OUTLINE

The RP506L 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 RP506L 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 (RP506Lxx1G/H/K/L) or an externally adjustable output voltage type (RP506L001N/M). The output voltage accuracy of the RP506Lxx1G/H/K/L is as high as ±1.5% or ±18 mV. The output voltage of the RP506L001N/M can be set by using the external resistors.

Oscillator frequency can be selected from 2.3 MHz (RP506Lxx1G/H/N) or 1.2 MHz (RP506Lxx1K/L/M). Soft-start time is Typ. 150 µs, and by connecting an external capacitor to the TSS pin, soft-start time is adjustable.

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

Protection circuits included in the RP506L 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\(_{\text{LX,LIM}}\)), 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\(_{\text{OUT}}\) continues being the half of the setting voltage for equal or longer than protection delay time (t\(_{\text{prot}}\)). 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 RP506L is available in DFN3030-12 which achieves high-density mounting on boards.

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\((1)\) This is an approximate value. The output current is dependent on conditions and external components.
RP506L

No. EC-296-181226

FEATURES
• Input Voltage Range (Maximum Rating) ........................................ 2.5 V to 5.5 V (6.5 V)
• Operating Temperature Range ................................................. −40°C to 105°C (RP506Lxx1x-TR-A)
  −40°C to 125°C (RP506Lxx1x-TR-K)
• Supply Current ................................................................. Typ. 48 µA (VFM mode, Lx at no load)
• Standby Current .............................................................. Typ. 0 µA
• Output Voltage Range(1) ..................................................

<table>
<thead>
<tr>
<th>Version</th>
<th>Forced PWM Control</th>
<th>PWM/VFM Auto Switching Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP506Lxx1G/H</td>
<td>1.1 V to 3.3 V</td>
<td>0.8 V to 3.3 V</td>
</tr>
<tr>
<td>RP506L001N</td>
<td>1.1 V to 4.0 V</td>
<td>0.8 V to 4.0 V</td>
</tr>
<tr>
<td>RP506Lxx1K/L</td>
<td>0.8 V to 3.3 V</td>
<td></td>
</tr>
<tr>
<td>RP506L001M</td>
<td>0.6 V to 4.0 V</td>
<td></td>
</tr>
</tbody>
</table>

• Output Voltage Accuracy ........................................... ±1.5% (VSET(2) ≥ 1.2 V),
  ±18 mV (VSET < 1.2 V) (RP506Lxx1G/H/K/L)
• Feedback Voltage Accuracy ........................................... ±9 mV (VFB = 0.6 V) (RP506L001N/M)
• Output Voltage/Feedback Voltage
  Temperature Coefficient ........................................... ±100 ppm/°C
• Oscillator Frequency .................................................. Typ. 2.3 MHz (RP506Lxx1G/H/N)
  .................................................. Typ. 1.2 MHz (RP506Lxx1K/L/M)
• Oscillator Maximum Duty ............................................. Min. 100%
• Built-in Driver ON Resistance ...................................... Typ. Pch. 0.130 Ω, Nch. 0.125 Ω (VIN = 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 ........................................................................... DFN3030−12

APPLICATIONS
• Power supply for accessories such as car audios, car navigation systems, and ETC systems
• Power supply for electronic control units such as EV inverter and battery charge control unit.

(1) Refer to Selection Guide for detailed information.
Fixed output voltage type (RP506Lxx1G/H/K/L) can be selected from 0.8 V, 1.0 V, 1.1 V, 1.2 V, 1.3 V, 1.5 V, 1.8 V, 1.85 V, 3.0 V and 3.3 V. Adjustable output voltage type (RP506L001N/M) can be set up to 4.0 V.

(2) VSET = 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>RP506Lxx1$-TR-#</td>
<td>DFN3030–12</td>
<td>3,000 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\(^{(3)}\): 0.8 V, 1.0 V, 1.1 V, 1.2 V, 1.3 V, 1.5 V, 1.8 V, 1.85 V, 3.0 V, 3.3 V

For Adjustable Output Voltage Type: 00 only

\(\$: 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>RP506Lxx1G</td>
<td>Fixed</td>
<td>No</td>
<td>2.3 MHz</td>
<td>1.1 V to 3.3 V</td>
</tr>
<tr>
<td>RP506Lxx1H</td>
<td>Fixed</td>
<td>Yes</td>
<td>1.2 MHz</td>
<td>0.8 V to 3.3 V</td>
</tr>
<tr>
<td>RP506L001N</td>
<td>Adjustable</td>
<td>Yes</td>
<td>1.1 V to 4.0 V</td>
<td>0.8 V to 4.0 V</td>
</tr>
<tr>
<td>RP506Lxx1K</td>
<td>Fixed</td>
<td>No</td>
<td>1.2 MHz</td>
<td>0.8 V to 3.3 V</td>
</tr>
<tr>
<td>RP506Lxx1L</td>
<td>Adjustable</td>
<td>No</td>
<td>0.6 V to 4.0 V</td>
<td></td>
</tr>
<tr>
<td>RP506L001M</td>
<td>Adjustable</td>
<td>No</td>
<td>0.6 V to 4.0 V</td>
<td></td>
</tr>
</tbody>
</table>

\(#\): Quality Class

<table>
<thead>
<tr>
<th>#</th>
<th>Operating Temperature Range</th>
<th>Test Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>−40°C to 105°C</td>
<td>25°C, High</td>
</tr>
<tr>
<td>K</td>
<td>−40°C to 125°C</td>
<td>Low, 25°C, High</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 \emph{Designation of Version} for detailed information.

\(^{(3)}\) 0.05 V step is also available as a custom code.
BLOCK DIAGRAMS

RP506Lxx1G/K Block Diagram

RP506Lxx1H/L Block Diagram
RP506L001N/M Block Diagram
PIN DESCRIPTIONS

DFN3030-12 Pin Configurations

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PV\textsubscript{IN}</td>
<td>PV\textsubscript{IN} Input Voltage Pin\textsuperscript{(2)}</td>
</tr>
<tr>
<td>2</td>
<td>PV\textsubscript{IN}</td>
<td>PV\textsubscript{IN} Input Voltage Pin\textsuperscript{(2)}</td>
</tr>
<tr>
<td>3</td>
<td>AV\textsubscript{IN}</td>
<td>AV\textsubscript{IN} Input Voltage Pin\textsuperscript{(2)}</td>
</tr>
<tr>
<td>4</td>
<td>PG</td>
<td>Power Good Pin</td>
</tr>
<tr>
<td>5</td>
<td>CE</td>
<td>Chip Enable Pin (Active “H”)</td>
</tr>
<tr>
<td>6</td>
<td>MODE</td>
<td>Mode Control Pin (“H”: forced PWM control, “L”: PWM/VFM auto switching control)</td>
</tr>
<tr>
<td>7</td>
<td>TSS</td>
<td>Soft-start Pin</td>
</tr>
<tr>
<td>8</td>
<td>V\textsubscript{OUT}/ V\textsubscript{FB}</td>
<td>Output/ Feedback Voltage Pin</td>
</tr>
<tr>
<td>9</td>
<td>AGND</td>
<td>Analog Ground Pin\textsuperscript{(3)}</td>
</tr>
<tr>
<td>10</td>
<td>L\textsubscript{X}</td>
<td>Switching Pin</td>
</tr>
<tr>
<td>11</td>
<td>NC</td>
<td>No Connection</td>
</tr>
<tr>
<td>12</td>
<td>PGND</td>
<td>Power Ground Pin\textsuperscript{(3)}</td>
</tr>
</tbody>
</table>

\textsuperscript{(1)} 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.

\textsuperscript{(2)} No.1 pin, No.2 pin and No.3 pin must be wired to the VIN plane when mounting on boards.

