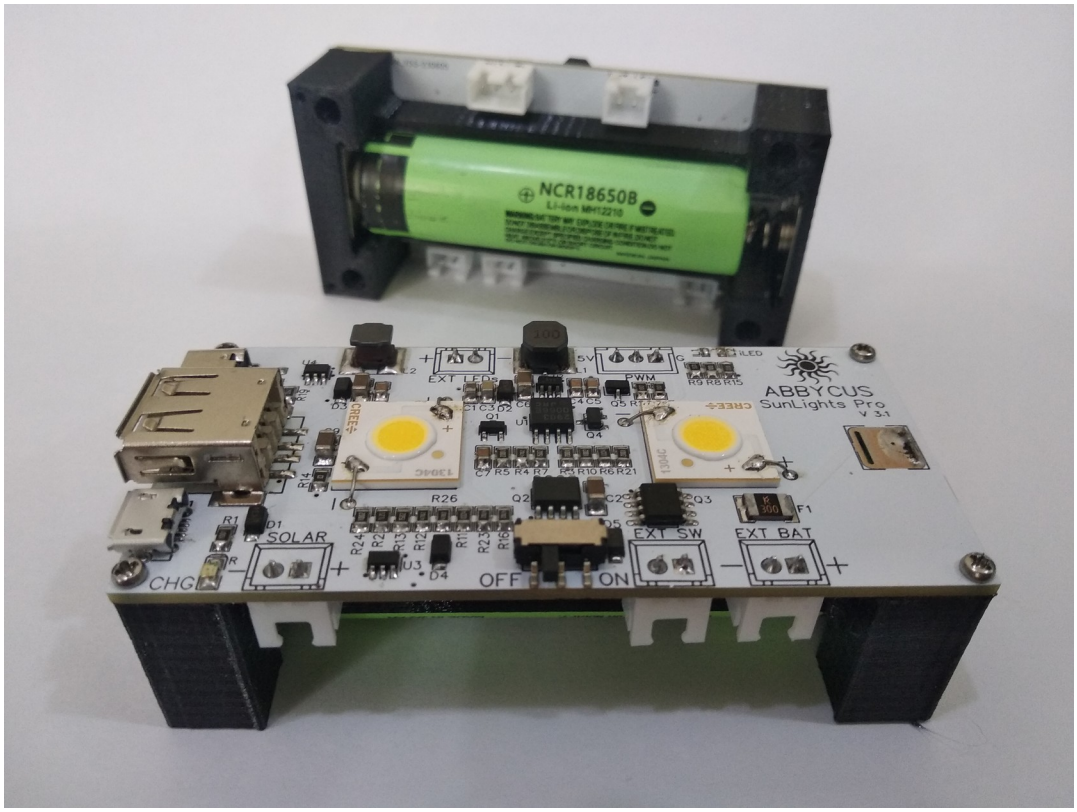
Abbycus 2023

SunLights Pro

Solar-Powered Lighting Solution and Multi-purpose Power Bank.



Introduction

Introducing the SunLights Pro: A Versatile Solar-Powered Lighting Solution and Multipurpose Power Bank. With its reliable performance and cost-effective design, the SunLights Pro empowers you to effortlessly implement practical solar lighting solutions that align with your specific needs. From illuminating gardens and pathways to charging devices in off-grid situations, this innovative solution offers a convenient and sustainable way to meet your solar lighting and energy harvesting requirements.

Versatile Lighting Solution

SunLights Pro provides a comprehensive solution for commercial and home lighting applications. With its high brightness COB LED array and automatic light-sensitive switching, it offers a simple and low cost method to provide high brightness illumination.

A complete system requires only a simple connection to a solar panel to capture solar energy and provide high brightness with long burn performance.

The integrated storage battery accumulates energy during daylight hours, ensuring a robust supply of power whenever it’s needed. As dusk falls, the lighting controller automatically activates the lights, providing illumination when darkness falls.

