

Components Document

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Solar Panels:

Explanation:

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:

Electrical Data (STC)	
Peak Rated Power	100 Watts
Maximum Power Voltage	10.6 Volts
Maximum Power Current	9.50 Amps
Open Circuit Voltage	13.3 Volts
Short Circuit Current	9.96 Amps
Mechanical Data	
Dimensions (mm)	1648 x 990 x 4.2
Dimensions (inch)	64.9 x 38.0 x 0.165
Weight	17 kg (37.5 lbs)
Frame	None
Junction Box	Tyco PV Bar 4
Cables / Connectors	Tyco PV4-S
Solar Cells	Bifacial PERC 5BB
Temperature Ratings	
Temperature Coefficient of Pmax	-0.39%/C
Temperature Coefficient Voc	-0.31%/C
Temperature Coefficient of Isc	-0.045%/C
Maximum Ratings	
Maximum System Voltage	1000 V
Maximum Series Fuse Rating	15A
Maximum Hail Resistance	38mm (1.5 in.)

Charge Controller:

Explanation:

Solar panels cannot charge batteries directly. 1.) They have unstable voltages, and thus should not be connected directly to the battery. 2.) Batteries with different chemical compositions charge differently. Solar panels do not charge them properly. We must have a charge controller. I like this one since it is not only custom-programmable, you can get a significant amount of data from it.

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

Company: Morningstar

Company Website: <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

Tristar Morningstar MPPT can monitor:

From the 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****Explanation:**

The greenhouse naturally changes 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.

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

Explanation:

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.

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

Explanation:

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:

Specifications		
Model name	CA180AHA	Alternative product marking CA180FI
Nominal voltage	3.2 V	Operating voltage under load is 3.0 V
Capacity	180 AH	+/- 5%
Internal impenetrableness	<0,6 mOhm	1 kHz AC
Operating voltage	min 2.6 V - max 3,6 V	At 80% DOD
Discharging cut-off voltage	2.5 V	The cells is damaged if voltage drops bellow this level
Charging cut-off voltage	3.65 V	The cells is damaged if voltage exceeds this level
Recommended charging - discharging Current	54 A	0.3 C
Maximum short-time discharging current	1000 A	5,5 C period = 10 s
Life cycles	2000	0.3C, 80% DDC
Operating thermal ambient - charging	0°C ~ 45°C	The battery temperature should not increase this level
Operating thermal ambient - discharging	-20°C ~ 55°C	The battery temperature should not increase this level
Storage thermal Ambient	-20°C ~ 45°C	The battery temperature should not increase this level
Shell Material	Plactic	Flame retardants
Dimensions	180 x 277,5 x 71 mm	Millimeters (tolerance +/- 1 mm)
Weight	5,6 kg	Kilograms (tolerance +/- 150 g)

Battery Management System:

Explanation:

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.

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

BMS control unit can monitor:

From the system as a whole:

Battery Charge

Charger Status

Current and Voltage

Distance and Energy (if applied to an electric vehicle)

BMS status

Time and Date

Version Number

From each individual cell and from the system as a whole:

Battery Balancing Rate

Temperature

Battery Voltage

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>
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

Explanation:

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

The product page and the datasheet are different pages because I want to purchase a whole breakout board instead of homebrewing my own board for it. It's easier to have a breakout board, and easier to order a new breakout board from ADAFRUIT than it would be to order a PCB, and solder the components onto it.

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

Also can measure pressure if necessary

Light Sensor:

Model: VEML7700

Quantity: 2

Company: Vishay Semiconductors:

Company Website:

Product Page: [https://www.adafruit.com/product/4162?](https://www.adafruit.com/product/4162?gclid=EAIaIQobChMIyOmfve7Q4wIV6f_jBx07fQ1yEAQYASABEgJti_D_BwE)

[gclid=EAIaIQobChMIyOmfve7Q4wIV6f_jBx07fQ1yEAQYASABEgJti_D_BwE](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

Faculty Microcontroller

Explanation:

There must be a master microcontroller to harvest data, process it, and send it to the server.

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

Python interpreter

4 USB ports

20 GPIO pins

I2C, UART, and SPI interface

Runs Linux

Bluetooth and Wi-Fi Capabilities

Sensors – Student

Explanation:

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 sensor:

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

Details:

Interface: One-wire

Range: -55 C to 125 C

Accuracy: +- 0.5 C from -10 C to 85 C

Programmable resolution from 9 bits to 12 bits

Student Microcontroller

Explanation:

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.

Model: Raspberry Pi 3 Zero W

Quantity: 2

Company: Raspberry Pi

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

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

Details:

Voltage: 5V

Heater – Battery pack

Explanation:

The battery pack must have a heater. If the batteries get too cold during the winter, they could become permanently damaged.

Model:

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&hvrnd=4833336270821486334&hvpone=&hvptwo=&hvqmt=&hvdev=c&hvdvcmdl=&hvlocint=&hvlocphy=9061320&hvtargid=pla-574478162578&psc=1

Details:

Rated Voltage: 12V

Rated Power: 100W

Cooler – Battery pack

Explanation:

We should be burying our batteries in the ground to protect against warmer temperatures. However, if the batteries have an excessive load, they become at risk for overheating, and eventually going dead. We must have a cooler for our battery pack in case of heated batteries. I propose we use a fan. The air underground usually stays at least 25 – 30 C; we can use that air to cool the batteries.

Model:

Company:

Company Page:

Product Page:

AC outlet

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:

Input Voltage: 12V

Maximum Power: 300W

See datasheet.

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>

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%7CG%7CVF%7CD27E%7C27-6_CONDUIT-BOXES-FITTINGS%7CNA%7CPLA%7c71700000033099037%7c58700003867178937%7c92700031086148565&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>

Product Page: [https://solarflexion.com/umc-1?
_vsrefdom=adwords&gclid=EAIaIQobChMI6q9_eTQ4wIVef_jBx3u-
AdIEAQYBSABEgKaCPD_BwE](https://solarflexion.com/umc-1?_vsrefdom=adwords&gclid=EAIaIQobChMI6q9_eTQ4wIVef_jBx3u-AdIEAQYBSABEgKaCPD_BwE)

GSM module

Explanation:

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.

Name: Raspberry Pi GSM/GPRS Shield

SKU: S13

Company: Sixfab

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

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

s

Features:

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

SIM card

Explanation:

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.

Web Server

Explanation:

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.

Crossing the bridge when we get to it.

Host: ucsc.edu

Website link: arboretum-backend.soe.ucsc.edu/

Server Location: ???

Who to call when things go bad: ???

Uptime Percentage: ???

Language Programmed in: ???