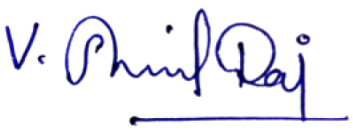
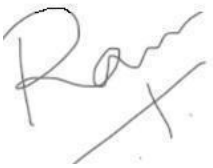
Ubifly Technologies Pvt Ltd

QA/QC MANUAL

AMBER WINGS	Ubifly Technologies Pvt Ltd Chennai, India

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Date : 21/05/2025	Date : 22/05/2025	Date : 22/05/2025

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Record of Revision

Any revision to this report is recorded along with the date of modification, revision number, a summary of amendments, the section and page number of the affected in the Revision History page accordingly. The report issue is identified by revision codes reported on each page, top right-hand side.

The revision code is numerical and starting at the number "0"; subsequent revisions are identified by the change of the code from "0" to "1" for the first revision to the basic publication, "2" for the second one, etc.

Additions, deletions and revisions to existing text will be identified by a revision bar (black line) in the left-hand margin of the page, adjacent to the change.

NOTE: It is the responsibility of the owner to maintain this handbook in a current status when it is being used for operational purposes.

Date	Revision No	Revision Details	Section & Pg.no
09/09/2023	**0**	**Initial release**	-
29/07/2024	**1**	**Updated Signed Proofs for QC process**	**All annexures**
22/08/2024	**2**	**Updated Annexure II ELECTRONICS FUNCTIONAL QC**	**Annexure II & Pg. no 151**
26/12/2024	**3**	**Annexures and minor technical details has been updated**	**All Section**
21/02/2025	**4**	**Technical Details has been updated**	**All Section**
09/04/2025	**5**	**Technical Details has been updated**	**All Section**
21/05/2025	**6**	**Annexures has been updated**	**All annexures**

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1.Quality Assurance Manual

1.1 Introduction

Incubated out of Indian Institute of Technology (IIT), Madras, founded by Prof. Satya Chakravarthy, with a vision to make electric aircraft a reality. The team comprises professionals from varied disciplines with career stints at some of the world's renowned organisations. At,we relentlessly work towards one unified goal - to help people save a significant amount of travel time, every day.

1.2 Scope of the Document

This manual describes the Quality Assurance Plan of Ubifly Technologies Private Limited.., for design, manufacture, integration, and sale of **ATVA- 1**.

2. Reference

The **UBIFLY TECHNOLOGIES Pvt Ltd** Quality Policy is understood, implemented, and maintained by all the personnel working in the **Ubifly Technologies** Private Limited.

3. Product Scope

ATVA -1 consist of
ATVA-1 Drone
GDT
Battery

4. System Overview

The offered system in ATVA-1 (Block diagram) :

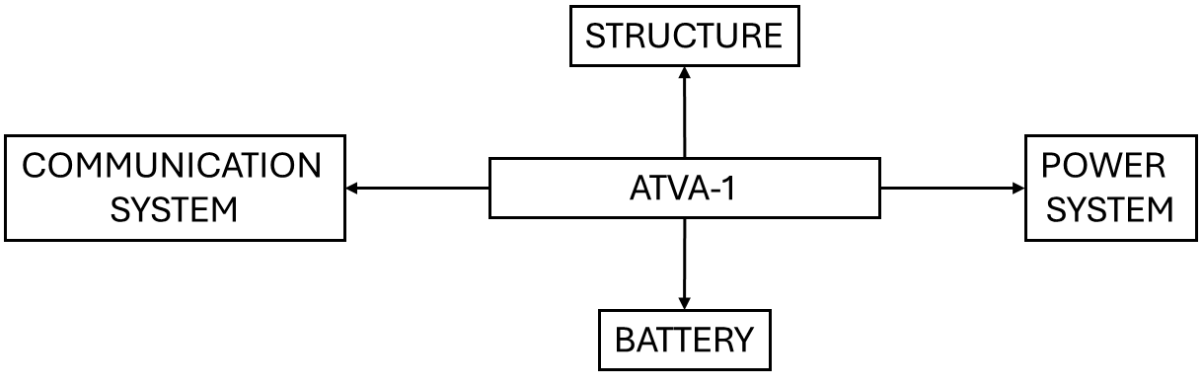


Figure 01 - System Overview

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5. Brief technical description of ATVA-1

The ATVA-1 is an electric UAV designed for cargo applications up to 2 kg of Payload, featuring a maximum take-off weight (MTOW) of 18 kg. This MTOW of 18 kg classifies the ATVA-1 in the **"Small unmanned aircraft system"**. This category includes UAVs with an MTOW greater than 2 kg and less than or equal to 25 kg, The ATVA-1 design and capabilities make it an ideal solution for efficient and reliable cargo transport.

5.1 Aircraft Specifications

S. No	Particular	Value
1	**Category**	**Hybrid**
2	**Max Weight**	**18 kg**
3	Max Payload	2 kg
4	**Max Speed in cruise**	**30 m/s**
5	**Operational Speed in cruise**	**23-29 m/s**
6	**Min Speed in cruise**	**23 m/s**
7	**Max operating Altitude**	**Less than 120m**
8	**Max Wind resistance**	**10 m/s**
9	**Endurance at 18 Kgs**	**36 minutes**

5.2 Propulsion Specifications

S. No	Particular	Value
1	Number of Motors	4 lift, 1 Cruise
2	Motor Type	BLDC
3	Motor kV Rating	210 Kv (Lift), 220Kv (Cruise)
4	Propeller Diameter	22 Inch (Lift), 16 Inch (Cruise)
5	Propeller Pitch	7.4 Inch (Lift), 16 Inch (Cruise)

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5.3 Power Specifications

S. No	Particular	Value
1	Battery Type	Solid State Lithium Ion
2	Nominal Voltage	44.4V
3	Charging Voltage	50.4V
4	Critical Voltage	40.5 V
5	Charging Methods	0.5C (Standard Charging), 1C (Fast Charging), 2C (Ultrafast Charging)
7	Charging Temperature	0°C to 45°C
8	Discharging Temperature	-10°C to 55°C
9	Weight	5 Kg ± 100 g
10	Volumetric Energy Density	560 Wh/L
11	Gravimetric Energy Density	270 Wh/Kg

5.4 Instrument and Equipment Specifications

S. No	Particular	Value
1	Holybro M9N GPS	2
2	Pixhawk Cube Orange Plus Flight Controller	1
3	Mateksys BEC12S-PRO	4
4	MAUCH M3001_1X	1
5	MAUCH PL200 Current Sensor	1
6	Herelink Air Unit	1
7	MatekSYS DLVR Air Speed Sensor	1

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5.5 Ground Control Specifications



Figure 02 Herelink v1.1 Ground control station

Herelink v1.1 GCS Specifications

Feature	Specification
Screen:	5.46-inch 1080P, 16 million colors, capacitive touch screen
Audio:	Built-in speaker × 1, built-in microphone × 2
Remote control:	Hall effect gimbals with removable sticks x 2, scroll wheel × 1, bottom button × 6 with backlight, top button × 1 (right)
Wireless:	WIFI /2.4G transmission ground
Antenna:	Circular (5dBi) × 1, detachable, omnidirectional (2dBi) × 1, detachable, built-in WIFI antenna, built-in GPS antenna, external GPS antenna interface x 1
Power :	Built-in 4950 mAh Lipo Battery
Charging :	Support micro-USB port 5v 2A current charging
Power consumption:	The average power consumption does not exceed 4W (only picture transmission work, medium screen brightness, WIFI off, GPS off)
Size:	217 × 106.5 × 31mm not including external antenna and rocker

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5.6 Flight Controller specifications



Figure 03 Pixhawk Cube Orange Plus Flight Controller

Flight Controller Specifications

Processor	STM32H757 (32bit ARM Cortex M7 (opens new window)) 400 MHz 1 MB RAM 2 MB Flash (fully accessible)
Failsafe co-processor	STM32F103 (32bit *ARM Cortex-M3*) 24 MHz 8 KB SRAM
Sensors	**Accelerometer** (3) **Gyroscope** (3) **Compass** (1) **Barometric Pressure Sensor** (2)
Operating Conditions	**Operating Temp:** -10C to 55C **IP rating/Waterproof:** Not waterproof **Servo rail input voltage:** 3.3V / 5V
Dimensions	38.25mm x 38.25mm x 22.3mm

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5.7 Payloads

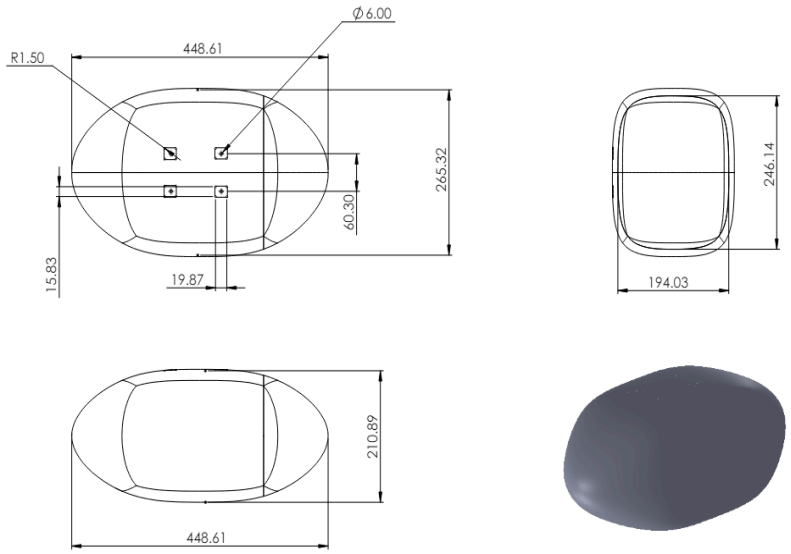


Figure 04 Payload Bay

The weight of the fixed payload bay is 0.455 Kg and The maximum allowable weight for the **variable payload must not exceed 2 kilograms.** Exceeding this limit may impact the performance, safety, and stability of the system, Therefore, the payload configuration must ensure that they remain within this specified weight limit.

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6. System and Quality control Process

The overall process flow followed at Ubifly Technologies Pvt. Ltd for ATVA-1 from the design phase to the delivery phase is briefly illustrated at Figure-05 .

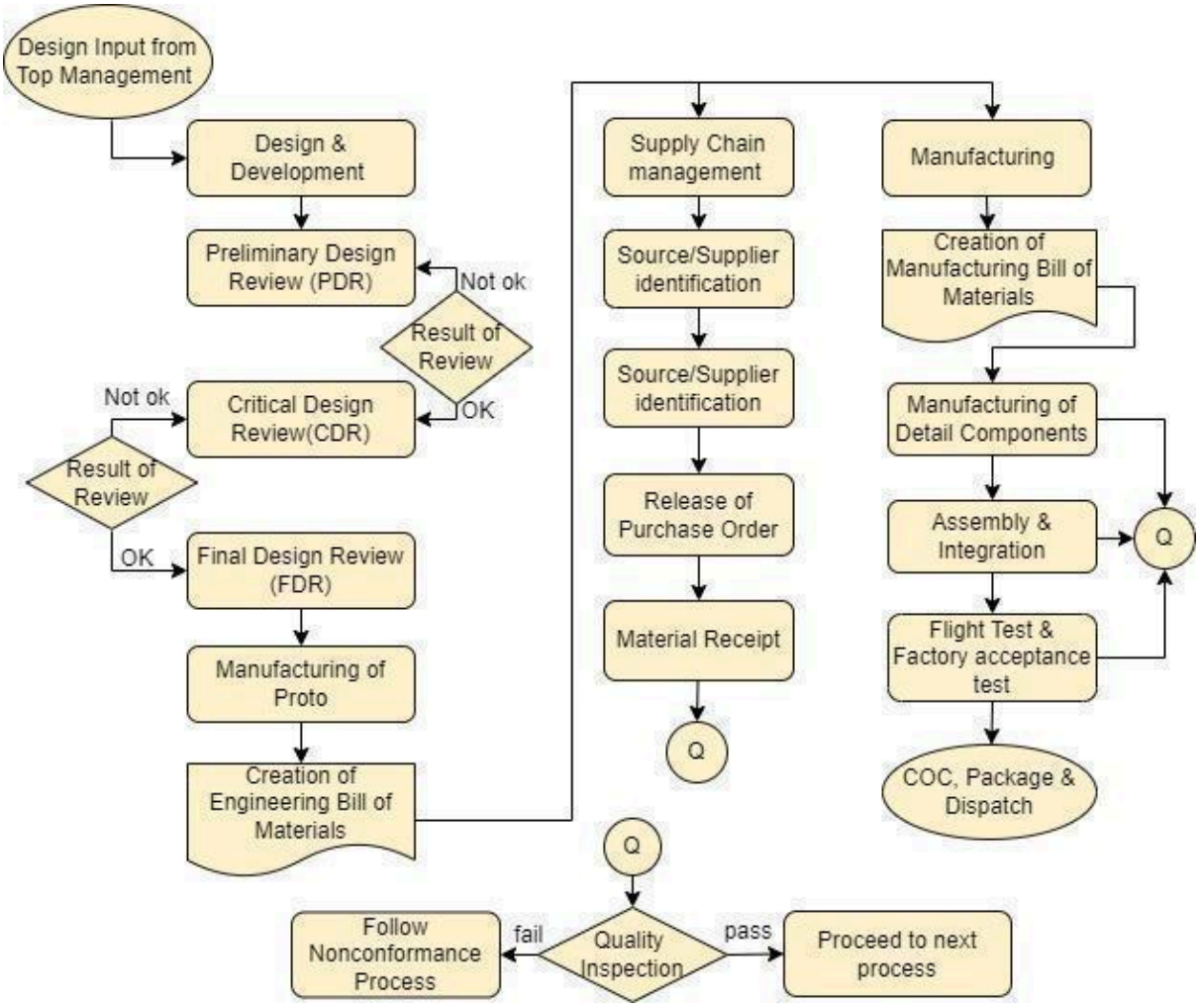


Figure 05 Process Flow followed at Ubifly Technologies Pvt. Ltd for ATVA-1

Design Phase

This phase focuses on conceptualizing, reviewing, and finalizing the design

6.1.1 Design Input from Top Management / From Market Study

The project begins with inputs from top management / From Market Study regarding specifications, requirements, and objectives.
These inputs may include customer requirements, regulatory standards, and technical constraints.

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6.1.2 Design & Development

Design Planning is made in this stage
Design team starts developing the product concept.
Preliminary models, simulations, and initial drafts are prepared.
Basic design principles and feasibility studies are conducted.
all statutory & regulatory requirements are considered.

6.1.3 Preliminary Design Review (PDR)

The first checkpoint to review the design concept.
Key aspects checked:

- Feasibility analysis.
- Basic structural and functional design.
- Compliance with initial requirements.
- Risk assessments.

Outcome:

- Base line Document
- all test, validation & acceptance criteria for validating the design
- Initial Engineering Bill Of Material .

6.1.4 Critical Design Review (CDR)

A more detailed review with deeper scrutiny of:

- Finalized system architecture.
- Manufacturing feasibility.
- Validation of design.
- Compliance with safety and performance standards.

Outcome:

- Final Engineering Bill Of Material
- Product ready for production .

6.2.1 Prototype

A prototype of the product is created to validate design.
The prototype is tested for:

- Structural integrity.
- Functional performance.
- Safety compliance.
- Manufacturing feasibility.

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6.3.1 Supply Chain Management

This phase focuses on sourcing, purchasing, and receiving materials.

6.3.1 Source/Supplier Identification (Outsource Activity)

Potential suppliers are identified based on requirements & quality.
Supplier Evaluations include:

- Supplier Audit.
- Supplier Capability analysis
- On time delivery.

6.3.2 Source/Supplier Identification (Commercially Of The Shelf item)

Identification of Suitable vendor/ OEM authorized Source

6.3.3 Release of Purchase Order

Purchase orders are issued to suppliers / vendors .

3.4 Material Receipt

Materials are received in stores &
Initial verification of received goods is performed (Qty & transit damages if any).

3.5 Quality Check (Q) – Incoming Materials

In-ward Inspection on goods received is performed .
If any Non Conformance is observed the part is identified with Quarantine tag &
SCAR(Supplier Corrective action Report) is raised & sent to the supplier.
based on the SCAR report the goods are sent back for correction or for replacement.
Quality cleared goods are identified by Acceptance tag ,stored in Bonded stores & issued by the stores person

4. Manufacturing Process

This stage includes production, assembly, and final integration.

Route Card is generated for all the activities mentioned above. The route card defines the Stages of inspection with respect to the process.

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During inspection if any minor Manufacturing non conformance was observed snag is raised for minor non conformance and for major non conformance (NC) like deviation from design non conformance Report is generated & rectified. NC is routed through the Material Review Board.

