OUTLINE

The R1207N Series are CMOS-based PWM control type step-up DC/DC converter ICs with low supply current. Each of these ICs consists of an NMOS FET, a diode, an oscillator, a PWM comparator, a voltage reference unit, an error amplifier, a current limit circuit, an under voltage lockout circuit (UVLO), an over-voltage protection circuit (OVP), a soft-start circuit, a Maxduty limit circuit, and a thermal shutdown protection circuit. This step-up DC/DC converter can be easily built with a few external components such as a coil, a resistor, and a capacitor. As the protection functions, the R1207N Series have a Lx peak current limit function, an over voltage protection (OVP) function, an under voltage lock out (UVLO) function and a thermal shutdown function.

The R1207N Series present the R1207N8xxA version that is optimized for the constant voltage power source, and the R1207N8xxB/C version that is optimized for driving the white LED with the constant current. The R1207N8xxB/C is an adjustable version that can change the LED brightness dynamically by using a 200Hz to 300kHz PWM signal toward the CE pin.

The R1207N Series are available in TSOT-23-6 package.

FEATURES

- Input Voltage Range .................................................. 2.3V to 5.5V (R1207N8xxA)
  1.8V to 5.5V (R1207N8xxB/C)
- Supply Current ........................................................... Typ. 800μA
- Standby Current ........................................................... Max. 5μA
- Feedback Voltage ...................................................... 1.0V±1.5% (R1207N8xxA)
  0.2V±10mV (R1207N8xxB)
  0.4V±10mV (R1207N8xxC)
- Oscillator Frequency .................................................. Typ. 1.2MHz
- Maximum Duty Cycle .................................................. Typ. 91%
- UVLO Function ......................................................... Typ.2.0V (Hys.Typ.0.2V) (R1207N8xxA)
  Typ.1.6V (Hys.Typ.0.1V) (R1207N8xxB/C)
- Lx Current Limit Function ........................................... Select from 350mA, 700mA
- Over Voltage Protection ............................................. Typ. 25V
- LED dimming control (R1207N8xxB/C) ....................... by external PWM signal (Frequency 200Hz to 300kHz)
- Thermal Protection Function ..................................... Typ.150°C(Hys.Typ.50°C)
- Switch ON Resistance ................................................ Typ. 1.35Ω
- Package ................................................................. TSOT-23-6
- Ceramic capacitors are recommended

APPLICATION

- Constant Voltage Power Source for portable equipment
- OLED power supply for portable equipment
- White LED Backlight for portable equipment
SELECTION GUIDE

The OVP threshold voltage, current limit and VFB/Auto discharge are user-selectable options.

<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>R1207N8x3*-TR-FE</td>
<td>TSOT-23-6</td>
<td>3,000 pcs</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

x : Designation of current limit.
   (1) 350mA
   (2) 700mA

* : Designation of VFB.
    (A) 1.0V
    (B) 0.2V
    (C) 0.4V
BLOCK DIAGRAMS
R1207N8xxA

R1207N8xxB/C
## PIN DESCRIPTIONS

### TSOT-23-6

<table>
<thead>
<tr>
<th>Pin No</th>
<th>Symbol</th>
<th>Pin Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LX</td>
<td>Switching Pin (Open Drain Output)</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground Pin</td>
</tr>
<tr>
<td>3</td>
<td>$V_{FB}$</td>
<td>Feedback Pin</td>
</tr>
<tr>
<td>4</td>
<td>CE</td>
<td>Chip Enable Pin (&quot;H&quot; Active)</td>
</tr>
<tr>
<td>5</td>
<td>$V_{OUT}$</td>
<td>Output Pin</td>
</tr>
<tr>
<td>6</td>
<td>$V_{IN}$</td>
<td>Input Pin</td>
</tr>
</tbody>
</table>
### ABSOLUTE MAXIMUM RATINGS

