

Battery Protection Technical Report

Test the charging:

1. Turn on power to the charger.
2. Note that the BMS appears to be operational. If a digital BMS, note the cell voltages.
3. Note that current is flowing into the pack.
4. Note that the BMS is aware of the current flowing into the pack, and that the SOC value (if available) is increasing.
5. Note the cell temperatures, making sure they are not excessive. If the BMS can read temperatures, note that it is seeing the correct values.
6. Note that balancing starts occurring on the most charged cells when their voltage reaches a certain threshold (if a top balancing BMS).
7. Note that, as soon as any cell's voltage reaches the maximum threshold, charging is interrupted.
8. When the pack is fully charged, turn off power to the charger.

Test the discharging:

1. Turn on the load (e.g., the ignition).
2. Note that the BMS appears to be operational. If a digital BMS, note the cell voltages.
3. Note that current is flowing out of the pack.
4. Note that the BMS is aware of the current flowing out of the pack, and that the SOC value (if available) is decreasing.
5. Note the cell temperatures, making sure they are not excessive.
6. Note that, as soon as any cell's voltage reaches the minimum threshold, discharging is interrupted.
7. Turn off the load.

- charge voltage is limited to 4.2 volts per cell with max charge current 1.7 amps, min temp. 0 °C and max temp. 45°C

- discharge voltage is limited to 2.65 volts per cell with max discharge current 8 amps, min temp. -20 °C and max temp. 60°C

Battery pack configuration are 56 cells per module, 28 modules per string, and only one string – total cell count is 1568 pieces (Fig. 1).

Those black holders outside the battery will be cut off, because we use 4x5 stackable holders. There is a air gap between batteries and we want to use air flow to cool down our battery pack.

