Description of Electric System [for Technical Inspection SEM 2013]

System Description

The system consist of a Lithium-ion polymer propulsion battery, and a Battery Management System (BMS) tailored to survey this battery chemistry. The system features a Digital Unit able to analyze safety relevant parameters and interrupt the current if any parameter exceeds allowable threshold. Furthermore, to ensure maximum safety, redundant protection, independent of the Digital Unit, has been implemented as part of the analog frontend, which handles the measurements at cell level, and like the Digital Unit is able to interrupt the battery current. protection thresholds, battery data, etc. can be seen below, in the chapter: Safety related Information.
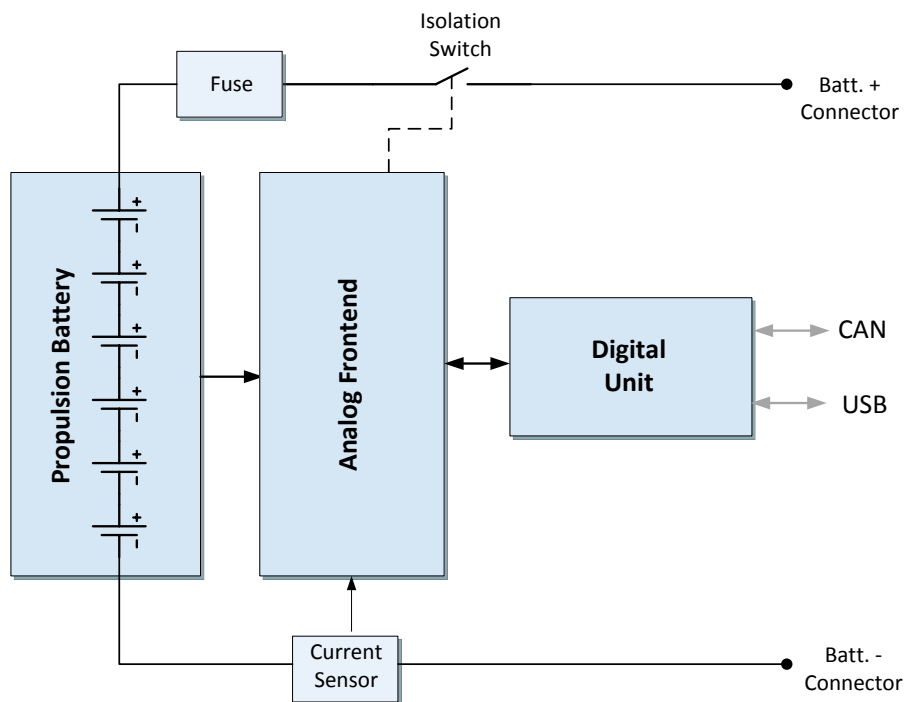
Block Diagram and Block Description

Figure 1 - general block diagram

Propulsion Battery

This unit, consisting of 6 Lithium-ion polymer battery cells, is responsible for storage of electrical energy. It captures energy from an external charger, solar panels and regenerative braking. And is capable of delivering the current needed to propel the propulsion motor.

Analog Frontend

This unit performs measurements and analog to digital conversion of cell voltages, battery temperatures and signal from current sensor. Furthermore it handles cell balancing on request from the digital unit, and redundant battery protection independent of the digital unit.

Current Sensor

Senses value and direction of battery current, and present this to the Analog Frontend.

Isolation Switch

This unit enables the BMS to interrupt the battery current.

