1 Introduction

The LMZ10501 and LMZ10500 nano modules offer excellent EMI performance. The evaluation board with the default components complies with the CISPR 22 Class B radiated emissions standard. Adding two small 0.1µF 0805 input capacitors results in CISPR 25 Class 5 radiated emissions standard compliance. The addition of a small LC filter (1µH and 1µF) to the input of the default evaluation board results in compliance with CISPR 22 Class B conducted emissions and allows for even larger margin of compliance in terms of radiated EMI.

2 Test Conditions

- $V_{\text{IN}} = 5\, \text{V}$
- $V_{\text{OUT}} = 1.8\, \text{V}$
- 1A load (LMZ10501)
- 650mA load (LMZ10500)
- 2MHz switching frequency
- 4 layer PCB with 1oz copper
- 4.3 x 4.3 cm (1700 x 1700 mil) PCB size
- CISPR 22 Class B Radiated EMI
- CISPR 22 Class B Conducted EMI
- CISPR 25 Class 5 Broadcast Radiated EMI

![Figure 1. CISPR 22 Radiated EMI 1A Load Default Evaluation Board BOM](image-url)
Figure 2. CISPR 22 Conducted EMI 1A Load
1µH 1µF Additional LC Input Filter

Figure 3. CISPR 22 Radiated EMI 1A Load
1µH 1µF Additional LC Input Filter
Figure 4. CISPR 25 Class 5 Radiated EMI 1A Load
2 x 0.1 µF Additional Input Capacitance

Figure 5. Evaluation Board Schematic

Table 1. LMZ10501 and LMZ10500 Bill of Materials

<table>
<thead>
<tr>
<th>Designator</th>
<th>Description</th>
<th>Case Size</th>
<th>Manufacturer</th>
<th>Manufacturer P/N</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>SIMPLE SWITCHER® Nano Module</td>
<td>SE08A</td>
<td>Texas Instruments</td>
<td>LMZ10501SE or LMZ10500SE</td>
<td>1</td>
</tr>
<tr>
<td>C_IN, C_OUT</td>
<td>10 µF, X5R, 10V</td>
<td>0805</td>
<td>KEMET</td>
<td>C0805C106K8PACTU</td>
<td>2</td>
</tr>
<tr>
<td>C_VC</td>
<td>1000 pF</td>
<td>0603</td>
<td>TDK</td>
<td>C1608C0G2A102J</td>
<td>1</td>
</tr>
<tr>
<td>R_B</td>
<td>82.5 kΩ</td>
<td>0603</td>
<td>Vishay-Dale</td>
<td>CRCW060382K5FKEA</td>
<td>1</td>
</tr>
<tr>
<td>R_T</td>
<td>187 kΩ</td>
<td>0603</td>
<td>Vishay-Dale</td>
<td>CRCW0603187KFKEA</td>
<td>1</td>
</tr>
<tr>
<td>C_IN2,3</td>
<td>0.1 µF</td>
<td>0805</td>
<td></td>
<td></td>
<td>2</td>
</tr>
</tbody>
</table>

(Additional Filter for CISPR 22 Conducted EMI Compliance)

(Additional capacitors for CISPR 25 Radiated EMI Compliance)
2.1 Board Layout and Components Information

The default evaluation board was used in all tests. Refer to AN-2166 LMZ10501 and LMZ10500 SIMPLE SWITCHER Nano Module Evaluation Board (SNVA491) for details on the board layout and specifications. The optional components $C_F$ and $L_F$ are needed for compliance with CISPR 22 Conducted EMI specifications. This LC filter also improves the CISPR 22 Radiated EMI compliance margin as illustrated in Section 3. The optional components $C_{IN2}$ and $C_{IN3}$ are necessary for compliance with CISPR 25 Class 5 Broadcast specifications.

3 CISPR 22 Class B Radiated and Conducted Emissions

Unless otherwise specified, the following conditions apply: $V_{IN} = 5V$, $V_{OUT} = 1.8V$. 

![Figure 6. Radiated EMI 1A Load](image)
**CISPR 22 Class B Radiated and Conducted Emissions**

![Graph showing radiated emissions](image)

**Figure 7. Radiated EMI 650mA Load**

![Diagram showing LC input filter](image)

**Figure 8. LC Input Filter for Conducted EMI**

![Graph showing conducted emissions](image)

**Figure 9. Conducted EMI with the LC Input Filter 1A Load**
Figure 10. Conducted EMI With the LC Input Filter 650mA Load

Figure 11. Radiated EMI With the LC Input Filter 1A Load
## CISPR 25 Class 5 Broadcast Radiated Emissions

Unless otherwise specified, the following conditions apply: $V_{IN} = 5V$, $V_{OUT} = 1.8V$.

<table>
<thead>
<tr>
<th>FREQUENCY (MHz)</th>
<th>RADIATED EMISSIONS (dB V/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>Peak Emissions</td>
</tr>
<tr>
<td>0.5</td>
<td>CISPR 25 Class 5 Limit</td>
</tr>
<tr>
<td>1</td>
<td>Peak Emissions</td>
</tr>
<tr>
<td>5</td>
<td>CISPR 25 Class 5 Limit</td>
</tr>
</tbody>
</table>

**Figure 12. 0.15 MHz-5 MHz 1A Load**

<table>
<thead>
<tr>
<th>FREQUENCY (MHz)</th>
<th>RADIATED EMISSIONS (dB V/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>Peak Emissions</td>
</tr>
<tr>
<td>0.5</td>
<td>CISPR 25 Class 5 Limit</td>
</tr>
<tr>
<td>1</td>
<td>Peak Emissions</td>
</tr>
<tr>
<td>5</td>
<td>CISPR 25 Class 5 Limit</td>
</tr>
</tbody>
</table>

**Figure 13. 0.15 MHz-5 MHz 650 mA Load**
Figure 14. 5 MHz-30 MHz 1A Load

Figure 15. 5 MHz-30 MHz 650 mA Load

Figure 16. 30 MHz-200 MHz Horizontal 1A Load
Figure 17. 30 MHz-200 MHz Horizontal 650 mA Load

Figure 18. 30 MHz-200 MHz Vertical 1A Load

Figure 19. 30 MHz-200 MHz Vertical 650 mA Load
Figure 20. 200 MHz-1000 MHz Horizontal 1A Load

Figure 21. 200 MHz-1000 MHz Horizontal 650 mA Load

Figure 22. 200 MHz-1000 MHz Vertical 1A Load
Figure 23. 200 MHz-1000 MHz Vertical 650 mA Load
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