Abstract:
The purpose of this application note is to aid the user in the implementation of an external power supply using a Stellaris LaunchPad. The current user manual for the Stellaris only includes two ways of powering the board, which require the use of a PC and the two micro-USB ports located in the upper left hand corner. In order to make the device mobile an external power supply can be used and the contents of this application note provides an alternative to the powering mechanisms as well as detailed steps of the development. This note also includes relevant schematics and figures to provide the user with visual references to the mentioned components to minimize misinterpretation.

Keywords: Microcontrollers, +VBUS, micro B-USB, USB 2.0 A, PCB, Stellaris, LaunchPad

Materials: Stellaris LM4F120 LaunchPad EVB, Digital Multimeter, 3.5-5V battery, two Banana to grabber wires or equivalent, 2 solder pins, solder, Low Wattage Soldering Iron, Wires (red and black preferably), Desoldering pump, Desoldering strips, Sharp edged tool.
Background

The use of a mobile (untethered) power supply with the Stellaris LaunchPad requires prior knowledge of basic soldering techniques, microcontrollers, BUS connections and circuits. The Stellaris board can be powered from the BUS connection at the bottom left hand corner of the board. This frees the micro B- ports to be used for other purposes. The power connection of the USB is depicted below. It requires a power connection at pin 5 to operate. To the right of the micro B USB are other types of USB connections. The Stellaris PCB has a BUS that is connected to each of the elements requiring some sort of power. Therefore, if you were to simply connect the Bus to power, you will power the board.

![Micro-B USB](image1)

Figure 1 Micro-USB: If you are to connect any USB to the ports make sure that it is a micro-B. The other micro connectors will not fit into the slot for the micro-B.

There are other types of USB connections (as seen on the right) that are standard for other kinds of devices. The Stellaris’s micro-USB ports can allow connections to the standard USB 2.0 A devices, as well as the others. This way you can connect devices that have other USB configurations to the Stellaris through a connector that converts one configuration to the next.

![Other types of USB connections](image2)

Figure 2: Other types of USB connections

The Launchpad expects anywhere between 4.75-5.25 VDC on VBUS. The system voltage is 3.3 VDC and the voltage regulator on the board has a very low dropout voltage, so powering the Launchpad with anything between 3.4-5.25 VDC should work well. If you are using a battery to power the board connect the header to the battery through a wired connection. To do this, follow the steps listed below. There are multiple ways to go about this. You can either solder standard solder pins to the VBUS header, and use a 2 pin connector to connect to your battery, or even simply solder wires directly to the empty header and connect the leads to the battery.
Below is an image of the Stellaris LaunchPad. Make sure that this is the LaunchPad in your possession. There is more than one model entitled LaunchPad. This specific one highlights the LM4F120H5QR microcontroller’s micro B-USB device interface as well as MSP430 Booster Packs to interface with peripherals.

Figure 3: Stellaris LM4F120 LaunchPad Evaluation Board

- +VBUS Connection is the red circle
- Micro B- USB Connections are the green circles.
- The blue rectangles represent the Booster pack.
Method 1: Soldering Standard pins for Battery Connection

- To connect the battery to the power BUS, take the solder pins and connect them to the empty VBUS header on the bottom left of the Stellaris.
- Solder the pins to the slots labeled GND and +VBUS. The ground slot might be indicated by the ground symbol.
- Next hook up the 2-pin connector to the battery.
- Connect the opposing end of the 2-pin connector to the solder pins connected at +VBUS and GND making sure to connect the red wire to the +VBUS header, and the black wire to the ground header. You should see the green LED located at the top of the PCB light up.

If you are using a battery with a voltage lower than ~5V you might run into other issues. If you probe the voltage on the 3.3V rail you should measure a stable voltage of 3.3V, because the voltage regulator is working properly. You can also notice that the regulator is functioning correctly due to the LED at D4 lighting up. However, the RGB LED located to the right of the board may not be lighting up.
Probing the LaunchPad

- Take a digital multimeter and connect two banana wires to the positive and negative terminals (red and black wires respectively).
- Locate the component labeled U4 in the upper portion of the LaunchPad.
- Take the red wire and touch the RESET, and the black wire and touch ground.
- If you measure a voltage less than 4.38 V the RESET is being pulled LOW. This will not allow the micro controlling the RGB LED to run code.

Looking at the power management schematics of the Stellaris LaunchPad, found on the datasheet, this issue lies with the U4 reset functionality. A closer look into this circuit will enable us to fix the issue. The datasheet can be found at [http://www.ti.com/lit/ug/spmu289/spmu289.pdf](http://www.ti.com/lit/ug/spmu289/spmu289.pdf)
Below is a closer look at the U4 TLV803MDBZR voltage regulator.

It is a Texas Instruments IC, which operates as a 5V single voltage supervisor. Due to this configuration, if powering the LaunchPad with any source less than ~4.5 V the RESET is LOW and the micro will not run. However, if this were a 3.3V voltage regulator this issue would not occur. In order to power the board with a lesser voltage, we should disable or remove this particular component. Doing so will effect other operations, so be sure not to connect the USB ports to anything that supply power.

Connecting the ports to a source that provides power may not only damage the PCB, but may also damage the battery. Using a battery that has integrated circuit protection should be used to offset this effect, but the connection can also damge the USB port on the Stellaris LaunchPad. Never connect the PCB to the computer while the battery is plugged in.

TARGETRST (Target reset) and ICDI_RST (ICDI reset) should not be affected if we remove the U4 component. The 10K pull up resistor should set the two bits high, as to not alter other Stellaris functions.

Method 1: Desoldering the Voltage Supervisor from the PCB

- Removal of the U4 component which represents the TLV803 voltage regulator requires, desoldering. Select the component on the PCB. Place the tip of the soldering iron against the joint. Be careful not to touch the tip to the copper connections on the board.

- Hold the pump against of the joint. Depress the pump with the plunger or button and then turn the soldering iron on. As the solder melts, suck it up by releasing the plunger on the pump. Do not hold the iron against the joint too long; use it to remelt as needed.

- Remove the component from the board when it is loose enough. Do this by lifting it up with your fingers, but do not yank it. You may need to use a tiny screwdriver or probe to loosen the leads.

- Wipe excess solder away from the circuit board using a brush or probe.

Method 2: Cutting Trace

- Even simpler and no desoldering involved: Using a sharp edge, cut the tiny trace between U4 and D2. Reference Figure 6.

- You should now be able to power your PCB with any source between 3.4VDC and 5.25VDC.
This is how the final powered board should look. The RGB LED to the left of the Stellaris as well as the the green LED located near the top left of the board should be powered. These connections should allow your Stellaris to operate normally while powered by a battery. However, these modifications disallow low-voltage shutdown on the Stellaris. Removing the U4 voltage supervisor causes this. This requires the user to be very mindful of all connections made, as to not permanently damage the Stellaris LaunchPad Evaluation Board.

References