OUTLINE

The RP508K is a low supply current PWM/VFM step-down DC/DC converter with synchronous rectifier featuring 600 mA(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, an under-voltage lockout (UVLO) circuit, an over current protection circuit, a thermal shutdown circuit and switching transistors.

By the adoption of the synchronous rectification circuit with built-in switching transistors, the RP508K works as efficient step-down DC/DC converter, without connecting external diodes. 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 is internally fixed type which allows output voltages that range from 0.8 V to 3.3 V in 0.1 V step. The output voltage accuracy is as high as ±1.5% or ±18 mV.

Protection circuits included in the RP508K are over current 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 Lx current limit (IₓLₓLIM), it turns off P-channel Tr. 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 RP508K is offered in a small and thin 6-pin DFN(PLP)1212-6F package which achieves the smallest possible footprint solution on boards where area is limited.

For an input capacitor (CIN) and an output capacitor (COUT), the smaller sized 0402/1005 (inch/mm) capacitor can be used. For an inductor (L), the smaller sized 0603/1608 or 1005/2012 (inch/mm) inductor can be used.

FEATURES

- Input Voltage Range (VIN) ............................................... 2.3 V to 5.5 V (Absolute Maximum Ratings: 6.5 V)
- Output Voltage Range (VOUT) ........................................... 0.8 V to 3.3 V (Adjustable in 0.1 V steps)
- Supply Current (IDD2) ................................................. Typ. 15 µA (VFM Mode with No-load)
- Standby Current (Istandby) ................................................ Typ. 0 µA
- Output Voltage Temperature Coefficient (ΔVOUT/Ta) ...... Typ. ±100 ppm/°C
- Oscillator Frequency (fosc) ............................................. Typ. 6.0 MHz
- Maximum Duty Cycle (Maxduty) ....................................... 100%
- Built-in Driver ON Resistance (Ronp, Ronn) .................. Typ. Pch. 0.33 Ω, Nch. 0.24 Ω (VIN = 3.6 V)
- UVLO Detector Threshold (UVLOd) ................................. Typ. 2.0 V
- Soft-start Time (tstart) ....................................................... Typ. 90 µs

(1) This is an approximate value. The output current is dependent on conditions and external components.
RP508K

NO. EA-318-171106

- **Lx Current Limit Circuit (I\text{LX,LIM})**: Typ. 1.1 A
- **Output Voltage Accuracy**: ±1.5% \((V_{\text{OUT}} \geq 1.2 \text{ V})\) or ±18 mV \((V_{\text{OUT}} < 1.2 \text{ V})\)
- **Package**: DFN(PLP)1212-6F

**APPLICATIONS**

- Cellular Phones
- Smartphones
- Digital Still Camera
- Notebook PCs, PDA’s
- Li-ion Battery-used Equipment

**SELECTION GUIDE**

The set output voltage and the auto discharge\(^{(1)}\) function 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>RP508K\text{x}1$-TR</td>
<td>DFN(PLP)1212-6F</td>
<td>5,000 pcs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

\(\text{xx: Specify the set output voltage (V}_{\text{SET}}\) within the range of 0.8 V (08) to 3.3 V (33) in 0.1 V steps\(^{(2)}\).}

If the set output voltage includes the 3rd digit, indicate the digit of 0.01.

\((1.05 \text{ V}, 1.25 \text{ V}, 1.35 \text{ V})\)

- Ex. If the set output voltage is 1.05 V: RP508K101$5
- If the set output voltage is 1.25 V: RP508K121$5
- If the set output voltage is 1.35 V: RP508K131$5

\$: Specify the auto-discharge option.

- A: Fixed output voltage type
- B: Fixed output voltage type, auto-discharge function in shutdown mode

\(^{(1)}\) 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.

\(^{(2)}\) 0.05 V step is also available as a custom code.
BLOCK DIAGRAM

RP508Kxx1A Block Diagram

RP508Kxx1B Block Diagram
PIN DESCRIPTION

DFN(PLP)1212-6F Pin Configurations

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Symbol</th>
<th>Pin Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>VOUT</td>
<td>Output Pin</td>
</tr>
<tr>
<td>2</td>
<td>MODE</td>
<td>Mode Control Pin (&quot;H&quot; forced PWM control, &quot;L&quot; PWM/VFM auto switching control)</td>
</tr>
<tr>
<td>3</td>
<td>CE</td>
<td>Chip Enable Pin (&quot;H&quot; active)</td>
</tr>
<tr>
<td>4</td>
<td>VIN</td>
<td>Input Pin</td>
</tr>
<tr>
<td>5</td>
<td>LX</td>
<td>LX Switching Pin</td>
</tr>
<tr>
<td>6</td>
<td>GND</td>
<td>Ground Pin</td>
</tr>
</tbody>
</table>
## 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>$V_{IN}$ Input 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 $V_{IN} +0.3$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{CE}$</td>
<td>CE Pin Input Voltage</td>
<td>$-0.3$ to $6.5$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{MODE}$</td>
<td>MODE Pin Input Voltage</td>
<td>$-0.3$ to $6.5$</td>
<td>V</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>$V_{OUT}$ Pin Voltage</td>
<td>$-0.3$ to $6.5$</td>
<td>V</td>
</tr>
<tr>
<td>$I_{LX}$</td>
<td>Lx Pin Output Current</td>
<td>$1300$</td>
<td>mA</td>
</tr>
<tr>
<td>$P_{D}$</td>
<td>Power Dissipation(1) (JEDEC STD 51-7 Test Land Pattern)</td>
<td>$666$</td>
<td>mW</td>
</tr>
<tr>
<td>$T_{j}$</td>
<td>Junction Temperature Range</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>