SunLights Pro can be easily installed indoors while the solar panel can be mounted elsewhere in an optimum location to capture maximum solar energy and optimize system performance.

Practical and Portable

SunLights Pro isn't limited to fixed installations. Its compact portable design allows you to take powerful illumination wherever you go. From camping trips and outdoor adventures to emergency lighting during power outages, SunLights Pro serves to provide portable and efficient lighting wherever needed.

Solar-Charged Power Bank

With SunLights Pro you not only have superior portable lighting but the stored solar energy is available for powering and charging your devices (phones, tablets, and other USB-compatible devices). Stay connected and empowered in off-grid situations.

Versatile Applications

SunLights Pro's can be seamlessly integrated into a wide range of applications, including artistic displays, event lighting, landscape illumination, and more. Let your creativity soar as you explore the limitless possibilities of SunLights Pro in bringing your projects to life.

Reliability That Matters

Built with industrial-grade components and rigorous testing, SunLights Pro delivers quality, reliability, and durability under extreme environmental conditions. Its robust construction ensures long-lasting performance, making it a trusted solution for demanding environments and applications.

Additional Features

SunLights Pro is not just a lighting controller and power bank – additional features enable more possibilities.

- Simple ON/OFF and brightness control using an external digital PWM control signal.
- External LED connection allows the SunLights Pro to power a string of external LED's instead of the embedded COB LED array.
- External battery connection allows the controller to use an alternate Lithium-Ion battery. Virtually any single 3.6V L-ion cell is compatible. An external battery has the same protections as the default battery.
- Any 5V solar panel can be used. The power output of the solar panel will determine the amount of energy harvested during daylight hours.
- The embedded battery can also be charged from a standard phone/tablet charger or charged from another power bank.

The Battery

The SunLights Pro incorporates a fixture used to mount a cylindrical Lithium-Ion 3.6V cell. The fixture contains spring loaded battery contacts to insure reliable contact under rugged use.

The battery fixture is a 3D printed part using PETG material for durability and temperature resistance.

Battery Selection

The user has a choice of fixtures to accommodate one of two battery types:

1) The standard 18650 flashlight type.

2) The 'Tesla' 21700 type.

The choice of battery type depends on the user application, size, weight, and budget.

Battery Type	Pros	Cons

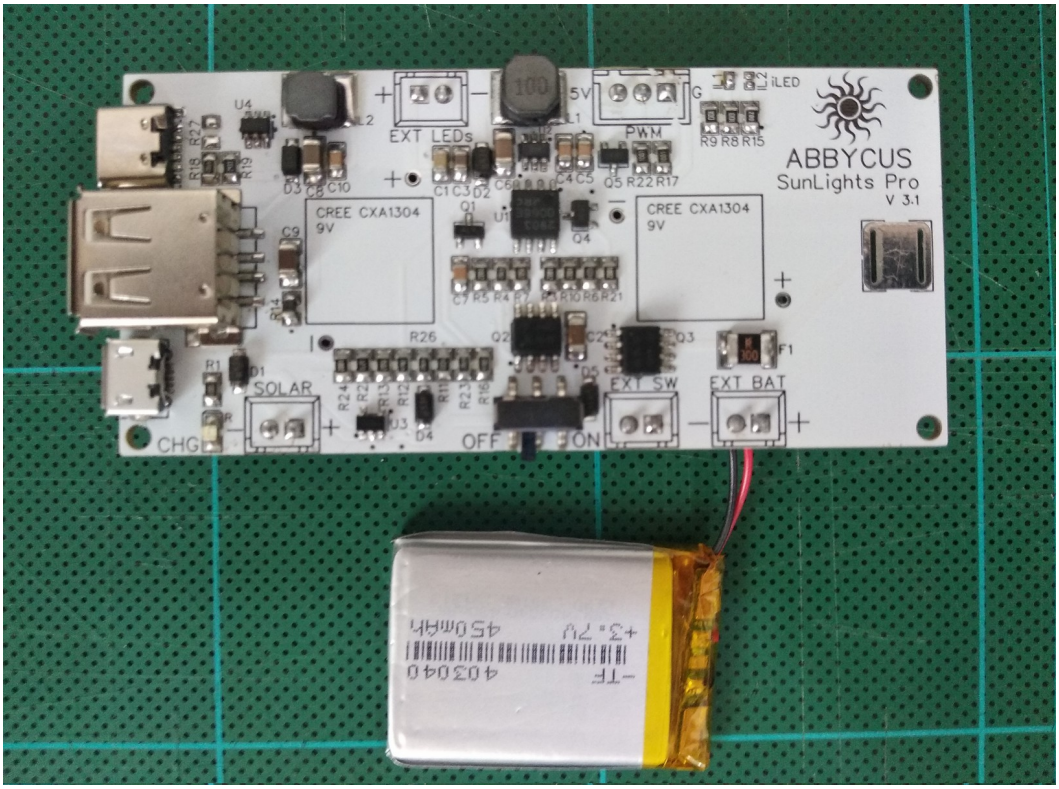
18650	• Smaller size and lighter weight • Less expensive • More popular – better availability	• Lower power capacity.
21700	• Higher power capacity	• Heavier and more expensive • Longer charge time