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIN</td>
<td>$V_{IN}$ Pin Voltage</td>
<td>−0.3 to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>VCE</td>
<td>$V_{CE}$ Pin Voltage</td>
<td>−0.3 to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>VFB</td>
<td>$V_{FB}$ Pin Voltage</td>
<td>−0.3 to 6.5</td>
<td>V</td>
</tr>
<tr>
<td>VOUT</td>
<td>$V_{OUT}$ Pin Voltage</td>
<td>−0.3 to 28</td>
<td>V</td>
</tr>
<tr>
<td>VLY</td>
<td>$V_{LY}$ Pin Voltage</td>
<td>−0.3 to 28</td>
<td>V</td>
</tr>
<tr>
<td>ILX</td>
<td>$I_{LX}$ Pin Current</td>
<td>1000 mA</td>
<td></td>
</tr>
<tr>
<td>PD</td>
<td>Power Dissipation (TSOT-23-6)*</td>
<td>460 mW</td>
<td></td>
</tr>
<tr>
<td>Tj</td>
<td>Junction Temperature Range</td>
<td>−40 to 125</td>
<td>°C</td>
</tr>
<tr>
<td>Tstg</td>
<td>Storage Temperature Range</td>
<td>−55 to 125</td>
<td>°C</td>
</tr>
</tbody>
</table>

*) Refer to POWER DISSIPATION for detailed information.

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause permanent damage 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

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Item</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIN</td>
<td>Operating Input Voltage</td>
<td>R1207N8xxA</td>
<td>2.3 to 5.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R1207N8xxB/C</td>
<td>1.8 to 5.5</td>
</tr>
<tr>
<td>Ta</td>
<td>Operating Temperature Range</td>
<td>−40 to 85</td>
<td>°C</td>
</tr>
</tbody>
</table>

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if 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.
### ELECTRICAL CHARACTERISTICS

**R1207N**

\( (T_a=25^\circ C) \)

