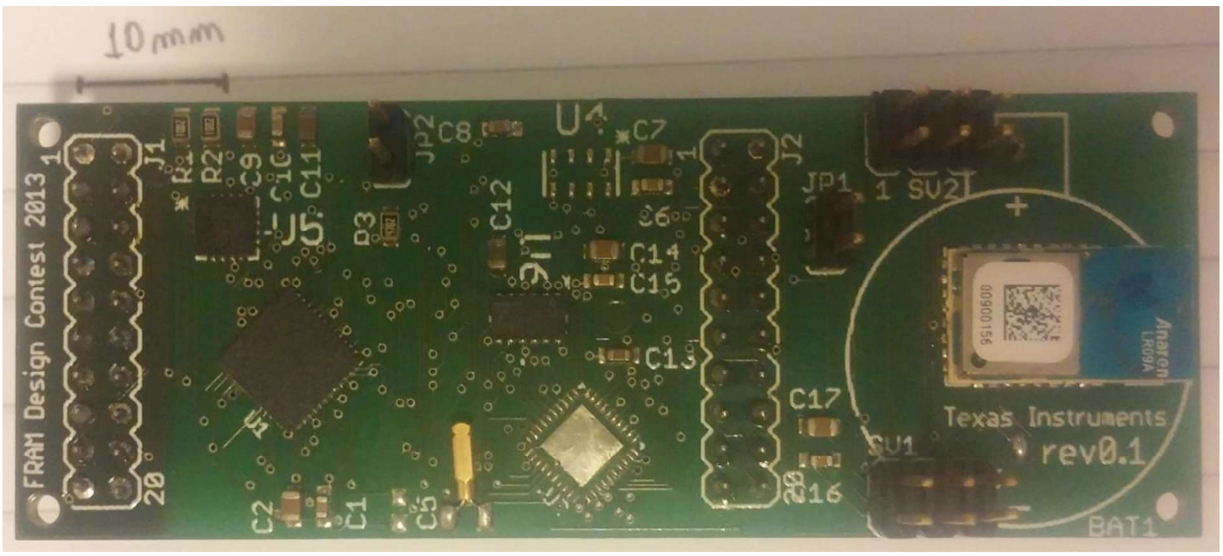
# I. Introduction

The purpose of this document is to show some hardware developed by myself. I have only selected hardware which I have specified, designed, assembled, programmed and tested myself so you can have a better picture of my background upon the subject. On each design I have added some information text regarding the board functionality, and eventually, some issues I have come across during the development. Here are only pictures of completed PCBs but together with this attachment there are schematics and layouts available for each of these designs.

P.S. I have taken the shots with my mobile camera and unfortunately they have very poor quality, sorry about that!