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

## RECOMMENDED OPERATING CONDITIONS

<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>$2.3$ 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>

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.

(1) Refer to POWER DISSIPATION for detailed information.
### ELECTRICAL CHARACTERISTICS

**RP508K 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>VOUT</td>
<td>Output Voltage</td>
<td>$V_{IN} = V_{CE} = 3.6 , V$</td>
<td>$V_{SET} \geq 1.2 , V$</td>
<td>$0.985 \times 1.015$</td>
<td>$V$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{SET} &lt; 1.2 , V$</td>
<td>$-0.018$</td>
<td>$+0.018$</td>
<td>$V$</td>
</tr>
<tr>
<td>fosc</td>
<td>Oscillator Frequency</td>
<td>$V_{IN} = V_{CE} = 3.6 , V$ ($V_{SET} \leq 2.6 , V$), $V_{IN} = V_{CE} = V_{SET} + 1 , V$ ($V_{SET} &gt; 2.6 , V$)</td>
<td>$5.4$</td>
<td>$6.0$</td>
<td>$6.6$</td>
<td>MHz</td>
</tr>
<tr>
<td>I0D1</td>
<td>Supply Current 1</td>
<td>$V_{IN} = V_{CE} = 5.5 , V$, $V_{OUT} = V_{SET} \times 0.8$</td>
<td>$1000$</td>
<td>$1300$</td>
<td>$\mu A$</td>
<td></td>
</tr>
<tr>
<td>I0D2</td>
<td>Supply Current 2</td>
<td>$V_{IN} = V_{CE} = V_{OUT} = 5.5 , V$</td>
<td>$V_{MODE} = 0 , V$</td>
<td>$15$</td>
<td>$25$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V_{MODE} = 5.5 , V$</td>
<td>$1000$</td>
<td>$1300$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>Istandby</td>
<td>Standby Current</td>
<td>$V_{IN} = 5.5 , V$, $V_{CE} = 0 , V$</td>
<td>$0$</td>
<td>$5$</td>
<td>$\mu A$</td>
<td></td>
</tr>
<tr>
<td>ICEH</td>
<td>CE &quot;H&quot; Input Current</td>
<td>$V_{IN} = V_{CE} = 5.5 , V$</td>
<td>$-1$</td>
<td>$0$</td>
<td>$1$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>ICEL</td>
<td>CE &quot;L&quot; Input Current</td>
<td>$V_{IN} = 5.5 , V$, $V_{CE} = 0 , V$</td>
<td>$-1$</td>
<td>$0$</td>
<td>$1$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>IMODEH</td>
<td>Mode &quot;H&quot; Input Current</td>
<td>$V_{IN} = V_{MODE} = 5.5 , V$, $V_{CE} = 0 , V$</td>
<td>$-1$</td>
<td>$0$</td>
<td>$1$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>IMODEL</td>
<td>Mode &quot;L&quot; Input Current</td>
<td>$V_{IN} = 5.5 , V$, $V_{CE} = V_{MODE} = 0 , V$</td>
<td>$-1$</td>
<td>$0$</td>
<td>$1$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>TVOUTH</td>
<td>VOUT &quot;H&quot; Input Current (1)</td>
<td>$V_{IN} = V_{OUT} = 5.5 , V$, $V_{CE} = 0 , V$</td>
<td>$-1$</td>
<td>$0$</td>
<td>$1$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>TVOUTL</td>
<td>VOUT &quot;L&quot; Input Current</td>
<td>$V_{IN} = 5.5 , V$, $V_{CE} = V_{OUT} = 0 , V$</td>
<td>$-1$</td>
<td>$0$</td>
<td>$1$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>RLOW</td>
<td>On Resistance for Auto Discharge (2)</td>
<td>$V_{IN} = 3.6 , V$, $V_{CE} = 0 , V$</td>
<td>$30$</td>
<td>$\Omega$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IXLEAKH</td>
<td>LX Leakage Current &quot;H&quot;</td>
<td>$V_{IN} = V_{XL} = 5.5 , V$, $V_{CE} = 0 , V$</td>
<td>$-1$</td>
<td>$0$</td>
<td>$5$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>IXLEAKL</td>
<td>LX Leakage Current &quot;L&quot;</td>
<td>$V_{IN} = 5.5 , V$, $V_{CE} = V_{XL} = 0 , V$</td>
<td>$-5$</td>
<td>$0$</td>
<td>$1$</td>
<td>$\mu A$</td>
</tr>
<tr>
<td>VCEH</td>
<td>CE &quot;H&quot; Input Voltage</td>
<td>$V_{IN} = 5.5 , V$</td>
<td>$1.0$</td>
<td>$V$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VCEL</td>
<td>CE &quot;L&quot; Input Voltage</td>
<td>$V_{IN} = 2.3 , V$</td>
<td>$0.4$</td>
<td>$V$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMODEH</td>
<td>Mode &quot;H&quot; Input Voltage</td>
<td>$V_{IN} = V_{CE} = 5.5 , V$</td>
<td>$1.0$</td>
<td>$V$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VMODEL</td>
<td>Mode &quot;L&quot; Input Voltage</td>
<td>$V_{IN} = V_{CE} = 2.3 , V$</td>
<td>$0.4$</td>
<td>$V$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RONP</td>
<td>On Resistance of Pch Tr.</td>
<td>$V_{IN} = 3.6 , V$, $I_{LX} = -100 , mA$</td>
<td>$0.33$</td>
<td>$\Omega$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RONN</td>
<td>On Resistance of Nch Tr.</td>
<td>$V_{IN} = 3.6 , V$, $I_{LX} = -100 , mA$</td>
<td>$0.24$</td>
<td>$\Omega$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxduty</td>
<td>Maximum Duty Cycle</td>
<td>$100$</td>
<td>$%$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tstart</td>
<td>Soft-start Time</td>
<td>Soft-start Time is between the rising edge of CE pin and $V_{OUT} \geq V_{SET} \times 0.9$</td>
<td>$90$</td>
<td>$150$</td>
<td>$\mu s$</td>
<td></td>
</tr>
<tr>
<td>IXLIM</td>
<td>LX Current Limit</td>
<td>$900$</td>
<td>$1100$</td>
<td>$mA$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UVLO1</td>
<td>UVLO Detector Threshold</td>
<td>$V_{IN} = V_{CE}$</td>
<td>$1.9$</td>
<td>$2.0$</td>
<td>$2.1$</td>
<td>$V$</td>
</tr>
<tr>
<td>UVLO2</td>
<td>UVLO Released Voltage</td>
<td>$V_{IN} = V_{CE}$</td>
<td>$2.0$</td>
<td>$2.1$</td>
<td>$2.2$</td>
<td>$V$</td>
</tr>
<tr>
<td>TTD</td>
<td>Thermal Shutdown Temperature</td>
<td>Junction Temperature</td>
<td>$140$</td>
<td>$\degree C$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TTR</td>
<td>Thermal Shutdown Released Temperature</td>
<td>Junction Temperature</td>
<td>$100$</td>
<td>$\degree C$</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.