The Inspection report or test report are generated whenever it is necessary.

On final clearance an accepted tag is issued to the component in detail or sub assembly stage .

---

5. Testing & Dispatch

The product is tested, approved, and prepared for shipment.

5.1 Flight Test & Factory Acceptance Test

Full-scale product testing.
Performance validation against Internal / customer specifications.
Factory acceptance test ensures the product meets required quality standards.

5.2 Certificate of Conformance (COC), Packaging & Dispatch

COC Issuance: Confirms compliance with all standards.
Packaging: The final product is securely packed as per the Packing instructions provided by the design team..
Dispatch: The product is shipped to the customer or to the next production stage.

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6.1 Manufacturing Phase Process (Inhouse fabrication method)

Manufacturing Phase Process Flow

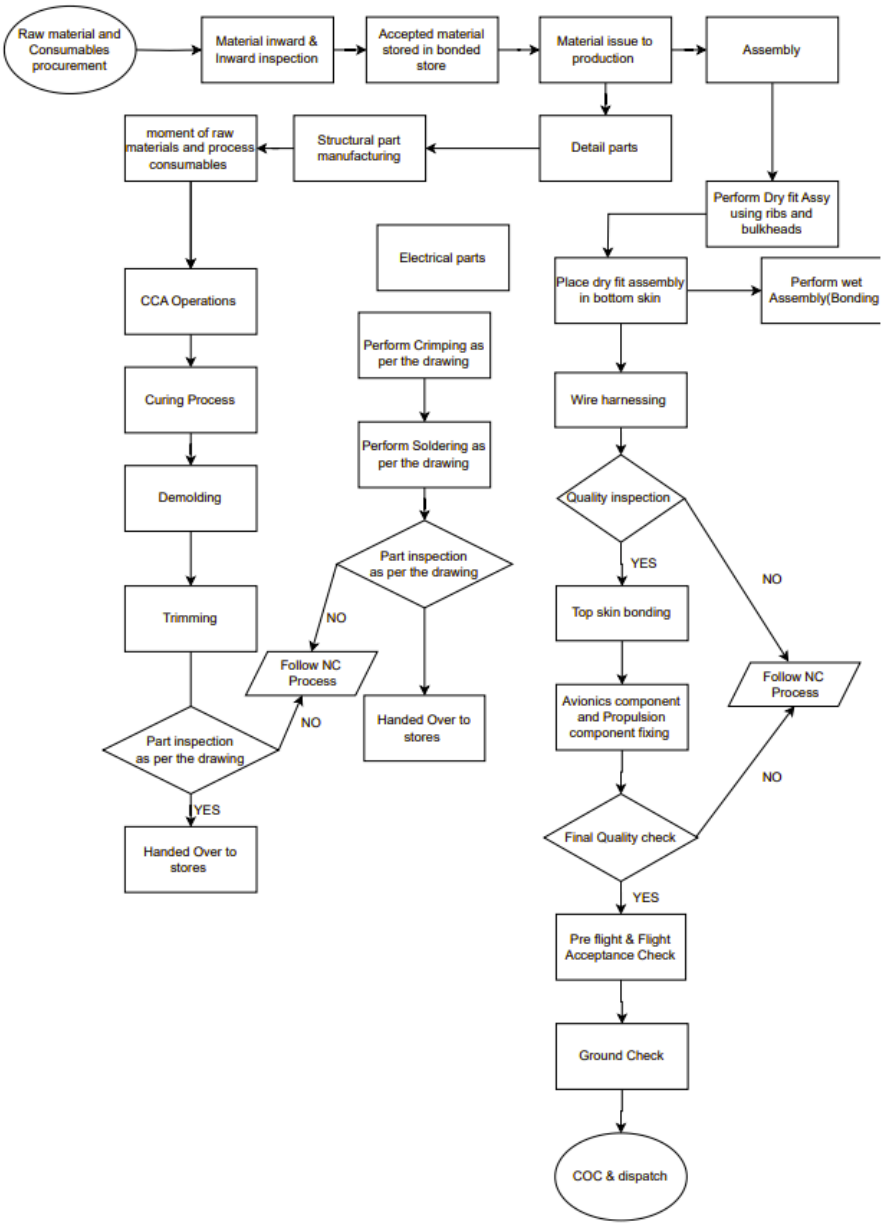


Figure 5.2(d) Manufacturing Process Flow Chart

The fabrication ,Assembly procedure of ATVA-1 till COC are detailed in Section 2 to 10 of Manufacturing Manual (ATVA/MFG/005)

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7.Quality Assurance Plan

The QAP document describes the inspection and quality assurance requirements to be fulfilled during the manufacturing and testing of the ATVA-1 , hereafter referred to as Unit/Product/System. This document brings in the processes for identification, inspection and testing of material/items/ parts/components/sub-assemblies which will be assembled in the product. The QAP describes various quality verification and test activities that are undertaken during the entire process of the build to assure quality and reliability of the ATVA-1. Components/Parts are classified as follows

7.1 In-ward inspection

The materials are received at inward inspection stage, all incoming raw materials, parts, components, sub-assemblies are subjected to inspection as per the Quality Inspection Plan. This ensures the material/part/components conform to the specification by inspecting physical, dimensional & functionally along with Drawing specification, CoC's, test reports , release note etc.., as applicable. Apart from the quality inspection plan, On completion of the inspection process, the materials are then forwarded to the stores. The following is ensured during the incoming stage.

i. Raw material inspection: Raw material received are checked as per purchase order and inspected/tested as per the Quality Plan referred.The availability of CoC or test reports is verified. The traceability is further maintained.

ii. Manufactured/Fabricated Parts: Composites parts/metal parts/PCB's etc. are received from vendors along with the CoC/test reports/dimensional reports as applicable. These parts are inspected as per the class of item mentioned in section:7 w.r.t the drawings, specification and on confirming, parts/components are accepted and recorded in the Inspection report.

iii. Sub-assemblies: The sub assemblies shall be inspected and accepted in conformance with the requirements.

On completion of the inspection activities the inspection reports are generated & material shall be either Accepted or Rejected.

Suspected parts will be quarantined and kept in the designated area. In case parts which have issues that don't have effect on form, fit, function details shall be communicated to the design team. Such parts will be accepted based on design concession or deviation acceptance from the design team .

In case raw material or outsourced part or component or sub assembly does not conform to the specified requirement or specification, then the material is

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rejected and Notified to the vendor or supplier for necessary corrective action through the SCM team. Those materials which shall not conform to design requirements shall be identified as rejected and the rejected material shall be stored at designated area. The material shall be retained until the further disposal to the supplier as per the company commercial terms.

It is ensured that all measuring instruments used are periodically calibrated and are within the due date.

7.2 In-process Inspection during Manufacturing and assembly of components of ATVA-1

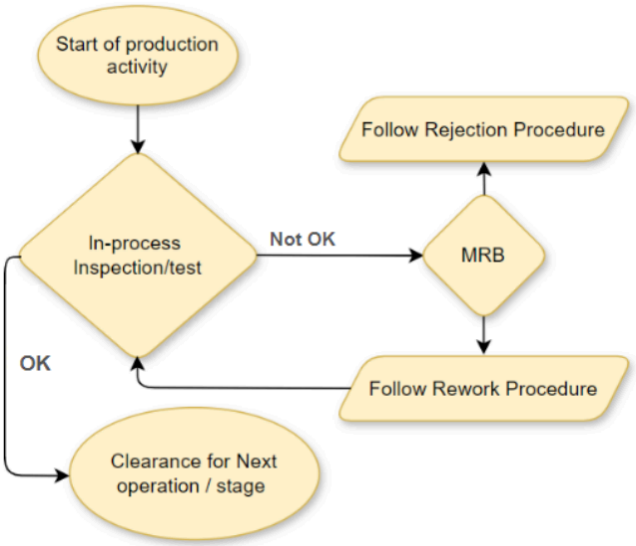


Figure 08 In-process inspection

In-progress inspection is done through **Route Cards** and is released for each sub-assembly. Materials are kitted and assembly is conducted as per the process document/ process standards/ assembly instructions/ assembly diagram. Assembly inspection and testing where applicable is conducted and records maintained **filled route cards are attached in ANNEXURE III in QAQC Manual (ATVA/MFG/016) – *SIGNED MANUFACTURING QC* and unfilled route cards are attached in *ANNEXURE V – Route cards for MANUFACTURING QC* in QAQC Manual (ATVA/MFG/016)**

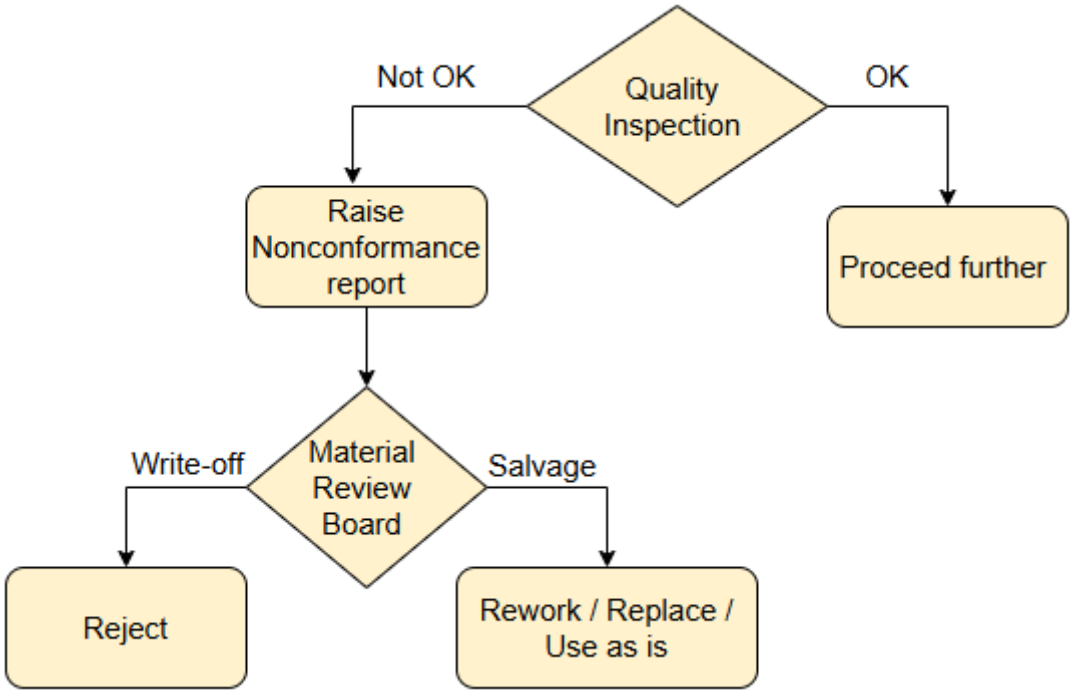
7.3 Flight Test & Factory Acceptance Test

Flight tests shall be conducted for all the aircraft manufactured. Factory acceptance test where the major checkpoints are listed, inspected and recorded to ensure the aircraft meets all the design & quality requirements & meets the intended purpose. Tests to be performed in UAS are elaborated in Annexure IV

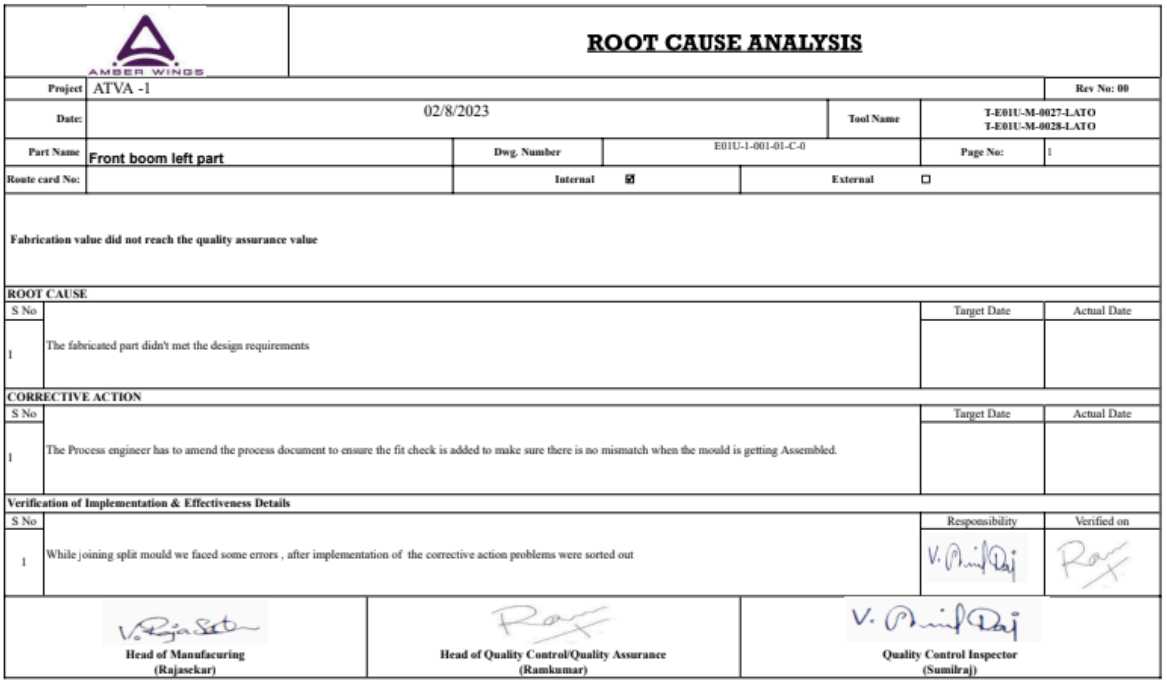
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8. Control on Non Conforming Output

All non-conformance outputs are subjected to Material Review Board (MRB) “Use As is” decisions given only by designer, rework or replacement decisions are given by the Cross Functional team(CFT). All Non-conformance cases are routed through MRB where 5-Why Analysis or fishbone analysis is carried out.



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ROOT CAUSE ANALYSIS

Project	ATVA -1			Rev No: 00
Date:	02/8/2023		Tool Name	T-E01U-M-0027-LATO T-E01U-M-0028-LATO
Part Name	Front boom left part	Dwg. Number	E01U-1-001-01-C-0	Page No: 1
Route card No:		Internal ☑	External ☐	

Fabrication value did not reach the quality assurance value

ROOT CAUSE

S No		Target Date	Actual Date
1	The fabricated part didn't met the design requirements		

CORRECTIVE ACTION

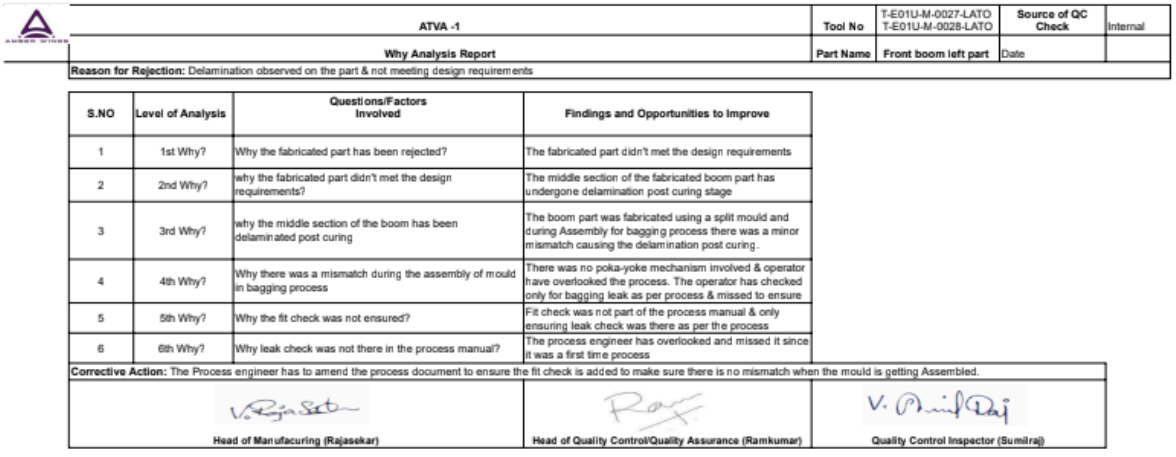
S No		Target Date	Actual Date
1	The Process engineer has to amend the process document to ensure the fit check is added to make sure there is no mismatch when the mould is getting Assembled.		