Digital Unit

Collects measured values from the analog frontend and perform calculations and estimations of cell and battery parameters. Furthermore it handles communication with external units.
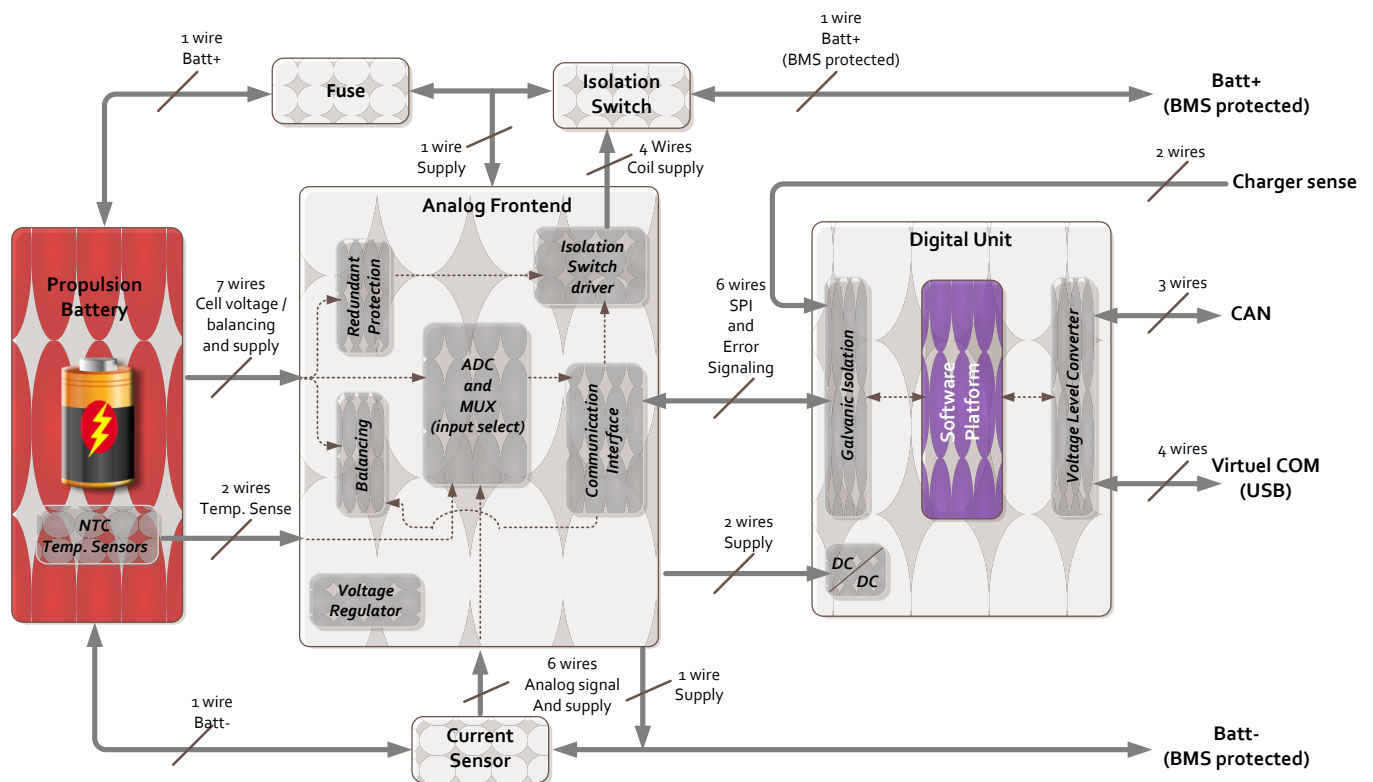
Elaborated Block Diagram

Figure 2 - elaborated block diagram

Safety related Information

Battery Data:

Chemistry: Lithium-ion polymer(Li-cobalt)
Manufacture: Turnigy
type: nano-tech
Nominal voltage: 22.2V

Max. charging voltage: 25.2V

Min. voltage: 18V

Capcity: 3300 mAh

Max. continues discharge: 45C

Max. charge rate: 10C

Fuse Data:

Type: KTK-30 fast-acting fuse

Nominal current: 30 A

Interrupt Rating: 100KA

Isolation Switch(relay) Data:

Manufacture: Durakool

Type: DG85C-8021-75-1024

Contact type: Normally Open

Max. continues current: 80A

Max. Break current: 80A

Nom. coil voltage: 24V

Parameters under surveillance, and action at out of range

Parameter	Action at out of range	Action required to reset
Cell voltage	Undervoltage: Battery is isolated from load, BMS goes to deep sleep to reduce consumption. Overvoltage: Battery is isolated from charger, bleeder resistor is applied across cells exceeding threshold, to force voltage down.	Undervoltage error is reset at connection of charger. Overvoltage error requires press at reset button.
Battery Temperature	Isolates battery from load/charger	Requires removal of error condition and press at reset button.
Charge current	Isolates battery from load/charger	Requires removal of error condition and press at reset button.
Discharge current	Isolates battery from load/charger	Requires removal of error condition and press at reset button.

BMS Threshold levels, primary protection levels

| Parameter	Upper threshold / delay	Lower threshold / delay
Cell voltage	4.19V / 201ms(max.)	3V / 201ms(max.)
Temperature (charge)	45°C / 201ms(max.)	0°C / 201ms(max.)
Temperature (discharge)	60°C / 201ms(max.)	-20°C / 201ms(max.)
Discharge current	50A / 10sec (55A / 201ms(max.))	-
Charge current	17A / 201ms(max.)	-

BMS Threshold levels, redundant protection levels

| Parameter	Upper threshold / delay	Lower threshold / delay
Cell voltage	4.2V / 500ms	2.9V / 100ms
Temperature	60°C / 20ms	-
Charge current	19A / 20ms	-

Cell Balancing

Dissipative balancing is performed based on final-voltage algorithm. When charger is connected and any cell exceeds 3.8V, the internal resistance is measured for all cells, to allow calculation of OCV's. Based on OCV's, cells with highest SOC is being partly bypassed by a resistor, to reduce the charging current to these cells. This procedure is being performed until all calculated OCV's are within a 30mV range. Balancing current is approximately 150mA.

