OUTLINE

The RP507K001B is a CMOS-based 600mA(1) step-down DC/DC converter with synchronous rectifier. Internally, a single converter consists of an oscillator, a reference voltage unit, an error amplifier, a switching control circuit, a soft-start circuit, an under voltage lockout (UVLO) circuit, an over current protection circuit, a thermal shutdown circuit and switching transistors. Replacing diodes with built-in switching transistors improves the efficiency of rectification. Therefore, by simply using an inductor, resistors and capacitors as the external components, a low ripple high efficiency synchronous rectifier step-down DC/DC converter can be easily configured.

The RP507K001B has an over current protection circuit which supervises the inductor peak current in each switching cycle, and turns the high-side driver off if the current exceeds the Lx current limit. The RP507K001B also contains a thermal shutdown circuit which detects overheating of the converter and stops the converter operation to protect it from damage if the junction temperature exceeds the specified temperature.

The RP507K001B is PWM/VFM auto switching control in which mode automatically switches from PWM mode to high-efficiency VFM mode in low output current.

The RP507K001B is available in DFN(PLP)1616-6D package which achieves high-density mounting on boards. For an input capacitor (CIN) and an output capacitor (COUT), the smaller sized 0402/1005 (inch/mm) capacitor can be used. Output voltage is adjustable with external divider resistors.

FEATURES

- Input Voltage Range ............................................. 2.3V to 5.5V (Absolute maximum rating: 6.5V)
- Output Voltage Range .............................. 0.7V to 5.5V
  (Note: As for 1.0V or less, input voltage range is limited.)
- Feedback Voltage Accuracy ........................................ 
  \( \pm 9\text{mV} (V_{FB}=0.6\text{V}) \)
- Temperature-Drift Coefficient of Feedback Voltage
  Typ. \( \pm 100\text{ppm/}^\circ\text{C} \)
- Oscillator Frequency ............................................. Typ. 2.0MHz
- Maximum Duty Cycle ............................................ 100%
- Built-in Driver ON Resistance ......................... Typ. Pch. 0.38Ω, Nch. 0.3Ω \((V_{IN}=3.6\text{V})\)
- Supply Current (at no load)............................ Typ. 34\(\mu\text{A}\)
- Standby Current.................................................. Max. 5\(\mu\text{A}\)
- UVLO Detector Threshold................................. Typ. 2.0V
- Soft-start Time..................................................... Typ. 150\(\mu\text{s}\)
- Lx Current Limit Circuit........................................ Typ. 1A
- Package .......................................................... DFN(PLP)1616-6D

(1) This is an approximate value, because output current depends on conditions and external components.
APPLICANCES

- Power source for portable equipment such as cellular, PDA, DSC, Notebook PC, smartphone
- Power source for Li-ion battery-used equipment

SELECTION GUIDE

<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>RP507K001B-TR</td>
<td>DFN(PLP)1616-6D</td>
<td>5,000pcs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Output voltage (V\text{\textsc{set}}) is adjustable with external divider resistors.
Recommended output voltage range is from 0.7V to 5.5V.
RP507K001B has an auto-discharge function\(^{(1)}\).

BLOCK DIAGRAMS

\(^{(1)}\) Auto-discharge function quickly lowers the output voltage to 0V, when the chip enable signal is switched from the active mode to the standby mode, by releasing the electrical charge accumulated in the external capacitor.
## PIN DESCRIPTIONS

### DFN(PLP)1616-6D

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CE</td>
<td>Chip Enable Pin (&quot;H&quot; Active)</td>
</tr>
<tr>
<td>2</td>
<td>AGND</td>
<td>Ground Pin (1)</td>
</tr>
<tr>
<td>3</td>
<td>PGND</td>
<td>Ground Pin (1)</td>
</tr>
<tr>
<td>4</td>
<td>LX</td>
<td>LX Switching Pin</td>
</tr>
<tr>
<td>5</td>
<td>VIN</td>
<td>Input Pin</td>
</tr>
<tr>
<td>6</td>
<td>VFB</td>
<td>Feedback Pin</td>
</tr>
</tbody>
</table>

The exposed tab on the bottom of the package enhances thermal performance and is electrically connected to GND (substrate level). It is recommended that the exposed tab be connected to the ground plane on the board or otherwise be left open.

