**Components Document**

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# Solar Panels:

## Introduction:

This is a client request.

These solar panels let certain wavelengths of light through them, and absorb the rest of the spectrum.

This allows plants to grow inside.

Model: LUMO 20M100GH

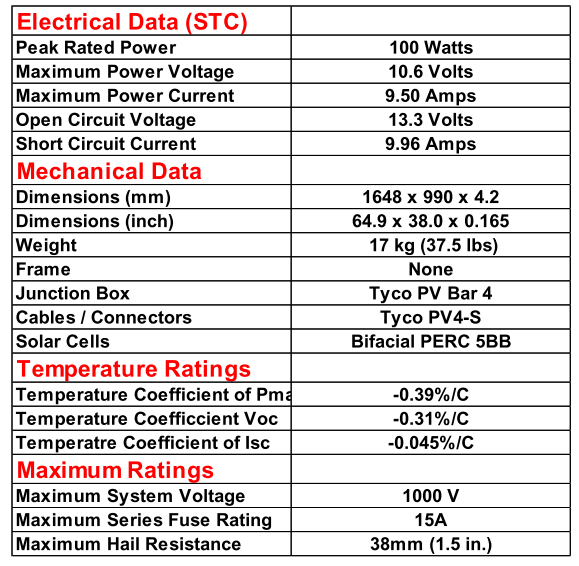
Quantity: 24x

Company: Soliculture

Company Website: <http://www.soliculture.com/>

Product Page: <http://www.soliculture.com/product/>

## Datasheet:



# Charge Controller:

## Introduction:

Solar panels cannot charge batteries directly for these reasons:

1.) They have unstable voltages, and thus should not be connected directly to the battery.

2.) Batteries with different chemical compositions charge differently.

3.) One solar panel cannot provide enough power to the battery alone, even if it reaches the nominal voltage of 12V.

4.) If we string 12 solar panels in series together and plug it into the batteries, the batteries will become permanently damaged.

Solar panels cannot charge batteries properly by themselves. We must have a charge controller to accompany the solar panels in order to charge the batteries properly. I like the TS-MPPT-60 because it is custom-programmable, and it can monitor a significant amount of values that could be useful someday. I included the values it can monitor below.

Model: MORNINGSTAR TS-MPPT-60 TriStar MPPT 150V

Company: Morningstar

Company Website: [https://www.morningstarcorp.com](https://www.morningstarcorp.com/)

Product link: <https://www.morningstarcorp.com/products/tristar-mppt/>

Quantity: 2x

## Features:

Customizable Charge Settings

Great networking capabilities

RS-232 electrical interface for Microcontroller communication.

Uses royalty-free MODBUS protocol for easy data harvesting

Operating Range: -40C to 40C

Up to 60A continuous battery current

Compatible with 12V, 24V, and 48V battery systems

Maximum 150V solar panels in series

Keyholes for mounting

Uses TrakStar MPPT technology to track the maximum power point of the solar panels.

Temperature compensation

Two Tristar Morningstar MPPT’s can be attached to the same battery pack

## Drawbacks:

The internal PLC settings can only be changed with a PC that can run MSView, Morningstar’s proprietary program that can program any Morningstar device, that can be downloaded from Morningstar’s website: <https://www.morningstarcorp.com/msview/>

It can only handle 150V of solar panels. We have 24 solar panels, which in series total to a nominal voltage of 192V. Therefore, we must have at least 2.

## Monitoring:

Tristar Morningstar MPPT can monitor:

### Internal ADC chips:

Battery Voltage

Battery Terminal Voltage

Battery Sense Voltage

Array Voltage (of the solar panels)

Battery Current

Array Current (of the solar panels),

12V supply,

3V supply,

meterbus voltage,

1.8V supply,

Reference voltage

### Temperature Data:

Heatsink Temperature

RTS temperature

Battery Regulation Temperature

### Status Data:

Battery Voltage (slow)

Charging Current (slow)

Minimum Battery Voltage

Maximum Battery Voltage

Hourmeter

Faults raised

Alarms raised

LED state

DIP switch status

### MPPT Data:

Output Power

Input Power

Max power of last sweep

Vmp of last sweep

Voc of last sweep

### Charger Data:

Charge state

Target Regulation Voltage

Ah charge resettable:

