Power to the Kookaberry

The Kookaberry has a generous and protected power supply which allows voltages to be used from different sources. Internally it takes an incoming voltage from up to three sources (simultaneously if required) and converts this into a board power supply voltage of 3.3 volts. This 3.3 voltage (Vcc) powers all the three microcontrollers on the Kookaberry as well as the peripheral components such as the display, serial random access memory (serial RAM), accelerometer, magnetometer, LED's etc.

The current drain on the incoming power supply is quite small and typically sits at around 20 mA peaking up to around 35 mA when the display is heavily used.

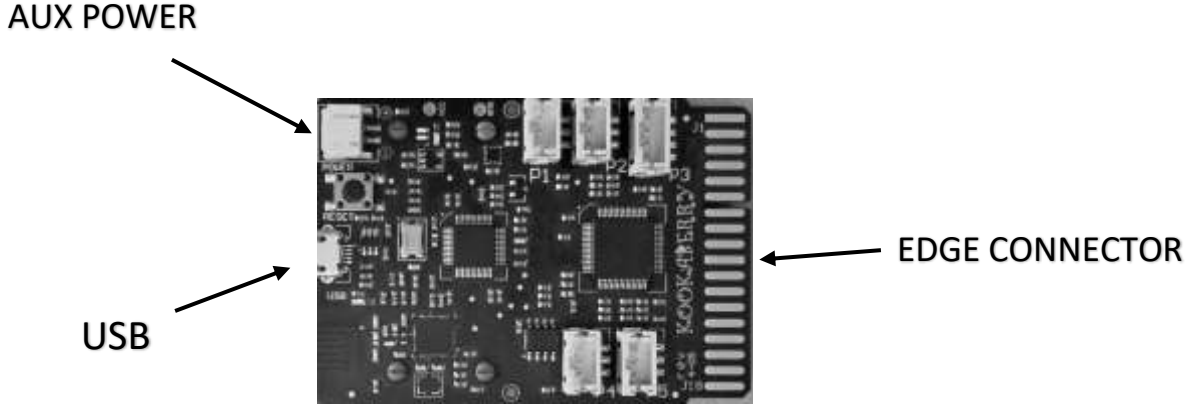
An allowance has been made for the Kookaberry to draw up to around 50 mA under certain operating conditions. An additional 100 mA has been allocated to power external peripherals associated with operating the Kookaberry including connected sensors. A user of the Kookaberry must consider this when connecting sensors to the board.

There are three power inputs to the Kookaberry

- The USB port.
- The AUX POWER input and
- Via the board Edge Connector

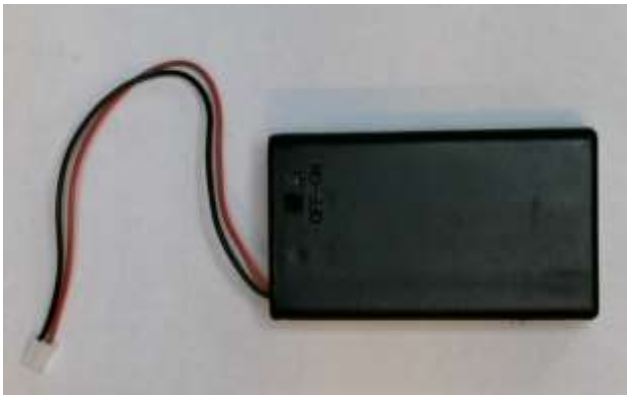
USB Port - The USB connector provides 5 volts to the Kookaberry when connected. Note that this 5 volts is a requirement of the USB 2.0 specification and a maximum of 200 mA can be drawn from this supply. This voltage is usually provided from a local PC having a USB 2.0 Master specification. This 5 volts is known as Vbus in the USB specification and it is used by the computer (i.e. a PC) and the Kookaberry to establish the enumeration connection required by the USB 2.0 specification. This 5 volts Vbus voltage from the computer (i.e. PC) is able to provide the 150 mA to the Kookaberry board.

AUX POWER - The AUX POWER input to the board is via the 2 pin JST-PH on board connector and can have a power supply voltage that is between 3.7 volts and 9 .0 volts. Users may choose different power supplies for different reasons.



Typically there are two different types of power supplies that are generally used with the Kookaberry

- 3 x AAA battery pack. Each AAA dry cell has a voltage of around 1.5 volts when new such that a battery pack of 3 x AAA cells would give around 4.5 volts



- A single USB re-chargeable battery that has an output of approximately 5.0 volts.

Both of the above power supplies can plug into the AUX POWER (2 pin JST-PH) connector on the Kookaberry given the appropriate cable connectors.

Edge Connector – The Edge Connector has a pin associated with brining power onto the Kookaberry board. It is only used if the Kookaberry is plugged into and auxiliary device that has an associated edge connector socket. The voltage is limited to the range 3.7 to 9.0 volts.

Battery Usage

All batteries and power supply systems such as is contained on board the Kookaberry have different working characteristics. It is important to have a working knowledge of these features

Power drain from batteries

The energy contained within a battery is commonly (typically) quoted in mAH (milliamp hours) for the sizes of batteries used by the Kookaberry. Whilst this might, on face value, give an indication of the theoretical energy content of the battery in practice it is quite difficult for the average person to comprehend and can be very misleading.

A typical user will simply want to know how long a particular battery will last. Unfortunately there is no simple answer to this.

Dry Cell Batteries

A typical AAA dry cell battery has a stated manufacturer's capacity around 1000 mAH (milliamp hours). From different manufacturers this can vary from say around 500 mAH to 1100 mAH. The only way to tell what WAS in the battery at a point in time is to discharge it at a known rate. ie put a known load on it and time the discharge. The time for the discharge will be a function of the load and different capacities of the battery will be found for different loads. To get more precise information you need to refer to the manufacturers specification and, if you can get the specification, there will be a series of load curves that show typical rated capacity for different discharge rates.