(1) No.2 pin and No.3 pin must be wired to the GND plane when mounting on boards.
**ABSOLUTE MAXIMUM RATINGS**

Absolute Maximum Ratings (AGND=PGND=0V)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V(_\text{IN})</td>
<td>VIN Input Voltage</td>
<td>-0.3 to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>V(_\text{LX})</td>
<td>LX Pin Voltage</td>
<td>-0.3 to V(_\text{IN}) + 0.3</td>
<td>V</td>
</tr>
<tr>
<td>V(_\text{CE})</td>
<td>CE Pin Input Voltage</td>
<td>-0.3 to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>V(_\text{FB})</td>
<td>V(_\text{FB}) Pin Voltage</td>
<td>-0.3 to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>I(_\text{LX})</td>
<td>LX Pin Output Current</td>
<td>1</td>
<td>A</td>
</tr>
<tr>
<td>P(_\text{D})</td>
<td>Power Dissipation(^{(1)})(DFN(PLP)1616-6D, JEDEC STD. 51-7)</td>
<td>1580</td>
<td>mW</td>
</tr>
<tr>
<td>T(_\text{j})</td>
<td>Junction Temperature</td>
<td>-40 to 125</td>
<td>°C</td>
</tr>
<tr>
<td>T(_\text{stg})</td>
<td>Storage Temperature Range</td>
<td>-55 to 125</td>
<td>°C</td>
</tr>
</tbody>
</table>

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 are not assured.

**RECOMMENDED OPERATING CONDITIONS**

Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>V(_\text{IN})</td>
<td>Input Voltage</td>
<td>1.0V ≤ V(_\text{SET})(^{(2)})</td>
<td>2.3 to 5.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.9V ≤ V(_\text{SET}) &lt; 1.0V</td>
<td>2.3 to 5.25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.7V ≤ V(_\text{SET}) &lt; 0.9V</td>
<td>2.3 to 4.5</td>
</tr>
<tr>
<td>Ta</td>
<td>Operating Temperature Range</td>
<td>-40 to 85</td>
<td>°C</td>
</tr>
</tbody>
</table>

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 ratings by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

\(^{(1)}\) Refer to POWER DISSIPATION for detailed information.

\(^{(2)}\) V\(_\text{SET}\)= Set Output Voltage
## Electrical Characteristics

### Symbol | Item | Conditions | Min. | Typ. | Max. | Unit
---|---|---|---|---|---|---
\( V_{FB} \) | Feedback Output Voltage | \( V_{IN}=V_{CE}=3.6V \) | 0.591 | 0.600 | 0.609 | V

\( \Delta V_{FB}/\Delta T \) | Feedback Output Voltage Temperature Coefficient | \(-40^\circ C \leq Ta \leq 85^\circ C\) | ±100 | ppm/°C

\( f_{osc} \) | Oscillator Frequency | \( V_{IN}=V_{CE}=3.6V \) (\( V_{SET} \leq 2.6V \)), \( V_{IN}=V_{CE}=V_{SET}+1V \) (\( V_{SET} > 2.6V \)) | 1.7 | 2.0 | 2.3 | MHz

\( I_{DD} \) | Supply Current | \( V_{IN}=V_{CE}=V_{FB}=3.6V \) | 32 | 45 | | µA

I_{standby} | Standby Current | \( V_{IN}=5.5V, V_{CE}=0V \) | 0 | 5 | | µA

I_{CEH} | CE "H" Input Current | \( V_{IN}=V_{CE}=5.5V \) | -1 | 0 | 1 | µA

I_{CEL} | CE "L" Input Current | \( V_{IN}=V_{CE}=5.5V \) | -1 | 0 | 1 | µA

I_{VFH} | VFB "H" Input Current | \( V_{IN}=V_{FB}=5.5V, V_{CE}=0V \) | -1 | 0 | 1 | µA

