



Peak Power Solar Charger

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Porting Arduino Charger to Contiki

- Original project by Tim Nolan
- . . . for Arduino platform
- Unfortunately original project no longer online

Additions

- + Port to Contiki OS for Merkurboard by **OSDomotics**
- + Code rewrite
- + Measurements as CoAP Resources via 6LoWPAN
- + 3.3V design

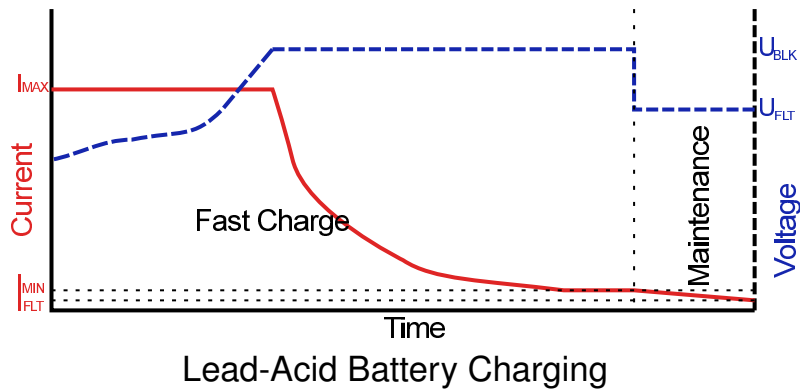


Lead-Acid Battery Charging

- Fast Charge in two phases
 - 1: Constant current (while voltage below U_{BLK})
 - 2: Constant voltage U_{BLK}
- Optional Maintenance Charge (not implemented)
- For photovoltaics I_{MAX} need not be reached
- U_{BLK} , I_{MAX} given by manufacturer datasheet
- I_{MAX} typically 1/10 Capacity in A
- e.g. 1A for a 10Ah battery



Lead-Acid Battery Charging

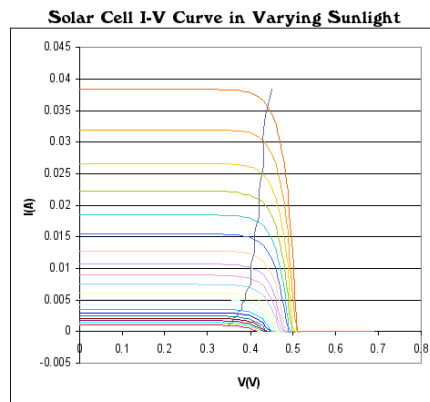


What is Peak Power Charging?

- $P = U * I$, (U in Volt, I in Ampere, P in Watt)
 - Photovoltaic Cells
 - ... mainly a *constant current* source
 - ... but not near maximum voltage point
 - Lead-Acid Battery maximum current should be above Photovoltaics Module
 - Below U_{MAX} we could simply connect the module to the battery
- inefficient
- And we need to limit U (voltage) to U_{MAX}



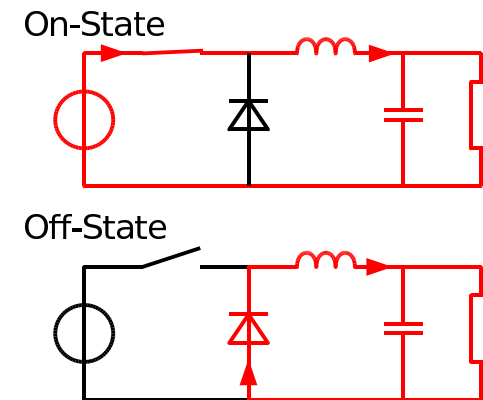
What is Peak Power Charging?



Solar Cell U/I with MPP (© Wikimedia)



Step-Down Converter Principle



Step-Down converter (Buck converter) (© Wikimedia)



Implementation

- For the switch we use MosFETs
- ... controlled by PWM-signal from microcontroller
- The width of the PWM controls the voltage
- We measure voltage @battery, current, voltage @photovoltaics
- calculate power
- regulate to maximum power
- Other modes for low current, constant voltage, dark/full battery



Contiki-OS

- For microcontrollers
- 6LoWPAN: IPv6 over IEEE 802.15.4 RFC 4944
- Cooperative Multitasking (non-preemptive)
- CoAP (Constrained Application Protocol RFC 7252)
- CoAP Resource-Handling
- In our application: U_{SOL} , I , U_{BAT} , power
- ... available as CoAP resources via IPv6
- Wireless remote monitoring



OSDomotics (OSD) Hardware and Software

- Open Hardware: Merkur Breakout-Board
- ATMEL ATmega128RFA1 with IEEE 802.15.4 on chip
- Contiki Port for Merkurboard
- Lots of examples
- ... from temperature sensor to servo control
- Timer: Contiki used the timer for hardware PWM
- Devices: Contiki comes with almost no device drivers



OSD Hardware: Merkurboard



Merkurboard



OSDomotics (OSD) Fork of Contiki-OS: Timer

- OSD-Port makes Contiki-Timer configurable
- We plan to bring this upstream
- Contiki comes with almost no device drivers
- OSD: Library/API for ATMEL hardware timers
- Support for hardware-PWM
- No interrupt management as in Arduino Timer1 yet
- Interface to other IOs (Arduino-like Interface)



OSDomotics (OSD) Fork of Contiki-OS: Arduino

- Many people are already familiar with Arduino API
- We support an API for Arduino
- ... on top of Contiki-OS
- Supports clock, hardware timers
- digital/analog inputs (and pwm output)
- Examples how to use this
- Run your Arduino Sketch on top of Contiki-OS
- Runs Arduino `loop` with configurable period
- ! Different Licenses for Arduino and Contiki



Resources

Everything available under Open Source Licenses

- Contiki-OS fork for Merkur Board
github.com/osdomotics/osd-contiki
- Solar Charger circuit design and sourcecode
github.com/osdomotics/solar-charger
- Getting started with Merkur Board (german)
wiki.osdomotics.com/doku.php/de:start