, $10mA \leq I_{OUT} \leq 100mA$</td>
<td>$\pm 15$ mV</td>
</tr>
<tr>
<td>$\Delta V_{OUTN_{TR}}/\Delta I_{OUT}$</td>
<td>$V_{CC}=2.9V \leftrightarrow 3.4V$, $T_R=T_F=50us$, $I_{OUT} = 100mA$</td>
<td>$\pm 25$ mV</td>
</tr>
</tbody>
</table>

### Inverting DC/DC [R1285L00xB]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Formula</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{FBN}$</td>
<td>$V_{FBN}$</td>
<td>V</td>
</tr>
<tr>
<td>$I_{FBN}$</td>
<td>$V_{FBN}$</td>
<td>mA</td>
</tr>
<tr>
<td>$V_{REF}$</td>
<td>$V_{REF}$</td>
<td>V</td>
</tr>
<tr>
<td>$\Delta V_{REF}/\Delta T$</td>
<td>$V_{REF}=3.7V$, $-40^\circ C \leq Ta \leq 85^\circ C$</td>
<td>$\pm 150$ ppm/°C</td>
</tr>
<tr>
<td>$\Delta V_{OUTN}/\Delta V_{CC}$</td>
<td>$2.9V \leq V_{CC} \leq 3.4V$, $I_{OUT} = 0mA$</td>
<td>$\pm 6$ mV</td>
</tr>
<tr>
<td>$\Delta V_{OUTN}/\Delta I_{OUT}$</td>
<td>$V_{CC}=3.7V$, $10mA \leq I_{OUT} \leq 100mA$</td>
<td>$\pm 15$ mV</td>
</tr>
<tr>
<td>$\Delta V_{OUTN_{TR}}/\Delta V_{OUTN}$</td>
<td>$V_{CC}=2.9V \leftrightarrow 3.4V$, $T_R=T_F=50us$, $I_{OUT} = 100mA$</td>
<td>$\pm 25$ mV</td>
</tr>
</tbody>
</table>

* In terms of TST pin (TST1, TST2), connect the GND level or remain it open.

**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.
Test Circuits

*In case of the R1285L00xB, the pin name is changed from TST1 to VFBN and TST2 to VREF.*
*In case of the R1285L00xB, the pin name is changed from TST1 to VFBN and TST2 to VREF.
<CH1 Soft-Start Time>

*In case of the R1285L00xB, the pin name is changed from TST1 to V_FB and TST2 to V_REF.*
Inverting DC/DC

*In case of the R1285L00xB, the pin name is changed from TST1 to V_FBn and TST2 to V_REF.
*In case of the R1285L00xB, the pin name is changed from TST1 to VFBN and TST2 to VREF.
TYPICAL APPLICATION AND TECHNICAL NOTES

● Set a ceramic 4.7 μF or more capacitor between Vcc and GND as C1.

● Set a ceramic 10 μF or more capacitor between VOUTP and GND, and between VOUTN and GND for each as C2 and C3.

● Start up Sequence
When CE level turns from ‘L’ to ‘H’ level, the soft start of CH1 starts the operation. After detecting output voltage of CH1 (VOUTP) as the nominal level, the soft start of CH2 starts the operation.
● Auto Discharge Function
When CE level turns from 'H' to 'L' level, the R1285 goes into standby mode and switching of the outputs of L\textsubscript{XP2} and L\textsubscript{XN} will stop. Then discharge switch between V\textsubscript{OUTN} and PV\textsubscript{CC} and switch between V\textsubscript{OUTP} and GND turn on and discharge the negative output voltage and positive output voltage. When the negative output voltage is discharged to 0V, the switch between V\textsubscript{OUTN} and PV\textsubscript{CC} turns off and the negative output will be Hi-Z. Positive output voltage is discharged to 0V in standby mode.
If Vcc voltage became lower than UVLO detect voltage, discharge switches also turn on and discharge output voltage (V\textsubscript{OUTN} and V\textsubscript{OUTP}).
In case of timer latch protection, discharge switches will keep off.

