220725: TI BQ25713/ BQ40Z50-R2 Battery Management System

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Scope

To resolve issues with battery packs that have effectively become disconnected from the battery charger

Background

The battery pack is used as part of a UPS system that provides continuous 12Vdc system power in the event of a power interruption.

Battery Pack

This comprises 4 off 18650 LiFePO4 cells arranged in a 4S1P stack.

Nominal Ratings	
Voltage	3.3 V
Capacity @ 23 °C Typ (Min)	1.2 Ah (1.1 Ah)
Energy @ 23 °C	3.63 Wh
Impedance (1kHz AC) Typ	12.6 mΩ
Cycle Life at 1.5 A charge /-10 A discharge, 100% DOD	> 2000 cycles
Discharging	
Max Continuous Discharge Current	30 A
Max Pulse Discharge Current (10s)	50 A
Minimum Voltage / HPPC Pulse	2 V / 1.6 V
Temperature	-30 °C to 55 °C
Charging	
Recommended Charge Current	1.5 A
Max Continuous Charge Current	4 A
Max Pulse Charge Current (10s)	10 A
Recommended Charge Voltage	3.6 V
Terminate Charge @ 3.6 V	< 50 mA
HPPC Pulse Voltage	3.8 V
Float Voltage	3.5 V
Temperature Range (reduce charging current to <40mA when under 0 °C)	0 °C to 55 °C
Storage	
Storage Temperature	-40 °C to 60 °C

On this basis the maximum charging current has been set at 1A and the maximum charging voltage set at 14400mV. The charger is disabled if the operating temperature is outside the 5-50C range.

The battery protection circuit is essentially the BQ40Z50-R2 reference design but with the following functions not fitted/ used:

- No BQ296100 circuit
- No thermistors
- No LEDs
- BTP_INT; /PRES/SHDN; /DISP;TS1-4;FUSE;PTC/PTC_EN tied to ground

Manufacture

Once the battery packs have been fully assembled they are connected to a 14.4V/1.4A battery charger and the charge is raised from nominal 30% (shipped state) to >50%. During this time they are programmed with the .srec file. The packs are then put into stock awaiting assembly into the end product.

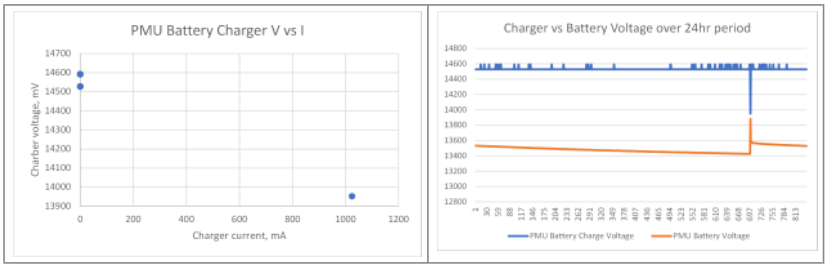
Modus Operandii

The battery management system comprises an STM32 communicating via separate I2C busses to both the BQ25713 charger and the BQ40Z50 battery pack. There is no I2C communication link between the charger and battery pack.

The STM32 configures the charger for 14400mV/ 1024mA maximum levels and will disable charging if the ambient exceeds the 0/50C limits. Otherwise the charger will remain in an operational state.

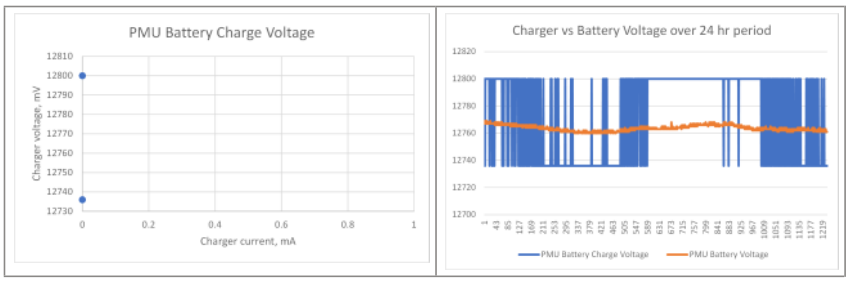
BQ40Z50 status

During operation the BQ40Z50-R2 appears to be turning the CHG FET off. The charger is then operating at the CV level with no charge current flowing.



Reported battery status is typically "00E0", periodically switching to status "00A7" during a charge then back to "00E0". These "good" units are reporting 100% remaining capacity (FC=1 in battery status) on our remote management system.

Symptomatic failing batteries are reported as having a remaining capacity of 50% if the battery status flags FC/FD=0.



The above characteristic shows no charge current flowing.

The battery status register reports "00C7" indicating that the battery pack is permanently in discharge. We now have one or two packs that have moved to state "02C7" indicating that battery capacity has now dropped below 30%.
We have remote access to the battery pack data and this typically indicates that whilst the cell voltages look ok, the BQ40Z50-R2 would appear to have latched the CHG FET into the off state thereby disabling charging.
Ideally a remote fix can be found for this issue.