



SMART BATTERY SAFETY GUIDELINE

TADASHI OKUTOH





Smart Battery Pack Safety

The most dangerous factor for battery pack is overcharge. There is possibility that lithium metal plating on anode by overcharge could be ignited by heat generation inside due to some reasons. There is report saying that fire is ignited by only first time overcharge in the most severe case.

1. Cause of overcharge

- 1) Higher voltage charge than regulated by third party chargers
- 2) Higher voltage charge than regulated voltage due to breakage of chargers
- 3) Higher voltage charge than regulated voltage due to sudden change of **CHARGING VOLTAGE()** data in SMBus (including input mistake)

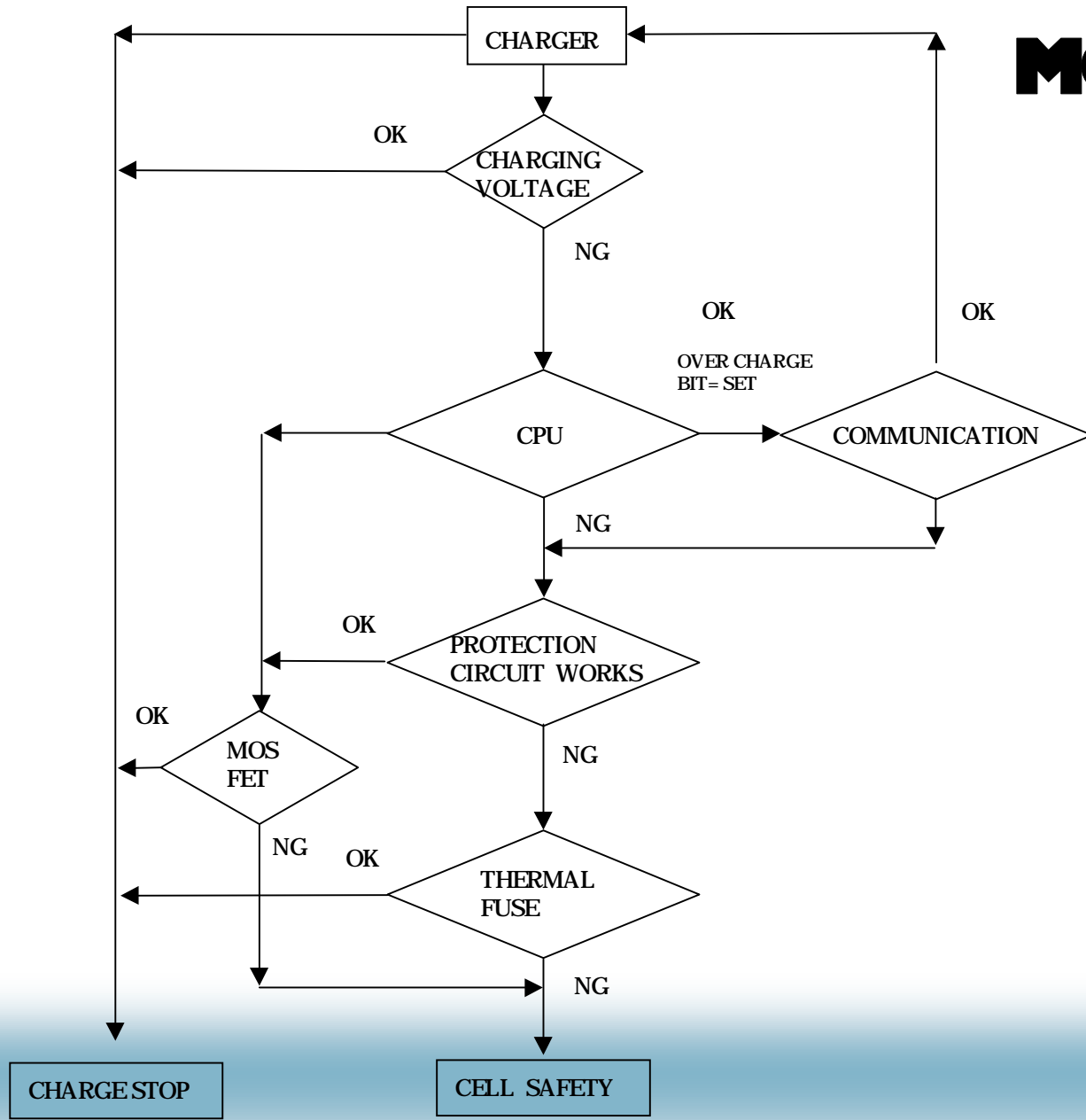


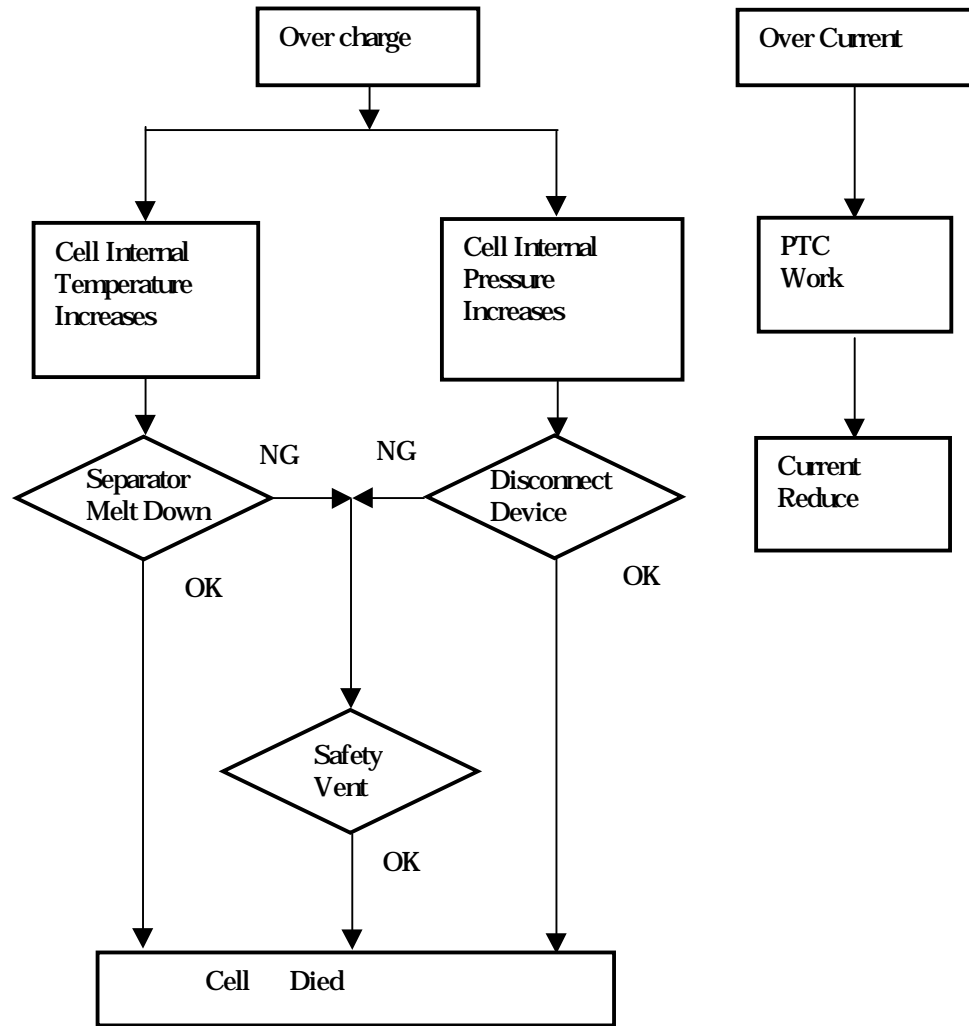
How to overcharge test

1. To charge by higher voltage than regulated voltage
2. To charge after cutting communication line
3. To input wrong **CHARGING VOLTAGE()** data
4. To cut or make short circuit on thermister line

To keep safe situation not so as to rely on safety control mechanism of cell itself in the above experiments







Over current

There is possibility that over current may cause not only temperature rise in the cell but also catching fire if cell itself has PTC inside.