Ah charge total

kWhr charge resettable

kWhr charge total

### Daily Data:

Battery Voltage Minimum

Battery Voltage Maximum

Input Voltage Maximum

Amp Hours accumulated

Watt hours accumulated

Minimum Power output

Minimum temperature

Maximum temperature

Time in ab stage

Time in equalize stage

Time in float stage

Alarms of the day

Faults of the day

Flags of the day

### Current Charge Settings:

EV\_absorp

EV\_float

Et\_absorp

Et\_absorp\_ext

EV\_absorp\_ext

EV\_float\_cancel

Et\_float\_exit\_cum

EV\_eq

Et\_eqcalendar

Et\_eq\_above

Et\_eq\_reg

Et\_battery\_service

EV\_tempcomp

EV\_hvd

EV\_hvr

Evb\_ref\_lim

ETb\_max

Etb\_min

Elb\_lim

EVa\_ref\_fixed\_init

EVa\_ref\_fixed\_pet\_init

LED settings

EV\_soc\_g\_gy

EV\_soc\_gy\_y

EV\_soc\_y\_yr

EV\_soc\_yr\_r

## Recommended Accessories:

### Remote Temperature Sensor

Introduction:

The greenhouse will naturally change temperature more than 5 C during the year. The Morningstar Corporation recommends that you add the RTS sensor for the Charge Controller to operate more effectively under these circumstances. It is simple to install. Follow Morningstar’s guide to installation.

Model: Remote Temperature Sensor

Quantity: 2x

Company: Morningstar

Company Website: <https://www.morningstarcorp.com/>

Product Page: <https://www.morningstarcorp.com/products/remote-temperature-sensor/>

### RS-232 to USB cable

Introduction:

RS-232 must be converted to USB format for easy monitoring by the Raspberry Pi. Luckily, I don’t have to reinvent the wheel. I can simply use this cable. It has an FTDI chip and board embedded inside the plug, so I don’t have to worry about fabricating a chip.

I’m going with a USB terminal because my microcontroller is a Raspberry Pi, and it’s simpler to use a USB and create a virtual COM port inside the Raspberry Pi’s Linux operating system.

RS-232 Male to USB male

Model: C2G 26886 USB to DB9 Serial RS232 Adapter Cable, Blue (1.5 Feet, 0.45 Meters)

Quantity: 2x

Company: C2G

Company Website: <https://www.cablestogo.com/>

Product Page: <https://www.amazon.com/C2G-Cables-26886-Serial-Adapter/dp/B000067RVJ>

# Batteries:

Lithium-ion Battery Cell

## Introduction:

Solar panels do not produce power all the time. Even when they do produce power, they often don’t produce enough power to satisfy the consumer. During the day, when the solar panels produce the most power, the consumer often isn’t using the system. To resolve this, we need to have a battery pack. During the day, the battery pack will be charged by the solar panels, and during the evening, the battery pack will be discharged by the consumer.

Model: IFP71/180/278-CA180FI

Quantity: 8

Company: CALB

Company website: <http://www.calbusainc.com/>

Product Page: <https://www.ev-power.eu/LiFePO4-small-cells/Prismatic/CALB-CA180FI-Lithium-Cell-LiFePO4-3-2V-180Ah.html>

## Datasheet:

# Battery Management System:

## Introduction:

Batteries don’t discharge evenly. Every battery has its own individual chemistry due to imperfections in the manufacturing process. If we discharge batteries unevenly, one battery could be worn out while another battery remains untouched. To resolve this, we use a Battery Management System.

## Main Controller:

Model: G1 EMUS BMS control unit

Quantity: 1

Company: Emus

Company Website: <https://emusbms.com/>

Product Page: <https://emusbms.com/product/g1-bms-control-unit>

### Features:

Automatically controls the battery operation process utilizing various interfaces for measurement, control, data exchange, configuration and indication.

Works with any charge controller

Application:

Any lithium chemistry, series connected battery pack of up to 254 cells if using serial cell communication

Any lithium chemistry, series connected battery pack, or pack of multiple parallel strings, up to 8128 cells total, if using EMUS CAN Cell Group Modules.

Storage Temperature: -40 C to 95 C

Operation Temperature: -40 C to 80 C

USB interface for Microcontroller reading

Proprietary serial interface for cell communication

### Monitoring:

BMS control unit can monitor:

#### System Status

Battery Charge

Charger Status

Current and Voltage

Distance and Energy (if applied to an electric vehicle)

BMS status

Time and Date

Version Number

#### System status and Individual Cells:

Battery Balancing Rate

Temperature

Battery Voltage

#### Statistics

Has an internal events log (each event happening at a recorded time)

Has a statistics log at a recorded time. Possible statistics to log:

