

Pi-top-battery investigations

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After all the negative things we have read about failures of the pi-top battery, we started a project together to study the battery. We used a pi-top on which pt-battery-fw-update_v2 was run successfully.

First of all, it is a great battery. Reducing screen brightness somewhat, one can easily achieve a battery life of 16 hours. The battery pack contains an intelligent battery fuel gauge from TI, the bq40z60. Lots of information can be obtained from this device.

During our investigation we observed a few problems, caused by our obsession to push the battery pack to the limits. Once the pi-top could not be started with the button any more, while the battery pack was at around 0% charge. But when connecting it to the main power, it was possible to boot the Raspberry Pi again and the battery had started to charge.

We wrote the necessary analysis tools for the Raspberry Pi, while in parallel using bq studio from TI.

All upper and lower voltage caps worked well and protected the battery. We were unable to drive the battery into a permanent failure mode.

We unsealed the bq40z60 and checked all relevant safety parameters. They were all set to meaningful values. We stopped charging, reset the device, put it back in shipping mode and other actions. It all worked and the battery always recovered properly. We then sealed the device again.

We checked the results of the self-calibration and gas gauging of the device and found it was appropriate.

After going through all these exercises the battery was still very healthy.

This was an extremely interesting project, and we are very pleased with the results. But there was quite some work we had to put into it because the device is extremely complex.

Below is a short output of the data obtained from the device, which in total fills hundreds of pages of parameters and protocols:

Status registers:

| | |
|----------------------------------|-----------|
| [0xA] Current | : -261 mA |
| [0xD] Relative state of charge | : 99 % |
| [0xC] Max err of state of charge | : 1 % |
| [0xE] Absolute state of charge | : 95 % |
| [0x3F] Cell voltage 1 | : 4109 mV |
| [0x3E] Cell voltage 2 | : 4126 mV |
| [0x3D] Cell voltage 3 | : 4122 mV |

| | |
|--------------------------|-------------|
| [0x3C] Cell voltage 4 | : 4120 mV |
| [0x9] Total voltage | : 16475 mV |
| [0x8] Temperature | : 25.4 C |
| [0x17] Cycle count | : 28 cycles |
| [0x4F] State of health | : 97 % |
| [0xF] Remaining capacity | : 3676 mAh |
| [0x10] Full capacity | : 3714 mAh |
| [0x18] Design capacity | : 3900 mAh |