I_{VFL} | VFB "L" Input Current | \( V_{IN}=5.5V, V_{CE}=V_{FB}=0V \) | -1 | 0 | 1 | µA

\( t_{dis} \) | Auto Discharge Time(2) | \( V_{IN}=2.3V, V_{CE}=0V, C_{OUT}=10\mu F \) | 5 | 10 | | ms

I_{LXEH} | LX Leakage Current "H" | \( V_{IN}=V_{LX}=5.5V, V_{CE}=0V \) | -1 | 0 | 5 | µA

I_{LXEL} | LX Leakage Current "L" | \( V_{IN}=5.5V, V_{CE}=V_{LX}=0V \) | -5 | 0 | 1 | µA

\( V_{CEH} \) | CE "H" Input Voltage | \( V_{IN}=5.5V \) | 1.0 | | | V

\( V_{CEL} \) | CE "L" Input Voltage | \( V_{IN}=2.3V \) | 0.4 | | | V

R_{ONP} | On Resistance of Pch Tr. | \( V_{IN}=3.6V, I_{LX}=-100mA \) | 0.38 | | | Ω

R_{ONN} | On Resistance of Nch Tr. | \( V_{IN}=3.6V, I_{LX}=-100mA \) | 0.3 | | | Ω

Maxduty | Maximum Duty Cycle | | 100 | | | %

\( t_{start} \) | Soft-start Time | \( V_{IN}=V_{CE}=3.6V \) (\( V_{SET} \leq 2.6V \)), \( V_{IN}=V_{CE}=V_{SET}+1V \) (\( V_{SET} > 2.6V \)) | 150 | 300 | | µs

I_{LXLM} | LX Current Limit | \( V_{IN}=V_{CE}=3.6V \) (\( V_{SET} \leq 2.6V \)), \( V_{IN}=V_{CE}=V_{SET}+1V \) (\( V_{SET} > 2.6V \)) | 800 | 100 | | mA

V_{UVLO1} | UVLO Detector Threshold | \( V_{IN}=V_{CE} \) | 1.9 | 2.0 | 2.1 | V

V_{UVLO2} | UVLO Released Voltage | \( V_{IN}=V_{CE} \) | 2.0 | 2.1 | 2.2 | V

\( T_{TSD} \) | Thermal Shutdown Temperature | Junction Temperature | 140 | | | °C

\( T_{TSR} \) | Thermal Shutdown Released Temperature | Junction Temperature | 100 | | | °C

---

Note: Test circuit is "OPEN LOOP" and AGND=PGND=0V unless otherwise specified.

---

(1) \( V_{SET} \) = Set Output Voltage

(2) It starts when the CE pin is low and ends when \( V_{OUT} \leq V_{SET} \times 0.1 \).
THEORY OF OPERATION

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

The step-down DC/DC converter charges energy in the inductor when L x Tr. turns “ON”, and discharges the energy from the inductor when L x Tr. turns “OFF” and operates with less energy loss, so that a lower output voltage (V_{OUT}) than the input voltage (V_{IN}) can be obtained.

The operation of the step-down DC/DC converter is explained in the following figures.

**Step 1.** Pch Tr. turns “ON” and IL (i1) flows, L is charged with energy. At this moment, i1 increases from the minimum inductor current (IL_{min}), which is 0A, and reaches the maximum inductor current (IL_{max}) in proportion to the on-time period (ton) of Pch Tr.

**Step 2.** When Pch Tr. turns “OFF”, L tries to maintain IL at IL_{max}, so L turns Nch Tr. “ON” and IL (i2) flows into L.

**Step 3.** i2 decreases gradually and reaches IL_{min} after the open-time period (topen) of Nch Tr., and then Nch Tr. turns “OFF”. This is called discontinuous current mode.

As the output current (I_{OUT}) increases, the off-time period (toff) of Pch Tr. runs out before IL reaches IL_{min}. The next cycle starts, and Pch Tr. turns “ON” and Nch Tr. turns “OFF”, which means IL starts increasing from IL_{min}. This is called continuous current mode.

In the case of PWM control system, V_{OUT} is maintained by controlling ton. During PWM control, the oscillator frequency (fosc) is being maintained constant.