Battery Protections

The battery has several protections as follows:

- Reverse polarity protection prevents damage caused by accidentally installing the battery backwards.
- Over current protection prevents high charge/discharge currents from damaging the battery. This is accomplished using a re-settable poly-fuse which opens if the current flow exceeds 3 amps. After a delay the fuse will close allowing continued operation. If the high current condition persists, the fuse will open again.
- Charge over-voltage protection prevents the battery voltage from exceeding 4.2 volts during charging.
- Charge over-current protection limits charge current to 0.8 amps.
- Under-voltage protection disables the controller when battery voltage falls below 2.75 volts (total discharge).

Optional External Battery



The SunLights Pro controller can optionally use an external battery. Any Lithium-Ion 3.6V cell can be utilized and the same battery protections apply to the external battery.

The optional battery is connected to the controller via a 2 pin connector labeled **'EXT BAT'**. The mating connector is a XH2.54 0.1" spacing wire connector.

Please note that the external battery is to be used as a alternative for the default battery and is not meant to be used in parallel with the default battery.

About Battery Capacity

Lithium-Ion battery cells have a useful voltage range of 4.2V (100% charged) down to 2.75V (fully discharged). Energy storage capacity is the continuous current that the battery can source over a period of one hour expressed as milliamp hours (mAh). For example, a battery that can supply 1 ampere of current for 1 hour would have a capacity rating of 1000 mAh.

Some 18650 batteries have capacities as high as 3500 mAh and some 21700 batteries have a capacity of more than 4500 mAh. The 21700 battery's higher capacity may be preferable in power bank applications but the 18650 battery is smaller, lighter, lower cost, and may have better availability.

Estimating Required Battery Capacity

Battery capacity for a particular application depends on the current required during a specified time period. Example:

- The power used by the LED's with the default 40ma current setting requires about 0.75W per hour.
- The device must operate continuously for 10 hours, therefore the battery capacity needed is 7.5W.
- Use the following formula to estimate required battery capacity: mAh = total watts used divided by an average voltage constant (**mAh = 7.5 / 0.0036)**. In this example the battery capacity would need to be ***at least*** 2083 mAh and it is always prudent to add a tolerance factor of say 20%, so a safe bet would be a battery whose actual rating is about 2500 mAh (see below About Battery Manufacturers).

About Battery Manufacturers

Buying a battery from one of the thousands of online sources can be daunting. Many sellers and manufacturers falsely state capacity numbers and sometimes these claims are absurd but since there is no policing, these claims are never corrected.