In addition to variability in the capacity of a dry cell battery not all of this power is available to the Kookaberry. Typically the manufacturer's battery capacity rating specification takes the discharge voltage of the battery down from a nominal 1.5 volts to 1.0 volts i.e. when the battery is no longer able to supply current. Note the battery may still have a measurable voltage of 1.0 volts but no meaningful power can be drawn.

The three AAA batteries in series give 4.5 volts to the Kookaberry. The discharge capacity of the battery combination is now specified to 3.0 volts. The power supply regulator on the Kookaberry board has an input cut off board input voltage of approximately 3.7 volts. Thus although the battery specification says it has around 1000 mAH (ie to discharge from 4.5 volts to 3.0 volts) because the Kookaberry will shut off at around 3.7 volts there may be only around 800 mAH is available for the Kookaberry to use. Thus the time available can be calculated as follows ----800 mAH at say 35 mA current drain gives around 23 hours. If the Kookaberry is powering any sensor with say a total load capacity of 150 mA then the AAA battery pack would last say around 5 to 6 hours.
The above is highly variable for any AAA batteries purchased.

USB Rechargeable batteries

The useability of the USB rechargeable batteries is a little different from the standard AAA dry cell batteries

Internal to the USB batteries packs are two generally two components being

- Charging / discharging electronics and
- Li-ion Battery

The Charging / Discharging electronics typically takes the power from the computers USB port. This is 5.0 volts and is limited to a maximum of 200 mA. There are two types of charging circuits. The simplest is a straight linear charger ie if you had a battery of a capacity of 1000 mAH then in theory it would take 5 hours to charge if a constant 200 mA could be supplied. This **does not happen** as the charge characteristics of the Li-ion batteries are far from linear. Typically, as current goes into the battery, the voltage rises and the charging current slows down. It is similar to a logarithmic curve with high current to start with and less current as time goes by.

Typically the Li-ion batteries used with the Kookaberry are around 3.7 volts. They can be run in series as well as parallel. Typically there is one industry standard round battery size (note - there are many standard sizes) known as a TR 18650 which is used in multiple applications such as torches etc as well as USB rechargeable batteries. The capacity standards (ie mAH) for these are highly variable due to their manufacture. Many are made in China and most manufactures distort the rated capacity.

The Charging / Discharging electronics inside the USB rechargeable battery must convert the 5 volts into 3.7 volts to charge the Li-ion battery. Linear chargers are most common but there are some so called “fast chargers” which use a pulsing system to get more energy into the battery in a quicker time. These need to monitor the battery temperature as there is a tendency for major issues with fast charging

When the USB charging voltage is disconnected the same electronics inside the USB rechargeable battery then converts to a dc/dc converter which changes the nominal 3.7 volts of the Li-ion battery to 5 volts. As the Li-ion battery discharges it is the job of the electronics to hold the 5 volts constant

As with the dry cell batteries the capacity of the Li-ion can vary considerably. Again whilst the actual energy put into a Li-ion battery can be measured using it can be a different issue. Most Li-ion batteries have a memory effect. If they are not completely discharged then it is not possible to put a full charge into them. ie if you have a partially discharged Li-ion battery and you plug it into a charger then without a measuring circuit you simply do not know what charged capacity is in the Li-ion battery. Most independent Li-ion chargers go through a discharge cycle before they charge the battery. This is not the case for normal USB chargers plugged into the mains to charge a USB rechargeable battery.

Also Li-Ion batteries have a limited number of charge/discharge cycles – with somewhere around 300 to 500 charge / discharge cycles being common.

A number of different USB rechargeable batteries have been trialled for use with the Kookaberry. Around 50% of them do not work well with the Kookaberry as they have discharge characteristics that do not work with the Kookaberry. This occurs when the USB rechargeable battery has been designed to re-charge a mobile phone battery. Many give

out random pulses to enhance the charging of the mobile phone battery and are unsuitable for the Kookaberry.

About 20 different USB rechargeable battery packs have been tested. In the long term we will need to buy in quantity, ie 1000 plus at a time, to get reasonable pricing and firm up on a manufacturer

The blue round USB rechargeable battery pack shown in the above picture is reasonably cost effective coming in at around $3.50 AUD landed costs when the batteries are brought in separately from the blue holder and electronics. They are a bit fiddly to set up and in the long term it will be necessary to find a manufacturer who supplies the complete unit.
These blue units have been tested with clone TR 18650 batteries and consistently give around 900 to 1000 mAH over 15 charge / discharge cycles -----note the clone battery claims to be 9900 mAH but this is quite an exaggeration. You would expect to pay around $30 for good quality TR18650 Li-ion battery. Tests have been performed on the 18650 batteries from Jaycar ($15.95) rated at 2600 mAH with results showing that it really is a 1200 mAH battery.
Also the Keji USB Powerbank from Officeworks ($4.98) was tested and again was around 1000 to 1100 mAH and not the 2000 mAH stated. The Green round Powerbank from Officeworks ($9.88) was also tested and found to be around the 900 to 1100 mAH capacity not the 2200 mAH stated.

Thus the same issues will arise when using the USB rechargeable batteries with the added complication that, without properly measurement, there is no way of telling how much charge is in the battery.
With the blue USB rechargeable battery in the picture above you would expect to get a life of around 24 hours at around 50 mA discharge rate. Much less if you are using power hungry sensors. This life will not vary much for the Officeworks USB power packs. Again, if the USB rechargeable batteries are not discharged before recharging then there is no way of really telling how much power is in the battery and how long it will last.

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