# II. The FRAM design challenge board



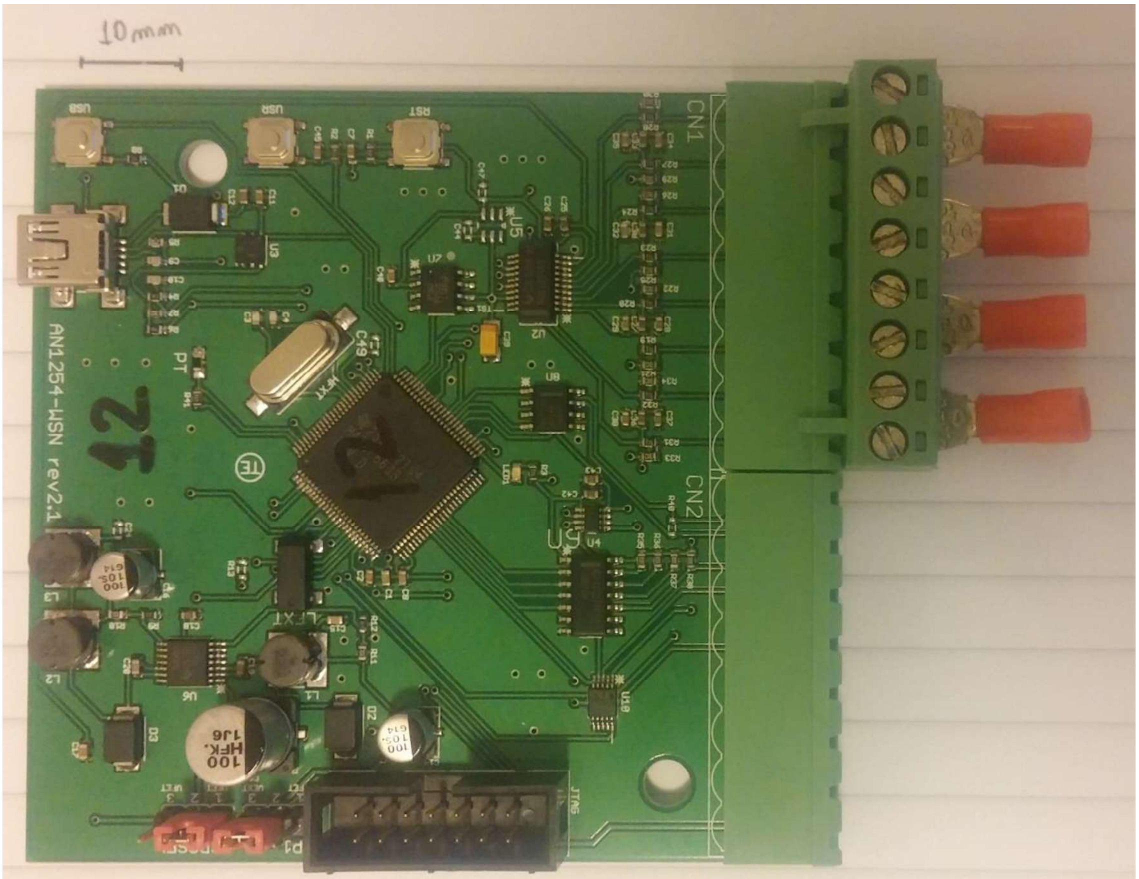

Early on 2013, while finishing my internship with Texas Instruments, I have taken part on the FRAM design challenge which is a challenge for TI interns to design some application using MCUs which have embedded FRAM memory, in order to highlight its advantages and so on…

Since innovation was a must for the project, I have decided to design a wind vane, capable of measuring orientation using an electronic compass and wind speed using an accelerometer (yes that's right, I have attempted to indirectly measure wind speed from the induced vibration on a structure, I've failed…). Although the design looks pretty poor (component placement and routing), the board was fully functional, and given that it took less than 10 days to go from concept to PCB order, the outcome was quite ok, and has awarded me the 1st place on the challenge.

Now if you look closely to this design, you will notice that it has an accelerometer, gyroscope, magnetometer, pressure sensor, radio transceiver and 4 PWM signals outputs. So, I have designed it in such a fashion, that I could use it also to control a quadcopter which I was playing with at that time.

