Additional Applications of the 2009 “MicroPuck”

The LEDdynamics 2009 One Watt LED Driver Module is a inexpensive device originally designed to efficiently and safely drive a one Watt Luxeon™ emitter from one or two batteries. However, the 2009's elegantly simple design allows a great deal of flexibility in application. This document will illustrate a number of possible alternate configurations, including the ability to drive newly released high-power emitters such as Nichia's Jupiter™ and the “Golden Dragon”™ from Osram, in addition to a review of the standard one Watt Luxeon connection.

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• LED
  1 Watt
    Luxeon™
    Osram Golden Dragon®
    ISP “High Power” .............................................................. Pages 2-5
  2,3 Watt
    Luxeon III™
    Nichia Jupiter™ and Sirius™ ................................................ Pages 4,5
  5 Watt
    Luxeon V™ .................................................................................. Page 4

• Battery
  Alkaline .................................. Page 2-6 ................... 1v - 3v one or two cells ...... Pages 2,5
  Rechargeable .......... Page 3 ........................................ 4v - 8v three to five cells ... Pages 3,4,6
  Lithium ............. Page 2-6 ........................................ 1v - 7v one to four cells ....... Pages 4,6

• Drive type
  Boost ................................................................................................. Pages 2,5
  Buck .................................................................................................. Page 3
  Buck/Boost ..................................................................................... Pages 4,6

* Luxeon is a registered trademark of LumiLEDs Corp. Sirius and Jupiter are registered trademarks of Nichia Corp. “Golden Dragon” is a registered tradename of OSRAM Opto Semiconductors GmbH.
2009 as a Boost Driver

Figure 1. 2009 in its standard boost configuration driving a single junction InGaN(P) LED, one Watt or greater

• Applicable LED configurations
  15 Parallel 5mm LEDs @ 20mA ea.
  1 1W Luxeon™ LED
  1 1W ISP High-Power LED

• Suggested battery configurations
  2 Alkaline cell(s)
  1 Lithium 3V cell

• Application examples
  1 or 2 cell flashlights/other portable lighting
  Point of load conversion

Figure 2. The 2009 driving 1W (thin line) and 3W (thick line) Luxeon emitters.

Figure 3. The 2009 driving 1W (thin line) and 3W (thick line) Luxeon emitters.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
<td>Input Voltage</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>LED Current</td>
<td>-</td>
<td>500mA</td>
</tr>
<tr>
<td>Efficiency</td>
<td>70%</td>
<td>85%</td>
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NOTE: LED(s) must always be connected whenever power is applied!
**2009 as a Buck Driver**

- **Applicable LED configuration:**
  15 Parallel 5mm LEDs @ 20mA ea.
  24 Series/Parallel 2V LEDs @ 30mA ea
  1 1W Luxeon™ LED
  1 1W ISP High-Power LED

- **Suggested battery configurations**
  4 or 5 Alkaline cells
  4 NiHM, or NiCad cell(s)
  2 Lithium 3V or 3.6V cell
  1 6V Lantern Battery

- **Application examples**
  3 to 5 cell flashlights
  4 to 8 volt embedded bulb drivers
  portable lighting
  low voltage accent lighting
  PC accent lighting (5v)

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**Figure 4.** The 2009 configured as a buck converter. The load must be floating for this buck topology. The 2009 will not function with less than ~3.7 volts (LED $V_f + 0.7$) in this configuration.

**Figure 5.** Operation is possible all the way up to 8 volts but the current quickly rises. Ideal 1W operation is at 6V, perfect for a four cell flashlight.

**Figure 6.** This figure demonstrates the inherent efficiency of a driver in buck mode. This topology is 12% more efficient than the standard boost mode.

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**Specification**

<table>
<thead>
<tr>
<th>Specification</th>
<th>Min</th>
<th>Max</th>
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</thead>
<tbody>
<tr>
<td>Input Voltage</td>
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<td>8</td>
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<tr>
<td>LED Current</td>
<td>-</td>
<td>500mA</td>
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<tr>
<td>Efficiency</td>
<td>82% @7V</td>
<td>90% @4V</td>
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2009 as a Buck/Boost Driver

**Figure 7.** 2009 configured in a novel buck/boost configuration. This topology boasts an extremely wide input voltage range that will continue to supply effective power as batteries become exhausted, but is 15% less efficient than boost.

