OUTLINE

The R1250Vxx1A Series are CMOS-based negative output charge pump regulator ICs, which can be developed as local power suppliers for portable appliances and small electric appliances used with batteries, with low supply current.

Each of these ICs consists of an oscillator, a control circuit, a reference voltage unit, an error amplifier, and an output driver circuit. The R1250Vxx1A can easily supply negative voltage, or regulated setting output voltage in the range from -2V to -4V from positive input voltage.

The chip enable function works to shut down the internal circuit and reduces supply current at the stand-by mode, therefore the R1250Vxx1A is very suitable for the application such as portable systems that require low supply current.

Since the package for this IC is TSSOP8 package (TSOP8 in EIAJ standard), high density mounting of the ICs on board is possible.

FEATURES

- Output Current ................. 100mA (Max. at VIN=5.0V, CN=CR=OUT=4.7µF, Set Output Voltage=-3.0V)
- Output Voltage Accuracy ...... ±3.0% (VIN=5.0V, CN=CR=OUT=4.7µF, Set Output Voltage=-3.0V, IOUT=0mA/10mA)
- ±9.0% (VIN=5.0V, CN=CR=OUT=4.7µF, Set Output Voltage=-3.0V, IOUT=50mA)
- Output Voltage ................. Stepwise setting with a step of 0.1V in the range from -2.0V to -4.0V is possible.
- Range of Input Voltage ........ |VIN| V to +5.5V (Set Output Voltage=-4.0V to -2.8V)
- Range of Output Voltage ....... |VOUT| V to +5.5V (Set Output Voltage=-2.7V to -2.0V)
- Oscillator Frequency ........... Typ. 280kHz
- Chip Enable Function (Active at "L")
- Package .......................... TSSOP8

APPLICATIONS

- Power source for Disk Drives.
- Power source for hand-held communication equipment and battery-powered equipment.
- Power source for PC peripherals and ADD-ON cards.
- Power source for portable audio-visual appliances such as cameras.
- Local power source for small electrical appliances.
PIN DESCRIPTION

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C+</td>
<td>Cr (Capacitor for Charge Pump) Positive Power Supply Pin</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground Pin</td>
</tr>
<tr>
<td>3</td>
<td>C-</td>
<td>Cr (Capacitor for Charge Pump) Negative Power Supply Pin</td>
</tr>
<tr>
<td>4</td>
<td>CE</td>
<td>Chip Enable Pin (active at “L”)</td>
</tr>
<tr>
<td>5</td>
<td>NC</td>
<td>No Connection Pin</td>
</tr>
<tr>
<td>6</td>
<td>Vref</td>
<td>Output Pin for Reference Voltage (*Note1)</td>
</tr>
<tr>
<td>7</td>
<td>VOUT</td>
<td>Output Pin for Negative Regulator</td>
</tr>
<tr>
<td>8</td>
<td>VIN</td>
<td>Power Supply Pin</td>
</tr>
</tbody>
</table>

*Note1 Vref is just a monitoring pin, therefore remain open. Do not connect any load. Refer to Technical Notes.

ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSS</td>
<td>VSS Supply Voltage</td>
<td>-0.3 to 7.5</td>
<td>V</td>
</tr>
<tr>
<td>VCE</td>
<td>CE Pin Input Voltage</td>
<td>-0.3 to VSS+0.3</td>
<td>V</td>
</tr>
<tr>
<td>VSS+</td>
<td>C+ Pin Input Voltage</td>
<td>-0.3 to VSS+0.3</td>
<td>V</td>
</tr>
<tr>
<td>Vref</td>
<td>Vref Pin Voltage</td>
<td>-0.3 to VSS+0.3</td>
<td>V</td>
</tr>
<tr>
<td>VR+</td>
<td>C- Pin Input Voltage</td>
<td>VSS-12 to +0.3</td>
<td>V</td>
</tr>
<tr>
<td>VR-</td>
<td>VR- Pin Voltage</td>
<td>VSS-12 to +0.3</td>
<td>V</td>
</tr>
<tr>
<td>IOUT</td>
<td>Output Current</td>
<td>200</td>
<td>mA</td>
</tr>
<tr>
<td>PD</td>
<td>Power Dissipation (*Note1)</td>
<td>490</td>
<td>mW</td>
</tr>
<tr>
<td>Topt</td>
<td>Operating Temperature Range</td>
<td>-40 to +85</td>
<td>ºC</td>
</tr>
<tr>
<td>Tstg</td>
<td>Storage Temperature Range</td>
<td>-55 to +125</td>
<td>ºC</td>
</tr>
</tbody>
</table>