- Total Discharge

- Total Charge

- Total Discharge Energy

- Total Charge Energy

- Total Discharge Time

- Total Charge Time

- Total Distance

- Max Discharge Current

- Max Charge Current

- Min Cell Voltage

- Max Cell Voltage

- Max cell Voltage Difference

- Min pack voltage

- Max pack voltage

- Min Cell Module Temperature

- Max Cell Module Temperature

- Max Cell Module Temperature Difference

- Protection Counts (undervoltage, overvoltage, discharge overcurrent, charge overcurrent, cell module overheat, leakage protection, no cell communication, low voltage power reduction, high current power reduction, high cell module temperature power reduction, charger connect, charger disconnect, cell overheat, high cell module temperature power reduction)

- Miscellaneous counts (# of Preheat stages, Precharge stages, main charge stages, balancing stages, charging finished stages, charging errors, charging retries, trips, charge restarts)

- Min Cell Temperature

- Max Cell Temperature

- Max Cell Temperature Difference

## **Necessary Accessories:**

### Cell Isolators

The BMS system requires that you have isolators to protect the main module.

Only works if only 1 group of batteries is used.

Model: G1 Top/Bottom Isolator

Company Website: <https://emusbms.com/>

Product Page: <https://emusbms.com/product/g1-top-bot-isolator>

Quantity: 2x

### Cell Modules

Every battery must have its own cell module.

Different batteries require different cell modules.

You can find all types of cell modules here:

<https://emusbms.com/product-category/cell_modules>

The standard solution is the A/B type, so that’s what we’re going with.

We must order this package for each battery.

EMUS BMS Cell Module A – 1x

EMUS BMS Cell Module B – 1x

Ring Terminal M8 – 2x

Communication Cable – 16cm – 2x

#### Ordering details:

Model: G1 Cell Module – A/B type

Company: Emus

Company Website: [https://emusbms.com](https://emusbms.com/)

Product Page: <https://emusbms.com/product/g1-cell-module-ab>

Quantity: 8x

### CAN Cell Group Module

We need to group batteries into groups.

Since the batteries we picked are 3.2V, we group batteries into groups of 4.

Model: G1 CAN Cell Group Module

Company: Emus

Company Website: <https://emusbms.com/>

Product Page: <https://emusbms.com/product/g1-can-cell-group-module>

Quantity: 2x

## **Recommended Accessories:**

### Current Sensor

In order to monitor current dispensing from the batteries to the load, you must have a current sensor. It’s not necessary for operation, but it’s recommended to have one. This one works using the hall effect, so it does not require contact with the wires; it only needs to have the wire running through its hole.

Model: G1 Loop Style Dual Range Current Sensor

Company: Emus

Company Website: <https://emusbms.com/>

Product Page: <https://emusbms.com/product/g1-loop-style-dual-range-current-sensor>

Quantity: 1x

# Sensors – Faculty

## Introduction:

The client wants their own sensors exclusive for faculty. They want to measure temperature, humidity, and light. I propose that we use these classes of sensors for this:

* Temperature and Humidity Sensor
* Light Sensor

The product page for the parts and their respective datasheets will be hosted by different companies. This is because it is easier to order a breakout board than it is to order the individual parts, order a custom PCB for the sensor, and solder the parts onto the board. Companies that sell breakout boards and companies that manufacture parts are separate from one another.

## **Temperature and Humidity Sensor:**

Model: BME280

Company: Bosch

Company Website: <https://bosch.us/>

Product Page: <https://www.adafruit.com/product/2652>

Datasheet: <https://cdn-shop.adafruit.com/product-files/2652/2652.pdf>

### Details:

+-3% accuracy for humidity

+-1% accuracy for temperature

1s response time maximum

Operating range: -40C to 85C

I2C interface

Measures pressure if necessary

See datasheet for reading this sensor properly.

Create a class in C++/python to read it.

## **Light Sensor:**

Model: VEML7700

Quantity: 2

Company: Vishay Semiconductors:

Company Website:

Product Page: <https://www.adafruit.com/product/4162?gclid=EAIaIQobChMIyOmfve7Q4wIV6f_jBx07fQ1yEAQYASABEgJti_D_BwE>

Datasheet: <https://www.vishay.com/docs/84286/veml7700.pdf>

### Details:

High resolution: 0.0036 lux/ct at night, 1.8 lux/ct in bright sunlight

Maximum 120,000 lux (bright sunlight)

I2C interface

See datasheet for reading this sensor properly (i.e. what addresses to read from, what slave address to use, etc.)

Create a class in Python/C++ to read it.

