OUTLINE
The RP506K is a low supply current CMOS-based PWM/VFM step-down DC/DC converter with synchronous rectifier featuring 2 A\(^{(1)}\) output current. Internally, a single converter consists of an oscillator, a reference voltage unit, an error amplifier, a switching control circuit, a mode control circuit, a soft start circuit, a latch type protection circuit, an under-voltage lockout (UVLO) circuit, a thermal shutdown circuit, and switching transistors. The RP506K is employing synchronous rectification for improving the efficiency of rectification by replacing diodes with built-in switching transistors. Using synchronous rectification not only increases circuit performance but also allows a design to reduce parts count.

Power controlling method can be selected from forced PWM control type or PWM/VFM auto switching control type by inputting a signal to the MODE pin. In low output current, forced PWM control switches at fixed frequency rate in order to reduce noise. Likewise, in low output current, PWM/VFM auto switching control automatically switches from PWM mode to VFM mode in order to achieve high efficiency.

Output voltage type can be selected from an internally fixed output voltage type (RP506Kxx1A/B/D/E) or an externally adjustable output voltage type (RP506K001C/F). The output voltage of the RP506Kxx1A/B/D/E can be set by 0.1 V step and the output voltage accuracy is as high as ±1.5% or ±18 mV. The output voltage of the RP506K001C/F can be set by using the external resistors.

Oscillator frequency can be selected from 2.25 MHz (RP506Kxx1A/B/C) or 1.2 MHz (RP506Kxx1D/E/F). Soft-start time is Typ. 0.15 ms, and by connecting an external capacitor to the TSS pin, soft-start time is adjustable.

Power good (PG) function monitors the V\(_{OUT}\) pin voltage or the feedback pin voltage (V\(_{FB}\)), and switches the PG pin to low if any abnormal condition is detected.

Protection circuits included in the RP506K are over current protection circuit, latch type protection circuit and thermal shutdown circuit. Over current protection circuit supervises the inductor peak current in each switching cycle, and if the current exceeds the L\(_X\) current limit (I\(_{LXLIM}\)), it turns off Pch Tr. Latch type protection circuit latches the built-in driver to the OFF state and stops the operation of the step-down DC/DC converter if the over current status continues or V\(_{OUT}\) continues being the half of the setting voltage for equal or longer than protection delay time (t\(_{prot}\)). Thermal shutdown circuit detects overheating of the converter if the output pin is shorted to the ground pin (GND) etc. and stops the converter operation to protect it from damage if the junction temperature exceeds the specified temperature.

The RP506K is available in DFN(PLP)2527-10 which achieves high-density mounting on boards.

\(^{(1)}\) This is an approximate value. The output current is dependent on conditions and external components.
FEATURES

- Supply Current: Typ. 48 µA (VFM mode, Lx at no load)
- Standby Current: Typ. 0 µA
- Input Voltage Range: 2.5 V to 5.5 V (Absolute Maximum Ratings: 6.5 V)
- Output Voltage Range: Fixed output voltage type (RP506Kxx1A/B/D/E) : to 3.3 V by 0.1 V step
  Adjustable output voltage type (RP506K001C/F) : to 4.0 V
- Output Voltage Accuracy: ±1.5% (V_SET(2) ≥ 1.2 V), ±18 mV (V_SET < 1.2 V) (RP506Kxx1A/B/D/E)
- Feedback Voltage Accuracy: ±9 mV (V_FB = 0.6 V) (RP506K001C/F)
- Output Voltage/Feedback Voltage Temperature Coefficient: ±100 ppm/°C
- Oscillator Frequency: Typ. 2.25 MHz (RP506Kxx1A/B/C), Typ. 1.2 MHz (RP506Kxx1D/E/F)
- Oscillator Maximum Duty: Min. 100%
- Built-in Driver ON Resistance: Typ. Pch. 0.130 Ω, Nch. 0.125 Ω (V_IN = 3.6 V)
- UVLO Detector Threshold: Typ. 2.2 V
- Inductor Current Limit Circuit: Current limit Typ. 2.8 A
- Latch Type Protection Circuit: Typ. 1.5 ms
- Package: DFN(PLP)2527−10

APPLICATION

- Power source for Li-ion battery-used equipment
- Power source for portable communication equipment, camcorder, DSC, Notebook PC
- Power source for HDD, WLAN

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(1) Refer to Selection Guide for detailed information.
(2) V_SET = Set Output Voltage
SELECTION GUIDE

The set output voltage, the output voltage type, the auto-discharge function\(^{(1)}\), and the oscillator frequency for the ICs are user-selectable options.

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>RP506Kxx1$$(y)$$-TR</td>
<td>DFN(PLP)2527−10</td>
<td>5,000 pcs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

xx: Designation of the set output voltage \((V_{SET})^{(2)}\)
   - For Fixed Output Voltage Type\(^{(3)}\): 0.6 V to 3.3 V in 0.1 V steps
   - For Adjustable Output Voltage Type: 00 only

(y): If \(V_{SET}\) includes the 3rd digit, indicate the digit of 0.01 V.
   - Ex. If \(V_{SET}\) is 1.25 V, RP506K121$5-TR.

$: Designation of Version

<table>
<thead>
<tr>
<th>Version</th>
<th>Output Voltage Type</th>
<th>Auto-discharge Function</th>
<th>Oscillator Frequency</th>
<th>(V_{SET})</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP506Kxx1A</td>
<td>Fixed</td>
<td>No</td>
<td>2.25 MHz</td>
<td>1.1 V to 3.3 V, 0.8 V to 3.3 V</td>
</tr>
<tr>
<td>RP506Kxx1B</td>
<td>Fixed</td>
<td>Yes</td>
<td>1.1 V to 4.0 V, 0.8 V to 4.0 V</td>
<td></td>
</tr>
<tr>
<td>RP506K001C</td>
<td>Adjustable</td>
<td>No</td>
<td>1.2 MHz</td>
<td>0.6 V to 3.3 V, 0.6 V to 4.0 V</td>
</tr>
<tr>
<td>RP506Kxx1D</td>
<td>Fixed</td>
<td>Yes</td>
<td>2.25 MHz</td>
<td>1.1 V to 3.3 V, 0.8 V to 3.3 V</td>
</tr>
<tr>
<td>RP506K001F</td>
<td>Adjustable</td>
<td>No</td>
<td></td>
<td>1.1 V to 4.0 V, 0.8 V to 4.0 V</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Auto-discharge function quickly lowers the output voltage to 0 V, 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.

\(^{(2)}\) \(V_{SET}\) can be set only within the specified range of voltage. Refer to Designation of Version for detailed information.

\(^{(3)}\) 0.05 V step is also available as a custom code.
BP506K
NO.EA-296-191122

BLOCK DIAGRAM

RP506Kxx1A/D Block Diagram

RP506Kxx1B/E Block Diagram
RP506K001C/F Block Diagram

- **AVIN**: Input Voltage
- **UVLO**: Under Voltage Lockout
- **TSS**: Thermal Shutdown Switch
- **MODE**: Mode Control
- **CE**: Chip Enable
- **AGND**: Analog Ground
- **PVIN**: Power Input
- **LX**: Inductor
- **PGND**: Power Ground
- **VFB**: Feedback Voltage
- **PG**: Power Good
- **OSC**: Oscillator
- **Over / Under Voltage Detection**: OVD, UVD
- **Soft Start**: (L during Soft Start)

**Features**:
- **Ramp Compensation**
- **Current Feedback**
- **Current Detector**
- **Switching Control**
- **Thermal Protection**
- **Chip Enable**
- **Mode Control**
- **Soft Start**
- **TSS**
- **UVLO**
- **VFB**
- **OVD**, **UVD**

**RP506K001C/F**
PIN DESCRIPTION

**DFN(PLP)2527-10 Pin Configurations**

![Top View](image1)