In the case of 18650 batteries, if a battery is rated much higher than 3500 mAh, it is very likely a false rating and the actual capacity is probably much lower.

Price is usually a valid indicator of quality. The ***"you-get-what-you-pay-for"*** adage applies here.

Weight is another good indicator of quality. Lithium is a heavy metal and the amount of that metal directly equates to energy capacity. A 18650 battery rated at 3000 mAh normally weighs approximately 50 grams while a 21700 battery rated at 4000 mAh normally weighs approximately 70 grams.

High quality Lithium batteries are typically available from Japanese or South Korean manufacturers (Samsung, LG, and Panasonic are some examples). Beware of manufacturers claiming high capacity at a low price point.

Fake battery's online. Note the absurd rating of 9800 mAh!

There are numerous articles written about fake or highly exaggerated batteries and are worth reading. Since battery sourcing is so uncertain, the best way to validate a battery is to use a battery capacity tester.

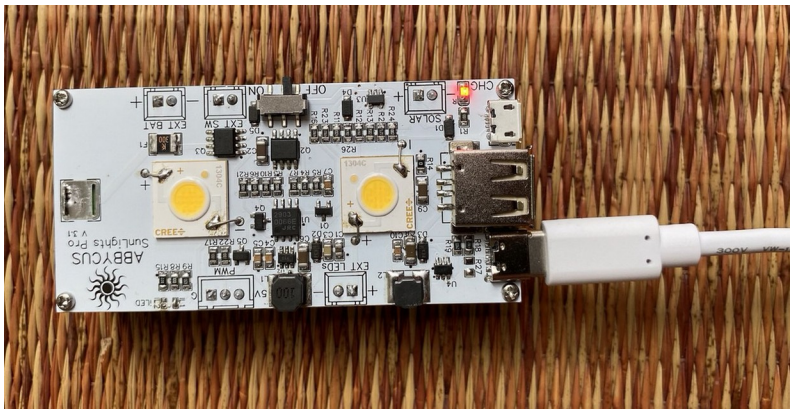
Measuring battery capacity

It is possible to use the SunLights Pro controller to measure battery capacity using a discharge approximation method. Since a batteries capacity is based on current discharge over time, the following method can approximate capacity:

1. Charge the battery to 100% (red charging light is off).
2. Unplug the solar panel and remove any connected USB chargers.
3. Turn on the light and measure the burn time (in hours) until the LED turns off (battery totally discharged).
4. Use this formula to estimate battery capacity in milliamp / hours: ***Real mAh capacity = (hours * 0.75) / 0.0036.*** ***** Example:** if the LED burn time is 8 hours, the battery capacity is approximately 1666 milliamp hours.

Please note the above method is an approximation but should yield reasonably close results.

Battery Charging



The SunLights Pro storage battery is charged from either the solar panel or through one of the USB charge ports (micro-USB or USB-C). The controller provides a maximum battery charge current of 0.8 amps (800 milliamps).