*Note1 Power dissipation is specified under the specified condition. Conditions: Evaluation Board Dimensions: 50mm × 50mm × 1.6mm Material: Glass Epoxy (FR-4) Reverse side of the evaluation board: Plane Copper Surface of the evaluation board: Land pattern and Wiring
SELECTION GUIDE

The output voltage and the active 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;

R1250Vxx1A-xx
↑ ↑ ↑
 a  b  c

<table>
<thead>
<tr>
<th>Code</th>
<th>Contents</th>
</tr>
</thead>
</table>
| a    | Setting Output Voltage  
 xx: The absolute value of Output Voltage  
 Stepwise setting with a step of 0.1V in the range of -2.0V to -4.0V is possible. |
| b    | Designation of Active Type of the Chip Enable Circuit:  
 A (fixed) : “L” active type |
| c    | Designation of Packing Type  
 E2 : E2 1reel=2000pcs |

Discontinued
## ELECTRICAL CHARACTERISTICS

R1250Vxx1A

<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>Set Output Voltage = -2.7V to -2.0V</td>
<td>2.7</td>
<td></td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Set Output Voltage = -4.0V to -2.8V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$I_{SS}$</td>
<td>Supply Current</td>
<td>Operation: Active, for IC itself $^*$Note1</td>
<td>-2.4V to -2.0V</td>
<td>1.50</td>
<td>2.30</td>
<td>mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-2.9V to -2.5V</td>
<td>1.60</td>
<td>2.55</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-3.4V to -3.0V</td>
<td>1.70</td>
<td>2.75</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-4.0V to -3.5V</td>
<td>1.80</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>$I_{SB}$</td>
<td>Shut-down Current</td>
<td>Operation: Shut-down, for IC itself $^*$Note2</td>
<td>-2.4V to -2.0V</td>
<td>0.1</td>
<td>1.0</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-2.9V to -2.5V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Output Voltage</td>
<td>$I_{OUT}=0mA/10mA$</td>
<td>-2.4V to -2.0V, $\pm0.95$</td>
<td>$\times1.05$</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{OUT}=50mA$</td>
<td>-2.4V to -2.0V, $\pm0.88$</td>
<td>$\times1.12$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{OUT}=75mA$</td>
<td>-2.4V to -2.0V, $\pm0.91$</td>
<td>$\times1.09$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-2.9V to -2.5V, $\pm0.97$</td>
<td>$\times1.03$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-3.4V to -3.0V, $\pm0.97$</td>
<td>$\times1.03$</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-4.0V to -3.5V, $\pm0.97$</td>
<td>$\times1.03$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{REF}$</td>
<td>Reference Voltage $^*$Note3</td>
<td>No load</td>
<td>$</td>
<td>V_{OUT}</td>
<td>$</td>
<td></td>
</tr>
<tr>
<td>$\Delta V_{OUT}/ \Delta I_{OUT}$</td>
<td>Load Regulation</td>
<td>$I_{OUT}=10mA$ to $50mA$</td>
<td>-2.4V to -2.0V</td>
<td>0.7</td>
<td></td>
<td>mV/mA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$I_{OUT}=10mA$ to $75mA$</td>
<td>-4.0V to -2.5V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$f_{OSC}$</td>
<td>Oscillator Frequency</td>
<td>Output Frequency</td>
<td>238</td>
<td>280</td>
<td>322</td>
<td>kHz</td>
</tr>
<tr>
<td>$\Delta f_{OSC}/\Delta T$</td>
<td>Oscillator Frequency Temperature Coefficient</td>
<td>$f_{OSC}$</td>
<td>$\pm0.25$</td>
<td>$\times1$</td>
<td>kHz/°C</td>
<td></td>
</tr>
<tr>
<td>$Duty$</td>
<td>Oscillator Duty Cycle</td>
<td>At no Load</td>
<td>50</td>
<td></td>
<td></td>
<td>%</td>
</tr>
<tr>
<td>$V_{DH}$</td>
<td>CE “H” Input Voltage</td>
<td></td>
<td>1.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{DL}$</td>
<td>CE “L” Input Voltage</td>
<td></td>
<td>0.25</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$R_{PU}$</td>
<td>CE Pull-up Resistance</td>
<td></td>
<td>0.68</td>
<td>1.25</td>
<td>3.00</td>
<td>MΩ</td>
</tr>
<tr>
<td>$R_{O}$</td>
<td>Resistance between $V_{OUT}$ and GND</td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td>kΩ</td>
</tr>
</tbody>
</table>

