Request for Proposal (RFP)

for

FORMOSAT-9 Battery Procurement
（RFP No.: TASA-P-1130365）

Taiwan Space Agency

RFP Date: July 10th, 2024

TABLE OF CONTENTS

1. Instruction

1.1 General Information

Taiwan Space Agency (TASA) is pleased to solicit Bidder to submit bid proposal in accordance with the procedures set forth in this Request for Proposal (RFP).

1.2 Budget of The Procurement

The budget of this procurement is NTD 32,000,000.

2. Bidder's Qualification

The bidder shall be a company or an organization legally registered by bidder's country and provides the non-original evidence. For a local bidder, a certificate of tax payment shall be included. Where the certificate of tax payment referred to in this paragraph is a certificate of business tax payment, it shall be a business tax payment receipt or the latest sales revenue and tax report approved and affixed with an official seal by the responsible tax-assessing authority. If the supplier is unable to provide the most recent certifying documents in time, the tax payment receipt of the immediate preceding period may be used in replacement. Newly established suppliers who have not reached the time limit for filing their first tax payment may use, as a replacement, the approval letter of business establishment issued by the responsible assessing authority of business tax. Where unified invoice system is mandatory to the supplier, the relevant documents in relation to the purchase of unified invoice shall also be submitted. Certificate of no outstanding taxes issued by the responsible tax-assessing authority within the same period specified above, may be used as a replacement of certificate of tax payment of business tax or income tax.

3. Guideline for Bid Submission

Bidders shall comply with the instructions of this Section. Failure to comply with the requirements of this section shall cause disqualification.

3.1. Point of Contact

Bidders shall designate a person as the point of contact and advise entity of the name, title, telephone, fax number, email, and address in its submitted Bid Proposal.

3.2. Sets of Bid Proposal and Proposal Organization

The bidder shall organize and submit Bid Proposal in one (1) signed original. The Bid Proposal shall be signed by an officer of the company who is authorized to act therein.

The Bid Proposal shall consist of:

(1) The bidder shall be a company or an organization legally registered by bidder's country and provides the non-original evidence. For a local bidder, a certificate of tax payment shall be included.

(2) A "LETTER OF AUTHORIZATION FOR DELEGATION" (Annex 1) for bidder's personnel to attend the bid opening meeting.

(3) A letter certifying bidder's compliance to the Bidder's Instructions and the Model Contract (Annex 2).

(4) Price Proposal Form: As Annex 3.

3.3. Packing Instructions to Prevent Unauthorized Disclosure

Bid Proposal must be sealed in the envelope or box with proper identification. The envelope or box shall be marked on the outside with Entity's RFP number, the full name and address of the bidder, point of contact, and the marking "Bidding Documents for TASA-P-1130365 FORMOSAT-9 Battery Procurement ".

3.4. Submission Method

Bid Proposal shall be received by entity through certified airmail, express courier service or hand carry on or before the submission deadline specified in Section 3.5 at the following address:

Attention: Ms. Hsueh-Lun Tung

Contracts Manager, Procurement Department, Taiwan Space Agency
No. 250, Sec. 2, Gongdao 5th Rd., East Dist., Hsinchu 300043, Taiwan, R.O.C.
Telephone: 886-3-5784208 ext.7241
Email: hltung@tasa.org.tw

3.5. Submission Deadline

Bid proposal must be received by the entity **on or before 14:00 PM on August 6th, 2024,** Taiwan Time, GMT + 8 Hours. Bid receives after this date and time shall be disqualified and shall not be opened or accepted.

3.6. Validity Date of Bid

The Bidder's proposals and the price quote shall remain valid for at least sixty (60) days from the submission deadline as specified in Section 3.5.

3.7. Non-Withdrawal of Bid

Except under the circumstances that Bidder's proposal being rejected or disqualified by entity due to unacceptable proposals or exceptions, the Bidder shall not withdraw the bid after the submission.

3.8. Price Basis

The price quoted in Price Proposal shall be firmly fixed and not subject to adjustment, change or escalation. The price shall be based on DDP TASA Jobsite as specified in the Model Contract. The quoted price shall be based on the currency of New Taiwan Dollars (NTD). If the Bidder's quoted price is not in NTD, during the lowest price tendering process, its quoted price shall be converted into New Taiwan Dollars (NTD) based on the **Spot Foreign Exchange closing selling rate of the Bank of Taiwan** the first working day before bid opening date. For the local Bidders, its quoted prices shall include all related taxes levied by

Taiwan government.

3.9. Bid Bond (Left Blank)

3.10. Circumstances Bid Bond will not be Returned or Refunded (Left Blank)

3.11. Non-Commitment of the Purchaser

The preparation and submission of Bid Proposal by the bidder shall be without commitment and free of charge to the entity. The bidder is not entitled to claim any sort of compensation.

3.12. Bid Language

English or Chinese shall be the language used in the bid and shall be used in all correspondences between the bidder and the Entity.

4. Bid Opening Meeting

Bid Proposal will be opened **at 15:30 PM on August 6th, 2024, Taiwan Time, GMT + 8 Hours, at TASA meeting room No. 513.**

4.1. Personnel to Attend

The bidder shall attend the meeting of Bid opening. The authorized person shall present a "LETTER OF AUTHORIZATION FOR DELEGATION" (Annex 1) when attending the meeting and signing relevant documents on behalf of the bidder.

Entity may limit the number of the bidder's personnel attending the meetings as necessary. If bidder is absence in the meeting of Bid opening, or if bidder is still absence 30 mins later after receiving the notice from Entity, whose bid is still valid but shall be without the right of price reduction.

4.2. Condition of Bid Opening

Entity will open the Bid Proposals where there is at least one (1) Bid Proposal at first bidding. The term "at least one (1) Bid Proposal" referred in the preceding sentence means there are one or more than one Bidders submitting their Bid Proposals and the Bid Proposals have been arriving at Entity designated place before the deadline for bidding. There will be no limitation of bidders' number for second or after second tendering procedure.

4.3. Ceasing of Bid Opening

Where there are any of the following circumstances under which Bids may not be opened or awarded.

1. Where the content of RFP is amended or supplemented;
2. Where illegal or improper activities that may impair the fairness of the procurement are found;
3. Where there is an emergency;

4. Where the plan for procurement is changed or cancelled; or
5. For any other special circumstances as determined by Entity.

4.4. Bid Clarification, Evaluation, and Disqualified Bid

The bidder shall present sufficient documents, data and evidence whose proposal meets Entity's requirement. Entity has the right to request for clarification on the Bid Proposals that the Bidders have submitted.

Bidder(s) whose Bid Proposals being reviewed as being non-compliant with any of the requirements of this RFP and/or equivalent provided being reviewed to be not acceptable shall be disqualified from attending the next step of lowest price tendering.

4.5. Lowest Price Tendering

After qualification and technical evaluation, only qualified Bidder(s) shall have the right to participate in the lowest price tendering and its process is as follows:

(a) Any price calculation error of line item(s) results in conflict between real total bid price and total bid price in price proposal form (Annex 3), the total bid price in price proposal form shall take precedence. After the Contract has awarded to the Bidder, the Bidder's quoted Contract Line Item prices, shall be adjusted proportionally based on total bid price in price proposal form.

(b) The Bidder whose TBP is the lowest one and is equal to or less than CEILING PRICE shall award the Contract.

(c) If all Bidders' TBP are higher than the CEILING PRICE , the Bidder, whose TBP is the lowest one, shall have one chance to make a TBP reduction. If the Bidder's reduced TBP is equal to or less than the Ceiling Price , the Bidder shall award the Contract.

(d) If all Bidders' TBP are higher than the CEILING PRICE and the reduced TBP of the Bidder, whose TBP is the lowest one, is still higher than the CEILING PRICE, then all the Bidders shall have the right to offer a TBP reduction until a Bidder whose reduced TBP is the lowest one and is equal to or less than the CEILING PRICE. Such price reduction shall not be more than three (3) times.

If , after the above process, the lowest tender still exceeds the CEILING PRICE but not over the budget amount, and Entity needs to award the contract for emergency, then the award for contract shall be approved by the person who has approved the CEILING PRICE or by Entity's authorized personnel, but the value of the award shall not exceed the CEILING PRICE by more than 8%.

(e) After the Contract has awarded to the Bidder, the Bidder's quoted Contract Line Item prices, shall be reduced proportionally based on final reduced TBP.

5. Disposal of Bids

The Bid Proposals will be returned to respective Bidders, upon bidder's request and expense, who do not pass the qualification evaluation and price competition under their requests and costs, but retain one copy of Bid Proposals which have been opened.

6. Return of Bid Bond (Left Blank)

7. Result of Bid Opening

The result of the bid opening will be published on the Procurement Bulletin on TASA website（www.tasa.org.tw).

8. Handling of Unreasonable Low Bid

Any Bidder whose total bid price is the lowest one and is 20 percent less than the ceiling price, may be handled as unreasonable low bid. Bidder shall, upon receipt of entity's request, within ten (10) calendar days, provide an explanation or a security bond. If the bidder fails to submit a reasonable explanation or a security bond before the deadline, the contract may not be awarded to the bidder, and the bidder offering the second lowest tender shall then be deemed as the bidder offering the lowest tender. All procedures under this article shall comply with Taiwan government procurement acts and related stipulations.

9. Time Limit of Questions For Content Of Tender Documentation

Where a bidder has questions about the content of the tender documentation, such questions shall be submitted in writing to TASA before one quarter of the period for tendering starting from the date following the date of publication; provided that the whole period shall not be less than ten days; and a segment of less than one day shall be counted as one day. The form of writing as stated in preceding sentence may be in letter, FAX or e-mail.

10. Dispute Settlement Protest and Complaint

For any dispute between enitity and a bidder or supplier arising out of the invitation to tender, the evaluation of tender, or the award of contract, or the inspection and acceptance, a protest or complaint may be raised in writing to:

Name: National Applied Research Lab.

Tel: 886-2-66300161

Address: 3F, No. 106, Sec. 2, Ho-Ping E. Rd., Taipei City, Taiwan, R.O.C.

11. Revoke the award, Terminate or Rescind the Contract

In case that any of the following circumstances occurs to a bidder, entity shall not open the tender of such bidder when such circumstance is found before tender opening, nor shall award the contract to such bidder when such circumstance is found after bid opening:

The tendering does not comply with the requirements of the tender(RFP) documentation;

The content of the tender, proposal, is inconsistent with the requirements of the tender(RFP) documentation;

The bidder borrows or assumes any other's name or certificate to bid, or bids with forged documents or documents with unauthorized alteration;

The bidder forges documents or alters documents without authorization in tendering;

The contents of the bid documents submitted by different bidders show a substantial and unusual connection; The bidder has any activities in breach of laws or regulations which impairs the fairness of the procurement; or

The Bidder is engaged in any other activities in breach of laws or regulations which impair the fairness of the procurement.

When any of the circumstances referred to in the preceding paragraph occurs to the winning bidder before the award of contract but is found after award or signing of the contract, the entity shall revoke the award, terminate or rescind the contract, and may claim for damages against such bidder.

ANNEX 1
SPECIMEN OF LETTER OF AUTHORIZATION FOR DELEGATION

Date: _____

Taiwan Space Agency
8 F, 9 Prosperity 1st Road,
Hsinchu Science Park,
Hsinchu 30078.
Taiwan, R.O.C.

Re: Letter of Authorization for TASA's RFP No.TASA-P-1130365

Dear Sirs:

We, _____, hereby authorize Mr./Ms. (Name and Title of the Person) of this bidder to attend the meeting(s) on our behalf and whatever he/she promises or signs relevant to the captioned RFP will be binding on us. We confirm that the specimen signature of the above-mentioned person that appears hereunder is true and correct:

Specimen Signature: _____

Thank you for your kind attention to the above.