![Diagram of CE, V\textsubscript{OUTP}, 0V, V\textsubscript{OUTN}, Discharge, Hi-Z (V\textsubscript{OUTN}), 0V (V\textsubscript{OUTP})]

● Short protection circuit timer
In case that the voltage of V\textsubscript{OUTP} drops, the error amplifier of CH1 outputs "H". In case that the voltage of V\textsubscript{OUTN} rises, the error amplifier of CH2 outputs "L". The built-in short protection circuit makes the internal 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 L\textsubscript{XP2} and L\textsubscript{XN} will stop and shutdown switch will turn off and both of discharge switches will keep off.
To release the latch operation, make the Vcc 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.

![Diagram of Amp output for Boost, Amp output for Inverting, Normal state, Short state, Latch state, Timer function (Typ. 50ms), Shutdown]

During a timer function, current is restricted by current limit protection or maxduty function until shutdown. After shutdown drivers and shutdown switch turn off.
Inverting DC/DC converter output voltage setting  [ R1285L00xB ]

The output voltage $V_{OUTN}$ of the inverting DC/DC converter is controlled with maintaining the $V_{FBN}$ as 0V. $V_{OUTN}$ can be set with adjusting the values of R1 and R2 as in the next formula.

$$V_{OUTN} = V_{FBN} - (V_{REF} - V_{FBN}) \times \frac{R2}{R1}$$

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.

$$F_{pole} \approx \frac{1}{(2 \times \pi \times \sqrt{L \times C})}$$

Zero will be formed with R2 and C4.

$$F_{zero} \approx \frac{1}{(2 \times \pi \times R2 \times C4)}$$

Set the cut-off frequency of the Zero close to the cut-off frequency of the pole by L and C.

If the noise of the system is large, the output noise affects the feedback and the operation may be unstable. In that case, another resistor R3 will be set. The appropriate value range is from 1kΩ to 5kΩ.

Set a ceramic $1\,\mu F$ to $2.2\,\mu F$ capacitor between $V_{REF}$ and GND as C5. [ R1285L00xB ]

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

<Basic Circuit>

<Current through L>

Discontinuous Mode

Continuous Mode
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 VIN. The inductor current (IL1) will be:

\[ IL1 = \frac{V_{IN} \times T_{on}}{L} \]  

Formula 1

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

\[ IL2 = \frac{(V_{OUT}-V_{IN}) \times T_f}{L} \]  

Formula 2

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

\[ V_{IN} \times T_{on} / L = (V_{OUT}-V_{IN}) \times T_{off} / L \]  

Formula 3

In the continuous mode, the duty cycle will be

\[ DUTY = \frac{T_{on}}{(T_{on}+T_{off})} = \frac{(V_{OUT}-V_{IN})}{V_{OUT}} \]  

Formula 4

If the input power equals to output power,

\[ I_{OUT} = \frac{V_{IN}^2 \times T_{on}}{(2 \times L \times V_{OUT})} \]  

Formula 5

When I_{OUT} becomes more then Formula 5, it will be continuous mode.

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

\[ IL_{xmax} = I_{OUT} \times V_{OUT} / (V_{IN} + V_{IN} \times T_{on} / (2 \times L)) \]  

Formula 6

\[ IL_{xmax} = I_{OUT} \times V_{OUT} / (V_{IN} + V_{IN} \times T_x (V_{OUT}-V_{IN}) / (2 \times L \times V_{OUT})) \]  

Formula 7

Therefore, peak current is more than I_{OUT}. Considering the value of ILmax, 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 VIN is low, the loss of VIN 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**

![Inverting DC/DC Converter Circuit Diagram]
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 VIN. The inductor current (IL1) will be:

\[ IL1 = \frac{VIN \times Ton}{L} \]  

Formula 8

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:

\[ IL2 = \frac{VOUT \times Tf}{L} \]  

