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Device: Infinity Solar Bank

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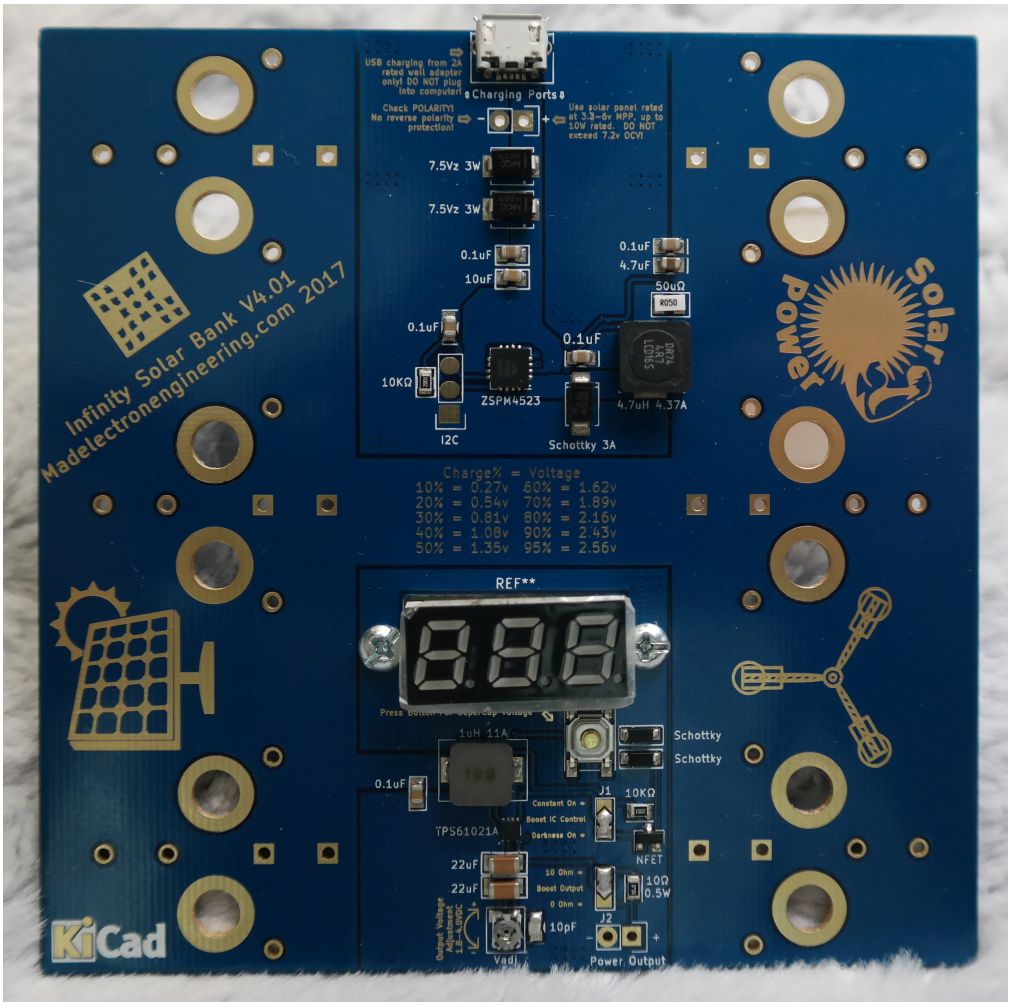
Description: Solar Supercapacitor Power Bank For LED’s And Microcontrollers



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Introduction

The Infinity Solar Bank is the culmination of years or research into solar, Supercapacitors, and energy efficiency with LED's and microcontrollers. The unit supports from 1 to 6 supercapacitors for energy storage. Charging can be done either by solar through the two through hole connections below the MicroUSB port, or can be charged by USB power when weather conditions inhibit solar charging.

Features

The Infinity Solar Bank has the following features:

- Supports 1-6 Supercapacitors conventionally, can be hacked to support 12 supercapacitors with a bit of ingenuity.
- Charging is controlled by IDT's ZSPM4523 Solar Supercapacitor MPPT Charger
- Boost Conversion is handled by Texas Instrument's TPS61021A.
- Output voltage adjustable from 2.5v to 4v.
- Optional 10Ω resistor for output LED current limiting via solder jumper.
- Boost converter can be enabled continuously or only on when darkness is detected via low charging voltage input(e.g. solar panel at night).
- Integrated voltmeter to measure current charge percentage of power bank.
- Adjustable charge termination voltage and charge current set either at the time of purchase or by the customer via a 3rd party USB to I2C adapter and Windows software provided by IDT.

Construction

The Infinity Solar Bank comes completely soldered and ready to use except for the solder jumpers. Simply add supercapacitors, a suitable solar panel and/or USB charger described in more detail later in this document.

Supercapacitor Selection

In selecting a suitable supercapacitor(s), please keep in mind it would be best to keep the total capacity below 3000 Farads. The maximum charge current from the ZSPM4523 charge IC is around 1.5-1.75A. Any higher then 3000 farads and you may not get a full charge on a normal sunny day and the extra capacity will be a waste of money in purchasing supercapacitors.