\textsuperscript{(3)} No.9 pin and No.12 pin must be wired to the GND plane when mounting on boards.
ABSOLUTE MAXIMUM RATINGS

Absolute Maximum Ratings (AGND = PGND = 0 V)

<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>A/PV$_{\text{IN}}$ Pin Voltage</td>
<td>−0.3 to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{LX}}$</td>
<td>L$_X$ Pin Voltage</td>
<td>−0.3 to A/PV$_{\text{IN}}$ +0.3</td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{CE}}$</td>
<td>CE Pin Voltage</td>
<td>−0.3 to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{OUT}}/V_{\text{FB}}$</td>
<td>V$<em>{\text{OUT}}$/V$</em>{\text{FB}}$ Pin Voltage</td>
<td>−0.3 to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{MODE}}$</td>
<td>MODE Pin Voltage</td>
<td>−0.3 to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{PG}}$</td>
<td>PG Pin Voltage</td>
<td>−0.3 to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>$V_{\text{TSS}}$</td>
<td>TSS Pin Voltage</td>
<td>−0.3 to AV$_{\text{IN}}$+0.3</td>
<td>V</td>
</tr>
<tr>
<td>$I_{\text{LX}}$</td>
<td>L$_X$ Pin Output Current</td>
<td>2.8</td>
<td>A</td>
</tr>
<tr>
<td>$P_{\text{D}}$</td>
<td>Power Dissipation$^{(1)}$</td>
<td>4300</td>
<td>mW</td>
</tr>
</tbody>
</table>

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

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

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>2.5 to 5.5</td>
<td>V</td>
</tr>
<tr>
<td>$T_a$</td>
<td>Operating Temperature Range</td>
<td>$-40$ to 105</td>
<td>°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$-40$ to 125</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 conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.
### ELECTRICAL CHARACTERISTICS

RP506Lxx1x-TR-A

The specifications surrounded by [ ] are guaranteed by design engineering at \(-40°C \leq T_a \leq 105°C\).

**RP506Lxx1 Electrical Characteristics \((T_a = 25°C)\)**

<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/PVin = 5.5 V, VCE = 0 V</td>
<td>0</td>
<td>5</td>
<td></td>
<td>µA</td>
</tr>
<tr>
<td>ICEH</td>
<td>CE “H” Input Current</td>
<td>A/PVin = VCE = 5.5 V</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>CEL</td>
<td>CE “L” Input Current</td>
<td>A/PVin = 5.5 V, VCE = 0 V</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>IMODEH</td>
<td>MODE “H” Input Current</td>
<td>A/PVin = VMODE = 5.5 V, VCE = 0 V</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>IMODEL</td>
<td>MODE “L” Input Current</td>
<td>A/PVin = 5.5 V, VCE = VMODE = 0 V</td>
<td>-1</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>ILXLEAKH</td>
<td>LX Leakage Current “H”</td>
<td>A/PVin = VLx = 5.5 V, VCE = 0 V</td>
<td>-1</td>
<td>0</td>
<td>8</td>
<td>µA</td>
</tr>
<tr>
<td>ILXLEAKL</td>
<td>LX Leakage Current “L”</td>
<td>A/PVin = 5.5 V, VCE = VLx = 0 V</td>
<td>-15</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>VCEH</td>
<td>CE “H” Input Voltage</td>
<td>A/PVin = 5.5 V</td>
<td>1.0</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>VCEL</td>
<td>CE “L” Input Voltage</td>
<td>A/PVin = 2.5 V</td>
<td>0.4</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>VMODEH</td>
<td>MODE “H” Input Voltage</td>
<td>A/PVin = 5.5 V</td>
<td>1.0</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>VMODEL</td>
<td>MODE “L” Input Voltage</td>
<td>A/PVin = 2.5 V</td>
<td>0.4</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>RONP</td>
<td>On Resistance of Pch Transistor</td>
<td>A/PVin = 3.6 V, ILx = −100 mA</td>
<td>0.130</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
<tr>
<td>RONN</td>
<td>On Resistance of Nch Transistor</td>
<td>A/PVin = 3.6 V, ILx = −100 mA</td>
<td>0.125</td>
<td></td>
<td></td>
<td>Ω</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/PVin = VCE = 3.6 V or VSET + 1 V, TSS = OPEN</td>
<td>75</td>
<td>150</td>
<td>200</td>
<td>µs</td>
</tr>
<tr>
<td>tstart2</td>
<td>Soft-start Time 2</td>
<td>A/PVin = VCE = 3.6 V or VSET + 1 V, CSS = 0.1 µF</td>
<td>15</td>
<td>30</td>
<td>45</td>
<td>ms</td>
</tr>
<tr>
<td>ILXLM</td>
<td>LX Current Limit</td>
<td>A/PVin = VCE = 3.6 V or VSET + 1 V</td>
<td>2200</td>
<td>2800</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>tprot</td>
<td>Protection Delay Time</td>
<td>A/PVin = VCE = 3.6 V or VSET + 1 V</td>
<td>0.5</td>
<td>1.5</td>
<td>5</td>
<td>ms</td>
</tr>
<tr>
<td>VUVLO1</td>
<td>UVLO Detector Threshold</td>
<td>A/PVin = VCE</td>
<td>2.1</td>
<td>2.2</td>
<td>2.3</td>
<td>V</td>
</tr>
<tr>
<td>VUVLO2</td>
<td>UVLO Released Voltage</td>
<td>A/PVin = VCE</td>
<td>2.2</td>
<td>2.3</td>
<td>2.4</td>
<td>V</td>
</tr>
<tr>
<td>TTSDF</td>
<td>Thermal Shutdown Temperature</td>
<td>Junction Temperature</td>
<td>165</td>
<td></td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>TTSSR</td>
<td>Thermal Shutdown Released Temperature</td>
<td>Junction Temperature</td>
<td>115</td>
<td></td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>RPG</td>
<td>On Resistance of PG Pin When Low Output</td>
<td>A/PVin = 3.6 V, VOUT = 0 V or VFB = 0 V</td>
<td>45</td>
<td></td>
<td></td>
<td>Ω</td>
</tr>
</tbody>
</table>

All test items listed under Electrical Characteristics are done under the pulse load condition \((T_j \approx T_a = 25°C)\).
ELECTRICAL CHARACTERISTICS (continued)

RP506Lxx1x-TR-A

The specifications surrounded by ❏ are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.

### RP506Lxx1G/H, RP506L001N (Oscillator Frequency: 2.3 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&lt;sub&gt;IN&lt;/sub&gt;</td>
<td>When MODE = H (Operating Input Voltage&lt;sup&gt;(1)&lt;/sup&gt;)</td>
<td>1.1 V ≤ V&lt;sub&gt;SET&lt;/sub&gt; &lt; 1.2 V</td>
<td>2.5</td>
<td>4.3</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.2 V ≤ V&lt;sub&gt;SET&lt;/sub&gt;</td>
<td>2.5</td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>When MODE = L (Operating Input Voltage&lt;sup&gt;(2)&lt;/sup&gt;)</td>
<td>0.8 V ≤ V&lt;sub&gt;SET&lt;/sub&gt; &lt; 1.0 V</td>
<td>2.5</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0 V ≤ V&lt;sub&gt;SET&lt;/sub&gt;</td>
<td>2.5</td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fosc</td>
<td>Oscillator Frequency</td>
<td>A/PV&lt;sub&gt;IN&lt;/sub&gt; = V&lt;sub&gt;CE&lt;/sub&gt; = 3.6 V or V&lt;sub&gt;SET&lt;/sub&gt; + 1 V</td>
<td>2.00</td>
<td>2.3</td>
<td>2.50</td>
<td>MHz</td>
</tr>
</tbody>
</table>

### RP506Lxx1K/L, RP506L001M (Oscillator Frequency: 1.2 MHz) Electrical Characteristics

| V<sub>IN</sub> | When MODE = H (Operating Input Voltage) | 0.6 V ≤ V<sub>SET</sub> < 0.7 V | 2.3 | 4.3 | | V |
| | | 0.7 V ≤ V<sub>SET</sub> | 2.5 | 5.5 | | |
| | When MODE = L (Operating Input Voltage) | 0.6 V ≤ V<sub>SET</sub> | 2.5 | 5.5 | | |
| fosc | Oscillator Frequency | A/PV<sub>IN</sub> = V<sub>CE</sub> = 3.6 V or V<sub>SET</sub> + 1 V | 1.00 | 1.20 | 1.40 | MHz |

All test items listed under Electrical Characteristics are done under the pulse load condition (T<sub>j</sub> ≈ T<sub>a</sub> = 25°C).