**Bottom View**

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PV&lt;sub&gt;IN&lt;/sub&gt;</td>
<td>PV&lt;sub&gt;IN&lt;/sub&gt; Input Voltage Pin&lt;sup&gt;(1)&lt;/sup&gt;</td>
</tr>
<tr>
<td>2</td>
<td>AV&lt;sub&gt;IN&lt;/sub&gt;</td>
<td>AV&lt;sub&gt;IN&lt;/sub&gt; Input Voltage Pin&lt;sup&gt;(1)&lt;/sup&gt;</td>
</tr>
<tr>
<td>3</td>
<td>PG</td>
<td>Power Good Pin</td>
</tr>
<tr>
<td>4</td>
<td>CE</td>
<td>Chip Enable Pin (Active “H”)</td>
</tr>
<tr>
<td>5</td>
<td>MODE</td>
<td>Mode Control Pin (“H”: forced PWM control, “L”: PWM/VFM auto switching control)</td>
</tr>
<tr>
<td>6</td>
<td>TSS</td>
<td>Soft-start Pin</td>
</tr>
<tr>
<td>7</td>
<td>V&lt;sub&gt;OUT&lt;/sub&gt;/V&lt;sub&gt;FB&lt;/sub&gt;</td>
<td>Output/ Feedback Voltage Pin</td>
</tr>
<tr>
<td>8</td>
<td>AGND</td>
<td>Analog Ground Pin&lt;sup&gt;(2)&lt;/sup&gt;</td>
</tr>
<tr>
<td>9</td>
<td>LX</td>
<td>Switching Pin</td>
</tr>
<tr>
<td>10</td>
<td>PGND</td>
<td>Power Ground Pin&lt;sup&gt;(2)&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

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

<sup>(1)</sup> No.1 pin and No.2 pin must be wired to the VIN plane when mounting on boards.

<sup>(2)</sup> No.8 pin and No.10 pin must be wired to the GND plane when mounting on boards.
## ABSOLUTE MAXIMUM RATINGS

### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>A/PV$_{IN}$ Pin Voltage</td>
<td>$-0.3$ to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{LX}$</td>
<td>LX Pin Voltage</td>
<td>$-0.3$ to A/PV$_{IN} +0.3$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE}$</td>
<td>CE Pin Voltage</td>
<td>$-0.3$ to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{OUT/VFB}$</td>
<td>V$_{OUT/VFB}$ Pin Voltage</td>
<td>$-0.3$ to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{MODE}$</td>
<td>MODE Pin Voltage</td>
<td>$-0.3$ to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{PG}$</td>
<td>PG Pin Voltage</td>
<td>$-0.3$ to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{TSS}$</td>
<td>TSS Pin Voltage</td>
<td>$-0.3$ to A/V$_{IN} +0.3$</td>
<td>V</td>
</tr>
<tr>
<td>$I_{LX}$</td>
<td>LX Pin Output Current</td>
<td>2.8</td>
<td>A</td>
</tr>
<tr>
<td>$P_{D}$</td>
<td>Power Dissipation$^{(1)}$</td>
<td>Standard Land Pattern</td>
<td>910</td>
</tr>
<tr>
<td></td>
<td></td>
<td>High Wattage Land Pattern</td>
<td>1400</td>
</tr>
<tr>
<td>$T_{j}$</td>
<td>Junction Temperature</td>
<td>$-40$ to 125</td>
<td>°C</td>
</tr>
<tr>
<td>$T_{stg}$</td>
<td>Storage Temperature Range</td>
<td>$-55$ to 125</td>
<td>°C</td>
</tr>
</tbody>
</table>

### ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause permanent damage 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>$V_{IN}$</td>
<td>Input Voltage</td>
<td>2.5 to 5.5</td>
<td>V</td>
</tr>
<tr>
<td>$T_a$</td>
<td>Operating Temperature Range</td>
<td>$-40$ to 85</td>
<td>°C</td>
</tr>
</tbody>
</table>

#### RECOMMENDED OPERATING CONDITIONS

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 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 PACKAGE INFORMATION for detailed information.
# RP506K

NO.EA-296-191122

## ELECTRICAL CHARACTERISTICS

### RP506Kxx1 Electrical Characteristics

(Ta = 25°C)

<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>Istandby</td>
<td>Standby Current</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
<td>5.5 V, V</td>
</tr>
<tr>
<td>I</td>
<td>CEH</td>
<td>CE &quot;H&quot; Input Current</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>I</td>
<td>CEL</td>
<td>CE &quot;L&quot; Input Current</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>I</td>
<td>MODEL</td>
<td>MODE “H” Input Current</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>I</td>
<td>MODEL</td>
<td>MODE “L” Input Current</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>ILXLEAKH</td>
<td>Lx Leakage Current “H”</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
<td>V</td>
</tr>
<tr>
<td>ILXLEAKL</td>
<td>Lx Leakage Current “L”</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
<td>V</td>
</tr>
<tr>
<td>V</td>
<td>CEH</td>
<td>CE “H” Input Voltage</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>V</td>
<td>CEL</td>
<td>CE “L” Input Voltage</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>V</td>
<td>MODEH</td>
<td>MODE “H” Input Voltage</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>V</td>
<td>MODEL</td>
<td>MODE “L” Input Voltage</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>R</td>
<td>ONP</td>
<td>On Resistance of Pch Transistor</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>R</td>
<td>ONN</td>
<td>On Resistance of Nch Transistor</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>Maxduty</td>
<td>Maximum Duty Cycle</td>
<td></td>
<td>100</td>
<td>%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tstart1</td>
<td>Soft-start Time 1</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
<td>V</td>
</tr>
<tr>
<td>tstart2</td>
<td>Soft-start Time 2</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
<td>V</td>
</tr>
<tr>
<td>ILX</td>
<td>LIM</td>
<td>Lx Current Limit</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>tprot</td>
<td>Protection Delay Time</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
<td>V</td>
</tr>
<tr>
<td>V</td>
<td>UVLO1</td>
<td>UVLO Detector Threshold</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>V</td>
<td>UVLO2</td>
<td>UVLO Released Voltage</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
<tr>
<td>T</td>
<td>TSD</td>
<td>Thermal Shutdown Temperature</td>
<td>Junction Temperature</td>
<td>150</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>TSR</td>
<td>Thermal Shutdown Released Temperature</td>
<td>Junction Temperature</td>
<td>100</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>PG</td>
<td>On Resistance of PG Pin When Low Output</td>
<td>A/</td>
<td>PV</td>
<td>IN</td>
<td>=</td>
</tr>
</tbody>
</table>
### ELECTRICAL CHARACTERISTICS (continued)

#### RP506Kxx1A/B, RP506K001C (Oscillator Frequency: 2.25 MHz) Electrical Characteristics  (Ta = 25°C)

<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>When MODE = H</td>
<td>$1.1 \ V \leq V_{SET} &lt; 1.2 \ V$</td>
<td>2.5</td>
<td></td>
<td>4.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Operating Input Voltage(1)</td>
<td>$1.2 \ V \leq V_{SET}$</td>
<td>2.5</td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>When MODE = L</td>
<td>$0.8 \ V \leq V_{SET} &lt; 1.0 \ V$</td>
<td>2.5</td>
<td></td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operating Input Voltage(2)</td>
<td>$1.0 \ V \leq V_{SET}$</td>
<td>2.5</td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>$f_{osc}$</td>
<td>Oscillator Frequency</td>
<td>$A/PV_{IN} = V_{CE} = 3.6 \ V$ or $V_{SET} + 1 \ V$</td>
<td>2.00</td>
<td>2.25</td>
<td>2.50</td>
<td>MHz</td>
</tr>
</tbody>
</table>

#### RP506Kxx1D/E, RP506K001F (Oscillator Frequency: 1.2 MHz) 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>When MODE = H</td>
<td>$0.6 \ V \leq V_{SET} &lt; 0.7 \ V$</td>
<td>2.5</td>
<td></td>
<td>4.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td>Operating Input Voltage</td>
<td>$0.7 \ V \leq V_{SET}$</td>
<td>2.5</td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>When MODE = L</td>
<td>$0.6 \ V \leq V_{SET}$</td>
<td>2.5</td>
<td></td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>$f_{osc}$</td>
<td>Oscillator Frequency</td>
<td>$A/PV_{IN} = V_{CE} = 3.6 \ V$ or $V_{SET} + 1 \ V$</td>
<td>1.00</td>
<td>1.20</td>
<td>1.40</td>
<td>MHz</td>
</tr>
</tbody>
</table>

---

(1) As for RP506Kxx1A/B/C (MODE = H), $V_{SET}$ can be set from 1.1 V.