Sincerely yours,

_____

(The same Signature and/or seal as shown in the Qualification Documents)

Note: The bidder is requested to use the stationery of its own company in typing or writing a letter of authorization as suggested herein.

ANNEX 2
SPECIMEN OF LETTER OF COMPLIANCE

Date: _____

Taiwan Space Agency
8 F, 9 Prosperity 1st Road,
Hsinchu Science Park,
Hsinchu 30078.
Taiwan, R.O.C.

Subject: Letter of Compliance for TASA's RFP No.TASA-P-1130365

Dear Sirs:

We, _____, hereby
(Name of the Bidder)

certify that we are fully comply with the Terms and Conditions and All Requirements of this RFP.

Sincerely yours,

_____
(The same Signature and/or seal as shown in the Qualification Documents)

Note: The bidder is requested to use the stationery of its own company in typing or writing a letter of compliance as suggested herein.

ANNEX 3
PRICE PROPOSAL FORM

TOTAL BID PRICE:

( ) _____.

Price Breakdown

Item No.	Contract Line Item	Bid Price
CLIN 1	Battery Engineering Model (EM, flight-like battery), EM01	
CLIN 2	Battery Engineering Model (EM, flight-like battery), EM02	
CLIN 3	Battery Flight Model (FM), FM 01	
CLIN 4	Battery Flight Model (FM), FM 02	

Note:

1.Bidder shall fill out and specify the currency of bidding price.

2.Bidder shall fill out and specify the currency of bidding price. If the Bidder's quoted price is not in New Taiwan Dollars (NTD), during the lowest price tendering process, its quoted price shall be converted into NTD based on the Spot Foreign Exchange closing selling rate of the Bank of Taiwan the first working day before bid opening date. For the local Bidders, its quoted prices shall include all related duties and taxes levied by Taiwan government.

BIDDER'S COMPANY NAME:

_____.

BIDDER'S AUTHORIZED SIGNATURE OR STAMPS:

_____ .

BIDDING DATE:

_____.

Annex 4 Model Contract

TABLE OF CONTENTS

Recitals

This Contract is made and entered into as of this day of , 2024 by and between Taiwan Space Agency ("TASA"), a functional entity fully authorized by its legal foundation incorporated and existing under the laws of Taiwan, with its principal office at 8F, NO.9 Prosperity 1st Road, Science-based Industrial Park, Hsin-Chu City, Taiwan.

, (the "Contractor"), a corporation organized and existing under the laws of , with principal office at .

Whereas, Contractor represents that it meets and complies with the following requirements:

it has full knowledge of Purchaser's requirements described in the Request for Proposal for the Taiwan Space Agency TASA-P-1130365 Contract, dated , 2024 (the "RFP") and has, before entering into the Contract, verified the correctness and sufficiency of the prices stated in the Contract which shall, except as otherwise specified in the Contract, cover all its obligations provided in the Contract.

NOW, THEREFORE, in consideration of the covenants and premises herein contained, the parties hereto agree as follows:

ARTICLE 1 - Definitions

1.1 In this Contract, unless the context otherwise requires:

1.1.1 Contract means this Contract, together with the Exhibits and Appendices/Annex hereto particulars of which are listed in Article 17 ENTIRE CONTRACT.

1.1.2 Contract Price means the total price payable by TASA to Contractor pursuant to Article 3 CONTRACT PRICE AND PAYMENT TERMS.

1.1.3 DDP TASA Jobsite means "DDP (named place of destination) " as defined in the International Chamber of Commerce INCOTERMS 2020.

1.1.4 Work means the whole scope of work to be performed by Contractor under the Contract as required by the contract

1.2 Contract Documents

The Exhibits and Appendices attached to the Contract are integral parts of the Contract. Contract documents are mutually explanatory. Any ambiguities or discrepancies shall be submitted to Purchaser for resolution. In case of any conflict between the terms and conditions of the Contract and the exhibits and/or appendices, the terms and conditions shall prevail over the exhibits and/or appendices; in case of conflicts among the appendices, the order of precedence shall be determined in

the order listed below provide, however, that all conflicts shall be solved taking into consideration Purchaser's best interest, without affecting the terms and conditions of the Contract. All exhibits listed below are of equal precedence.

Exhibit A Contract Effective Date Certificate
Exhibit B Milestone Completion Certificate
Exhibit C Certificate of Conformance
Exhibit D Model of Refund Bond
Appendix I Price Breakdown & Payment Schedule
Appendix II Statement Of Work (SOW)
Appendix III Battery Component Specification
Appendix IV Contractor's proposal

ARTICLE 2 – Scope of Procurement and Services

2.1 Procurement and Services

According to Appendices of this contract, Contractor shall deliver all Contract Line Items (CLINs) listed below, as detailed in appendix II, FORMOSAT-9 Battery Procurement Statement Of Work (SOW), with required documents.

CONTRACT LINE ITEMS

CLIN 1: Battery Engineering Model (EM, flight-like battery), EM01

CLIN 2: Battery Engineering Model (EM, flight-like battery), EM02

CLIN 3: Battery Flight Model (FM), FM 01

CLIN 4: Battery Flight Model (FM), FM 02

2.2 Delivery Terms and Schedule

Within Twenty-one (21) months after Contract Effective Date (CED), all CLINs shall be delivered by Purchaser on DDP TASA Jobsite.

Purchaser shall apply for the customs duty exemption from Taiwan, the Republic of China (ROC) government authorities and Contractor shall be responsible for customs clearance for the imported CLINs. Contractor shall provide Purchaser all necessary information one (1) month prior to shipment so as to enable Purchaser to apply for exemption of such duty and tax.

Contractor shall to obtain and maintain its validity in full force during the period of the Contract, all governmental approvals, licenses, permits, authorizations and other clearances required for the execution and performance of the Contract.

For shipment of any deliverable CLINs, including any repaired or replaced items, Contractor shall sign a Certificate of Conformance ("COC") in form of Exhibit C, assuring that the items shipped conform to the requirements of the Contract and are correctly packaged, packed, and marked. Purchaser shall conduct a visual inspection and acceptance upon arrival of the shipped items at Purchaser's site to assure that such items are in compliance with the COC. Purchaser shall, within thirty (30) days of receipt of a COC, either countersign the COC without unreasonable delay, or state the items which do not comply with the requirement of the Contract. In such event of non-compliance, Contractor shall make corrections within the period of time as may be prescribed by the Purchaser and shall be responsible for any resulting schedule impact if it fails to make the correction within the prescribed period of time. If any damage, shortages, discrepancies, non-conformity, misidentification of products, misdirected products, etc. is found, Contractor shall promptly, within a reasonable period of time specified by Purchase, provide repair or replacement at its own cost and responsibility, such cost includes transportation and insurance cost from and to Purchaser's site.

Countersignature of a COC by purchaser shall constitute Purchaser's acceptance of the Equipments/Products/Services/Items that the COC indicates.

ARTICLE 3 – Contract Price and Payment Terms

3.1 Contract Price

The Contract Price is with requirement list detailed in Appendix II, FORMOSAT-9 Battery Procurement Statement Of Work (SOW).

3.2 Payment Terms

For Contract Line Items procured under this Contract, TASA shall, in accordance with the table in Section 2 of Appendix I Price Breakdown & Payment Schedule, make payments upon conditions of each payment met. Each payment will be made within thirty (30) days after

Contractor's presentation of the invoice and document as set forth in Section 2 of the Appendix I Price Breakdown & Payment Schedule. The payment shall be through telegraphic transfer to the bank account of Contractor as indicated in contractor's invoice.

Any payment requested by Contractor during the transitional period (January 1st to March 15th) of each fiscal year, payment shall be made by Purchaser after March 15th as soon as the funding becomes available.

3.3 Refund Bond ("RB")

Contractor shall submit, at its own cost, a Refund Bond for the principal of and interest on the first milestone payment received from Purchaser pursuant to Appendix I, Price Breakdown & Payment Schedule. The RB shall be an irrevocable standby letter of credit in form of Exhibit D. The RB shall be an initial amount equal to the first payment as specified in Appendix I. All banking charges in relation to the RB shall be borne by Contractor. Other instruments for RB submission will only be acceptable upon TASA's prior written consent.

The RB shall be valid until at least three (3) months after the scheduled date of FM01 & FM02 delivery. If there is any extension of the Contract schedule or performance delay, Contractor shall, no later than thirty (30) days prior to the expiration of the RB, have its validity extended by a period of time reasonably determined by Purchaser, or Purchaser shall have the right to collect the RB before its expiration.

ARTICLE 4 - Taxes

Any and all taxes, levies or charges which may be assessed to Contractor under DDP terms by any taxation authorities without the territory of Taiwan with respect to the efforts performed by Contractor or its subcontractors or their personnel shall be the responsibility of Contractor. Purchaser is responsible for acquiring duties and taxes exemption levied by Taiwan government, so contract price shall be exclusive of duties and taxes of Taiwan. For local contractor, all duties and taxes levied by taxation authorities which are not in the purchaser's tax exemption of this contract pursuant to regulations of taxation authorities of Taiwan shall be the responsibility of local contractor.

ARTICLE 5 - Warranty

5.1 The title to and risk of all delivered items under this contract shall transfer to Purchaser upon the date Purchaser's countersignature of the COC.

5.2 Contractor warrants that all CLINs to be delivered under the Contract shall be of new manufacture and not previously used in any manner as well as free and clear of any security interest, liens, charges or other encumbrances. Contractor shall, upon breach of this warranty, take immediately actions to:

a. remove any title defect;

b. replace the CLINs thereof which are defective in title; or

c. provide such other remedy as is mutually agreed upon by the parties.

5.3 The warranty for all CLINs shall be one (1) year from the date of acceptance and purchaser countersigning the COC.

5.4 Contractor will, free of charge, within the warranty period set out in 5.3 above, repair or replace any item which is proven to the reasonable satisfaction of Contractor to not comply with the agreed Specification due to significant defects in material, or workmanship or design (other than a design made, furnished or specified by TASA), PROVIDED ALWAYS THAT:

a. the defective items are returned to Contractor at TASA's risk but Contractors reasonable expense (to be invoiced);

b. the items have not been altered in any way whatsoever;

c. the items have not been subject to misuse or unauthorised repair;

d. a handling log book has been maintained and made available to Contractor;

e. the items have been properly installed and connected;

f. any instructions as to storage, handling or use of the items have been complied with in all respects;

g. any maintenance requirements relating to the items have been complied with in all respects.

Contractor's guarantee shall not extend to compensation for damage resulting from the use of items covered by the contract after acceptance. Consequently, TASA shall have no claim against Contractor for damage suffered by it and shall indemnify Contractor in respect of any expense or claim relating to third parties.

All other warranties are excluded including without limitation express or implied warranties of merchantability and fitness for purpose and any implied warranties arising from the course of dealing, usage or trade, or course of performance.

5.5 In the above cases, the warranty period for the repaired or replaced item shall be the remaining portion of the original warranty period, or six (6) months from the date the repaired or the replaced item function properly, whichever is longer.

ARTICLE 6 – Liquidated Damages and liability

If the deliveries of CLINs are delayed, pursuant to Contract Schedule, and the delay is attributed to the Contractor, the Contractor shall pay Purchaser in the amount equal to one tenth of one percent (0.1%) of the delayed CLIN's contracted prices for each day of delay, to the actual delivery date, i.e. the date Purchaser received the shipment of CLINs. The maximum amount of the Liquidated Damages shall not exceed ten percent (10%) of Contract Price.

Purchaser may deduct the amount of the Liquidated Damages from any payment due Contractor pursuant to the Contract or, if no payments remain to be paid to Contractor, demand Contractor to pay within thirty (30) days from the due date.