As shown in Figure 2, when the step-down DC/DC operation is constant, IL_{min} and IL_{max} during ton of Pch Tr. would be same as during toff of Pch Tr.

The current differential between IL_{max} and IL_{min} is described as ∆I.

\[
\Delta I = I_{L\text{max}} - I_{L\text{min}} = V_{\text{OUT}} \times \text{topen} / L = (V_{\text{IN}} - V_{\text{OUT}}) \times \text{ton} / L
\]

Equation 1

However,

\[
T = 1 / fosc = \text{ton} + \text{toff}
\]

Duty (%) = ton / T × 100 = ton × fosc × 100
topen ≤ toff
In Equation 1, “\( V_{OUT} \times \text{topen} / L \)” shows the amount of current change in “OFF” state. Also, “\((V_{IN} - V_{OUT}) \times \text{ton} / L\)” shows the amount of current change at “ON” state.

**Discontinuous Mode and Continuous Mode**

As illustrated in Figure 3., when \( I_{OUT} \) is relatively small, \( \text{topen} < \text{toff} \). In this case, the energy charged into L during \( \text{ton} \) will be completely discharged during \( \text{toff} \), as a result, \( IL_{min} = 0 \). This is called discontinuous mode.

When \( I_{OUT} \) is gradually increased, eventually \( \text{topen} = \text{toff} \) and when \( I_{OUT} \) is increased further, eventually \( IL_{min} > 0 \). This is called continuous mode.

![Figure 3. Discontinuous Mode](image1)

![Figure 4. Continuous Mode](image2)

In the continuous mode, the solution of Equation 1 is described as \( \text{tonc} \).

\[
\text{tonc} = T \times \frac{V_{OUT}}{V_{IN}} \\
\text{Equation 2}
\]

When \( \text{ton} < \text{tonc} \), it is discontinuous mode, and when \( \text{ton} = \text{tonc} \), it is continuous mode.
VFM Mode
In low output current, the IC automatically switches into VFM mode in order to achieve high efficiency. In VFM mode, ton is forced to end when the inductor current reaches the pre-set ILmax. In the VFM mode, ILmax is typically set to 180mA. When ton reaches 1.5 times of T=1/fosc, ton will be forced to end even if the inductor current is not reached ILmax.

Figure 5. VFM Mode
Output Current and Selection of External Components

The following equations explain the relationship between output current and peripheral components used in the diagrams in “TYPICAL APPLICATIONS”.

Ripple Current P-P value is described as \( I_{RP} \), ON resistance of Pch Tr. is described as \( R_{ONP} \), ON resistance of Nch Tr. is described as \( R_{ONN} \), and DC resistor of the inductor is described as \( R_L \).

First, when Pch Tr. is “ON”, the following equation is satisfied.

\[
V_{IN} = V_{OUT} + (R_{ONP} + R_L) \times I_{OUT} + L \times \frac{I_{RP}}{t_{on}} \]

Equation 3

Second, when Pch Tr. is "OFF" (Nch Tr. is "ON"), the following equation is satisfied.

\[
L \times \frac{I_{RP}}{t_{off}} = R_{ONN} \times I_{OUT} + V_{OUT} + R_L \times I_{OUT} \]

Equation 4

Put Equation 4 into Equation 3 to solve ON duty of Pch Tr. \( (D_{ON} = \frac{t_{on}}{t_{off} + t_{on}}) \):

\[
D_{ON} = \frac{(V_{OUT} + R_{ONN} \times I_{OUT} + R_L \times I_{OUT})}{(V_{IN} + R_{ONN} \times I_{OUT} - R_{ONP} \times I_{OUT})} \]

Equation 5

Ripple Current is described as follows:

\[
I_{RP} = \frac{(V_{IN} - V_{OUT} - R_{ONP} \times I_{OUT} - R_L \times I_{OUT}) \times D_{ON}}{f_{osc} \times L} \]

Equation 6

Peak current that flows through \( L \), and \( L_X \) Tr. is described as follows:

\[
I_{LX_{MAX}} = I_{OUT} + \frac{I_{RP}}{2} \]

Equation 7

★ Please consider \( I_{LX_{MAX}} \) when setting conditions of input and output, as well as selecting the external components.