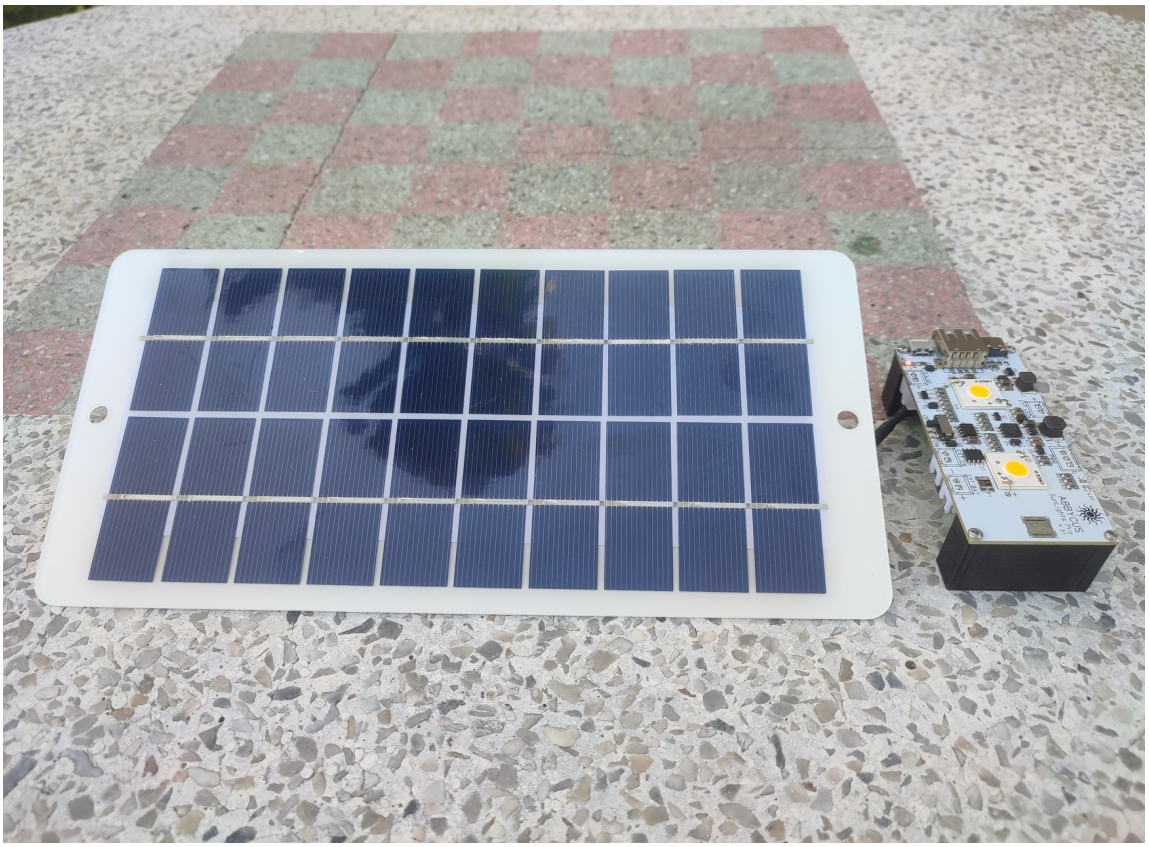
An on-board RED LED indicates if the battery is being charged. The LED will turn off when the battery is fully charged and the battery is not under load.

Note: If the device is also running other loads (charging a phone or lighting the LED's), the time to recharge the battery will be increased.

Solar Panel

The SunLights Pro can utilize any 5 volt (6.5V max) small form factor solar panel to charge the battery. Glass covered or PET encapsulated mono-crystalline panels are reasonably efficient and robust. Cheaper epoxy resin encapsulated panels work but oxidize quickly in the sun and are not recommended for long term installations.

Solar Panel Power Estimation



Solar panels are generally rated using power in watts but can also have ratings in milliamps. If the panel power rating is not expressed in watts, it can be easily calculated using the formula: ***Pw = 5V * (mAh / 1000).***

The following calculation shows how you can estimate the type of solar panel power for your particular application:

PP = Solar panel power output in watts.

BT = LED burn time in hours.

SE = Hours that the panel is exposed to the sun.

So **PP = (BT * 0.75) / SE**

Example: If the LED burn time is required to be at least 10 hours, and the panel has 4 hours of unrestricted exposure to the sun, the panel would need to produce approximately 2 watts of energy.

Solar panels are generally overrated by at least a factor of three. This is because solar panel ratings are idealized under conditions that aren't available in the average locale. Additionally, manufacturers and sellers of solar panels embellish performance numbers to sell panels so one must expect lower performance from their stated numbers.

This makes it difficult to estimate solar panel performance without trial & error. However a panel with a true output of 2 watts should yield a burn time up to 10 hours. This of course is greatly dependent on sun exposure, geographical location, time of year, etc.