Notwithstanding any other provision of this contract, the Contractors total cumulative liability under or in connection with this Contract, at law or any separate course of action shall be limited to the Contract Price. Contractor shall not be liable for any indirect, consequential or punitive damages.

ARTICLE 7 -Termination

7.1 Termination for Purchaser's Convenience

Purchaser may terminate the Contract in whole or in part by no less than thirty (30) days prior written notice Contractor. Promptly after the effective date of the termination, Contractor shall submit its claim for the costs that are allowable and allocable to the terminated portion of the Contract up to the effective date of termination. In no event the aggregate amount claimed by Contractor shall exceed the price of the Contract Line Item(s) so terminated and/or the Contract Price. The amount paid by Purchaser in excess of the value of Contractor's claim set forth above shall be refunded to Purchaser and any amount owed to Contractor as a result of such claim shall be paid to Contractor against Contractor's commercial invoice within thirty (30) days of the termination settlement.

7.2 Termination Due to Contractor's Default

Any of the following events constitutes Contractor's default under the Contract. Purchaser may terminate the Contract in whole or in part:

a. Contractor commences a voluntary action pursuant to the bankruptcy law or any proceeding under any liquidation or similar law of any jurisdiction is commenced against Contractor, or Contractor fails to secure its financial, technical ability or other ability to perform the Contract; or

b. The export license or any governmental approval required for the performance of the Contract is suspended or revoked by the government of Contractor, which is attributed to Contractor, or

c. The amount of the liquidated damages for delay assessed in accordance with Article 6 has reached ten percent (10%) of the Contract Price.

Upon occurrence of an event of default, Contractor shall promptly provide clarification and a cure plan for Purchaser's consideration. Purchaser may, at its sole discretion, accept or reject the cure plan proposed by Contractor. Should Contractor fail to promptly provide clarification and a cure plan or should Purchaser find such clarification or cure plan unacceptable, Purchaser may terminate the Contract in whole or in part and immediately proceed to avail itself of any and all appropriate remedies. If Purchaser accepts contractor’s clarification and cure plan, this contract shall, upon purchaser’s decision, remain valid but the contractor shall be responsible for liquidated damages pursuant to article 6.

Purchaser shall have the option to accept any delivered Contract Line Item(s). Should Purchaser opt to do so, Purchaser shall pay for the Contract Line Item(s) so accepted at the contracted price. Contractor shall at its own cost and risk remove, within a reasonable period of time, any delivered Contract Line Item(s) which have been cancelled by Purchaser.

7.3 All costs of Contractor included in the termination claim shall be subject to reasonable substantiation and verification by Contractor's controller and a Certified Public Accountant firm acceptable to Purchaser. The responsibility for the costs associated with the use of such an accounting firm shall:

a. in the case of termination pursuant to Article 7.1 shall be borne by Purchaser; or

b. in the case of rescission pursuant to Article 7.2 shall be borne by Contractor.

ARTICLE 8 - Notices

Any notice required or permitted to be given pursuant to the Contract shall be given by certified airmail, personal delivery, fax, e-mail to the address specified below, as may be changed by written

notice given by either party to the other. Notices sent by certified airmail shall be deemed to be delivered ten (10) days after certification. Notice given by fax or e-mail shall be deemed to have been received on the next following working day and shall be confirmed by certified airmail.

ARTICLE 9 – Conditions to Effectiveness

9.1 The Contract shall become effective when the conditions set forth below are satisfied:

a. the Contract has been signed by Contractor and TASA;

b. all governmental approvals and/or export licenses necessary for the performance of the Contract are available at Contractor./ or A notice of no governmental approvals and/or export licenses required for the performance of the Contract from Contractor.

9.2 Upon fulfillment of the conditions set forth in Article 9.1, Contractor shall issue and deliver to TASA a Contract Effective Date Certificate in duplicate in form of Exhibit A. TASA shall, upon confirmation of compliance, countersign and return one copy to Contractor.

9.3 In the event that the conditions set forth in Article 9.1 are not satisfied within six (6) months after signing of the Contract by both parties or an extended period as may be agreed upon by both parties, the Contract shall be considered null and void. In such event, Contractor shall bear all costs and liabilities incurred on its part.

ARTICLE 10 - Amendment

The Contract shall only be amended or modified in writing signed by the authorized representatives of the parties.

ARTICLE 11 –Arbitration

11.1 All disputes, claims or controversies arising under or in connection with the Contract, or its interpretation or performance shall be reduced to writing and addressed to the other party pursuant to Article 8. The other party shall within thirty (30) days from the date of receipt of such notice submit its response. The parties shall exert their best efforts to reach an amicable settlement.

11.2 Any dispute arising out of or related to the Contract which is not settled by amicable agreement between the parties shall be finally settled by arbitration. The arbitration shall be conducted in the English language and held in accordance with Taiwan ROC Arbitration Act in Taipei, Taiwan. Each of the parties shall appoint one

arbitrator and the two so nominated shall, in turn, choose a third arbitrator. If the arbitrators chosen by the parties cannot agree on a choice of the third arbitrator within a period of sixty (60) days after their nomination, then the third arbitrator shall be appointed by Taiwan ROC Arbitration Association and serve as the chairman of the arbitration panel. Unless otherwise agreed upon by the parties hereto, the third arbitrator shall be from a country other than that of the parties. The parties waive any objection to the matters stated in this clause on the grounds of inconvenient forum or otherwise. Any award rendered by such arbitration forum shall be conclusive, binding and enforceable upon the parties in any jurisdiction. For the local contractor, the arbitration shall be conducted in the Chinese language.

11.3 All information relating to or disclosed by any party in connection with the arbitration of any dispute relating to the Contract shall be treated by the parties and the arbitration panel as confidential information and no disclosure of such information shall be made without the prior written authorization of the party furnishing such information.

11.4 The arbitration panel shall indicate in the award how to distribute the arbitrator's fees and arbitration expenses between the parties in accordance with what they deem just and equitable under the circumstances. Each party shall bear its own counsel fee incurred in connection with the arbitration.

11.5 The occurrence of any dispute and the submission thereof to arbitration shall not relieve Contractor of its obligations to continue performance of the Contract in good faith.

ARTICLE 12 - Governing Law

The Contract shall be governed by the laws of Taiwan, ROC, without giving effect to the conflict of law rules thereof.

ARTICLE 13 - Licenses, Permits and Compliance with Export Requirements

13.1 Contractor undertakes to obtain, and maintain its validity in full force during the period of the Contract, all governmental approvals, licenses, permits, authorizations and other clearances required for the execution, delivery and performance of the Contract, in particular, the export license required for the delivery (and redelivery where necessary) into the Taiwan of the Contract Line Items, data and documentation in connection therewith, and to obtain from time to time all such other governmental approvals required for any amendment, modification and/or extension thereof, all at Contractor's risk and expenses.

13.2 Contractor shall obtain governmental approvals, licenses, permits, authorizations and other clearances required for the execution, delivery and performance of the Contract, in particular, the export license required for the delivery (and redelivery where necessary) into the Taiwan of the Contract Line Items. Purchaser reserve the right to

extend the delivery schedule pursuant to Article 14 or terminate this contract in whole or in part pursuant to Article 7.

13.3 Contractor undertakes to fulfil all requirements prescribed in and to comply in all respects with the applicable laws, such as safety, health, environment protection, labor, import and export laws and regulations relating to the execution, performance and delivery of the Contract and all governmental administrative acts pursuant to such laws and regulations.

Article14-Excusable Delay

14.1 Force Majeure

14.1.1 Any delay in or failure of performance by either party pursuant to the Contract (except the payment of money) shall not constitute default nor give rise to any claims for damages if and to the extent caused by Acts of God, acts of government in its sovereign capacity, riots, strike, war, revolution, warlike operations, fires, floods, earth quake, epidemics of contagious diseases, quarantine restrictions, sabotage or other similar events (the "Force Majeure") which are not attributable to, and are beyond the control of the affected party. Force Majeure occurred during Contractor's delay shall not be excusable.

14.1.2 Failure to provide or inability to perform by Contractor's subcontractors shall not be considered as the Force Majeure unless such failure or inability have been caused by the Force Majeure as defined in Article 14.1.1 and Contractor is unable to engage other subcontractors within reasonable time and expense.

14.1.3 The affected party shall immediately provide written notice, with evidence, to the other party of the causes of the Force Majeure and in any event within ten (10) days.

The affected party shall be entitled to an extension as may reasonably be required to remove or remedy the Force Majeure provided that it has timely notified the other party and furnished evidence, which shall be concurred with by the other party. The extension of the Complete Date(s) shall be granted only when the above requirements have been satisfied.

14.1.4 The other party shall within ten (10) days of receipt of the notice from the affected party, reply in writing if the extension has been granted and the acceptable period of extension, if any. Should the other party fail to so notify the affected party, the other party shall be deemed to have granted the extension as requested.

14.1.5 The affected party shall take all steps necessary to remove the effects of the Force Majeure and to regain time lost and shall in no event discontinue or delay the

performance of any obligations provided in the Contract not directly affected by the Force Majeure.

14.2 Non-fulfilment of Purchaser's Responsibility

14.2.1 Purchaser shall comply with its obligations specified in the Contract. Should Purchaser fail to timely fulfil any of its obligations specified in the Contract, Contractor shall continue the performance on its part and no excusable delay shall be granted unless Contractor's performance is directly affected thereby.

14.2.2 Should Purchaser fail to fulfil any of its obligations pursuant to the schedule explicitly specified in the Contract and the failure has affected Contractor's performance of the Contract, Contractor shall use its best effort to minimize the impact. Should Purchaser's delay has affected the Contract Schedule, then,

a. in the case where a delay has continued for sixty (60) consecutive days or less, Contractor may specify the extent to which its performance is affected thereby, with adequate explanation, and request for an extension of the relevant Contract Schedule by the number of days which shall not exceed the number of days of Purchaser's delay, without affecting the Contract Price.

b. in the case where a delay has continued for more than sixty (60) consecutive days, Contractor may specify the extent to which its performance is affected thereby, with adequate explanation, and make a modification proposal. The parties shall determine the effect of the modification, if any, and agree upon the terms thereof.

Article 15 Waiver of Breach

The failure of either party, at any time, to require performance by the other of any obligations provided in the Contract shall in no way affect the full right to require such performance at any time thereafter. The waiver by either party of a breach of any obligation provided in the Contract does not constitute a waiver of any succeeding breach of the same or any other obligations, nor shall it constitute a waiver of the obligation itself.

Article 16 Assignment

The Contract shall not be transferred or assigned, in whole or in part, by Contractor to any other individual, firm, partnership, corporation, institution, government agency or any other entity.

ARTICLE 17 Entire Contract

17.1 The Contract shall be executed in two (2) originals, with one (1) original copy for each party.

17.2 The provisions contained in the Contract or incorporated by reference constitute the entire Contract and supersede all previous oral or written communications between the parties with respect to the subject matter.

IN WITNESS WHEREOF, TASA and Contractor have caused the Contract to be executed by their duly authorized officers or representatives as of the day and year indicated below.

TASA:	**Contractor:**
National Space Organization,	
By:	By:
Name Typed: Dr. JONG SHINN WU	Name Typed:_____
Title: Director General of TASA	Title:_____
Date:_____, 2024	Date:_____, 2024

EXHIBIT A Contract Effective Date Certificate

Pursuant to Contract No. TASA-P-1130365 (hereinafter referred to as the "Contract") between Taiwan Space Agency (“TASA” or “Purchaser”) and_____("Contractor"), the undersigned, a duly authorized representative of Contractor, hereby certifies that all the conditions to the effectiveness of the Contract as specified in Article 9 have been satisfied on _____. Such date is the Contract Effective Date ("CED").