Verification of Implementation & Effectiveness Details

S No		Responsibility	Verified on
1	While joining split mould we faced some errors , after implementation of the corrective action problems were sorted out	V. Sumiraj	Ram

Head of Manufacuring (Rajasekar)	Head of Quality Control/Quality Assurance (Ramkumar)	Quality Control Inspector (Sumiraj)

Figure 09 Root Cause Analysis Report sample



ATVA -1		Tool No	T-E01U-M-0027-LATO T-E01U-M-0028-LATO	Source of QC Check	Internal
Why Analysis Report		Part Name	Front boom left part	Date	

Reason for Rejection: Delamination observed on the part & not meeting design requirements

S.NO	Level of Analysis	Questions/Factors Involved	Findings and Opportunities to Improve
1	1st Why?	Why the fabricated part has been rejected?	The fabricated part didn't met the design requirements
2	2nd Why?	why the fabricated part didn't met the design requirements?	The middle section of the fabricated boom part has undergone delamination post curing stage
3	3rd Why?	why the middle section of the boom has been delaminated post curing	The boom part was fabricated using a split mould and during Assembly for bagging process there was a minor mismatch causing the delamination post curing.
4	4th Why?	Why there was a mismatch during the assembly of mould in bagging process	There was no poka-yoke mechanism involved & operator have overlooked the process. The operator has checked only for bagging leak as per process & missed to ensure
5	5th Why?	Why the fit check was not ensured?	Fit check was not part of the process manual & only ensuring leak check was there as per the process
6	6th Why?	Why leak check was not there in the process manual?	The process engineer has overlooked and missed it since it was a first time process

Corrective Action: The Process engineer has to amend the process document to ensure the fit check is added to make sure there is no mismatch when the mould is getting Assembled.

Head of Manufacuring (Rajasekar)	Head of Quality Control/Quality Assurance (Ramkumar)	Quality Control Inspector (Sumiraj)

Figure 10 WHY Analysis Report sample

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SOP for various failures Procedure:

Snag Identification & Logging

When an issue or snag is detected, immediately record it in the ATVA-1 Snag Monitoring Record.
Fill in the following fields based on observations:

Snag Reported On: Date of detection.
Snag Reference Number: Unique tracking number.
Accident/Incident: Indicate if the snag led to any safety concerns and Description of the issue, symptoms, and affected components.

b) Root Cause Analysis

The Cross functional teams will conduct a root cause analysis for reported defects/incidents.
Findings will be documented in the corresponding column of the monitoring log.

Procedure of RCA

1. **Identification of Components:**
Record the serial number of the drone.
List all components along with their specifications that are subject to monitoring.
2. **Recording Defect Information:**
When a defect is observed during routine checks or reported by the drone operator, record the following details in the Component Monitoring Records:

Sr. No.: Sequential number for easy reference.
Name of Component with Specifications: Clearly specify the name and specifications of the affected component.
Date of Defect: The date when the defect was identified.
Component Hours at Defect: The total operational hours of the component at the time of the defect.
Cumulative Failure (Numbers): The total number of times this specific component has failed in the past.

3. **Root Cause Analysis (RCA) :**
Add the reference number for RCA document in the snag monitoring records
Conduct a preliminary analysis to identify the root cause of the defect.
Record the identified root cause in the "Root Cause Analysis" column by performing methods like 5 why analysis.
If further investigation is required, report it to the maintenance team for a detailed RCA.
4. **Proposed Action** / **Corrective Measures:**
Implement immediate corrective measures to address the identified defect.

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Record the corrective measures taken in the "Corrective Measure Implemented" column.
Ensure that the corrective measures are in compliance with approved maintenance procedures and guidelines.

5. Severity level and documentation:

Place the severity level based on criticality and recursiveness
Ensure that all information is accurately recorded in the Component Monitoring Records.
File the completed records in an organized manner for future reference and analysis.

6. Periodic Review:

Periodically review the Component Monitoring Records to identify patterns, trends, or recurring issues.
Use the information to enhance preventive maintenance strategies and minimize future defects.

7. Communication:

Communicate relevant information to the Respective team, providing insights into component performance and potential areas for improvement.

All records should be maintained and reviewed regularly.
A trend analysis should be conducted periodically to identify recurring issues.
Lessons learned should be documented to improve future processes.

Compliance & Review

This SOP should be reviewed quarterly or after any major system update.
Any deviations from the SOP must be documented and approved by the Product Team.

Categorization of Accident/Incident

Each event will be categorized as either an Accident or Incident based on severity and impact to conclude the action requires global action or Local action.

Corrective Actions and Remarks

Engineering and Quality teams will determine the necessary corrective actions.
Any additional remarks or observations will be documented.

Documentation & Record-Keeping

The ATVA-1 Snag Monitoring Log will be maintained electronically for reference.
All reports will be reviewed periodically to ensure compliance and safety enhancements.

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Compliance & Review

This SOP will be reviewed quarterly by the compliance and quality teams. Necessary updates will be made based on regulatory changes and internal assessments.

Pre-Dispatch Inspection

Pre-Dispatch Inspection Checklist for ATVA-1

1. Visual Inspection

Frame and Structure: Check for any cracks, dents, or signs of damage.
Propellers: Inspect for chips, cracks, or deformities. Ensure they are securely attached.
Battery Compartment: Look for corrosion or loose connections.
Landing Gear: Ensure it's intact and functions correctly.

2. Electrical Components

Battery: Check the charge level and physical condition. Ensure connections are secure.
Wiring: Inspect for frayed wires or loose connections.
Motors: Ensure all motors spin freely and are free from obstruction.

3. Software and Firmware

Updates: Ensure the ATVA-1’s software and firmware are up to date.
Calibration: Confirm that all sensors (gyroscope, accelerometer, GPS) are calibrated.

4. Control System

Remote Controller: Check battery level, and ensure all controls function properly.
Failsafe Settings: Verify that failsafe modes are set correctly (return-to-home, etc.).

5. Payload Check

Attachment: Ensure that any payloads or cameras are securely mounted.

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Functionality: Test the payload or camera systems to ensure they are operational.

6. Flight Test

Range Test: Conduct a ground range test to ensure signal integrity.
Short Flight Test: If possible, perform a brief test flight to check overall functionality.

7. Regulatory Compliance

Flight Authorization: Confirm that all necessary permissions and waivers are in place.
No-Fly Zones: Ensure the flight plan avoids any restricted areas.

8. Documentation

Logbook: Update the flight log with any maintenance, inspections, or incidents.
Flight Plan: Prepare and review the flight plan, including waypoints and objectives.

Final Check

Ensure all equipment is loaded securely and that any necessary tools are on hand for the mission.

Packing & Dispatch.

Packing and Dispatching Checklist for ATVA-1

1. Preparation

Clean the ATVA-1: Remove any dirt, debris, or moisture to prevent damage during transit.
Disassemble Components: Detach propellers, antennas, and any removable parts to minimize damage risk.

2. Packing Box (Transportation Box)
The packing box is designed in such a way that UAS is protected from transit vibration & damages.

3. Packing the ATVA-1

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Secure the Frame: Place the ATVA-1 in the case with the frame secured and cushioned.
Pack Propellers: Wrap each propeller individually in bubble wrap or a protective sleeve.
Battery Care: Pack batteries separately and ensure they are stored in fire-resistant containers if required by regulations.
Accessories: Include any necessary accessories (e.g., remote controller, chargers, tools) in designated compartments.

4. Documentation

User Manual: Include a copy of the user manual or a quick-start guide for reference.
Flight Logs: Attach any relevant flight logs or maintenance records.
Customs Documents: If shipping internationally, ensure all customs paperwork is prepared and included.

5. Labeling

Clear Labels: Use waterproof labels to indicate contents and handling instructions (e.g., "Fragile," "This Side Up").
Contact Information: Include sender and recipient contact details inside and outside the package.

6. Shipping

Choose a Reliable Carrier: Select a shipping service with experience in handling sensitive electronic equipment.
Insurance: Consider insuring the shipment for its full value, especially if it includes high-cost components.

7. Final Check

Double-Check Contents: Before sealing the case, ensure all components are packed securely.
Seal the Case: Use appropriate sealing methods (e.g., locks, straps) to secure the case during transit.

8. Notification

Inform the Recipient: Notify the recipient about the shipment, including tracking details and expected delivery dates.

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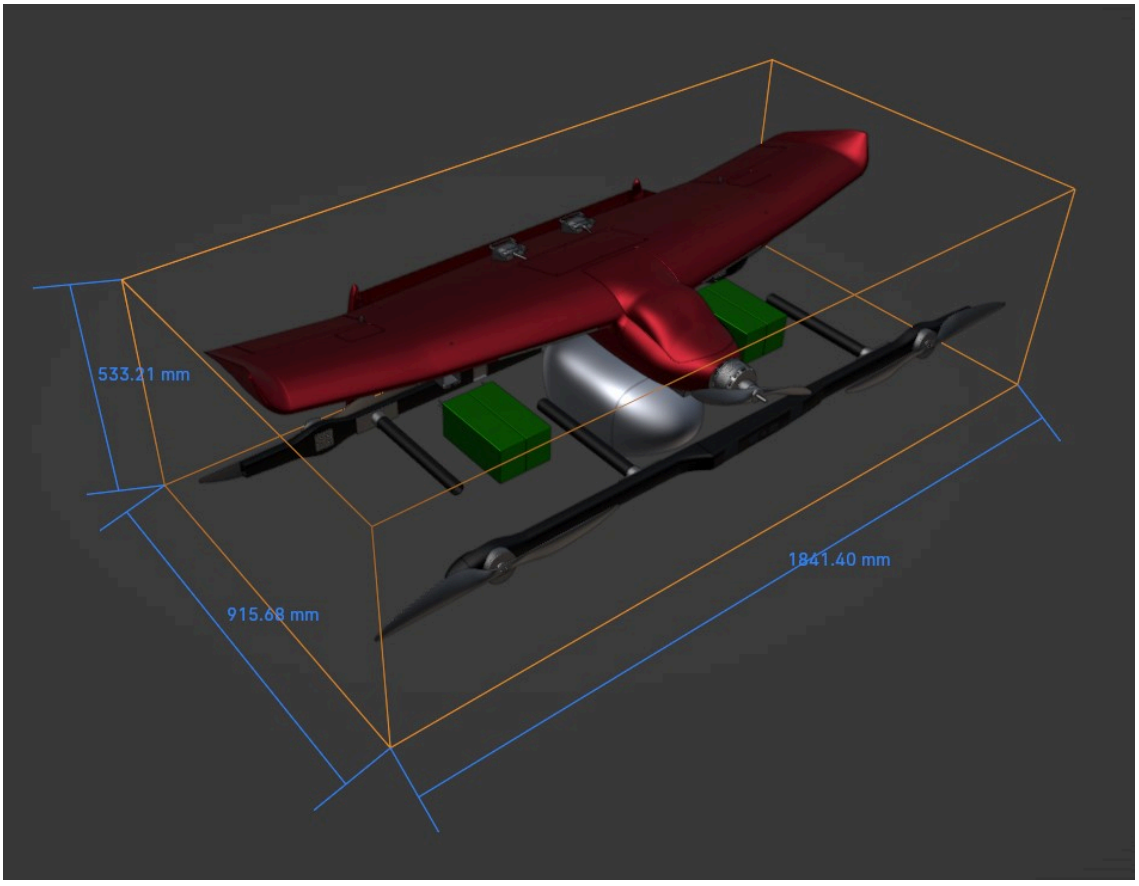


Figure 11 Transportation Box for ATVA-1

9.Issuance of Certificate of Conformance.

Procedure of Issuance of CoC [Certificate of Conformity]

Step 1: Ensure that the RPAS is manufactured according to the manufacturing process as specified in the Type Certification Review Document.

Step 2: Ensure that the Serial Numbers of all the components of the RPAS are noted and recorded in our database.

Step 3: Verification of All entries, checklist and the SOP manuals and ensure that the same are followed in the facility by checking the entries against the RPAS Serial Number.

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Step 4: Ensure that all the required information area recorded in the database for future reference.

Step 5: On Verification of the above requirements against CoC, RPAS will be issued a CoC and that will be added to our database and retained.

CERTIFICATE OF CONFORMITY

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Date of Manufacturing of UAS model :	Company Name: Ubifly Technologies Pvt Ltd,	Model Name : ATVA-1
Address: 1FA, First Floor, IIT-M Research Park, Kanagam Road, Taramani, Chennai 600113.		
Type: Drone	Category: HYBRID	
Class: SMALL	Sub-Category: RPAS	
UIN:	Manufacturers Serial No :	
FCM SN:	RPS SN:	
Type Certification Number:		
Manufacturer Signature : (Head of Quality)	Name:	Date:
Place of Issue:		
Note: This ATVA-1 model complies with the regulations and requirements outlined in the Type Certification, as per CSUAS scheme 2022 & Drone rules 2021. This manufactured product complies with the specifications and requirements outlined in Type Certificate No. _____, as issued by the Directorate General of Civil Aviation (DGCA).		

10.Issuance of UIN

Once the RPAS is type certified from the DGCA, UIN Numbers will be generated from Digital Sky Platform

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The Individual / Organization to whom the Drone is sold should make sure that they provide their Digital Sky ID or Create one by providing us all the required credentials.
The Authorized person from the organization will Create the UIN Number for the UAS by providing necessary details.
Once Approved, the UIN Number will be generated.

11.Transfer of UIN

As a Transferor:

I have an UIN, and I want to transfer my UIN to someone else.
Request the transferee to Create an account and profile on Digital Sky if not already created.
Login to the Digital Sky platform and go to My UIN in the UIN section.
Select 'Transfer' option against the UIN you wish to transfer.
Search the registered transferee, using his/her email address and send the Transfer request via Form D-3 (Application for Transfer or Deregistration of Unmanned Aircraft Systems).
The request will go to the transferee for approval.
After approval from the Transferee, go to the UIN in 'UIN Transfer' section and pay ₹100 fee.
The UIN will be transferred upon successful receipt of payment.

As a Transferee:

I want to get a UIN transferred in my name.
Create your account and profile on Digital Sky platform, if not already created.
Request the transferor to initiate the Transfer Request, if not done already
Accept the Transfer request initiated by the transferor.
Upon successful receipt of requisite fee through Digital Sky from the Transferor, the UIN will be Transferred to you.

Quality Checklist Document

The Quality Check records are maintained for the manufacturing of a single prototype.[Refer to *Annexure- I*]

Inspection Report Document

Once we move on to mass production, QC for each and every part becomes a big

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task. Thus we are formulating an inspection plan which is to be carried out for each LOT produced. Thus, instead of carrying out QC in each part, we are randomly pulling out a few samples from the lot and carrying out the usual QC process on it. If the majority of the samples pass the test, the whole lot is considered as accepted or else it is sent back under nonconformance of quality and dimensions.

Incoming Inspection

Component	Inspection Type	Inspection Criteria	Acceptance Criteria	Pass / Fail
Pixhawk Cube Orange plus	Visual Inspection	Check for physical damage, loose connections, missing components	No physical defects, all ports intact	
	Dimensional Verification	Ensure dimensions match specifications	Dimensions within specified tolerances	
	Electrical Testing	Power on, verify firmware and sensor diagnostics	Boots correctly, no sensor faults	
BEC (Battery Eliminator)	Visual Inspection	Inspect for solder quality, loose or burned connections	No physical damage	
	Voltage/Current Testing	Measure output voltage and current	Matches rated output	
Battery	Visual Inspection	Inspect for physical damage, swollen cells, or leakage	No visible damage, no leakage	
	Voltage Check	Measure individual cell voltage and total voltage	Voltage matches specifications (22.2V for 6s)	
	Capacity Test	Discharge under controlled conditions	Meets rated capacity of 30 Ah	
Here Link Ground Station	Visual Inspection	Check for cracks, scratches, or damage to the screen	Screen intact, no visible damage	
	Functionality Testing	Power on, verify software functions and telemetry control	No software faults, all controls functional	
M9N GPS	Visual Inspection	Inspect casing, connectors, and cable	No physical defects	
	Signal Testing	Test satellite lock and position accuracy	Accurate position data, stable satellite connection	
Bhor Prepreg	Visual Inspection	Check for tears, delamination, or surface defects	Material is smooth, no visible damage	
	Material Specification Verification	Confirm resin content and fiber alignment	Matches specification	
	Dimensional Verification	Measure thickness, width, length	Within tolerance	
T Motors	Visual	Inspect for motor housing damage	No damage, smooth wire	

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	Inspection	and wire connections	connections	
	Electrical Testing	Measure resistance between phases, check rotation	Resistance within spec, smooth rotation	
	RPM Testing	Measure RPM under standard voltage	Meets rated RPM	
ESC (Electronic Speed Controller)	Visual Inspection	Check for damage to housing, connectors, and wires	No physical damage	
	Electrical Testing	Test throttle response, measure current draw	Smooth throttle response, stable current draw	
Propeller	Visual Inspection	Check for cracks or deformation	No cracks or defects	
	Dimensional Verification	Measure propeller's pitch and length	Matches specifications	
	Balancing Test	Perform dynamic balance test	Propeller balanced	
Mauch Current Sensor 200A	Visual Inspection	Check for physical damage or burned components	No visible damage	
	Electrical Testing	Measure output under load, check stability	Accurate readings, stable under load	
Servos	Visual Inspection	Inspect for physical damage, loose wires	No physical damage, all wires intact	
	Operational Testing	Test movement range, responsiveness	Full range of movement, smooth response	
Wires	Visual Inspection	Check for cuts, insulation defects, and quality of soldering	No visible damage or cuts, intact insulation	
	Continuity Testing	Test for continuity across the wire length	Continuity confirmed, no breaks in wiring	
Connectors	Visual Inspection	Check for physical damage, deformities, and proper fit	No cracks or deformations, correct fit for application	
	Electrical Testing	Connect and test for proper signal transmission	Smooth connection, no signal loss or resistance issues	
Airspeed Sensor	Visual Inspection	Inspect for damage to housing, connectors, and tubes	No physical damage	
	Functional Testing	Verify accurate airspeed readings during simulated conditions	Accurate and stable readings	
LED	Visual Inspection	Check for damage, broken connections, or poor soldering	No visible damage	
	Electrical Testing	Power on and check brightness and color consistency	Brightness and color meet specifications, no flickering	

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DECLARATION

Applicant's Name: Dr. Satya Chakravarthy
UAS Manufacturer: Ubifly Technologies Private Limited
UAS Model Name: ATVA -1

I , Satya Chakravarthy - Director of Ubifly Technologies Private Limited do hereby declare the Quality Assurance/ Quality Control Manual of UAS Model of ATVA -1.

