



OMAP35x Torpedo SOM Power Management

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Abstract

This application note provides a high-level explanation of power management schemes available on the OMAP35x Torpedo SOM.

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Table of Contents

1	Introduction	1
2	OMAP35x Torpedo SOM Power	1
2.1	Powering On the SOM	1
3	Recommended Power Management Paths	1
3.1	Lithium-ion Battery Powered	1
3.2	No Battery Power	2
4	Charging a Battery using the TPS65950	2
4.1	Usage Scenarios	2
4.1.1	Usage: Max current at typical room temperature	3
4.1.2	Usage: Max current at typical room temperature with heat-save	3
4.1.3	Usage: Max current at temperatures below 40°C with heat-save and 5V input	3
4.1.4	Usage: Max current at room temperature and USB charging	3
4.1.5	Usage: Max temperature with safe current	3
4.1.6	Usage: Max temperature with safe current and with heat-save	3
4.2	Key Battery Charging Registers	3
5	External Battery Charging	4
6	Reference Voltages	4
7	Power Supplies	5
7.1	VAUX4	5
7.2	Sample Script to Enable VAUX4	5
8	Summary	5
Appendix A: Sample Scripts		6

1 Introduction

This document summarizes how power management is handled on the OMAP35x Torpedo SOM and offers different approaches for implementing power management schemes in custom applications.

2 OMAP35x Torpedo SOM Power

The OMAP35x Torpedo SOM can be powered by several different sources since the power rails on the SOM have been divided to allow for flexibility. The table below lists the different power sources and a brief description of each.

Power Source	Description
MAIN_BATTERY	External power source input. This signal should be driven directly by a single-cell lithium-ion battery or a fixed 3.3V regulated power source.
5V	Charging device power input. Used by power management controller to charge external MAIN_BATTERY supply.
BACKUP_BATT	External input that supplies power to the onboard power management controller and real time clock (RTC) interface. This signal should be powered by a coin-cell type battery or an always-on power source.
USB1_VBUS	May be used to charge the battery. NOTE: Current limited by USB specification.

2.1 Powering On the SOM

The OMAP35x Torpedo SOM will power on when MAIN_BATTERY is supplied to the SOM; all other signals may remain in their default state. The SOM will also power on if 5V is supplied (without MAIN_BATTERY); however, this is not a supported operating mode. Supplying USB1_VBUS to the SOM will not power on the SOM.

The PWRON signal may be used to power on/off the SOM only after MAIN_BATTERY has been supplied to the SOM and software must set up the signal before it becomes a valid power switch. MAIN_BATTERY must be supplied to the SOM at all times when using the PWRON signal to power on/off the SOM. For more information please see the Texas Instruments (TI) [TPS65950 OMAP Power Management and System Companion Device ES 1.0 Technical Reference Manual \(TRM\)](http://focus.ti.com/docs/prod/folders/print/tps65950.html#technicaldocuments).¹

3 Recommended Power Management Paths

3.1 Lithium-ion Battery Powered

If a lithium-ion battery is used, the input power supplies should be connected as follows:

Power Source	Connections for Power through Lithium-ion Battery
MAIN_BATTERY	Connect to the lithium-ion battery. Recommend connecting a minimum 80uF capacitor to this rail on the baseboard.
5V	Can be connected to a DC voltage source to charge the MAIN_BATTERY. If connected, this signal will be used as a charging source in this context. If the TPS65950 is not going to be used as the charging source of the battery, this input should be connected to GND.
BACKUP_BATT	Connect to a coin-cell type battery or an always-on power source if desired. If not used, connect to GND.
USB1_VBUS	Can be connected to a USB host to charge the MAIN_BATTERY. Software is required to enable charging. NOTE: USB charging current is limited by the USB specification.

¹ <http://focus.ti.com/docs/prod/folders/print/tps65950.html#technicaldocuments>

3.2 No Battery Power

To power the SOM without using a battery, the input power supplies should be connected as follows:

Power Source	Connections for Power through MAIN_BATTERY
MAIN_BATTERY	Connect to a fixed 3.3V regulated power source. Recommend connecting a minimum 80uF capacitor to this rail on the baseboard.
5V	Connect to GND.
BACKUP_BATT	Connect to a coin-cell type battery or an always-on power source if desired. If not used, connect to GND.
USB1_VBUS	Should only be used as an output power source. USB1_VBUS will try to charge MAIN_BATTERY if software enables charging, which may damage the PMIC or MAIN_BATTERY circuitry.

4 Charging a Battery using the TPS65950

The OMAP35x Torpedo SOM was designed to optimize space and cost constraints; that level of optimization required necessary tradeoffs that may impact battery charging. Please adhere to the following guidelines when designing an application that utilizes battery charging; also, please note that some applications may require an external charger.