Contractor's Representative	Confirmed by TASA
_____	_____
By:	By:
Typed Name:	Typed Name:
Title:	Title:
Date:	Date:

EXHIBIT B Milestone Completion Certificate

Pursuant to Contract No. TASA-P-1130365 (hereinafter referred to as the "Contract") between Taiwan Space Agency (“TASA” or “Purchaser”) and_____ __("Contractor"), the undersigned, a duly authorized representative of Contractor, hereby certifies that the following tasks which are required for the _____ Milestone Payment have been completed in accordance with the Contract and that no default under the Contract has occurred or is continuing:

	Date of Completion	
Milestone Tasks	Scheduled Date	Actual Date

The successful completion date for the milestone shall denote the date on which this certificate is duly countersigned by Purchaser.

Contractor's Representative	Accepted by TASA
_____	_____
By:	By:
Typed Name:	Typed Name:
Title:	Title:
Date:	Date:

EXHIBIT C CERTIFICATE OF CONFORMANCE

Pursuant to Contract No. TASA-P-1130365 (hereinafter referred to as the "Contract") between Taiwan Space Agency (“TASA” or “Purchaser”) and _("Contractor"), the undersigned, a duly authorized representative of Contractor, hereby certifies that the Contract Line Item(s) to be shipped as described herein below conforms to the requirements of the Contract and are duly packaged, packed and marked.

Item Name	Item Description	Quantity	Package No.

Contractor's Representative	Accepted by TASA
By:	By:
Typed Name:	Typed Name:
Title:	Title:
Date:	Date:

EXHIBIT D Model of Refund Bond

IRREVOCABLE STANDBY LETTER OF CREDIT

We hereby issue our irrevocable Standby Letter of Credit No. _____ for the account of _____ (hereinafter referred to as "Contractor"), in favor of National Space Organization (hereinafter referred to as "Customer"), for an amount of _____, representing **Ten** percent (**10**%) of the Contract Price, as the Refund Bond required under Contract No. TASA-P-1130365 (hereinafter referred to as "Contract") executed by and between Customer and Contractor, dated _____.

Drawings under this Standby Letter of Credit shall be available at the counters of _____ (the ROC issuing or confirming bank) and payable two (2) business days after presentation of a simple receipt drawn on us, accompanied by a statement signed by Customer, stating that "Contractor has failed to comply with the terms of the Contract and an amount of _____ is due and payable to Customer under Article _____" or "Contractor has failed to maintain the amount and/or validity of the RB as required by Article 5.5 of the Contract".

This Standby Letter of Credit may be drawn in whole or in part on or before the expiration date as mentioned below.

All banking charges in connection with this Standby Letter of Credit shall be for account of Contractor.

We hereby engage that all receipts drawn and/or documents presented under and in compliance with the terms of this Standby Letter of Credit will be duly honored upon presentation on (the ROC paying bank) no later than _____.

This documentary credit is subject to the "Uniform Customs and Practice for Documentary Credit", _____ revision, International Chamber of Commerce Publication No. ____.

Truly yours,

Appendix I Price Breakdown & Payment Schedule

1. Price Breakdown

Total Contract Price & Price Breakdown

Item No.	Contract Line Item	Price
CLIN 1	Battery Engineering Model (EM, flight-like battery), EM01	
CLIN 2	Battery Engineering Model (EM, flight-like battery), EM02	
CLIN 3	Battery Flight Model (FM), FM 01	
CLIN 4	Battery Flight Model (FM), FM 02	
Total Contract Price		

2. Payment Schedule

Summary of Payment Schedule

Payment No.	MCC/COC	Payment Milestone	Payment Amount
1		After CED	(10% of total Contract Price)
2	MCC for Kick Off MCC for CDR	After CDR	(15% of total Contract Price)
3	MCC for TRR COC for CLIN1 EM01 COC for CLIN2 EM02	After EM01 and EM 02 Delivery and Acceptance	(30% of total Contract Price)
4	MCC for PSR	After FM01 and FM 02 Delivery	(45% of total Contract Price)

	COC for CLIN3 FM01 COC for CLIN4 FM02	and Acceptance	

MCC: Milestone Completion Certificate

COC: Certificate of Conformance

2.1 Payment #1

The payment shall be 10% of the Contracted Price and shall be effective within thirty (30) days after the presentation of the following documents by the Contractor:

- The Contractor's invoice in one (1) copies;
- Documents regarding the approval of all necessary export licenses/ or A notice of no governmental approvals and/or export licenses required.
- The RB in amount of 10% of total Contract Price;
- Countersigned Contract Effective Date Certificate.

2.2 Payment #2

The payment shall be 15% of the Contracted Price and shall be effective within thirty (30) days after the presentation of the following documents by the Contractor:

- The Contractor's invoice in one (1) copy;
- The original duly countersigned MCC for Kick Off and MCC for CDR.

2.3 Payment #3

The payment shall be30% of the Contracted Price and shall be effective within thirty (30) days after the presentation of the following documents by the Contractor:

- The Contractor's invoice in one (1) copy;
- - The original duly countersigned MCC for TRR;
- - The original duly countersigned COC for CLIN1 EM01 and CLIN2 EM02.

2.4 Payment #4

The payment shall be 45% of the Contracted Price and shall be effective within thirty (30) days after the presentation of the following documents by the Contractor:

- The Contractor’s invoice in one (1) copy;
- The original duly countersigned MCC for PSR;
- The original duly countersigned COC for CLIN 3 FM01 and COC for CLIN 4 FM02.

Appendix II Statement Of Work (SOW)

TASA 國家太空中心 Taiwan Space Agency

2024/04/15

FORMOSAT-9 Battery
Statement Of Work (SOW)

Taiwan Space Agency

國 家 太 空 中 心

TABLE OF CONTENTS

1 Reporting, Reviews and Meetings

The contractor shall ensure that during the course of the design and the development information of the contractor is adequately shared with TASA, typically by participating in review activities at

- Kick-off
- CDR
- TRR
- PSR/EIDP Review.

Whenever meetings at the contractor's site are planned TASA will be invited for participation.

1.1 Kick-Off (KO)

Kick-off is held after the contractor is granted the product export license to TASA. The contractor can release the long lead items and piece parts procurement / manufacturing if agreed on this review. Any available information will be shared with TASA:

- Circuit design margins
- Radiation effects
- Single point failures, fault detection and isolation functions
- Life limited items
- Analysis Tools
- Visible availability and status of manufacturing documentation
- Availability and adequacy of design and interface documentation
- Potential waivers / specification status
- Unit mechanical design (strength /stiffness)
- Unit thermal design
- Test planning and test procedures

In preparation for the kick-off, the contractor shall provide

- Overall project flow/schedule plan
- Detailed description of design
- Block diagrams & current schematics
- Interface circuit diagrams
- Mechanical design or manufacturing drawing
- Parts and materials list
- Proposed specification updates
- Results of preliminary performance analysis (input from specifications)
- A list of critical items / areas related to specification compliance (waivers), potential performance problems, potential schedule risk.

Documentation delivered for KO will be provided as a preliminary version from information / data to date. TASA will update the input data for performance analysis next milestone.

1.2 Critical Design Review (CDR)

In frame of the peer review, the unit design and contractor activities will be assessed towards the fulfillment of the procurement / component specification.

In individual sessions, it will focus on critical areas of the following issues:

- EEE parts stress / de-rating requirements
- Design margins by discussing worst-case circuit performance or the results of margin testing (accounting for worst case circuit, environmental, and failure conditions under which the part is required to operate).
- Radiation effects (total dose, single event effects)
- Single point failures, fault detection and isolation functions
- Software requirements and design if any
- Life limited items
- Required analyses including the methodology, applicable databases and assumptions
- Visible availability and status of manufacturing documentation
- Availability and adequacy of design and interface documentation
- Potential waivers / specification status
- Unit mechanical design (strength /stiffness)
- Unit thermal design
- Test planning and test procedures
- Compliance status of specifications

In preparation for the CDR, the contractor shall deliver advance copies in electronic form of background documentation to TASA at least ten calendar days prior to the review. The information shall include as a minimum:

- Detailed design description
- Block diagrams, current schematics
- Interface circuit diagrams
- Mechanical design or manufacturing drawing
- Parts and materials list
- Proposed specification updates
- Results of performance analysis
- Test result summary (if applicable)
- Input to system FMECA, assessment of fault tolerance requirements, single point failure list
- A list of specification compliance (waivers), potential performance problems, potential schedule risk.
- Documentation of heritage, and a list of changes to the heritage design or the design requirements.

During the review the contractor shall make available for insight wiring diagrams, manufacturing drawings and process documents to support detailed discussions, whenever necessary. This information is considered proprietary contractor company information and will not be made a deliverable. Any copy will only be made with the agreement of the contractor.

The contractor shall update master contract schedule to TASA. Successful closure of this review will freeze the battery design and release manufacturing activities.

1.3 Manufacturing/Assembly Readiness Review (MRR/ARR)

The MRR and ARR are contractor's solely responsibility. The contractor provides the visibility of minutes of review to TASA.

1.4 Test Readiness Review (TRR)

TRR is held after the completion of battery flight unit manufacturing and is ready for unit test. With respect to activities in review, the contractor shall provide the following:

- Detailed test procedure
- Compliance status of specifications
- Non-conformance / waiver status
- Proposed plan for product shipment and the remaining schedule

The detailed test procedure shall be in line with delivered Test Plan. During the review the contractor shall make available for insight the manufactured battery for TASA as well as the test equipment and facility wherever available at contractor's premise.

1.5 Pre-ship Review (PSR)

The main goal for PSR is to review the results of flight units test campaign and perform the final product inspection to TASA. All analysis results updated after CDR will be addressed as well. All final documentation, including that had been delivered, shall be enclosed in the End Item Data Package (EIDP). Advanced copies of EIDP in electronic form shall be provided to TASA at least ten calendar days prior to the review. A successful closure of this review board allows delivery of contract items.

2 Required Deliverables

2.1 Deliverable Hardware

2.1.1 Hardware List

The contractor shall deliver the following hardware items at the indicated delivery date

Item: Two sets of Battery Engineering Model (EM, flight-like battery)

Two sets of Battery Flight Model (FM)

Each hardware shall be delivered with the following additional equipment:

- Connector protective caps
- Connector savers

2.1.2 User Furnished Items

n/a

2.2 Deliverable Documents

2.2.1 Deliverable Documents List

The contractor shall provide copies of any of the listed deliverable documents in electronic or paper form to TASA.

The contractor shall provide the following documents as listed as a minimal. Contents or documents can be combined or separated by contractor. Any other document required for each milestone review will be defined by contractor. All required documents shall be included in the EIDP at PSR whatever they have been revised.

Document	Delivery Due			Remarks
	KO	CDR	TRR	
Electrical Analysis Report (including dissipation profiles)	x	x	-	Flight Unit
Thermal Analysis Report	-	x	-	
Structural Analysis Report	-	x	-	
Parts, Materials and Processing List	-	x	-	Flight Unit
Parts de-rating, Stress Analysis	-	x	-	Flight Unit
FMECA and Hazard Report	-	x	-	Flight Unit
User Manual and Design Description	x	x	-	Flight Unit
Cell Screening and Matching Report	-	-	x	Flight Unit
Interface Control Document (ICD)	-	x	-	

Document	Delivery Due			Remarks
	KO	CDR	TRR	
Mechanical Interface Control Drawing (MICD)	x	x	-	
Electrical Interface Control Drawing (EICD)	x	x	-	
Battery Thermal Model	-	x	-	Flight Unit
Battery CAD Model	-	x	-	Flight Unit
Test Plan	x	x	-	
Test Procedure	-	-	x	As-run provided for flight unit at PSR only
Test Report	-	-	-	Flight Unit at PSR
Verification Control Document	x	x	x	
Battery Air-freight permit	-	-	-	At PSR
NCR/ECR	As required			
Certificates of Conformity	-	-	-	At PSR

The Progress Report can be waived if any of the contract milestone takes place with minutes of meeting.