**NOTE:**
LED(s) must always be connected whenever power is applied!

<table>
<thead>
<tr>
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<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
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<td>7</td>
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<tr>
<td>Output Voltage</td>
<td>-</td>
<td>10</td>
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<table>
<thead>
<tr>
<th>Specification</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED Current</td>
<td>-</td>
<td>300mA</td>
</tr>
<tr>
<td>Efficiency</td>
<td>65% @6v</td>
<td>72% @2v</td>
</tr>
</tbody>
</table>

• Applicable LED configurations
  15 Parallel 5mm LEDs @ 20mA
  1 1W Luxeon™ LED
  1 2W Nichia Jupiter™
  1 1W ISP High-Power LED

• Suggested battery configurations
  1 to 4 Alkaline cells
  2 Lithium 3V or 3.6V cell
  1 6V Lantern Battery

• Application examples
  1 to 5 cell flashlights
  6 volt embedded bulb drivers
  low voltage accent lighting
  portable lighting where completely exhausting batteries is desired

**Figure 8.** This circuit delivers substantial LED current from the maximum input of 7 volts all the way down to 1.5 volts!

**Figure 9.** Efficiency is lower with this configuration than with buck or boost alone.
Two 2009s in Parallel, Boost

- Applicable LED configurations
  1  5W Luxeon V™
  1  3W Luxeon III™
  1  3W Nichia Sirius™
  2  2W Nichia Jupiter™
  2-4 1W Luxeon™
  2-4 1W ISP High-Power LED
  30  5mm LEDs @ 20mA ea (parallel)

- Suggested battery configurations
  1-3W 5W
  1-2  2-4 Alkaline standard cells
  1  2  Lithium 3V cell(s)

- Application examples
  Dual CR123 cell flashlight with Lux V emitter
  Single CR123 cell flashlight with Lux III LED
  1-4 cell flashlights

**NOTE:**
LED(s) must always be connected whenever power is applied!

![Figure 10](image10.png) **Figure 10.** Two 2009s can be paralleled to nearly double LED current for a high-power emitter such as Luxeon III or V.

**Table 1**

<table>
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<tbody>
<tr>
<td>Input Voltage</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>-</td>
<td>8</td>
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<tr>
<td>LED Current</td>
<td>-</td>
<td>800mA</td>
</tr>
<tr>
<td>Efficiency</td>
<td>72%</td>
<td>78%</td>
</tr>
</tbody>
</table>

*3W at 1V 3W at 3V*

![Figure 11](image11.png) **Figure 11.** Two 2009s driving a LuxIII and LuxV. A single 2009 driving a LuxIII is included for reference.

![Figure 12](image12.png) **Figure 12.** Two 2009s driving a Luxeon III emitter.
Two 2009s in Parallel, Buck/Boost

![Diagram of 2009s in parallel buck/boost configuration](image)

**Figure 13.** Two 2009s running buck/boost can be paralleled to nearly double LED current for a high-power emitter such as Luxeon III or Nichia Jupiter emitters. The second 2009 can be connected by switch to provide extra power only when necessary.

<table>
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<tr>
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<th>Max</th>
<th>Specification</th>
<th>Min</th>
<th>Max</th>
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<td>1</td>
<td>7</td>
<td>LED Current</td>
<td>-</td>
<td>700mA</td>
</tr>
<tr>
<td>Output Voltage</td>
<td>-</td>
<td>10</td>
<td>Efficiency</td>
<td>65% @7V</td>
<td>72% @2V</td>
</tr>
</tbody>
</table>

**NOTE:**
LED(s) must always be connected whenever power is applied!

**Figure 14.** Two 2009s in parallel buck/boost running a LuxIII.

**Figure 15.** Two 2009s in parallel buck/boost running a LuxIII.

- **Applicable LED configurations**
  1. 3W Luxeon III™
  2. Nichia Jupiter™
  1. Nichia Sirius™
  2. 1W Luxeon™
  2. 1W ISP High-Power LED
  30. Parallel 5mm LEDs @ 20mA

- **Suggested battery configurations**
  1 to 4. Alkaline cells
  2. Lithium 3V or 3.6V cell
  1. 6V Lantern Battery

- **Application examples**
  1 to 5. Cell flashlights
  6 volt embedded bulb drivers
  low voltage accent lighting
  high power portable lighting