Application Note
Powering the USB device

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Team 9

Abstract:

This note is to describe how to power the USB receiver and Stellaris® LM4F120 LaunchPad using a 24V DC to 5V DC converter. Also, giving introduction of making a USB connector.

Keywords:
USB, 12-24V to 5V, DC-DC converter, power
**Introduction:**
The major objective is to power the USB receiver and Stellaris® LM4F120 LaunchPad from 24V DC battery. The requirement power supply of USB devices is 5V DC. A 24V DC to 5V DC converter will be used as power supply for these devices. The easiest way to reduce the voltage of DC power supply is using a linear regulator. However the linear regulator will waste energy as heat. Buck converter is a more efficiency device by controlling the duty cycle of switch to get the target output voltage.

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**Waveforms**

1. **Circuit**
   - Ein
   - \( i_r \)
   - \( S \)
   - \( i_l \)
   - L
   - D
   - C
   - Eout

2. **S on**
   - Ein
   - \( i_r \)
   - \( S \)
   - \( i_l \)
   - L
   - D
   - C
   - Eout

3. **S off**
   - Ein
   - \( i_r \)
   - \( S \)
   - \( i_l \)
   - L
   - D
   - C
   - Eout

**Buck Converter**

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**gate of S**

- \( T \)
- \( Ton \)
- \( Toff \)

**voltage**

- Ein
- \( i_r \)
- \( V \)
- Eout

**current**

- \( i_l \)
- \( i_T \)
- \( i_D \)
- \( i_T \)
- \( i_D \)
Requirement of power and part selection

<table>
<thead>
<tr>
<th></th>
<th>Port</th>
<th>Voltage</th>
<th>Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB Receiver</td>
<td>USB 2.0</td>
<td>5V DC</td>
<td>500mA</td>
</tr>
<tr>
<td>Stellaris® LM4F120</td>
<td>USB 2.0</td>
<td>5V DC</td>
<td>500mA</td>
</tr>
</tbody>
</table>

Both the receiver and Stellaris® LM4F120 LaunchPad work at 5V. The devices are connected as USB port. The current of each device is 500mA. The simplest solution for this is to use the circuit of USB Car Charger Vehicle Power Adapter. The input of adapter is from 12V to 24V and the output voltage is 5V with max 700mA current. We can use two adapters to power each device individually. The price of this adaptor is around $1 from Amazon.com and free from BMW in Engineering Expo, which will save project budget as well as get more efficiency power supply.
Testing

In the testing, we use a DC power supply to generate 12-24V input powers. The output voltage can be measured with HP 34401A MULTMETER. The result is shown as follows:

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>12V</td>
<td>5.1789V</td>
</tr>
<tr>
<td>13V</td>
<td>5.1817V</td>
</tr>
<tr>
<td>14V</td>
<td>5.1849V</td>
</tr>
<tr>
<td>15V</td>
<td>5.1882V</td>
</tr>
<tr>
<td>16V</td>
<td>5.1920V</td>
</tr>
<tr>
<td>17V</td>
<td>5.1956V</td>
</tr>
<tr>
<td>18V</td>
<td>5.1998V</td>
</tr>
<tr>
<td>19V</td>
<td>5.2044V</td>
</tr>
<tr>
<td>20V</td>
<td>5.2082V</td>
</tr>
<tr>
<td>21V</td>
<td>5.2126V</td>
</tr>
<tr>
<td>22V</td>
<td>5.2159V</td>
</tr>
<tr>
<td>23V</td>
<td>5.2172V</td>
</tr>
<tr>
<td>24V</td>
<td>5.2174V</td>
</tr>
</tbody>
</table>
Concusion:

The converter can get a constant 5V DC output. The USB Reciver and Stellaris® LM4F120 LaunchPad can be powered by the converter. Both devices are working properly.
References:
http://en.wikipedia.org/wiki/Buck_converter
http://www.ti.com/tool/ek-lm4f120xl
Note from ECE 821