<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>I_{DD}</td>
<td>Supply Current</td>
<td>( V_{IN}=5.5V, V_{FB}=0V ) , ( L_x ) at no load</td>
<td>0.8</td>
<td>1.2</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>I_{standby}</td>
<td>Standby Current</td>
<td>( V_{IN}=5.5V, V_{CE}=0V )</td>
<td>1.0</td>
<td>5.0</td>
<td></td>
<td>( \mu A )</td>
</tr>
<tr>
<td>( V_{UVLO1} )</td>
<td>UVLO Detector Threshold</td>
<td>( V_{IN} ) falling</td>
<td>R1207N8xxA</td>
<td>1.9</td>
<td>2.0</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R1207N8xxB/C</td>
<td>1.5</td>
<td>1.6</td>
<td>1.7</td>
</tr>
<tr>
<td>( V_{UVLO2} )</td>
<td>UVLO Released Voltage</td>
<td>( V_{IN} ) rising</td>
<td>R1207N8xxA</td>
<td>2.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R1207N8xxB/C</td>
<td>V_{UVLO1} +0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>V_{UVLO1} +0.1</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>( V_{CEH} )</td>
<td>CE Input Voltage &quot;H&quot;</td>
<td>( V_{IN}=5.5V )</td>
<td>1.5</td>
<td></td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>( V_{CEL} )</td>
<td>CE Input Voltage &quot;L&quot;</td>
<td></td>
<td></td>
<td>0.5</td>
<td></td>
<td>V</td>
</tr>
<tr>
<td>( R_{CE} )</td>
<td>CE Pull Down Resistance</td>
<td></td>
<td></td>
<td></td>
<td>1200</td>
<td>k( \Omega )</td>
</tr>
<tr>
<td>( V_{FB} )</td>
<td>( V_{FB} ) Voltage Accuracy</td>
<td>( V_{IN}=3.6V )</td>
<td>R1207N8xxA</td>
<td>0.985</td>
<td>1.000</td>
<td>1.015</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R1207N8xxB</td>
<td>0.19</td>
<td>0.2</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R1207N8xxC</td>
<td>0.39</td>
<td>0.4</td>
<td>0.41</td>
</tr>
<tr>
<td>( \Delta V_{FB}/\Delta T_a )</td>
<td>( V_{FB} ) Voltage Temperature Coefficient</td>
<td>( V_{IN}=3.6V, -40^\circ C \leq T_a \leq 85^\circ C )</td>
<td></td>
<td></td>
<td>( \pm 150 )</td>
<td>ppm ( /^\circ C )</td>
</tr>
<tr>
<td>I_{FB}</td>
<td>( V_{FB} ) Input Current</td>
<td>( V_{IN}=5.5V, V_{FB}=0V ) or 5.5V</td>
<td>-0.1</td>
<td></td>
<td>0.1</td>
<td>( \mu A )</td>
</tr>
<tr>
<td>t_{start}</td>
<td>Soft-start Time</td>
<td></td>
<td>R1207N8xxB/C</td>
<td>2.0</td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>( R_{ON} )</td>
<td>FET ON Resistance</td>
<td>( I_{LX}=100mA )</td>
<td></td>
<td></td>
<td>1.35</td>
<td></td>
</tr>
<tr>
<td>( I_{OFF} )</td>
<td>FET Leakage Current</td>
<td>( V_{LX}=24V )</td>
<td></td>
<td></td>
<td>3.0</td>
<td></td>
</tr>
<tr>
<td>( I_{LIM} )</td>
<td>FET Current Limit</td>
<td></td>
<td>R1207N81xx</td>
<td>250</td>
<td>350</td>
<td>450</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>R1207N82xx</td>
<td>500</td>
<td>700</td>
<td>900</td>
</tr>
<tr>
<td>( V_{F} )</td>
<td>Diode Forward Voltage</td>
<td>( I_{SW}=100mA )</td>
<td></td>
<td></td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>( I_{DIODEleak} )</td>
<td>Diode Leakage Current</td>
<td>( V_{OUT}=24V, V_{LX}=0V )</td>
<td></td>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>f_{osc}</td>
<td>Oscillator Frequency</td>
<td>( V_{IN}=3.6V, V_{FB}=0V )</td>
<td></td>
<td></td>
<td>1000</td>
<td>1200</td>
</tr>
<tr>
<td>Maxduty</td>
<td>Maximum Duty Cycle</td>
<td>( V_{IN}=3.6V, V_{FB}=0V )</td>
<td></td>
<td></td>
<td>86</td>
<td>91</td>
</tr>
<tr>
<td>( V_{OVP1} )</td>
<td>OVP Detect Voltage</td>
<td>( V_{IN}=3.6V, V_{OUT \text{ rising}} )</td>
<td></td>
<td></td>
<td>24.2</td>
<td>25</td>
</tr>
<tr>
<td>( V_{OVP2} )</td>
<td>OVP Release Voltage</td>
<td>( V_{IN}=3.6V, V_{OUT \text{ falling}} )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T_{TSO}</td>
<td>Thermal Shutdown Detect Temperature</td>
<td>( V_{IN}=3.6V )</td>
<td></td>
<td></td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>T_{TSR}</td>
<td>Thermal Shutdown Release Temperature</td>
<td>( V_{IN}=3.6V )</td>
<td></td>
<td></td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
THEORY OF OPERATION

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

<Basic Circuit>

There are two operation modes of the step-up PWM control-DC/DC converter. That is the continuous mode and discontinuous mode by the continuousness inductor.

When the transistor turns ON, the voltage of inductor L becomes equal to $V_{IN}$ voltage. The increase value of inductor current ($i_1$) will be

$$\Delta i_1 = \frac{V_{IN} \times t_{on}}{L}$$  \hspace{1cm} Formula 1

As the step-up circuit, during the OFF time (when the transistor turns OFF) the voltage is continually supply from the power supply. The decrease value of inductor current ($i_2$) will be

$$\Delta i_2 = \frac{(V_{OUT} - V_{IN}) \times t_{open}}{L}$$  \hspace{1cm} Formula 2
At the PWM control-method, the inductor current become continuously when t_{open}=t_{off}, the DC/DC converter operate as the continuous mode.