(2) As for RP506Kxx1A/B/C (MODE = L), $V_{SET}$ can be set from 0.8 V.
### ELECTRICAL CHARACTERISTICS (continued)

**RP506Kxx1A/B/D/E (Fixed Output Voltage Type) 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_{\text{OUT}} )</td>
<td>Output Voltage</td>
<td>( A/PV_{\text{IN}} = V_{\text{CE}} = 3.6 , \text{V} ) or ( V_{\text{SET}} + 1 , \text{V} )</td>
<td>( V_{\text{SET}} \geq 1.2 , \text{V} )</td>
<td>( 0.985 \times )</td>
<td>( 1.015 \times )</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( V_{\text{SET}} &lt; 1.2 , \text{V} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \Delta V_{\text{OUT}} / \Delta T_a )</td>
<td>Output Voltage Temperature Coefficient</td>
<td>(-40^\circ C \leq T_a \leq 85^\circ C)</td>
<td>±100</td>
<td>ppm</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>( I_{\text{DD1}} )</td>
<td>Supply Current 1</td>
<td>( A/PV_{\text{IN}} = V_{\text{CE}} = 5.5 , \text{V} ), ( V_{\text{OUT}} = V_{\text{SET}} \times 0.8 )</td>
<td>600</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{\text{DD2}} )</td>
<td>Supply Current 2</td>
<td>( A/PV_{\text{IN}} = V_{\text{CE}} = V_{\text{OUT}} = 5.5 , \text{V} )</td>
<td>( V_{\text{MODE}} = 0 , \text{V} )</td>
<td>48</td>
<td>72</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( V_{\text{MODE}} = 5.5 , \text{V} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{\text{VOUTL}} )</td>
<td>( V_{\text{OUT}} ) &quot;L&quot; Current</td>
<td>( A/PV_{\text{IN}} = 5.5 , \text{V} ), ( V_{\text{CE}} = V_{\text{OUT}} = 0 , \text{V} )</td>
<td>(-1 )</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>( V_{\text{OVD}} )</td>
<td>OVD Voltage</td>
<td>( A/PV_{\text{IN}} = 3.6 , \text{V} )</td>
<td>( V_{\text{SET}} \times 1.2 )</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{\text{UVD}} )</td>
<td>UVD Voltage</td>
<td>( A/PV_{\text{IN}} = 3.6 , \text{V} )</td>
<td>( V_{\text{SET}} \times 0.8 )</td>
<td>V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RP506Kxx1A/D (Fixed Output Voltage Type without Auto-discharge Function)**

<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>( I_{\text{VOUTH}} )</td>
<td>( V_{\text{OUT}} ) &quot;H&quot; Current</td>
<td>( A/PV_{\text{IN}} = V_{\text{OUT}} = 5.5 , \text{V} ), ( V_{\text{CE}} = 0 , \text{V} )</td>
<td>(-1 )</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
</tbody>
</table>

**RP506Kxx1B/E (Fixed Output Voltage Type with Auto-discharge Function)**

<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>( R_{\text{LOW}} )</td>
<td>On Resistance of Low Output</td>
<td>( A/PV_{\text{IN}} = 3.6 , \text{V} ), ( V_{\text{CE}} = 0 , \text{V} )</td>
<td>45</td>
<td>Ω</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RP506K001C/F (Adjustable Output Voltage Type) 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_{\text{FB}} )</td>
<td>Feedback Voltage</td>
<td>( A/PV_{\text{IN}} = V_{\text{CE}} = 3.6 , \text{V} )</td>
<td>0.591</td>
<td>0.600</td>
<td>0.609</td>
<td>V</td>
</tr>
<tr>
<td>( \Delta V_{\text{FB}} / \Delta T_a )</td>
<td>Feedback Voltage Temperature Coefficient</td>
<td>(-40^\circ C \leq T_a \leq 85^\circ C)</td>
<td>±100</td>
<td>ppm</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>( I_{\text{DD1}} )</td>
<td>Supply Current 1</td>
<td>( A/PV_{\text{IN}} = V_{\text{CE}} = 5.5 , \text{V} ), ( V_{\text{FB}} = 0.48 , \text{V} )</td>
<td>600</td>
<td>µA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{\text{DD2}} )</td>
<td>Supply Current 2</td>
<td>( A/PV_{\text{IN}} = V_{\text{CE}} = V_{\text{FB}} = 5.5 , \text{V} )</td>
<td>( V_{\text{MODE}} = 0 , \text{V} )</td>
<td>48</td>
<td>72</td>
<td>µA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( V_{\text{MODE}} = 5.5 , \text{V} )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( I_{\text{VFBH}} )</td>
<td>( V_{\text{FB}} ) &quot;H&quot; Current</td>
<td>( A/PV_{\text{IN}} = V_{\text{FB}} = 5.5 , \text{V} ), ( V_{\text{CE}} = 0 , \text{V} )</td>
<td>(-1 )</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>( I_{\text{VFBL}} )</td>
<td>( V_{\text{FB}} ) &quot;L&quot; Current</td>
<td>( A/PV_{\text{IN}} = 5.5 , \text{V} ), ( V_{\text{CE}} = V_{\text{FB}} = 0 , \text{V} )</td>
<td>(-1 )</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>( V_{\text{OVD}} )</td>
<td>OVD Voltage</td>
<td>( A/PV_{\text{IN}} = 3.6 , \text{V} )</td>
<td>0.72</td>
<td>V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( V_{\text{UVD}} )</td>
<td>UVD Voltage</td>
<td>( A/PV_{\text{IN}} = 3.6 , \text{V} )</td>
<td>0.48</td>
<td>V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All test items listed under Electrical Characteristics are done under the pulse load condition \( (T_j \approx T_a = 25^\circ C) \) except Output Voltage Temperature Coefficient and Feedback Voltage Temperature Coefficient.
## ELECTRICAL CHARACTERISTICS (continued)

### RP506K Electrical Characteristics by Different Output Voltage

(Ta = 25°C)

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Output Voltage (V&lt;sub&gt;OUT&lt;/sub&gt;) [V]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
</tr>
<tr>
<td>RP506K061x</td>
<td>0.582</td>
</tr>
<tr>
<td>RP506K071x</td>
<td>0.682</td>
</tr>
<tr>
<td>RP506K081x</td>
<td>0.782</td>
</tr>
<tr>
<td>RP506K091x</td>
<td>0.882</td>
</tr>
<tr>
<td>RP506K101x</td>
<td>0.982</td>
</tr>
<tr>
<td>RP506K111x</td>
<td>1.082</td>
</tr>
<tr>
<td>RP506K121x</td>
<td>1.182</td>
</tr>
<tr>
<td>RP506K131x</td>
<td>1.281</td>
</tr>
<tr>
<td>RP506K141x</td>
<td>1.379</td>
</tr>
<tr>
<td>RP506K151x</td>
<td>1.478</td>
</tr>
<tr>
<td>RP506K161x</td>
<td>1.576</td>
</tr>
<tr>
<td>RP506K171x</td>
<td>1.675</td>
</tr>
<tr>
<td>RP506K181x</td>
<td>1.773</td>
</tr>
<tr>
<td>RP506K191x</td>
<td>1.872</td>
</tr>
<tr>
<td>RP506K201x</td>
<td>1.97</td>
</tr>
<tr>
<td>RP506K211x</td>
<td>2.069</td>
</tr>
<tr>
<td>RP506K221x</td>
<td>2.167</td>
</tr>
<tr>
<td>RP506K231x</td>
<td>2.266</td>
</tr>
<tr>
<td>RP506K241x</td>
<td>2.364</td>
</tr>
<tr>
<td>RP506K251x</td>
<td>2.463</td>
</tr>
<tr>
<td>RP506K261x</td>
<td>2.561</td>
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<tr>
<td>RP506K271x</td>
<td>2.66</td>
</tr>
<tr>
<td>RP506K281x</td>
<td>2.758</td>
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<tr>
<td>RP506K291x</td>
<td>2.857</td>
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<tr>
<td>RP506K301x</td>
<td>2.955</td>
</tr>
<tr>
<td>RP506K311x</td>
<td>3.054</td>
</tr>
<tr>
<td>RP506K321x</td>
<td>3.152</td>
</tr>
<tr>
<td>RP506K331x</td>
<td>3.251</td>
</tr>
<tr>
<td>RP506K121x5</td>
<td>1.232</td>
</tr>
</tbody>
</table>
THEORY OF OPERATION

Soft-start Time Adjustment Function

Soft-start time (tstart) of the RP506K is adjustable by connecting a soft-start time adjustment capacitor (C_{SS}) between the TSS pin and GND. tstart can be set from Typ. 0.15 ms. As Figure 6 shows, if 0.1 \mu F C_{SS} is connected, tstart will be 30 ms. The TSS pin must be open if the soft-start time function is not used. tstart is set to 0.15 ms (Typ.) when the TSS pin is open.