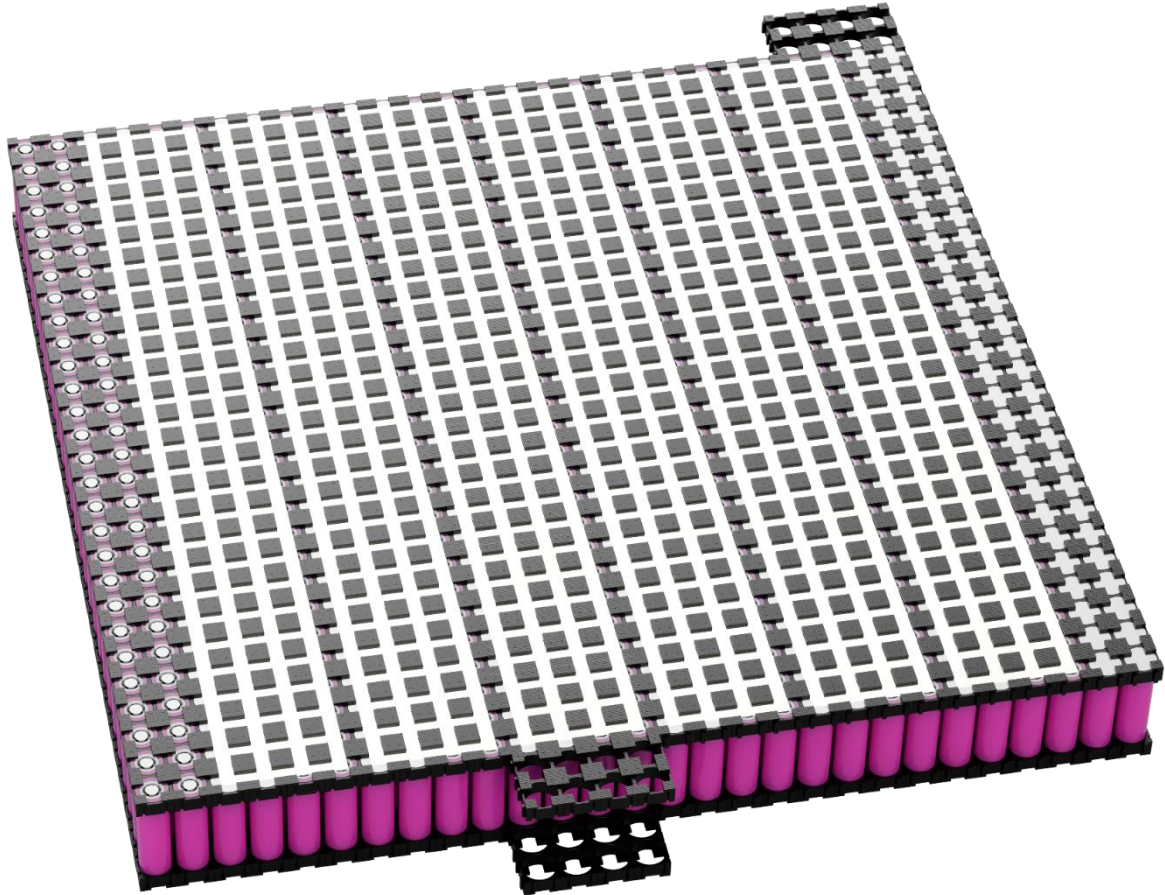


Figure 1. Half of the Battery pack (784 batteries).

Battery Management System is realized with two modules (Fig. 2) and microcontroller (Fig. 3).



Figure 2. BQ76PL536EVM-3

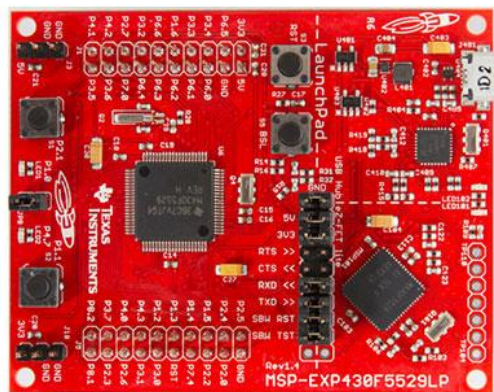


Figure 3. MSP430F5529

Main Battery Pack

BATTERY PROTECTION SYSTEM OVER VOLTAGE(OV) TEST

☒ String ☐ Module ☐ Cell – Test Level ☐ Pass ☐ Fail

Nominal Voltage: 100.8 Vnom @ 23 °C **BPS V Resolution:** 12 Bit
Max Voltage: 119 Vmax @ 23 °C **BPS V Range:** 84 - 117.6 VDC
BPS Max Trip: 117.6 Vmax_trip **BPS Sample Rate:** 2 S/s
☐ Filtering ☐ Delay **BPS Disconnect Delay:** 2 s

Notes: _____

BATTERY PROTECTION SYSTEM UNDER VOLTAGE(UV) TEST

☒ String ☐ Module ☐ Cell – Test Level ☐ Pass ☐ N/A ☐ Fail

Nominal Voltage: 100.8 Vnom @ 23 °C **BPS V Resolution:** 12 Bit
Min Voltage: 82.6 Vmin @ 23 °C **BPS V Range:** 84 - 117.6 VDC
BPS Min Trip: 84 Vmin_trip **BPS Sample Rate:** 2 S/s
☐ Filtering ☐ Delay **BPS Disconnect Delay:** 2 s

Notes: _____

BATTERY PROTECTION SYSTEM OVER CURRENT(OC) TEST

☒ String ☐ Module – Test Level ☐ Pass ☐ N/A ☐ Fail

Max Current (charge): 112 A Imax @ 23 °C **BPS I Resolution:** 12 Bit
Max Current (discharge): 448 A Imax @ 23 °C **BPS I Range:** 0 - 12 VDC
BPS I Trip: 120 A Imax_trip **BPS Sample Rate:** 10 S/s
☐ Filtering ☐ Delay **BPS Disconnect Delay:** 2 s