<sup>(1)</sup> As for RP506Lxx1G/H/N (MODE = H), V<sub>SET</sub> can be set from 1.1 V.

<sup>(2)</sup> As for RP506Lxx1G/H/N (MODE = L), V<sub>SET</sub> can be set from 0.8 V.
**RP506Lxx1x-TR-A**

The specifications surrounded by [ ] are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.

### RP506Lxx1G/H/K/L (Fixed Output Voltage Type) 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&lt;sub&gt;OUT&lt;/sub&gt;</td>
<td>Output Voltage</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = V&lt;sub&gt;CE&lt;/sub&gt; = 3.6 V or V&lt;sub&gt;SET&lt;/sub&gt; + 1 V</td>
<td>V&lt;sub&gt;SET&lt;/sub&gt; ≥ 1.2 V</td>
<td>x0.985</td>
<td>x1.015</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>V&lt;sub&gt;SET&lt;/sub&gt; &lt; 1.2 V</td>
<td>k0.975</td>
<td>k1.025</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;OD1&lt;/sub&gt;</td>
<td>Supply Current 1</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = V&lt;sub&gt;CE&lt;/sub&gt; = 5.5 V, V&lt;sub&gt;OUT&lt;/sub&gt; = V&lt;sub&gt;SET&lt;/sub&gt; × 0.8</td>
<td>600</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;OD2&lt;/sub&gt;</td>
<td>Supply Current 2</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = V&lt;sub&gt;CE&lt;/sub&gt; = V&lt;sub&gt;OUT&lt;/sub&gt; = 5.5 V</td>
<td>V&lt;sub&gt;MODE&lt;/sub&gt; = 0 V</td>
<td>48</td>
<td>72</td>
<td>μA</td>
</tr>
<tr>
<td>I&lt;sub&gt;VOUTL&lt;/sub&gt;</td>
<td>V&lt;sub&gt;OUT&lt;/sub&gt; “L” Current</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = 5.5 V, V&lt;sub&gt;CE&lt;/sub&gt; = V&lt;sub&gt;OUT&lt;/sub&gt; = 0 V</td>
<td>−1</td>
<td>0</td>
<td>0</td>
<td>μA</td>
</tr>
<tr>
<td>V&lt;sub&gt;OVD&lt;/sub&gt;</td>
<td>OVD Voltage</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = 3.6 V</td>
<td>V&lt;sub&gt;SET&lt;/sub&gt; × 1.2</td>
<td></td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;UVD&lt;/sub&gt;</td>
<td>UVD Voltage</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = 3.6 V</td>
<td>V&lt;sub&gt;SET&lt;/sub&gt; × 0.8</td>
<td></td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

### RP506Lxx1G/K (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&lt;sub&gt;VOUTH&lt;/sub&gt;</td>
<td>V&lt;sub&gt;OUT&lt;/sub&gt; “H” Current</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = V&lt;sub&gt;OUT&lt;/sub&gt; = 5.5 V, V&lt;sub&gt;CE&lt;/sub&gt; = 0 V</td>
<td>−1</td>
<td>0</td>
<td>0</td>
<td>μA</td>
</tr>
</tbody>
</table>

### RP506Lxx1H/L (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&lt;sub&gt;LOW&lt;/sub&gt;</td>
<td>On Resistance of Low Output</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = 3.6 V, V&lt;sub&gt;CE&lt;/sub&gt; = 0 V</td>
<td>45</td>
<td>Ω</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### RP506L001N/M (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&lt;sub&gt;FB&lt;/sub&gt;</td>
<td>Feedback Voltage</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = V&lt;sub&gt;CE&lt;/sub&gt; = 3.6 V</td>
<td>0.591</td>
<td>0.600</td>
<td>0.609</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.588</td>
<td>0.600</td>
<td>0.615</td>
<td></td>
</tr>
<tr>
<td>ΔV&lt;sub&gt;FB&lt;/sub&gt; /ΔTa</td>
<td>Feedback Voltage Temperature Coefficient</td>
<td>−40°C ≤ Ta ≤ 105°C</td>
<td>±100</td>
<td>ppm /°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;OD1&lt;/sub&gt;</td>
<td>Supply Current 1</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = V&lt;sub&gt;CE&lt;/sub&gt; = 5.5 V, V&lt;sub&gt;FB&lt;/sub&gt; = 0.48 V</td>
<td>600</td>
<td>μA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;OD2&lt;/sub&gt;</td>
<td>Supply Current 2</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = V&lt;sub&gt;CE&lt;/sub&gt; = V&lt;sub&gt;FB&lt;/sub&gt; = 5.5 V</td>
<td>V&lt;sub&gt;MODE&lt;/sub&gt; = 0 V</td>
<td>48</td>
<td>72</td>
<td>μA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>V&lt;sub&gt;MODE&lt;/sub&gt; = 5.5 V</td>
<td>600</td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>I&lt;sub&gt;VFBH&lt;/sub&gt;</td>
<td>V&lt;sub&gt;FB&lt;/sub&gt; “H” Current</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = V&lt;sub&gt;FB&lt;/sub&gt; = 5.5 V, V&lt;sub&gt;CE&lt;/sub&gt; = 0 V</td>
<td>−1</td>
<td>0</td>
<td>0</td>
<td>μA</td>
</tr>
<tr>
<td>I&lt;sub&gt;VFBL&lt;/sub&gt;</td>
<td>V&lt;sub&gt;FB&lt;/sub&gt; “L” Current</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = 5.5 V, V&lt;sub&gt;CE&lt;/sub&gt; = V&lt;sub&gt;FB&lt;/sub&gt; = 0 V</td>
<td>−1</td>
<td>0</td>
<td>0</td>
<td>μA</td>
</tr>
<tr>
<td>V&lt;sub&gt;OVD&lt;/sub&gt;</td>
<td>OVD Voltage</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = 3.6 V</td>
<td></td>
<td>0.72</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>V&lt;sub&gt;UVD&lt;/sub&gt;</td>
<td>UVD Voltage</td>
<td>A/P&lt;sub&gt;VIN&lt;/sub&gt; = 3.6 V</td>
<td></td>
<td>0.48</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

All test items listed under Electrical Characteristics are done under the pulse load condition (Tj = Ta = 25°C) except Feedback Voltage Temperature Coefficient.
**ELECTRICAL CHARACTERISTICS (continued)**

RP506Lxx1x-TR-A

The specifications surrounded by **are guaranteed by design engineering at −40°C ≤ Ta ≤ 105°C.**

