Powering the TMS320C6745 and TMS320C6747 with the TPS650061

Daniel Acevedo

ABSTRACT

This document details the design considerations of a low-cost power solution for the TMS320C6745 and TMS320C6747 (C6745/47) low-power application processors with a TPS650061, three-rail Power Management Unit (PMU) also known as a Power Management IC (PMIC).

Portable application solution size demands a high level of integration and the C6745/47 require at least three different voltage rails with specific sequencing and reset requirements. The TPS6500061 is a highly integrated low-cost power solution that can provide the 1.2 V, 1.8 V and 3.3 V rails and RESET signal required by the C6745/47. The TPS650061 has a single step-down converter, two low dropout regulators and a voltage supervisor.

Included in this document is a power solution for the C6745/47. Power requirements, illustrated schematic, operation waveforms and bill of materials are included.

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1 Power Requirements

The C6745/47 power requirements are listed in Table 1.

Table 1. C6745/47 Power Requirements

<table>
<thead>
<tr>
<th>Rail Name</th>
<th>Voltage (V)</th>
<th>Imax (mA)</th>
<th>Tolerance</th>
<th>Power-On</th>
<th>Power-Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTC.CVDD, CVDD, PLL0_VDDA, RVDD</td>
<td>1.2</td>
<td>660</td>
<td>±5%</td>
<td>1st</td>
<td>2nd</td>
</tr>
<tr>
<td>USB0_VDDA18, USB1_VDDA18</td>
<td>1.8</td>
<td>50</td>
<td>±5%</td>
<td>2nd</td>
<td>2nd</td>
</tr>
<tr>
<td>DVDD, USB0_VDDA33, USB1_VDDA33</td>
<td>3.3</td>
<td>115</td>
<td>±5%</td>
<td>3rd</td>
<td>1st</td>
</tr>
</tbody>
</table>

The TPS650061 meets these power requirements with its single step-down converter, two low dropout regulators and voltage supervisor.

1.1 Power-On Sequence

To meet the C6745/47 power-on requirements, the 1.2V rail must power on first, then both the 1.8V rail and the 3.3V. After all 3 rails are powered on, RESET may be released.

The power-on sequence is described in the following text from the DM335/355 datasheet.

Per the excerpt from the C6745/47 datasheet, the device should be powered-on in the following order:
1. Power on 1.2 V: RTC.CVDD, CVDD, PLL0_VDDA, RVDD
2. Power on 1.8 V: USB0_VDDA18, USB1_VDDA18
3. Power on 3.3 V: DVDD, USB0_VDDA33, USB1_VDDA33

You may power-on the 1.8 V and 3.3 V power supplies in either order but the 3.3V must be powered on after 1.2 V rail.

1.2 Power-Off Sequence

The C6745/47 power-down requirements state that the power supplies can be powered-off in any order as long as the 3.3V supplies do not remain powered with the other supplies unpowered.

1.3 Power Solution

To best achieve this power up/down sequence and minimize cost, two 2N222 transistors are used in conjunction with the TPS650061.

- The enable for the 1.2 V supply (EN_DCDC) is connected to VIN.
- The output, VODC, is connected to the base of an NPN transistor, Q1. The collector of Q1 has a 100 kΩ pull-up to VIN; the emitter is connected to ground.

---

Figure 1. TPS650061 and C6745/47 Simplified Block Diagram
• The collector of Q1 is also connected to the base of another NPN transistor, Q2. The collector of Q2 has a 47.5k pull-up to VIN; the emitter is connected to ground
• The collector of Q2 is also connected to the enable of the 1.8 V supply (EN_LDO2).
• The 1.8 V supply (VLDO2) is connected to the enable of the 3.3 V supply (EN_LDO1).
• When VIN is applied, it will turn on the 1.2 V supply (VODC) and Q2; keeping EN_VLDO2 tied to ground.
• VODC will then turn on Q1 which will turn-off Q2 and enable VLDO2 when EN_LDO2 gets pulled-up to VIN.
• VLDO2 will enable VLDO1.
• During power-off, the 3.3 V rail ramps down with VIN as VIN nears VOUT, then the 1.8 V rail, then the 1.2 V rail.
• A resistor divider connects RSTSNS to VLDO1, the MR pin is connected to VODC and the pin RST is pulled up to VLDO2. This will assert the RESET, to 1.8 V only when all three supplies are up.
• Additionally, to add deglitch time to the RESET, a capacitor (C5) can be added in parallel with the top resistor of the RTSNS divider.

The proper connections for the power-on/off sequence are shown in Figure 1.
2 Schematic, Waveforms, and Bill of Materials

2.1 Schematic

This is the schematic of the power solution for the C6745/47.