The solar panel is connected to the controller PCB via a 2 pin header labeled **'SOLAR'**. The mating connector is a XH2.54 0.1" spacing wire connector.

LED's

The SunLights Pro controller uses two CREE CXA1304 9V LED arrays. The CREE LED's are connected in series to optimize efficiency and brightness matching.

Two colors are available: The default color is Cool White (color temp = 5000K). Warm White (color temp = 3000K) is also available. The Cool White LED's offer better lighting visibility but are not as aesthetically pleasing (IMHO).

LED Current Setting

LED current is selected using solder jumpers on the top of the PCB. Four levels of current setting are provided: 20, 30, 40, and 50 milliamps.

There are two solder jumpers on the PCB labeled IL1 & IL2 which are used to select the LED current as follows:

IL1	IL2	LED Current in Milliamps
Open	Open	20 ma
Open	Closed	30 ma
Closed	Open	40 ma (standard setting)
Closed	Closed	50 ma

Other LED current values can be set by changing the current set resistor value at **R9** (located next to the PWM connector). The standard current set resistor is 10 ohms but the user can change this value to achieve a custom LED current using the following formulas:

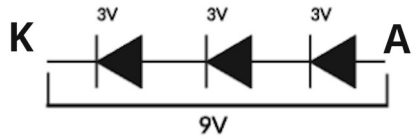
To calculate a custom value for R9 and you know the desired LED current, use the formula **R9 (in Ohms) = 0.2 / iLED (in Amps).** Example: If the desired iLED is 20 milliamps (0.02 amps), the formula **0.2 / 0.02** yields a current set resistor value of 10 ohms.

To calculate the LED current if the value of R9 is known, use the formula **ILED = 0.2 / R9.** Example: If the current set resistor is 4 ohms, the formula **0.2 / 4** yields an LED current of 0.05 amps (50 milliamps).

Note: The maximum LED current supported is 600 ma.

External LED Connection

SunLights Pro provides connection for external LED lights to be used. The external lights can be series connected strings of most types of LED's with a maximum forward voltage of 36 volts.



Example: If the individual external LED has a forward voltage drop of 3V, a string of up to 12 LED's can be connected.

The external LED's are connected via a 2 pin connector labeled **'EXT LEDs'**. The ANODE of the external LED string is attached to **'+'** terminal, the CATHODE (K) of the external LED string is attached to the **'-'** terminal.

External ON/OFF and Brightness Control

External ON/OFF can be controlled in two ways. There is a simple 2 pin connector labeled **'EXT SW'**. This connection parallels the on-board power switch.

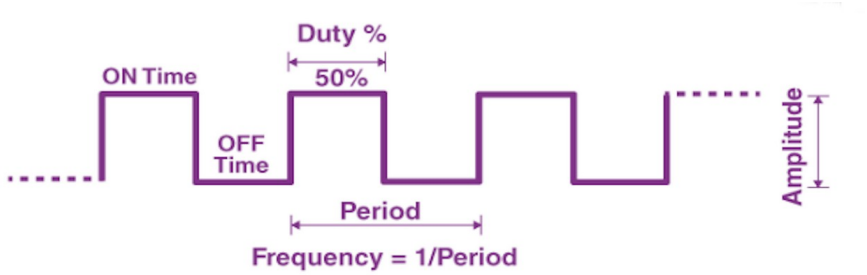
The second method uses the the 3 pin connector labeled **'PWM'**. If the middle pin (PWM) is connected to the outer pin labeled '5V', this will disable the lights.

Pin	Description
GND	System ground pin.
PWM	On/Off or brightness PWM signal.
5V	5V power supplied to the external circuit.

Brightness can be controlled by connecting a digital PWM signal to the middle pin labeled 'PWM'. The Pulse Width Modulated (PWM) signal can modify brightness by controlling the **duty cycle** of

the PWM signal. The PWM signal **period** can be in the range of 5KHz to 100KHz. The LED brightness will be proportional to the duty cycle of the square wave.