![Soft-start Time (tstart) vs. Soft-start Time Adjustment Capacitor (C_{SS})](image)

Power Good Function

The RP506K contains a power good function using Nch open drain. If any abnormal condition is detected, the power good function turns Nch transistor on and switches the PG pin to low. If the cause of the abnormal condition is removed, the power good function turns Nch transistor off and switches the PG pin back to high. After the recovery from abnormal condition, it takes typically 0.05 ms for the IC to turns Nch transistor off. The followings are the abnormal conditions that the power good function can detect.

- CE = "L" (Shut down)
- UVLO (Shut down)
- Thermal Shutdown
- Over Voltage Detection: Typ. \(V_{\text{SET}} \times 1.2\) V (RP506Kxx1A/B/D/E) or 0.72 V (RP506K001C/F)
- Under Voltage Detection: Typ. \(V_{\text{SET}} \times 0.8\) V (RP506Kxx1A/B/D/E) or 0.48 V (RP506K001C/F)
- Latch Type Protection

Notes: When using the power good function, the resistance of PG pin (R_{PG}) should be between 10 k\Omega to 100 k\Omega. The PG pin must be open or connected to GND if the power good function is not used.
Sequential Start-Up Using Soft-Start Time Adjustment and Power Good Functions

Sequential startup circuits can be built by using soft-start time adjustment and power good functions of the RP506K. The figure below is an example of sequential startup circuits using DC/DC1 and DC/DC2.

The DC/DC1 starts up first followed by the DC/DC2: the output of DC/DC1 reaches 1.44 V ($V_{SET} \times 0.8$), the PG pin of DC/DC1 sends a high signal to the CE pin of DC/DC2, and then the DC/DC2 starts soft-start.

**DC/DC1 (RP506K001C/F):** $V_{IN} = 5.0$ V, $V_{OUT} = 1.8$ V, $t_{start} = 30$ ms ($C_{SS} = 0.1$ μF)

**DC/DC2 (RP506K001C/F):** $V_{IN} = 5.0$ V, $V_{OUT} = 1.2$ V, $t_{start} = 30$ ms ($C_{SS} = 0.1$ μF)

---

**Circuits Example using Sequential Startup**
Operation of Step-Down DC/DC Converter and Output Current

The step-down DC/DC converter charges energy in the inductor when Lx Tr. turns “ON”, and discharges the energy from the inductor when Lx Tr. turns “OFF” and controls with less energy loss, so that a lower output voltage (VOUT) than the input voltage (VIN) can be obtained. The operation of the step-down DC/DC converter is explained in the following figures.

![Basic Circuit](image1)

![Inductor Current (IL) flowing through Inductor (L)](image2)

**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 (ILmin), which is 0 A, and reaches the maximum inductor current (ILmax) in proportion to the on-time period (ton) of Pch Tr.

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

**Step 3.** 
i2 decreases gradually and reaches ILmin 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 (IOUT) increases, the off-time period (toff) of Pch Tr. runs out before IL reaches ILmin. The next cycle starts, and Pch Tr. turns “ON” and Nch Tr. turns “OFF”, which means IL starts increasing from ILmin. This is called continuous current mode.

In the case of PWM mode, VOUT is maintained by controlling ton. During PWM mode, the oscillator frequency (fosc) is being maintained constant.

When the step-down DC/DC operation is constant, ILmin and ILmax during ton of Pch Tr. would be same as during toff of Pch Tr. The current differential between ILmax and ILmin is described as $\Delta I$.

$$\Delta I = IL_{\text{max}} - IL_{\text{min}} = V_{\text{OUT}} \times \text{topen} / L = (V_{\text{IN}} - V_{\text{OUT}}) \times \text{ton} / L \quad \cdots \cdots \cdots \cdots \cdots \cdots \cdots \quad \text{Equation 1}$$

However,

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

$$\text{duty} (%) = \text{ton} / T \times 100 = \text{ton} \times fosc \times 100$$

$$\text{topen} \leq \text{toff}$$

In Equation 1, “$V_{\text{OUT}} \times \text{topen} / L$” shows the amount of current change in “ON” state. Also, “$(V_{\text{IN}} - V_{\text{OUT}}) \times \text{ton} / L$” shows the amount of current change at “OFF” state.
Discontinuous Mode and Continuous Mode

As illustrated in Figure A, when \( I_{OUT} \) is relatively small, \( t_{open} < t_{off} \). In this case, the energy charged into \( L \) during \( t_{on} \) will be completely discharged during \( t_{off} \), as a result, \( I_{L_{min}} = 0 \). This is called discontinuous mode.

When \( I_{OUT} \) is gradually increased, eventually \( t_{open} = t_{off} \) and when \( I_{OUT} \) is increased further, eventually \( I_{L_{min}} > 0 \), as illustrated in Figure B. This is called continuous mode.

\[
\begin{align*}
I_{L_{max}} & \quad I_{L_{min}} \\
t_{on} & \quad t_{off} \\
T = \frac{1}{f_{osc}}
\end{align*}
\]

\[
\begin{align*}
I_{L_{max}} & \quad I_{L_{min}} \\
t_{on} & \quad t_{off} \\
T = \frac{1}{f_{osc}}
\end{align*}
\]

**Figure A. Discontinuous Mode**

**Figure B. Continuous Mode**

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

\[
\text{tonc} = T_{a} \times \frac{V_{OUT}}{V_{IN}}
\]

**Equation 2**

When \( \text{ton} < \text{tonc} \), it is discontinuous mode, and when \( \text{ton} = \text{tonc} \), it is continuous mode.
Forced PWM Mode
By setting the MODE pin to “H”, the IC switches the frequency at the fixed rate to reduce noise even when the output load is light. Therefore, when $I_{\text{OUT}}$ is $\Delta I_L/2$ or less, $I_{\text{Lmin}}$ becomes less than 0. That is, the accumulated electricity in $C_L$ is discharged through the IC side while $I_L$ is increasing from $I_{\text{Lmin}}$ to 0 during $t_{\text{on}}$, and also while $I_L$ is decreasing from 0 to $I_{\text{Lmin}}$ during $t_{\text{off}}$.

![Forced PWM Mode Diagram]

VFM Mode
By setting the MODE pin to “L”, in low output current, the IC automatically switches into VFM mode in order to achieve high efficiency. In VFM mode, $t_{\text{on}}$ is forced to end when the inductor current reaches the pre-set $I_{\text{Lmax}}$. In the VFM mode, $I_{\text{Lmax}}$ is typically set to 400 mA for the RP506Kxx1A/B/C, and 550 mA for the RP506Kxx1D/E/F. When $t_{\text{on}}$ reaches 1.5 times of $T = 1 / f_{\text{osc}}$, $t_{\text{on}}$ will be forced to end even if the inductor current is not reached $I_{\text{Lmax}}$.

![VFM Mode Diagram]
Output Current and Selection of External Components

The following equations explain the relationship between output current and peripheral components that are listed in Table1. Recommended External Components in TYPICAL APPLICATION.

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.

$$V_{IN} = V_{OUT} + (R_{ONP} + R_L) \times I_{OUT} + L \times I_{RP} / \text{ton} \quad \cdots \quad \text{Equation 3}$$

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

$$L \times I_{RP} / \text{toff} = R_{ONN} \times I_{OUT} + V_{OUT} + R_L \times I_{OUT} \quad \cdots \quad \text{Equation 4}$$

Put Equation 4 into Equation 3 to solve ON duty of Pch Tr. ($D_{ON} = \text{ton} / (\text{toff} + \text{ton})$):

$$D_{ON} = (V_{OUT} + R_{ONN} \times I_{OUT} + R_L \times I_{OUT}) / (V_{IN} + R_{ONN} \times I_{OUT} - R_{ONP} \times I_{OUT}) \quad \cdots \quad \text{Equation 5}$$

Ripple Current is described as follows:

$$I_{RP} = (V_{IN} - V_{OUT} - R_{ONP} \times I_{OUT} - R_L \times I_{OUT}) \times D_{ON} / fosc / L \quad \cdots \quad \text{Equation 6}$$

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

$$I_{LXmax} = I_{OUT} + I_{RP} / 2 \quad \cdots \quad \text{Equation 7}$$

Notes: Please consider $I_{LXmax}$ 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.