**RP506L Electrical Characteristics by Different Output Voltage (Ta = 25°C)**

<table>
<thead>
<tr>
<th>Product Name</th>
<th>V&lt;sub&gt;OUT [V] (Ta = 25°C)&lt;/sub&gt;</th>
<th>V&lt;sub&gt;OUT [V] (Ta = -40 ~ 105°C)&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>RP506L081x</td>
<td>0.782</td>
<td>0.800</td>
</tr>
<tr>
<td>RP506L101x</td>
<td>0.982</td>
<td>1.000</td>
</tr>
<tr>
<td>RP506L111x</td>
<td>1.082</td>
<td>1.100</td>
</tr>
<tr>
<td>RP506L121x</td>
<td>1.182</td>
<td>1.200</td>
</tr>
<tr>
<td>RP506L131x</td>
<td>1.281</td>
<td>1.300</td>
</tr>
<tr>
<td>RP506L151x</td>
<td>1.478</td>
<td>1.500</td>
</tr>
<tr>
<td>RP506L181x</td>
<td>1.773</td>
<td>1.800</td>
</tr>
<tr>
<td>RP506L181x5</td>
<td>1.823</td>
<td>1.850</td>
</tr>
<tr>
<td>RP506L301x</td>
<td>2.955</td>
<td>3.000</td>
</tr>
<tr>
<td>RP506L331x</td>
<td>3.251</td>
<td>3.300</td>
</tr>
</tbody>
</table>
### ELECTRICAL CHARACTERISTICS (continued)

**RP506Lxx1x-TR-K**

#### RP506Lxx1 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>$I_{standby}$</td>
<td>Standby Current</td>
<td>$A/PVIN = 5.5 , V, , V_{CE} = 0 , V$</td>
<td>0</td>
<td>10</td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td>$I_{CEH}$</td>
<td>CE “H” Input Current</td>
<td>$A/PVIN = V_{CE} = 5.5 , V$</td>
<td>−1</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>$I_{CEL}$</td>
<td>CE “L” Input Current</td>
<td>$A/PVIN = 5.5 , V, , V_{CE} = 0 , V$</td>
<td>−1</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>$I_{MODEH}$</td>
<td>MODE “H” Input Current</td>
<td>$A/PVIN = V_{MODE} = 5.5 , V, , V_{CE} = 0 , V$</td>
<td>−1</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>$I_{MODEL}$</td>
<td>MODE “L” Input Current</td>
<td>$A/PVIN = 5.5 , V, , V_{CE} = V_{MODE} = 0 , V$</td>
<td>−1</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>$I_{LXLEAKH}$</td>
<td>LX Leakage Current “H”</td>
<td>$A/PVIN = V_{LX} = 5.5 , V, , V_{CE} = 0 , V$</td>
<td>−1</td>
<td>0</td>
<td>6</td>
<td>µA</td>
</tr>
<tr>
<td>$I_{LXLEAKL}$</td>
<td>LX Leakage Current “L”</td>
<td>$A/PVIN = 5.5 , V, , V_{CE} = V_{LX} = 0 , V$</td>
<td>−40</td>
<td>0</td>
<td>1</td>
<td>µA</td>
</tr>
<tr>
<td>$V_{CEH}$</td>
<td>CE “H” Input Voltage</td>
<td>$A/PVIN = 5.5 , V$</td>
<td>1.0</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{CEL}$</td>
<td>CE “L” Input Voltage</td>
<td>$A/PVIN = 2.5 , V$</td>
<td></td>
<td>0.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{MODEH}$</td>
<td>MODE “H” Input Voltage</td>
<td>$A/PVIN = 5.5 , V$</td>
<td>1.0</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$V_{MODEL}$</td>
<td>MODE “L” Input Voltage</td>
<td>$A/PVIN = 2.5 , V$</td>
<td></td>
<td>0.4</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>$R_{ONP}$</td>
<td>On Resistance of Pch Transistor</td>
<td>$A/PVIN = 3.6 , V, , I_{LX} = -100 , mA$</td>
<td></td>
<td></td>
<td></td>
<td>0.130</td>
</tr>
<tr>
<td>$R_{ONN}$</td>
<td>On Resistance of Nch Transistor</td>
<td>$A/PVIN = 3.6 , V, , I_{LX} = -100 , mA$</td>
<td></td>
<td></td>
<td></td>
<td>0.125</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>$t_{start1}$</td>
<td>Soft-start Time 1</td>
<td>$A/PVIN = V_{CE} = 3.6 , V$ or $V_{SET} + 1 , V$, $TSS = OPEN$</td>
<td>75</td>
<td>150</td>
<td>300</td>
<td>µs</td>
</tr>
<tr>
<td>$t_{start2}$</td>
<td>Soft-start Time 2</td>
<td>$A/PVIN = V_{CE} = 3.6 , V$ or $V_{SET} + 1 , V$, $C_{SS} = 0.1 , µF$</td>
<td>15</td>
<td>30</td>
<td>45</td>
<td>ms</td>
</tr>
<tr>
<td>$I_{LXLEM}$</td>
<td>LX Current Limit</td>
<td>$A/PVIN = V_{CE} = 3.6 , V$ or $V_{SET} + 1 , V$</td>
<td>2000</td>
<td>2800</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>$t_{prot}$</td>
<td>Protection Delay Time</td>
<td>$A/PVIN = V_{CE} = 3.6 , V$ or $V_{SET} + 1 , V$</td>
<td>0.5</td>
<td>1.5</td>
<td>5</td>
<td>ms</td>
</tr>
<tr>
<td>$V_{UVLO1}$</td>
<td>UVLO Detector Threshold</td>
<td>$A/PVIN = V_{CE}$</td>
<td>2.1</td>
<td>2.2</td>
<td>2.3</td>
<td>V</td>
</tr>
<tr>
<td>$V_{UVLO2}$</td>
<td>UVLO Released Voltage</td>
<td>$A/PVIN = V_{CE}$</td>
<td>2.2</td>
<td>2.3</td>
<td>2.4</td>
<td>V</td>
</tr>
<tr>
<td>$T_{TSD}$</td>
<td>Thermal Shutdown Temperature</td>
<td>Junction Temperature</td>
<td>165</td>
<td></td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>$T_{TSR}$</td>
<td>Thermal Shutdown Released Temperature</td>
<td>Junction Temperature</td>
<td>115</td>
<td></td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>$R_{PG}$</td>
<td>On Resistance of PG Pin When Low Output</td>
<td>$A/PVIN = 3.6 , V, , V_{OUT} = 0 , V$ or $V_{FB} = 0 , V$</td>
<td></td>
<td></td>
<td>45</td>
<td>Ω</td>
</tr>
</tbody>
</table>
### ELECTRICAL CHARACTERISTICS (continued)

**RP506Lxx1x-TR-K**

#### RP506Lxx1G/H, RP506L001N (Oscillator Frequency: 2.3 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>VIN</td>
<td>When MODE = H Operating Input Voltage(^1)</td>
<td>$1.1 , V \leq V_{SET} &lt; 1.2 , V$</td>
<td>2.5</td>
<td>2.5</td>
<td>4.5</td>
<td>V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1.2 , V \leq V_{SET}$</td>
<td>2.5</td>
<td>2.5</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>VIN</td>
<td>When MODE = L Operating Input Voltage(^2)</td>
<td>$0.8 , V \leq V_{SET} &lt; 1.0 , V$</td>
<td>2.5</td>
<td>2.5</td>
<td>4.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$1.0 , V \leq V_{SET}$</td>
<td>2.5</td>
<td>2.5</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>fosc</td>
<td>Oscillator Frequency</td>
<td>$A/P_{VIN} = V_{CE} = 3.6 , V$ or $V_{SET} + 1 , V$</td>
<td>2.00</td>
<td>2.3</td>
<td>2.50</td>
<td>MHz</td>
</tr>
</tbody>
</table>

#### RP506Lxx1K/L, RP506L001M (Oscillator Frequency: 1.2 MHz) Electrical Characteristics

<table>
<thead>
<tr>
<th>VIN</th>
<th>Item</th>
<th>Conditions</th>
<th>Min.</th>
<th>Typ.</th>
<th>Max.</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>When MODE = H Operating Input Voltage</td>
<td>$0.6 , V \leq V_{SET} &lt; 0.7 , V$</td>
<td>2.5</td>
<td>2.5</td>
<td>4.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$0.7 , V \leq V_{SET}$</td>
<td>2.5</td>
<td>2.5</td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When MODE = L Operating Input Voltage</td>
<td>$0.6 , V \leq V_{SET}$</td>
<td>2.5</td>
<td>2.5</td>
<td>5.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fosc</td>
<td>Oscillator Frequency</td>
<td>$A/P_{VIN} = V_{CE} = 3.6 , V$ 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 RP506Lxx1G/H/N (MODE = H), $V_{SET}$ can be set from 1.1 V.