Formula 9

(The above formula and after, the absolute value of the negative output voltage is assumed to be \( V_{OUT} \). : Output voltage = -10V, \( V_{OUT} = 10 \) )

In terms of the PWM control, when the \( T_f = Toff \), 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

\[ VIN \times Ton / L = VOUT \times Toff / L \]  

Formula 10

In the continuous mode, the duty cycle will be:

\[ DUTY = \frac{Ton}{(Ton+Toff)} = \frac{VOUT}{(VOUT + VIN)} \]  

Formula 11

If the input power equals to output power,

\[ IOUT = \frac{VIN^2 \times Ton}{(2 \times L \times VOUT)} \]  

Formula 12

When \( IOUT \) becomes more then Formula 12, it will be continuous mode.

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

\[ IL_{x\text{max}} = \frac{IOUT \times VOUT}{VIN + VIN \times Ton/(2 \times L)} \]  

Formula 13

\[ IL_{x\text{max}} = \frac{IOUT \times VOUT}{VIN + VIN \times VOUT \times T/(2 \times L \times (VOUT + VIN))} \]  

Formula 14

Therefore, peak current is more than \( IOUT \). 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 \( VIN \) is low, the loss of \( VIN \) is generated with on resistance of the switch. As for \( VOUT \), \( V_F \) (as much as 0.3V) of the diode should be considered.
**R1285LxxxX Typical Characteristics**

1) Output voltage vs. Output Current

![Output voltage vs. Output Current](image1)

\[ V_{OUTP} = 4.6V \]

\[ V_{OUTN} = -5.4V \]

2) Efficiency vs. Output Current

![Efficiency vs. Output Current](image2)

\[ V_{IN} = 4.5V \]

\[ V_{IN} = 3.7V \]

\[ V_{IN} = 2.9V \]
3) Output Current vs. Output Voltage (Load Regulation)

R1285Lxx1A/001B(VoutP= 4.6V) Ta=25°C

R1285Lxx1A(VoutN= -5.4V) Ta=25°C

R1285L00xB(VoutN= -5.4V) Ta=25°C

R1285L00xB(VoutN= -4.9V) Ta=25°C
4) Turn-on/Turn-off Speed by CE signal

R1285L491A

Vin = 3.7V, IoUT = 0mA, ta = 25°C

R1285L001B(VOUTN= -4.9V)

Vin = 3.7V, IoUT = 0mA, ta = 25°C

5) Load Transient Response

R1285Lxx1A(VOUTP= 4.6V)

Vin = 3.7V, ta = 25°C, tr / tf = 10us

R1285L49xA(VOUTN= -4.9V)

Vin = 3.7V, ta = 25°C, tr / tf = 10us

6) Line Transient Response

R1285Lxx1A(VOUTP= 4.6V)

Load Current = 100mA, ta = 25°C, tr / tf = 50us

R1285L49xA(VOUTN= -4.9V)

Load Current = 100mA, ta = 25°C, tr / tf = 50us
7) UVLO Voltage VS. Temperature
R1285Lxxxx

8) VOUTP Voltage VS. Temperature
R1285Lxx1A

9) VOUTN Voltage VS. Temperature
R1285L20xA
R1285L48xA
R1285L60xA

Limited Product
16) LXN Current Limit VS. Temperature

17) Oscillator Frequency VS. Temperature

18) Maxduty1 VS. Temperature

19) Maxduty2 VS. Temperature

20) CH1 Soft-Start Time VS. Temperature

21) CH2 Soft-Start Time VS. Temperature
For the conservation of the global environment, Ricoh is advancing the decrease of the negative environmental impact material. After Apr. 1, 2006, we will ship out the lead free products only. Thus, all products that will be shipped from now on comply with RoHS Directive. Basically after Apr. 1, 2012, we will ship out the Power Management ICs of the Halogen Free products only. (Ricoh Halogen Free products are also Antimony Free.)

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