# Faculty Microcontroller

## Introduction:

In every computer system, there must be a main processor. In this greenhouse system, a master microcontroller is utilized to harvest data, process it, and send it to a main server somewhere on campus. See the website manual for details on how it’s processed there. The main microcontroller must be able to communicate with the Faculty Sensors somehow, and communicate with the slave microcontrollers when we implement them. I have chosen to interface the main microcontroller with the slave microcontrollers via Bluetooth. Bluetooth is wireless, and easy to program. Does not require any wires running across the greenhouse floor, and reduces tripping hazard. So, our Microcontroller has these requirements:

* Must be capable of sending packets of data over a 2G internet connection to a server somewhere at UCSC.
* Must be capable of communicating over Bluetooth to a slave microcontroller somewhere in the greenhouse.
* Must be capable of reading I2C data.

The microcontroller I have chosen for this job is the Raspberry Pi Model 3B+. It is a capable microcontroller. It runs Linux on its systems, so it’s easy to debug on site if necessary. The code can be stored on an SD card. If necessary, it will be possible to retrieve a log of the past 30 days of data from the Raspberry Pi. The Raspberry Pi Raspbian system uses a FAT32 file system, meaning the absolute maximum amount of data it is possible of addressing is 32GB. So, it should be enough for at least 30 days worth of data. But, the SD card also has to store the operating system it will use (Raspian).

This microcontroller uses a +5V power source. Therefore, we will have to design a power source for it. The tolerance values for the microcontroller are tight: it only accepts +4.5V to +5.5V. It can draw up to 2A of current when running a stress-test. So, let’s just say it draws a maximum of 10W of power.

## Details:

Model: Raspberry Pi 3 Model B+

Quantity: 1

Company: Raspberry Pi

Company page: <https://www.raspberrypi.org/>

Product Page: <https://www.raspberrypi.org/products/raspberry-pi-3-model-b-plus/>

## Features:

1.6GHz ARM processor

C++ compiler

Python interpreter

4 USB ports

20 GPIO pins

I2C, UART, and SPI interface

Runs Linux

Bluetooth and Wi-Fi Capabilities

Upgradeable

## Drawbacks:

Requires +4.5V to +5.5V of power.

Requires a Micro USB to power it. We can fabricate something that can deliver the necessary power to run it.

## Recommended Accessories:

### Sixfab’s GSM/GPRS shield:

I don’t like the FONA module. I would like to replace it. I would like to instead use this GSM/GPRS shield. It slides easily onto the master Raspberry Pi, and can also fit another shield onto it if so desired. I will be fabricating a faculty sensor shield utilizing the I2C protocol. This shield utilizes the UART protocol. The Raspberry Pi can only accommodate 1 use of the UART protocol using the GPIO pins. The others will be using the Virtual COM ports of the Raspberry Pi. The Tristars will be using a RS-232 to USB converters with an FTDI chip installed in them for communication, and the BMS system will be using a split-open USB wire that will connect directly to the BMS control unit.

Model: Raspberry Pi GSM/GPRS shield

Company: Sixfab

Company Page: <http://sixfab.com/>

Product Page: <https://sixfab.com/product/gsmgprs-shield/>

Features:

Uses Quectel M66 2G IoT modem.

Fully compatible with Raspberry Pi models that have the 40-pin GPIO header (3, 2, B+, A+, Zero)

High Data Speed: GPRS Multi-slot class 12, 85.6kbps downlink and 85.6kbps uplink data rates

Quad-band: 850/900/1800/1900MHz

Built-in PCB antenna, also there is an external antenna port available

Supported Protocols: TCP/ UDP/ PPP/ FTP/ HTTP/ SMTP/ CMUX/ SSL

Quectel’s QuecLocator Feature, lets you get the location without GPS/GNSS

Extremely low standby power consumption by M66, 1.3mA at DRX=5

Efficient and low quiescent current regulator circuit can hold up to 3.6A

Bluetooth Function, V3.0 specification, SPP and OPP profiles available.

Micro SIM Card socket can easily reachable on the downside of the shield.

Can be used standalone with PC/Laptop over micro USB, without stacking with Raspberry Pi thanks to FTDI chip on the shield.

Sending/Receiving standard V.25ter AT commands over UART port to Raspberry Pi is available

Working temperature range: -30°C to +80°C

### Antenna:

Any antenna that can physically connect to this shield will do. But, here’s one from Sixfab:

Model: GSM 2G/3G Antenna – u.FL PCB Antenna – 0dBi

Company: Sixfab

Company page: <https://sixfab.com/>

Product Page: <https://sixfab.com/product/gsm-2g-3g-antenna-u-fl-pcb-antenna-0dbi/>

### SIM Card:

If we will be sending data with our GSM module, we must have a SIM card to tell the cell phone tower what carrier we are using, and if we have permission to use their cell phone tower. The SIM card only stores 1 piece of data: our ID number. That’s all it does, but it’s very important.