$^*$Note1: Refer to Test Circuit 1.
$^*$Note2: Refer to Test Circuit 6.
$^*$Note3: Do not connect to load. Refer to Technical Notes.
$^*$Use Ceramic Capacitors with low ESR. Capacitors with high ESR could have bad effect on the performance of this IC.
TYPICAL CHARACTERISTICS

1) Supply Current at no load vs. Input Voltage

2) Supply Current at no load vs. Temperature

3) Input Current vs. Output Load Current

4) Efficiency vs. Load Current

5) Oscillator Frequency vs. Input Voltage

6) Oscillator Frequency vs. Temperature
7) Output Voltage vs. Output Load Current

**R1250V201A**

- **VIN=5.0V**
  - 25°C: -1.9V
  - 50°C: -2.0V
  - 85°C: -2.1V

- **VIN=4.0V**
  - 25°C: -2.9V
  - 50°C: -3.0V
  - 85°C: -3.1V

**R1250V301A**

- **VIN=5.0V**
  - 25°C: -3.6V
  - 50°C: -3.7V
  - 85°C: -3.8V

- **VIN=4.0V**
  - 25°C: -4.1V
  - 50°C: -4.2V

**Discontinued**
8) Output Voltage vs. Temperature

- **R1250V201A**
  - Temperature Topt (°C): -50, -25, 25, 75, 50, 100
  - Output Voltage VOUT (V): -1.99, -1.98, -2.00, -2.01, -2.02

- **R1250V301A**
  - Temperature Topt (°C): -50, -25, 25, 75, 50, 100
  - Output Voltage VOUT (V): -3.05, -3.03, -3.03, -3.02, -3.01, -3.00, -2.99

- **R1250V401A**
  - Temperature Topt (°C): -50, -25, 25, 75, 50, 100
  - Output Voltage VOUT (V): -4.06, -4.05, -4.04, -4.03, -4.02, -4.01, -4.00, -3.99, -3.98

9) Output Voltage Waveform

Unless otherwise provided, conditions are as follows:
- Sample: R1250V301A
- VSW=5.0V
- CIN=COUT=4.7μF
- IOUT=0mA
- BW=20MHz
TEST CIRCUITS
Test Circuit 1) Supply Current 1
Test Circuit 2) Typical Characteristics 1), 2)
Test Circuit 3) Typical Characteristics 3), 4), 7), 8)
Test Circuit 4) Typical Characteristics 5), 6)
Test Circuit 5) Typical Characteristics 9)
Test Circuit 6) Standby Current

1) Test Circuit 1

<Definition> $I_{SS} = I_{SS-P} + I_{SS-N}$

(*) To stabilize voltage, a few µF bypass capacitors are applied to $V_{OUT}$ pin and $V_{IN}$ pin.
2) Test Circuit 2

3) Test Circuit 3

<Definition> \eta = (|V_{out}| \times \text{Load})/(V_{ref}) \times 100(\%)

4) Test Circuit 4

(*) To stabilize voltage, a few \mu F bypass capacitor is applied to V_{in} pin.
5) Test Circuit 5

6) Test Circuit 6

TYPICAL APPLICATION

(*) Vref pin should not be wired. Refer to Technical Notes.
R1250Vxx1A

OPERATION

1) Basic Operation

The R1250Vxx1A Series make SW1 through SW4 ON and OFF by the clock generated by internal oscillator (OSC) with fixed frequency, and operate as an inverting charge pump with the capacitor \( C_b \) and the capacitor \( C_{OUT} \).