---

**Notes:**

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.

Notes: 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)

Notes: 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 $V_{OUT}$. 

Depending on Power Supply, Load Current, External Components
(3) Over Current Protection Circuit, Latch Type 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_LXLIM), it turns off Pch Tr. I_LXLIM of the RP506K is set to Typ. 2.800 mA.

Latch type protection circuit latches the built-in driver to the OFF state and stops the operation of the step-down DC/DC converter if the over current status continues or V_OUT continues being the half of the setting voltage for equal or longer than protection delay time (tprot). To release the latch type protection circuit, restart the IC by inputting "L" signal to the CE pin, or restart the IC with power-on or make the supply voltage lower than V_UVLO1.

Notes: I_LXLIM and tprot 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 and tprot could be affected.
The timing chart below shows the voltage shift of $V_{CE}$, $V_{LX}$ and $V_{OUT}$ when the IC status is changed by the following orders: $V_{IN}$ rising $\rightarrow$ stable operation $\rightarrow$ high load $\rightarrow$ CE reset $\rightarrow$ stable operation $\rightarrow$ $V_{IN}$ falling $\rightarrow$ $V_{IN}$ recovering (UVLO reset) $\rightarrow$ stable operation.

(1)(2) If the large current flows through the circuit or the IC goes into low $V_{OUT}$ condition due to short-circuit or other reasons, the latch type protection circuit latches the built-in driver to "OFF" state after $t_{prot}$. Then, $V_{LX}$ becomes "L" and $V_{OUT}$ turns "OFF".

(3) The latch type protection circuit is released by CE reset, which puts the IC into "L" once with the CE pin and back into "H".

(4) The latch type protection circuit is released by UVLO reset, which makes $V_{IN}$ lower than $V_{UVLO1}$.

---

**Timing Chart**

---

Input Voltage ($V_{IN}$)  
---

CE Pin Input Voltage ($V_{CE}$)  
---

Lx Voltage ($V_{LX}$)  
---

Output Voltage ($V_{OUT}$)  
---

UVLO Released Voltage ($V_{UVLO2}$)  
UVLO Detector Threshold ($V_{UVLO1}$)  
---

$V_{SET}$ Threshold Level  
---

Protection Delay Time  
---

CE Reset  
---

UVLO Reset  
---

Latch-type Protection  
---

Stable Operation  
---

Soft-start Time  
---

Stable Operation  
---

Soft-start Time  
---

Stable Operation  
---

Soft-start Time  
---

---
APPLICATION INFORMATION

Typical Application

PG function is used, 30 ms Soft-start Time

\(^1\) MODE = “H”: forced PWM control, MODE = “L”: PWM/VFM auto switching control

![Application Diagram 1](image)

RP506Kxx1A/B/D/E (Fixed Output Voltage Type)

PG function is not used, 150 µs Soft-start Time

\(^1\) MODE = “H”: forced PWM control, MODE = “L”: PWM/VFM auto switching control

![Application Diagram 2](image)

RP506K001C/F (Adjustable Output Voltage Type)
Table 1. Recommended External Components

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Size</th>
<th>Part Description</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>C&lt;sub&gt;IN&lt;/sub&gt;</td>
<td>10 µF</td>
<td>Ceramic Capacitor</td>
<td>C1608JB0J106M (TDK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>JMK107BJ106MA (Taiyo Yuden)</td>
</tr>
<tr>
<td>C&lt;sub&gt;OUT&lt;/sub&gt;</td>
<td>22 µF x 2</td>
<td>Ceramic Capacitor</td>
<td>C2012JB0J226M (TDK)</td>
</tr>
<tr>
<td></td>
<td>10 µF x 3</td>
<td>Ceramic Capacitor</td>
<td>C1608JB0J106M (TDK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>JMK107BJ106MA (Taiyo Yuden)</td>
</tr>
<tr>
<td>L</td>
<td>2.2 µH</td>
<td>Inductor</td>
<td>SLF6045T-2R2N3R3 (TDK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CLF7045T-2R2N (TDK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FDSD0415-2R2M (TOKO)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RLF7030T-2R2M5R4 (TDK)</td>
</tr>
<tr>
<td>L</td>
<td>4.7 µH</td>
<td>Inductor</td>
<td>SLF6045T-4R7N2R4 (TDK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>CLF7045T-4R7N (TDK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FDSD0415-4R7M (TOKO)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>RLF7030T-4R7M3R4 (TDK)</td>
</tr>
</tbody>
</table>

Small and Low Profile External Components

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Size</th>
<th>Part Description</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>1.0 µH</td>
<td>Inductor</td>
<td>DFE252010R-H-1R0M (TOKO)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>VLS252010HBX-1R0M (TDK)</td>
</tr>
<tr>
<td>L</td>
<td>1.5 µH</td>
<td>Inductor</td>
<td>DFE252010R-H-1R5M (TOKO)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>VLS252010HBX-1R5M (TDK)</td>
</tr>
<tr>
<td>L</td>
<td>2.2 µH</td>
<td>Inductor</td>
<td>DFE252010R-H-2R2M (TOKO)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>VLS252010HBX-2R2M (TDK)</td>
</tr>
</tbody>
</table>

(1) Only for RP506K001C/F
TECHNICAL NOTES

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

- AGND and PGND must be wired to the GND plane when mounting on boards.
- AVIN and PVIN must be wired to the VIN plane when mounting on boards.
- Ensure the A/PVIN and A/PGND lines are sufficiently robust. A large switching current flows through the A/P GN D line, the VDD line, the VOUT line, an inductor, and LX. 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, place a capacitor (CIN) as close as possible to the PVIN pin and PGND. For the RP506Kxx1A/B/D/E, separate the wiring between the VOUT pin and an inductor (L1) from the wiring between L1 and Load. Likewise, for the RP506K001C/F, separate the wiring between a resistor for setting output voltage (R1) and an inductor (L2) from the wiring between L2 and Load.
- Choose a low ESR ceramic capacitor. The ceramic capacitance of CIN should be more than or equal to 10 μF. For a ceramic capacitor (COUT), it is recommended that three paralleled 10 μF ceramic capacitors or two paralleled 22 μF ceramic capacitors be used.
- When VSET ≤ 3.3 V, a 2.2 μH inductor is recommended for RP506Kxx1A/B/C/D/E/F. When VSET ≤ 2.3 V, a 1.5 μH inductor can be used for RP506Kxx1A/B/C. When VSET ≤ 1.5 V, a 1 μH inductor can be used for RP506Kxx1A/B/C. When VSET > 3.3 V, a 4.7 μH inductor is recommended for RP506K001C/F. The phase compensation of this IC is designed according to the COUT 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 LX may increase along with the load current. As a result, over current protection circuit may start to operate when the peak current of LX reaches to “LX limit current”.

Set Output Voltage Range vs. Inductance Range

<table>
<thead>
<tr>
<th>Version</th>
<th>RP506Kxx1A/B</th>
<th>RP506Kxx1D/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSET (V)</td>
<td>L = 1.0 μH</td>
<td>L = 1.5 μH</td>
</tr>
<tr>
<td>up to 1.5</td>
<td>Acceptable</td>
<td>Acceptable</td>
</tr>
<tr>
<td>1.6 to 2.3</td>
<td>-</td>
<td>Acceptable</td>
</tr>
<tr>
<td>2.4 to 3.3</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Version</th>
<th>RP506K001C</th>
<th>RP506K001F</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSET (V)</td>
<td>L = 1.0 μH</td>
<td>L = 1.5 μH</td>
</tr>
<tr>
<td>up to 1.5</td>
<td>Acceptable</td>
<td>Acceptable</td>
</tr>
<tr>
<td>1.6 to 2.3</td>
<td>-</td>
<td>Acceptable</td>
</tr>
<tr>
<td>2.4 to 3.3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3.4 or more</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Over current protection circuit and latch type protection circuit may be affected by self-heating or power dissipation environment.