When purchasing supercapacitors, name brands such as Maxwell, Bussmann/ Eaton, Ioxus, etc… you will realize the best results and satisfaction with your purchase. The unit can fit supercapacitors as small as 100F radial leaded units, or snap-in supercapacitors up to 600F will also fit.

Each spot designated for a supercapacitor on the circuit board, can accommodate three different styles of mounting. It can support the screw in, 2 pin, and 4 pin mounting styles.

When purchasing supercapacitors from eBay or Aliexpress, buyer beware when purchasing 500F Samwha branded supercapacitors. Samwha has never manufactured a 500F variant in their lineup. They come in all 3 mounting varieties, and usually with a black plastic wrap with white printing on it.

They are more then likely 300-350F re-badged supercapacitors that failed Samwha's quality control, either for excessive leakage current or insufficient rated capacity. The best results I have obtained are with the 4 pin mounting option, while the screw top variety has consistently shown the worst amount of leakage current.

Solar Panel & USB Considerations

The ZSPM4523 accepts an input voltage from 3.2 to 7.2 volts. A 6 volt nominal solar panel with an open circuit voltage no higher then 7.5 volts and 1-10 watts rating would be ideal. Below 3.2 volts the IC will stop charging, and over 7.5 volts you will waste power in the two 3 watt Zener diodes located just below the MicroUSB port as an overvoltage protection.

For USB charging, a 2A rated adapter would be considered necessary if you have the charge current turned up to the maximum of 1.5A. Using a lower rated USB adapter will suffer from voltage drop and could end up halting charging. NEVER PLUG THIS UNIT INTO A COMPUTER, THERE IS NO CURRENT LIMITING PROVIDED AND COULD DAMAGE COMPUTER USB PORTS!!!

Voltmeter Operation

The voltmeter is triggered by a momentary switch just below it. It needs at least 3.3v for proper operation. When charging, the voltmeter will operate correctly. When not charging, the boost converter must be set to a minimum output voltage of 3.3v for correct operation. If powering a single white LED, the built-in 10Ω current limiting resistor may not allow you to have the boost converter set to the minimum required voltage of 3.3v for the voltmeter to operate correctly. In this case, you can bypass the built-in current limiting resistor and use a higher value resistor to allow you to raise the voltage output safely while protecting the LED from excessive current.

Heat Generation Cautions

The circuit board is designed to shed the heat generated by various components by utilizing thermal vias and large copper pours on the top and bottom of the board. When charging, the Zener diodes can get warm to the touch. There is also a 3A Schottky diode to the right of the ZSPM4523 IC that will warm up. When charging, the ZSPM4523 IC and its associated inductor will heat up to 120'F to 180'F. This is normal.

When the boost converter is active, currents lower then 200mA will keep the TPS61021A and associated inductor cool. Higher currents up to the maximum 1.5A will heat up the IC and inductor.