\(^2\) As for RP506Lxx1G/H/N (MODE = L), $V_{SET}$ can be set from 0.8 V.
### ELECTRICAL CHARACTERISTICS (continued)

#### RP506Lxx1x-TR-K

**RP506Lxx1G/K/L (Fixed Output Voltage Type) Electrical Characteristics**  
\([-40°C ≤ Ta ≤ 125°C]\)

<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_{OUT})</td>
<td>Output Voltage</td>
<td>(A/P_{VIN} = V_{CE} = 3.6,\text{V}) or (V_{SET} + 1,\text{V})</td>
<td>(V_{SET} ≥ 1.2,\text{V})</td>
<td>(\text{Ta} = 25°C)</td>
<td>(x0.985)</td>
<td>(x1.015)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(V_{SET} &lt; 1.2,\text{V})</td>
<td>(\text{Ta} = 25°C)</td>
<td>(−0.018)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>(I_{DD1})</td>
<td>Supply Current 1</td>
<td>(A/P_{VIN} = V_{CE} = 5.5,\text{V}), (V_{OUT} = V_{SET} × 0.8)</td>
<td></td>
<td></td>
<td></td>
<td>600</td>
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<tr>
<td>(I_{DD2})</td>
<td>Supply Current 2</td>
<td>(A/P_{VIN} = V_{CE} = 5.5,\text{V})</td>
<td>(V_{MODE} = 0,\text{V})</td>
<td></td>
<td></td>
<td>48</td>
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<tr>
<td>(I_{VOUTL})</td>
<td>(V_{OUT}) “L” Current</td>
<td>(A/P_{VIN} = 5.5,\text{V}), (V_{CE} = V_{OUT} = 0,\text{V})</td>
<td></td>
<td></td>
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<td>(-1)</td>
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<tr>
<td>(V_{OVD})</td>
<td>OVD Voltage</td>
<td>(A/P_{VIN} = 3.6,\text{V})</td>
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<td>(V_{SET} × 1.2)</td>
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<tr>
<td>(V_{UVD})</td>
<td>UVD Voltage</td>
<td>(A/P_{VIN} = 3.6,\text{V})</td>
<td></td>
<td>(V_{SET} × 0.8)</td>
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</table>

#### RP506Lxx1G/K (Fixed Output Voltage Type without Auto-discharge Function)

| \(I_{VOUTH}\) | \(V_{OUT}\) “H” Current | \(A/P_{VIN} = V_{OUT} = 5.5\,\text{V}\), \(V_{CE} = 0\,\text{V}\) | | | | \(-1\) | 0 | 1 | \(\mu\text{A}\) |

#### RP506Lxx1H/L (Fixed Output Voltage Type with Auto-discharge Function)

| \(R_{LOW}\) | On Resistance of Low Output | \(A/P_{VIN} = 3.6\,\text{V}\), \(V_{CE} = 0\,\text{V}\) | | | | 45 | | \(\Omega\) |

#### RP506L001N/M (Adjustable Output Voltage Type) Electrical Characteristics

| \(V_{FB}\) | Feedback Voltage | \(A/P_{VIN} = V_{CE} = 3.6\,\text{V}\) | \(\text{Ta} = 25°C\) | \(0.591\) | \(0.600\) | \(0.609\) | \(\text{V}\) |
| | | | \(-40°C ≤ \text{Ta} ≤ 125°C\) | \(0.585\) | \(0.615\) | | | |
| \(I_{DD1}\) | Supply Current 1 | \(A/P_{VIN} = V_{CE} = 5.5\,\text{V}\), \(V_{FB} = 0.48\,\text{V}\) | | | | 600 | | \(\mu\text{A}\) |
| \(I_{DD2}\) | Supply Current 2 | \(A/P_{VIN} = V_{CE} = 5.5\,\text{V}\), \(V_{FB} = 5.5\,\text{V}\) | \(V_{MODE} = 0\,\text{V}\) | | | 48 | 72 | \(\mu\text{A}\) |
| \(I_{VFBH}\) | \(V_{FB}\) “H” Current | \(A/P_{VIN} = V_{FB} = 5.5\,\text{V}\), \(V_{CE} = 0\,\text{V}\) | | | | \(-1\) | 0 | 1 | \(\mu\text{A}\) |
| \(I_{VFBL}\) | \(V_{FB}\) “L” Current | \(A/P_{VIN} = 5.5\,\text{V}\), \(V_{CE} = V_{FB} = 0\,\text{V}\) | | | | \(-1\) | 0 | 1 | \(\mu\text{A}\) |
| \(V_{OVD}\) | OVD Voltage | \(A/P_{VIN} = 3.6\,\text{V}\) | | | | 0.72 | | \(\text{V}\) |
| \(V_{UVD}\) | UVD Voltage | \(A/P_{VIN} = 3.6\,\text{V}\) | | | | 0.48 | | \(\text{V}\) |
ELECTRICAL CHARACTERISTICS (continued)

RP506Lxx1x-TR-K

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<tr>
<th>Product Name</th>
<th>$V_{\text{OUT}}$ [V] (Ta = 25°C)</th>
<th>$V_{\text{OUT}}$ [V] (Ta = -40 ~ 125°C)</th>
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<td>RP506L301x</td>
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<td>RP506L331x</td>
<td>3.251</td>
<td>3.300</td>
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</table>
THEORY OF OPERATION

Soft-start Time Adjustment Function

Soft-start time (t\text{start}) of the RP506L is adjustable by connecting a soft-start time adjustment capacitor (C\text{SS}) between the TSS pin and GND. t\text{start} can be set from Typ. 0.15 ms. As the figure below shows, if 0.1 \mu F C\text{SS} is connected, t\text{start} will be 30 ms. The TSS pin must be open if the soft-start time function is not used. t\text{start} is set to 0.15 ms (Typ.) when the TSS pin is open.

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

Power Good Function

The RP506L 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 (RP506Lxx1G/H/K/L) or 0.72 V (RP506L001N/M)
- Under Voltage Detection: Typ. \( V_{\text{SET}} \times 0.8 \) V (RP506Lxx1G/H/K/L) or 0.48 V (RP506L001N/M)
- Latch Type Protection

Notes: When using the power good function, the resistance of PG pin (R\text{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 RP506L. 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 (VSET x 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 (RP506L001N/M):**
- VIN = 5.0 V
- VOUT = 1.8 V
- tstart = 30 ms
- CSS = 0.1 µF

**DC/DC2 (RP506L001N/M):**
- VIN = 5.0 V
- VOUT = 1.2 V
- tstart = 30 ms
- CSS = 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 (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.