I have read the guidelines, terms and conditions governing the certification scheme and undertake to abide by them on behalf of our organization and we hereby confirm that the Quality Assurance / Quality Control Manual meets the compliance requirements.

Applicant/Authorized/Signatory with Seal



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ANNEXURE I – PARTS QUALITY CHECKLIST

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Part Number			
Part Name		Source of Fabrication	☐ Inhouse ☐ outsourced
Dwg. Number		QC Inspector Name	
Date of Inspection		Place of Inspection	Ubifly Technologies Pvt. Ltd.

PART IMAGE

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Ref.	Actual Dimension (mm)	Tolerance (mm)	Fabricated Dimension (mm)	Equipment Used	Equipment ID	QC ✓ PASS (OR) ✗ FAIL	Remarks
A							
B							
C							
D							

CONCLUSION

☐ PASS ☐ FAIL

FINAL COMMENTS:

INSPECTED BY:	APPROVED BY:
(Quality Team Member)	(Quality Head)

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ANNEXURE II – ELECTRICAL & ELECTRONICS FUNCTIONAL QC CHECKLIST

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Name of Component Under Test

Issued To:	Issued By:
Respective Team	Respective Team

Test Requested By	Respective Team
Customer Name	Ubifly Technologies Pvt. Ltd
Purpose of Test	Testing & Validation
Equipment Under Test	Component Name
Model No (Part No)	Model Number
Serial No	XXXXX
Quantity	X
Condition of EUT when Received	Good / Bad
Lab Environmental Conditions During Testing	Temperature: in ºC
Test Specification	Specification
Total Test Duration	(In Minutes)
Actual Test Duration	(In Minutes)
Date of Testing	Test Started on: XX-XX-XXX & XX:XX AM/PM Test Completed on: XX-XX-XXX & XX:XX AM/PM
Tested by	Respective Person

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Applicable Standard	Acceptance Criteria / Conformity	Result
-	Acceptance Criteria	P/F/NA

P – Meets the Criteria, F – Do not Meets the requirements, NA – Not Applicable

Test Result	Remarks
Test Observation	Refer to Photographs

PREPARED BY:	REVIEWED BY:	APPROVED BY:
Name	Name	Name
Signature	Signature	Signature
(Respective Team)	(Respective Team)	(Quality Team)

Test Equipment	**Test Equipment Details**	
	Name	XXXXXXXXXXX
	Model No	XXXXXXXXXXX
	Manufacturer	XXXXXXXXXXX
	Test Instrument Used Details	
		Instrument 1 / Instrument 2
	Name	XXXXXXXXX / XXXXXXXXX
	Model	XXXXXXXXX / XXXXXXXXX
	Manufacturer	XXXXXXXXX / XXXXXXXXX

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Test Setup



Figure 1. Test Setup

Test Samples

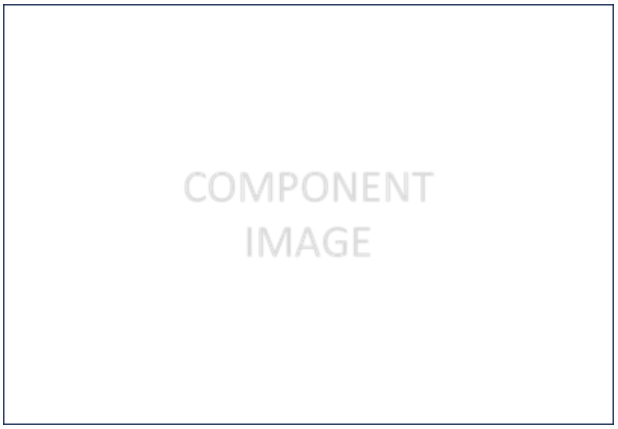


Figure 2. Test Sample

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Test Observations



Figure 4. Test Observation

Remarks (If any):

Results and Discussion:

All planned test cases were executed, and the application performed as expected with no critical defects. The product is considered stable and ready for release.

-----End of Report-----

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ANNEXURE III – MANUFACTURING QUALITY CHECKLIST

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	WORK INSTRUCTION SHEET	Document no:	E01U-0-000-00-0-0-001	Revision No:	-
AMBER WINGS	TITLE: ATVA-1 Assembly(E01U-0-000-00-0-0)	Released By		Date	

BILL OF MATERIAL(BOM)

SNO	Description	Material	Requried Qty	Remarks
1	Main wing upper skin	CFRP	1	
2	Main wing Lower skin	CFRP	1	
3	Main wing front spar Left	CFRP +PVC	1	
4	Main wing front spar Middle	CFRP +PVC	1	
5	Main wing front spar Right	CFRP +PVC	1	
6	Main wing Rear spar	CFRP +PVC	1	
7	Flight Control plate	CFRP +PVC	1	
8	Main wing rib L1	CFRP +PVC	1	
9	Main wing rib L2	CFRP +PVC	1	
10	Main wing rib L3	CFRP +PVC	1	
11	Main wing rib L4	CFRP +PVC	1	
12	Main wing rib L5	CFRP +PVC	1	
13	Main wing rib L6	CFRP +PVC	1	
14	Main wing rib L7	CFRP +PVC	1	
15	Main wing rib R1	CFRP +PVC	1	
16	Main wing rib R2	CFRP +PVC	1	
17	Main wing rib R3	CFRP +PVC	1	
18	Main wing rib R4	CFRP +PVC	1	
19	Main wing rib R5	CFRP +PVC	1	
20	Main wing rib R6	CFRP +PVC	1	
21	Main wing rib R7	CFRP +PVC	1	
22	Fuselage Bulkheads 1	CFRP +PVC	1	
23	Fuselage Bulkheads 2	CFRP +PVC	1	
24	Fuselage Bulkheads 3	CFRP +PVC	1	
25	Fuselage Bulkheads 4	CFRP +PVC	1	
26	Fuselage Bulkheads 5	CFRP +PVC	1	
27	Floor Board	CFRP +PVC	1	
28	crusie motor Mount	CFRP +PVC	1	
29	Wing left Hatch	CFRP +PVC	1	
30	Flight Control plate Hatch	CFRP +PVC	1	
31	Wing Right Hatch	CFRP +PVC	1	
32	GPS Holder 1 L	3D printing (pro-blk)	1	
33	GPS Holder 2 L	3D printing (pro-blk)	2	
34	GPS Holder 1 R	3D printing (pro-blk)	1	
35	GPS Holder 2 R	3D printing (pro-blk)	2	
36	Battery hatch	CFRP+NOMEX	1	
37	Tail upper skin	CFRP	1	
38	Tail Lower skin	CFRP	1	

39	winglet lower skin L	CFRP	1	
40	winglet upper skin L	CFRP	1	
41	winglet lower skin R	CFRP	1	
42	winglet upper skin R	CFRP	1	
43	Tail wing Front spar Left	CFRP +PVC	1	
44	Tail wing Front spar Right	CFRP +PVC		
45	Tail wing rear spar L	CFRP +PVC	1	
46	Tail wing rear spar R	CFRP +PVC		
47	Tail winglet rear spar L+R	CFRP +PVC	2	
48	Tail Rib 1	CFRP +PVC	1	
49	Tail Rib 2	CFRP +PVC	1	
50	Tail Rib 3	CFRP +PVC	1	
51	Tail Rib4	CFRP +PVC	1	
52	Tail Rib 5	CFRP +PVC	1	
53	Tail Rib 6	CFRP +PVC	1	
54	Tail Rib 7	CFRP +PVC	1	
55	Winglet Front Spar L	CFRP +PVC	1	
56	Winglet Front Spar R	CFRP +PVC	1	
57	Winglet Rear Spar L	CFRP +PVC	1	
58	Winglet Rear Spar R	CFRP +PVC	1	
59	Winglet Rib 1 L	CFRP +PVC	1	
60	Winglet Rib 2 L	CFRP +PVC	1	
61	Winglet Rib 3 L	CFRP +PVC	1	
62	Winglet Rib 1 R	CFRP +PVC	1	
63	Winglet Rib 2 R	CFRP +PVC	1	
64	Winglet Rib 3 R	CFRP +PVC	1	
65	Tail Rib 8	CFRP +PVC	1	
66	Aileron upper skin L	CFRP	1	
67	Aileron upper skin R	CFRP	1	
68	Aileron Lower skin L	CFRP	1	
69	Aileron Lower skin R	CFRP	1	
70	Aileron Spar L	CFRP +PVC	1	
71	Aileron Spar R	CFRP +PVC	1	
72	Aileron Rib L 1	CFRP +PVC	1	
73	Aileron Rib L 2	CFRP +PVC	1	
74	Aileron Rib L 3	CFRP +PVC	1	
75	Aileron Rib R 1	CFRP +PVC	1	
76	Aileron Rib R 2	CFRP +PVC	1	
77	Aileron Rib R 3	CFRP +PVC	1	
78	Right Aileron Left Holder	AL6061	1	
79	Right Aileron Right Holder	AL6061	1	
80	Left Aileron Left Holder	AL6061	1	
81	Left Aileron Right Holder	AL6061	1	
82	Aileron Rod	CFRP	2	
83	Right Aileron right Mount	AL6061	1	
84	Right Aileron Left Mount	AL6061	1	

85	Left Aileron Right Mount	AL6061	1	
86	Left Aileron Left Mount	AL6061	1	
87	Left Aileron Servo actuator linkage	AL6061	1	
88	Right Aileron Servo actuator linkage	AL6061	1	
89	Rudder Skin Outward L	CFRP	1	
90	Rudder Skin Inward R	CFRP	1	
91	Rudder Skin Outward R	CFRP	1	
92	Rudder Spar L	CRFP+PVC	1	
93	Rudder Spar R	CRFP+PVC	1	
94	Rudder Rib L 1	CRFP+PVC	1	
95	Rudder Rib L 2	CRFP+PVC	1	
96	Rudder Rib L 3	CRFP+PVC	1	
97	Rudder Rib R 1	CRFP+PVC	1	
98	Rudder Rib R 2	CRFP+PVC	1	
99	Rudder Rib R 3	CRFP+PVC	1	
100	Left Rudder Lower Holder	AL6061	1	
101	Left Rudder Top Holder	AL6061	1	
102	Left Rudder Lower Mount	AL6061	1	
103	Left Rudder Top Mount	AL6061	1	
104	Left Rudder Rod	CFRP	1	
105	Right Rudder Lower Holder	AL6061	1	
106	Right Rudder Top Holder	AL6061	1	
107	Right Rudder Lower Mount	AL6061	1	
108	Right Rudder Top Mount	AL6061	1	
109	Right Rudder Rod	CFRP	1	
110	Elevator upper Skin	CFRP	1	
111	Elevator lower Skin	CFRP	1	
112	Elevator Spar	CFRP +PVC	1	
113	Elevator Rib 1	CFRP +PVC	1	
114	Elevator Rib 2	CFRP +PVC	1	
115	Elevator Rib 3	CFRP +PVC	1	
116	Elevator Arm Rib	CFRP +PVC	1	
117	Elevator Rib 4	CFRP +PVC	1	
118	Elevator Rib 5	CFRP +PVC	1	
119	Elevator Rib 6	CFRP +PVC	1	
120	Elevator Rod	CFRP	1	
121	Elevator Mount L	AL6061	1	
122	Elevator Mount R	AL6061	1	
123	Elevator Holder L	AL6061	1	
124	Elevator Holder R	AL6061	1	
125	Elevator Servo Actuator Linkage L	AL6061	1	
126	Front Boom L	CFRP	1	
127	Front Boom R	CFRP	1	
128	Rear Boom L	CFRP	1	
129	Rear Boom R	CFRP	1	
130	Front Boom L	3D PRINT POLYETHYLENE	1	

131	Front Boom R	3D PRINT POLYETHYLENE	1	
132	Rear Boom L	3D PRINT POLYETHYLENE	1	
133	Rear Boom R	3D PRINT POLYETHYLENE	1	
134	landing gear Plate L	CFRP	2	
135	landing gear Plate R	CFRP	2	
136	Boom Lower plate L	AL6061	4	
137	Motor Mount	AL6061	4	
138	Propeller	CFRP	4	
139	Landing Gear	CFRP	4	
140	Boom Lower plate L	AL6061	4	
141	Motor Mount	AL6061	4	
142	Acetone	-	AS REQUIRED	
143	Emery sheet 80	Silicon carbide	AS REQUIRED	
144	Emery sheet 120	Silicon carbide	AS REQUIRED	
145	3M Scotch Weld-9323 adhesive	two component epoxy paste adhesive	AS REQUIRED	
146	Safety mask	Microfibre	AS REQUIRED	
147	Safety goggles	Polycarbonate	AS REQUIRED	
148	M3 x 10L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	AS REQUIRED	
149	M3 x 10L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	6	
150	M2 x 12L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	8	
151	M2 X 8L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	8	
152	M4 x 10L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	8	
153	M2 x 10L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	16	
154	M3 x 8L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	4	
155	M3 x10L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	5	
156	M3 x 16L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	3	
157	M2 x 12L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	4	
158	M2 x10L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	4	
159	M2 x 10L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	4	
160	M4 x 15L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	16	
161	M4 x8L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	16	
162	M3 x 8L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	8	
163	M3 x25L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	4	
164	M3 x15L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	4	
165	M3 x35L /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	4	
166	M2 x 18 /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS		
167	M2 x 20 /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS		
168	M6X70 /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	2	
169	M6X40 /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	4	
170	M6X120 /washer/locknut	8.8 GRADE OR HIGHER, socket head, SS	2	
171	M9N GPS	-	2	
172	Cube orange +	-	1	
173	GPS stand	-	2	
174	Airspeed sensor	-	1	
175	Jetson nvidia	-	1	
176	V605 motors	-	4	

177	AT7215		1	
178	Aileron servo	-	1	
179	Rudder servo	-	1	
180	Elevator Servo	-	1	
181	Ball horns	-	6	
182	Metal clevis	-	6	
183	3mm rods	-	2	
184	Push pull rods	-	2	
185	Linkage	-	12	
186	hinge	-	1	
187	Latch	-	1	
188	Aluminum alloy servo horn	-	1	

Sl. no	Equipment/Tool Name	Equipment/Tool/Document No	Qty	UOM	Remarks
1	Measuring scale 1000mm	HT/CC/240229-26/006	1	EA	
2	Measuring scale 600mm	HT/CC/240229-26/005			
3	Measuring scale 300mm	HT/CC/240229-26/008			
4	Weighing Balance	HT/CC/240229-26/001			
5	Try square	-	1	EA	
6	Bevel protractor	HT/CC/231201-08/010	1	EA	
7	Spirit level	HT/CC/240229-26/004	1	EA	
8	Measuring Tape	HT/CC/240229-26/002	1	EA	
9	Combination set	HT/CC/231201-08/011	1	EA	
10	Vernier Caliper 600mm	HT/CC/231201-08/005	1	EA	
11	Vernier Caliper 150mm	HT/CC/231201-08/004	1	EA	
12	Micrometer	-	1	EA	
13	Barometer	HT/CC/240229-26/009			
14	Height Guage	HT/CC/240229-26/003	1	EA	
15	Nylon/Teflon Mallet	-	1	EA	
16	M3 & M4 nut riviter	-	1	EA	
17	Nose piler	-	1	EA	
18	Hammer	-	1	EA	
19	Needle file (diamond)	-	1	EA	

Sl. No.	Opeweight weight ration No	Performed By	Work Centre	Operation Description	Stamp/Signature & date
1	5	OP	Assy	**Pre- Assembly procedure** **Marking EOP Lines:** Use the drawing as a reference to mark End of Part (EOP) lines on the part. Trimming the Part: Trim the part according to the EOP lines marked earlier.	