The Output Voltage is feedback and the voltage between the Output Voltage and Reference Voltage (\( V_{REF} = |V_{OUT}| \)) is divided half, and it is compared with the GND (=0V) level by an internal operational amplifier.

By this action, the impedance of SW3 is controlled to correspond with its load current and Output Voltage keeps “Set \( V_{OUT} \)” level.

2) Status of Internal Circuits at Standby mode and Standby Current

At Standby mode, R1250V Series keep the voltage of \( C_b \) as shown below:

When you design a system with using this IC, consider the following subjects:

2-(1) If very small leakage current would be a critical, the leakage current of both \( C_b \) and \( C_{OUT} \) should be considered.

2-(2) Because the voltage level of \( C_b \) keeps as much as \( V_{IN} \) level, the speed for start-up from stand-by mode is faster than the start-up by power-on.

2-(3) \( V_{OUT} \) is internally pulled down through 5kΩ to GND. Time constant \( \tau \) of transient response (turn-off speed) of \( V_{OUT} \) can be calculated as follows:

\[ \tau = (5[\Omega]) \times \frac{C_{OUT}}{R_{OUT}} \quad (R_{OUT}: \text{Output load resistance}) \]

2-(4) Load current should be OFF synchronously with this IC if the load is electronic or connected between \( V_{IN} \) and \( V_{OUT} \). If some charge is continuously flown to the Output \( V_{OUT} \) at the “OFF” state, the voltage level of \( V_{OUT} \) will rise and could be beyond 0V. And if the voltage will be +0.3V (that is designated as absolute maximum rating.), this IC might be break down.

3) Ripple Voltage

Ripple voltage of Output waveform can be roughly calculated as follows:

\[ \text{Ripple [mVp-p]} \equiv 0.5 \times \left( \frac{\text{I}_{\text{OUT}} \text{[mA]} + \text{Supply Current at no load \text{[mA]}}}{(\text{Oscillator Frequency} \times 280000 \text{[Hz]})} \right) / C_{OUT} \text{[F]} \]

Supply Current at no load [mA] \( \equiv \) Supply Current 1 [mA]
4) Power Consumption

Power Consumption at large load current of this IC can be calculated as follows:

\[ \text{Wchip [mW]} = (V_{\text{IN}} [V] - \text{Set Output Voltage}) \times (I_{\text{OUT}} [mA]) \]

**TECHNICAL NOTES**

To use this IC, the following things should be considered.

1) Short Protection function for each pin is not included in this IC.
2) Use capacitors with low equivalent series resistor (ESR) for \( C_{\text{IN}}, C_{\text{OUT}} \) pins. Capacitors with large ESR make this IC’s performance worse.
3) Make wiring of GND, \( V_{\text{IN}}, V_{\text{OUT}} \) secure enough and decrease impedance. High impedance could be a cause of unstable operation of this IC.
4) When this IC is used with large load current, consider its radiation of heat.
5) Basically, Vref pin can be used for soldering to the mount pad of PCB. Do not make it wiring.
6) Load type is electronic or setting between \( V_{\text{IN}} \) and \( V_{\text{OUT}} \), in cases of OFF-state of this IC and start-up state of this IC, make sure not to raise \( V_{\text{OUT}} \) level on positive voltage side. If the voltage level is beyond +0.3V, which is designated as the absolute maximum rating, this IC could be broken.
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RICOH COMPANY, LTD. Electronic Devices Company

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Ricoh presented with the Japan Management Quality Award for 1999.
Ricoh continually strives to promote customer satisfaction, and shares the achievements of its management quality improvement program with people and society.

Ricoh awarded ISO 14001 certification.
The Ricoh Group was awarded ISO 14001 certification, which is an international standard for environmental management systems, at both its domestic and overseas production facilities. Our current aim is to obtain ISO 14001 certification for all of our business offices.

Ricoh completed the organization of the Lead-free production for all of our products. 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.

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