Introduction

This application note will provide the steps necessary to operate and evaluate ROHM’s synchronous buck DC/DC converter using the BD70522GUL evaluation board. Component selection and operating procedures are included.

Description

The BD70522GUL converter is a power supply solution designed for battery powered devices. 180nA quiescent current and ULP (Ultra Low Power) mode enable excellent light load efficiency at 10µA load, extending battery life, while output currents up to 500mA are supported. Users can select from among 9 preset output voltages via the VSEL pin. And when the input voltage gets close to the output voltage, the IC enters 100% ON mode that stops switching operation.

Applications

- Smoke detectors
- Thermostats
- Portable devices
- Wearables
- Low-Iq sets without standby switcher
- Energy harvesting

Features

Nano Energy™
- Up to 90% efficiency at 10µA output current
- 9 selectable output voltages (1.2V, 1.5V, 1.8V, 2.0V, 2.5V, 2.8V, 3.0V, 3.2V, 3.3V)
- Power Good output
- 100% ON Mode for low input voltage
- Discharge function on VOUT.

Key Specifications

- Input voltage range: 2.5 to 5.5V
- Output voltage range: 1.2 to 3.3V
- Maximum output current: 500mA
- Operation quiescent current: 180nA
- Standby current: 50nA
- VCSP50L1C package

Evaluation Board Operating Limits and Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Limit</th>
<th>Unit</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>MIN</td>
<td>TYP</td>
<td>MAX</td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>VSYS</td>
<td>2.5</td>
<td>-</td>
<td>5.5</td>
</tr>
<tr>
<td>Output Current</td>
<td>Iout</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
</tr>
<tr>
<td>PG Sink Current</td>
<td>Ipg</td>
<td>-</td>
<td>-</td>
<td>10</td>
</tr>
</tbody>
</table>
Evaluation Board

Figure 1: BD70522GUL Evaluation Board

Board Schematic

Figure 2: BD70522GUL Evaluation Board Schematic
Output Voltage Settings
Below is a table of output voltages selectable using the VSEL1 and VSEL2 pins.

<table>
<thead>
<tr>
<th>VSET</th>
<th>VSEL1</th>
<th>VSEL2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2V</td>
<td>GND</td>
<td>OPEN</td>
</tr>
<tr>
<td>1.5V</td>
<td>OPEN</td>
<td>GND</td>
</tr>
<tr>
<td>1.8V</td>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>2.0V</td>
<td>VIN</td>
<td>GND</td>
</tr>
<tr>
<td>2.5V</td>
<td>OPEN</td>
<td>VIN</td>
</tr>
<tr>
<td>2.8V</td>
<td>VIN</td>
<td>OPEN</td>
</tr>
<tr>
<td>3.0V</td>
<td>OPEN</td>
<td>OPEN</td>
</tr>
<tr>
<td>3.2V</td>
<td>GND</td>
<td>VIN</td>
</tr>
<tr>
<td>3.3V</td>
<td>VIN</td>
<td>VIN</td>
</tr>
</tbody>
</table>

Table 1: Output Voltage Settings

<table>
<thead>
<tr>
<th>EN Pin</th>
<th>BD70522GUL Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Enable</td>
</tr>
<tr>
<td>GND</td>
<td>Shutdown</td>
</tr>
</tbody>
</table>

Table 2: EN Pin Settings

Evaluation Board BOM
Below is a table showing the Bill of Materials. Part numbers and suppliers are included.

<table>
<thead>
<tr>
<th>Reference</th>
<th>Part Number</th>
<th>Manufacturer</th>
<th>Description [Unit: inch]</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>BD70522GUL</td>
<td>ROHM</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>C2</td>
<td>JMK107BBJ226MA</td>
<td>TAIYO YUDEN</td>
<td>22uF, 10V, X5R, 0603</td>
<td>1</td>
</tr>
<tr>
<td>C3,C4,C5</td>
<td>JMK107BBJ226MA</td>
<td>TAIYO YUDEN</td>
<td>22uF, 10V, X5R, 0603</td>
<td>3</td>
</tr>
<tr>
<td>C1</td>
<td>EMK212ABJ106KD-T</td>
<td>TAIYO YUDEN</td>
<td>10uF, 16V, X5R, 0805</td>
<td>1</td>
</tr>
<tr>
<td>L1</td>
<td>MAMK2520H2R2M</td>
<td>TAIYO YUDEN</td>
<td>2.2uH, 2.8A, 2520</td>
<td>1</td>
</tr>
<tr>
<td>R1</td>
<td>PMR03EZPJ000</td>
<td>ROHM</td>
<td>0, 0603</td>
<td>1</td>
</tr>
<tr>
<td>R2</td>
<td>MCR01MRTF1002</td>
<td>ROHM</td>
<td>10k, 0402</td>
<td>1</td>
</tr>
<tr>
<td>J1,J2,J3, SW1</td>
<td>61300311121</td>
<td>Wurth Electronics</td>
<td>2.54mm, 3pin, straight</td>
<td>4</td>
</tr>
<tr>
<td>SW1</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VSYS, VO</td>
<td>5000</td>
<td>Keystone Electronics</td>
<td>Red Test Point</td>
<td>2</td>
</tr>
<tr>
<td>GND1,GND3</td>
<td>5001</td>
<td>Keystone Electronics</td>
<td>Black Test Point</td>
<td>2</td>
</tr>
<tr>
<td>EN,GND2,GND4,PG,VSEL1,VSEL2</td>
<td>N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Bill of Materials