The OMAP35x Torpedo SOM is designed to support DC current-limited chargers on the 5V rail and to support USB charging on USB1_VBUS. The 5V input to the SOM can support input voltages from 4.6V-7.0V. Because the input voltage directly relates to the power loss in the Power MOSFET ($P = IV$), the lower the input voltage the higher the amount of current that can go through the FET. The minimum voltage that the charger can handle is defined as:

- $V_{BATMAX} + 2 \text{ PMOS drop} + 0.22 \text{ Ohm resistor drop}$ (where V_{BATMAX} is the maximum voltage value of the battery; that is, 4.2V for Li-ion battery)

For a Li-ion battery, the input can go down to about 4.6V given the circuitry of the OMAP35x Torpedo SOM. Using a 4.6V input to the 5V charging power rail of the SOM will help improve the amount of charge current that can be delivered to the battery.

The current that flows through the charging circuitry is shared between the system and the battery, so the more current that is used by the system, the less current remains for battery charging. Because of this, it is recommended to charge the battery with the processor in a low power or sleep state. Additional charging current will also go to the battery if the baseboard components are powered directly by the DC charger when it is inserted.

The following examples provide scenarios for using battery charging on the OMAP35x Torpedo SOM. There may be more options than what are listed below. If your application does not fit any of these guidelines, please [contact Logic PD](#)² for help evaluating your charging needs.

4.1 Usage Scenarios

Note: All of the temperatures listed below are ambient temperatures. Enclosing the OMAP35x Torpedo SOM in a case will require special attention to airflow and heat dissipation.

² <http://support.logicpd.com/TechnicalSupport/AskAQuestion.aspx>

4.1.1 Usage: Max current at typical room temperature

Setup: 4.6V input to 5V power rail of the SOM; Li-ion battery operating from 3.2V (start of main charge) to 4.2V (end of charge)

When using the OMAP35x Torpedo SOM at typical room temperatures (below 30°C), it is recommended to limit the total current through the SOM to 0.6A. This will provide safe operating conditions for all ICs in the power path.

4.1.2 Usage: Max current at typical room temperature with heat-save

Setup: 4.6V input to 5V power rail of the SOM; Li-ion battery operating from 3.2V (start of main charge) to 4.2V (end of charge)

When using the heat-save feature of the TPS65950 at typical room temperatures (below 30°C), the starting current threshold should be set to 0.541A. The heat-save voltage threshold can be set to 3.95V and the charging current can be set to 1.2A when above that voltage.

4.1.3 Usage: Max current at temperatures below 40°C with heat-save and 5V input

Setup: 5.0V input to 5V power rail of the SOM; Li-ion battery operating from 3.2V (start of main charge) to 4.2V (end of charge)

When using the heat-save feature of the TPS65950 at temperatures below 40°C, the starting current threshold should be set to 0.42A. The heat-save voltage threshold can be set to 4.0V and the charging current can be set to 0.75A when above that voltage.

4.1.4 Usage: Max current at room temperature and USB charging

Setup: 5.0V input to USB1_VBUS power rail of the SOM; Li-ion battery operating from 3.2V (start of main charge) to 4.2V (end of charge)

When using the OMAP35x Torpedo SOM at typical room temperatures (below 30°C), it is recommended to limit the total current through the SOM to 0.45A. This will provide safe operating conditions for all ICs in the power path.

4.1.5 Usage: Max temperature with safe current

Setup: 4.6V input to 5V power rail of the SOM; Li-ion battery operating from 3.2V (start of main charge) to 4.2V (end of charge)

To operate the OMAP35x Torpedo SOM at temperatures up to 60°C, the charge current should be set to 0.44A.

4.1.6 Usage: Max temperature with safe current and with heat-save

Setup: 4.6V input to 5V power rail of the SOM; Li-ion battery operating from 3.2V (start of main charge) to 4.2V (end of charge)

When using the heat-save feature of the TPS65950 at temperatures up to 60°C, the starting current threshold should be set to 0.42A. The heat-save voltage threshold can be set to 4.0V and the charging current can be set to 1.0A when above that voltage.

4.2 Key Battery Charging Registers

This section provides some key registers that must be configured for battery charging to work correctly; it is not meant to provide all necessary information to properly charge a battery.

For additional information, please refer to the “Battery Charger Interface and Backup Battery” chapter of TI’s *TPS65950 OMAP Power Management and System Companion Device ES 1.0 TRM*.

Register	Description
GPBR1(MADC_HFCLK_EN & DEFAULT_MADC_CLK_EN)	Both MADC_HFCLK_EN and DEFAULT_MADC_CLK_EN should be set to “1” after power on. Turning these bits on will enable the ADC to work properly, which is necessary for the TPS65950 to monitor the battery voltage. If these bits are not set, battery charging will not start. This should be one of the first tasks the boot code performs.
BCIMFTH1(VBATOV1TH)	VBATOV1TH sets the voltage threshold when the battery charger changes modes from pre-charge to main charge. On a fully depleted battery (voltage less than 3.2V) the charger will enter pre-charge mode until the battery voltage reaches 3.2V. Once at 3.2V, the charger turns off while the system boots. If the battery drops below VBATOV1TH during the time from when the boot starts until the GPBR1 register (above) is set, the charger will return to pre-charge mode and limit the charging current to only 100mA. Changing VBATOV1TH to a lower value can help with this situation. This should also be one of the first tasks the boot code performs. The VBATOV1TH setting is dependent upon the battery used in the system and should be verified on individual designs.
BCIREF1 & BCIREF2	BCIREF1 and BCIREF2 set the main charging current. This is just one of many locations the charging current can be set. Please reference TI’s <i>TPS65950 TRM</i> for alternate methods.
BCIMFTH9(HSVOLTTH)	HSVOLTTH defines the heat-save voltage threshold. Please refer to the “Heat-Save Detection” section of TI’s <i>TPS65950 TRM</i> for information on enabling heat-save.
BCIMFTH9(HSCURTH)	HSCURTH defines the heat-save current threshold. Please refer to the “Heat-Save Detection” section of TI’s <i>TPS65950 TRM</i> for information on enabling heat-save.

