Components Document

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Solar Panels:

This is a client request.

Model: LUMO 20M100GH
Quantity: 24x
Company: Soliculture

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 Pma	-0.39%/C
Temperature Coefficcient Voc	-0.31%/C
Temperatre 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.)

Product link:
http://www.soliculture.com/product/

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 read:

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

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 read:

From the system as a whole:

Battery Charge
Charger Status
Current and Voltage
Distance and Energy (if applied to an electric vehicle)

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, cell
- Min Cell Temperature
- Max Cell Temperature
- Max Cell Temperature Difference

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.

Temperature and Humidity Sensor:

Model: DHT22
Quantity: 1
Company: ADAFRUIT
Company Website: https://www.adafruit.com/
Product Page: https://www.adafruit.com/product/385

Details:

Good for 0-100% humidity readings with 2-5% accuracy
Good for -40 C to 80 C temperature readings with +-0.5 C accuracy
No more than 0.5Hz sampling rate
Interface: I2C

Light Sensor:

Model: TSL2561
Quantity: 1
Company: ADAFRUIT
Company Website: https://www.adafruit.com/
Product Page: https://www.adafruit.com/product/439

Details:

Temperature range: -30 C to 80 C
Dynamic range: 0.1 to 40,000 Lux
Voltage range: 2.7 – 3.6V
Interface: I2C
Approximates Human Eye Response

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&hvrand=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

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: ???