★ The above calculation formulas are based on the ideal operation of the ICs in continuous mode.
Timing Chart

(1) Soft-start Time

Starting-up with CE Pin

The IC starts to operate when the CE pin voltage ($V_{CE}$) exceeds the threshold voltage. The threshold voltage is preset between CE “H” input voltage ($V_{CEH}$) and CE “L” input voltage ($V_{CEL}$).

After the start-up of the IC, soft-start circuit starts to operate. Then, after a certain period of time, the reference voltage ($V_{REF}$) in the IC gradually increases up to the specified value.

![Diagram showing soft-start time and voltage levels](image)

Soft-start time starts when soft-start circuit is activated, and ends when the reference voltage reaches the specified voltage.

★ Soft start time is not always equal to the turn-on speed of the step-down DC/DC converter. Please note that the turn-on speed could be affected by the power supply capacity, the output current, the inductance value and the $C_{OUT}$ value.
Starting-up with Power Supply
After the power-on, when $V_{IN}$ exceeds the UVLO released voltage ($V_{UVLO2}$), the IC starts to operate. Then, soft-start circuit starts to operate and after a certain period of time, $V_{REF}$ gradually increases up to the specified value. Soft-start time starts when soft-start circuit is activated, and ends when $V_{REF}$ reaches the specified voltage.

Depending on Power Supply, Load Current, External Components

★ Please note that the turn-on speed of $V_{OUT}$ could be affected by the power supply capacity, the output current, the inductance value, the $C_{OUT}$ value and the turn-on speed of $V_{IN}$ determined by $C_{IN}$.
(2) Under Voltage Lockout (UVLO) Circuit
If $V_{IN}$ becomes lower than $V_{SET}$, the step-down DC/DC converter stops the switching operation and ON duty becomes 100%, and then $V_{OUT}$ gradually drops according to $V_{IN}$.

If the $V_{IN}$ drops more and becomes lower than the UVLO detector threshold ($V_{UVLO1}$), the UVLO circuit starts to operate, $V_{REF}$ stops, and Pch and Nch built-in switch transistors turn "OFF". As a result, $V_{OUT}$ drops according to the $C_{OUT}$ capacitance value and the load.

To restart the operation, $V_{IN}$ needs to be higher than $V_{UVLO2}$. The timing chart below shows the voltage shifts of $V_{REF}$, $V_{LX}$ and $V_{OUT}$ when $V_{IN}$ value is varied.

![Timing Chart](image)

- Falling edge (operating) and rising edge (releasing) waveforms of $V_{OUT}$ could be affected by the initial voltage of $C_{OUT}$ and the output current of $V_{OUT}$. 
(3) Over Current Protection Circuit
Over current protection circuit supervises the inductor peak current (the peak current flowing through Pch Tr.) in each switching cycle, and if the current exceeds the Lx current limit ($I_{LX\text{lim}}$), it turns off Pch Tr. $I_{LX\text{lim}}$ of the RP507K001B is set to Typ. 1000mA.

Notes: $I_{LX\text{lim}}$ could be easily affected by self-heating or ambient environment. If the $V_{IN}$ drops dramatically or becomes unstable due to short-circuit, protection operation could be affected.
APPLICATION INFORMATION

Typical Application
(Adjustable Output Voltage Type)