The EIDP for battery EM can be delivered with the hardware in the same shipment. However, the closure of document review at TASA is a part of the acceptance of battery EM.

2.2.2 Document Content Requirements

The documents shall be prepared following the instructions as outlined below.

User Manual and Design Description: This document shall describe the battery with its physical, mechanical, thermal and electrical characteristics and summarize its key performance data and interface details. It shall contain operator guidelines for transport, storage as well as for its operation on-ground and in-orbit. As a minimum this document shall address the following issues:

- Description of the design to a level allowing the user to understand the implementation and compliance to functional and performance requirements
- Operational, system integration and handling constraints
- Mass budgets
- Result summary of analyses and tests (can be individual document each)

Interface Control Document: This document shall define and outline to an adequate level the mechanical, thermal and electrical interfaces of the battery towards the spacecraft.

2.2.3 End Item Data Package (EIDP)

The end item data package shall be delivered together with the each hardware to the address indicated in section 2.1.1, a simultaneous copy to the address indicated in section 2.1.1. The package shall consist of the following documents besides defined in the Deliverable Documents List elsewhere:

- Shipping Documents
- Pre-ship Review Board Meeting Minutes
- Configuration Item Data List
- RFW List / RFWs
- Mate/Demate Records
- Log Book

2.3 Key Milestones

No.	Task	Dates	Payment
1	Contract Signature Date (CSD) CED < CSD + 6 months		-
2	Contract Effectiveness Date (CED = T0) At export license confirmed or waived	CED < CSD + 6 months	10%
3	Kick-off	T0 + 2 months	-
4	Critical Design Review	T0 + 6 months	15%
5	Test Readiness Review	T0 + 14 months	-
6	EM01 & EM02 Delivery	T0 + 16 months	30%
7	FM01 & FM02 PSR	T0 + 20 months	-
8	FM01 & FM02 Delivery	T0 + 21 months	45%

3 Product Warranty

Twelve months warranty of hardware is required after each hardware delivery and acceptance satisfactory.

TASA 國家太空中心 Taiwan Space Agency

FS9-SPEC
Rev. 01
2024/04/15

FORMOSAT-9
Battery Component Specification

Taiwan Space Agency
國 家 太 空 中 心

Revision/Change Record
改版/變更記錄

Revision 版次	Author 作者	Authorization Date 核可日期	Revision / Change Description 改版/變更說明	Pages Affected 影響頁次
01			New Issue	All

TABLE OF CONTENTS

1 Introduction

1.1 Purpose

This document delineated the requirement specifications used to obtain the FORMOSAT-9 spacecraft Battery.

1.2 Scope

The scope of this document is to provide the contractually relevant requirements and constrains for the battery supplied in the context of the FORMOSAT-9 spacecraft development program. These requirements enclose

- the required performance, design and interfaces of the subject hardware
- the deliverable hardware, software and documentation together and their respective delivery dates
- the applicable verification and testing requirements.

Each of the requirements in section 3 and 4 are marked with a requirements identifier. This identifier has been implemented for the benefit of user's ease of information handling. It is of no contractual relevance.

1.3 FORMOSAT-9 Program Summary

The Taiwan Space Agency (TASA) initiated a space program, called FORMOSAT-9 Program, to develop and strengthen its satellite system and subsystems design and development capabilities as well as to establish a state-of-the-art heritage bus platform with open, modular and expandable architecture for future high performance remote-sensing missions.

The FORMOSAT-9 program is the first SAR (Synthetic Aperture Radar) satellite being developed with full responsibility by Taiwan Space Agency (TASA). The spacecraft will operate over 5 years life time on a low inclination orbit at about 514 km altitude.

1.4 Technical Reference Design

The primary function of the battery is to store excess energy during phases with sun illumination and deliver energy into the system during eclipse periods or periods in sun phases during which the solar array generated power is less than demanded by the on-board users.

The battery is embedded in a power system consisting of a solar generator and power control unit (PCU). The solar array GaAs cells are accommodated on two deployed solar panels (TBC) on spacecraft minus Y axis.

The power control unit consists of

- a set of solar power shunt regulator to control the energy flow into the system, in particular the battery

- the power distribution stage allowing the switching of all connected bus (except S-band receivers) and instrument users and providing short-circuit protection of the PCU internal main bus
- a serial interface to communicate with the On-Board Computer that is controlling the charge process and the switching of the system/instrument power users.

2 Related Documents

2.1 Applicable Document

[AD1] FS9A-REQ-0001 FORMOSAT-9A System Requirements Document (SRD)

2.2 Reference documents

The following documents are for reference only. Parts of these documents that are applicable for the development of the subject product are only those clearly made applicable in the context of this specification.

Whenever the supplier relies and refers to design and development standards a preference to the utilization of documents from the following list is desired:

[RD 01]	ESA PSS-01-301	De-rating Requirements and Application Rules for Electronic Components
[RD 02]	ANSI/J-STD-001	Joint industrial standard: requirement for soldered electrical and electronic assemblies
[RD 03]	ASTM E 595-90	Total mass loss and allocated volatile condensable materials from out-gassing in a vacuum environment
[RD 04]	deleted	
[RD 05]	IEC 60812	Analysis techniques for system reliability - Procedure for failure mode and effects analysis (FMEA)
[RD 06]	LN 29949	Cheese head screw with internal serration, CRES for T up to 650 °C
[RD 07]	MIL-HDBK-217	Reliability Prediction for Electronic Equipment (use as Guideline)
[RD 08]	MIL-STD-461	Electromagnetic Emission and Susceptibility Requirements for the control of Electromagnetic Interference
[RD 09]	MIL-STD-462D	Measurement of Electromagnetic Interference Characteristics
[RD 10]	MIL-STD-1547	Electronic Parts Materials and Processes for Space and Launch Vehicles
[RD 11]	MSFC-SPEC-522	Design Criteria for Controlling Stress Corrosion Cracking

[RD 12]	MSFC-SPEC-250	Protective Finishes for Space Vehicle Structures
[RD 13]	NASA-STD-8739.1	Workmanship Standards for Staking and Conformal Coating of Printed Wiring Boards an Electronic Assemblies
[RD 14]	RADC-NPRD-91	Non-electronic Parts Reliability Data (Reliability Analysis Center RAC) (use as Guideline)
[RD 15]	ANSI / IPC-A-610	Acceptability of Electronic Assemblies
[RD 16]	ESA/SCC QPL	Qualified Parts List
[RD 17]	ESA/SCC QML	Qualified Manufacturers List
[RD 18]	NPSL	NASA Parts Selection List
[RD 19]	NPSL	EIA RS-422-A Standard

3 Specific Product Requirements

3.1 Functional / Performance Requirements

RQ-3.1-005: The battery design shall be based on battery cells with space flight heritage.
Verification: Information to show cell flight heritage.

RQ-3.1-010: All cells shall be screened in accordance with supplier internal screening and matching procedures. The cells used for the FORMOSAT-9 battery assembly shall not deviate in their capacity characteristics by more than 3%.
Verification: Cell screening and matching report

RQ-3.1-015: The battery shall facilitate numbers of strings in parallel each consisting of 8 cells in series (8sXp), where X represents the number of string in parallel, to provide sufficient output voltage from 24.0V to 33.0V.
Verification: Review of design

RQ-3.1-020: The battery shall provide protected or not protected battery level voltage monitoring point(s) in connector interface.
Verification: Review of design, test

RQ-3.1-030: The battery shall provide temperature sensor(s) inside the battery at thermally representative locations as defined in the mechanical ICD.
Verification: Review of design, test

RQ-3.1-040: The long-term self-discharge rate of the battery shall be less than 0.15 % per day.
Verification: Similarity, insight into cell level test data to be closed out as part of the design description report.

RQ-3.1-050: The battery shall provide the following EOL performance:

- Discharge Voltage: > 22 V at +10 °C at end-of-discharge

assuming that the end-of-charge voltage is maintained between BOL and EOL at supplier's recommended voltage and taking into account

- the life cycle input data as provided in A.3-1 of Annex 3
- and an assumed string open-circuit failure at EOL

Verification: EOL simulation of operating temperature between 10°C to 20°C with BOL performance test as outlined in section 6.2.2 successfully passed. The battery capacity at BOL shall be greater than 72(TBC) Amp-hours as a minimum.

3.2 Physical Properties

RQ-3.2-010: The unit mass in flight configuration shall be less than 20 kg.

Verification: Actual mass provided for design review and measurement on the fully assembled unit.

RQ-3.2-030: The dimensions of the battery shall be in the envelop, excluding grounding stud, within
Footprint: 370mm x 270mm
Height: 200 mm

Verification: MICD provided for design review and measurements according to MICD on unit level.

3.3 Mechanical Design Requirements

RQ-3.3-010: The battery and in particular the cells shall be designed that no cell internal material will leak to the outside of the battery.

Verification: Residual Gas Analysis (RGA) during system level TV test without identifiable traces of electrolyte. On unit level the supplier shall present the lot acceptance test results (being part of the design description) showing the integrity of the containment devices of all examined samples.

3.4 Thermal Design Requirements

3.4.1 Unit Dissipation

RQ-3.4-010: The supplier shall provide a dissipation model for the battery as part of the deliverable document and/or simulation tool.

Verification: BOL thermal cycle test data which are correlated via analysis to the EOL predicted behavior as laid down in Annex 3.

RQ-3.4-020: The supplier shall provide a definition of nodes and heat transfer linkages sufficient to create a reduced thermal model of the battery with two nodes.

Verification: Review of design

3.4.2 Thermal Properties

RQ-3.4-030: Deleted

Verification: NA

RQ-3.4-040: The battery thermal capacity shall be provided to user.

Verification: Data review in the design description.

3.4.3 Thermal Interfaces

RQ-3.4-050: The design of the unit shall be compliant with the following temperature levels at temperature reference point (TRP):

Table 3.4.3-1: *Temperature Limit Definition*

	Lower Limit	Upper Limit
Non-Operating Temperature	- 10 °C	+ 40 °C
Operating Temperature	+ 0 °C	+ 30 °C

Definition: The non-operating temperature limits define that range of temperature in which the inactive unit, other than transportation period defined elsewhere, shall survive without damage.

The operating temperature limits define that temperature range in which the unit provides the required functions and performance. This temperature definitions shall be based on the battery mounted on spacecraft wall panel with thermal filler and dissipating the heat through the mounting interface only. The other external surfaces of battery are covered by MLI.

Verification: Unit level Test

3.5 Electrical Design Requirements

3.5.1 Power Consumption

n/a

3.5.2 Electrical Interface Summary

RQ-3.5-020: The unit design shall be compliant with at least two individual connectors to other spacecraft equipment:

Connector Designation	Source/Target
Charge/Discharge Power Line	from/to Power Unit
Battery Voltage/Temperature Sensor	to Data Processor

Verification: Review of Design

RQ-3.5-030: The battery shall be designed to receive charge currents and provide discharge current on the same physical harness lines.

Verification: Review of Design

RQ-3.5-040: The temperature of the battery shall be delivered to the Data Processor using temperature sensors with the characteristics as outlined in EICD and the table at thermally representative points within the battery.

Verification: Review of Design

RQ-3.5-050: The voltage of the battery shall be delivered to the Data Processor using differential lines, each of those protected with a resistor.