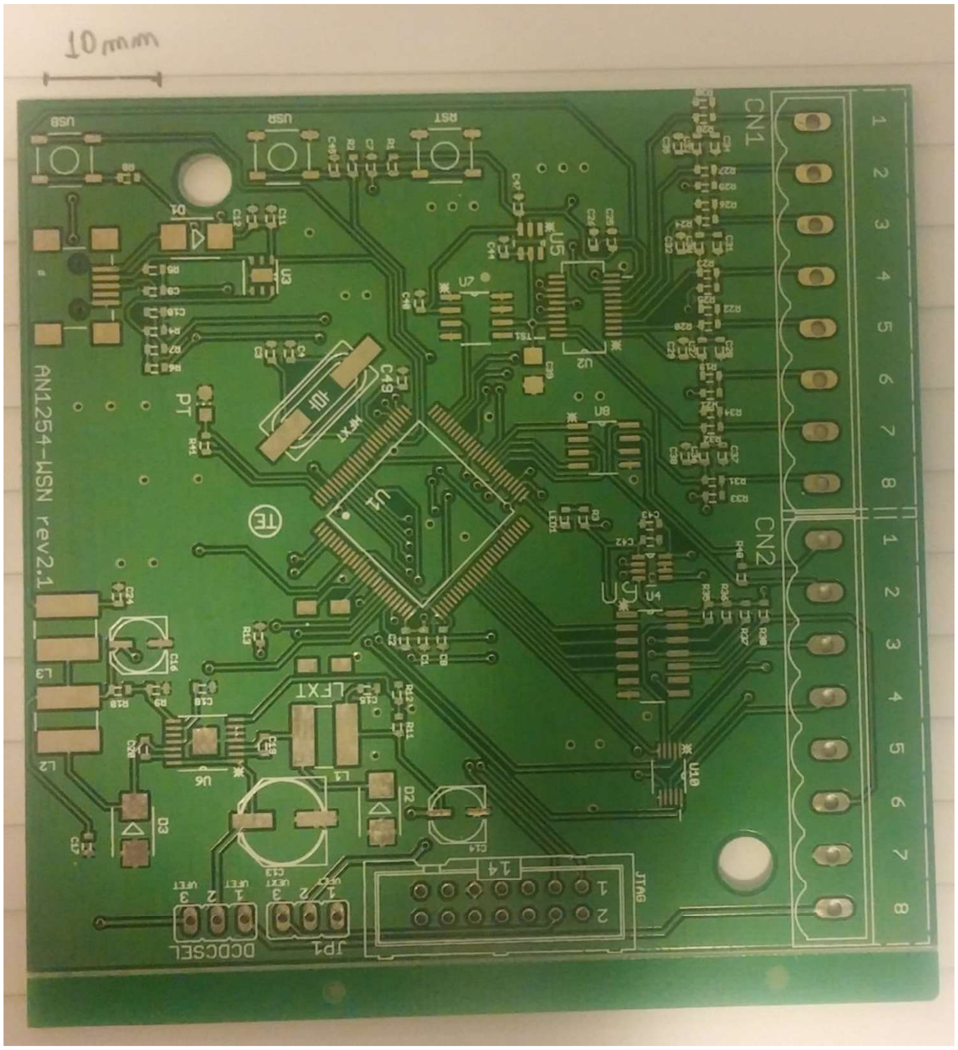
The design also became slightly complex to fit on the board size I choose due to the fact that I have added two microcontrollers on the project (not for redundancy but for an OR option). The reason was that back in 2013, TI was about to release the family FR59XX, I already had access to the silicon but some peripherals were pretty unstable still, I knew that a new revision was about to be released so I have made the design compatible with FR59XX family as well as FR57XX family devices.