In the continuous mode, the variation of current of i1 and i2 is same at regular condition.

\[ \frac{\text{VIN} \times t_{on}}{L} = \frac{\text{VOUT} - \text{VIN}}{t_{off}} \]  \quad \text{Formula 3} \]

The duty at continuous mode will be

\[ \text{duty} (\%) = \frac{t_{on}}{t_{on} + t_{off}} = \frac{\text{VOUT} - \text{VIN}}{\text{VOUT}} \]  \quad \text{Formula 4} \]

The average of inductor current at \( t_f = t_{off} \) will be

\[ \text{IL(Ave.)} = \frac{\text{VIN} \times t_{on}}{2 \times L} \]  \quad \text{Formula 5} \]

If the input voltage = output voltage, the \( I_{OUT} \) will be

\[ I_{OUT} = \frac{\text{VIN}^2 \times t_{on}}{2 \times L \times \text{VOUT}} \]  \quad \text{Formula 6} \]

If the \( I_{OUT} \) value is large than above the calculated value (Formula 6), it will become the continuous mode, at this status, the peak current (\( I_{Lmax} \)) of inductor will be

\[ I_{Lmax} = \frac{I_{OUT} \times \text{VOUT}}{\text{VIN} + \text{VIN} \times t_{on}} \times \frac{L}{2} \]  \quad \text{Formula 7} \]

\[ I_{Lmax} = \frac{I_{OUT} \times \text{VOUT}}{\text{VIN} + \text{VIN} \times T} \times \frac{(\text{VOUT} - \text{VIN})}{(2 \times L \times \text{VOUT})} \]  \quad \text{Formula 8} \]

The peak current value is larger than the \( I_{OUT} \) value. In case of this, selecting the condition of the input and the output and the external components by considering of \( I_{Lmax} \) value.

The explanation above is based on the ideal calculation, and the loss caused by Lx switch and the external components are not included.

The actual maximum output current will be between 50% and 80% by the above calculations. Especially, when the IL is large or \( \text{VIN} \) is low, the loss of \( \text{VIN} \) is generated with on resistance of the switch. Moreover, it is necessary to consider \( V_f \) of the diode (approximately 0.8V) about \( \text{VOUT} \).

- **Soft-Start (R1207N8xxB/C)**
  
The output and reference of the error amplifier start from 0V and the reference gradually rises up to 1.0V. After the softstart time (\( T_{SS} \)), output voltage rise up to the setting voltage.

  The output of the error amplifier starts from 0V and the inrush current is suppressed when starting by the CE pin "H" input. Moreover, the inrush current can be suppressed by gradually enlarging Duty of the PWM signal to the CE pin.

- **Current Limit Function**
  
  Current limit function monitors the over current and if it reaches the peak current, it will turn off the driver. When the over current decreases, it will restart oscillation and will restart the monitoring.
APPLICATION INFORMATION

Typical Applications

- **Inductor Selection**
  The peak current of the inductor at normal mode can be estimated as the next formula when the efficiency is 80%.

\[
IL_{\text{max}} = 1.25 \times I_{\text{OUT}} \times V_{\text{OUT}} / V_{\text{IN}} + 0.5 \times V_{\text{IN}} \times (V_{\text{OUT}} - V_{\text{IN}}) / (L \times V_{\text{OUT}} \times f_{\text{osc}})
\]

In the case of start-up or dimming control by CE pin, inductor transient current flows, and the peak current of it must be equal or less than the current limit of the IC. The peak current should not beyond the rated current of the inductor. The recommended inductance value is 10\(\mu\)H - 22\(\mu\)H.