Verification: Review of Design

3.5.3 Primary Power Supply Interfaces

n/a

3.5.4 Unit Specific Electrical Design Requirements

RQ-3.5-060: A minimum of 1MΩ DC isolation shall be maintained between

- voltage monitoring leads and battery structure
- temperature sensor leads and battery structure
- primary power leads and temperature sensor leads
- voltage monitoring leads and temperature sensor leads.

Verification: Functional / performance test

RQ-3.5-070: Power connectors shall have socket contacts.

Verification: Review of design, inspection

3.6 Software Interfaces

n/a

4 General Design & Interface Requirements

4.1 Life Time

RQ-4.1-010: The unit shall be designed to meet all performance and functional requirements during and after experiencing

- starting from delivery an on-ground life time of
  - up to 4 years under supplier recommended storage conditions
  - 1 year testing and assembly under ambient conditions (2 months fully charged, the remaining time under defined low charge conditions)
- an in-orbit life time of 5 years

Verification: Review of parts and material selection; the specific life time related performance is already verified via RQ-3.1-050 and RQ-3.4-010.

4.2 Unit Identification and Marking

RQ-4.2-010: The unit shall be marked by an identification label containing the following identification:

- Project Name: FORMOSAT-9
- Unit Name: Battery
- Part Number: TBD by supplier
- Serial Number: TBD by supplier

Verification: Review of Design, Incoming Inspection

RQ-4.2-020: The identification label shall be attached to the unit in form of a name plate permanently attached to the unit at a position that is easily visible during handling and after integration into the system. In case of standard parts or in cases where the size or design of the unit does not allow the attachment to the unit itself a bag-and-label technique shall be applied. For individual parts or components the marking with a serial number is sufficient.

Verification: Review of Design, Incoming Inspection

4.3 Mechanical / Structural Requirements

RQ-4.3-010: Deleted

RQ-4.3-020: The unit shall exhibit a first natural frequency of greater than 150 Hz on a rigid interface.

Verification: Accelerometer data during sine sweep testing (see section 6.2.4).

RQ-4.3-030: The unit shall be designed to withstand the following shock response spectrum:

Table 3.5.5-1: *Shock Response Spectrum (TBC)*

Frequency in Hz	Acceleration in g
100	30

746	640
10000	640

Verification: Review of Qualification Evidence.

4.4 Unit Mounting Requirements

RQ-4.4-010: Unless otherwise specified, the unit shall be designed to be mounted to the structure with M6 size screws.

Verification: Review of design (ICD)

RQ-4.4-020: The hole diameter for the M6 mounting screws shall be 6.8 ±0.1 mm.

Verification: Review of design (ICD)

RQ-4.4-040: Deleted

Verification: NA

RQ-4.4-050: Deleted

Verification: NA

RQ-4.4-060: All mounting points and the contact area shall be in a common plane within 0.2mm or 0.1mm/100mm.

Verification: Measurement

RQ-4.4-070: Each contact area shall have a roughness of less than 3.2 microns.

Verification: CoC from parts manufacturer available in the build file for review.

4.5 Maintenance, Modularity and Handling Requirements

RQ-4.5-010: The unit shall be designed to meet all performance and functional requirements over the specified life time without any need for maintenance.

Verification: Electrical Performance Analysis and the user manual.

4.6 Thermal Control Requirements

RQ-4.6-010: The temperature reference point (TRP), defined in the ICD, is located on the housing close to a mounting bolt and thus represents the unit interface temperature.

Notes: The TRP will be used as the reference point at which the temperature will be maintained by the spacecraft thermal control algorithms within the specified limits during the thermal acceptance testing.

Verification: Review of design

RQ-4.6-020: Deleted

Verification: NA

4.7 Electrical Interface Requirements

4.7.1 Primary Power Interfaces

n/a

4.7.2 Standard Signal Electrical Interfaces

n/a

4.8 Electrical EMC Requirements

4.8.1 General EMC Requirements

n/a

4.8.2 Bonding, Grounding & Isolation

Note: The grounding scheme of the FORMOSAT-9 spacecraft represents a distributed star-point grounding (DPSG) as outlined in Figure 4.8.2-1.

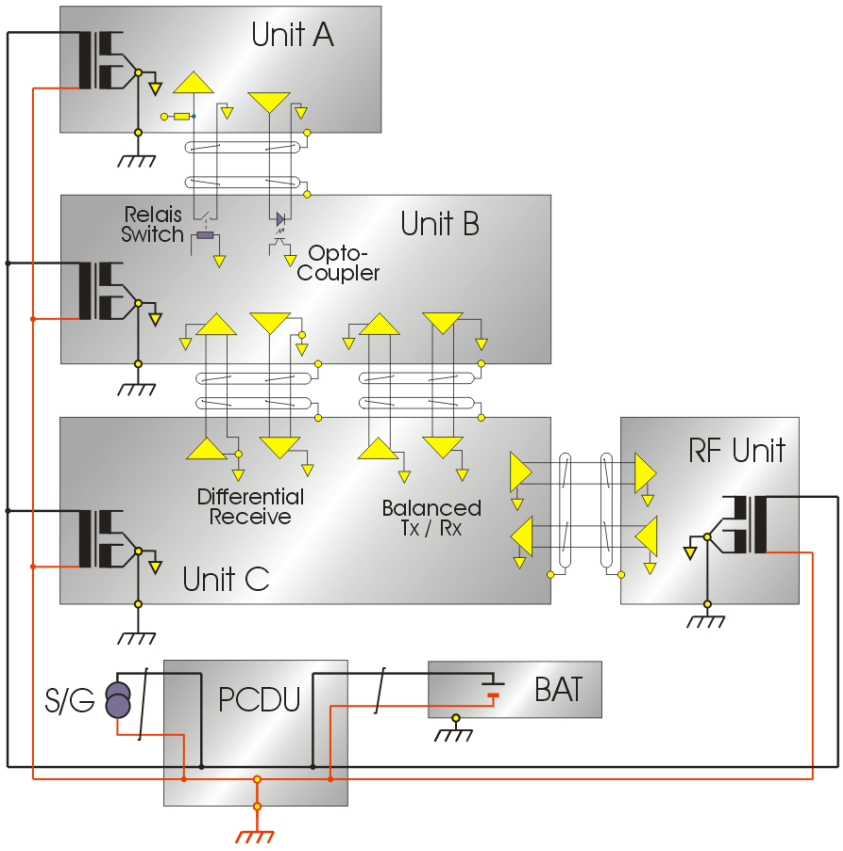

Figure 4.8.2-1: *FORMOSAT-9 Grounding Concept*

RQ-4.8-030: The design of the unit shall foresee a minimum of 1MΩ DC isolation between the primary power leads and the battery support structure.

Verification: Test

RQ-4.8-035: Metallic shells/receptacles of connectors shall be electrically bonded to the equipment case or to the bracket structure with a DC resistance of 100 mΩ or less.

Verification: Test

RQ-4.8-040: The unit shall provide a bonding stud (M4 size) with a minimum length of 7mm.

Verification: Review of design, inspection

RQ-4.8-045: A DC resistance of less than 100 mΩ shall be maintained between any metallic part of the unit structure and the bonding stud.

Verification: Test

4.8.3 Current Limiting and Inrush Current

n/a

4.8.4 Conducted EMC

n/a

4.8.5 Radiated EMC

n/a

4.8.6 Arc Discharge

n/a

4.8.7 Magnetic Cleanliness

RQ-4.8-290: Wherever possible, non-magnetic material shall be used and the utilisation of permanent magnets avoided.

Verification: Review of material list

4.8.8 Connector Characteristics

RQ-4.8-300: Magnetism level ≤ 200 gamma connectors and shells shall be used, contacts not used shall be equipped as well. Cable shields are to be connected to the outside of the box, i.e. via the connector shell. The connection must be of low impedance. A pigtail connection from shield to connector shell is not allowed. In no case it is allowed to route a cable shield via a pin

into the unit housing, to be terminated to ground inside. If a high current, low DC impedance termination of the shield is required, the shield may be additionally grounded via a low impedance pigtail wire to the outside of the unit.

Cadmium plated connectors are not allowed.

Verification: Review of Design

4.9 Radiation Environment

RQ-4.9-010: The unit shall be designed and verified withstand a radiation Total Ionizing Dose up to 40 krad.

Verification: Review of Test Record.

4.10 Atmospheric and Vacuum Environment

RQ-4.10-010: The unit shall be designed to operate within a pressure range from 1 bar down to vacuum.

Verification: Review of system TV test data at lower than 5 x 10^{-5} mbar

RQ-4.10-020: The unit shall be designed to withstand without damage or degradation in function a relative humidity of less than 60% during integration, test and transport phases.

Verification: Review of design, in particular parts & material lists

RQ-4.10-030: The out-gassing rate of any material used shall be less than 1% TML (Total Mass Loss) of and 0.1% CVCM (Collected Volatile Condensable Material). Exceptions up to TML < 5% are allowable for hygroscopic materials like CFRP or thermal foils. Other exceptions include

	TML	CVCM
Araldite 420	2.20%	0.023%

Verification: Review of material list

RQ-4.10-040: The unit shall have suitable venting provisions, that is 2 mm² venting hole area per litre volume. Outgassing vents shall be < 5mm diameter and shall be located closest to but not within the unit mounting plane. For EMC reasons, there shall be no other openings than necessary for connectors and venting holes.

Verification: Review of design

5 Product Assurance Requirements

The supplier PA approach shall ensure an effective an economic procurement program including design, development, manufacturing, assembly, test and delivery of the equipment specified in this document.

PA activities shall be performed in accordance with the following rules:

- Each contractor shall nominate a team engineer as focal point of contact related to product assurance issues.
- Each unit engineer shall be responsible for the execution of the PA tasks as defined in this chapter in his engineering / AIV work package (total quality management).
- All deliverable documents and all additional PA relevant documentation on unit level shall be signed by at least one members of the component engineering team and by the designated PA focal point engineer.
- Existing PA management policies, forms, processes and procedures may be utilized.
- The PA tasks shall be performed on all qualification, flight models and for the GSE, as relevant
- The requirements shall be applicable to all involved sub-contractors.
- The requirements shall be applicable for all hardware and software items and for all services provided under this contract

TASA PA shall support the procurement process and has the right to attend the project meetings at supplier's site.

All Major NCRs, deviation/waiver, engineering changes will be given to TASA for approval.

5.1 Personnel Safety

Personnel safety shall be the responsibility of each supplier. Safety hazards shall be identified in all relevant test and integration procedures referring to specific safety assurance procedures where necessary. The main goal is to prevent personal injury and to prevent damage of flight equipment and facilities.

The supplier shall use his own safety policy and procedures considering local, state and national safety requirements.

The procedures shall clearly identify hazard and also include preventive measures, required infrastructure or environment etc. controlling or eliminating these hazards.

The applicable range safety requirements shall be met.

5.2 Reliability

Qualitative reliability shall be assured by design and proven by analysis and testing as specified hereafter. Reliability of electronic and electromechanical components shall be proven by a two-fold approach consisting of reviews of circuit design for reliability and operating time requirements.

The supplier will provide the empirical, tested, or analysis reliability value for its product.

5.2.1 Design for Fault Tolerance

To support the one failure tolerance at system level, the unit shall be internally one failure tolerant w.r.t. credible failures. The following failures are considered non-credible:

- Fracture of Harness
- Self-demating of connector

Failure propagation shall be limited to the affected module.

5.2.2 Support to System Level FMECA

The supplier shall support the system level FMECA by providing a related functional description of the equipment and a detailed design description of its electrical interfaces as contained within the user manual.

Furthermore the supplier shall, on request, provide a disposition to the system FMECA as far as the battery is affected.

5.2.3 Operating Time

Note: The operating time is defined as the time electronic units shall be operated before launch for the purpose of burn-in. This is not applicable for the battery.