Model: Ting GSM SIM card

Quantity: 1

Carrier: Ting

Company Website: <https://ting.com/>

Product Page: <https://ting.com/shop/gsmSIM>

You must register with Ting and pay a monthly fee of $50 for an unlimited 2G service plan.

### Custom-fabricated I2C shield for Raspberry Pi.

Will be custom-designed at home here at UCSC. Will be rushed, though. If I find a design, will be using it. Will have these features:

* Capable of holding at least 8 I2C devices
* Capable of detaching I2C devices at will, like a plug.
* Has Pull-up resistors embedded inside

## Touch screen for Raspberry Pi

This is not completely necessary, but it would be nice to be able to see what is happening inside the raspberry pi 3 at any given moment.

Model: Raspberry Pi Touch Display

Company: Raspberry Pi

Company Page: <https://www.raspberrypi.org/>

Product Page: <https://www.raspberrypi.org/products/raspberry-pi-touch-display/>

## Case for Raspberry Pi Touch Display

If we have a Raspberry Pi touch display, we will need a case for it to add that extra touch. We will need to find a way to mount it, though.

Model: RS Raspberry Pi 7-Inch LCD Touch Screen Case, Black, Model number FBA\_102035

Company: Raspberry Pi

Company Page: <https://raspberrypi.org/>

Product Page: <https://www.amazon.com/Raspberry-Pi-7-Inch-Touch-Screen/dp/B01GQFUWIC/ref=asc_df_B01GQFUWIC/?tag=hyprod-20&linkCode=df0&hvadid=309751315916&hvpos=1o1&hvnetw=g&hvrand=10505497938605347385&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9061320&hvtargid=pla-406360183578&psc=1&tag=&ref=&adgrpid=67183599252&hvpone=&hvptwo=&hvadid=309751315916&hvpos=1o1&hvnetw=g&hvrand=10505497938605347385&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9061320&hvtargid=pla-406360183578>

# Sensors – Student

## Introduction

As an optional feature, the client would like the system to be capable of having students be able to use their own sensors. Here are some potentially useful sensors for students:

## Water Temperature sensors

### DS18B20

The DS18B20 is sold in a different form factor from ADAFRUIT. This form factor is more usable, so we will be using that one. The sensor and its datasheet are provided by Maxim Integrated.

Model: DS18B20

Quantity: 1

Company: Maxim Integrated

Company Website: <https://www.maximintegrated.com/en.html/>

Product Page: <https://www.adafruit.com/product/381?gclid=EAIaIQobChMIh5e--PmU4wIViJWzCh3vLA9XEAQYASABEgKZSfD_BwE/>

Datasheet: <https://datasheets.maximintegrated.com/en/ds/DS18B20.pdf>

Details:

Interface: One-wire

* Reduce Component Count with Integrated Temperature Sensor and EEPROM
* Unique 1-Wire® Interface Requires Only One Port Pin for Communication
* Measures Temperatures from -55°C to +125°C (-67°F to +257°F)
* ±0.5°C Accuracy from -10°C to +85°C
* Programmable Resolution from 9 Bits to 12 Bits
* No External Components Required
* Parasitic Power Mode Requires Only 2 Pins for Operation (DQ and GND)
* Simplifies Distributed Temperature-Sensing Applications with Multidrop Capability
* Each Device Has a Unique 64-Bit Serial Code Stored in On-Board ROM
* Flexible User-Definable Nonvolatile (NV) Alarm Settings with Alarm Search Command
* Identifies Devices with Temperatures Outside Programmed Limits
* Available in 8-Pin SO (150 mils), 8-Pin µSOP, and 3-Pin TO-92 Packages

## Soil Moisture Sensors:

This one is a potential keeper for students:

Model: I2C Soil Moisture Sensor

Company: White Boxes

Company Page: <https://www.whiteboxes.ch/>

Product Page: <https://www.whiteboxes.ch/shop/i2c-soil-moisture-sensor/?v=7516fd43adaa>

Features:

* Comes with its own Arduino and Raspberry Pi examples library, located here:
  + <https://github.com/Miceuz/i2c-moisture-sensor>
* Version 2.7.5
* Supply voltage 3.3V – 5V
* Current consumption: 1.1mA @ 5V, 0.7mA @ 3.3V when idle, 14mA @ 5V, 7.8mA @ 3.3V when taking a measurement. When constantly polling sensor at full speed, current consumption averages to 4.5mA @ 5V, 2.8mA @ 3.3V
* Operating temperature 0°C – 85°C
* Moisture reading drift with temperature – <10% over full temp range

## Pressure Sensors:

Honeywell manufactures this pressure sensor, but ADAFRUIT distributes it.