Notes: _____

BATTERY PROTECTION SYSTEM OVER TEMPERATURE(OT) TEST

☒ String ☐ Module ☐ Cell – Test Level ☐ Pass ☐ N/A ☐ Fail

(Charge) / (Discharge)
Max Operating Temperature: 45 / 60 °C **BPS T Resolution:** 12 Bit
BPS T Trip: 40 °C Tmax_trip_charge **BPS T Range:** -10 - 60 °C
BPS T Trip: 45 °C Tmax_trip_discharg **BPS Sample Rate:** 2 S/s
BPS Disconnect Delay: 2 s

Notes: _____

Supplemental battery

BATTERY PROTECTION SYSTEM OVER VOLTAGE(OV) TEST

☒ String ☐ Module ☐ Cell – Test Level ☐ Pass ☐ Fail

Nominal Voltage: 12 Vnom @ 25 °C **BPS V Resolution:** 12 Bit
Max Voltage: 15 Vmax @ 25 °C **BPS V Range:** 0 - 16 VDC
BPS Max Trip: 13,8 Vmax_trip **BPS Sample Rate:** 1 S/s
☐ Filtering ☐ Delay **BPS Disconnect Delay:** 2 s

Notes: _____

BATTERY PROTECTION SYSTEM UNDER VOLTAGE(UV) TEST

☒ String ☐ Module ☐ Cell – Test Level ☐ Pass ☐ N/A ☐ Fail

Nominal Voltage: 12 Vnom @ 23 °C **BPS V Resolution:** 12 Bit
Min Voltage: 10,5 Vmin @ 23 °C **BPS V Range:** 0 - 16 VDC
BPS Min Trip: 10,5 Vmin_trip **BPS Sample Rate:** 1 S/s
☐ Filtering ☐ Delay **BPS Disconnect Delay:** 2 s

BATTERY PROTECTION SYSTEM OVER CURRENT(OC) TEST

☒ String ☐ Module – Test Level ☐ Pass ☐ N/A ☐ Fail

Max Current (charge): (0.3C) 8 A Imax @ 23 °C **BPS I Resolution:** 12 Bit
Max Current (discharge): (1C) 55 A Imax @ 23 °C **BPS I Range:** 0 - 12 VDC
BPS I Trip: 45 A Imax_trip **BPS Sample Rate:** 1 S/s
☐ Filtering ☐ Delay **BPS Disconnect Delay:** 2 s

Notes: _____

BATTERY PROTECTION SYSTEM OVER TEMPERATURE(OT) TEST

☒ String ☐ Module ☐ Cell – Test Level ☐ Pass ☐ N/A ☐ Fail

(Charge) / (Discharge)
Max Operating Temperature: 40 / 45 °C **BPS T Resolution:** 12 Bit
BPS T Trip: 35 °C Tmax_trip_charge **BPS T Range:** -10 - 60 °C
BPS T Trip: 40 °C Tmax_trip_discharg **BPS Sample Rate:** 1 S/s
BPS Disconnect Delay: 2 s

When External Cutoff switch is pushed the supply circuit for main battery contactor coil is disconnected. Then the driver can see a fault indicator on the dashboard. Additionally external lights will strobe. Those lights are supplied by supplemental 12 V VRLA battery.

Description of how the BPS will operate for start-up and fault conditions for each battery type is presented in:

PolitechnikaPoznanska_ASC2020VDR_ElectricalSystemTechnicalReport.pdf

Monitoring of the electrochemical cells

We have 2 printed circuits with a total number of battery supervising systems. They monitor 28 series connected packets and send information to the microcontroller, which in the event of incorrect voltages decides to disconnect the battery from the car. In addition, the driver can monitor all on-screen information about the battery. In the event of a short circuit, safety is ensured by fuses and the current sensor when it detects a high current consumption, which is not expected at the moment. The battery is disconnected in this case.