# III. The data acquisition card

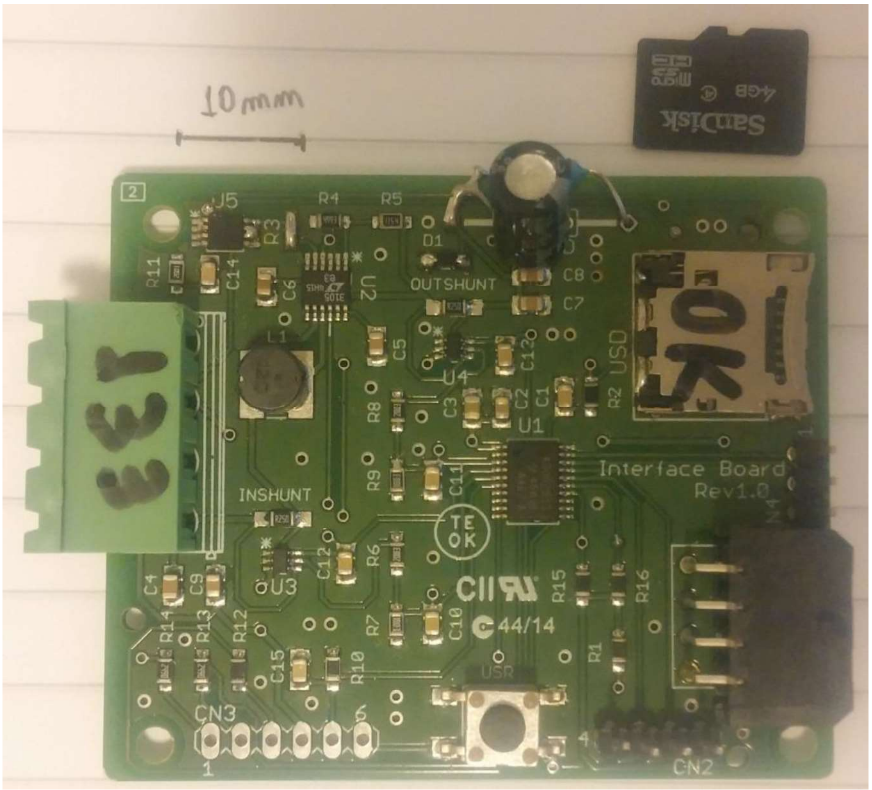



I have started working on this project in 2010 and the last revision I did on this hardware was in 2014. It features a 4 differential channel 24 bit sigma-delta ADC and it was first designed to read several types of thermocouples. Over the years, I have updated the original design a couple of times, in order to incorporate features like, RS485 interface, wireless interface (with OR layout for ZigBee, Bluetooth and Wi Fi chips), USB interface, digital and analog outputs, battery management (not present on this revision) and so on…

This was a successful project, the company I used to work for uses this device in several of its products and it’s still in production today.