---

(1) RP508Kxx1A only
(2) RP508Kxx1B only
THEORY OF OPERATION

Fast Frequency and Fast Response

There are the following advantages when it operates at fast frequency (6 MHz).
- Inductance value can be reduced.
- The fluctuation of energy in one cycle is fast and small, as a result, the capacitance value of C\textsubscript{OUT} can be also reduced.
- Small LC value reduced the feedback delay, then response frequency band can be wide and transient response is much improved compared with conventional line-up.

Maximum Frequency (6 MHz) Lock

* The frequency goes faster and faster without this.
Switching frequency in order to become reference frequency (6 MHz), delay time is included the output voltage feedback loop and locked the frequency (6 MHz).

**Frequency Control for Minimum On/Off Time**

Minimum on/off time/Minimum off time is set. (But 100% duty is available.) In the 6 MHz, based on the calculation of input/output relation, on/off time can be calculated, and if it is not satisfy the minimum on time / minimum off time, the reference frequency must be reduced and switching frequency is reduced.

---

**Example Min On Time (40 ns)**

1. \( V_{IN} = 3.6 \text{ V} \) \( V_{OUT} = 1.0 \text{ V} \)
   
   \[
   \frac{1}{6 \text{ MHz}} \times \frac{1.0 \text{ V}}{3.6 \text{ V}} = 46 \text{ ns} > \text{Min On Time} (= 40 \text{ ns})
   \]
   
   \( \rightarrow \) 6 MHz Switching OK

2. \( V_{IN} = 5.5 \text{ V} \) \( V_{OUT} = 1.0 \text{ V} \)
   
   \[
   \frac{1}{6 \text{ MHz}} \times \frac{1.0 \text{ V}}{5.5 \text{ V}} = 30 \text{ ns} < \text{Min On Time} (= 40 \text{ ns})
   \]
   
   \( \rightarrow \) It must be slow down from 6 MHz

**Example Min Off Time (40 ns)**

1. \( V_{IN} = 5.0 \text{ V} \) \( V_{OUT} = 3.3 \text{ V} \)
   
   \[
   \frac{1}{6 \text{ MHz}} \times (1 - \frac{3.3 \text{ V}}{5.0 \text{ V}}) \approx 57 \text{ ns} > \text{Min Off Time} (= 40 \text{ ns})
   \]
   