Connection Diagram
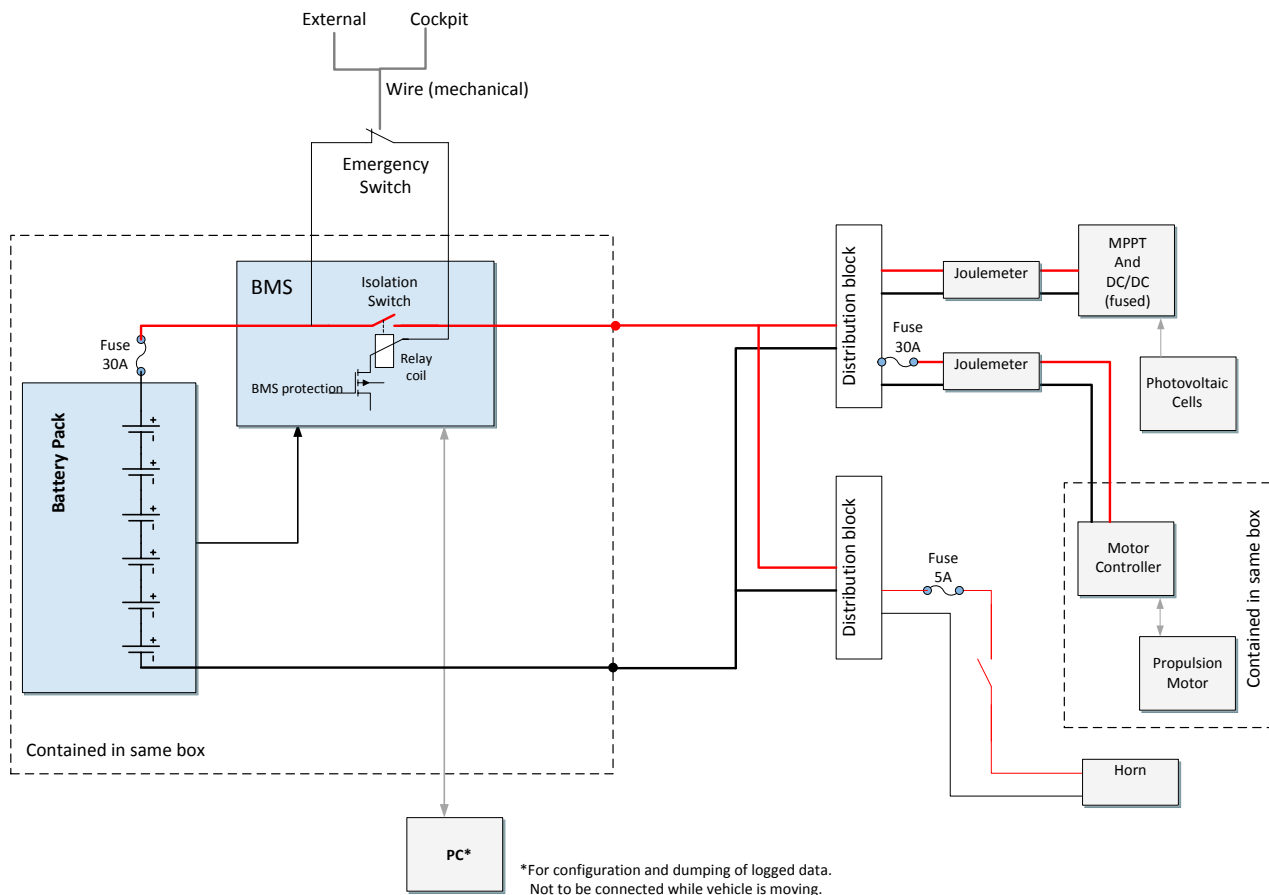
Placement of Electronic devices

Front
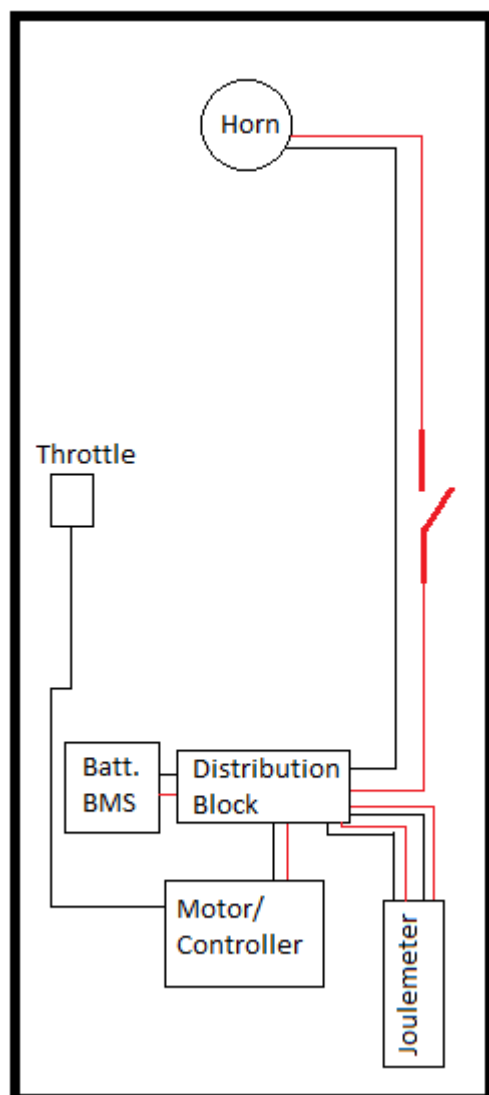
Photovoltaic panels and related joule meter may be added in final design.