5.3 Electronic Parts Reliability

5.3.1 Parts Selection and Quality

Parts used in the design of the satellite units shall preferably be selected from a valid Qualified Parts List (QPL) or Preferred Parts List (PPL) of a recognized authority (e.g. ESA, NASA, MIL, CNES) which will be mutually agreed. Parts from these lists shall be considered as ”standard parts” all others as “non-standard parts”. The minimum quality level for EEE Parts shall be:

- Integrated Circuits — QML class Q or MIL 883 class B
- Discrete — JAN TX
- Passive — MIL ER failure rate R or ESCC equivalent
- Multi-layer Printed Wiring Boards — MIL P 55110

Where possible, preference shall be given to using heritage standard parts.

Use of non-standard parts shall be identified to the user prior to integration. A decision whether additional testing has to be performed shall be mutually decided by TASA.

5.3.2 Parts Lists

The supplier shall deliver the as-designed and as-built EEE parts list for the unit. This parts list will be approved by the user.

The component parts list shall be established and maintained by the supplier, typically including:

1) Part name / type
2) Part manufacturer
3) Description
4) Package
5) Date code
6) Quantity per board/equipment
7) Procurement specification (include. issue/revision)
8) Quality level
9) Reference to qualification/heritage (ESA/SCC, MIL, other successful program)
10) Up-screening requirements
11) Comments

5.3.3 Derating

Derating Requirements and Application Rules for Electronic Components (ESA PSS-01-301 or ESA ECSS-Q-60-11A or ECSS-Q-ST-30-11C) shall be followed in the design of the unit.

5.4 Materials and Processes Control

Material Selection: Materials shall preferably be selected from a valid Materials List of a recognized authority (e.g. ESA, NASA, or MIL) or from previously flown space hardware. Early notification of new or unproven materials together with proposed testing and analysis shall be provided for approval to TASA.

The following typical information to materials shall be provided:

- Applicable drawing ID / usage
- Type of material
- Identification of life limited items
- Identification of flight heritage or reference to standard parts list
- Main dimension.

Life Limited items: Life limited materials shall be avoided wherever possible. Potential limited life items that are planned for use in flight hardware shall be identified in the material list (including maintenance / replacement requirements).

Coupon Testing: Coupon samples for all multi-layer Printed Wiring Boards (PWBs) shall be evaluated by certified inspection personnel prior to board population. The inspection shall be in accordance with the IPC-A-600 Class 3 quality level.

Certification and Traceability: Materials and semi-finished products shall have been inspected by the manufacturer/supplier to ensure compliance to requirements (e.g. chemical composition and basic strength testing for structural/ mechanical materials). Certification of compliance according to DIN 50049-2.2B or 3.1B or equivalent shall be provided by the manufacturer.

In frame of the EIDP the supplier shall certify full compliance between the as-designed and the as-built status.

5.5 Critical Items

Critical items (CI) shall be identified in accordance with the definitions as given below:

- Safety critical items
- Life limited items
- Long lead items with lead time of more than 15 months (tbc)
- Items not previously space qualified
- Items whose failing may significantly affect the mission success (single point failures)
- Items with high process sensitivity
- Items requiring export license (e.g. U.S. ITAR)

CI's shall be controlled via a critical items list which shall be supplied to user during CDR and at final equipment delivery

5.6 Hardware Quality Assurance

The supplier shall use their existing QA programs and practices. No formal documentation is required, TASA may, however, perform inspections / audits to ensure that appropriate space standards in the unit design, fabrication, assembly and test are applied. The supplier shall allow TASA personnel to witness these inspections and audits, as well.

The following points shall be considered:

- Personnel training and certification
- Application of space qualified processes and procedures
- Procedures for handling, shipping, storage of hardware
- Inspection processes (incoming, workmanship, safety, etc.)
- Calibration of support and test equipment
- Control of test facilities to protect the test article from damage or degradation due to handling, storage, environmental conditions etc.
- Protection / control of Electrostatic Discharge (ESD) sensitive parts, assemblies and equipment
- Workmanship and process control against written procedures and plans

- Interface and configuration control
- Quality certification
- Safety procedures
- Manufacturing documentation

Records that provide evidence of inspections, tests, configuration and material review actions during the fabrication and assembly process shall be maintained.

Connector mating/de-mating cycles shall be reduced to a minimum and connector savers shall be used, where possible.

Cleanliness: After unit assembly, all flight hardware shall be handled in a Class 100,000 environment or at least shall be cleaned before delivery. Class 100,000 conditions is considered sufficient unless supplier request higher requirement to guarantee the performance.

Workmanship: All parts shall be manufactured and finished in a thorough manner with established aerospace industry standards. Particular attention shall be paid to neatness and precision of working parts and assemblies. All parts shall be free of burrs, sharp edges and other imperfections that might affect assembly or cause the start of malfunction or cause injury to personnel.

For the design, manufacturing and assembly of the printed circuit boards the following standards shall be maintained:

- Layout: IPC-2220-FAM, IPC-6010-FAM with Performance Class 3 or equivalent standard
- Manufacturing: MIL-P-55110 / MIL-P-50884
- Cable and wire harness: IPC/WHMA-A-620 Class 3 or other requirements
- Assembly: ANSI/J-STD-001 Class 3, IPC-A-610 Class 3

Procedures: For hardware fabrication and assembly written procedures shall be used. In the procedure specific assembly instructions, inspection operations and tests, including criteria and techniques shall be defined.

Inspection Points (MIP's/KIP's): TASA reserves the right to witness major manufacturing and integration steps, in particular MIP's on PCBs prior to coating at supplier's site. The presence of TASA staff shall be allowed.

5.7 Software Quality Assurance

n/a

5.8 Configuration Management

Unit configuration control shall be performed by TASA and supplier as follows:

Unit Component Specifications:

TASA: Preparation of unit specification, review, approval and configuration control

Supplier: Provide inputs and approve via contract changes to be submitted via proposed specification updates / deviations to be tracked via Requests for Waivers (RFWs) or document updates

Unit Manufacturing and Verification Documentation:

Supplier: Preparation of documentation, configuration control (tracking of changes via NCRs, ECR or document updates) until unit final acceptance.

Configuration control starts with manufacturing release

Unit EIDP plus related hardware and software

TASA: Review and approval

Supplier: Preparation of EIDP, configuration control (tracking of changes and update of related documents resulting from NCRs at system level test) until unit final acceptance

Remark: The final as designed and as built status of a unit including NCRs and ECRs shall be provided in the EIDP

Configuration control starts at consent to ship.

5.9 Ground Support Equipment Product Assurance

n/a

5.10 Non-Conformance Reporting

Non-conformances or problem / failures shall be reported by the supplier. The supplier may utilize his standard failure and anomaly reporting processes. To streamline non-conformance reporting (NCR) for the MICROSAT project, an NCR log shall be kept to document all NCRs as follows:

- Issue date
- NCR title / description
- NCR classification (major or minor)
- Close out status / date

The NCR classification shall be performed as follows:

Major NCRs: Problems / failure which are impacting the function, performance, interfaces, reliability or schedule as specified in this document or exhibit a potential personnel or hardware safety concern. Furthermore problems / failures / changes which are affecting the qualification / acceptance procedures.

All Major NCRs will be given to TASA and require TASA approval, signature for final disposition and closure.

Minor NCRs: Minor NCRs are not directly impacting the schedule or deviating from specified performance. These NCRs typically include human errors in the manufacturing or verification process, or minor interface inconsistencies.

The supplier shall inform TASA about major NCRs within 48 hours and about minor NCRs within two calendar weeks. The TASA assumes the right to adapt the rating in accordance to his evaluation.

Anyone witnessing an anomaly has the responsibility and authority to report a problem and generate a NCR. Requirements for reporting problems/failures start as follows and last until final unit acceptance:

- Electronics: Starting with unit / assembly / box level first power-on
- Mechanical devices: Starting with unit / assembly level first functional test
- Flight software: Starting with first use with flight hardware

Failure analyses including electrical, thermal and/or mechanical stress analyses, if needed, shall be conducted to adequately determine and characterize the failure, as well as to under-stand the cause of the problem and possible implications on all elements of the unit.

If necessary for failure analysis, a DPA of the failed parts shall be performed at supplier facility. On request failed parts and related NCRs shall be delivered to TASA on request.

All NCRs shall be compiled in the unit EIDP.

5.11 Request for Waiver

The supplier shall prepare a Request for Waiver (RFW) in case of deviations from this specification. The waiver shall include all necessary technical information, justification and risk statement. RFWs shall be established also for deviations in areas of EEE-parts, PMPs, de-rating analyses and deviations reported via NCRs.

The RFW shall be approved / disapproved by TASA.

5.12 Consent to Ship

The TASA will provide consent to ship (for system integration) based upon:

- Availability of deliverable hardware
- Successful unit level test performance
- Availability and successful review of deliverable documents / EIDP (electronic form)
- No major open work resulting from NCRs

The EIDP shall arrive at TASA site for review at least 2 weeks before scheduled shipment.

In order to derive a consent to ship TASA reserves the right to perform the necessary review of EIDP and associated hardware in the context of a Pre-Ship Review at the supplier's site which may also include a post-test hardware inspection. TASA shall be invited.

5.13 Handling, Packaging and Transportation

The equipment shall be properly packed according to the company standards and heritage to guarantee proper and safe airfreight transport to the customer. A written procedure shall be prepared and implemented by supplier for preservation, packaging, handling, transportation, and storage of flight equipment subject to damage or deterioration or requiring safety precautions throughout the entire handling, shipping, transportation, and storage activities. ESA PSS-01-202 or equivalent standard practices should be followed. The Supplier's procedure shall be reviewed by TASA prior to shipment of equipment.

The following topics shall be considered and applied if as guideline:

- Cleaning and inspection shall be completed before packaging to ensure that the surface cleanliness meets the visual cleanliness level
- For ESD sensitive equipment, ESD suitable packing materials shall be used
- Connectors shall be protected by dust caps resp. connector savers
- Equipment shall be double bagged with drying agent and humidity sensor to guarantee dry conditions below 70% humidity
- Shock sensors in three axis shall be mounted directly to the equipment transportation/fixation plate to monitor shock levels exceeding during transport handling. The shock sensor sensitivity when applied to the equipment shall be selected in accordance to equipment sensitivity as guideline. Details to be frozen at PSR meeting before shipment.
- The equipment shall be double packed using a shock absorbing / damping foam inner insert within an external metal container box.
- The inner container and external transport package shall be labelled with necessary handling and pre-caution / warning information / labels.
- The transport package shall contain minimum documentation like delivery note / packing list, log sheets and transport / handling procedure or other agreed documentation.
- Further equipment related packing / transportation details are as follow:
    - The following transport temperatures limits are to be monitored
        - General temperatures to be maintained between -20°C and +25°C
        - Temperatures between +25°C and +40°C can be experienced for up to 6 weeks duration
        - Exposure to temperatures between +40°C and +55°C must be limited to shorter than 48 h on no more than 2 separate occasions

5.14 Acceptance

A **preliminary acceptance** will be provided by the user within 2 weeks after EIDP delivery based on:

- Complete delivery and acceptance of all documents including EIDP
- Consent to ship

Final acceptance will be provided by TASA after arrival of the product based upon:

- Successful incoming inspection at TASA site
- Complete delivery and acceptance of all documents

6 Requirements Verification

6.1 Analysis

The supplier shall perform the following analyses and present the results in the relevant document of the EIDP. The analyses documents which are not deliverables shall be available for on-site review during review meeting, if such a review is requested.

Structural Analysis: No structural analysis is required if supplier provides product qualification evidence. Final verification of required natural frequency and the ability to withstand the vibration and shock loads is performed by unit level test as outlined in sections 6.2.4 and 6.2.5.