GPIO Control
"L" -> Disable
"H" -> Enable
Table 1. Recommended Components

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Value</th>
<th>Components</th>
<th>Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_{IN}</td>
<td>4.7,\mu F</td>
<td>Ceramic Capacitor</td>
<td>C1005X5R0J475M (TDK) JMK105BBJ475MV (Taiyo Yuden) GRM155R60J475ME47 (Murata)</td>
</tr>
<tr>
<td>C_{OUT}</td>
<td>10,\mu F</td>
<td>Ceramic Capacitor</td>
<td>GRM155R60J106ME44 (Murata) JMK105CBJ106MV (Taiyo Yuden)</td>
</tr>
<tr>
<td>L</td>
<td>2.2,\mu H</td>
<td>Inductor</td>
<td>LQM21PN2R2NGC (Murata) CIG21L2R2MNE (Samsung Electro-Mechanics) MIPSZ2012D2R2 (FDK)</td>
</tr>
<tr>
<td></td>
<td>4.7,\mu H</td>
<td></td>
<td>CIG21L4R7MNE (Samsung Electro-Mechanics) MIPS2520D4R7 (FDK)</td>
</tr>
</tbody>
</table>
When using the RP507K001B, please consider the following points.

- AGND and PGND must be wired to the GND plane when mounting on boards.

- Ensure the \( V_{\text{IN}} \) and AGND/PGND lines are sufficiently robust. A large switching current flows through the AGND/PGND lines, the \( V_{\text{DD}} \) line, the \( V_{\text{OUT}} \) line, an inductor, and \( L_{X} \). If their impedance is too high, noise pickup or unstable operation may result. Set the external components as close as possible to the IC and minimize the wiring between the components and the IC, especially between a capacitor \( (C_{\text{IN}}) \) and the \( V_{\text{IN}} \) pin. The wiring between a resistor for setting output voltage \( (R_{1}) \) and an inductor \( (L) \) and between \( L \) and Load should be separated.

- Choose a low ESR ceramic capacitor. The capacitance of \( C_{\text{IN}} \) should be more than or equal to 4.7\( \mu \)F. The capacitance of a capacitor \( (C_{\text{OUT}}) \) should be 10\( \mu \)F.

- The Inductance value should be set within the range of 1.5\( \mu \)H to 4.7\( \mu \)H. However, the inductance value is limited by output voltage, so please refer to the table below. The phase compensation of this IC is designed according to the \( C_{\text{OUT}} \) and \( L \) values. Choose an inductor that has small DC resistance, has enough allowable current and is hard to cause magnetic saturation. If the inductance value of an inductor is extremely small, the peak current of \( L_{X} \) may increase. The increased \( L_{X} \) peak current reaches "\( L_{X} \) limit current" to trigger over current protection circuit even if the load current is less than 600mA.

<table>
<thead>
<tr>
<th>Set Output Voltage (V)</th>
<th>Inductance</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{SET}} )</td>
<td>( L=1.5\mu \text{H} )</td>
</tr>
<tr>
<td>0.7~1.0</td>
<td>Ok</td>
</tr>
<tr>
<td>1.1~1.7</td>
<td>-</td>
</tr>
<tr>
<td>1.8~2.5</td>
<td>-</td>
</tr>
<tr>
<td>2.6~</td>
<td>-</td>
</tr>
</tbody>
</table>

- Over current protection circuit may be affected by self-heating or power dissipation environment.

- The output voltage \( (V_{\text{OUT}}) \) is adjustable by changing the \( R_{1} \) and \( R_{2} \) values as follows.

\[
V_{\text{OUT}} = V_{\text{FB}} \times \frac{(R_{1} + R_{2})}{R_{2}} \quad (0.7V \leq V_{\text{OUT}} \leq 5.5V)
\]
The recommended resistance values for R₁, R₂ and C₁ are as follows.

<table>
<thead>
<tr>
<th>Set Output Voltage (V)</th>
<th>R₁ (kΩ)</th>
<th>R₂ (kΩ)</th>
<th>C₁ (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>120</td>
<td>180</td>
<td>22</td>
</tr>
<tr>
<td>1.2</td>
<td>180</td>
<td>180</td>
<td>22</td>
</tr>
<tr>
<td>1.5</td>
<td>270</td>
<td>180</td>
<td>22</td>
</tr>
<tr>
<td>1.8</td>
<td>240</td>
<td>120</td>
<td>22</td>
</tr>
<tr>
<td>2.5</td>
<td>380</td>
<td>120</td>
<td>15</td>
</tr>
<tr>
<td>2.8</td>
<td>275</td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td>3.3</td>
<td>270</td>
<td>60</td>
<td>15</td>
</tr>
</tbody>
</table>

The performance of power source circuits using this IC largely depends on the peripheral circuits. When selecting the peripheral components, please consider the conditions of use. Do not allow each component, PCB pattern and the IC to exceed their respected rated values (voltage, current, and power) when designing the peripheral circuits.