The output voltage ($V_{SET}$) is adjustable by changing the resistance values of resistors (R1, R2) as follows.

$$V_{SET} = V_{FB} \times \frac{(R1 + R2)}{R2}$$

(Recommended $V_{OUT}$ range for RP506K001F: $0.6 \leq V_{SET} \leq 4.0$ V)

(Recommended $V_{OUT}$ range for RP506K001C: $0.8 \leq V_{SET} \leq 4.0$ V)

If R1 and R2 are too large, the impedances of $V_{FB}$ also become large, as a result, the IC could be easily affected by noise. For this reason, R2 should be 220 kΩ or less. If the operation becomes unstable due to the high impedances, the impedances should be decreased. C1 can be calculated by the following equations. Please use the value close to the calculation result.

If the output voltage is lower than or equal to 3.3 V:

$$C1 = 4.84 \times 10^{-6} / R2 \ [F]$$

If the output voltage exceeds 3.3 V:

$$C1 = 1.50 \times 10^{-6} / R2 \ [F]$$

The recommended resistance values for R1 and C1 when R2 = 220 kΩ or 100 kΩ are as follows.

<table>
<thead>
<tr>
<th>$V_{SET}$ [V]</th>
<th>0.6</th>
<th>0.7</th>
<th>0.8</th>
<th>1.2</th>
<th>1.8</th>
<th>2.5</th>
<th>3.3</th>
<th>3.8</th>
<th>4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 [kΩ]</td>
<td>0</td>
<td>36.7</td>
<td>73.3</td>
<td>220</td>
<td>440</td>
<td>697</td>
<td>990</td>
<td>533</td>
<td>567</td>
</tr>
<tr>
<td>R2 [kΩ]</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>C1 [pF]</td>
<td>-</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>15</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

Soft-start Time (tstart) is adjustable by connecting a capacitor ($C_{SS}$) between the TSS pin and GND. The capacitance value for $C_{SS}$ that is suitable for tstart can be calculated by the following equation.

$$C_{SS} \ (nF) = 3.5 \times tstart \ (ms)$$

The TSS pin must be open if Soft-start time function is not used. Soft-start time is set to typically 150 µs when the TSS pin is open.

When using the power good function, the resistance value of a resistor ($R_{PG}$) should be between 10 kΩ to 100 kΩ. The PG pin must be open or connected to GND if the power good function is not used.
Reference PCB Layouts

RP506xxxA/B/D/E (PKG: DFN(PLP)2527−10pin) PCB Layout

Topside

Backside

RP506K001C/F (PKG: DFN(PLP)2527−10pin) PCB Layout

Topside

Backside

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

Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.

1) Output Voltage vs. Output Current

RP506Kxx1A/B/C  \( V_{OUT} = 1.2 \text{ V} \)

MODE = “L” PWM/VFM Auto Switching Control

RP506Kxx1A/B/C  \( V_{OUT} = 1.2 \text{ V} \)

MODE = “H” Forced PWM Control

RP506Kxx1A/B/C  \( V_{OUT} = 1.8 \text{ V} \)

MODE = “L” PWM/VFM Auto Switching Control

RP506Kxx1A/B/C  \( V_{OUT} = 1.8 \text{ V} \)

MODE = “H” Forced PWM Control

RP506Kxx1A/B/C  \( V_{OUT} = 3.3 \text{ V} \)

MODE = “L” PWM/VFM Auto Switching Control

RP506Kxx1A/B/C  \( V_{OUT} = 3.3 \text{ V} \)

MODE = “H” Forced PWM Control
RP506K

MODE = “L” PWM/VFM Auto Switching Control

MODE = “H” Forced PWM Control

Output Current I_{OUT}(mA)

Output Voltage V_{OUT}(V)

Vin=3.6V

Vin=4.5V

Vin=3.6V

Vin=5.0V

Vin=3.6V

Vin=5.0V
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2) Output Voltage vs. Input Voltage

**RP506Kxx1D/E/F**  \[V_{OUT} = 0.6 \text{ V}\]
**MODE = “L”** PWM/VFM Auto Switching Control

**RP506Kxx1D/E/F**  \[V_{OUT} = 0.8 \text{ V}\]
**MODE = “H”** Forced PWM Control
RP506K  \( \text{V}_{\text{OUT}} = 1.2 \) V
MODE = “H” Forced PWM Control

RP506K  \( \text{V}_{\text{OUT}} = 1.8 \) V
MODE = “H” Forced PWM Control

RP506K  \( \text{V}_{\text{OUT}} = 3.3 \) V
MODE = “H” Forced PWM Control

3) Output Voltage vs. Ambient Temp.
RP506K181A/B/D/E  \( \text{V}_{\text{OUT}} = 1.8 \) V

4) Feedback Voltage vs. Ambient Temp.
RP506K001C/F
5) Efficiency vs. Output Current

**RP506Kxx1A/B/C**  \( V_{\text{OUT}} = 1.2 \text{ V} \)

- \( V_{\text{IN}} = 5.0 \text{ V}, \ V_{\text{MODE}} = 0 \text{ V} \)
- \( V_{\text{IN}} = 3.6 \text{ V}, \ V_{\text{MODE}} = 0 \text{ V} \)
- \( V_{\text{IN}} = V_{\text{MODE}} = 5.0 \text{ V} \)
- \( V_{\text{IN}} = V_{\text{MODE}} = 3.6 \text{ V} \)

**RP506Kxx1A/B/C**  \( V_{\text{OUT}} = 1.8 \text{ V} \)

- \( V_{\text{IN}} = 5.0 \text{ V}, \ V_{\text{MODE}} = 0 \text{ V} \)
- \( V_{\text{IN}} = 3.6 \text{ V}, \ V_{\text{MODE}} = 0 \text{ V} \)
- \( V_{\text{IN}} = V_{\text{MODE}} = 5.0 \text{ V} \)
- \( V_{\text{IN}} = V_{\text{MODE}} = 3.6 \text{ V} \)

**RP506Kxx1A/B/C**  \( V_{\text{OUT}} = 3.3 \text{ V} \)

- \( V_{\text{IN}} = 4.3 \text{ V}, \ V_{\text{MODE}} = 0 \text{ V} \)
- \( V_{\text{IN}} = 5.0 \text{ V}, \ V_{\text{MODE}} = 0 \text{ V} \)
- \( V_{\text{IN}} = V_{\text{MODE}} = 4.3 \text{ V} \)
- \( V_{\text{IN}} = V_{\text{MODE}} = 5.0 \text{ V} \)

**RP506Kxx1D/E/F**  \( V_{\text{OUT}} = 0.6 \text{ V} \)

- \( V_{\text{IN}} = 4.5 \text{ V}, \ V_{\text{MODE}} = 0 \text{ V} \)
- \( V_{\text{IN}} = 3.6 \text{ V}, \ V_{\text{MODE}} = 0 \text{ V} \)
- \( V_{\text{IN}} = V_{\text{MODE}} = 4.5 \text{ V} \)
- \( V_{\text{IN}} = V_{\text{MODE}} = 3.6 \text{ V} \)

**RP506Kxx1D/E/F**  \( V_{\text{OUT}} = 0.8 \text{ V} \)

- \( V_{\text{IN}} = 5.0 \text{ V}, \ V_{\text{MODE}} = 0 \text{ V} \)
- \( V_{\text{IN}} = 3.6 \text{ V}, \ V_{\text{MODE}} = 0 \text{ V} \)
- \( V_{\text{IN}} = V_{\text{MODE}} = 5.0 \text{ V} \)
- \( V_{\text{IN}} = V_{\text{MODE}} = 3.6 \text{ V} \)
6) Supply Current vs. Ambient Temp.