2	10	OP	Assy	**Cleaning with Acetone:** Cleaning with Acetone: **Attachment Slots:** ribs and spar attachment slots as required.	
3	15	OP	Triming	• With the reference of drawing mark the EOP lines on the part. •Trim the part with the reference of EOP lines. •Clean the part with the cleaning agent Acetone.	
4	25	QC	Assy	•Compare each machined part against the dimensions specified in the drawing. •Ensure all critical dimensions, tolerances, and features match the drawing requirements.	
5	30	OP	Assy	•Mark each inspected part visibly and clearly with a permanent marker. •Include relevant identifiers such as part numbers or batch codes as per standard operating procedures . •Verify the accuracy of part markings against records or identification standards. •Confirm that each part is correctly marked before proceeding •Ensure all inspected parts that meet drawing specifications are ready for assembly.	
6	35	OP	Assy	•Separate out any parts that require rework or further inspection. •Document inspection results, including any deviations or corrective actions taken. •Hand off approved parts to the assembly team along with relevant documentation.	
7	40	OP	Assy	**Preparation and Dry Fit Assembly Procedure:** Confirm that all leveling and suiting adjustments are completed as per requirements. •Ensure the workspace and parts are ready for the next steps.	
8	45	OP	Assy	•Use acetone to clean the slot thoroughly •Apply acetone using a lint-free cloth or suitable applicator. •Allow the acetone to evaporate and the slot to dry for a minimum of 10 minutes.	
9	50	QC	Assy	•Double-check that all leveling and suiting adjustments have been completed according to requirements. •Ensure the workspace is clean, organized, and ready for the next steps of the process.•Verify that the parts related to the slot cleaning are prepared and positioned correctly. •Use acetone to clean the slot thoroughly. •Apply acetone using a lint-free cloth or suitable applicator to ensure even coverage. •Ensure the slot is completely cleaned of any residues or contaminants. **NOTE:** •Allow the acetone to evaporate naturally. •Ensure the slot is dry for a minimum of 10 minutes before proceeding to the next step	
10	55	OP	Assy	**Process of Main Wing Ribs & Spar:** **Modifying Ribs and Spar Attachment Slots:** •Adjust the ribs and spar attachment slots as required.	
11	60	OP	Assy	**Dry Fit Assembly:** •Perform a dry fit assembly of the ribs and spar, ensuring they align properly when the lower skin is placed in its respective fixture or mould. •Ensure ribs and spars make full contact with the lower skin.	
12	65	OP	Assy	**Cleaning Slots and Preparing for Bonding:** •Once proper fitting is confirmed, clean the slots with acetone and allow 10 minutes for drying before bonding. •Applying Structural Adhesive (3M Scotch Weld-9323): •Mix the bonding material as per the weight ratio (100:27). Mixing start time _____& end time_____ Curing start time_____& end time_____ •Apply the adhesive on the ribs, spar, and Pixhawk base plate slots using fixtures and jigs.	

13	70	OP	Assy	**Clamping and Bonding:** •Place clamps or dead weights over the jigs and fixtures to ensure proper bonding. •Wipe off any excess adhesive from the bonding area.	
14	75	OP	Assy	**Bonding Main Wing Ribs R4, R6, L4, L6 (Note):** Note: Do not apply bonding material on Main Wing Rib R4, R6, L4, L6 as these will be bonded after left and right aileron assembly respectively, serving as reference points. •Leave the bonded parts to cure for 24 hours. **Verifying Bonding:** •After curing, verify that bonding is completed properly and securely.	
15	80	OP	Assy	**Bonding Ribs and Spars Skeleton Structure with Low er Skin:** •Place clamps or dead weights over the ribs and spar skeleton structure to ensure a proper bond with the lower skin.	
16	85	OP	Assy	**Installing Servo Holder:** •Fix the servo holder with M3 fasteners onto the spar. •Perform this installation on both sides where servo locations are designated.	
17	90	OP	Assy	**Attaching Servo:** •Attach the servo to the servo holder using M2 fasteners.	
18	95	QC	Assy	**Visual Inspection:** •Conduct a detailed visual inspection of the assembled main wing ribs, spar, and associated components. •Verify overall alignment, fitment, and cleanliness of the assembly. **Dimensional Verification:** •Measure critical dimensions of the assembled structure against engineering drawings and specifications. •Ensure all dimensions meet tolerance requirements as specified. **Bonding Integrity Check:** •Inspect bonding areas for any signs of adhesive failure, gaps, or uneven bonding. •Ensure all bonded joints exhibit uniformity and meet strength requirements. **Surface Condition Inspection:** •Check surfaces for any scratches, dents, or imperfections that could affect structural integrity or aerodynamic performance. •Verify that surfaces are smooth and free of contaminants.	
19	105	OP	Assy	**Process for Tail Structure Assembly:** **Trimming with EOP Lines:** •Trim the vertical tail structure parts precisely along the End of Part (EOP) lines referenced in the engineering drawings.	
20	110	OP	Assy	**Modifying Ribs and Spar Attachment Slots:** •Increase the vertical tail structure ribs and spar attachment slots as required according to specifications.	
21	115	OP	Assy	**Initial Alignment Check:** •Place the vertical tail lower skin over the tail ends to check alignment of vertical tail structure spar and ribs. •Ensure proper alignment before proceeding with bonding.	
22	120	OP	Assy	**Bonding Preparation:** •Remove the vertical tail lower skin after alignment check. •Mix the bonding material Structural Adhesive 3M Scotch Weld-9323 with the correct weight ratio (100:27 grams). •Mix the bonding material as per the weight ratio (100:27). Mixing start time _____& end time_____ Curing start time_____& end time_____	
23	125	OP	Assy	**Excess Material Management:** •Wipe off any excess bonding material from the bonding area to maintain cleanliness and prevent buildup.	
24	130	OP		**Curing Process**: •Leave the bonded parts undisturbed until the adhesive cures completely. •Conduct a thorough inspection after curing to ensure bonding integrity and quality.	

25	135	OP	Assy	**Installation of Winglets:** •Properly place the winglets and verify their alignment and fit with the vertical tail structure.	
26	140	OP	Assy	**Rudder Assembly Preparation:** •Ensure vertical tail upper ribs are not bonded with spar at this stage. •Perform a dry fit assembly of rudder top and lower holder, along with rudder top and lower mounts on both left and right sides of the vertical tail structure. •Check functionality to ensure rudders move properly.	
27	145	OP	Assy	**Bonding of Rudder Components:** •Apply bonding mixture on the rudder top and lower holder, as well as on the rudder top and lower mounts with ribs on both left and right sides of the vertical tail structure •Leave the bonded rudder components until the adhesive cures completely.	
28	150	QC	Assy	**Visual and Dimensional Inspections:** Conduct visual inspections at each stage to ensure parts are aligned, trimmed correctly, and bonded properly. **Documentation and Compliance:** •Maintain detailed records of assembly processes, inspections, and any deviations encountered. **Adherence to Specifications:** •Ensure all assembly steps strictly adhere to engineering drawings, material specifications, and safety standards.	
29	160	OP	Assy	**Process for control surface assembly:** **Trimming with EOP Lines:** •Trim the vertical tail structure parts precisely along the End of Part (EOP) lines referenced in the engineering drawings.	
30	165	OP	Assy	**Modifying Ribs and Spar Attachment Slots:** •Increase the vertical tail structure ribs and spar attachment slots as required according to specifications.	
31	170	OP	Assy	**Initial Alignment Check:** •Place the vertical tail lower skin over the tail ends to check alignment of vertical tail structure spar and ribs. •Ensure proper alignment before proceeding with bonding.	
32	175	OP	Assy	**Bonding Preparation:** •Remove the vertical tail lower skin after alignment check. •Mix the bonding material Structural Adhesive 3M Scotch Weld-9323 with the correct weight ratio (100:27). Mixing start time _____& end time_____ Curing start time_____& end time_____	
33	180	OP	Assy	**Excess Material Management:** •Wipe off any excess bonding material from the bonding area to maintain cleanliness and prevent buildup.	
34	185	OP	Assy	**Curing Process:** •Leave the bonded parts undisturbed until the adhesive cures completely. •Conduct a thorough inspection after curing to ensure bonding integrity and quality.	
35	190	OP	Assy	**Applying Bonding Material:** •Apply the bonding mixture material on the ribs, spar, and the marked area of the vertical tail lower skin.	
36	195	OP	Assy	**Clamping for Bonding:** •Place clamps on the vertical tail structure to secure and maintain proper bonding pressure.	
37	200	QC	Assy	**Post-Bonding Inspection:** •After curing is complete, inspect the bonded parts thoroughly to verify bonding integrity and adherence to quality standards. •Ensure all bonded joints are secure and meet specified requirements.	
38	205	OP	Assy	**Integweight weight ration with Lower Skin:** •Bond the ribs and spar skeleton structure with the lower skin using clamps or dead weights to ensure a strong and secure bond.	
				Visual Inspection: •Conduct visual inspections at each stage of the assembly process to check alignment, fit, and cleanliness. **Dimensional Verification:** -Measure critical dimensions against engineering drawings to confirm accuracy and adherence to specifications	

37	210	QC	Assy	•Measure critical dimensions against engineering drawings to confirm accuracy and adherence to specifications. **Adhesive Application:** •Ensure proper mixing and precise application of adhesive to achieve optimal bonding strength **Documentation:** •Maintain detailed records of assembly processes, inspection results, and any corrective actions taken.	
38	220	OP	Assy	**Process Description for Boom Preparation for Bonding** **Demolding and Trimming:** •After demolding, transfer the boom to the trimming area. •Remove excess resin stains from the part using a buffing machine.	
39	225	OP	Assy	**Buffing Process:** •Perform buffing on the entire part using a 120 grit buffing pad to achieve a smooth surface finish.	
40	230	OP	Assy	**Motor Mount Area Preparation:** •Cut the motor mount area as per marking specifications. •Verify clearance around the motor mount, ensuring a minimum 5 mm gap on all sides for proper fit.	
41	235	OP	Assy	**ESC Area Preparation:** •Cut the ESC (Electronic Speed Controller) area as marked. •Physically check that the ESC fits freely within the designated area.	
42	240	OP	Assy	**Weight Measurement:** •Conduct a weight measurement of the boom after trimming to verify adherence to weight specifications.	
43	245	OP	Assy	**Carbon Fabric Layering:** •Place three layers of 160 GSM dry carbon fabric below the motor mount area. •Use Structural Adhesive 3M Scotch Weld-9323 mixed at a weight ratio of 100:27 to bond the carbon fabric layers securely. Mixing start time _____& end time_____ Curing start time_____& end time_____	
44	250	OP	Assy	**Vacuum Bagging and Curing:** •Apply vacuum bagging over the boom assembly to ensure even pressure during curing. •Leave the boom assembly in the vacuum bag for 24 hours to allow the adhesive to cure properly. Post-Curing Inspection: •After curing, remove the vacuum bag and inspect the boom for bonding integrity and adherence to specifications. • Maintain minimum vacuum of Below 584mm Hgfor minimum 15 minutes • Vacuum achieved: _____ mm Hg • Compaction start time & date _____& _____ • Compaction end time & date: _____& _____	
	255	QC	Assy	LEAK CHECK: • Compaction start time & date: _____& _____ • Vacuum observed at start time: _____ mm Hg • Compaction end time & date: _____& _____ • Vacuum observed at end time: _____ mm Hg • Leak obtained: _____ mm Hg **Note**: Only 2 leak is allowed for 5 mins	
45	260	OP	Assy	**Marking and Drilling:** •Mark and drill holes as per motor mount specifications using a motor mount as a template.	
46	265	OP	Assy	**Bonding Metal Plate:** •Bond a 1.5 mm metal plate using Structural Adhesive 3M Scotch Weld-9323 mixed at a weight ratio of 100:27. •Ensure the metal plate is securely bonded to the boom surface. Mixing start time _____& end time_____ Curing start time_____& end time_____	

47	270	OP	Assy	**Fastener Installation:** •Use M4 fasteners to tightly secure the metal plate. •Coat all fasteners with Frekote to prevent adhesive bonding and ensure ease of future maintenance.	
	275	QC	Assy	Inspect all the plate and fasterner are bond.	
48	285	OP	Assy	**Process for E6 Boom Bonding with Lower Skin** **Marking:** •Mark the lower portion of the skin and the upper portion of the boom where bonding is required.	
49	290	OP	Assy	**Surface Preparation:** •Use sandpaper to prepare the surfaces. •Clean the surfaces with Acetone or a suitable cleaning agent to ensure they are free from contaminants.	
50	295	OP	Assy	**Marking Alignment:** •Use assembly jigs to ensure accurate marking and alignment of the boom and skin.	
51	300	OP	Assy	**Boom Alignment:** •Fix the boom securely on the jig. •Verify the alignment of the boom to ensure it meets specifications.	
52	305	OP	Assy	**Position Verification**: •Place the lower skin over the boom. •Verify and adjust the position of the lower skin relative to the boom.	
53	310	OP	Assy	**Bonding Material Preparation:** •Prepare the structural adhesive (3M Scotch Weld-9323) with a mixing weight weight ratio of 100:27. •Optionally, mix approximately 2 grams of carbon powder into the adhesive for bonding (note: tail bonding may not require carbon powder). Mixing start time _____& end time_____ Curing start time_____& end time_____	
54	315	OP	Assy	**Application of Bonding Material:** •Apply the prepared bonding material to the areas on the boom and skin where bonding is designated.	
55	320	OP	Assy	**Assembly:** •Place the lower skin over the boom immediately after applying the bonding material. •When we attached the boom to lower skin apply gas sealant to control vibweight weight ration. •E nsure the skin makes full contact with the boom surface.	
56	325	OP	Assy	**Clamping and Weight Application:** •Apply dead weight and/or use clamps to secure the skin tightly against the boom. •This helps to ensure proper adhesion and eliminates air gaps.	
57	330	OP	Assy	**Excess Material Removal (if applicable):** •If feasible, remove any excess bonding material to maintain a neat finish.	
58	335	OP	Assy	**Curing:** •Leave the bonded parts undisturbed as per the adhesive manufacturer's curing recommendations. •Typically, this involves allowing sufficient time for the adhesive to cure and achieve full strength Note:For tail bonding, follow a similar procedure but omit the addition of carbon powder to the bonding material.	
59	340	QC	Assy	**Surface Inspection:** •Ensure surfaces of both boom and lower skin are clean, smooth, and free from contaminants or defects before bonding. •Either check the gas sealent is cure or not. **Adhesive Application Control:** •Follow precise mixing guidelines for 3M Scotch Weld-9323 adhesive and use calibrated equipment for accurate application. **Clamping and Fixturing:** •Apply correct clamps and fixtures with adequate pressure to ensure intimate contact between boom and lower skin during curing without causing distortion. **Curing Conditions:** •Maintain specified curing conditions (temperature, humidity, curing time) and monitor the curing process to ensure full bond strength. **Post-Bonding Inspection:**	