<table>
<thead>
<tr>
<th>Condition</th>
<th>(V_{\text{IN}}) (V)</th>
<th>(V_{\text{OUT}}) (V)</th>
<th>(I_{\text{OUT}}) (mA)</th>
<th>(L) ((\mu)H)</th>
<th>(IL_{\text{max}}) (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>14</td>
<td>20</td>
<td>10</td>
<td>215</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>20</td>
<td>22</td>
<td>160</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td>20</td>
<td>10</td>
<td>280</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td>20</td>
<td>22</td>
<td>225</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2 Recommended inductors**

<table>
<thead>
<tr>
<th>(L) ((\mu)H)</th>
<th>Part No.</th>
<th>Rated Current (mA)</th>
<th>Size (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>LQH32CN100K53</td>
<td>450</td>
<td>3.2x2.5x1.55</td>
</tr>
<tr>
<td>10</td>
<td>LQH2MC100K02</td>
<td>225</td>
<td>2.0x1.6x0.9</td>
</tr>
<tr>
<td>10</td>
<td>VLF3010A-100</td>
<td>490</td>
<td>2.8x2.6x0.9</td>
</tr>
<tr>
<td>10</td>
<td>VLS252010-100</td>
<td>520</td>
<td>2.5x2.0x1.0</td>
</tr>
<tr>
<td>22</td>
<td>LQH32CN220K53</td>
<td>250</td>
<td>3.2x2.5x1.55</td>
</tr>
<tr>
<td>22</td>
<td>LQH2MC220K02</td>
<td>185</td>
<td>2.0x1.6x0.9</td>
</tr>
<tr>
<td>22</td>
<td>VLF3010A-220</td>
<td>330</td>
<td>2.8x2.6x0.9</td>
</tr>
</tbody>
</table>
**Capacitor Selection**
Set 1µF or more value bypass capacitor C1 between VIN pin and GND pin as close as possible.

**R1207NxxxA**
Set 1µF – 4.7µF or more capacitor C2 between VOUT and GND pin.

### Table 3-A Recommended components for R1207NxxxA

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Rated voltage(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>6.3</td>
</tr>
<tr>
<td>C2</td>
<td>25</td>
</tr>
<tr>
<td>C3</td>
<td>25</td>
</tr>
<tr>
<td>R1</td>
<td>For VOUT Setting</td>
</tr>
<tr>
<td>R2</td>
<td>For VOUT Setting</td>
</tr>
<tr>
<td>R3</td>
<td>2kΩ</td>
</tr>
</tbody>
</table>

If the transient drop of output voltage by the load fluctuation is large and exceeds the allowable range in above setting, refer to Table 3-B to change the capacitors of C2 and C3 for the response improvement and the transient voltage drop reduction.

### Table 3-B Recommended components for R1207xxxxA

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Rated voltage(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>6.3</td>
</tr>
<tr>
<td>C2</td>
<td>50</td>
</tr>
<tr>
<td>C3</td>
<td>25</td>
</tr>
<tr>
<td>R1</td>
<td>For VOUT Setting</td>
</tr>
<tr>
<td>R2</td>
<td>For VOUT Setting</td>
</tr>
<tr>
<td>R3</td>
<td>2kΩ</td>
</tr>
</tbody>
</table>

**R1207NxxxB/C**
Set 0.22µF or more capacitor C2 between VOUT and GND pin. (R1207N8xxB)
Set 0.47µF or more capacitor C2 between VOUT and GND pin. (R1207N8xxC)
Note the VOUT that depends on LED used, and select the rating of VOUT or more.

### Table 4 Recommended components for R1207NxxxB/C

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Rated voltage(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>6.3</td>
</tr>
<tr>
<td>C2</td>
<td>25</td>
</tr>
<tr>
<td>C2</td>
<td>25</td>
</tr>
<tr>
<td>C2</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Rated voltage(V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>6.3</td>
</tr>
<tr>
<td>C2</td>
<td>25</td>
</tr>
<tr>
<td>C2</td>
<td>25</td>
</tr>
<tr>
<td>C2</td>
<td>50</td>
</tr>
</tbody>
</table>

RICOH
- **External Components Setting**
  
  If the V<sub>OUT</sub> spike noise is high, it may influence on the V<sub>FB</sub> pin to cause the operation of R1205x8xxA unstable. To reduce the noise coming into V<sub>FB</sub> pin, please place a 1kΩ to 5kΩ resistor in R3 in Fig. 1.

