IoT Logger





Determining what battery can power our IoT gadget

Deep Sleep

Normal running: abt 60-70mA current.

Deep sleep: Way under 1 mA.

Strategy? Design your "project" so that ESP is asleep a large proportion of the time.

Minimises battery power required.

Battery Options

- (1)AA cells (or similar), throw-away.
- (2)AA cells NiCD or NiMH.
- (3)Gell-cell or motor-cycle battery.
- (4)Lithium Ion cells.

(Re-)Charging Options

(1)None. Throw away when flat

(2)Rotating sets of batteries, some running, some charging.

(3)Battery on 240V standby charge while also running. "Floating", UPS.

(4)Solar panel charging.

NiCD / NiMH

- About 1.25V / cell, not much volt drop until nearly empty.
- Happy to be cycled nearly down to empty.
- Vulnerable to overheating on overcharge, releasing gas & doing damage.
- "Constant current" charge modes:
 - Regular C/10 for 14 hours, then off charger
 - Fast about C, but careful detection against overcharge (temp monitor, or volt bump)
 - Trickle charge, eg C/50 or less, indefinite float.

Car & Gel-Cell batteries

Nominal 2.0V / cell

Lasts better if NOT often drained down to near flat. Pref not below 1.8V/cell.

Constant voltage charging (2.3 to 2.5V/cell)

Can be left on charger indefinitely.

Quite large capacities are available.

Li-Ion

Nominal 3.7V/cell.

Can be successfully run several in parallel if they start off matched. Needs much care:

- Very damaging to fully flatten it (below 2.6V?)
- Complicated charging requirement (part controlled current, part controlled volts, never above 4.3?) Overcharge will destroy.
- Mistreatment (eg short circuit, put in fire) can cause explosions.

BUT, tame its temperamental habits, and it is a very "efficient" battery (cycle life, energy/weight)

Li-Ion

Universally, Li-Ion cells are used with a suitably matching controller circuit board:

- Controls recharging, with correct current/voltage, & cuts off when full.
- Controls discharge, cuts off when volts too low.

Matching battery to its job:

Lead-Acid types can be a good IoT power supply, with 240V charger, and **huge** capacity to survive power outages. Overdesign = don't need to care much.

Li-Ion cells have restricted capacity relative to gell-cell. Requires efficient current draw by your project. Without careful design, your lot (using wifi that needs current) can need more energy than your battery can deliver.

Formulae

Ohms Law:AmpsI = V / RVoltsOhms

Power:

 $P = I \times V$ Watts or horsepower

Energy:

 $E = P \times T$

Watt-Hours or Joules



Efficiency (power)

A "back of the envelope" calculation

A-B 3.7 / 5 * 0.8 (2 voltages, battery in/out efficiency)

B-C 0.7 (convertor efficiency)

C-D 3.3 / 5 (voltages)

A-B-C-D total = 27% power efficiency

Ie, at best, only 27% of power from panel is available to the ESP8266.

Charging by solar panel:

Effective panel full-output hours/day (Brisbane) = 4.2

Theory. Does it work?

We want 5 – 7 volts from panel, not 12V. Many are 12V. "5V 1.2W" panel. Maybe we will get full output = 200 mA. Charge = 840 mAh each day. Battery charge circuit is volt-drop regulator. So only the panel current is relevant, not its wattage. Battery storage efficiency say 80%. So 672mAh effectively stored & re-available each day. Would take 6 days to fully charge from empty.

ESP8266 currents:

- 70mA steady, rising to 80mA if wifi busy.
- About 0.6mA if in deep sleep. And this is mainly the power LED! Could remove that led.

Very short spikes to 300mA.

Either the supply must be rated to supply 300mA (eg large AMS1117 regulator), or use 100mA supply with min 2000uF filter cap.

Boost convertor 3.7V - 5V:

Power out = power in, less convertor efficiency losses (say 70% efficient). Volts raised 3.7V to 5V. So output (ESP) current / input (battery) current = 0.70 * 3.7 / 5 = 0.51 So 4000mAh of battery gives 2040mAh to ESP8266.

We have 2000 mAh per day (best case) available for running the ESP8266.

In practice ...

When we measure our battery capacity (full charge mAh in, and full discharge mAh out), we seem to get values MUCH lower than this.

Why? What of our assumptions is wrong?

Practical tasks for this week (20 Aug–27 Aug):

- (1)Test our solar panel. What mA (instantaneous) and mAh (over the day) does a good sunny day give us? (Load = battery or old phone, etc)
- (2)Test our battery. What mAh is used to fill it up from flat? What mAh can a full discharge deliver? (Charger? Solar panel [slow!]? PC and usb cable? 5V phone charger?)