   \( \rightarrow \) 6 MHz Switching OK

2. \( V_{IN} = 4.2 \text{ V} \) \( V_{OUT} = 3.3 \text{ V} \)
   
   \[
   \frac{1}{6 \text{ MHz}} \times (1 - \frac{3.3 \text{ V}}{4.2 \text{ V}}) \approx 36 \text{ ns} < \text{Min Off Time} (= 40 \text{ ns})
   \]
   
   \( \rightarrow \) It must be slow down from 6 MHz

---

**Cycle time becomes long in order to satisfy Min. on time. It is suitable with keeping the duty.**

**LX Waveform**

---

**Cycle time becomes long in order to satisfy Min. off time. It is suitable with keeping the duty.**

**LX Waveform**
Operation of Step-Down DC/DC Converter and Output Current

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

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

**Figure 1. Basic Circuit**

**Figure 2. Inductor Current (\( I_L \)) flowing through Inductor**

**Step1.** P-channel Tr. turns “ON” and the inductor current (\( I_L = i_1 \)) flows, \( L \) is charged with energy. At this moment, \( i_1 \) increases from the minimum inductor current (\( I_{L\text{MIN}} \)), which is 0 A, and reaches the maximum inductor current (\( I_{L\text{MAX}} \)) in proportion to the on-time period (\( T_{on} \)) of P-channel Tr.

**Step2.** When P-channel Tr. turns “OFF”, \( L \) tries to maintain \( I_L \) at \( I_{L\text{MAX}} \), so \( L \) turns N-channel Tr. “ON” and the inductor current (\( I_L = i_2 \)) flows into \( L \).

**Step3.** \( i_2 \) decreases gradually and reaches \( I_{L\text{MIN}} \) after the open-time period (\( T_{open} \)) of N-channel Tr., and then N-channel Tr. turns “OFF”. This is called discontinuous current mode.

As the output current (\( I_{OUT} \)) increases, the off-time period (\( T_{off} \)) of P-channel Tr. runs out before \( I_L \) reaches \( I_{L\text{MIN}} \). The next cycle starts, and P-channel Tr. turns “ON” and N-channel Tr. turns “OFF”, which means \( I_L \) starts increasing from \( I_{L\text{MIN}} \). This is called continuous current mode.

In the case of PWM mode, \( V_{OUT} \) is maintained by controlling \( T_{on} \). During the PWM mode, the oscillator frequency (\( f_{osc} \)) is constantly maintained.

As shown in Figure 2., when the step-down DC/DC operation is constant, \( I_{L\text{MIN}} \) and \( I_{L\text{MAX}} \) during \( T_{on} \) of P-channel Tr. is same as the P-channel Tr. during \( T_{off} \).

The current differential between \( I_{L\text{MAX}} \) and \( I_{L\text{MIN}} \) is described as \( \Delta I \).

\[
\Delta I = I_{L\text{MAX}} - I_{L\text{MIN}} = V_{OUT} \times T_{open} / L = (V_{IN} - V_{OUT}) \times T_{on} / L \text{............................................... Equation 1}
\]

However,

\[
T = 1 / f_{osc} = T_{on} + T_{off}
\]

\[
\text{Duty} (%) = \frac{T_{on}}{T} \times 100 = \frac{T_{on} \times f_{osc}}{T_{off}}
\]

\( T_{open} \leq T_{off} \)

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

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

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

\[
T = \frac{1}{f_{osc}}
\]

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

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

When \( \text{ton} < \text{tonc} \), it indicates discontinuous mode, and when \( \text{ton} \geq \text{tonc} \), it indicates continuous mode.
Forced PWM Mode
By setting the MODE pin to “H”, the RP508K switches on/off at the fixed frequency to reduce noise even under the light load. When IOUT is $\Delta I_L / 2$ or less, ILMIN becomes less than 0. That is, the accumulated electricity in CL is discharged through the IC side at IL increase period from ILMIN to “0” during ton and at IL decrease period from "0" to ILMIN during toff.

\[
T = \frac{1}{f_{osc}}
\]

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, a value of ton is determined by VIN and VOUT.
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.

Soft-start time starts when soft-start circuit is activated, and ends when the reference voltage reaches the specified voltage. Soft start time is not always equal to the turn-on speed of the step-down DC/DC converter. 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.
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 $V_{IN}$ becomes lower than the UVLO detector threshold ($V_{UVLO1}$), the UVLO circuit starts to operate, $V_{REF}$ stops, and P-channel and N-channel 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.