Reference PCB Layout

RP507K001B (PKG: DFN(PLP)1616–6D) PCB Layout

- R₁₁ and R₁₂ are arranged as a substitute for R₁ so that two resistors can be connected in series.
TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current

<table>
<thead>
<tr>
<th>VIN (V)</th>
<th>VOUT (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>1000</td>
</tr>
</tbody>
</table>

2) Output Voltage vs. Input Voltage

<table>
<thead>
<tr>
<th>Input Voltage VIN (V)</th>
<th>Output Voltage VOUT (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.6</td>
<td>0.01</td>
</tr>
<tr>
<td>4.3</td>
<td>0.1</td>
</tr>
<tr>
<td>5.0</td>
<td>1</td>
</tr>
<tr>
<td>5.5</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>100</td>
<td>1000</td>
</tr>
</tbody>
</table>

RICOH
3) Feedback Voltage vs. Temperature

![Feedback Voltage vs. Temperature Graph]

4) Efficiency vs. Output Current

![Efficiency vs. Output Current Graph]
5) Supply Current vs. Temperature
RP507K001B Vout=1.8V (VIN=3.6V)

6) Supply Current vs. Input Voltage
RP507K001B Vout=1.8V

7) DC/DC Output Waveform
RP507K001B Vout=1.0V (VIN=3.6V)
8) Oscillator Frequency vs. Temperature

9) Oscillator Frequency vs. Input Voltage

10) Soft-start Time vs. Temperature

11) UVLO Detector Threshold / Released Voltage vs. Temperature
12) CE Input Voltage vs. Temperature

CE"H" Input Voltage (V_{IN}=5.5V)  

CE"L" Input Voltage (V_{IN}=2.3V)  

13) LX Current Limit vs. Temperature  

14) On Resistance of Pch Tr. vs. Temperature  

15) On Resistance of Nch Tr. vs. Temperature
16) Load Transient Response ($C_{\text{OUT}}=10\,\mu\text{F}$ GRM155R60J106ME44)

**RP507K001B** ($V_{\text{IN}}=3.6\,\text{V}$, $V_{\text{OUT}}=1.0\,\text{V}$)

- **Output Voltage $V_{\text{OUT}}$ (V)**
  - $0.85, 0.9, 0.95, 1, 1.05$
- **Output Current $I_{\text{OUT}}$ (mA)**
  - $0, 10, 20, 30, 40, 50, 60, 70, 80, 90$
- **Time $t$ (µs)**
  - $0, 10, 20, 30, 40, 50, 60, 70, 80, 90$

- **Output Current $I_{\text{OUT}}$ (mA)**
  - $0.85, 0.9, 0.95, 1, 1.05$
- **Output Voltage $V_{\text{OUT}}$ (V)**
  - $0, 100, 200, 300, 400, 500, 600, 700, 800, 900$
- **Time $t$ (µs)**
  - $0, 100, 200, 300, 400, 500, 600, 700, 800, 900$

**RP507K001B** ($V_{\text{IN}}=3.6\,\text{V}$, $V_{\text{OUT}}=1.2\,\text{V}$)

- **Output Voltage $V_{\text{OUT}}$ (V)**
  - $0.85, 0.9, 0.95, 1, 1.05$
- **Output Current $I_{\text{OUT}}$ (mA)**
  - $0, 10, 20, 30, 40, 50, 60, 70, 80, 90$
- **Time $t$ (µs)**
  - $0, 10, 20, 30, 40, 50, 60, 70, 80, 90$

- **Output Current $I_{\text{OUT}}$ (mA)**
  - $0.85, 0.9, 0.95, 1, 1.05$
- **Output Voltage $V_{\text{OUT}}$ (V)**
  - $0, 100, 200, 300, 400, 500, 600, 700, 800, 900$
- **Time $t$ (µs)**
  - $0, 100, 200, 300, 400, 500, 600, 700, 800, 900$
RP507K001B (V\textsubscript{IN}=5.0V, V\textsubscript{OUT}=3.3V)

