RE F E R E N C E D E S I G N N O T E

LED Driver with MagIQC Power Module

MagIQC Power Modules
VDRM - LED Driver Application

7 - 24V INPUT / 0 – 1.5A LED CURRENT

1. Introduction

The DNS14 is a reference design for the WLMDU9456008T LED driver capable of driving up to 1.5 A output current using a voltage regulated module and an external secondary regulation loop to establish current regulation. The external loop regulates a DC output current which results in a constant photon flow. Compared to other solutions with PWM, this solution is less harmful to the eyes due to the constant photon flow, allowing the pupil opening to be the proper size for the light intensity emitted. Depending on the LED flux voltage up to 4 LEDs in series can be connected.

2. Features

- Input voltage range from 7 V to 24 V
- Output current up to 1.5 A
- Adjustable current from 10 mA to 1.5 A
- Dimming voltage 0 V (10 mA) to 5 V (1.5 A)
- Current regulation
- Output current ripple typ. < 10 mA
- Output power up to 22.5 W
- Series connected LEDs up to 15 V total flux voltage

Figure 1: Development Example

Figure 2: Simplified Schematic
3. Description

The power consumption of LEDs on the lighting market is constantly increasing. LEDs require currents of 700 mA, 1 A or higher. High output currents are supported commonly with voltage regulated modules. Constant high current led drivers are uncommon on the market. This design note describes how to convert a voltage regulated module to a current regulated module. Typical supplies for LEDs are modules operating as current sources. They include dual protection against output short circuits. A current regulated circuit is - if designed properly - short circuit protected by itself due to its nature of forcing a defined current into the load regardless if the load is an LED or a low resistance like a short circuit. The second overcurrent protection circuit is integrated in the module commonly through a cycle by cycle current limit.

A MagIC VDRM module is used in this application. Natively it is voltage regulated. The current through a specific number of LEDs will flow from LED+ pin through the LEDs to the LED- pin. The LED current flows through a shunt resistor, R3, and the voltage across R3 is compared with a dimming voltage. A 5 V dimming voltage at the DIM terminal results in a voltage of 75 mV at the regulation loop amplifier (IC3, pin4) with which the shunt voltage (IC3, pin 3) is compared. IC3 is used for an outer and slower regulation circuit which drives the feedback pin of the VDRM module. The compensation network consists of C8, C9 and R6, which may be trimmed by the design engineer depending on the customer PCB layout if modified from the reference design PCB layout.

An external dimming (adjusting) voltage is always required. This can be derived directly from Vin if stable or from a resistor divider from the 3.3 V of the linear regulator (IC2).

The supply of the operational amplifier is derived from Vin with a linear regulator (IC2) with a capability of abs. max. 40V or 60V input voltage. Its output voltage is set to 3.3V. The Input voltage of the design ranges from 7 V to 50 V (only with the 60 V version of the LM2936, which is not available in this small package) and the output current ranges from 0 A to 2.5 A. Note that the output power shall not exceed 22.5 W. The compensation may be adapted for various operating points.

This Reference Design is developed using the following specification:

\[ V_{in} = 7 \text{ V} - 24 \text{ V} \quad V_{out} = 0 \text{ V} - 15 \text{ V} \quad I_{out} = 10 \text{ mA} - 1.5 \text{ A} \]
# REFERENCE DESIGN NOTE

LED Driver with MagI³C Power Module

MagI³C Power Modules
VDRM - LED Driver Application

## 4. Bill of Material

<table>
<thead>
<tr>
<th>Index</th>
<th>Description</th>
<th>Size</th>
<th>Value</th>
<th>Order Code</th>
<th>Supplier</th>
</tr>
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<tbody>
<tr>
<td>IC1</td>
<td>MagI³C power module</td>
<td>BQFN-41</td>
<td>WPMDU1251501N</td>
<td>171 021 501</td>
<td>Würth Elektronik eSos</td>
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<td>IC2</td>
<td>Linear regulator</td>
<td>SOT-223</td>
<td>LM2936(HV)</td>
<td>LM2936MP-3.3 (40V)</td>
<td>Texas Instruments</td>
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<tr>
<td>IC3</td>
<td>Operational amplifier</td>
<td>SOT-23</td>
<td>OPA364</td>
<td>OPA364</td>
<td>Texas Instruments</td>
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<tr>
<td>R5,R6,R8,R13</td>
<td></td>
<td>0603 1% TK100</td>
<td>1K00</td>
<td></td>
<td></td>
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<tr>
<td>R10,R11,R12</td>
<td></td>
<td>0603 1% TK100</td>
<td>2K00</td>
<td></td>
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<tr>
<td>R1</td>
<td></td>
<td>0603 5% TK100</td>
<td>10R0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td></td>
<td>0603 5% TK100</td>
<td>0R02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R4,R9</td>
<td>Change R9 to your UVLO needs</td>
<td>0603 1% TK100</td>
<td>10K0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R7</td>
<td>Defines max current at 5 V at DIM pin/pad (5 V = 1.5 A)</td>
<td>0603 1% TK100</td>
<td>64K9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td>Shunt resistor</td>
<td>1210 0.5%</td>
<td>0R05</td>
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<td></td>
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<tr>
<td>C2,C3</td>
<td></td>
<td>X5R or X7R</td>
<td>10µ/50V</td>
<td></td>
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<tr>
<td>C5,C10,C11</td>
<td></td>
<td>X7R 0603 10%</td>
<td>100n/50V</td>
<td>885 012 206 095</td>
<td>Würth Elektronik eSos</td>
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<td>C7,C9</td>
<td></td>
<td>COG,NP0 0603</td>
<td>22p/50V</td>
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<td>C8</td>
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<td>C6</td>
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<td>10µ/10V</td>
<td>885 012 107 010</td>
<td>Würth Elektronik eSos</td>
</tr>
</tbody>
</table>

Table 1: Bill of Material
5. Schematic and Layout

Figure 3: Schematic

Figure 4: Layout
6. Suitable Würth Elektronik eiSos High power LEDs

**WL-SWTC**  
SMD White Top View Ceramic LED  
Size 3535, waterclear dome lens

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**Figure 5: Recommended High Power White LEDs**
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VDRM - LED Driver Application

WL-SMDC
Ceramic mono-color High Power LED
Size 3535, waterclear

Figure 6: Recommended High Power Colored LEDs
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Application Notes:
http://www.we-online.com/app-notes

Component Selector:
http://www.we-online.com/component-selector

Toolbox:
http://www.we-online.com/toolbox

Product Catalog:
http://katalog.we-online.de/en/

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