Cause of over current

- 1) pack external short
- 2) cell internal short circuit
- 3) pack internal short circuit
- 4) Third party charger



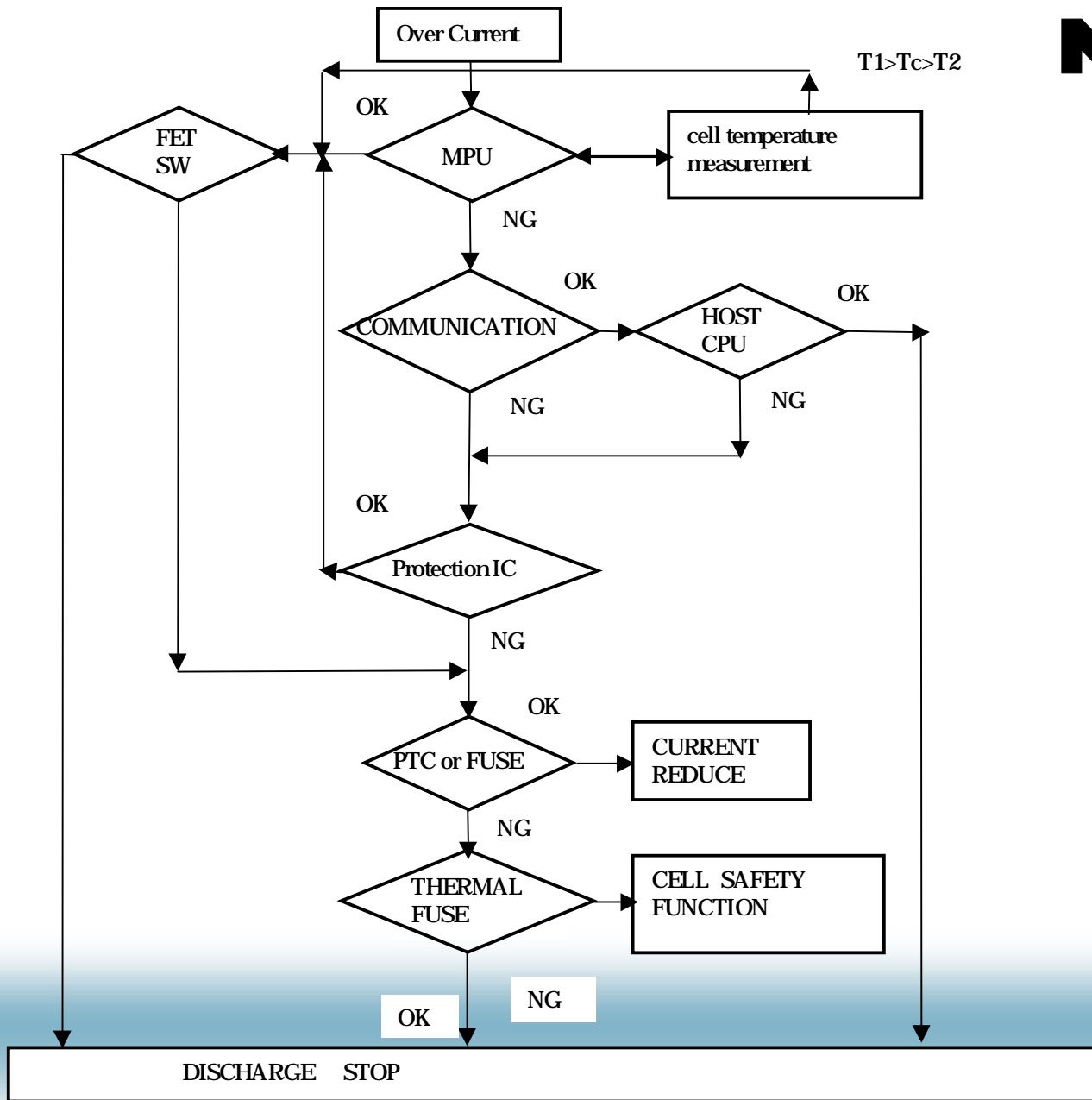
How to over current test

- 1) To have external hard short circuit to battery pack
- 2) To discharge to end of discharge voltage by loading current almost near to maximum acceptable current for battery pack
- 3) To charge by charge which has no over current protection

Reference Experiment

- 4) To perform nail penetration test to battery pack







Electrostatic discharge

There is possibility that extreme high level of electrostatic discharge on battery pack may cause breakage of device inside and make battery pack beyond control.

Countermeasure toward above situation is only safety mechanism of cell itself. Even if degree of damage to the device is not so sever as the above case, communication interruption or change of device may happen due to breakage of device for communication.

Reference

In case smart battery is installed in artificial satellite in the future, breakage of devices by cosmic ray has to be considered also.





