# Design Example Report

<table>
<thead>
<tr>
<th>Title</th>
<th>2 W Non-isolated Power Supply using LinkSwitch™-TN LNK305P</th>
</tr>
</thead>
</table>
| Specification | Input: 85 VAC - 265 VAC  
Output: 15 V / 130 mA (220 mApk) |
| Application | Motor Control |
| Author | Power Integrations Applications Department |
| Document Number | DER-47 |
| Date | April 7, 2014 |
| Revision | 1.1 |

**Summary and Features**
- Highly integrated solution
- Lowest possible component count
- No optocoupler or Zener diode required for regulation
- Thermal overload protection with automatic recovery
- Less than 300 mW no-load consumption
- Very high efficiency at full load

The products and applications illustrated herein (including circuits external to the products and transformer construction) may be covered by one or more U.S. and foreign patents or potentially by pending U.S. and foreign patent applications assigned to Power Integrations. A complete list of Power Integrations’ patents may be found at www.powerint.com
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**Important Note:**
This board is designed to be non-isolated. Please take necessary safety precautions.

Design Reports contain a power supply design specification, schematic, bill of materials, and transformer documentation. Performance data and typical operation characteristics are included. Typically only a single prototype has been built.
1 Introduction

This document is a prototype engineering report describing a 15 V, 130 mA non-isolated power supply using a LNK305P from Power Integrations.

This document contains the power supply specification, schematic, bill of materials and measurements results.
## 2 Power Supply Specification

<table>
<thead>
<tr>
<th>Description</th>
<th>Symbol</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td>$V_{IN}$</td>
<td>85</td>
<td></td>
<td>265</td>
<td>V AC</td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>$f_{LINE}$</td>
<td>47</td>
<td>50/60</td>
<td>63</td>
<td>Hz</td>
<td></td>
</tr>
<tr>
<td><strong>Outputs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Voltage</td>
<td>$V_{OUT}$</td>
<td>15</td>
<td></td>
<td>150</td>
<td>V</td>
<td>[±3%]</td>
</tr>
<tr>
<td>Output Ripple Voltage</td>
<td>$V_{RIPPLE}$</td>
<td>130</td>
<td></td>
<td>220</td>
<td>mV</td>
<td>20 MHz Bandwidth</td>
</tr>
<tr>
<td>Output Current</td>
<td>$I_{OUT}$</td>
<td></td>
<td></td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td><strong>Total Output Power</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous Output Power</td>
<td>$P_{OUT}$</td>
<td>1.95</td>
<td></td>
<td></td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Peak Output Power</td>
<td>$P_{OUT_PEAK}$</td>
<td>3.3</td>
<td></td>
<td></td>
<td>W</td>
<td></td>
</tr>
<tr>
<td>Ambient Temperature</td>
<td>$T_{AMB}$</td>
<td>0</td>
<td></td>
<td>70</td>
<td>°C</td>
<td>Open frame</td>
</tr>
</tbody>
</table>

*Table 1 - Power Supply Specification*
3 Schematic

Figure 1 - Schematic after AC rectification
4 Circuit Description

The tested power supply had an input stage including one diode for the rectification and a \( \pi \) filter (4.7 \( \mu \)F, 1 mH, 4.7 \( \mu \)F), but this stage is not included in the schematic, and may not be needed in other systems if EMI filtering is present.

The voltage across L1 is rectified and smoothed by D1 and C2 during U1’s off-time. To a first order, the forward voltage drop of D2 (slow diode used in the tests) and D1 (must be an ultrafast) can be considered similar. Therefore the voltage across C3 tracks the output voltage. The voltage across C3 is sensed and regulated via the resistor divider R1-R3 connected to U1’s EN-pin. Resistor R4 provides a small pre-load current (3.8mA) for operation down to 0mA output current.
4.1 Bill of Materials

<table>
<thead>
<tr>
<th>Item</th>
<th>Ref Des</th>
<th>Description/part number</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>R1</td>
<td>16.9 kΩ, 1%, 0.25 W</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>R3</td>
<td>2.2 kΩ, 1%, 0.25 W</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>R4</td>
<td>3.9 kΩ, 5%, 0.5 W</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>L1</td>
<td>1 mH, 220mArms</td>
<td>Tokin</td>
</tr>
<tr>
<td>5</td>
<td>C1</td>
<td>100 nF</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>C2</td>
<td>100 μF, 35 V, low ESR</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>C3</td>
<td>0.47 μF, 50 V</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>D1</td>
<td>UF4005 (ultrafast diode)</td>
<td>Vishay</td>
</tr>
<tr>
<td>9</td>
<td>D2</td>
<td>1N4005 (normal p/n diode)</td>
<td>Vishay</td>
</tr>
<tr>
<td>10</td>
<td>U1</td>
<td>LNK305</td>
<td>Power Integrations</td>
</tr>
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</table>

Table 2 - SMPS Bill of Materials
5 Performance Data
All measurements performed at room temperature, 50 Hz input frequency.

5.1 Efficiency

Figure 2 – Efficiency measurements vs input voltage (@130mA and 220mA load)
5.2 Regulation

5.2.1 Line regulation

![Figure 3 - Output voltage tolerance (in % of the nominal output voltage level) vs input voltage, at 0, 130mA and 220 mA load]

5.2.2 Load regulation

![Figure 4 - Load regulation (in % of the nominal output voltage level)]
5.2.3 No-load input power

![Graph showing no-load input power vs input voltage]

**Figure 5** - No-load input power vs input voltage
6 Output noise measurements

Figure 6 - Output ripple at 230 Vac input and 130 mA load
## Revision History

<table>
<thead>
<tr>
<th>Date</th>
<th>Author</th>
<th>Revision</th>
<th>Description &amp; changes</th>
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<td>20-Apr-05</td>
<td>TP</td>
<td>1.0</td>
<td>Initial release</td>
<td>VC/JC / AM</td>
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<tr>
<td>07-Apr-14</td>
<td>KM</td>
<td>1.1</td>
<td>Fix Circuit Description Text</td>
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