Mesobot Battery Trade Study

DGI 2017-11-14

Requirement:

Approximately 2-4 kWh lithium ion battery at 4S bus voltage, to supply LRAUV motherboard with power for Mesobot operations.

Constraints/Assumptions:

Load Control Board channel power is 5A or 60W maximum. This limit applies to each thruster. Total battery discharge current is 25A max. Guaranteed power is 300W (25A@12V) .

Recharge time is overnight or 10 hours. Faster turnaround is only possible by removing the entire battery housing and replacing it with a fully charged one.

Battery housing inside diameter is 11-12 inches by 16 inches long.

Other battery systems:

SWE modules are 1 kWh waterproof modules with Subconn IL10F connector potted into a brick. They are compact, heavy, and pre-engineered, no housings required. They make hot-swapping batteries easy. Unfortunately, they are expensive at $8/Wh and the lowest possible bus voltage is 5S so they are not highly compatible with LRAUV infrastructure.

Inspired Energy background:

Inspired Energy is low cost battery pack supplier at approx $1.3/Wh.

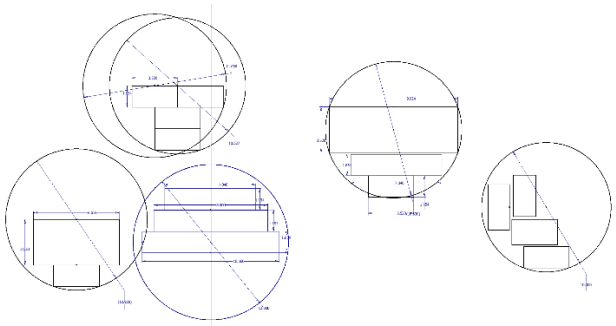
WHOI and MBARI are satisfied with packs reliability and performance. All other battery systems are more expensive, considering only the cost of swapping out all the cells for fresh ones.

MBARI is using a system based on Ocean Server battery charger and serial relay, combined with MBARI-made mux which slowly cycles through packs so that all are interrogated eventually by the Ocean Server serial relay.

Ocean Server is discontinuing the battery charger and serial relay boards upon which the MBARI battery system is built, so this system must be reworked in any case.

WHOI has similar systems with WHOI-made serial relay to interrogate the packs sequentially.

Fitting rectangles into circles, 40 Inspired Energy NH2034 packs can fit in an 11 inch inside diameter, while 48 packs can fit in a 12 inch inside diameter.



Charging constraints:

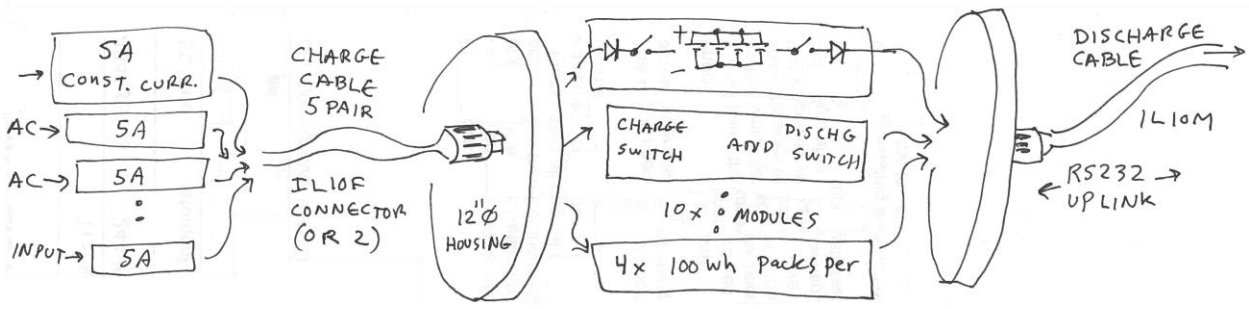
Energy can be supplied at bus voltage, or at a higher voltage.

Assume charger is a 36V supply and stepped down to 14V inside battery housing. Advantage is that fewer current need to pass through wet connectors, which are generally limited to 5A per pin. At 36V, a single Subconn IL10F can pass 25A through 5 pairs, or 900W. This will charge the vehicle in about 4.5 hours, although maximum speed charging will depend on ambient temperature and unlikely to be feasible most of the time because of heat produced inside the housing by the step-down converters.

The alternative is to charge at bus voltage, or 14V@25A = 350W. This dissipate very little heat inside the housing because there is no conversion. Unfortunately, it will take 11 hours through this IL10F connector. However, a useful compromise is to use two IL10F connectors to double the current that can be passed into the battery housing. This scheme will be more consistent than the high voltage charger because it is independent of ambient temperature, and will charge in about 5 hours.

Proposed Battery System:

Build a module made of several Inspired Energy 4S packs. The module size is driven by charging constraints. To ensure that current is shared equally by charging connector pin pairs, and prevent overcurrent on any particular pack, supply each pin pair with a separate 5A current source, and charge only one small group of packs with each pin pair. Therefore, the module size should be 4 packs. Up to 10 modules will be installed in a Mesobot, all sharing a single multidrop RS232 interface for status information.



In the above block diagram, switches would be double pole latching relays to galvanically isolate unused conductors, and diodes will be ideal diodes to minimize heat dissipation inside the housing.

One of these same modules could be used to power the tether buoy.

Critical Function Prototype:

ASAP build one 4-pack module to verify the entire power chain from charger through load including mechanical arrangement of NH2034 packs, voltage and current limits and transients of constant current supply, ideal diode function, latching relay function, trickle charge function and serial relay functions. It is unlikely there will be any giant mishaps, since similar variations have been built and tested. Nevertheless, for smoothest integration, prototype this module early and often and test with vehicle as it is developed and built. The cost per module is low since the modules are small, to allow fast iteration and prototyping.