				Post-Bonding Inspection: •Conduct visual, tactile, and non-destructive inspections to ensure the bonded joint meets dimensional, aesthetic, and strength requirements	
60	350	OP	Assy	**Pre-assembly procedure:** •Inspect for any sign of wear or damage of aluminum components. •Inspect for rotation between motor bell and base. •Spin the motor by hand and inspect for rough or constricted rotation. •Inspect motor bell for any dents or scratches indicating prior impact	
61	355	OP	Assy	**Process of motor assmbly** **VTOL Motors Assembly** **Alignment:** •Ensure all four quad motors are aligned with a 5-degree angle.	
62	360	OP	Assy	**Fixture Use:** •Use a fixture to create precise holes in the motor mount and motor locating area.	
63	365	OP	Assy	**Mounting:** •Assemble the motor mount using M4x15 socket head fasteners. •Use a 3mm Allen key for tightening and secure with Nylock nuts.	
64	370	OP	Assy	**Positioning and Fastening:** •After positioning the motor, apply the fasteners from the underside to secure it in place.	
65	375	OP	Assy	**Cruise Motor Assembly** **Mounting to Floorboard:** •Fix the cruise motor to the floorboard using a dedicated mount.	
66	380	OP	Assy	**Alignment:** •Attach the mount to the floorboard and align the motor using an angle meter . •Set the angle meter to 0 degrees, ensuring the motor is perpendicular to the landing gear. **NOTE:** • Double-check the alignment angles before final tightening. •Ensure all fasteners are securely tightened to prevent any loosening during opeweight weight ration. •Verify that the cruise motor is perfectly perpendicular to the landing gear for optimal performance.	
67	385	QC	Assy	Cruise Motor Assembly Mounting to Floorboard: •Fix the cruise motor to the floorboard using a dedicated mount.	
68	395	QC	STORE	**Collect Parts and Tools:** •Avionics team members gather all necessary parts and tools from the inventory. **Quality Inspection:** •Parts are inspected by quality check personnel to ensure they meet the required standards. **Component Check:** •Avionics team verifies the components again for any defects or issues. **Flatness Check:** •Use a spirit level to check the flatness of the worktable. •Place the spirit level on the motor and ensure it is flat. •If there's any deviation in the bubble of the spirit level, adjust the Flight Controller (FC) position until the bubble is centered. **Mounting the FC**	

				Mounting the FC: •Once the worktable and FC flatness are confirmed: •Tighten the FC mount using M3*12mm screws. •Use a 2.5mm Allen key with Loctite 222 to secure the screws. •This procedure ensures that the assembly is done accurately and securely.	
69	405	QC	Assy	**Incoming Inspection:** •Thoroughly inspect all incoming components and materials to ensure they meet stringent quality standards before assembly. **Assembly Verification:** •Verify precise adherence to assembly procedures and engineering specifications to ensure accurate installation of avionics components. **Functional and Performance Testing:** •Conduct rigorous functional tests to validate opeweight weight rational integrity and performance of avionics systems under simulated or actual conditions.	
70	410	OP	Assy	**Attach Mount on Avionics Floorboard:** •Securely attach the mount for the Flight Controller (FC) on the avionics floorboard. .	
71	415	OP	Assy	**Install Flight Controller (FC) :** •Use 3MM tape to install the FC in the floorboard. •Ensure the arrow on the FC points in the direction of the nose of the aircraft.	
72	420	OP	Assy	**Attach GPS Mounts:** •Position and attach the GPS mounts on the top of the fuselage in designated locations.	
73	425	OP	Assy	**Fix GPS onto its Mount:** •Securely fix the GPS unit onto its mount on the fuselage. •Attach Servo for Control Surfaces: •Install servos in the designated control surface areas of the aircraft	
74	430	OP	Assy	**Connect ESC Signal Wires:** •Plug the Electronic Speed Control (ESC) signal wires into their respective slots on the Flight Controller (FC).	
75	435	OP	Assy	**Install Receiver:** •Mount the receiver in the center frame of the aircraft. •Connect the receiver's cable into the appropriate slot on the Flight Controller (FC).	
76	440	OP	Assy	**Install Receiver Antenna:** •Position the receiver antenna on the bottom side of the aircraft. •Route the antenna through the center frame, securing it on both sides to ensure proper reception.	
77	445	QC	Assy	Inspect all the components are fix and attacted with mount	
78	455	OP	Painting	After completing the assembly, apply putty to fill the pinholes on the aircraft	
79	460	OP	Painting	Putty curing • start time_____ • end time _____	
80	465	OP	Painting	After the putty has cured, buff it on the aircraft	
81	470	OP	Painting	Before painting, apply the first layer of primer. start time _____& end time_____	
82	475	OP	Painting	Paint the aircraft using a mixture of paint and hardener in the specified ratio_____ painting start time _____ painting end time _____	

83	480	QC	Painting	**Surface & Application**: Ensure surface prep, primer, and paint are smooth and evenly applied. **Curing & Thickness**: Verify proper curing and measure paint thickness meets standards. **Final Finish**: Inspect for defects, adhesion, and overall finish quality.	
84	455	QC	Flight test	Handover to flight test team	

ANNEXURE IV – FUNCTIONAL TEST FOR AIRWORTHINESS

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Purpose

This SOP outlines the comprehensive procedure for conducting functional tests on the ATVA-1 drone to verify its airworthiness and compliance. The goal is to ensure that all critical components are operational and reliable before flight operations.

Scope

This procedure applies to all ground tests conducted on the ATVA-1, focusing on:

- Actuator functionality
- GPS accuracy
- Motor performance
- Sensor calibration
- Herelink Module
- Flight Controller (Pixhawk Orange Cube Plus) PWM matching
- Control Surface checks with servos

Flight Testing Sequence

Before the ATVA-1 can be submitted for certification, a series of comprehensive tests must be conducted to ensure its safety, reliability, and compliance with regulatory standards. These tests are designed to evaluate various operational capabilities and performance metrics of the drone in different scenarios. The following flight tests were carried out to validate the air worthiness of the ATVA-1:

- Flight Test 1: Ground Tests
- Flight Test 2: Quad Flight Test
- Flight Test 3: Switching from Quad Flight Test Mode to Cruise Mode
- Flight Test 4: Controlling the Loiter to Left
- Flight Test 5: Controlling the loiter to Right
- Flight Test 6: Incrementing the payload weight
- Flight Test 7 : Endurance Tests with components not being replaced
- Flight Test 8: Endurance Tests in case the critical components are replaced
- Flight Test 9: Operational Envelope test for Minimum and Maximum Operating Speed
- Flight Test 10: GPS Accuracy test
- Flight Test 11: RSSI Value at different voltage levels

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- Flight Test 12: Geo Fence

Procedure

Flight Test 1 : Ground Tests

Procedure

Ground Test Preparation

Safety Checks

- Ensure all personnel involved in the testing are wearing appropriate safety gear.
- Identify and establish a safe testing area that is free from obstructions and populated areas.
- Review emergency procedures in case of a malfunction or accident.

Equipment Setup

- **Drone Positioning**: Place the drone on a flat, stable surface, preferably outdoors or in a large indoor area free from obstructions.
- **Power Check**: Connect the drone to the ground control station (GCS). Power on all systems, including the flight controller, GPS, and remote control.
- **Communication Check**: Verify that the GCS can communicate with the drone's flight controller and all subsystems.

Actuator and Sensor Tests

Actuator Functionality

- **Initial Inspection**: Inspect all actuators for physical damage, loose connections, or improper installations.
- **Test Procedure**:
    - Manually operate each actuator through the GCS or RC transmitter to check for proper movement.
    - Confirm that actuators respond accurately to input commands.
    - Document the responsiveness and any discrepancies observed.

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GPS Check

- **Signal Acquisition**:
  - Power on the GPS module and wait for it to acquire a satellite signal (minimum 4 satellites recommended).
  - Check the GPS status on the GCS to confirm a valid fix.
- **Data Logging**:
  - Record the GPS coordinates and altitudes reported by the module.
  - Verify the accuracy by comparing it with known reference points.
- **Failure Response**: Note any failures in GPS signal acquisition and troubleshoot as necessary.

Motor Spin Test

- **Motor Inspection**:
  - Inspect each motor for physical damage, wiring issues, or loose connections.
- **Spin Test**:
  - Using the GCS, manually spin each motor one at a time at low power settings.
  - Observe the rotational direction and speed; motors should spin freely without binding or unusual noise.
- **Temperature Monitoring**:
  - Measure and record motor temperatures using an infrared thermometer.
  - Ensure temperatures remain within operational limits.

Sensor Calibration

- **Calibration Procedure**:
  - Connect the drone to the calibration software and follow the on-screen instructions for each sensor (IMU, barometer, magnetometer).
  - Complete necessary calibration procedures, such as level calibration for the IMU and barometric pressure calibration.
- **Verification**:
  - After calibration, verify that sensor outputs are stable and within expected ranges.
  - Document calibration values for future reference.

RC Manual Control Test with Herelink Module

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Manual Control Setup

- **Receiver Connection**:
  - Ensure that the RC receiver is correctly connected to the flight controller.
- **Control Check**:
  - Power on the RC transmitter and verify that all channels are functioning correctly.
  - Move each control stick and switch to confirm corresponding movements in the drone's actuators.

Testing Procedure

- **Response Assessment**:
  - Test each control input (elevator, ailerons, throttle, rudder) and monitor the drone’s response.
  - Adjust the RC transmitter settings as needed to ensure precise control.
- **Documentation**:
  - Record the response time for each control input and note any discrepancies.

Flight Controller PWM Match

PWM Signal Verification

- **Setup**: Connect an oscilloscope or multimeter to the PWM output pins on the flight controller for each motor.
- **Testing Procedure**:
  - Send commands from the GCS or RC transmitter to vary motor throttle.
  - Measure and record the PWM signal values for each motor at different throttle levels (e.g., low, mid, high).
- **Comparison**:
  - Verify that the measured PWM values match the expected values in the flight controller configuration.
  - Note any discrepancies and make adjustments to the flight controller settings as necessary.

Control Surfaces and Servo Check

Servo Functionality Test

- **Initial Inspection**:

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    - Inspect all servos for physical damage, proper installation, and secure connections.
- **Testing Procedure**:
    - Manually operate each servo through the GCS or RC transmitter.
    - Ensure that deflectors respond accurately to commands, opening and closing smoothly without binding.
- **Position Recording**:
    - Document the deflector positions during operation and verify they meet design specifications.

Flight Test 2: Quad Flight Test

Objective

The purpose of the Quad mode test is to validate the stability, control, and performance of the ATVA-1 drone when it operates in its quadcopter configuration. This mode is typically used during vertical takeoff and landing (VTOL) phases. The test will verify the proper functioning of the drone's motors, sensors, flight controller, and power systems under hovering and maneuvering conditions.

Test Overview

The following key aspects of the ATVA-1 drone will be evaluated during the Quad mode test:

1. **Stability in Hover**: Ensuring that the drone can maintain a stable hover at different altitudes without drift or instability.
2. **Control Response**: Testing how the drone responds to manual control inputs for pitch, roll, yaw, and throttle.
3. **Altitude Hold**: Verifying that the drone can maintain a constant altitude in automatic or manual control modes.
4. **Yaw Performance**: Assessing the smoothness and precision of yaw movements (rotation around the vertical axis).
5. **Power and Battery Monitoring**: Evaluating power consumption and battery performance during sustained flight in Quad mode.

Pre-Flight Setup

1. **Flight Area Setup**:
    - Choose a wide, open area for testing, free from obstacles or interference.

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- Set up safety boundaries to prevent unauthorized access during testing.

2. **System Pre-Checks**:
   - **Battery Check**: Ensure the battery is fully charged, and all connections are secure.
   - **Motor and Propeller Inspection**: Confirm that all motors and propellers are functioning properly and free from damage.
   - **Flight Controller Calibration**: Verify that the flight controller (e.g., Pixhawk Orange Cube Plus) is calibrated correctly, especially the sensors like IMU and barometer.
   - **RC Transmitter/Receiver Link**: Ensure that the RC transmitter and receiver are properly linked and operational.
   - **GPS Signal**: Ensure that the GPS module has locked onto a sufficient number of satellites (minimum 6) to maintain stable positioning.

Test Procedure

1. **Takeoff Test**
   - **Procedure**:
     - Initiate takeoff using manual control or through the Ground Control Station (Amber GCS)
     - Observe how smoothly the drone transitions from the ground to hover mode.
     - Ensure the ascent is stable, and there is no wobbling.
   - **Expected Outcome**: The drone should lift off smoothly and enter a stable hover at a designated altitude (10 meters).
2. **Hover Stability Test**
   - **Procedure**:
     - Maintain the drone in a stable hover for at least 30 seconds to 1 minute.
     - Observe any drift in horizontal (X, Y) or vertical (Z) axes.
     - Check if the flight controller can compensate for external factors like wind.
   - **Expected Outcome**: The drone should hover stably, maintaining its position without drifting or needing excessive manual corrections.
3. **Manual Control Test (Pitch, Roll, Yaw, Throttle)**
   - **Procedure**:
     - Use the RC transmitter to test the pitch, roll, yaw, and throttle controls.
     - Apply small inputs to each control axis, and observe how the drone responds.

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        - Test the following movements:
            - **Pitch**: Forward and backward.
            - **Roll**: Left and right.
            - **Yaw**: Rotational movement about the vertical axis.
            - **Throttle**: Vertical climb and descent.
    - **Expected Outcome**: The drone should respond promptly and smoothly to all control inputs, without excessive delay or overcorrection.
4. **Yaw Performance Test**
    - **Procedure**:
        - Command the drone to rotate about its vertical axis (yaw).
        - Observe how smoothly the drone can rotate 90°, 180°, or 360° while maintaining altitude and stability.
    - **Expected Outcome**: The yaw movements should be smooth, and the drone should not lose altitude or experience instability during rotation.
5. **Altitude Hold Test**
    - **Procedure**:
        - Enable altitude hold mode through the flight controller.
        - Command the drone to maintain a set altitude (e.g., 10 meters).
        - Observe if the drone can maintain the altitude without significant vertical oscillations.
    - **Expected Outcome**: The drone should be able to maintain the designated altitude within a small tolerance (±0.5 meters), adjusting for any minor wind disturbances.
6. **Lateral Movement Test (Forward, Backward, Left, Right)**
    - **Procedure**:
        - Command the drone to move forward, backward, left, and right while in hover mode.
        - Observe how well the drone maintains altitude and control during lateral movements.
    - **Expected Outcome**: The drone should be able to move in all directions while maintaining stability and altitude without drift .
7. **Power Consumption Monitoring**
    - **Procedure**:
        - Monitor the battery voltage, current, and power consumption during the flight.
        - Assess power usage during hover, maneuvers, and different throttle levels.
        - Record the battery's state of charge after a defined flight duration (e.g., 5 minutes).

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- **Expected Outcome**: Power consumption should remain within expected limits, and the battery should retain enough charge for safe landing with a reasonable margin.

8. **Landing Test**
   - **Procedure**:
     - Command the drone to descend and perform a manual or automated landing.
     - Observe the descent rate and stability during the landing phase.
   - **Expected Outcome**: The drone should descend smoothly and land gently without tipping over or experiencing hard impact.

Post-Flight Analysis

1. **Motor and Propeller Inspection**:
   - After landing, inspect the motors and propellers for any signs of wear, damage, or overheating.
2. **Flight Data Review**:
   - Review the flight logs (if available) for any anomalies in sensor readings, control inputs, or power consumption.
   - Ensure no critical warnings or errors were generated during the flight.

Flight Test 3: Switching from Quad Flight Test Mode to Cruise Mode

Objective

The purpose of this test is to evaluate the smooth and safe transition of the ATVA-1 drone from Quad mode (vertical takeoff and hovering) to Cruise mode (forward flight with wing lift). This transition is critical for the operational efficiency of the drone during mid-mission phases, such as when it switches from hovering to forward flight for long-range travel.

Test Overview

This test aims to assess the following key points during the mode switch:

1. **Stability during Transition**: Ensuring the drone remains stable and controlled while switching between flight modes.

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2. **Motor and Control Surface Performance**: Verifying that the motors and control surfaces respond correctly to the flight controller commands during the transition.
3. **Aerodynamic Behavior**: Observing the drone's aerodynamic performance when it switches from rotor-driven lift to wing-based lift.
4. **Power and Throttle Response**: Evaluating the power consumption and throttle control before, during, and after the transition.
5. **Controller Functionality**: Ensuring that the flight controller smoothly switches between Quad mode and Cruise mode without glitches.

Pre-Flight Setup

1. **Flight Area Setup**:
    - Select a large, open area for the transition test, ensuring sufficient horizontal and vertical space for safe operation.
    - Establish a safety perimeter to prevent unintended interference during the flight.
2. **System Pre-Checks**:
    - **Battery Check**: Ensure the battery is fully charged, and power reserves are adequate for extended flight operations.
    - **Motor and Propeller Inspection**: Confirm that all motors, propellers are in good condition and free from defects.
    - **Wing and Control Surface Inspection**: Check that all control surfaces (elevators, ailerons, rudder) are functional and correctly aligned.
    - **Flight Controller Configuration**: Verify that the flight controller is properly configured for mode switching (Quad to Cruise mode)
    - **GPS and Altitude Hold**: Ensure the GPS module is receiving signals from sufficient satellites and that the altitude hold function is working in Quad mode.

