***\*Notice:***

***This file is an example based on generic satellite design and does not guarantee to be approved on the review process for launch or deployment. In accordance with design of each satellite, this document may have to be changed. Details of this template are subject to change without notice. Please change YELLOW sentence according to each satellite.***

***(本文書は標準的な設計の衛星を想定した一例であり、打上げ・放出のための審査プロセスでの承認を保証しているものではありません。各衛星の設計によって内容を変更する必要があります。また、本テンプレートの内容は予告なく変更される場合があります。黄色の箇所を各衛星に応じて変更してください。)***

[Satellite Name]

Battery Verification Test Report

Initial Release: DD/MM/YYYY

[Project Team Name]

Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Version | Date | Writer | Annotations |
| 1 | DD/MM/YYYY | XXX | Initial Release |
| 1.1 |  |  |  |
| 1.2 |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

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# **Purpose**

This document summarizes the result of battery verification test for [Satellite Name] which will be deployed from JEM Small Satellites Orbital Deployer (J-SSOD).

# **Applicable Document**

1. JX-ESPC-101132-C JEM Payload Accommodation Handbook-Vol.8-

Small Satellite Deployment Interface Control Document

1. [Document Number] [Satellite Name] Flight Safety Assessment Report

for phase XXX

1. [Document Number] HR Battery Description Form for [Satellite Name]

# **Design for the Battery and Hardware**

* 1. **Short Description of the Battery System**

The battery cell is COTS. The cells are installed in a holder. The electrodes are sealed with an insulator, and each cell is covered with a Kapton tape for insulation independently.

* 1. **Cell Description:**

Chemistry: Li-ion or Ni-MH etc

Size: φXXX\*XX mm

Manufacturer: XXX

Model number: XXXXX

Nominal open circuit voltage: XXX V

Expected load voltage: XXX V

Rated capacity: XXXX mAh

* 1. **Battery Description:**

Quantity of cells per battery: XXX

Cell connectivity (#P#S, #S#P): XSXP

Operating voltage range: XX - XX V

Operating temperature range: -XX to +XX deg C

Charge: -XX to +XX degC,

Discharge: -XX to +XX degC,

Storage: -XX to +XX degC

Average Load and duration: XX mA, XX min

Peak Load and duration: XX mA, XX sec

Capacity Required: XX mAh

**Please add a figure or a photo of the battery (cell, pack) to see external view**

Figure 3-1. Battery circuit (\*please use the same figure of Battery Form)

# **Test Method**

The battery cells were purchased by COTS product. The battery cell itself is screened by environment test and function test.

## **Lot Sampling Test**

1. Screening Test

20 cell packs are tested to evaluate that their charge/discharge characteristics are stable and similar between all cells. 16 cell packs are selected based on equivalent characteristics, the first and second groups (8 cells for each) are selected as FM and FM backup respectively.

Test Contents;

* + - * Visual inspection (scratches, misaligned seals, electrolyte leakage, etc.)
			* Open Circuit Voltage
			* Mass
			* Capacity
			* Charge/Discharge Characteristic
			* Discharge Temperature

## **Acceptance Test**

1. Random Vibration Test

Random vibration test for flight cells is performed for screening purpose.

Test condition is summarized as below.

 Vibration Level: Two times Minimum Screening Level (MSL)

*\*Note that “two times” is required only for Li-ion battery and Li-polymer battery*

 Tolerance: +/- 1.5dB for PSD

 Direction: 2 axes (Radial direction and Axial direction)

*\*if battery is not cylinder shape, 3 axes are required*

 Test Duration: Over 60 sec

Please include the image of vibration test

Figure 4.2-1 Vibration test configuration

Table 4.2-1 Random Vibration Level for cells

|  |  |  |
| --- | --- | --- |
| **Freq. [Hz]** | **PSD [G2/Hz] (MSL)** | **PSD [G2/Hz] (2xMSL)** |
| 20 | 0.01 | 0.02 |
| 80 | 0.04 | 0.08 |
| 350 | 0.04 | 0.08 |
| 2000 | 0.007 | 0.014 |
| Overall | 6.06 Grms | 8.6 Grms |
| Duration | 1 min/axis | 1 min/axis |

1. Vacuum Test

Vacuum test of battery cell level is performed for screening. Test condition is summarized as below.