**RP506K**  
**V_{OUT} = 1.8 V**  
**V_{IN} = 5.5 V**  
**MODE = “L” PWM/VFM Auto Switching Control**

7) Supply Current vs. Input Voltage

**RP506K**  
**V_{OUT} = 1.8 V**  
**MODE = “L” PWM/VFM Auto Switching Control**
8) Output Voltage Waveform

RP506Kxx1A/B/C  \( V_{\text{OUT}} = 0.8 \, \text{V} (V_{\text{IN}} = 3.6 \, \text{V}) \)
MODE = “L” PWM/VFM Auto Switching Control

\[
\begin{align*}
\text{Output Voltage} & = 0.8 \, \text{V} (V_{\text{IN}} = 3.6 \, \text{V}) \\
\text{MODE} & = \text{“L” PWM/VFM Auto Switching Control} \\
\text{Inductor Current} \, I_L & = 10\, \text{mA} \\
\text{Output Ripple Voltage} & = \pm 0.03 \, \text{V}
\end{align*}
\]

RP506Kxx1A/B/C  \( V_{\text{OUT}} = 1.2 \, \text{V} (V_{\text{IN}} = 3.6 \, \text{V}) \)
MODE = “H” Forced PWM Control

\[
\begin{align*}
\text{Output Voltage} & = 1.2 \, \text{V} (V_{\text{IN}} = 3.6 \, \text{V}) \\
\text{MODE} & = \text{“H” Forced PWM Control} \\
\text{Inductor Current} \, I_L & = 10\, \text{mA} \\
\text{Output Ripple Voltage} & = \pm 0.03 \, \text{V}
\end{align*}
\]
RP506K

RP506Kxx1A/B/C  \( V_{OUT} = 3.3 \, V \) (\( V_{IN} = 5.0 \, V \))  
MODE = “L” PWM/VFM Auto Switching Control

\[
\begin{align*}
\text{Output Ripple Voltage (AC)} & \quad (V) \\
\text{Inductor Current IL (mA)} & \quad (mA) \\
\text{Time t (μs)} & \quad (μs)
\end{align*}
\]

RP506Kxx1A/B/C  \( V_{OUT} = 1.8 \, V \) (\( V_{IN} = 5.0 \, V \))  
MODE = “H” Forced PWM Control

\[
\begin{align*}
\text{Output Ripple Voltage (AC)} & \quad (V) \\
\text{Inductor Current IL (mA)} & \quad (mA) \\
\text{Time t (μs)} & \quad (μs)
\end{align*}
\]

RP506Kxx1D/E/F  \( V_{OUT} = 0.6 \, V \) (\( V_{IN} = 3.6 \, V \))  
MODE = “L” PWM/VFM Auto Switching Control

\[
\begin{align*}
\text{Output Ripple Voltage (AC)} & \quad (V) \\
\text{Inductor Current IL (mA)} & \quad (mA) \\
\text{Time t (μs)} & \quad (μs)
\end{align*}
\]

RP506Kxx1D/E/F  \( V_{OUT} = 0.6 \, V \) (\( V_{IN} = 3.6 \, V \))  
MODE = “H” Forced PWM Control

\[
\begin{align*}
\text{Output Ripple Voltage (AC)} & \quad (V) \\
\text{Inductor Current IL (mA)} & \quad (mA) \\
\text{Time t (μs)} & \quad (μs)
\end{align*}
\]

RP506Kxx1D/E/F  \( V_{OUT} = 0.8 \, V \) (\( V_{IN} = 3.6 \, V \))  
MODE = “L” PWM/VFM Auto Switching Control

\[
\begin{align*}
\text{Output Ripple Voltage (AC)} & \quad (V) \\
\text{Inductor Current IL (mA)} & \quad (mA) \\
\text{Time t (μs)} & \quad (μs)
\end{align*}
\]

RP506Kxx1D/E/F  \( V_{OUT} = 0.8 \, V \) (\( V_{IN} = 3.6 \, V \))  
MODE = “H” Forced PWM Control

\[
\begin{align*}
\text{Output Ripple Voltage (AC)} & \quad (V) \\
\text{Inductor Current IL (mA)} & \quad (mA) \\
\text{Time t (μs)} & \quad (μs)
\end{align*}
\]
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RP506Kxx1D/E/F  \( V_{\text{OUT}} = 1.2 \, V \) (\( V_{\text{IN}} = 3.6 \, V \))
MODE = “L” PWM/VFM Auto Switching Control

\begin{align*}
\text{Output Voltage} & \quad \text{Inductor Current IL (mA)} \\
\text{Vripple (V)} & \quad \text{Time t (μs)} \\
0 & \quad -500 \, -400 \, -300 \, -200 \, -100 \, 0 \, 100 \, 200 \, 300 \, 400 \, 500 \\
\end{align*}

RP506Kxx1D/E/F  \( V_{\text{OUT}} = 1.2 \, V \) (\( V_{\text{IN}} = 3.6 \, V \))
MODE = “H” Forced PWM Control

\begin{align*}
\text{Output Voltage} & \quad \text{Inductor Current IL (mA)} \\
\text{Vripple (V)} & \quad \text{Time t (μs)} \\
0 & \quad -500 \, -400 \, -300 \, -200 \, -100 \, 0 \, 100 \, 200 \, 300 \, 400 \, 500 \\
\end{align*}

RP506Kxx1D/E/F  \( V_{\text{OUT}} = 1.8 \, V \) (\( V_{\text{IN}} = 3.6 \, V \))
MODE = “L” PWM/VFM Auto Switching Control

\begin{align*}
\text{Output Voltage} & \quad \text{Inductor Current IL (mA)} \\
\text{Vripple (V)} & \quad \text{Time t (μs)} \\
0 & \quad -500 \, -400 \, -300 \, -200 \, -100 \, 0 \, 100 \, 200 \, 300 \, 400 \, 500 \\
\end{align*}

RP506Kxx1D/E/F  \( V_{\text{OUT}} = 1.8 \, V \) (\( V_{\text{IN}} = 3.6 \, V \))
MODE = “H” Forced PWM Control

\begin{align*}
\text{Output Voltage} & \quad \text{Inductor Current IL (mA)} \\
\text{Vripple (V)} & \quad \text{Time t (μs)} \\
0 & \quad -500 \, -400 \, -300 \, -200 \, -100 \, 0 \, 100 \, 200 \, 300 \, 400 \, 500 \\
\end{align*}

RP506Kxx1D/E/F  \( V_{\text{OUT}} = 3.3 \, V \) (\( V_{\text{IN}} = 5.0 \, V \))
MODE = “L” PWM/VFM Auto Switching Control

\begin{align*}
\text{Output Voltage} & \quad \text{Inductor Current IL (mA)} \\
\text{Vripple (V)} & \quad \text{Time t (μs)} \\
0 & \quad -500 \, -400 \, -300 \, -200 \, -100 \, 0 \, 100 \, 200 \, 300 \, 400 \, 500 \\
\end{align*}

RP506Kxx1D/E/F  \( V_{\text{OUT}} = 3.3 \, V \) (\( V_{\text{IN}} = 5.0 \, V \))
MODE = “H” Forced PWM Control

\begin{align*}
\text{Output Voltage} & \quad \text{Inductor Current IL (mA)} \\
\text{Vripple (V)} & \quad \text{Time t (μs)} \\
0 & \quad -500 \, -400 \, -300 \, -200 \, -100 \, 0 \, 100 \, 200 \, 300 \, 400 \, 500 \\
\end{align*}
9) Oscillator Frequency vs. Ambient Temp.

![Graph showing Oscillator Frequency vs. Ambient Temp. for RP506Kxx1A/B/C and RP506Kxx1D/E/F.](image)

10) Oscillator Frequency vs. Input Voltage

![Graph showing Oscillator Frequency vs. Input Voltage for RP506Kxx1A/B/C and RP506Kxx1D/E/F.](image)


![Graph showing Soft-start Time vs. Ambient Temp.](image)
12) UVLO Detector Threshold/Released Voltage vs. Ambient Temp.

- UVLO Detector Threshold
- UVLO Released Voltage

13) CE Input Voltage vs. Ambient Temp.

- CE “H” Input Voltage ($V_{IN} = 5.5$ V)
- CE “L” Input Voltage ($V_{IN} = 2.5$ V)

14) Lx Limit Current vs. Ambient Temp.


17) PG Detector Threshold vs. Ambient Temp.