- **Application of Using 5.5V or more Power Supply**
  
  Other than the IC power supply, if there is a power supply greater than 5.5V, the high power output can be achieved by using the power supply as an inductor power supply. In this case, please place a capacitor between an inductor power supply and GND (shown in Fig. 2) aside from a bypass capacitor between the V<sub>IN</sub> pin and GND of the IC.

![Fig. 1 R1207N8xxA](image1)

![Fig. 2 R1207N8xxB/C](image2)

- **The Method of Output Voltage Setting (R1207N8xxA)**
  
  The output voltage (V<sub>OUT</sub>) can be calculated with divider resistors (R1 and R2) values as the following formula:

  \[
  \text{Output Voltage (V}_{\text{OUT}}\text{)} = \frac{V_{\text{FB}} \times (R_1 + R_2)}{R_1}
  \]

  The total value of R1 and R2 should be equal or less than 300kΩ. Make the V<sub>IN</sub> and GND line sufficient. The large current flows through the V<sub>IN</sub> and GND line due to the switching. If this impedance (V<sub>IN</sub> and GND line) is high, the internal voltage of the IC may shift by the switching current, and the operating may become unstable. Moreover, when the built-in LX switch is turn OFF, the spike noise caused by the inductor may be generated. As a result of this, recommendation voltage rating of capacitor (C2) value is equal 1.5 times larger or more than the setting output voltage.

- **LED Current setting (R1207N8xxB/C)**
  
  When CE pin input is "H" (Duty=100%), LED current can be set with feedback resistor (R1)

  \[
  I_{\text{LED}} = \frac{V_{\text{FB}}}{R_1}
  \]
● LED Dimming Control (R1207N8xxB/C)

The LED brightness can be controlled by inputting the PWM signal to the CE pin. If the CE pin input is "L" in the fixed time (Typ.0.5ms), the IC becomes the standby mode and turns OFF LEDs.

The current of LEDs can be controlled by Duty of the PWM signal of the input CE pin. The current of LEDs when High-Duty of the CE input is "Hduty" reaches the value as calculatable following formula.

\[ I_{LED} = \frac{Hduty \times V_{FB}}{R1} \]

The frequency of the PWM signal is using the range between 200Hz to 300kHz.

When controlling the LED brightness by the PWM signal of 5kHz or less, R1207N8xxB/C are recomended to avoide discharge function during dimming control.

When controlling the LED brightness by the PWM signal of 20kHz or less, the increasing or decreasing of the inductor current might be make a sounds in the hearable sound wave area. In that case, please use the PWM signal in the high frequency area.

![Dimming Control by CE Pin Input](image)

● Low luminance Dimming Accuracy (R1207N8xxC)

Low luminance Dimming filtered \( V_{FB} \) voltage tolerance depends on the offset voltage of the internal DC/DC converter. By this offset voltage, some voltage difference may be generated between VREF voltage and \( V_{FB} \) voltage. Low luminance Dimming Accuracy is shown below.

<table>
<thead>
<tr>
<th>The duty of a PWM signal for the CE pin</th>
<th>I_{LED} Min.</th>
<th>I_{LED} Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.5% (Frequency = 20kHz ~ 300kHz)</td>
<td>0.01mA(^2)</td>
<td>2.1mA(^2)</td>
</tr>
</tbody>
</table>

\(^2\) guaranteed by design engineering (Ta=25 °C)
TECHNICAL NOTES

● Current Path on PCB
The current paths in an application circuit are shown in Fig. 3 and 4. A current flows through the paths shown in Fig. 3 at the time of MOSFET-ON, and shown in Fig. 4 at the time of MOSFET-OFF. In the paths pointed with red arrows in Fig. 4, current flows just in MOSFET-ON period or just in MOSFET-OFF period. Parasitic impedance / inductance and the capacitance of these paths influence stability of the system and cause noise outbreak. So please minimize this side effect. In addition, please shorten the wiring of other current paths shown in Fig. 3 and 4 except for the paths of LED load.

● Layout Guide for PCB
- Please shorten the wiring of the input capacitor (C1) between V_in pin and GND pin of IC. The GND pin should be connected to the strong GND plane.

- The area of Lx land pattern should be smaller.