10mm
AN1254-WSN rev2.1
CN1
CN2
JTAG
DCDCSEL
JP1
LFXT
USB
USR
RST

# IV. Low power solar MPPT controller

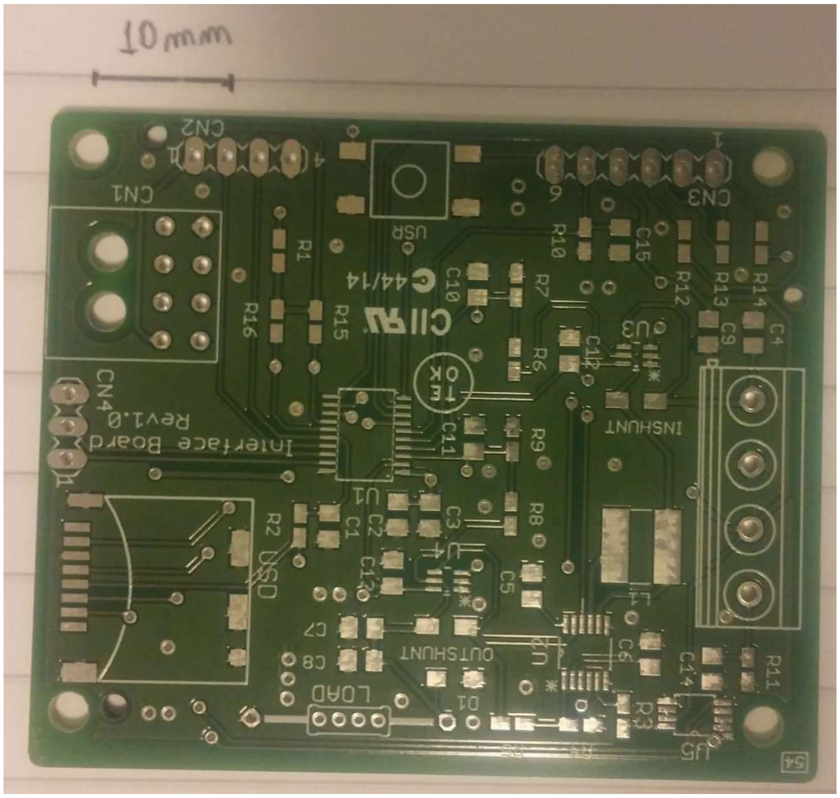



This board was designed to be used by a solar panel manufacturer in Brazil, to evaluate module performance, so the HW had several analog channels, which were used to measure temperature, current and voltage in different stages of the power processing (e.g. panel output power and MPPT output power). The board had a SD card interface to log the measurements, and had also another interface available (I2C) to connect to another system (data acquisition station).

This was a very nice design, but the first prototype was not approved by the customer. The reason was that the power controller IC (LTC3105, which had been selected by customer) used a method called “constant voltage” to regulate the power delivered to the output load and it presented pretty poor performance if not operating at full solar radiation intensity. The “constant voltage” is not actually a true MPPT technique.

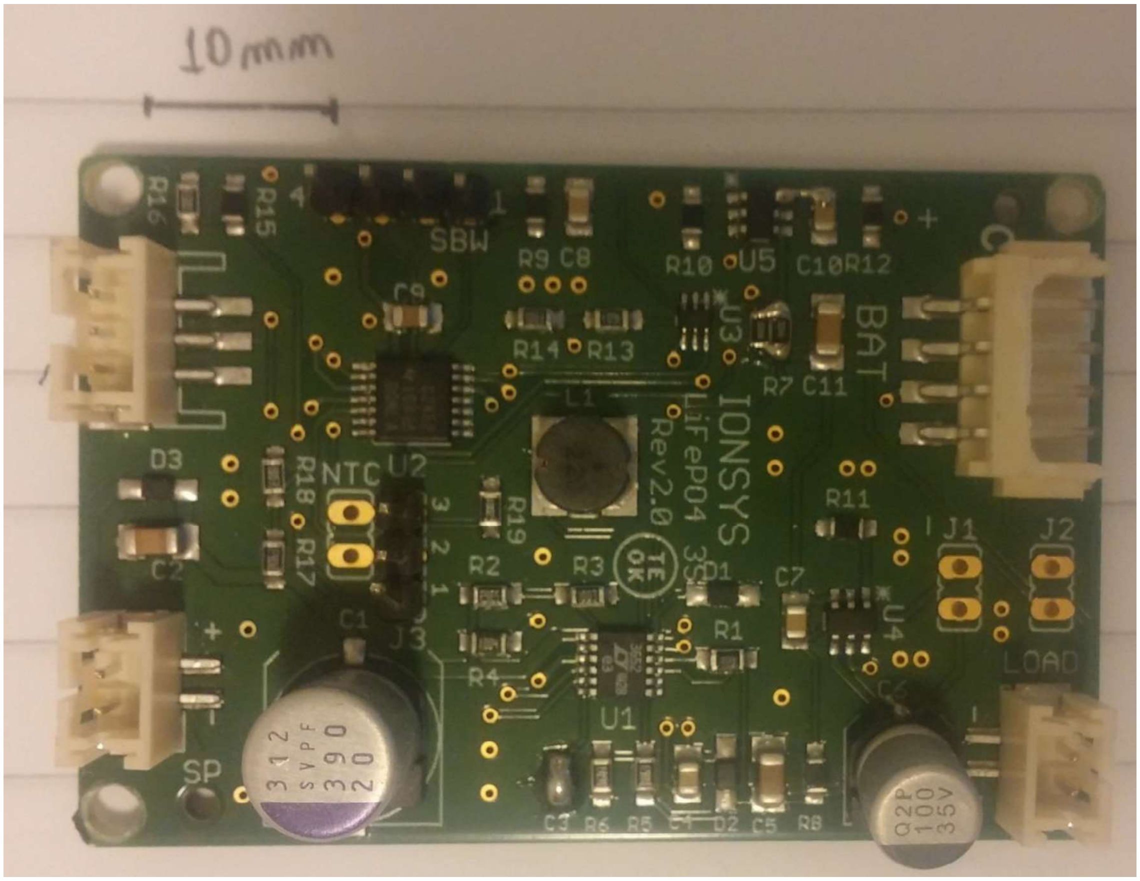
Fortunately, I was able to design a fix without having to remove LTC3105 from the design, the fix was actually simple in concept and worked nicely. It consisted on the addition of a DAC IC on the design, which was controlled by the system MCU to provide a dynamic reference voltage to LTC3105’s MPPC pin, which was the reference voltage to control the MPP point.