Model: Adafruit MPRLS Ported Pressure Sensor Breakout - 0 to 25 PSI

Company: Honeywell

Company Page: <https://sensing.honeywell.com/>

Product Page: <https://www.adafruit.com/product/3965?gclid=EAIaIQobChMIx4HYxr7-5AIVDtvACh3JSggcEAQYBSABEgJE7_D_BwE>

Datasheet: <https://sensing.honeywell.com/micropressure-mpr-series>

Comes with its own example code library: <https://github.com/adafruit/Adafruit_MPRLS>

# Student Microcontroller

## Introduction:

Instead of having every student plug into one microcontroller (which would require a lot of cables running around), I propose that for every experiment, we have a separate microcontroller that the student can take with them. The Raspberry Pi 3 Zero W is a great candidate for this. It’s Bluetooth enabled, so they aren’t burdened by a cable length. It’s just as powerful as the normal Raspberry Pi, with the addition of writing their own code for their own sensors.

We will have to use our own sensor shields.

## Raspberry Pi Zero W:

Model: Raspberry Pi 3 Zero W

Quantity: 2

Company: Raspberry Pi

Company Website: <https://raspberrypi.org/>

Product page: <https://www.adafruit.com/product/3400?gclid=EAIaIQobChMI9Lbyu_qU4wIVDp6fCh3MuA5QEAQYASABEgJT5PD_BwE/>

Details:

* 1GHz, single-core CPU
* 512MB RAM
* Mini HDMI and USB On-The-Go ports
* Micro USB power
* HAT-compatible 40-pin header
* Composite video and reset headers
* CSI camera connector

Networking:

* 802.11 b/g/n wireless LAN
* Bluetooth 4.1
* Bluetooth Low Energy (BLE)

Drawbacks:

* Requires a voltage range of +4.5V to +5.5V, and a power converter.
* Requires a Micro USB.

## Recommended Accessories:

### Custom SPI, I2C, UART, and One-Wire shield

Will be designed in-house. Everything will be documented. Requirements:

* Take these data formatting protocols: SPI, I2C, UART, 1-wire.
* Be a wall bug. It will plug in to a 12V power supply with a 12V converter.

### Custom Housing

Will be designed in-house. Everything will be documented. Requirements:

* Cover the Raspberry Pi Zero W from the elements.
* Have ports for:
  + The 5V Power supply
  + The SPI, I2C, UART, and 1-Wire
* Optional: Covers for the ports.

# Heater – Battery pack

## Introduction:

All battery packs must have a heater. When batteries get too cold, there is a possibility of permanent damage to the batteries, and an unnatural reduction of life cycles might occur. There is no heater for the battery pack currently on-site, but here is my proposal: install a heater for wherever the batteries are stored. The heater will be controlled by a relay, which will be controlled by the BMS system. The BMS system has temperature sensors on-board to tell when the batteries are getting too cold.

Model: Asixx Air Heater, 100W 12V Energy Saving PTC Car Fan Air Heater Constant Temperature Heating Element Heaters for Heater, Humidifier, Air Conditioning and More

Company: Asixx

Company Website:

Product Page: <https://www.amazon.com/Asixx-Constant-Temperature-Humidifier-Conditioning/dp/B07HCB95SJ/ref=asc_df_B07HCB95SJ/?tag=hyprod-20&linkCode=df0&hvadid=309851778232&hvpos=1o1&hvnetw=g&hvrand=4833336270821486334&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9061320&hvtargid=pla-574478162578&psc=1>

Details:

Rated Voltage: 12V

Rated Power: 100W

Mounting Hole Distance: Approx. 87mm / 3.4inch

Mounting Hole Size: Approx. 4mm / 0.2inch

Product Size: Approx. 6 \* 6 \* 4.2cm / 2.4 \* 2.4 \* 1.7inch

Product Weight: Approx. 120g

We will mount this wherever the battery pack is.

# Cooler – Battery pack

## Introduction:

We should be burying our batteries underground to protect against warmer temperatures (according to forum rumors). If the batteries have an excessive load, they become at risk for overheating. If the batteries are overheated for too long, they will become permanently damaged. We must have a cooler for our battery pack to cool the batteries. I propose we install a fan or a radiator. The air underground usually stays at least 25 – 30 C, so we can use that air to cool the batteries.