Test Procedure

1. **Initial Hover in Quad Mode**
    - **Procedure**:
        - Begin by performing a vertical takeoff in Quad mode and maintain a stable hover at a designated altitude .
        - Verify that the drone is stable in hover, with minimal drift or altitude variation.
    - **Expected Outcome**: The drone should hover smoothly, with stable control inputs and accurate altitude hold.
2. **Forward Transition to Cruise Mode**
    - **Procedure**:

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- Command the drone to initiate the switch from Quad mode to Cruise mode.
- This should involve the transition from rotor-driven lift (hover mode) to wing-based lift (forward flight).
- Observe the drone's behavior during the transition, focusing on:
  - **Motor behavior**: observe the smoothness of the motor as they rotate.
  - **Control surface activation**: Ensure that the control surfaces (ailerons, elevators) become active to control forward flight.

- **Expected Outcome**: The drone should transition smoothly, with the motor cruise forward or powering down appropriately, and the wings should start generating lift without a sudden drop in altitude or erratic movements.

3. **Stability During Cruise Mode**
   - **Procedure**:
     - Once in Cruise mode, observe how the drone handles forward flight. Maintain a steady altitude and speed.
     - Test manual control inputs to check the responsiveness of the ailerons, elevators, and rudder.
   - **Expected Outcome**: The drone should fly smoothly, maintaining stability and responding correctly to manual input for pitch, roll, and yaw.
4. **Power and Throttle Management**
   - **Procedure**:
     - Monitor the throttle and power consumption throughout the transition.
     - Ensure the power draw is appropriate for each mode—higher power consumption during the Quad mode (hover) and a reduction in power as the drone transitions to Cruise mode (due to wing lift).
   - **Expected Outcome**: The power consumption should shift appropriately. Hover mode generally requires more power, while Cruise mode should show a decrease in power demand as aerodynamic lift assists the motors.
5. **Emergency Reversion Test (Optional)**
   - **Procedure**:
     - While in Cruise mode, simulate an emergency scenario requiring a reversion to Quad mode (e.g., for landing or a controlled hover).
     - Command the flight controller to switch back to Quad mode and observe the drone's response.

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- **Expected Outcome**: The drone should smoothly revert to Quad mode without sudden altitude loss or erratic behavior. The VTOL motors should turn on and regain control in vertical flight mode.

6. **Landing in Quad Mode**
   - **Procedure**:
     - After successfully completing the Cruise mode flight, switch back to Quad mode for landing.
     - Ensure the transition back to hover is smooth, and command a controlled descent for landing.
   - **Expected Outcome**: The drone should transition back to Quad mode with ease and perform a controlled descent and gentle landing without significant drift or instability.

Post-Flight Analysis

1. **Motor and Control Surface Inspection**:
   - After landing, inspect the motors, propellers, and control surfaces for any signs of wear, damage, or overheating due to the mode switch.
2. **Flight Data Review**:
   - Review the flight logs and data collected during the transition, power consumption, throttle responses, and control surface movements.
   - Check for any anomalies or unexpected behavior during the transition phase.
3. **Document Findings**:
   - Compile the results of the transition test into a report, detailing the stability, control, power management, and overall performance of the drone during the Quad to Cruise mode switch.

Flight Test 4: VTOL to Cruise Transition Towards Left

Objective : The purpose of this test is to evaluate the drone's ability to transition from VTOL mode to fixed-wing cruise flight while executing a leftward trajectory. This transition is crucial for smooth and stable flight performance in missions requiring efficient forward flight after vertical takeoff.

Test Overview : This test will assess the following aspects:

- **Transition Stability:** Ensuring a smooth transition from VTOL to cruise mode without loss of control.

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- **Yaw and Roll Coordination:** Verifying that yaw and roll inputs are well-coordinated for a controlled leftward transition.
- **Altitude and Speed Management:** Monitoring altitude hold and acceleration during the transition.
- **Power Management:** Checking power consumption efficiency during the transition.

Pre-Flight Setup

Flight Area Setup:

- Select an open, obstacle-free area for a safe transition.
- Establish a designated transition path using GPS waypoints.

System Pre-Checks:

- **Battery Check:** Ensure the battery is fully charged and capable of sustaining the transition and cruise flight.
- **Motor and Propeller Inspection:** Confirm all motors and propellers are functioning properly.
- **GPS Lock:** Verify that the GPS module has a strong signal (minimum of 6 satellites).
- **Transition Mode Configuration:** Ensure the flight controller is properly configured for smooth VTOL to cruise transition.

Test Procedure

Initial Hover in VTOL Mode

1. Take off in VTOL mode and ascend to a safe altitude.
2. Engage position hold to verify stable hovering.
3. Observe the drone’s ability to hold position and altitude accurately.

Executing the Leftward Transition

1. Initiate the transition by commanding the drone to begin a gradual roll to the left while increasing forward thrust.
2. Monitor the drone’s pitch and roll behavior to ensure smooth transition.
3. Verify that the rear motors reduce thrust gradually while the forward propulsion system takes over.
4. Ensure that the aircraft follows the designated leftward path while maintaining altitude and accelerating to cruise speed.

Yaw and Roll Coordination Check

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1. Observe how yaw and roll inputs influence the transition to cruise mode.
2. Apply minor manual yaw and roll adjustments to verify response stability.
3. Ensure there are no abrupt attitude changes that could destabilize the aircraft.

Altitude and Speed Management

1. Monitor altitude and ensure it remains within the expected transition envelope.
2. Check airspeed readings to confirm the drone achieves sufficient forward velocity for sustained cruise flight.

Power Consumption Monitoring

1. Track power consumption during the transition phase.
2. Ensure power usage remains within acceptable limits for a stable transition.

Manual Override and Emergency Stop (Optional)

1. Test manual override by switching back to VTOL mode mid-transition.
2. Observe the aircraft's response to ensure a safe reversion to hover.

Landing

1. After completing the transition test, command the drone to return to hover mode.
2. Perform a controlled descent and land safely.

Post-Flight Analysis

- Inspect motors and propellers for wear or overheating.
- Review flight logs for altitude, airspeed, yaw/roll coordination, and power data.
- Identify any anomalies in the transition process.

Flight Test 5: VTOL to Cruise Transition Towards Right

Objective : The goal of this test is to evaluate the drone's ability to transition from VTOL mode to fixed-wing cruise flight while executing a rightward trajectory. This ensures operational reliability for mission-critical applications requiring controlled transitions.

Test Overview This test will evaluate:

- **Transition Stability:** Assessing smooth and stable conversion from VTOL to cruise.
- **Yaw and Roll Coordination:** Ensuring effective control during the rightward transition.
- **Altitude and Speed Management:** Monitoring altitude retention and speed gain.

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- **Power Efficiency:** Evaluating energy consumption throughout the transition.

Pre-Flight Setup

Flight Area Setup:

- Select an open space with a pre-planned rightward transition path.
- Set GPS waypoints for controlled navigation.

System Pre-Checks:

- **Battery Check:** Verify sufficient charge for transition and cruise phases.
- **Motor and Propeller Inspection:** Ensure all propulsion systems are functioning properly.
- **GPS Lock:** Confirm stable GPS reception.
- **Transition Mode Configuration:** Validate correct flight controller settings for transitioning.

Test Procedure

Initial Hover in VTOL Mode

1. Take off in VTOL mode and ascend to a predetermined altitude.
2. Activate position hold and confirm stability in hover mode.

Executing the Rightward Transition

1. Command the drone to gradually roll to the right while increasing forward thrust.
2. Observe the drone's pitch, roll, and yaw adjustments.
3. Verify that the rear motors reduce thrust smoothly while the forward propulsion takes over.
4. Ensure the aircraft follows the designated rightward transition path.

Yaw and Roll Coordination Check

1. Evaluate how yaw and roll inputs impact the transition.
2. Apply manual yaw/roll adjustments and assess response stability.

Altitude and Speed Management

1. Monitor altitude retention throughout the transition.
2. Ensure the drone gains sufficient speed for fixed-wing cruise flight.

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Power Consumption Monitoring

1. Track power usage for efficiency analysis.
2. Ensure power consumption remains stable.

Manual Override and Emergency Stop (Optional)

1. Test ability to revert to VTOL mode mid-transition.
2. Assess response smoothness.

Landing

1. Command the drone to return to hover mode.
2. Initiate controlled descent and land safely.

Post-Flight Analysis

- Inspect hardware components.
- Analyze flight logs for performance metrics.
- Identify any irregularities during the rightward transition.

Flight Test 6: Incrementing the payload weight

Objective

The goal of this test is to evaluate the ATVA-1 drone's performance under incremental payload conditions, simulating various mission scenarios. The test aims to measure the drone's stability, power consumption, and control response as the payload increases from 0.5 kg to 2 kg, in steps of 0.5 kg. Each payload increment will be assessed for how it impacts the drone's flight dynamics, battery efficiency, and motor performance.

Test Overview

This test will involve gradually increasing the payload weight, allowing for real-time evaluation of the drone's ability to handle additional loads. Key performance indicators will be:

1. **Lift and Stability**: Ensuring the drone can take off, hover, and maintain stable flight at each payload increment.

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2. **Motor Performance**: Monitoring motor output and power efficiency at increasing payload levels.
3. **Battery Drain**: Assessing battery consumption at each step to determine the drone's endurance under various load conditions.
4. **Control Response**: Verifying that the drone's maneuverability and response to control inputs remain consistent with the additional payload.

Pre-Flight Setup

1. **Flight Area Setup**:
    - Conduct the test in a spacious, clear area with sufficient room to handle variations in flight performance.
    - Ensure emergency landing zones are identified in case of instability at higher payload levels.
2. **System Pre-Checks**:
    - **Battery Check**: Ensure the battery is fully charged and capable of supporting the entire series of test flights with increasing payloads.
    - **Motor and Propeller Inspection**: Verify that all motors and propellers are functioning optimally for the expected increased load.
    - **Payload Setup**: Use securely mounted weights that can be incrementally increased in 0.5 kg steps. Ensure payloads are evenly distributed for balance.
    - **Flight Controller Tuning**: Check that the flight controller is properly tuned for payload compensation, ensuring stability at each payload increment.

Test Procedure

1. **Initial Test with 0.5 Kg Payload**
    - **Procedure**:
        - Attach a 0.5 kg payload to the drone.
        - Take off and ascend to a standard altitude (e.g., 10 meters).
        - Hover for at least 1 minute to assess stability.
        - Perform basic maneuvers (yaw, pitch, and roll) to evaluate control response with the initial payload.
        - Observe battery consumption and motor performance.
    - **Expected Outcome**: The drone should lift off smoothly, maintain stable hover, and execute maneuvers without any loss of control or excessive battery drain.
2. **Increment Payload to 1 Kg**
    - **Procedure**:

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        - After safely landing, increase the payload to 1 kg.
        - Repeat the same process of takeoff, hover, and basic maneuverability checks.
        - Pay close attention to any changes in motor strain, control responsiveness, or power usage.
    - **Expected Outcome**: The drone should handle the additional weight without significant changes in flight behavior. Any minor adjustments in control response should remain within acceptable limits.
3. **Increment Payload to 1.5 Kg**
    - **Procedure**:
        - Increase the payload to 1.5 kg and repeat the flight procedure, monitoring stability, motor output, and control accuracy.
        - Perform a hover test and maneuverability checks.
        - Track battery consumption during this phase to understand how the increasing load affects endurance.
    - **Expected Outcome**: The drone should still maintain acceptable levels of control and stability, although slight increases in motor output and battery drain may be observed.
4. **Increment Payload to 2 Kg**
    - **Procedure**:
        - Increase the payload to 2 kg, the maximum payload for this test.
        - Perform the same takeoff, hover, and maneuverability checks, with special attention to any signs of motor overload or reduced flight stability.
        - Monitor battery levels closely to ensure there is sufficient power for a safe return to base.
    - **Expected Outcome**: The drone should handle the maximum payload without significant instability. There may be some increase in motor noise or heat, and battery consumption will likely be higher, but the drone should remain controllable and able to land safely.
5. **Monitoring Flight Dynamics**
    - **Procedure**:
        - Throughout each increment, assess the drone's ability to maintain level flight, handle wind disturbances, and recover from minor control adjustments.
        - Ensure that altitude control remains steady and that there is no unintended descent or drift during hovering.
    - **Expected Outcome**: The drone should remain stable under all payload conditions, with control responses adjusted to account for the added weight. Flight dynamics should remain predictable and smooth.

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6. **Power Consumption and Battery Analysis**
    - **Procedure**:
        - At each payload increment, record battery drain rates to analyze the drone's endurance under different load conditions.
        - Check for any significant differences in power efficiency as the payload increases.
    - **Expected Outcome**: Battery consumption will increase with added weight, but power usage should remain within expected limits. The drone should still have enough battery capacity to safely complete the flight with each payload.
7. **Landing and Post-Flight Inspection**
    - **Procedure**:
        - After each flight, land the drone safely and inspect motors, propellers, and payload mounts for signs of wear or strain.
        - Conduct a post-flight analysis of the motor temperature and overall system performance.
    - **Expected Outcome**: The drone should complete each flight phase without significant wear on the motors or propellers, and all components should function within safe operational limits.

Post-Flight Analysis

1. **Motor and Propeller Inspection**:
    - After each flight, inspect the motors and propellers to check for overheating, wear, or performance degradation under increasing loads.
2. **Flight Data Review**:
    - Review flight logs, focusing on battery consumption, motor output, control response, and stability under each payload condition.
    - Assess if the drone can maintain its expected endurance and stability under varying payloads.

Flight Test 7 : Endurance Tests with critical components not being replaced

Objective

The purpose of this test is to evaluate the ATVA-1 drone's endurance performance using its original critical components (motors, ESCs, batteries, and flight controller) without any

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replacements. The goal is to assess how long the drone can maintain safe flight operations under standard conditions, measuring battery life, motor efficiency, and overall system performance during extended flight periods.

Test Overview

This endurance test will focus on how the drone performs over a longer flight duration, monitoring key aspects such as:

1. **Battery Life**: How efficiently the drone uses battery power and how long it can sustain flight.
2. **Motor and Propeller Performance**: Ensuring motors and propellers can maintain performance throughout the entire test without overheating or wearing out.
3. **Flight Controller Stability**: Verifying that the flight controller and sensors maintain stability over the course of the flight.
4. **Thermal Management**: Monitoring critical components for heat management, especially under extended load.

Pre-Flight Setup

1. **System Pre-Checks**:
    - **Battery**: Ensure the original battery is fully charged and in good condition. Record the initial voltage.
    - **Motors and Propellers**: Inspect motors and propellers to ensure they are functioning correctly and capable of extended operation.
    - **Flight Controller Calibration**: Confirm that all sensors (GPS, barometer, gyroscope) are calibrated and stable.
    - **Payload**: Attach a standard payload (if applicable) that reflects typical operational weight for the endurance test.
2. **Flight Area Setup**:
    - Choose an open, safe environment for extended flight, free from obstacles or interference.
    - Ensure emergency landing zones are clearly identified in case of component failure during the endurance test.

Test Procedure

1. **Takeoff and Hover**
    - **Procedure**:
        - Take off and ascend to a pre-defined altitude (e.g., 10 meters).

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        - Hold the drone in a stable hover for a set duration (e.g., 5 minutes).
    - **Expected Outcome**: The drone should lift off smoothly and hover without noticeable drift or instability, with battery consumption remaining within expected parameters.
2. **Extended Forward Flight**
    - **Procedure**:
        - After hovering, initiate forward flight in a predetermined pattern (e.g., figure-eight or straight-line path) to simulate real-world operational flight.
        - Continue flying for an extended period while monitoring battery voltage, motor output, and control stability.
    - **Expected Outcome**: The drone should maintain stable forward flight with consistent control responsiveness. Battery consumption should be proportional to the flight time, with no signs of power loss or instability.
3. **Monitoring Critical Components**
    - **Procedure**:
        - Throughout the test, monitor the temperatures of the motors, ESCs, and battery to ensure they remain within safe operating limits.
        - Observe motor performance for any signs of wear, reduced output, or unusual noise, especially during longer segments of continuous flight.
    - **Expected Outcome**: All components should maintain stable performance, with temperatures staying within acceptable ranges. Motors and ESCs should not show signs of overloading or overheating.
4. **Power Consumption Analysis**
    - **Procedure**:
        - During the endurance flight, continuously track the battery voltage and overall power consumption.
        - Calculate estimated remaining flight time based on the current power draw.
    - **Expected Outcome**: The battery should deplete at a steady rate, with sufficient power left for safe landing at the end of the test. Power consumption should remain within expected limits for the duration of the flight.
5. **Altitude and Position Hold**
    - **Procedure**:
        - Periodically engage loiter or position hold mode to check how well the drone maintains altitude and position during prolonged flight.

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        - Evaluate GPS stability and altitude control during these hold periods.
    - **Expected Outcome**: The drone should maintain its altitude and position accurately, with minimal drift or fluctuations over time, demonstrating stability in flight control.
6. **Final Approach and Landing**
    - **Procedure**:
        - As the battery reaches a predefined low-voltage threshold, initiate a return-to-home (RTL) or manual landing.
        - Ensure a controlled descent and safe landing with remaining battery capacity.
    - **Expected Outcome**: The drone should return and land safely without any power loss or component failure during the final descent.