- Please put output capacitor (C2) close to the V_out pin.

- Please make the GND side of output capacitor (C2) close to the GND pin of IC.

● PCB Layout
R1207N (PKG: TSOP-23-6pin)

<table>
<thead>
<tr>
<th>Top Layer</th>
<th>Back Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Top Layer Diagram" /></td>
<td><img src="image2.png" alt="Back Layer Diagram" /></td>
</tr>
</tbody>
</table>

U1- ■ indicates the position of No.1 pin.
TYPICAL CHARACTERISTICS

1) Efficiency vs. Output Current Characteristics (R1207N823A)

- **V_{out}=10V, L=10\mu H (LQH32CN100K53)**
  - Vin=3V
  - Vin=3.6V
  - Vin=4.2V
  - Vin=5V

- **V_{out}=10V, L=22\mu H (LQH32CN220K53)**
  - Vin=3V
  - Vin=3.6V
  - Vin=4.2V
  - Vin=5V

- **V_{out}=15V, L=10\mu H (LQH32CN100K53)**
  - Vin=3V
  - Vin=3.6V
  - Vin=4.2V
  - Vin=5V

- **V_{out}=15V, L=22\mu H (LQH32CN220K53)**
  - Vin=3V
  - Vin=3.6V
  - Vin=4.2V
  - Vin=5V

- **V_{out}=20V, L=10\mu H (LQH32CN100K53)**
  - Vin=3V
  - Vin=3.6V
  - Vin=4.2V
  - Vin=5V

- **V_{out}=20V, L=22\mu H (LQH32CN220K53)**
  - Vin=3V
  - Vin=3.6V
  - Vin=4.2V
  - Vin=5V
**Typical Applications with Using 5.5V or Greater**

**V_{out}=15V, L=10\mu H** (LQH32CN100K53)

**V_{out}=20V, L=10\mu H** (LQH32CN100K53)

2) **Efficiency vs. Output Current Characteristics (R1207N823B/C)**

**4LED, L=10\mu H** (LQH32CN100K53)

**4LED, L=22\mu H** (LQH32CN220K53)
5LED, L=10µH (LQH32CN100K53)

6LED, L=10µH (LQH32CN100K53)

6LED, L=22µH (LQH32CN220K53)

6LED, VIN=3.6V

50 55 60 65 70 75 80 85 90
0 5 10 15 20

Output Current ILED (mA)

Efficiency (%) Vin=3V Vin=3.6V Vin=4.2V Vin=5V

LQH32CN100K53L (3.2×2.5×1.55)
VLF3010AT-100MR33 (2.8×2.6×0.9)
LQH2MCN100K02 (2.0×1.6×0.9)
Typical Applications with Using 5.5V or Greater

5LED, $V_{\text{IN(IC)}}=3.6\text{V}$

6LED, $V_{\text{IN(IC)}}=3.6\text{V}$

3) Output Voltage vs. Output Current (R1207N823A)

$V_{\text{OUT}}=10\text{V}, L=10\mu\text{H}$ (LQH32CN100K53)

$V_{\text{OUT}}=10\text{V}, L=22\mu\text{H}$ (LQH32CN220K53)

$V_{\text{OUT}}=15\text{V}, L=10\mu\text{H}$ (LQH32CN100K53)

$V_{\text{OUT}}=15\text{V}, L=22\mu\text{H}$ (LQH32CN220K53)
R1207N

NO.EA-298-190808

**Typical Applications with Using 5.5V or Greater**

<table>
<thead>
<tr>
<th>Output Voltage (V)</th>
<th>Output Current (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>V_out=15V, L=10µH (LQH32CN100K53)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>V_out=20V, L=10µH (LQH32CN100K53)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>V_out=20V, L=22µH (LQH32CN220K53)</strong></td>
<td></td>
</tr>
</tbody>
</table>

**LQH32CN100k53L (3.2×2.5×1.55)**

**VLF3010AT-100MR33 (2.8×2.6×0.9)**

**LQH2MCN100K02 (2.0×1.6×0.9)**
4) Maxduty vs. ILED
   R1207N823B/C

5) OVP Output Waveform
   R1207N823B/C

6) Waveform (6LED)
   R1207N823B/C (CE Freq=200Hz)