Falling edge (operating) and rising edge (releasing) waveforms of $V_{OUT}$ could be affected by the initial voltage of $C_{OUT}$ and the output current of $V_{OUT}$.
3. Over Current Protection Circuit
Over current protection circuit supervises the inductor peak current (the peak current flowing through P-channel Tr.) in each switching cycle. If the current exceeds the $L_X$ current limit ($I_{LX,\text{LIM}}$) of 1100 mA (Typ.), P-channel Tr. is turned off. $I_{LX,\text{LIM}}$ could be easily affected by self-heating or ambient environment. If the $V_{IN}$ drops dramatically or becomes unstable due to short-circuit, protection operation could be affected.
APPLICATION INFORMATION

Typical Application

![RP508K Typical Application Diagram]

Recommended Components

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Size</th>
<th>Type</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIN</td>
<td>2.2 µF</td>
<td>Ceramic</td>
<td>C1005JB0J25K (TDK)</td>
</tr>
<tr>
<td></td>
<td>4.7 µF</td>
<td>Ceramic</td>
<td>C1005JB0J475K (TDK)</td>
</tr>
<tr>
<td>COUT</td>
<td>4.7 µF</td>
<td>Ceramic</td>
<td>C1005JB0J475K (TDK)</td>
</tr>
<tr>
<td>L</td>
<td>0.47 µH (0.5 µH)</td>
<td>Inductor</td>
<td>MIPSZ2012D0R5 (FDK)</td>
</tr>
<tr>
<td></td>
<td>1.0 µH</td>
<td>Inductor</td>
<td>MIPSZ2012D1R0 (FDK)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MDT1608CHR47N (TOKO)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>MDT1608CH1R0N (TOKO)</td>
</tr>
</tbody>
</table>
Cautions in Selecting External Components

- Ensure the VIN and GND lines are sufficiently robust. A large switching current flows through the GND lines, 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 between a capacitor (CIN) and the VIN pin. The wiring between VOUT and load and between L and VOUT should be separated.
- Choose a low ESR ceramic capacitor. The capacitance of CIN should be more than or equal to 2.2 µF. The capacitance of a capacitor (COUT) should be between 4.7 µF to 10 µF.
- The Inductance value should be set within the range of 0.47 µH to 1.0 µH. However, the inductance value is limited by output voltage. Refer to the table below. 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. The increased LX peak current reaches “LX limit current” to trigger over current protection circuit even if the load current is less than 600 mA.

<table>
<thead>
<tr>
<th>Set Output Voltage (V)</th>
<th>Input Voltage (V)</th>
<th>Inductance L = 0.47 µH</th>
<th>Inductance L = 1.0 µH</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSET</td>
<td>VIN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.8 to 1.2</td>
<td>up to 5.5</td>
<td>Recommended</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>up to 4.5</td>
<td>Recommended</td>
<td>Acceptable</td>
</tr>
<tr>
<td>1.3 to 1.5</td>
<td>4.5 to 5.5</td>
<td>Acceptable</td>
<td>Recommended</td>
</tr>
<tr>
<td>1.6 to 2.6</td>
<td>up to 3.6</td>
<td>Recommended</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>up to 4.5</td>
<td>Acceptable</td>
<td>Recommended</td>
</tr>
<tr>
<td></td>
<td>4.5 to 5.5</td>
<td>-</td>
<td>Recommended</td>
</tr>
<tr>
<td>2.7 to 3.3</td>
<td>up to 4.5</td>
<td>Recommended</td>
<td>Acceptable</td>
</tr>
<tr>
<td></td>
<td>4.5 to 5.5</td>
<td>-</td>
<td>Recommended</td>
</tr>
</tbody>
</table>

- Over current protection circuit may be affected by self-heating or power dissipation environment.
- The performance of power source circuits using this IC largely depends on the peripheral circuits. When selecting the peripheral components, consider the conditions of use. Do not allow each component, PCB pattern and the IC to exceed their respected rated values (voltage, current and power) when designing the peripheral circuits.
Output Current and Selection of External Components

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

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

First, when P-channel Tr. is “ON”, the following equation is satisfied.

\[
V_{IN} = V_{OUT} + (R_{ONP} + R_L) \times I_{OUT} + L \times I_{RP} / ton \tag{3}
\]

Second, when P-channel Tr. is “OFF” (N-channel Tr. Is “ON”), the following equation is satisfied.

\[
L \times I_{RP} / toff = R_{ONN} \times I_{OUT} + V_{OUT} + R_L \times I_{OUT} \tag{4}
\]

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

\[
D_{ON} = (V_{OUT} + R_{ONN} \times I_{OUT} + R_L \times I_{OUT}) / (V_{IN} + R_{ONN} \times I_{OUT} - R_{ONP} \times I_{OUT}) \tag{5}
\]

Ripple Current is described as follows:

\[
I_{RP} = (V_{IN} - V_{OUT} - R_{ONP} \times I_{OUT} - R_L \times I_{OUT}) \times D_{ON} / fosc / L \tag{6}
\]

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

\[
I_{LXMAX} = I_{OUT} + I_{RP} / 2 \tag{7}
\]

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.
TECHNICAL NOTES

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

- Ensure the \( V_{IN} \) and GND lines are sufficiently robust. A large switching current flows through the GND lines, the \( V_{DD} \) line, the \( V_{OUT} \) line, an inductor, and \( L_X \). If their impedance is too high, noise pickup or unstable operation may result. Set the external components as close as possible to the IC and minimize the wiring between the components and the IC, especially between a capacitor (\( C_{IN} \)) and the \( V_{IN} \) pin. The wiring between \( V_{OUT} \) and load and between \( L \) and \( V_{OUT} \) should be separated.