I don’t have a solid choice of cooler yet, but this is my best guess so far:

Model:

Company:

Company Page:

Product Page:

<https://www.amazon.com/Performance-Electric-Radiator-Mounting-%EF%BC%88Diameter/dp/B01N0686K5/ref=asc_df_B01N0686K5/?tag=hyprod-20&linkCode=df0&hvadid=241994092016&hvpos=1o4&hvnetw=g&hvrand=169244523548284450&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9061320&hvtargid=pla-449411562922&psc=1>

Details:

* Overall Diameter:11.73 INCH,
* Overall Thickness:2.56 INCH
* 1550 CFM Car Cooling Fans
* Amp Draw: 6.6 amp
* Watts:80W
* Blade Length: 11inch
* Number of Blades: 10
* Blade Type: straight
* High-quality, lightweight, and durable; great as replacement or upgrade from factory parts.
* Simple installation, no modifications required. Fan can be used as pusher or puller with the adaptable mounting kit.
* How to choose the correct fan?
  + Step 1: Confirm the width and depth of your radiator
  + Step 2: Compare the fan diameter and depth with radiator
  + Step 3: Choose the right size fan
  + ATTENTION: It can be installed only if the diameter of the fan is smaller than the width of radiator! Make sure the depth of the fan is smaller than the gap of radiator and other parts!

# AC outlet

Explanation:

Every once in a while, somebody will want to use an AC outlet to power a laptop or charge a phone. An AC outlet is absolutely necessary to do these things. To have an AC outlet on a DC power grid, we must have an inverter. Here’s our inverter:

Model: Morningstar Suresine Inverter 300W

Model number: SI-300-115V-UL (60Hz)

Company: Morningstar

Company Website: <https://www.morningstarcorp.com/>

Product Page: <https://www.morningstarcorp.com/products/suresine/>

**Details:**

Data Communications: RJ-11Connection with Morningstar Meterbus / MODBUS RTU (16-bit)

Continuous Power Rating: 300W @ 25 C

Peak Power Rating (10 minutes): 600W

DC input voltage: 10.0V - 15.5 V

Waveform: Pure Sine Waveform

AC Output Voltage (RMS): 220V or 115V +/- 10%

AC Output Voltage Frequency: 50 or 60 Hz +/- 0.1%

Peak efficiency: 92%

Total Harmonic Distortion (THD): < 4%

Self Consumption:

Inverter On (no load): 450mA

Inverter Off: 25mA

Stand-by: 55mA

Low voltage Disconnect (LVD): 11.5V or 10.5V

Low Voltage Reconnect; 12.6V or 11.6V

LVD Warning Threshold (buzzer): 11.8V or 10.8V

LVD Delay Period: 4 minutes

High voltage disconnect: 15.5V

High Voltage Reconnect: 14.5V

Standby On Threshold: ~8W

Standby Off Threshold: ~8W

High Temperature Disconnect: 95 C (heatsink)

High temperature reconnect; 80 C (heatisnk)

**Electronic Protections:**

Reverse Polarity (fused)

AC Short Circuit

AC overload

DC Terminals: Max wire size:

– 2.5 to 35 mm^2 / 14 to 2 AWG

Remote On/Off terminals: Max. Wire size:

– 0.25 to 1.0 mm^2 / 24 to 16 AWG

Enclosure: IP20

Cast anodized Aluminum

**Physical Characteristics:**

Dimensions: 213 x 152 x 105 mm (8.4 x 6.0 x 4.1 in)

Weight: 4.5 Kg/10.0lbs

AC terminals: Max wire size:

– 4 mm^2 / 12AWG

**Environmental Protections:**

Ambient Operating Temperature: -40 C to +45C

Storage Temperature: -55 C to +85C

Humidity: 100% (non-condensing)

Tropicalization: Conformal coating on PCBs. Epoxy encapsulated transformer and inductors.

# Accessories:

3A fuse

100A fuse

GFCI outlet:

Model: 15 Amp Self-Test smartlock pro slim duplex GFCI Outlet, white

Company: Home Depot

Company Website: <https://www.homedepot.com/>

Product Page: <https://www.homedepot.com/p/Leviton-15-Amp-Self-Test-SmartlockPro-Slim-Duplex-GFCI-Outlet-White-R02-GFNT1-0KW/206001533>

GFCI outlet box:

Model: 1-Gang Weather Box While-In-Use cover

Company: Home Depot

Company Website: [https://www.homedepot.com](https://www.homedepot.com/)