![Graph showing output current and output voltage over time for different current transitions (1mA to 300mA, 300mA to 1mA, 200mA to 500mA, 500mA to 200mA)]

RP507K001B (V\textsubscript{IN}=5.0V, V\textsubscript{OUT}=3.3V)

![Graph showing output current and output voltage over time for different current transitions (1mA to 300mA, 300mA to 1mA, 200mA to 500mA, 500mA to 200mA)]
The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following measurement conditions are based on JEDEC STD. 51-7.

**Measurement Conditions**

<table>
<thead>
<tr>
<th>Item</th>
<th>Measurement Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td>Mounting on Board (Wind Velocity = 0 m/s)</td>
</tr>
<tr>
<td>Board Material</td>
<td>Glass Cloth Epoxy Plastic (Four-Layer Board)</td>
</tr>
<tr>
<td>Board Dimensions</td>
<td>76.2 mm × 114.3 mm × 0.8 mm</td>
</tr>
<tr>
<td>Copper Ratio</td>
<td>Outer Layer (First Layer): Less than 95% of 50 mm Square</td>
</tr>
<tr>
<td></td>
<td>Inner Layers (Second and Third Layers): Approx. 100% of 50 mm Square</td>
</tr>
<tr>
<td></td>
<td>Outer Layer (Fourth Layer): Approx. 100% of 50 mm Square</td>
</tr>
<tr>
<td>Through-holes</td>
<td>Ø 0.2 mm × 15 pcs</td>
</tr>
</tbody>
</table>

**Measurement Result**

(Ta = 25°C, Tjmax = 125°C)

<table>
<thead>
<tr>
<th>Item</th>
<th>Measurement Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Dissipation</td>
<td>1580 mW</td>
</tr>
<tr>
<td>Thermal Resistance ((\theta_{ja}))</td>
<td>(\theta_{ja} = 63^\circ C/W)</td>
</tr>
<tr>
<td>Thermal Characterization Parameter ((\psi_{jt}))</td>
<td>(\psi_{jt} = 33^\circ C/W)</td>
</tr>
</tbody>
</table>

\(\theta_{ja}\): Junction-to-Ambient Thermal Resistance  
\(\psi_{jt}\): Junction-to-Top Thermal Characterization Parameter

![Power Dissipation vs. Ambient Temperature](image1)

![Measurement Board Pattern](image2)
The tab on the bottom of the package shown by circle is a substrate potential (GND). It is recommended that this tab be connected to the ground plane on the board but it is possible to leave the tab floating.
1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to Ricoh sales representatives for the latest information thereon.

2. The materials in this document may not be copied or otherwise reproduced in whole or in part without prior written consent of Ricoh.

3. Please be sure to take any necessary formalities under relevant laws or regulations before exporting or otherwise taking out of your country the products or the technical information described herein.

4. The technical information described in this document shows typical characteristics of and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under Ricoh’s or any third party’s intellectual property rights or any other rights.

5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a Ricoh product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death (aircraft, space vehicle, nuclear reactor control system, traffic control system, automotive and transportation equipment, combustion equipment, safety devices, life support system etc.) should first contact us.

6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.

7. Anti-radiation design is not implemented in the products described in this document.

8. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.

9. WCLSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.

10. There can be variation in the marking when different AOI (Automated Optical Inspection) equipment is used. In the case of recognizing the marking characteristic with AOI, please contact Ricoh sales or our distributor before attempting to use AOI.

11. Please contact Ricoh sales representatives should you have any questions or comments concerning the products or the technical information.

Ricoh is committed to reducing the environmental loading materials in electrical devices with a view to contributing to the protection of human health and the environment. Ricoh has been providing RoHS compliant products since April 1, 2006 and Halogen-free products since April 1, 2012.

Ricoh is providing RoHS compliant products since April 1, 2006 and Halogen-free products since April 1, 2012.

https://www.e-devices.ricoh.co.jp/en/