![Basic Circuit](chart1)

**Basic Circuit**

**Inductor Current (IL) flowing through Inductor (L)**

**Step1.** 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.

**Step2.** When Pch Tr. turns “OFF”, L tries to maintain IL at ILmax, so L turns Nch Tr. “ON” and IL (i2) flows into L.

**Step3.** 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 (I_{OUT}) 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, V_{OUT} 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.

\[
\Delta I = ILmax - ILmin = V_{OUT} \times topen / L = (V_{IN} - V_{OUT}) \times ton / L \quad \text{Equation 1}
\]

However,

\[T = 1 / fosc = ton + toff\]

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

\[topen \leq toff\]

In Equation 1, “V_{OUT} \times topen / L” shows the amount of current change in “ON” state. Also, “(V_{IN} - V_{OUT}) \times 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, $I_{Lmin} = 0$. This is called discontinuous mode. When $I_{OUT}$ is gradually increased, eventually $t_{open} = t_{off}$ and when $I_{OUT}$ is increased further, eventually $I_{Lmin} > 0$, as illustrated in Figure B. This is called continuous mode.

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

\[ t_{onc} = T_a \times \frac{V_{OUT}}{V_{IN}} \]  \hspace{1cm} \text{Equation 2}

When $t_{on} < t_{onc}$, it is discontinuous mode, and when $t_{on} = t_{onc}$, 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 $I_{OUT}$ is $\Delta I_L/2$ or less, $I_{Lmin}$ becomes less than 0. That is, the accumulated electricity in $C_L$ is discharged through the IC side while $I_L$ is increasing from $I_{Lmin}$ to 0 during $t_{on}$, and also while $I_L$ is decreasing from 0 to $I_{Lmin}$ during $t_{off}$.

![Diagram of Forced PWM Mode](image)

**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, $t_{on}$ is forced to end when the inductor current reaches the pre-set $I_{Lmax}$. In the VFM mode, $I_{Lmax}$ is typically set to 400 mA for the RP506Lxx1G/H//N, and 550 mA for the RP506Lxx1K/L/M. When $t_{on}$ reaches 1.5 times of $T = 1 / f_{osc}$, $t_{on}$ will be forced to end even if the inductor current is not reached $I_{Lmax}$.

![Diagram of VFM Mode](image)
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.

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

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

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

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

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

Ripple Current is described as follows:

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

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

$$I_{LX_{max}} = I_{OUT} + I_{RP} / 2 \quad \text{Equation 7}$$

Notes: 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-of 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.

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

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.

![Timing Chart]

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.

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 $V_{OUT}$. 

Timing Chart
(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 $L_x$ current limit ($I_{LXLIM}$), it turns off Pch Tr. $I_{LXLIM}$ of the RP506L is set to Typ.2800 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 ($t_{prot}$). 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 $t_{prot}$ 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 $t_{prot}$ 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](image-url)
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

---

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

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

---

(1) $V_{SET} > 3.3$ V is only for RP506L001N/M.
Table 1. Recommended External Components

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<tr>
<th>Symbol</th>
<th>Size</th>
<th>Part Description</th>
<th>Model</th>
</tr>
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<td><strong>CIN</strong></td>
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<td>Ceramic Capacitor</td>
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<td><strong>COUT</strong></td>
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Small and Low Profile External Components

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<td>1.5 µH</td>
<td>Inductor</td>
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<td>2.2 µH</td>
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<td>VLS252010HBX-2R2M (TDK)</td>
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</tbody>
</table>

(1) **VSET** > 3.3 V is only for RP506L001N/M.
TECHNICAL NOTES

The performance of a power source circuit using this device is highly dependent on a peripheral circuit. A peripheral component or the device mounted on PCB should not exceed a rated voltage, a rated current or a rated power. When designing a peripheral circuit, please be fully aware of the following points.

- 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/PGND 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 RP506Lxx1G/H/K/L, separate the wiring between the VOUT pin and an inductor (L1) from the wiring between L1 and Load. Likewise, for the RP506L001N/M, 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 RP506Lxx1G/H//N/K/L/M. When VSET ≤ 2.3 V, a 1.5 µH inductor can be used for RP506Lxx1G/H//N. When VSET ≤ 1.5 V, a 1 µH inductor can be used for RP506Lxx1G/H//N. When VSET > 3.3 V, a 4.7 µH inductor is recommended for RP506L001N/M. 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 (VSET) Range vs. Inductance Range

<table>
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<th>Version</th>
<th>RP506Lxx1G/H</th>
<th>RP506Lxx1K/L</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>

<table>
<thead>
<tr>
<th>Version</th>
<th>RP506L001N</th>
<th>RP506L001M</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>
Overcurrent protection circuit and latch type protection circuit may be affected by self-heating or power dissipation environment.

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

\[ V_{OUT} = V_{FB} \times \frac{(R1 + R2)}{R2} \]

Recommended V_{OUT} range for RP506L001M: 0.6 V ≤ V_{SET} ≤ 4.0 V,
Recommended V_{OUT} range for RP506L001N: 0.8 V ≤ V_{SET} ≤ 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:

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

If the output voltage exceeds 3.3 V:

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

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>22</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

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

\[ C_{SS} (nF) = 3.5 \times t_{start} (ms) \]

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.
PCB Layout

RP506Lxx1G/H/K/L (PKG: DFN3030-12 pin) PCB Layout

RP506L001N/M (PKG: DFN3030-12 pin) PCB Layout

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

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

1) Output Voltage vs. Output Current

**RP506Lxx1G/H/N**  \( V_{OUT} = 1.2 \text{ V} \)

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

**RP506Lxx1G/H/N**  \( V_{OUT} = 1.2 \text{ V} \)

**MODE** = “H” Forced PWM Control

---

**RP506Lxx1G/H/N**  \( V_{OUT} = 1.5 \text{ V} \)

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

**RP506Lxx1G/H/N**  \( V_{OUT} = 1.5 \text{ V} \)

**MODE** = “H” Forced PWM Control

---

**RP506Lxx1G/H/N**  \( V_{OUT} = 1.8 \text{ V} \)

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

**RP506Lxx1G/H/N**  \( V_{OUT} = 1.8 \text{ V} \)

**MODE** = “H” Forced PWM Control
RP506Lxx1G/H/N  \( V_{\text{OUT}} = 3.3 \) V  
 MODE = “L”PWM/VFM Auto Switching Control

[Graph showing output voltage vs. output current for different input voltages (Vin=4.3V, Vin=5.0V)]

RP506Lxx1K/L/M  \( V_{\text{OUT}} = 0.6 \) V  
 MODE = “L”PWM/VFM Auto Switching Control

[Graph showing output voltage vs. output current for different input voltages (Vin=3.6V, Vin=4.5V)]

RP506Lxx1K/L/M  \( V_{\text{OUT}} = 0.8 \) V  
 MODE = “L”PWM/VFM Auto Switching Control

[Graph showing output voltage vs. output current for different input voltages (Vin=3.6V, Vin=5.0V)]

RP506Lxx1G/H/N  \( V_{\text{OUT}} = 3.3 \) V  
 MODE = “H” Forced PWM Control

[Graph showing output voltage vs. output current for different input voltages (Vin=4.3V, Vin=5.0V)]

RP506Lxx1K/L/M  \( V_{\text{OUT}} = 0.6 \) V  
 MODE = “H” Forced PWM Control

[Graph showing output voltage vs. output current for different input voltages (Vin=3.6V, Vin=4.5V)]

RP506Lxx1K/L/M  \( V_{\text{OUT}} = 0.8 \) V  
 MODE = “H” Forced PWM Control

[Graph showing output voltage vs. output current for different input voltages (Vin=3.6V, Vin=5.0V)]
RP506L
No. EC-296-181226

RP506Lxx1K/L/M  \( V_{OUT} = 1.2 \) V
MODE = “L”PWM/VFM Auto Switching Control

![Graph showing output voltage vs. output current for \( V_{OUT} = 1.2 \) V.]