Product Page: [https://www.homedepot.com/p/1-Gang-Weather-Box-While-In-Use-Cover-WIU-1/206469236?cm\_mmc=Shopping%7CG%7CVF%7CD27E%7C27-6\_CONDUIT-BOXES-FITTINGS%7CNA%7CPLA%7c71700000033099037%7c58700003867178937%7c92700031086148565&gclid=EAIaIQobChMI2PLwrenQ4wIVAf\_jBx2q5Q92EAkYASABEgKGrPD\_BwE&gclsrc=aw.ds](https://www.homedepot.com/p/1-Gang-Weather-Box-While-In-Use-Cover-WIU-1/206469236?cm_mmc=Shopping|G|VF|D27E|27-6_CONDUIT-BOXES-FITTINGS|NA|PLA|71700000033099037|58700003867178937|92700031086148565&gclid=EAIaIQobChMI2PLwrenQ4wIVAf_jBx2q5Q92EAkYASABEgKGrPD_BwE&gclsrc=aw.ds)

Recommended Accessories:

RJ-11 Meterbus to USB MODBUS adapter

Model: Morningstar USB MeterBus Adapter > UMC-1

Company: Morningstar

Company Website: [https://www.morningstarcorp.com](https://www.morningstarcorp.com/)

Product Page: <https://solarflexion.com/umc-1?_vsrefdom=adwords&gclid=EAIaIQobChMIs6q9_eTQ4wIVef_jBx3u-AdIEAQYBSABEgKaCPD_BwE>

RJ-11 data communications cable

Model: USB Meterbus Adapter

Company: Morningstar

Company Website: <https://www.morningstarcorp.com/>

Product Page:<https://www.morningstarcorp.com/products/usb-meterbus-adapter/>

# Web Server

## Introduction:

We must have a server to send the data to. I’m sending all my data in JSON format so it’s easier for the website to read it.

In my down time (when I’m too tired to work on electronics), I would like to work on the website.

I would also like to use Squarespace temporarily. They advertise everywhere, they offer hosting, and they offer good templates.

I will be crossing the bridge when we get to it.

Also, I would like to call upon the help of a professor for this one.

Host: ucsc.edu

Website link: arboretum-backend.soe.ucsc.edu/ (user requested)

Server Location: ???

Who to call when things go bad: ???

Uptime Percentage: ???

Language Programmed in: ???

# Power Conversion

## Introduction:

All our microcontrollers that we are using need +5V to operate properly. Our batteries distribute power in +12V packages. Therefore, we need a way to convert that power reliably.

## Requirements:

* Tolerance ranges: +4.5V to +5.5V
* Ends in a Micro-USB plug

We can either design a DC-DC voltage converter ourselves, or we could try to get one from a commercial retailer and hope it has good enough tolerances for our Raspberry Pi. Either way, we must have a DC-DC voltage converter.

I propose that we get one from a commercial retailer. That way, if there are any malfunctions with it, we don’t have to build another one ourselves, we can simply buy another one from the same retailer.

Here’s my recommendation:

Model: DC-DC 12V to 5V 3A Micro USB Converter Voltage Step Down Regulator Waterproof Power Converters for Car Smartphone

Company: Car Power Technlogies (CPT)

Company Website:

Product Pages:

<https://www.amazon.com/Converter-Regulator-Waterproof-Converters-Smartphone/dp/B07H7X37T6/ref=asc_df_B07H7X37T6/?tag=hyprod-20&linkCode=df0&hvadid=241968535606&hvpos=1o1&hvnetw=g&hvrand=2561462318447783132&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9061320&hvtargid=pla-600746528101&psc=1>

<https://www.aliexpress.com/item/32581610768.html>

Sales pitch:

* This voltage converter uses high quality industrial-grade chip, with high conversion rate and stability
* Widely used for car stereo, radio, monitoring, LED display, electric fan, motors and other electrical appliances, etc.
* It supports 3 intelligent security protection including over-current protection, over temperature protection and output short circuit protection
* Copper wire has great electrical conductivity, low thermal, low carbon and save more power
* Fire retardant plastic casing and organic silicone sealing technology has strong thermal conductivity, IP67 ingress rating, waterproof and shockproof
* Type: Non-isolated step-down voltage converter

Features:

* Output Connector: Micro USB
* Input Voltage: DC12V
* Output Voltage: DC5V
* Output Current: 3A, 2.5A(no need to enhance heat dissipation for long time use)
* Output Power: 15W
* Max. Efficiency: >95%
* Operating Temperature: -40¡æ to 80¡æ
* Overall Length: 50cm/19.7in
* Block Size: 6.4\*2.7\*1.4cm/2.5\*1.1\*0.6in
* Weight: 41g(approx.)
* Working temperature: -40C to 80C

I propose we use this power converter for all our 5V devices.