Board Operating Procedure
1. Set the output voltage using the jumper settings at J1 and J2. (refer to Table 1)
2. Disable the IC by setting the SW1 jumper to the upper position (EN → GND).
3. Connect the power supply’s GND terminal to the GND1 or GND3 test point on the evaluation board.
4. Connect the power supply’s VCC terminal to the Vsys test point on the evaluation board. This will provide VIN to the IC. Please note that VIN should be in the range of 2.5V to 5.5V.
5. Connect the electronic load to GND1 or GND3 and VO. Connect the voltmeter to GND1 or GND3 and VO.
6. Turn on the power supply and enable the IC by setting the jumper at SW1 to the lower position (EN → VSYS). The output voltage can be measured at test point VO. Now turn on the load. The load can be increased up to 0.5A (max.).
Reference Application Data
The following are graphs of the hot plugging test, efficiency, switching frequency, load response, output voltage, ripple, startup and shutdown.

Typical Performance Curves  (Unless otherwise indicated, L=2.2uH, Cout=22μF×1, Ta=25°C)

Figure 3. Efficiency vs Output Current  
(VOUT=1.2V)

Figure 4. Efficiency vs Output Current  
(VOUT=1.8V)

Figure 5. Efficiency vs Output Current 
(VOUT=2.5V)

Figure 6. Efficiency vs Output Current  
(VOUT=3.3V)
Typical Performance Curves (continued)

Figure 7. Switching Frequency vs Output Current
\(V_{\text{OUT}} = 1.2\text{V}\)

Figure 8. Switching Frequency vs Output Current
\(V_{\text{OUT}} = 1.8\text{V}\)

Figure 9. Switching Frequency vs Output Current
\(V_{\text{OUT}} = 2.5\text{V}\)

Figure 10. Switching Frequency vs Output Current
\(V_{\text{OUT}} = 3.3\text{V}\)
Typical Performance Curves (continued)

**Figure 11. Load Transient Response**

(V$_\text{IN}$=3.6V, V$_\text{OUT}$=1.2V, I$_\text{OUT}$=1μA⇔500mA, t$_{r}$=t$_{f}$=1μs)

Droop=113.9mV
Overshoot=65.1mV

**Figure 12. Load Transient Response**

(V$_\text{IN}$=3.6V, V$_\text{OUT}$=1.8V, I$_\text{OUT}$=1μA⇔500mA, t$_{r}$=t$_{f}$=1μs)

Droop=137.5mV
Overshoot=66.9mV

**Figure 13. Load Transient Response**

(V$_\text{IN}$=3.6V, V$_\text{OUT}$=2.5V, I$_\text{OUT}$=1μA⇔500mA, t$_{r}$=t$_{f}$=1μs)

Droop=174.9mV
Overshoot=85.6mV

**Figure 14. Load Transient Response**

(V$_\text{IN}$=3.6V, V$_\text{OUT}$=3.3V, I$_\text{OUT}$=1μA⇔500mA, t$_{r}$=t$_{f}$=1μs)

Droop=260.2mV
Overshoot=88.1mV
Typical Performance Curves (continued)

Figure 15. Output Voltage vs Output Current (Load Regulation, $V_{OUT}$=1.2V)

Figure 16. Output Voltage vs Output Current (Load Regulation, $V_{OUT}$=1.8V)

Figure 17. Output Voltage vs Output Current (Load Regulation, $V_{OUT}$=2.5V)

Figure 18. Output Voltage vs Output Current (Load Regulation, $V_{OUT}$=3.3V)
Typical Performance Curves (continued)

Figure 19. Output Ripple Voltage vs Output Current (Peak to Peak Output Ripple Voltage, $V_{OUT}$=1.2V)

Figure 20. Output Ripple Voltage vs Output Current (Peak to Peak Output Ripple Voltage, $V_{OUT}$=1.8V)

Figure 21. Output Ripple Voltage vs Output Current (Peak to Peak Output Ripple Voltage, $V_{OUT}$=2.5V)

Figure 22. Output Ripple Voltage vs Output Current (Peak to Peak Output Ripple Voltage, $V_{OUT}$=3.3V)
Typical Performance Curves (continued)

Figure 23. Startup
(V_{IN}=3.6V, V_{OUT}=2.5V, I_{OUT}=0mA, EN=0→V_{IN})

Figure 24. Startup
(V_{IN}=3.6V, V_{OUT}=2.5V, I_{OUT}=500mA, EN=0→V_{IN})

Figure 25. Shutdown
(V_{IN}=3.6V, V_{OUT}=2.5V, I_{OUT}=0mA, EN=V_{IN}→0)

Figure 26. Shutdown
(V_{IN}=3.6V, V_{OUT}=2.5V, I_{OUT}=500mA, EN=V_{IN}→0)
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