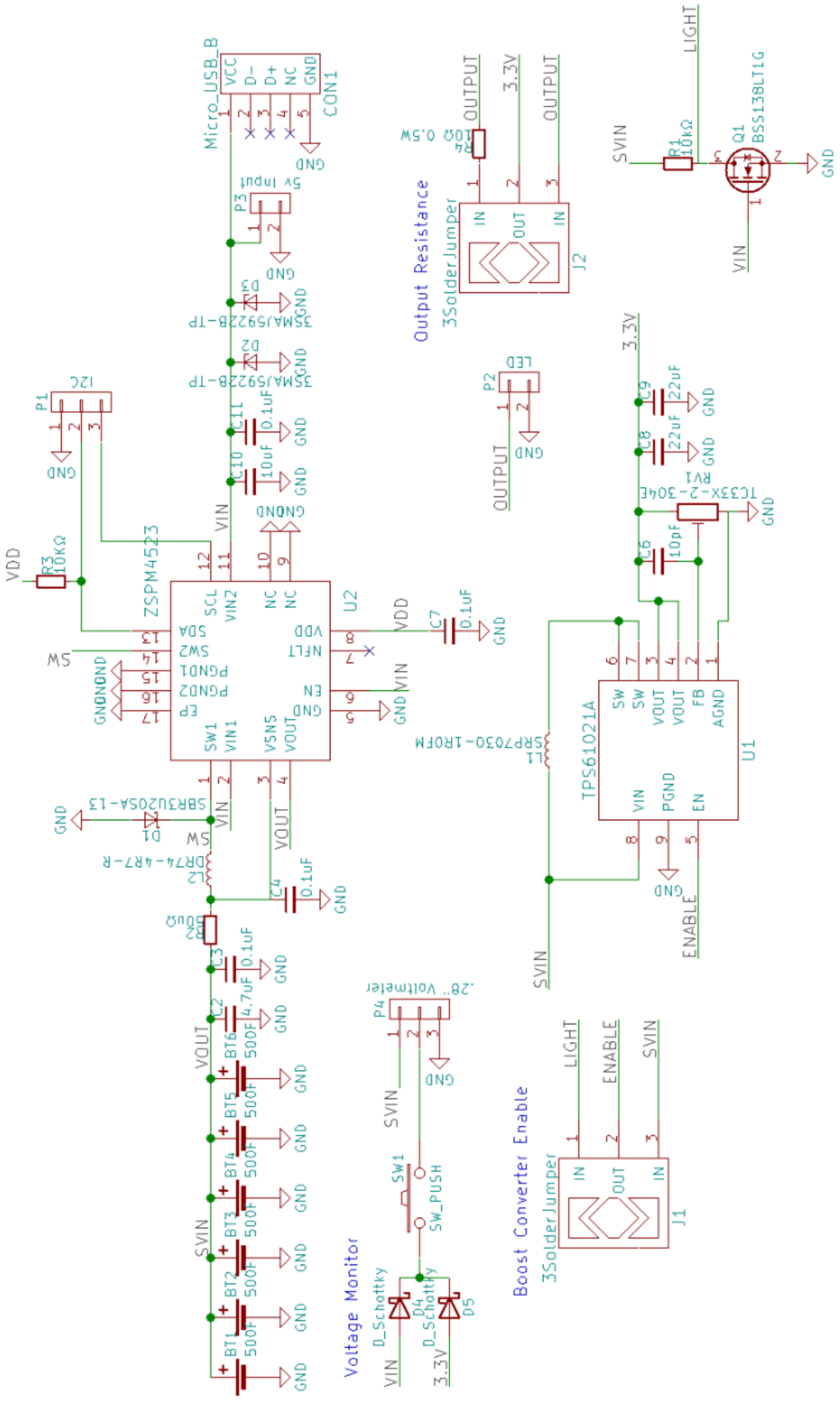
I2C Programming ZSPM4523

The ZSPM4523 can be reprogrammed via I2c and IDC's windows software. You can change the charge termination voltage and charging current. You will need a I2C to USB adapter. I have used the adapter supplied with the ZSPM4523 developer kit, although any I2C to USB adapter "should" work. Please refer to IDT's ZSPM4523 developer kit documentation for further information regarding reprogramming. The programming header is to the left of the IC on the circuit board. Ground is the bottom square, SDA is the middle connection, and the top connection is SDL.

Cautions & Warnings

- If using the through hole connections below the MicroUSB port for solar charging, make sure you have the polarity correct. The is no reverse polarity protection. If you reverse positive and negative, you will damage the charging circuitry.
- When charging through USB, use a 2A rated wall adapter. NEVER PLUG INTO A COMPUTER, YOU WILL DAMAGE THE COMPUTERS USB PORT!!!
- When installing or removing supercapacitors from the circuit board, make sure not the short the supercapacitors terminals. They can produce high currents in excess of 100A when fully charged.
- When changing the solder jumper for the boost converter operation from constant on to darkness on or vice versa, make sure the supercapacitor(s) are fully discharged otherwise you risk damaging the MOSFET to the right of the solder jumper that controls the darkness on control.
- When powering a microcontroller, bypass the 10Ω built-in resistor via the solder jumper, and set the voltage to the requirements of the uC.
- When powering a single white LED, you can either utilize the built-in 10Ω resistor as a current limiter and set the voltage of the boost converter till you reach the forward current limit of the LED, or bypass the built-in resistor and use your own current limiting resistor in series with your LED.
- If setting the output voltage lower then 2.7v, please realize that the TPS61021A will shut off and pass through the higher voltage when the supercapacitors are fully charged. Once the voltage drops below the set voltage, the TPS61021A will turn back on and begin boosting voltage.
- The TPS61021A has built-in short circuit protection. Once the short has been removed, normal operation will resume.
- When charging with a solar panel, use a panel rated between 3.3-7v, optimally, 6 volt panel with an open circuit voltage no more then 7.2v, and up to 10 watts.
- When installing supercapacitors, note the polarity markings on the bottom of the board. If you reverse the polarity, you risk damaging the entire circuit board and/or shorting the supercapacitor with other installed supercapacitors, resulting in the possibility of high amp flow through the circuit board.
- When soldering snap-in supercapacitors to the circuit board, please note that the negative connections have a solid connection to the ground plane. You will need a quality soldering iron rated at least 40 watts to provide enough heat to make a good solder connection to the negative terminal and the circuit board. Using cheap soldering pens will ensure a poor soldering bond.

Schematic


Micro_USB_B
CON1
5v Input
Output Resistance
3SolderJumper
J2
BSS138LT1G
Q1
R1
10kΩ
LIGHT
SVIN
GND
VIN
3.3V
OUTPUT
LED
P2
P1
I2C
ZSPM4523
U2
R3
10KΩ
VDD
SW
C11
0.1uF
C10
10uF
C7
0.1uF
SBR3U20SA-13
D1
DR74-4R7-R
L2
C4
0.1uF
C3
0.1uF
C2
4.7uF
BT6
BT5
BT4
BT3
BT2
BT1
500F
TPS61021A
U1
SRP7030-1R0FM
L1
C9
22uF
C8
22uF
RV1
TC33X-2-304E
C5
10pF
ENABLE
Boost Converter Enable
3SolderJumper
J1
.28" Voltmeter
P4
SW_PUSH
SW1
Voltage Monitor
D_Schottky
D4
D5