 Vacuum Level: less than 0.1 psia

 Test Duration: Over 6 hours

1. Function Test

Before and after the environment tests (vibration test and vacuum test), several function tests below are performed to see that there is no change in characteristics.

Note that the Charge/Discharge Characteristics test measures the range between maximum voltage and minimum voltage.

Test Load: XX [A] *\*In general, test is conducted with load between 0.2C and 1.0C*

Test Contents;

 Visual inspection (scratches, misaligned seals, electrolyte leakage, etc.)

Open Circuit Voltage (the change is less than 0.1%)

Mass (the change is less than 0.1%)

Capacity (the change is less than 5%)

Charge/Discharge Characteristic

Discharge Temperature

*Note: the change is verified by the difference between each test result and the previous test result.*

Charge and discharge characteristics tests are performed for each battery cells before and after the environmental tests. Test set-up is shown in Figure 4.2-2.

From these tests, it is confirmed that charge and discharge characteristics do not change due to the environmental tests and are within the nominal range.

****

Figure 4.2-2 Charge/Discharge Characteristics Test Configuration

## **Final Checkout after Assembling CubeSat**

Prior to CubeSat handover after the environment tests for CubeSat, Charge/Discharge Characteristic of battery inside CubeSat is measured to see that there is no damage. Test method is the same as section 4.2(3).

Note that the Charge/Discharge Characteristics test measures the range between maximum voltage and minimum voltage.

***\*Notice:***

***This plan is based on the alternative option a) described on the “Battery Description Form” template. When this option is selected, the test plan must be coordinated with JAXA Battery Safety Team at safety review phase 2.***

***(この試験計画は、“Battery Description Form”テンプレートで示すオプションa)をベースに記載している。この試験計画を実施する場合は安全審査Phase2にてJAXAのバッテリー安全担当と調整が必要となります。)***

# **Test Results**

Date of test：[YYYY/MM/DD]

Place of test：[XXXX]

## **Lot Sampling Test**

1. **Screening Test**

Test configuration is shown on Figure 5.1-1. Test result is referred to Figure 5.1-2 to Figure 5.1-X. The following cells are selected.

Flight battery serial no.: XXX, XXX, XXX, XXX, XXX, XXX, XXX, XXX

Flight backup battery serial no.: XXX, XXX, XXX, XXX, XXX, XXX, XXX, XXX

## **Acceptance Test**

1. **Random Vibration Test**

Test configuration is shown on Figure 5.2-1-1. Test result is referred to Figure 5.2-1-2 to Figure 5.2-1-5.

1. **Vacuum Test**

Test configuration is shown on Figure 5.2-2-1. Test result is referred to Figure 5.2-2-2.

1. **Function Test**

Test configuration is shown on Figure 5.2-3-1. Test result is referred to Figure 5.2-3-2 to Figure 5.2-3-5 and Table 5.2-3-1.

Photo

Figure 5.1-1 Test Configuration for Battery Screening Test

|  |  |
| --- | --- |
|  |  |
| Figure 5.1-2 Serial 001 characteristics (Left : Charge，Right: Discharge) |
|  |  |
| Figure 5.1-3 Serial 002 characteristics (Left : Charge，Right: Discharge) |
| *Add test results for all batteries* |

Photo

Figure 5.2-1-1 Test Configuration for Battery Random Vibration Test

|  |
| --- |
| Add graph of acceleration at control sensor * + - * Test target does NOT include battery.
* X axis: Frequency, Y axis: PSD
* Include upper limit and lower limit of tolerance
* PSD should be within upper and lower limit.
 |
| Figure 5.2-1-2 Battery Random Vibration Test Result (Radius direction, without battery) |
| Add graph of acceleration at control sensor * + - * Test target include battery.
* X axis: Frequency, Y axis: PSD
* Include upper limit and lower limit of tolerance
* PSD should be within upper and lower limit.
 |
| Figure 5.2-1-3 Battery Random Vibration Test Result (Radius direction) |
| Add graph of acceleration at control sensor * + - * Test target does NOT include battery.
* X axis: Frequency, Y axis: PSD
* Include upper limit and lower limit of tolerance
* PSD should be within upper and lower limit.
 |
| Figure 5.2-1-4 Battery Random Vibration Test Result (Axial direction, without battery) |
| Add graph of acceleration at control sensor * + - * Test target include battery.
* X axis: Frequency, Y axis: PSD
* Include upper limit and lower limit of tolerance
* PSD should be within upper and lower limit.
 |
| Figure 5.2-1-5 Battery Random Vibration Test Result (Axial direction) |