RP506Lxx1K/L/M  \( V_{OUT} = 1.8 \) V
MODE = “L”PWM/VFM Auto Switching Control

![Graph showing output voltage vs. output current for \( V_{OUT} = 1.8 \) V.]

RP506Lxx1K/L/M  \( V_{OUT} = 3.3 \) V
MODE = “L”PWM/VFM Auto Switching Control

![Graph showing output voltage vs. output current for \( V_{OUT} = 3.3 \) V.]

RP506Lxx1K/L/M  \( V_{OUT} = 1.2 \) V
MODE = “H” Forced PWM Control

![Graph showing output voltage vs. output current for \( V_{OUT} = 1.2 \) V.]

RP506Lxx1K/L/M  \( V_{OUT} = 1.8 \) V
MODE = “H” Forced PWM Control

![Graph showing output voltage vs. output current for \( V_{OUT} = 1.8 \) V.]

RP506Lxx1K/L/M  \( V_{OUT} = 3.3 \) V
MODE = “H” Forced PWM Control

![Graph showing output voltage vs. output current for \( V_{OUT} = 3.3 \) V.]
2) Output Voltage vs. Input Voltage

RP506Lx1K/L/M  \( V_{OUT} = 0.6 \text{ V} \)
MODE = “H” Forced PWM Control

RP506Lx1K/L/M  \( V_{OUT} = 0.8 \text{ V} \)
MODE = “H” Forced PWM Control

RP506L  \( V_{OUT} = 1.2 \text{ V} \)
MODE = “H” Forced PWM Control

RP506L  \( V_{OUT} = 1.8 \text{ V} \)
MODE = “H” Forced PWM Control

RP506L  \( V_{OUT} = 3.3 \text{ V} \)
MODE = “H” Forced PWM Control
3) Output Voltage vs. Ambient Temperature
RP506L181G/H/K/L $V_{OUT} = 1.8$ V

4) Feedback Voltage vs. Ambient Temperature
RP506L001N/M

5) Efficiency vs. Output Current
RP506Lxx1G/H/N $V_{OUT} = 1.2$ V

RP506Lxx1G/H/N $V_{OUT} = 1.5$ V

VIN=5.0V, VMODE=0V
VIN=3.8V, VMODE=0V
VIN=VMODE=5.0V
VIN=VMODE=3.6V

VIN=3.3V, VMODE=0V
VIN=5V, VMODE=0V
VIN=VMODE=3.3V
VIN=VMODE=5.0V
6) Supply Current vs. Ambient Temperature
RP506L  $V_{OUT} = 1.8\, V$ ($V_{IN} = 5.5\, V$)
MODE = "L"PWM/VFM Auto Switching Control

7) Supply Current vs. Input Voltage
RP506L  $V_{OUT} = 1.8\, V$
MODE = "L"PWM/VFM Auto Switching Control

8) Output Voltage Waveform
RP506Lxx1G/H/N  $V_{OUT} = 0.8\, V$ ($V_{IN} = 3.6\, V$)
MODE = "L"PWM/VFM Auto Switching Control

RP506Lxx1G/H/N  $V_{OUT} = 1.2\, V$ ($V_{IN} = 3.6\, V$)
MODE = "L"PWM/VFM Auto Switching Control

RP506Lxx1G/H/N  $V_{OUT} = 1.2\, V$ ($V_{IN} = 3.6\, V$)
MODE = "H" Forced PWM Control
**RP506Lxx1G/H/N**  \( V_{OUT} = 1.8 \text{ V} \ (V_{IN} = 3.6 \text{ V}) \)  
MODE = “L”PWM/VFM Auto Switching Control

**RP506Lxx1G/H/N**  \( V_{OUT} = 1.8 \text{ V} \ (V_{IN} = 3.6 \text{ V}) \)  
MODE = “H” Forced PWM Control

**RP506Lxx1K/L/M**  \( V_{OUT} = 0.6 \text{ V} \ (V_{IN} = 3.6 \text{ V}) \)  
MODE = “L”PWM/VFM Auto Switching Control

**RP506Lxx1K/L/M**  \( V_{OUT} = 0.6 \text{ V} \ (V_{IN} = 3.6 \text{ V}) \)  
MODE = “H” Forced PWM Control
RP506L

No. EC-296-181226

**RP506Lxx1K/L/M**  \( V_{OUT} = 0.8 \text{ V (} V_{IN} = 3.6 \text{ V) } \)

MODE = “L” PWM/VFM Auto Switching Control

**RP506Lxx1K/L/M**  \( V_{OUT} = 0.8 \text{ V (} V_{IN} = 3.6 \text{ V) } \)

MODE = “H” Forced PWM Control

---

**RP506Lxx1K/L/M**  \( V_{OUT} = 1.2 \text{ V (} V_{IN} = 3.6 \text{ V) } \)

MODE = “L” PWM/VFM Auto Switching Control

**RP506Lxx1K/L/M**  \( V_{OUT} = 1.2 \text{ V (} V_{IN} = 3.6 \text{ V) } \)

MODE = “H” Forced PWM Control

---

**RP506Lxx1K/L/M**  \( V_{OUT} = 1.8 \text{ V (} V_{IN} = 3.6 \text{ V) } \)

MODE = “L” PWM/VFM Auto Switching Control

**RP506Lxx1K/L/M**  \( V_{OUT} = 1.8 \text{ V (} V_{IN} = 3.6 \text{ V) } \)

MODE = “H” Forced PWM Control
9) Oscillator Frequency vs. Ambient Temperature

RP506Lxx1G/H/N

10) Oscillator Frequency vs. Input Voltage

RP506Lxx1G/H/N
11) Soft-start Time vs. Ambient Temperature

![Graph showing Soft-start Time vs. Ambient Temperature]

12) UVLO Detector Threshold/ Released Voltage vs. Ambient Temperature

UVLO Detector Threshold

![Graph showing UVLO Detector Threshold vs. Ambient Temperature]

UVLO Released Voltage

![Graph showing UVLO Released Voltage vs. Ambient Temperature]

13) CE Input Voltage vs. Ambient Temperature

CE“H” Input Voltage ($V_{IN} = 5.5\, V$)

![Graph showing CE“H” Input Voltage vs. Ambient Temperature]

CE“L” Input Voltage ($V_{IN} = 2.5\, V$)

![Graph showing CE“L” Input Voltage vs. Ambient Temperature]
14) Lx Limit Current vs. Ambient Temperature

15) Nch Tr. On Resistance vs. Ambient Temperature

16) Pch Tr. On Resistance vs. Ambient Temperature

16) PG Detector Threshold vs. Ambient Temperature

- Overvoltage Detection $V_{OVD}$
- Undervoltage Detection $V_{UVD}$
18) Soft-start Waveform

RP506L $V_{OUT} = 1.8$ V, TSS = Open

RP506L $V_{OUT} = 1.8$ V, TSS = $0.1 \mu F$

19) Load Transient Response

RP506Lxx1G/H/N ($V_{IN} = 3.6$ V, $V_{OUT} = 0.8$ V)

MODE = “L”PWM/VFM Auto Switching Control

RP506Lxx1G/H/N ($V_{IN} = 3.6$ V, $V_{OUT} = 0.8$ V)

MODE = “L”PWM/VFM Auto Switching Control
RP506L

No. EC-296-181226

RP506Lxx1G/H/N (V\text{IN} = 3.6\ V, V\text{OUT} = 1.8\ V)
MODE = “L” PWM/VFM Auto Switching Control

RP506Lxx1G/H/N (V\text{IN} = 3.6\ V, V\text{OUT} = 1.8\ V)
MODE = “H” Forced PWM Control