5 External Battery Charging

If the TPS65950 does not provide an adequate solution for your battery charging requirements, TI features other power management devices that can be incorporated in a baseboard design to provide battery charging external to the OMAP35x Torpedo SOM.

The BQ24074 USB-friendly Li-Ion battery charger and power-path management IC is one such device. Refer to the datasheet on TI’s [BQ24074 product page](#)³ for additional information.

6 Reference Voltages

A couple voltages are available on the high-density connectors for use as reference voltages. While the intent of these voltages is strictly as a reference level, some of the supplies may be connected on custom baseboards to supply low-current devices. In the table below, the recommended maximum current is stated for each reference voltage.

IMPORTANT NOTE: These values are only suggestions. Please verify supply voltage current limits of the TPS65950 in custom designs.

Reference Voltage	Usage
VIO_1V8	Used to power most peripherals on the SOM. Can supply up to 200mA of power, but it is recommended to use an external supply.
VMMC1	Can supply up to 200mA off-board.

³ <http://focus.ti.com/docs/prod/folders/print/bq24074.html>

7 Power Supplies

7.1 VAUX4

VAUX4 is disabled by default on the TPS65950. If using one of the camera GPI signals, this supply must be turned on by software. There are two key registers for setting and enabling the VAUX4 voltage. Details can be found in TI's *TPS65950 OMAP Power Management and System Companion Device ES 1.0 TRM*.

Register	Description
VAUX4_DEDICATED	This register controls the voltage for VAUX4, and must be configured first.
VAUX4_DEV_GRP	This register controls when VAUX4 is enabled, and must be configured second.

NOTE: The voltage range for this power supply is 1.71V to 1.89V. Operation outside this range is not recommended.

7.2 Sample Script to Enable VAUX4

A sample LogicLoader script for enabling VAUX4 is provided below. Please see Appendix A at the end of this document for the I2C losh script referenced below.

```

losh> add=0x4b  #0x4b is the address inside the TPS65950 for the
                PM_RECEIVER module.
losh> reg=0x81  #0x81 is the VAUX4_DEDICATED register
losh> dat=0x05  #Set voltage to 1.8V
losh> source i2cwrite.losh
losh> reg=0x7e  #0x7e is the VAUX_DEV_GRP register
losh> dat=0xe0  #Set VAUX4 to all device groups. Causes VAUX4 to turn on
losh> source i2cwrite.losh

```

8 Summary

There are several different powering options for the OMAP35x Torpedo SOM using either a DC supply or battery. This document has provided a high-level perspective of the different power supplies available for custom applications.

Appendix A: Sample Scripts

The following is the I2C Write Script referenced in Section 7 above.

```
#TPS95650 is attached to I2C1
#I2C1 base address is 0x48070000
#Bitrate is 2.6 MHz
#High speed mode

# Write to an I2C register

# $add is source I2C address
# $reg is the internal register address
# $dat = Data to write

w /h 0x48070014 0x0047 #I2C_BUF      Clear the TXFIFO
w /h 0x4807002c $add #I2C_SA      Write the slave address $add
w /h 0x48070018 0x0002 #I2C_CNT      Length of 2 = one byte address, one
byte data
#Don't wait for busy bits to go away
w /h 0x48070024 0x9601 #I2C_CON      Enable port, High Speed, Master,
TRX, STT
sleep 5 # Wait on I2C_SYS reset done
x /h 0x48070010 #I2C_SYSS See 0x0001 here
x /h 0x48070024 #I2C_CON See 0x9600 here
w /h 0x48070024 0x9602 #I2C_CON      Enable port, High speed, Master,
TRX, STP
x /h 0x48070008 #I2C_STAT See bit 14 or bit 4 set here, 0x5500
is Ok
# Blat the transmit bytes, don't worry
about FIFO space
w /b 0x4807001c $reg #I2C_DATA $reg = I2C register to write
w /b 0x4807001c $dat #I2C_DATA $dat = data to write
sleep 5 #Pause after transmission
w /h 0x48070008 0x5110 #I2C_STAT Clear XDR, BB, BF and XRDY bits
w /h 0x48070024 0x0000 #I2C_CON Disable I2C port
sleep 5 #Pause between transmissions

exit #End of script
```