Reference PCB Layout

![DFN1212-6 Typical Board Layout](image-url)
TYPICAL CHARACTERISTICS

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

01) Output Voltage vs. Output Current

**RP508K081x, V_OUT = 0.8 V**
MODE = "L" PWM/VFM auto switching control

**RP508K081x, V_OUT = 0.8 V**
MODE = "H" forced PWM control

---

**RP508K101x, V_OUT = 1.0 V**
MODE = "L" PWM/VFM auto switching control

**RP508K101x, V_OUT = 1.0 V**
MODE = "H" forced PWM control

---

**RP508K121x, V_OUT = 1.2 V**
MODE = "L" PWM/VFM auto switching control

**RP508K121x, V_OUT = 1.2 V**
MODE = "H" forced PWM control
RP508K

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RP508K181x, V\text{OUT} = 1.8\, \text{V}
MODE = "L" PWM/VFM auto switching control

MODE = "H" forced PWM control

Output Voltage vs. Input Voltage

02) Output Voltage vs. Input Voltage

RP508K081x, V\text{OUT} = 0.8\, \text{V}
MODE = "H" forced PWM control

RP508K101x, V\text{OUT} = 1.0\, \text{V}
MODE = "H" forced PWM control
RP508K121x, \( V_{\text{OUT}} = 1.2 \) V  
MODE = "H" forced PWM control

RP508K181x, \( V_{\text{OUT}} = 1.8 \) V  
MODE = "H" forced PWM control

RP508K331x, \( V_{\text{OUT}} = 3.3 \) V  
MODE = "H" forced PWM control

03) Output Voltage vs. Temperature
04) Efficiency vs. Output Current

**RP508K081x, V\text{OUT} = 0.8 V**

L = MIPSZ2012D0R5 (2012size_0.5 µH)

**RP508K101x, V\text{OUT} = 1.0 V**

L = MIPSZ2012D0R5 (2012size_0.5 µH)

**RP508K121x, V\text{OUT} = 1.2 V**

L = MIPSZ2012D0R5 (2012size_0.5 µH)

**RP508K181x, V\text{OUT} = 1.8 V**

L = MIPSZ2012D0R5 (2012size_0.5 µH)

**RP508K331x, V\text{OUT} = 3.3 V**

L = MIPSZ2012D1R0 (2012size_1.0 µH)
RP508K081x, $V_{OUT} = 0.8$ V
$L = MDT1608CHR47N$ (1608size_0.47 $\mu$H)

RP508K101x, $V_{OUT} = 1.0$ V
$L = MDT1608CHR47N$ (1608size_0.47 $\mu$H)

RP508K121x, $V_{OUT} = 1.2$ V
$L = MDT1608CHR47N$ (1608size_0.47 $\mu$H)

RP508K181x, $V_{OUT} = 1.8$ V
$L = MDT1608CHR47N$ (1608size_0.47 $\mu$H)

RP508K331x, $V_{OUT} = 3.3$ V
$L = MDT1608CHR1R0N$ (1608size_1.0 $\mu$H)
05) Supply Current vs. Temperature
RP508K181x, V_{OUT} = 1.8 V (V_{IN} = 5.5 V)
MODE = "L" PWM/VFM auto switching control

06) Supply Current vs. Input Voltage
RP508K181x, V_{OUT} = 1.8 V
MODE = "L" PWM/VFM auto switching control

07) Output Voltage Waveform
RP508K081x, V_{OUT} = 0.8 V (V_{IN} = 3.6 V)
MODE = "L" PWM/VFM auto switching control

RP508K081x, V_{OUT} = 0.8 V (V_{IN} = 3.6 V)
MODE = "H" forced PWM control

RP508K121x, V_{OUT} = 1.2 V (V_{IN} = 3.6 V)
MODE = "L" PWM/VFM auto switching control

RP508K121x, V_{OUT} = 1.2 V (V_{IN} = 3.6 V)
MODE = "H" forced PWM control
RP508K181x, $V_{OUT} = 1.8$ V ($V_{IN} = 3.6$ V)  
MODE = "L" PWM/VFM auto switching control

RP508K181x, $V_{OUT} = 1.8$ V ($V_{IN} = 3.6$ V)  
MODE = "H" forced PWM control

RP508K331x, $V_{OUT} = 3.3$ V ($V_{IN} = 4.3$ V)  
MODE = "H" forced PWM control

08) Frequency vs. Input Voltage  
RP508K181x, $V_{OUT} = 1.8$ V  
MODE = "H" forced PWM control
09) Frequency vs. Input Voltage with Various Output Currents
RP508K121x, \( V_{\text{OUT}} = 1.2 \) V  
MODE = "H" forced PWM control  
RP508K181x, \( V_{\text{OUT}} = 1.8 \) V  
MODE = "H" forced PWM control