Photo

Figure 5.2-2-1 Test Configuration for Battery Vacuum Test

|  |
| --- |
| Add vacuum data profileX axis: Time, Y axis: pressure |
| Figure 5.2-2-2 Battery Vacuum Test Result |

Photo

Figure 5.2-3-1 Test Configuration for Battery Function Test

|  |  |
| --- | --- |
|  |  |
|  | Figure 5.2-3-2 Serial 001 charge characteristics(Upper Left : Initial，Upper Right: After vibration test,Lower Left: After vacuum test) |
|  |  |
|  |  |
|  | Figure 5.2-3-3 Serial 002 charge characteristics(Upper Left : Initial，Upper Right: After vibration test,Lower Left: After vacuum test) |
| *Add test results for all batteries* |

IMAGE

IMAGE

|  |  |
| --- | --- |
|  |  |
|  | Figure 5.2-3-4 Serial 001 discharge characteristics(Upper Left : Initial，Upper Right: After vibration test,Lower Left: After vacuum test) |
|  |
|  |  |
|  | Figure 5.2-3-5 Serial 002 discharge characteristics(Upper Left : Initial，Upper Right: After vibration test,Lower Left: After vacuum test) |
| *Add test results for all batteries* |

Table 5.2-3-1 Measurement Result of Function Test

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S/N | Test Phase | Visual Inspection(Pass or Fail) | Open Voltage[V](< 0.1%) | Mass[g](< 0.1%) | Capacity[mAh](< 5%) |
| [V] | Diff. [%] | [g] | Diff. [%] | [mAh] | Diff. [%] |
| 001 | Initial |  |  | - |  | - |  | - |
|  | After Vibration |  |  |  |  |  |  |  |
|  | After Vacuum |  |  |  |  |  |  |  |
| 002 | Initial |  |  | - |  | - |  | - |
|  | After Vibration |  |  |  |  |  |  |  |
|  | After Vacuum |  |  |  |  |  |  |  |
| 003 | Initial |  |  | - |  | - |  | - |
|  | After Vibration |  |  |  |  |  |  |  |
|  | After Vacuum |  |  |  |  |  |  |  |
| 004 | Initial |  |  | - |  | - |  | - |
|  | After Vibration |  |  |  |  |  |  |  |
|  | After Vacuum |  |  |  |  |  |  |  |
| 005 | Initial |  |  | - |  | - |  | - |
|  | After Vibration |  |  |  |  |  |  |  |
|  | After Vacuum |  |  |  |  |  |  |  |
| 006 | Initial |  |  | - |  | - |  | - |
|  | After Vibration |  |  |  |  |  |  |  |
|  | After Vacuum |  |  |  |  |  |  |  |
| 007 | Initial |  |  | - |  | - |  | - |
|  | After Vibration |  |  |  |  |  |  |  |
|  | After Vacuum |  |  |  |  |  |  |  |
| 008 | Initial |  |  | - |  | - |  | - |
|  | After Vibration |  |  |  |  |  |  |  |
|  | After Vacuum |  |  |  |  |  |  |  |

## **Final Checkout after Assembling CubeSat**

Test configuration is shown on Figure 5.3-1. Test result is referred to Figure 5.3-2 to Figure 5.3-5.

Photo

Figure 5.2-3-1 Test Configuration for Battery Function Test

|  |  |
| --- | --- |
| IMAGE | IMAGE |
| Figure 5.3-2 Serial 001 charge characteristics | Figure 5.3-3 Serial 002 charge characteristics |
| *Add test results for all batteries* |

|  |  |
| --- | --- |
|  |  |
| Figure 5.3-4 Serial 001 discharge characteristics | Figure 5.3-5 Serial 002 discharge characteristics |
| *Add test results for all batteries* |

# **Conclusion**

 The result of the battery verification test conforms to the requirement.