**A. Overview**

The following provides some of the thinking in the pcb design. The design intends to provide a number of hardware configuration options. Some of these are to facilitate testing and program development and would not be needed in a later refined design.

This bms connects to a 16 series cell battery module. Multiple modules (six or seven) are connected in series to make a battery string. Hence, a battery string would use six or seven of these bms boards. The boards communicate and get their power from a CAN bus. This CAN bus carries the two CAN signals, plus “system” ground and system 12v (nominal). In addition to the modules on the CAN bus there will be a CAN node that is the “energy management controller” (EMC).

Since battery string is floats, or is biased via very large resistors, all of the battery modules are isolated from the system ground. The bms board processor and bms ic ground is at battery module minus level. CAN, FAN control, master reset, dc-dc power, are all isolated from system ground. More detail on this later.

For the processor this board can accommodate a STM32F405RxT6, STM32F446RxT6, or STM32L431RxT6. These are all 64 pin LPFQ packages. There small differences in the power pins so there is provision of the pcb for zero ohm or capacitors in several locations. The main target processor is the ‘L431. This processor has comparator and op-amp features not available in the ‘F405 or ‘F446, and is somewhat lower power as well.

The BMS controller is the Texas Instruments BQ76952, in a 48 pin LPFQ package.

The main features of the bms are--

- Low current module charger (approximately 80 ma)

- Cell-by-cell voltage measurement

- Cell-by-cell discharging

- Thermistors (three on BQ adc, plus two on processor adc)

- FET to discharge entire module via a resistor

- FET to turn on module heater

- FAN controller

- Headers for external pcb for external (to BQ) FET discharging

- Header for I2C

- Header for two external processor controlled LEDs

- Header for SWD (ST’s Single Wire Debugger, non-isolated!)

- Header for UART (non-isolated!)

The files for this project are on github repository--

GliderWinchItems/BMS

The files of interest for the board design described here, within the repository, can be found at

hw/eagle/bmsbmsBQ/bmsbq.sch and ‘.brd.

The general board layout has three ground plane sections. The leftmost (as viewed in eagle .brd) is the system ground (and 12v, etc.). The middle section is processor ground (which is at battery module minus level) and the right section the BQ cell wiring (which is also at battery module minus level). The processor ground and BQ ground are connected at one point in a effort to reduce the effect of digital noise from the processor with the BQ adc measurements.

**B. CAN bus connection**

A 10 pin ribbon with IDC type plug plugs into the bms board with a 2x5 keyed header. At the other end it is crimped into a 9-pin female D connector and a short distance onward to a male D connector. These 9 pin D connectors are mounted on the battery module box. Cables daisy-chain the battery modules together. Having the chain form a ring allows cutting the current drop in the power carrying wires in half. Furthermore, the plus and minus wires are tripled.

1 – system +12V

2 – system ground

3 – CAN L2

4 – CAN H2

5 – system ground

6 – master reset

7 - system +12V

8 - system +12V

9 - system ground

10 - unused

**12v polarity protection--**

Reverse polarity protection is provide by a pfet (U$1). The FET blocks if the +12v and system ground are reversed.

**Input current measurement--**

A 0.1 ohm series resistor (R33) allows for measuring the current input.

**Master reset--**

The master reset goes to a H11L1S opto-coupler. Pulling this line to system ground turns on the coupler LED and the output pulls the NRST (reset) line on the processor to ground. The 3.3K, R30 resistor on the opto input limits the current on the input, and the 10K, R61, pull-up resistor holds the NRST line normally high. The pushbutton allows manually resetting the processor. Diode D3 on the opto input protects against reverse polarity.

**LED-12V power--**

LED2, 6.8K, R18 indicates that 12V power is present.

**CAN 5v supply--**

From the 12v power, the AP7380Y (smd) linear regulator supplies 5v to the system side of the isolated CAN driver (ISO1042). The eagle net designation 5V/2.

**FAN 12v supply--**

Given the cooling fan(s) are 12v +/- 10%, but the system 12v will at times be 13.8v or even higher, a regulator is provided to limit the voltage to the FAN(s). There are two options. One is the LDK320 which is a SOT-89 package, which has a low quiescent current, but may not be available. The other is the venerable LM7812T which is a TO-220 package, but has an 8 ma quiescent draw.

**C. Power supply chain**

A 2x