10) VFM Frequency vs. Output Current
RP508K121x, \( V_{\text{OUT}} = 1.2 \) V  
MODE = "L" PWM/VFM auto switching control  
RP508K181x, \( V_{\text{OUT}} = 1.8 \) V  
MODE = "L" PWM/VFM auto switching control

11) Soft-start Time vs. Temperature
12) UVLO Detector Threshold/ Released Voltage vs. Temperature

UVLO Detector Threshold

UVLO Release Voltage

13) CE Input Voltage vs. Temperature

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

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

14) $L$ Current Limit vs. Temperature

15) Standby Current vs. Temperature
16) Nch Transistor On Resistance vs. Temperature

![Nch Transistor On Resistance vs. Temperature](image)

17) Pch Transistor On Resistance vs. Temperature

![Pch Transistor On Resistance vs. Temperature](image)

18) Load Transient Response ($C_{OUT} = 4.7 \mu F$, $C1005X5R0J475M$)

RP508K081x ($V_{IN} = 3.6 \text{ V}, V_{OUT} = 0.8 \text{ V}$)

$L = \text{MIPSZ2012D0R5 (2012size_0.5 \mu H)}$

MODE = "H" forced PWM control

![Load Transient Response](image)
RP508K121x (VIN = 3.6 V, VOUT = 1.2 V)  
L = MIPSZ2012D0R5 (2012size_0.5 µH)  
MODE = "H" forced PWM control

RP508K121x (VIN = 3.6 V, VOUT = 1.2 V)  
L = MIPSZ2012D0R5 (2012size_0.5 µH)  
MODE = "H" forced PWM control

RP508K121x (VIN = 3.6 V, VOUT = 1.2 V)  
L = MIPSZ2012D0R5 (2012size_0.5 µH)  
MODE = "H" forced PWM control

RP508K121x (VIN = 3.6 V, VOUT = 1.2 V)  
L = MIPSZ2012D0R5 (2012size_0.5 µH)  
MODE = "H" forced PWM control
RP508K181x (V_{IN} = 3.6 V, V_{OUT} = 1.8 V)
L = MIPSZ2012D0R5 (2012size_0.5 \mu H)
MODE = "H" forced PWM control

RP508K331x (V_{IN} = 5.0 V, V_{OUT} = 3.3 V)
L = MIPSZ2012D1R0 (2012size_1.0 \mu H)
MODE = "H" forced PWM control

RP508K181x (V_{IN} = 3.6 V, V_{OUT} = 1.8 V)
L = MIPSZ2012D0R5 (2012size_0.5 \mu H)
MODE = "H" forced PWM control

RP508K331x (V_{IN} = 5.0 V, V_{OUT} = 3.3 V)
L = MIPSZ2012D1R0 (2012size_1.0 \mu H)
MODE = "H" forced PWM control
Load Transient Response ($C_{OUT} = 4.7\mu F$, $C_{1005X5R0J475M}$)

RP508K081x ($V_{IN} = 3.6\, V$, $V_{OUT} = 0.8\, V$)
L = MIPSZ2012DOR5 (2012size_0.5 µH)
MODE = "L" PWM/VFM auto switching control

RP508K121x ($V_{IN} = 3.6\, V$, $V_{OUT} = 1.2\, V$)
L = MIPSZ2012DOR5 (2012size_0.5 µH)
MODE = "L" PWM/VFM auto switching control

RP508K181x ($V_{IN} = 3.6\, V$, $V_{OUT} = 1.8\, V$)
L = MIPSZ2012DOR5 (2012size_0.5 µH)
MODE = "L" PWM/VFM auto switching control
RP508K

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RP508K331x (VIN = 5.0 V, VOUT = 3.3 V)
L = MIPSZ2012D1R0 (2012size_1.0 µH)
MODE = "L" PWM/VFM auto switching control

Load Transient Response (COUT = 4.7 µF, C1005X5R0J475M)
RP508K081x (VIN = 3.6 V, VOUT = 0.8 V)
L = MDT1608CHR47N (1608size_0.47 µH)
MODE = "H" forced PWM control

RP508K081x (VIN = 3.6 V, VOUT = 0.8 V)
L = MDT1608CHR47N (1608size_0.47 µH)
MODE = "H" forced PWM control

RP508K081x (VIN = 3.6 V, VOUT = 0.8 V)
L = MDT1608CHR47N (1608size_0.47 µH)
MODE = "H" forced PWM control

RP508K081x (VIN = 3.6 V, VOUT = 0.8 V)
L = MDT1608CHR47N (1608size_0.47 µH)
MODE = "H" forced PWM control
RP508K121x (Vin = 3.6 V, Vout = 1.2 V)  
L = MDT1608CHR47N (1608size_0.47 μH)  
MODE = "H" forced PWM control

RP508K181x (Vin = 3.6 V, Vout = 1.8 V)  
L = MDT1608CHR47N (1608size_0.47 μH)  
MODE = "H" forced PWM control