Thermal Analysis: Temperature prediction based on operating TRP range shall be included. Recommended average operating temperature and range at TRP shall be provided to optimize battery usage in-orbit. Final thermal verification will be demonstrated by successful performance of unit level test as outlined in sections 6.2.6.

Electrical Sizing Analysis: The electrical sizing analysis represents the functional performance analysis of the battery based on user's input.

It contains the predicted behavior of the battery in terms of capacity, voltage, internal resistance, charge/discharge efficiency and temperature.

6.2 Unit Level Tests

The content and sequence of unit level tests shall be defined by the supplier and presented in the test plan.

The procedures for the unit level tests shall cover as a minimum:

- All test steps planned to verify the required unit functions and performance
- Traceability of proposed tests to requirements of section 3 and 4 of this document
- Description of test set-up
- Test configuration of hardware and software
- Accuracy of all characteristics measured during the test
- Performance and calibration summary of test support equipment used

Note: The user standard test procedures can be used and the traceability of the standard tests to the respective functional and performance requirements may be given in a separate document, if necessary.

The unit level tests shall be executed using adequately calibrated test equipment only. The maximum allowable test tolerances shall be as presented in Table 6.2.1 when applied to the verification tests in this document.

Table 6.2-1: *Allowed Test Tolerances*

Subject	Tolerance
Temperature -50°C to +100°C maximum temperature limit minimum temperature limit	 0°C / +3°C -3°C / 0°C
Thermal dissipation	± 5%
Pressure (Vacuum chamber) >1.3hPa $1.3*10^{-3}$hPa to 1.3hPa <$1.3*10^{-3}$ hPa	 ± 15% ± 30% ± 80%
Static test Force Spin rate	 -3% / 5% < 1%
Strain	± 10%
Flow rate	± 5 %
Leak rate	± 10^{-5}Pa.m^3.s^{-1} of Helium at 1013hPa pressure differential
Acceleration	± 5%
Sinusoidal vibration Amplitude Frequency Sweep rate	 ± 10% ± 2% ± 5%
Random vibration Frequency Qualification Acceptance overall g rms	 ± 5% (or 1Hz whichever is greater) -1dB / +3dB -3dB / +1.5dB ± 10%
Acoustic vibration 1/3-Octave Midband Frequency(Hz) 31.5 to 50 63 to 2000 2500 to 10000 Overall	 ±6.0dB ±3.0dB ±6.0 dB ±1.5 dB
Shock Natural Frequency fn < 3 kHz fn > 3 kHz	 ±6 dB +9/-6 dB Note: At least 50% of the spectrum values will be greater than the nominal test specification.
Mass Equipment	 ±60g or ±0.15% (whichever is greater)

Subject	Tolerance
Dimensions	± 0.125 mm (unless otherwise specified on drawings)
COG measurement M = 22.7 – 3000kg	1mm radius sphere
MOI measurement for units, systems > 22.7kg(50lb) I = 1.0 – 2.5kg.m^2	± 3.0%
Angular measurements	0.5 arcmin with respect to each axis of the facility reference system and at least < 10% of the optical unit alignment
Test duration	0% / + 10%
Balancing Static dynamic	 lateral = ± 0.1mm axial = ± 1mm 600kg.mm^2

The supplier shall perform the following tests on flight unit level:

- Mass determination
- Functional performance test
- Random / Sine Vibration test
- Thermal vacuum cycling
- Bonding & Isolation
- Short functional test

6.2.1 Functional & Performance Test

The functional and performance tests shall include as a minimum

- String continuity and isolation
- Internal resistance
- Capacity
- Self-discharge rate (if not performed on cell level)
- Functional verification
- Performance parameters
- Electrical interface verification

6.2.2 Short Functional & Performance Test

Note: The short functional & performance test will be used to verify the general function and performance of the unit. This test will in particular be used before and after the environmental test to discern any changes resulting from the applied tests.

The supplier's standard capacity measurement (SCM) shall be used as short functional & performance test.

6.2.3 EMC Tests

A bonding and isolation test in accordance with the respective in-house standards shall be performed.

6.2.4 Random Vibration Tests

The unit shall be hard-mounted via its regular mounting interface to the shaker or vibration adapter during the execution of the sine and vibration tests.

Units that are powered during the launch of the spacecraft shall be powered during the respective vibration tests, as well. During these tests failures or operation anomalies shall be monitored and logged.

A **low level resonance search** before and after the vibration tests shall be executed between 5 Hz and 2 kHz at a sweep rate of 2 oct/min.

Table 6.2.4-1: *Battery Random Vibration Test Levels*

Frequency Range in Hz	*Proto-Flight*	
	Out of plane	*In Plane*
20 – 100	*+ 3 dB/oct*	*+ 3 dB/oct*
100 - 600	*0.2 g^2/Hz *)*	*0.1 g^2/Hz*
600-2000	*- 6 dB/oct *)*	*- 6 dB/oct*
Test Duration	*1 min*	*1 min*
Rms in g	*13.92*	*9.84*
Test Duration: 1 min/axis		

A standard capacity measurement shall be executed before and after the vibration tests.

6.2.5 Sine Vibration Test

The sine environment shall apply to the unit between 5 and 100Hz. At low frequency it is understood that tested acceleration levels will be limited by the shaker capability.

Hz	Qualification (Design Level)	Acceptance (Flight Level)
5-X	Max shaker capability	Max shaker capability
X-100	25g	21g
Test Duration	1 sweep up with 2 oct/min	1 sweep up with 4 oct/min

X ≤ 25
Protoflight Level= Acceptance Level *1.25
Protoflight test duration = Acceptance test duration

6.2.6 Thermal Vacuum Cycling Tests

Thermal Vacuum Cycling shall follow the ECSS standard as a guideline. Based on the existing battery qualification, the battery is to be tested to acceptance levels with 8 thermal cycles (or 4 cycles with operating temperature range plus 5°C outreach) under vacuum condition. Vacuum level shall be ≤ 5 * 10^{-5} mbar. The dwell at high and low shall be ≥ 2 hours. The battery acceptance test temperature limits are:

Table 6.2.5-1: *Battery Thermal Cycle Test Levels*

	Lower Acceptance Test Limit	Upper Acceptance Test Limit
Operating Temperature	0 °C	+ 30 °C

Note: As the battery is densely packed with cells and nearly no volume for convection is present, no extra test margin is needed for the temperature cycle test. Note: A short vacuum drop in first cycle to 10-4mbar, due to facility out-gassing, is acceptable.

7 Abbreviations

AIT	Assembly, Integration and Test
AOC	Attitude and Orbit Control
ARO	After Receipt of Order
ATOX	Atomic Oxygen
BW	Bandwidth
CDR	Critical Design Review
CE	Conducted Emissions
CESS	Coarse Earth and Sun Sensor
CFRP	Carbon Fibre Reinforced Plastics
CIDL	Configuration Item Data List
CIP	Carriage and Insurance Paid
CLCW	Command Link Control Word
CLS	Clear to Send
CMD	Command
CoC	Certificate of Compliance
CoG	Center of Gravity
CPU	Central Processing Unit
CS	Conducted Susceptibilities
CTS	Coax Transfer Switch
CVCM	Collected Volatile Condensable Material
CVM	Converter Module
DC	Direct Current
DID	Design and Interface Document
DPA	Destructive Physical Analysis
DSPG	Distributed Star-Point Grounding
EB	Elegant Bread-Board
ECR	Engineering Change Request
EEE	Electromechanic, Electric and Electronic
EEPROM	Electrically Erasable and Programmable Read-Only Memory
EIDP	End Item Data Package
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
EUT	Equipment under Test
FDIR	Fault Detection, Isolation and Recovery
FIFO	First In, First Out
FM	Flight Model
FMECA	Failure Mode Effects and Criticality Analysis
GPS	Global Positioning System
HPC	High Priority Command
HK	Housekeeping
H/W	Hardware
ICD	Interface Control Document/Drawing
ICU	Instrument Control Unit
IFU	Interface-to-Units Module
IMU	Inertia Measurement Unit (Gyro)
IPU	Instrument Processing Unit
ITAR	International Traffic in Arms Regulations
I/F	Interface
I/O	Input/Output
JPL	Jet Propulsion Laboratory
kbps	kBit per Second
LB	Local Bus
LED	Light Emitting Diode
LISN	Line Impedance Simulation Network
LSB	Least Significant Bit
Mbps	MegaBit per Second
MLC	Memory Load Command
MLI	Multi-Layer Insulation
MMU	Mass Memory Module
Mbps	MegaBit per Second
NCR	Non-Conformance Report
NRZ-L	Non-Return to Zero Logic
NVRAM	Non-Volatile Random Access Memory
OBC	On-Board Computer
OBDH	On-Board Data Handling
OS	Operating System
PA	Procuct Assurance
PCB	Printed Circuit Board
PCDU	Power Conditioning and Distribution Unit
PFR	Problem/Failure Reporting
PIND	Particle Impact Noise Detection
PM	Processor Module
PROM	Programmable ROM
QA	Quality Assurance
QPL	Qualified Parts List
RCS	Reference Coordinate System
RCS	Reaction Control System
RD	Reference Document
RE	Radiated Emissions
RF	Radio Frequency
RFEA	Radio Frequency Equipment Assembly
RfW	Request for Waiver
RM	Reconfiguration Module
rms	root mean square
RS	Radiated Susceptibilities
RTS	Request to Send
RW	Reaction Wheel
Rx	Receiver
RXD	Receive Data

SCL	Subcarrier Lock
SCOE	System or Special Check-Out Equipment
SCM	Standard Capacity Measurement
SDLC	Serial Data Link Communication
SEE	Single Event Effect
SEB	Single Event Burn-Out
SEGR	Single-Event Gate Rupture
SEL	Single Event Latch-Up
SEU	Single Event Upset
S/C	Spacecraft
S/W	Software
TB	Thermal Balance
TBC	To be confirmed
TBD	To be defined
TC	Telecommand Decoder
TCC	Telecommand Clock
TCS	Telecommand Stream
TM	Telemetry Encoder
TML	Total Mass Loss
TRP	Temperature Reference Point
TSP	Twisted Shielded Pair
TT&C	Telemetry/Telecommand, Tracking & Control
Tx	Transmitter
TXD	Transmit Data
TV	Thermal Vacuum
UART	Universal Asynchronous Receiver and Transmitter
UTC	Universal Time Coordinated
VC	Virtual Channel

Annex 1: FORMOSAT-9 Representative Simulation Inputs (TBD)

All simulations shall be performed using the inputs provided by TASA, assuming both no failure and the loss of one battery string as a result of a string open-circuit failure at EOL.

A.3-1: Model Input (Calculation of Fade):

- Shipping: 1 month at 30 °C (low SoC)
- On-Ground Storage Time: 4 years @ supplier's recommended condition
- On-Ground Ambient Test: 2 months AIT/ground test @ 22 °C (100% SoC)
- On-Ground Idle: 10 months @ 22 °C (low SoC)
- In-Orbit Cycle Life: 5 years, i.e. 27,700 cycles
- Orbit Period: 95.02 min

leading to

- EOL Retained Capacity: by supplier
- EOC Resistance Increase: by supplier
- EOL operating voltage: by supplier
- BOL & EOL thermal dissipation: by supplier

A.3-2: Sequence of Operation: (TBC)

The worse case of operation for 30% mission life:

Time (min.)	Battery Power (W)
0	-468.66
20	-3977.16
22	184.80
25	305.43
95	305.43

The normal case of operation for 70% mission life:

Time (min.)	Battery Power (W)
0	134.48
20	-2889.43
22	184.80
25	305.43
95	305.43