7) Diode Forward Voltage vs. Temperature
   R1207N823B/C (CE Freq=300KHz)
8) Standby Current vs. Temperature

![Standby Current vs. Temperature Graph]

9) Supply Current vs. Temperature

![Supply Current vs. Temperature Graph]

10) UVLO Output Voltage vs. Temperature

- R1207N8xxA
  - ![UVLO Voltage Graph for R1207N8xxA]
- R1207N8xxB
  - ![UVLO Voltage Graph for R1207N8xxB]

11) VFB Voltage vs. Temperature

- R1207N8xxA
  - ![VFB Voltage Graph for R1207N8xxA]
- R1207N8xxB
  - ![VFB Voltage Graph for R1207N8xxB]
12) Switch ON Resistance RON vs. Temperature

Switch ON Resistance RON (Ω)

Temperature Ta (°C)

-40 -15 10 35 60 85

0.5 0.7 0.9 1.1 1.3 1.5 1.7 1.9

VFB Voltage (V)

-40 -15 10 35 60 85

0.390 0.392 0.394 0.396 0.398 0.400 0.402 0.404 0.406 0.408

13) OVP Voltage vs. Temperature

OVP Voltage (V)

Temperature Ta (°C)

-40 -15 10 35 60 85

22 23 24 25 26 27 28

200 250 300 350 400 450 500

14) Lx Current Limit vs. Temperature

Lx Limit Current (mA)

Temperature Ta (°C)

-40 -15 10 35 60 85

200 250 300 350 400 450 500

Vin=2.8V

Vin=3.6V

Vin=5.5V

R1207N81xx

R1207N82xx
15) Oscillator Frequency vs. Temperature

![Graph of Oscillator Frequency vs. Temperature]

- Frequency vs. Temperature
- Vin=1.8V
- Vin=3.6V
- Vin=5.5V

16) Maxduty vs. Temperature

![Graph of Maxduty vs. Temperature]

- Maxduty vs. Temperature
- Vin=1.8V
- Vin=3.6V
- Vin=5.5V

17) Thermal Shutdown Detect / Release Temperature vs. Input Voltage

![Graph of Thermal Shutdown Detect / Release Temperature vs. Input Voltage]

- Thermal Shutdown Detect
- Thermal Shutdown Release
18) Load Transient Response

\[ V_{\text{IN}} = 3.6 \text{ V}, \ V_{\text{OUT}} = 15 \text{ V} \quad I_{\text{OUT}} = 0 \ \text{mA} \leftrightarrow 30 \ \text{mA} \]

L = 10 µH  Setting : Table 3-A

L = 22 µH  Setting : Table 3-A

L =10 µH  Setting : Table 3-B
L = 22 µH  Setting : Table 3-B
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>Standard 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 (Double-Sided Board)</td>
</tr>
<tr>
<td>Board Dimensions</td>
<td>40 mm × 40 mm × 1.6 mm</td>
</tr>
<tr>
<td>Copper Ratio</td>
<td>Top Side: Approx. 50%</td>
</tr>
<tr>
<td></td>
<td>Bottom Side: Approx. 50%</td>
</tr>
<tr>
<td>Through-holes</td>
<td>φ 0.5 mm × 44 pcs</td>
</tr>
</tbody>
</table>

**Measurement Result**

(Ta = 25°C, Tjmax = 125°C)

<table>
<thead>
<tr>
<th></th>
<th>Standard Test Land Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Dissipation</td>
<td>460 mW</td>
</tr>
<tr>
<td>Thermal Resistance</td>
<td>θja = (125 − 25°C) / 0.46 W = 217°C/W</td>
</tr>
<tr>
<td></td>
<td>θjc = 40°C/W</td>
</tr>
</tbody>
</table>

**Power Dissipation vs. Ambient Temperature**

**Measurement Board Pattern**
TSOT-23-6 Package Dimensions (Unit: mm)
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