Post-Flight Analysis

1. **Battery and Power Review**:
    - After landing, record the remaining battery voltage and flight time. Compare the actual endurance with expected values.
    - Inspect the battery for any signs of excessive heat or damage caused by extended use.
2. **Motor and Component Inspection**:
    - Conduct a thorough inspection of the motors, ESCs, and propellers for wear, overheating, or signs of reduced performance.
    - Review the performance logs from the flight controller to check for any anomalies or unexpected deviations during the flight.
3. **Flight Data Review**:
    - Analyze the flight logs to assess overall system stability, power consumption, and component performance over the extended flight duration.
    - Compare the recorded data with baseline values from previous tests to ensure consistency in performance with original critical components.

Flight Test 8: Endurance Tests in case the critical components are replaced

Objective

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The goal of this test is to evaluate the endurance and operational performance of the ATVA-1 drone after replacing two critical components: the GPS module and the Pixhawk flight controller. The test will assess how well these replacements integrate with the overall system and ensure the drone can maintain extended, stable flight while operating efficiently.

Test Overview

The test will focus on verifying:

1. **System Integration**: Ensuring that the new GPS and Pixhawk communicate effectively with other components.
2. **GPS Performance**: Verifying GPS signal strength, accuracy, and stability, especially during extended flight.
3. **Flight Controller Stability**: Evaluating how the new Pixhawk performs in terms of sensor calibration, flight control, and overall system reliability.
4. **Battery and Power Efficiency**: Monitoring battery drain to ensure the new components do not increase power consumption.
5. **Flight Dynamics**: Assessing the drone's ability to maintain stable and consistent flight for an extended period.

Pre-Flight Setup

1. **System Pre-Checks**:
    - **New GPS Module**: Ensure the GPS is securely mounted, correctly wired, and has a clear line of sight to satellites.
    - **Pixhawk Installation**: Confirm that the new Pixhawk is properly installed, calibrated, and connected to all necessary systems, including ESCs, sensors, and the RC system.
    - **Flight Controller Calibration**: Conduct a thorough calibration of the IMU, compass, accelerometer, and other sensors associated with the new Pixhawk.
    - **Battery Check**: Make sure the battery is fully charged and able to support the entire endurance test.
2. **Flight Area Setup**:
    - Choose a clear, open area free from obstructions, where GPS signal strength will be consistent and uninterrupted.
    - Designate emergency landing zones in case of instability or component failure during the test.

Test Procedure

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1. **Takeoff and Initial Hover**
    - **Procedure**:
        - After ensuring GPS lock and flight controller readiness, take off and ascend to a predetermined altitude (e.g., 10 meters).
        - Hover for at least 2 minutes to assess system stability and GPS signal integrity.
    - **Expected Outcome**: The drone should lift off smoothly, maintain a stable hover, and hold its position with the GPS showing strong signal and accurate positioning. The flight controller should manage the drone's stability without drift or irregular movements.
2. **Extended Forward Flight**
    - **Procedure**:
        - Initiate forward flight in a predefined pattern (such as straight-line or figure-eight) to evaluate the drone's endurance and control with the new components.
        - Monitor GPS accuracy and how the new Pixhawk manages flight dynamics over extended periods.
    - **Expected Outcome**: The drone should maintain smooth and stable forward flight, with no GPS signal loss or flight control issues. The Pixhawk should handle maneuvers efficiently without signs of system strain.
3. **GPS Performance and Position Hold**
    - **Procedure**:
        - Periodically engage the position hold or loiter mode to assess the new GPS module's ability to lock the drone's position accurately.
        - Track the stability of the drone's location while in loiter, ensuring there's no significant drift or position loss.
    - **Expected Outcome**: The drone should maintain its position accurately with minimal deviation, showing that the GPS signal is strong and the new module is functioning as intended.
4. **Monitoring Power Consumption and Component Temperatures**
    - **Procedure**:
        - Continuously monitor battery voltage, Pixhawk performance, and motor output during the endurance test.
        - Pay attention to the power consumption rates and check if the new components affect the overall energy efficiency.
    - **Expected Outcome**: Battery consumption should remain consistent with standard endurance values, and there should be no signs of increased power draw from the new GPS or Pixhawk. All components should remain within safe operating temperatures.

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5. **Altitude and Stability Control**
    - **Procedure**:
        - Engage various altitude control modes, such as altitude hold, to verify that the new Pixhawk is accurately managing height during extended flights.
        - Monitor sensor readings, particularly barometer and accelerometer data, to ensure altitude is maintained without significant deviation.
    - **Expected Outcome**: The drone should maintain stable altitude without oscillations, demonstrating that the new flight controller is managing the sensors and system data effectively.
6. **Final Approach and Safe Landing**
    - **Procedure**:
        - As the battery reaches a low-voltage threshold, initiate a return-to-home (RTL) or manual landing procedure.
        - Ensure that the GPS and Pixhawk coordinate correctly to guide the drone back to its starting point and land safely.
    - **Expected Outcome**: The drone should return and land smoothly, with the GPS accurately tracking its position and the flight controller managing a stable descent. There should be no significant power loss or system failures.

Post-Flight Analysis

1. **GPS and Pixhawk Performance Review**:
    - Analyze the GPS data to ensure signal strength remained consistent throughout the flight. Look for any interruptions or inconsistencies in position tracking.
    - Review Pixhawk logs to check for any flight control anomalies, sensor misalignments, or calibration issues that may have occurred during the flight.
2. **Battery and Power Usage**:
    - Record the total flight time and battery consumption, comparing these values with previous tests using the original components.
    - Ensure that the power consumption remained within expected limits and that no excessive energy was drawn by the new components.
3. **Motor and System Inspection**:
    - Inspect motors, ESCs, and other components for signs of overheating or strain caused by the new flight controller or GPS module.

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   - Ensure that the system handled the new components without overloading any parts of the drone.
4. **Flight Dynamics Analysis**:
   - Review flight data to assess how the new Pixhawk managed flight stability, maneuverability, and control response. Ensure that there were no unexplained deviations in flight performance.

Flight Test 9: Operational Envelope

Objective

The objective of this test is to evaluate the operational speed limits of the ATVA-1 drone, specifically determining the maximum and minimum sustainable speeds. The drone should consistently operate within a maximum speed of **30 m/s** and a minimum speed of **23 m/s**. This assessment will ensure that the drone can maintain safe and effective flight performance while adhering to regulatory requirements and operational guidelines.

Operational Limits Test Procedure

Test Parameters

- **Maximum Speed**: **30 m/s**
- **Minimum Speed**: **23 m/s**

Test Setup

1. **Flight Area**: Select an open flight area free from obstacles, allowing for safe acceleration and deceleration.
2. **Safety Protocols**: Establish emergency procedures and designated landing zones to ensure safety during speed testing.

Test Procedure

1. **Pre-Flight Checks**:
   - Conduct thorough pre-flight checks, including battery status, GPS calibration, and flight controller readiness.
   - Verify that all systems are functional and prepared for speed tests.
2. **Initial Hover**:

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   - Take off and hover for a few minutes to stabilize the drone and monitor sensor readings.
3. **Minimum Speed Test (23 m/s)**:
   - Gradually increase the speed of the drone until it reaches **23 m/s**.
   - Maintain this speed for a minimum duration (e.g., 5 minutes) to assess stability, control response, and overall performance.
   - Monitor all relevant data, including GPS accuracy, altitude stability, and battery usage during the test.
4. **Maximum Speed Test (30 m/s)**:
   - Gradually increase the speed from the minimum up to the **maximum speed of 30 m/s**.
   - Maintain this speed for a minimum duration (e.g., 5 minutes) while monitoring the drone's handling and performance characteristics.
   - Ensure the drone can sustain this speed without losing control or experiencing system strain.
5. **Speed Variation Test**:
   - Conduct a series of speed variations between **23 m/s** and **30 m/s** to test the drone's response to changes in speed.
   - Evaluate how quickly and smoothly the drone can accelerate and decelerate within the specified limits.
6. **Data Collection**:
   - Collect data on battery performance, GPS accuracy, and flight controller responsiveness throughout the speed tests.
   - Analyze data to determine how well the drone maintains stability and control at both operational limits.

Criteria for Success

- **Minimum Speed Test**: The drone should consistently maintain stable flight at **23 m/s** for the duration of the test without significant deviation in altitude or control issues.
- **Maximum Speed Test**: The drone should reach and sustain **30 m/s** without experiencing instability, excessive power consumption, or any other operational anomalies.
- **Speed Variation Response**: The drone must demonstrate quick and responsive handling during speed changes, maintaining stable flight and control throughout the testing process.

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Flight Test 10: **GPS Function Test for VTOL Landing**

Objective The objective of this test is to evaluate the accuracy and reliability of the GPS system during VTOL landing, ensuring that the drone can autonomously land within a defined 2-meter radius of the original takeoff point. This test is essential for precise autonomous landings in mission-critical operations.

Test Overview This test will assess the following aspects:

- **GPS Accuracy:** Ensuring the drone can navigate and land within the designated 2-meter radius.
- **Position Hold Stability:** Evaluating how well the drone maintains position before descent.
- **Descent and Landing Precision:** Checking that the landing approach is controlled and accurate.
- **Power Management:** Monitoring battery consumption during descent and landing.
- **System Redundancy:** Verifying GPS signal reliability and response to potential GPS drift.

Pre-Flight Setup

Flight Area Setup:

- Select an open, obstacle-free area with minimal GPS interference.
- Mark the takeoff center point with a visual or GPS-based reference.
- Define a 2-meter radius landing zone around the takeoff point.

System Pre-Checks:

- **Battery Check:** Ensure the battery is fully charged and sufficient for the flight duration.
- **Motor and Propeller Inspection:** Verify all motors and propellers are in optimal condition.
- **GPS Lock:** Confirm a stable GPS signal with a minimum of 6 satellites before takeoff.
- **Landing Mode Configuration:** Ensure the flight controller is configured for precision VTOL landing.

Test Procedure

Takeoff and Position Hold Verification

1. Take off in VTOL mode and ascend to a predefined altitude.
2. Engage position hold mode to verify GPS stabilization.

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3. Observe for any unwanted drift or instability in GPS-based position holding.

Navigating to the Landing Zone

1. Command the drone to initiate an autonomous return-to-home (RTH) or manual navigation to the takeoff point.
2. Monitor the drone's ability to follow the designated path and align itself with the landing zone.

Descent and Landing Execution

1. Begin a controlled descent while continuously monitoring GPS accuracy.
2. Observe whether the drone adjusts its position to remain within the 2-meter radius.
3. Ensure the descent rate remains stable, avoiding sudden drops or instability.

Landing Precision Check

1. Once landed, measure the deviation from the original takeoff point.
2. Confirm that the drone is within the designated 2-meter radius.

Power Consumption Monitoring

1. Track power usage during descent and landing.
2. Ensure the battery level remains sufficient for safe operation.

Manual Override and Emergency Stop (Optional)

1. Test the ability to manually override the landing sequence.
2. Simulate an emergency stop by switching to manual hover mode mid-descent.

Post-Flight Analysis

- Inspect motors and propellers for signs of wear or overheating.
- Review flight logs for GPS accuracy, landing deviation, and power consumption.
- Identify any anomalies such as excessive GPS drift or instability during landing.

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Flight Test 11: RSSI Values at different voltage levels

Objective

The objective of this test is to evaluate the Received Signal Strength Indicator (RSSI) values of the ATVA-1 drone at different battery voltage levels. This assessment will help determine how battery voltage affects the radio signal strength and overall communication reliability between the drone and its ground control station.

RSSI Values Test Procedure

Test Setup

1. **Flight Area**: Choose an open area with minimal interference from obstacles, ensuring clear communication between the drone and the ground station.
2. **Equipment**: Ensure the drone is equipped with a telemetry system that provides RSSI readings. Have a fully charged battery and a secondary battery to test various voltage levels.

Test Parameters

- **Voltage Levels**: Test the RSSI at different battery voltage levels, such as:
    - Fully Charged: **100%**
    - High Voltage: **75%**
    - Medium Voltage: **50%**
    - Low Voltage: **25%**
    - Critical Voltage: **10%**

Test Procedure

1. **Pre-Flight Checks**:
    - Verify that the telemetry system is operational and calibrated.
    - Ensure that the drone's battery is fully charged and that all systems are functioning properly.
2. **Initial Hover**:
    - Take off and hover the drone at a stable altitude for a few minutes to establish a baseline for RSSI readings.
    - Record the RSSI value at 100% battery voltage.
3. **Voltage Reduction Tests**:

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   - **Step 1**: Discharge the battery to approximately 75% and hover the drone. Record the RSSI value.
   - **Step 2**: Continue to discharge the battery to 50% and hover again. Record the RSSI value.
   - **Step 3**: Discharge the battery to 25% and hover once more. Record the RSSI value.
   - **Step 4**: Finally, discharge the battery to the critical voltage of 10% and record the RSSI value.
4. **Data Collection**:
   - For each voltage level, take note of environmental conditions (e.g., wind, interference) that could affect RSSI readings.
   - Record all RSSI values, noting any fluctuations or trends observed at different voltage levels.
5. **Repeatability**:
   - To ensure accuracy, consider repeating the test multiple times at each voltage level to average out any anomalies in the data.

Data Analysis

- Compile the RSSI values recorded at each battery voltage level.
- Analyze how the RSSI changes as the battery discharges, identifying any trends or patterns in signal strength relative to voltage levels.
- Evaluate whether any specific voltage levels lead to significant drops in RSSI, indicating potential issues with communication reliability.

Criteria for Success

- **Stable RSSI Values**: RSSI values should remain within acceptable ranges for reliable communication throughout the majority of the tested voltage levels.
- **Trend Identification**: Clear trends should emerge showing the relationship between battery voltage and RSSI values, allowing for predictive maintenance and operational planning.

Flight Test 12: Geo Fence

Objective

The objective of this test is to evaluate the functionality and reliability of the geo-fencing feature on the ATVA-1 drone. Geo-fencing is designed to create virtual boundaries that the drone must not cross during operation, enhancing safety and compliance with airspace

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regulations. This test will confirm that the drone adheres to the defined geo-fence parameters and responds appropriately when approaching or breaching these boundaries.

Geo-Fence Test Procedure

Test Setup

1. **Flight Area**: Select a flight area that allows for the establishment of a clearly defined geo-fence, ideally with known landmarks to aid in monitoring the boundaries.
2. **Equipment**: Ensure that the drone is equipped with a GPS module and a telemetry system that can monitor the drone's position in real-time.

Test Parameters

- **Geo-Fence Parameters**: Define the geo-fence area, specifying:
    - **Radius**: Distance from a central point (e.g., 500 meters).
    - **Coordinates**: Latitude and longitude of the geo-fence center.
    - **Height Restrictions**: Maximum altitude allowed within the geo-fenced area.

Test Procedure

1. **Pre-Flight Checks**:
    - Verify that the geo-fencing settings are correctly configured in the flight controller software.
    - Confirm that the GPS module is calibrated and provides accurate positioning data.
2. **Initial Hover**:
    - Take off and hover the drone at a stable altitude within the geo-fenced area to ensure proper functioning of the system.
3. **Geo-Fence Activation**:
    - Gradually maneuver the drone towards the defined geo-fence boundaries.
    - Monitor the drone’s behavior as it approaches the geo-fence, ensuring that the system alerts the pilot before reaching the boundary.
4. **Boundary Testing**:
    - Conduct the following scenarios:
        - **Approaching the Geo-Fence**: Fly the drone towards the boundary to test if the system provides an alert (visual or auditory) when nearing the geo-fence.

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- **Breaching the Geo-Fence**: Intentionally fly the drone beyond the geo-fence to verify that it automatically responds by:
  - Activating a return-to-home (RTL) function.
  - Stopping RTL movement in the prohibited direction.
  - Maintaining its position until commands are issued to return within the geo-fenced area.

5. **Data Collection**:
   - Record telemetry data, including GPS coordinates, altitude, and any alerts triggered during the test.
   - Document the drone's behavior when approaching and breaching the geo-fence, noting response times and effectiveness of the geo-fencing feature.

Criteria for Success

- The drone should accurately detect and respond to the geo-fence boundaries, providing appropriate alerts as it approaches the limits.
- Upon breaching the geo-fence, the drone must automatically execute the designated fail-safe actions (e.g., returning to the defined area or hovering in place) without pilot intervention.
- Data collected during the test should demonstrate consistent adherence to the defined geo-fence parameters across multiple flight attempts.

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