Battery Testing Protocol

VERSION 1.1

Project: DEEPSAT
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Revisión histórica del documento

Date	Version	Change log	Author
28/06/18	V 1	Initial Version	Luis Sánchez Velasco
04/07/18	V 1.1	Minor Changes	Andrés Roldán Aranda
04/07/18	V 1.2	Fixed diagrams / add battery size control	Luis Sánchez Velasco

1 Contenido

2 Introduction

During this document, the protocol followed by the GranaSAT space group is described, resuming all the relevant and under what conditions they should be accomplished.

3 Equipment Used

E3631A DC-Supply	
6063B DC-Load	
YC-747UD 4 channel temperature logger	
TVAC Chamber	

4 Protocol Description

During all the operations described above a log document is produced, containing all the raw data produced by the battery testing process.

4.1 High Vacuum test:

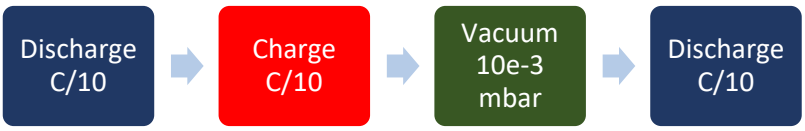
Aim:

Measuring the capacity loss after the battery has been exposed to high vacuum conditions.

Process description:

The battery is discharged until end of discharge voltage is reached, at C/10 and then it is charged to maximum capacity by a CC + CV algorithm. During the charging process, the energy delivered to the battery is calculated. After that, the pressure in the chamber is lowered to 10^{-3} mbar during 5 minutes. Once the process is over, the battery is discharged to minimum in order to obtain the delivered energy to the load. The battery size before and after the high vacuum test will also be measured and controlled.

Diagram:



Expected results:

- Battery capacity
- Battery loss percentage after vacuum
- Change in size after vacuum test

4.2 Capacity and Internal Resistance vs Temperature:

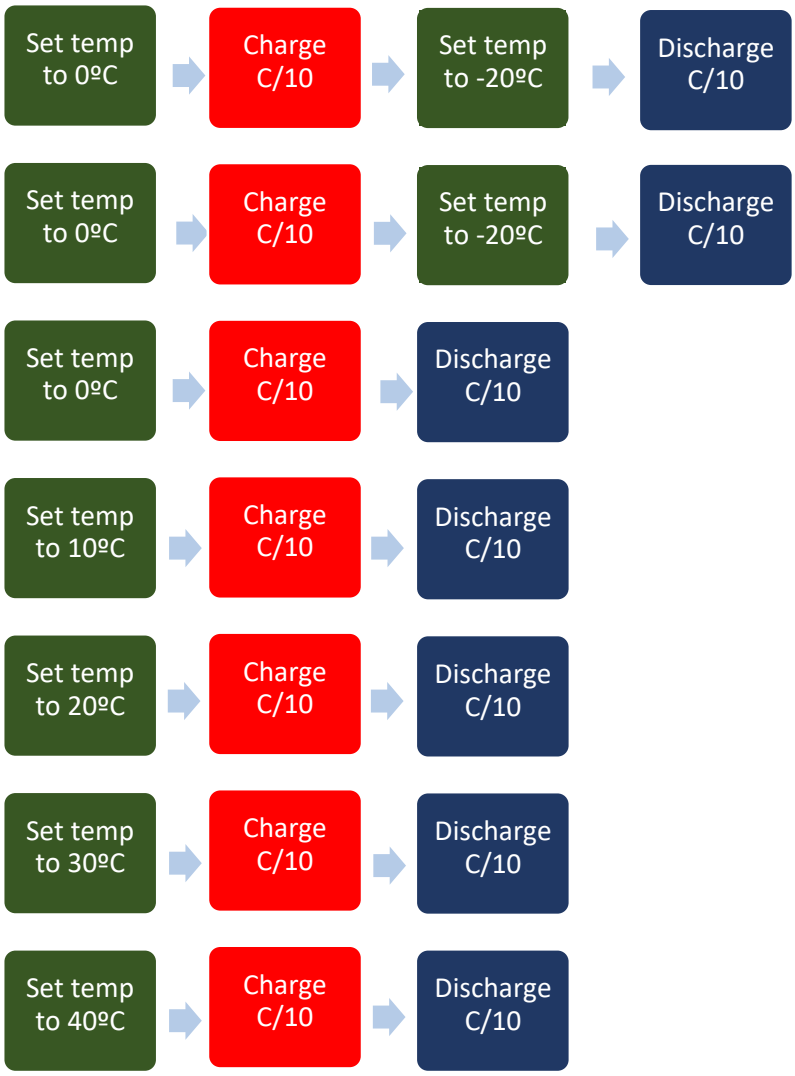
Aim:

Measure the charge and discharge curve at several temperatures. (Not performed in a preliminary test)

Process description:

The batteries charged and then discharged at a constant rate of C/10 (CC+CV at charging) at a set of different temperatures. Precisely (-20, -10, 0, 10, 20, 30, 40 ºC). The input/output charging/discharging current is switched off at a constant rate to obtain the open circuit voltage and the internal resistance vale. For temperatures where charge is not allowed (-20, -10 ºC), charge will be done at 0ºC). The change in cell size at maximum and minimum charge will also be controlled.

Diagram:



Expected results:

- Battery capacity versus temperature
- Battery internal resistance versus temperature
- Charging/ discharging voltage and current curves at different temperatures.
- Battery size in charged and uncharged state

4.3 Self-Discharge Test:

Aim:

Obtain the battery response to long periods untouched.

Process description:

The battery is charged to maximum charge (CC+CV), then the battery is left for 24h on open circuit state. Thereupon the battery is discharged to minimum thus obtaining the total stored charge.

Diagram:

Expected results:

- Battery loss of energy over long periods.

4.4 LEO Cycling:

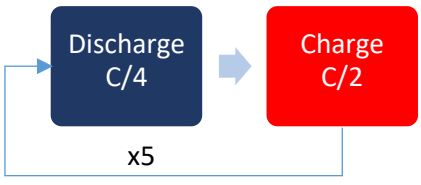
Aim:

Measuring the capacity loss after the battery is charged and discharged 5 times.

Process description:

The battery is charged at C/2 and discharged at C/4 5 times at 0 ºC.

Diagram:



Expected results:

- Battery degradation over continuous charge/discharge periods at border temperatures.
- Battery charge/ discharge curve degradation.

4.5 EMF vs SOC:

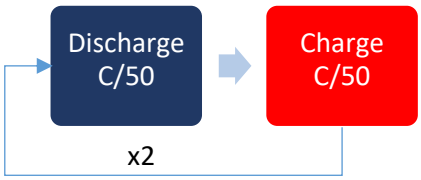
Aim:

Obtain the relationship between the internal electromotive force and the state of charge.

Process description:

The battery is charged and discharged slowly two times, at C/50, so the internal resistance effect can be neglected, and the relationship of the electromotive force versus the state of charge can be easily obtained

Diagram:



Expected results:

- Battery curve of the electromotive force versus the state of charge

4.6 Reduced pressure 30 % DOD Cycling:

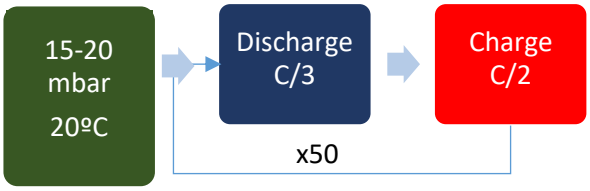
Aim:

Obtain the cell degradation when it is cycled under low pressure conditions for long periods.(Not performed in a preliminary test)

Process description:

The battery is cycled, C/3 for discharge and C/2 (CC+CV) for charge at a reduced pressure of 15 to 20 mbar at 20ºC for 50 cycles. The battery is discharged to consume 30 % of the total energy rating.

Diagram:



Expected results:

- Evolution of EODV (End Of Discharge Voltage) versus degradation.
- Evolution of the battery capacity and efficiency versus degradation.

4.7 Reduced pressure 80% DOD Cycling:

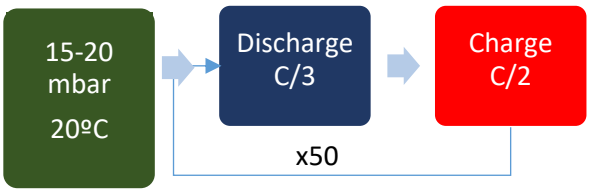
Aim:

Obtain the cell degradation when it is cycled under low pressure conditions for long periods.

Process description:

The battery is cycled, C/3 for discharge and C/2 (CC+CV) for charge at a reduced pressure of 15 to 20 mbar at 20ºC for 50 cycles. The battery is discharged to consume 80% of the total energy rating.

Diagram:



Expected results:

- Evolution of EODV (End of Discharge Voltage) versus degradation.
- Evolution of the battery capacity and efficiency versus degradation.