With this modification, came also the need for a more sophisticated algorithm on the MCU side, since now the MPP point could be controlled, I could actually perform true MPPT, so I have developed a hybrid algorithm featuring a “perturb and observe” method and a “incremental conductance” method in order to switch MPPT technique according to solar radiation intensity (I have observed through experimentation, that “incremental conductance” was more effective for lower levels of solar radiation).

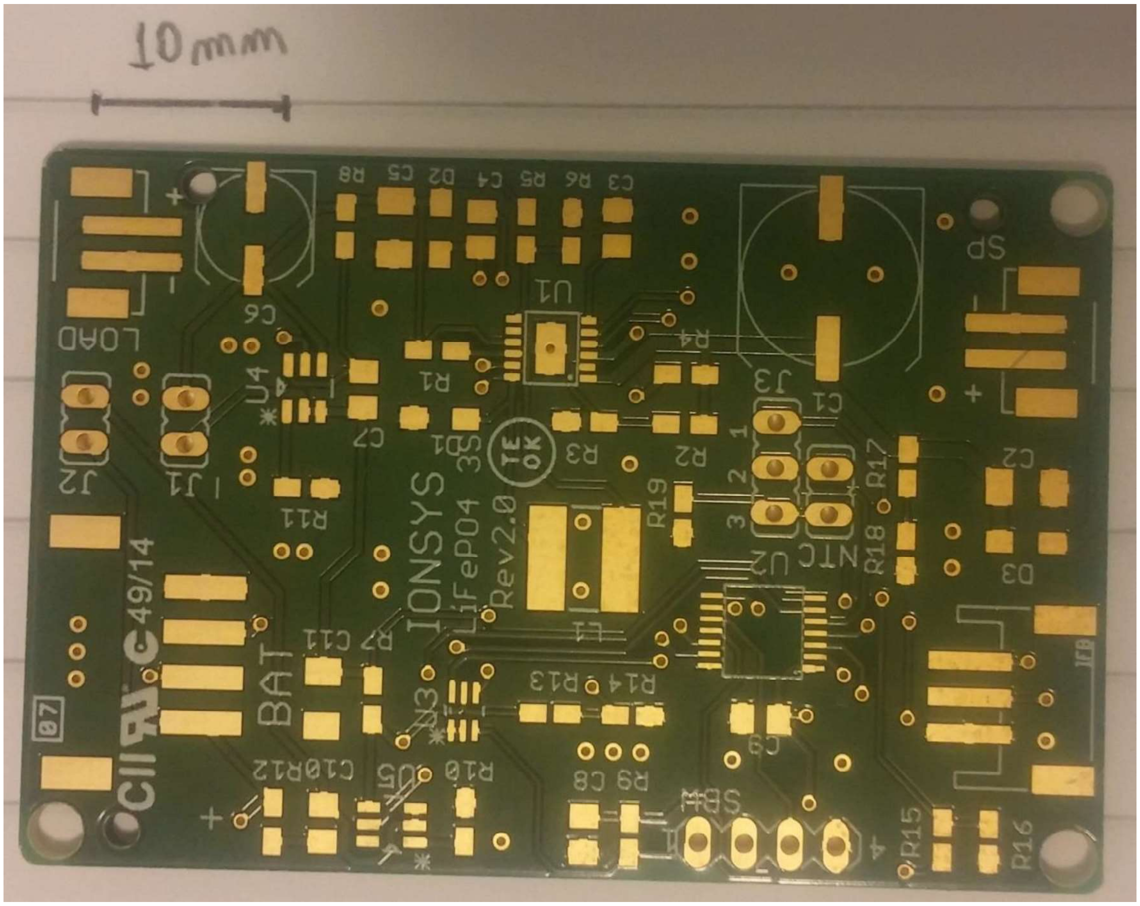


10mm
Interface Board
Rev1.0
CN1
CN2
CN3
CN4
USR
INSHUNT
OUTSHUNT
LOAD
USD

# V. Solar power management system

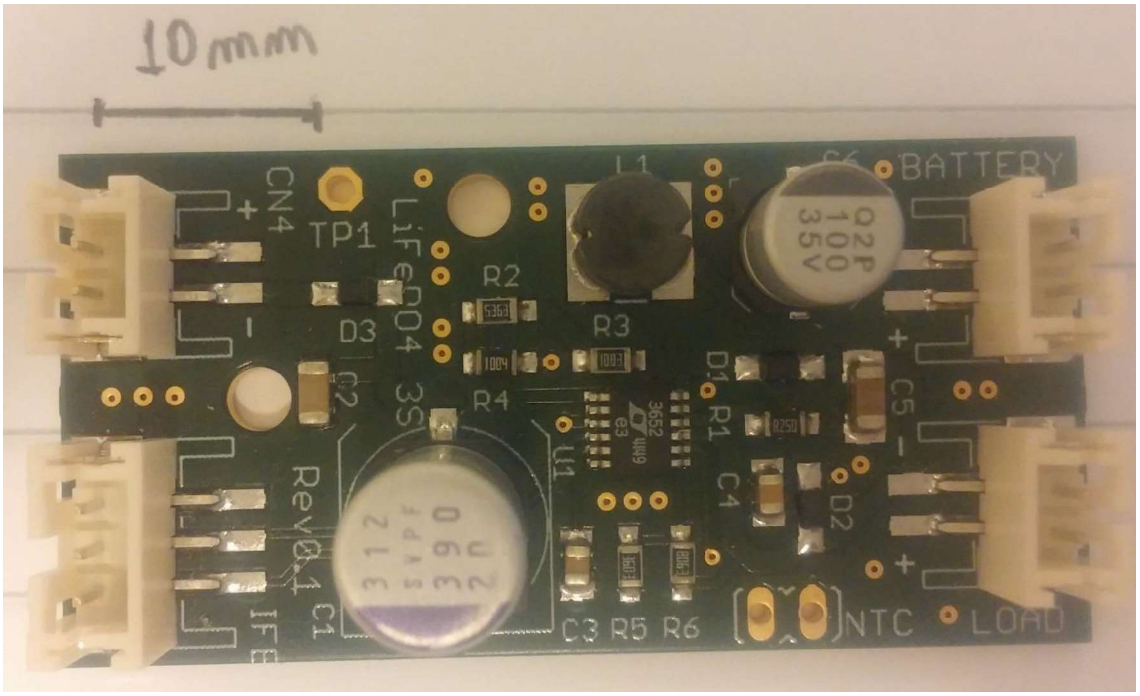



This design is a microcontrolled 5W solar charger for Lithium batteries (compatible with LiFePO4, Li-PO and Li-ION by replacing R5 and R6). It basically does some load management using load switches and controls battery charging using a MPPC IC. It has an I2C interface to communicate with another board which is part of this solution, which goes into a remote weather data acquisition station.



10mm
IONSYS
LiFePO4 3S
Rev2.0
LOAD
BAT
SP
NTC
SBW
TE
OK
49/14

# VI. Tiny solar battery charger




This one is a tiny version of the solar power management system. It does not have a MCU and the battery needs additional protection to be used with this charger.