In order to prevent bad influence from electrodischarge, following items have to be considered in design of battery pack.

- 1) Mechanical structure of battery pack
- 2) Layout of circuit board
- 3) Position of circuit board in the battery pack
- 4) Selection of devices etc..





How to test electrostatic discharge for battery pack.

To test battery pack by contact discharge at 4kv,
air discharge at 8kv(humidity 10% or less) **IEC61690-2.**

Actual condition to measure is higher than above value

To confirm any proper functions of battery pack after testing.



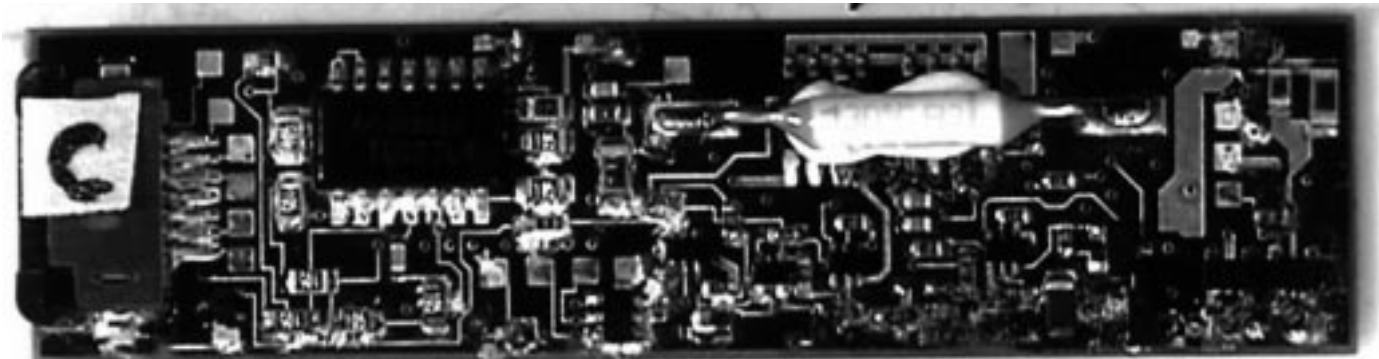


Leakage of electrolyte

This is well-known failure mode of battery.
In case leaked electrolyte from cell printed circuit board, electrolyte is decomposed and is charged into carbon, which generates heat and ignites remained electrolyte.

Communication interruption may be caused even by slighter electrolyte leakage on communication line in circuit pattern





Mechanical safety test

- 1) Mechanical shock test
- 2) Mechanical vibration test
- 3) Free fall test