Over Voltage Detection (VOVD)

Under Voltage Detection (VUVD)

18) Soft-start Waveform

RP506K V<sub>OUT</sub> = 1.8 V TSS = Open

RP506K V<sub>OUT</sub> = 1.8 V TSS = 0.1 µF
19) Load Transient Response

**RP506Kxx1A/B/C (VIN = 3.6 V, VOUT = 0.8 V)**
MODE = “L” PWM/VFM Auto Switching Control

**RP506Kxx1A/B/C (VIN = 3.6 V, VOUT = 0.8 V)**
MODE = “L” PWM/VFM Auto Switching Control

**RP506Kxx1A/B/C (VIN = 3.6 V, VOUT = 1.2 V)**
MODE = “L” PWM/VFM Auto Switching Control

**RP506Kxx1A/B/C (VIN = 3.6 V, VOUT = 1.2 V)**
MODE = “L” PWM/VFM Auto Switching Control
RP506Kxx1A/B/C (Vin = 3.6 V, Vout = 1.2 V)  
MODE = “H” Forced PWM Control

RP506Kxx1A/B/C (Vin = 3.6 V, Vout = 1.2 V)  
MODE = “H” Forced PWM Control

RP506Kxx1A/B/C (Vin = 3.6 V, Vout = 1.2 V)  
MODE = “L” PWM/VFM Auto Switching Control

RP506Kxx1A/B/C (Vin = 3.6 V, Vout = 1.8 V)  
MODE = “L” PWM/VFM Auto Switching Control
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RP506Kxx1A/B/C (Vin = 3.6 V, Vout = 1.8 V) MODE = “H” Forced PWM Control

MODE = “H” Forced PWM Control

RP506Kxx1A/B/C (Vin = 3.6 V, Vout = 1.8 V) MODE = “L” PWM/VFM Auto Switching Control

Output Voltage V_out (V)

Output Current I_out (mA)

Output Voltage V_out (V)

Output Current I_out (mA)

Output Voltage V_out (V)

Output Current I_out (mA)

Output Voltage V_out (V)

Output Current I_out (mA)
RP506Kxx1A/B/C (VIN = 5.0 V, VOUT = 3.3 V)  
MODE = “H” Forced PWM Control

Output Voltage VOUT (V) vs. Output Current IOUT (mA) for different load conditions.

RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 0.6 V)  
MODE = “L” PWM/VFM Auto Switching Control

Output Voltage VOUT (V) vs. Output Current IOUT (mA) for different load conditions.
RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 0.6 V)  
MODE = “H” Forced PWM Control

RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 0.6 V)  
MODE = “H” Forced PWM Control

RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 0.8 V)  
MODE = “L” PWM/VFM Auto Switching Control

RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 0.8 V)  
MODE = “L” PWM/VFM Auto Switching Control
**RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 0.8 V)**

**MODE = “H” Forced PWM Control**

![Graph 1](image1)

**RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 0.8 V)**

**MODE = “L” PWM/VFM Auto Switching Control**

![Graph 2](image2)

**RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 1.2 V)**

**MODE = “H” Forced PWM Control**

![Graph 3](image3)

**RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 1.2 V)**

**MODE = “L” PWM/VFM Auto Switching Control**

![Graph 4](image4)
RP506K

MODE = “H” Forced PWM Control

RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 1.2 V)

Output Voltage VOUT (V)

Output Current IOUT (mA)

Time t (μs)

Output Voltage VOUT (V)

Output Current IOUT (mA)

Time t (μs)

RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 1.8 V)

MODE = “L” PWM/VFM Auto Switching Control

Output Voltage VOUT (V)

Output Current IOUT (mA)

Time t (μs)

Output Voltage VOUT (V)

Output Current IOUT (mA)

Time t (μs)
RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 1.8 V)  
MODE = “H” Forced PWM Control

RP506Kxx1D/E/F (VIN = 3.6 V, VOUT = 1.8 V)  
MODE = “H” Forced PWM Control

RP506Kxx1D/E/F (VIN = 5.0 V, VOUT = 3.3 V)  
MODE = “L” PWM/VFM Auto Switching Control

RP506Kxx1D/E/F (VIN = 5.0 V, VOUT = 3.3 V)  
MODE = “L” PWM/VFM Auto Switching Control
**RP506K**

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**RP506Kxx1D/E/F (VIN = 5.0 V, VOUT = 3.3 V)**  
**MODE = “H” Forced PWM Control**

<table>
<thead>
<tr>
<th>Time t (μs)</th>
<th>Output Voltage VOUT (V)</th>
<th>Output Current IOUT (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>200 mA → 1000 mA</td>
</tr>
<tr>
<td></td>
<td>1000 mA → 200 mA</td>
<td></td>
</tr>
</tbody>
</table>

---

**RP506Kxx1D/E/F (VIN = 5.0 V, VOUT = 3.3 V)**

**MODE = “H” Forced PWM Control**

<table>
<thead>
<tr>
<th>Time t (μs)</th>
<th>Output Voltage VOUT (V)</th>
<th>Output Current IOUT (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>200 mA → 1000 mA</td>
</tr>
<tr>
<td></td>
<td>1000 mA → 200 mA</td>
<td></td>
</tr>
</tbody>
</table>

---

20) Auto Switching Control Waveform

**RP506Kxx1A/B/C**  
**(VIN = 3.6 V, VOUT = 1.2 V, IOUT = 1 mA)**  
**MODE = “L” → MODE = “H”**

<table>
<thead>
<tr>
<th>Time t (μs)</th>
<th>Output Voltage VOUT (V)</th>
<th>Mode Input Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>1000 mA → 2000 mA</td>
<td></td>
</tr>
</tbody>
</table>

---

**RP506Kxx1A/B/C**  
**(VIN = 3.6 V, VOUT = 1.2 V, IOUT = 1 mA)**  
**MODE = “H” → MODE = “L”**

<table>
<thead>
<tr>
<th>Time t (μs)</th>
<th>Output Voltage VOUT (V)</th>
<th>Mode Input Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1.15</td>
</tr>
<tr>
<td></td>
<td>2000 mA → 1000 mA</td>
<td></td>
</tr>
</tbody>
</table>

---

**RICOH**

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RP506K

NO.EA-296-191122

RP506Kxx1A/B/C
(VIN = 3.6 V, VOUT = 1.8 V, IOUT = 1 mA)
MODE = “L” → MODE = “H”

RP506Kxx1D/E/F
(VIN = 3.6 V, VOUT = 1.2 V, IOUT = 1 mA)
MODE = “L” → MODE = “H”

RP506Kxx1D/E/F
(VIN = 3.6 V, VOUT = 1.8 V, IOUT = 1 mA)
MODE = “H” → MODE = “L”

RP506Kxx1D/E/F
(VIN = 3.6 V, VOUT = 1.8 V, IOUT = 1 mA)
MODE = “H” → MODE = “L”
The power dissipation of the package is dependent on PCB material, layout, and environmental conditions. The following conditions are used in this measurement.

### Measurement Conditions

<table>
<thead>
<tr>
<th></th>
<th>High Wattage Land Pattern</th>
<th>Standard Land Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td>Mounting on Board (Wind Velocity = 0 m/s)</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>
<td>Glass Cloth Epoxy Plastic (Double-Sided Board)</td>
</tr>
<tr>
<td>Board Dimensions</td>
<td>35 mm × 90 mm × 0.8 mm</td>
<td>40 mm × 40 mm × 1.6 mm</td>
</tr>
<tr>
<td>Copper Ratio</td>
<td>Outer Layers (First and Fourth Layers): Approx. 15%</td>
<td>Top Side: Approx. 50%</td>
</tr>
<tr>
<td></td>
<td>Inner Layers (Second and Third Layers): Approx. 15%</td>
<td>Bottom Side: Approx. 50%</td>
</tr>
<tr>
<td>Copper Foil Thickness</td>
<td>Outer Layers (First and Fourth Layers): Approx. 35 µm</td>
<td>Top Side: Approx. 35 µm</td>
</tr>
<tr>
<td></td>
<td>Inner Layers (Second and Third Layers): Approx. 18 µm</td>
<td>Bottom Side: Approx. 35 µm</td>
</tr>
<tr>
<td>Through-holes</td>
<td>φ 0.3 mm × 9 holes (connecting outer and inner layers to a package tab)</td>
<td>φ 0.54 mm × 30 holes</td>
</tr>
<tr>
<td></td>
<td>φ 0.5 mm × 10 holes (connecting pins)</td>
<td></td>
</tr>
</tbody>
</table>

### Measurement Result

<table>
<thead>
<tr>
<th></th>
<th>High Wattage Land Pattern</th>
<th>Standard Land Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Dissipation</td>
<td>1400 mW (Tjmax = 125°C)</td>
<td>910 mW (Tjmax = 125°C)</td>
</tr>
<tr>
<td>Thermal Resistance</td>
<td>θja = (125 − 25°C) / 1.4 W = 71°C/W</td>
<td>θjc = (125 − 25°C) / 0.91 W = 110°C/W</td>
</tr>
</tbody>
</table>

---

**Power Dissipation vs. Ambient Temperature**

**Measurement Board Pattern**
The tab on the bottom of the package is substrate level (GND). It is recommended that the tab be connected to the ground plane on the board, or otherwise be left floating.
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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.

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