RP506Lxx1G/H/N (V\text{IN} = 3.6\ V, V\text{OUT} = 1.8\ V)

RP506Lxx1G/H/N (V\text{IN} = 3.6\ V, V\text{OUT} = 1.8\ V)
RP506Lxx1G/H/N (VIN = 5.0 V, VOUT = 3.3 V) MODE = “L” PWM/VFM Auto Switching Control

RP506Lxx1G/H/N (VIN = 5.0 V, VOUT = 3.3 V) MODE = “H” Forced PWM Control

Output Voltage VOUT (V) vs Time t (μs)

Output Current IOUT (mA) vs Time t (μs)

Output Current
200mA → 1000mA

Output Current
1000mA → 200mA

Output Voltage
0

Output Voltage
3.10

Output Voltage
3.20

Output Voltage
3.30

Output Voltage
3.40

Output Current
3.10

Output Current
3.20

Output Current
3.30

Output Current
3.40

Output Voltage
0

Output Voltage
500

Output Voltage
1000

Output Voltage
1500

Output Voltage
3.10

Output Voltage
3.20

Output Voltage
3.30

Output Voltage
3.40

Output Current
0

Output Current
500

Output Current
1000

Output Current
1500

Output Voltage
0

Output Voltage
500

Output Voltage
1000

Output Voltage
1500
RP506L

No. EC-296-181226

RP506Lxx1K/L/M (V\text{IN} = 3.6 \text{V}, V\text{OUT} = 0.6 \text{V})
MODE = "L" PWM/VFM Auto Switching Control

RP506Lxx1K/L/M (V\text{IN} = 3.6 \text{V}, V\text{OUT} = 0.6 \text{V})
MODE = "H" Forced PWM Control

RP506Lxx1K/L/M (V\text{IN} = 3.6 \text{V}, V\text{OUT} = 0.6 \text{V})
MODE = "L" PWM/VFM Auto Switching Control

RP506Lxx1K/L/M (V\text{IN} = 3.6 \text{V}, V\text{OUT} = 0.6 \text{V})
MODE = "H" Forced PWM Control
RP506Lxx1K/L/M (V\textsubscript{IN} = 3.6 V, V\textsubscript{OUT} = 0.8 V)  
MODE = "L"PWM/VFM Auto Switching Control

RP506Lxx1K/L/M (V\textsubscript{IN} = 3.6 V, V\textsubscript{OUT} = 0.8 V)  
MODE = "H" Forced PWM Control

RP506Lxx1K/L/M (V\textsubscript{IN} = 3.6 V, V\textsubscript{OUT} = 0.8 V)  
MODE = "L"PWM/VFM Auto Switching Control

RP506Lxx1K/L/M (V\textsubscript{IN} = 3.6 V, V\textsubscript{OUT} = 0.8 V)  
MODE = "H" Forced PWM Control
RP506L

No. EC-296-181226

RP506Lxx1K/L/M (V_{IN} = 3.6 V, V_{OUT} = 1.2 V)  
MODE = “L” PWM/VFM Auto Switching Control

RP506Lxx1K/L/M (V_{IN} = 3.6 V, V_{OUT} = 1.2 V)  
MODE = “H” Forced PWM Control

Output Voltage V_{OUT} (V)  
Output Current I_{OUT} (mA)
RP506Lxx1K/L/M (VIN = 3.6 V, VOUT = 1.8 V)  
MODE = “L” PWM/VFM Auto Switching Control

RP506Lxx1K/L/M (VIN = 3.6 V, VOUT = 1.8 V)  
MODE = “H” Forced PWM Control

Output Voltage VOUT (V)  
Output Current IOUT (mA)
RP506L

No. EC-296-181226

RP506Lxx1K/L/M (V_{IN} = 5.0 \, \text{V}, \, V_{OUT} = 3.3 \, \text{V})

MODE = “L”PWM/VFM Auto Switching Control

RP506Lxx1K/L/M (V_{IN} = 5.0 \, \text{V}, \, V_{OUT} = 3.3 \, \text{V})

MODE = “H” Forced PWM Control

Output Current
200mA→1000mA

Output Voltage
3.10
3.20
3.30
3.40
3.50

Output Voltage V_{OUT} (\text{V})

Output Current I_{OUT} (\text{mA})

Time t (\mu\text{s})

-20 0 20 40 60 80 100 120 140 160 180

Output Voltage
3.10
3.20
3.30
3.40
3.50

Output Voltage V_{OUT} (\text{V})

Output Current I_{OUT} (\text{mA})

Time t (\mu\text{s})

-20 0 20 40 60 80 100 120 140 160 180

Output Current
1000mA→200mA

Output Voltage
3.10
3.20
3.30
3.40
3.50

Output Voltage V_{OUT} (\text{V})

Output Current I_{OUT} (\text{mA})

Time t (\mu\text{s})

-20 0 20 40 60 80 100 120 140 160 180

Output Current
200mA→1000mA

Output Voltage
3.10
3.20
3.30
3.40
3.50

Output Voltage V_{OUT} (\text{V})

Output Current I_{OUT} (\text{mA})

Time t (\mu\text{s})

-20 0 20 40 60 80 100 120 140 160 180

Output Current
1000mA→200mA

Output Voltage
3.10
3.20
3.30
3.40
3.50

Output Voltage V_{OUT} (\text{V})

Output Current I_{OUT} (\text{mA})

Time t (\mu\text{s})

-20 0 20 40 60 80 100 120 140 160 180

3.10
3.20
3.30
3.40
3.50

-20 0 20 40 60 80 100 120 140 160 180

0
500
1000
1500
2000
3000

0
500
1000
1500

0
500
1000
1500
2000
3000

0
500
1000
1500

0
500
1000
1500
2000
3000

0
500
1000
1500
2000
3000

RP506L

RICOH
20) Auto Switching Control Waveform

RP506Lxx1G/H/N (VIN = 3.6 V, VOUT = 1.2 V, IOUT = 1 mA) 
MODE = “L” → MODE = “H”

RP506Lxx1G/H/N (VIN = 3.6 V, VOUT = 1.2 V, IOUT = 1 mA) 
MODE = “H” → MODE = “L”

RP506Lxx1G/H/N (VIN = 3.6 V, VOUT = 1.8 V, IOUT = 1 mA) 
MODE = “L” → MODE = “H”

RP506Lxx1G/H/N (VIN = 3.6 V, VOUT = 1.8 V, IOUT = 1 mA) 
MODE = “H” → MODE = “L”

RP506Lxx1K/L/M (VIN = 3.6 V, VOUT = 1.2 V, IOUT = 1 mA) 
MODE = “L” → MODE = “H”

RP506Lxx1K/L/M (VIN = 3.6 V, VOUT = 1.2 V, IOUT = 1 mA) 
MODE = “H” → MODE = “L”
RP506Lxx1K/L/M (VIN = 3.6 V, VOUT = 1.8 V, IOUT = 1 mA)  
MODE = “L” → MODE = “H”  

MODE = “H” → MODE = “L”
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>φ 0.3 mm × 32 pcs</td>
</tr>
</tbody>
</table>

### Measurement Result

(Ta = 25°C, Tjmax = 150°C)

<table>
<thead>
<tr>
<th>Item</th>
<th>Measurement Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Dissipation</td>
<td>4300 mW</td>
</tr>
<tr>
<td>Thermal Resistance (θja)</td>
<td>θja = 29°C/W</td>
</tr>
<tr>
<td>Thermal Characterization Parameter (ψjt)</td>
<td>ψjt = 3.1°C/W</td>
</tr>
</tbody>
</table>

θja: Junction-to-Ambient Thermal Resistance
ψjt: Junction-to-Top Thermal Characterization Parameter

---

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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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.

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