Figure 2. TPS650061 Schematic Diagram
2.2 Waveforms

The following waveforms demonstrate the startup and power down sequence of the TPS650061 as required by the C6745/47. Figure 3, shows the TPS650061 power on sequence of 1.2 V then 1.8 V and 3.3 V. Figure 4 shows the reset pin, RST, being released after the voltage on RSTSNS rises above the threshold and after the reset recovery time, \( t_{\text{RST}} \), is exceeded. Figure 5 shows the power down sequence, 3.3 V and 1.8 V then the 1.2 V supply. For the following tests, the 1.2 V supply had a 200mA load, the 1.8 V supply had a 95 mA load and the 3.3 V supply had a 30mA load.

Figure 3. TPS650061 Power-Up, Ch. 1 - VIN, Ch. 2 - 1.2V Rail, Ch. 3 - 1.8V Rail, Ch. 4 - 3.3V Rail

Figure 4. TPS650061 Power-Up and RESET, Ch. 1 - RESET, Ch. 2 - 1.2V Rail, Ch. 3 - 1.8V Rail, Ch. 4 - 3.3V Rail

Figure 5. TPS650061 Power-Off Sequence, Ch. 1 - RESET, Ch. 2 - 1.2V Rail, Ch. 3 - 1.8V Rail, Ch. 4 - 3.3V Rail
Conclusion

2.3 Bill of Materials

The bill of materials is displayed in Table 2.

Table 2. Bill of Materials

<table>
<thead>
<tr>
<th>Count</th>
<th>RefDes</th>
<th>Value</th>
<th>Description</th>
<th>Size</th>
<th>Part Number</th>
<th>MFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>C1, C6, C8, C9</td>
<td>10uF</td>
<td>Capacitor, Ceramic, 10V, X5R, 10%, 0805</td>
<td>Std</td>
<td>Std</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>C2, C3</td>
<td>2.2uF</td>
<td>Capacitor, Ceramic, 10V, X5R, 10%</td>
<td>0603</td>
<td>Std</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>C4</td>
<td>0.1uF</td>
<td>Capacitor, Ceramic, 16V, X7R, 10%</td>
<td>0603</td>
<td>Std</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>C7</td>
<td>22pF</td>
<td>Capacitor, Ceramic, 50V, C0G, 5%</td>
<td>0603</td>
<td>Std</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>L1</td>
<td>2.2uH</td>
<td>Inductor, SMT, 2.0A, 110milliohm</td>
<td>0.118 x 0.118 inch</td>
<td>LPS3015-222ML</td>
<td>Coilcraft</td>
</tr>
<tr>
<td>2</td>
<td>Q1, Q2</td>
<td>2N2222</td>
<td>Transistor, NPN, 40V</td>
<td>SOT-23</td>
<td>2N2222</td>
<td>Std</td>
</tr>
<tr>
<td>2</td>
<td>R2, R9</td>
<td>47.5k</td>
<td>Resistor, Chip, 1/16W, 1%</td>
<td>0603</td>
<td>Std</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>R3</td>
<td>976k</td>
<td>Resistor, Chip, 1/16W, 1%</td>
<td>0603</td>
<td>Std</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>R5, R7</td>
<td>475k</td>
<td>Resistor, Chip, 1/16W, 1%</td>
<td>0603</td>
<td>Std</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>R4</td>
<td>232K</td>
<td>Resistor, Chip, 1/16W, 1%</td>
<td>0603</td>
<td>Std</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>R6</td>
<td>402k</td>
<td>Resistor, Chip, 1/16W, 1%</td>
<td>0603</td>
<td>Std</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>R8</td>
<td>100k</td>
<td>Resistor, Chip, 1/16W, 1%</td>
<td>0603</td>
<td>Std</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>U1</td>
<td>TPS650061RUJK</td>
<td>IC, 2.25 MHz Step Down Converter with Dual LDOs and SVS</td>
<td>QFN</td>
<td>TPS650061RUJK</td>
<td>TI</td>
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</table>

3 Conclusion

The TPS650061 provides a low cost, comprehensive power solution for the C6745/47. A 1.2 V rail (capable of supplying 1 A) is powered on followed by a 1.8 V rail (300 mA) then a 3.3 V rail (300 mA). Once all three supplies have reached regulation, RESET goes high (i.e. rises to its pull-up voltage). For power-down, the 3.3 V turns then the 1.8 V then the 1.2 V rail. This meets the power requirements of the C6745/47.

4 References

1. TPS650061 Datasheet (SLVS810B)
2. TMS320C6745, TMS320C6747 Datasheet (SPRS377D)
3. 5Vin DM355 Power using LDO’s (SLVR331B)
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