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

-4 0 4 8 12 16  
Time t (us)
RP508K

NO. EA-318-171106

RP508K181x (Vin = 3.6 V, Vout = 1.8 V)
L = MDT1608CHR47N (1608size_0.47 µH)
MODE = "H" forced PWM control

RP508K181x (Vin = 3.6 V, Vout = 1.8 V)
L = MDT1608CHR47N (1608size_0.47 µH)
MODE = "H" forced PWM control

RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
L = MDT1608CH1R0N (1608size_1.0 µH)
MODE = "H" forced PWM control

RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
L = MDT1608CH1R0N (1608size_1.0 µH)
MODE = "H" forced PWM control

RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
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MODE = "H" forced PWM control

RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
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MODE = "H" forced PWM control

RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
L = MDT1608CH1R0N (1608size_1.0 µH)
MODE = "H" forced PWM control

RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
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L = MDT1608CH1R0N (1608size_1.0 µH)
MODE = "H" forced PWM control

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RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
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RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
L = MDT1608CH1R0N (1608size_1.0 µH)
MODE = "H" forced PWM control

RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
L = MDT1608CH1R0N (1608size_1.0 µH)
MODE = "H" forced PWM control

RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
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RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
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MODE = "H" forced PWM control

RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
L = MDT1608CH1R0N (1608size_1.0 µH)
MODE = "H" forced PWM control

RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
L = MDT1608CH1R0N (1608size_1.0 µH)
MODE = "H" forced PWM control
Load Transient Response (\(C_{\text{OUT}} = 4.7\mu F, C_{1005X5R0J475M}\))

\(\text{RP508K081x} (V_{\text{IN}} = 3.6\, V, V_{\text{OUT}} = 0.8\, V)\)
\(L = \text{MDT1608CHR47N (1608size}_0.47\mu H)\)
\(\text{MODE} = "L" \text{ PWM/VFM auto switching control}\)

\(\text{RP508K081x} (V_{\text{IN}} = 3.6V, V_{\text{OUT}} = 0.8\, V)\)
\(L = \text{MDT1608CHR47N (1608size}_0.47\mu H)\)
\(\text{MODE} = "L" \text{ PWM/VFM auto switching control}\)

\(\text{RP508K121x} (V_{\text{IN}} = 3.6\, V, V_{\text{OUT}} = 1.2\, V)\)
\(L = \text{MDT1608CHR47N (1608size}_0.47\mu H)\)
\(\text{MODE} = "L" \text{ PWM/VFM auto switching control}\)

\(\text{RP508K121x} (V_{\text{IN}} = 3.6\, V, V_{\text{OUT}} = 1.2\, V)\)
\(L = \text{MDT1608CHR47N (1608size}_0.47\mu H)\)
\(\text{MODE} = "L" \text{ PWM/VFM auto switching control}\)

\(\text{RP508K181x} (V_{\text{IN}} = 3.6\, V, V_{\text{OUT}} = 1.8\, V)\)
\(L = \text{MDT1608CHR47N (1608size}_0.47\mu H)\)
\(\text{MODE} = "L" \text{ PWM/VFM auto switching control}\)

\(\text{RP508K181x} (V_{\text{IN}} = 3.6\, V, V_{\text{OUT}} = 1.8\, V)\)
\(L = \text{MDT1608CHR47N (1608size}_0.47\mu H)\)
\(\text{MODE} = "L" \text{ PWM/VFM auto switching control}\)
RP508K

NO. EA-318-171106

RP508K331x (Vin = 5.0 V, Vout = 3.3 V)
L = MDT1608CH1RON (1608size_1.0 µH)
MODE = "L" PWM/VFM auto switching control

19) Mode Switching Waveform
RP508K121x (Vin = 3.6 V, Vout = 1.2 V, Iout = 1 mA)
MODE = "L" → MODE = "H"

RP508K181x (Vin = 3.6 V, Vout = 1.8 V, Iout = 1 mA)
MODE = "L" → MODE = "H"
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>JEDEC STD.51-7 Test Land Pattern</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 × 1.6 mm</td>
</tr>
<tr>
<td>Copper Ratio</td>
<td>Outer Layers (First and Fourth Layers): Less than 10% of 60 mm Square</td>
</tr>
<tr>
<td></td>
<td>Inner Layers (Second and Third Layers): 100% of 74.2 mm Square</td>
</tr>
<tr>
<td>Through-holes</td>
<td>φ 0.85 mm × 44 pcs</td>
</tr>
</tbody>
</table>

### Measurement Result

(Ta = 25°C, Tjmax = 125°C)

<table>
<thead>
<tr>
<th></th>
<th>JEDEC STD.51-7 Test Land Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Dissipation</td>
<td>666 mW</td>
</tr>
<tr>
<td>Thermal Resistance</td>
<td>θja = (125 − 25°C) / 0.666 W = 150°C/W</td>
</tr>
<tr>
<td></td>
<td>θjc = 28°C/W</td>
</tr>
</tbody>
</table>

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

![Measurement Board Pattern](image2.png)
DFN(PLP)1212-6F Package Dimensions (Unit: mm)
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