Note that the PWM signal input is inverted. This means that a decreasing duty cycle will cause an increase in brightness.



As an example, if the square wave duty cycle is 50%, the brightness will be 50% of its maximum value. A duty cycle of 25% will yield 75% brightness. A duty cycle of 60% will yield 40% brightness, and so on.

The **amplitude** of the input PWM signal can be in the range of 2V to 12V relative to the GND pin.

Extended Lighting Mode

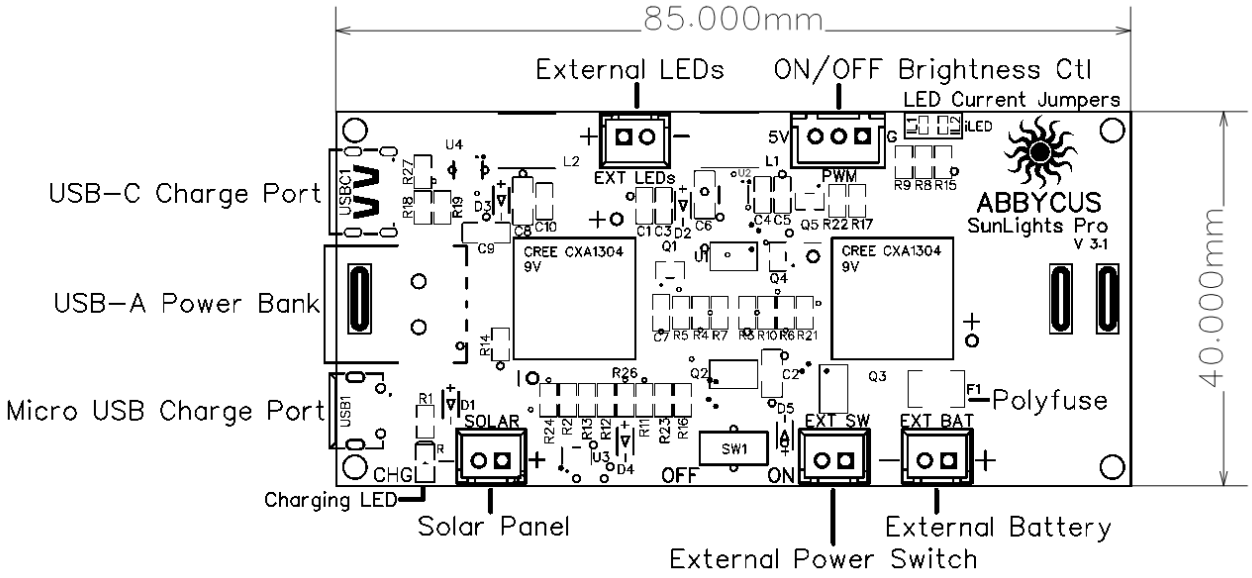
Extended light mode occurs when the battery falls below 20% of full charge. The light output is reduced to about 50% which increases the total burn time by approximately 5%.

Power Bank Feature

The energy harvested from the solar panel and stored in the embedded battery is available to power and charge phones, tablets, and other devices. The power bank feature can also be used to power other remote devices such as home automation cameras, sensors, etc.

The power bank output is available through a standard USB-A socket connector which provides 5 volt power at up to 2.0 amps.

Physical Dimensions



The SunLights Pro PCB has an outline dimension of 85L x 40W x 10H mm. Additional height of the 18650 battery mount is 18mm whereas the 21700 battery mount is 22 mm high.

The combined weight of the SunLights Pro PCB and the associated battery mount is 34 grams. This weight does not include the battery.

Mounting Detail

The user can mount the SunLights Pro using the four M3 brass inserts embedded into the bottom face of the battery well.

The mounting screw spacing is as follows:

X – 72mm (2.8“)

Y – 32mm (1.25”)