U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

September 21, 2015

Exemption No. 12946
Regulatory Docket No. FAA−2015−2557

Mr. Ryan Baker
Director, sUAS Flight Operations
Black and Veatch Corporation
11401 Lamar Avenue
Overland Park, KS 66211

Dear Mr. Baker:

This letter is to inform you that we have granted your request for exemption. It transmits our decision, explains its basis, and gives you the conditions and limitations of the exemption, including the date it ends.

By letter dated June 10, 2015, you petitioned the Federal Aviation Administration (FAA) on behalf of Black and Veatch Corporation (hereinafter petitioner or operator) for an exemption. The petitioner requested to operate an unmanned aircraft system (UAS) to conduct aerial photography, videography, inspections, and data collection.

See Appendix A for the petition submitted to the FAA describing the proposed operations and the regulations that the petitioner seeks an exemption.

The FAA has determined that good cause exists for not publishing a summary of the petition in the Federal Register because the requested exemption would not set a precedent, and any delay in acting on this petition would be detrimental to the petitioner.

Airworthiness Certification

The UAS proposed by the petitioner is a DJI S1000.

The petitioner requested relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*. In accordance with the statutory criteria provided in Section 333 of Public Law 112−95 in reference to 49 U.S.C. § 44704, and in consideration of the size, weight, speed, and limited operating area associated with the aircraft and its operation, the Secretary of Transportation has determined that this aircraft meets the conditions of Section 333. Therefore, the FAA finds that the requested relief from 14 CFR part 21, *Certification procedures for products and parts, Subpart H—Airworthiness Certificates*, and any associated noise certification and testing requirements of part 36, is not necessary.

The Basis for Our Decision

You have requested to use a UAS for aerial data collection[1]. The FAA has issued grants of exemption in circumstances similar in all material respects to those presented in your petition. In Grants of Exemption Nos. 11062 to Astraeus Aerial (*see* Docket No. FAA−2014−0352), 11109 to Clayco, Inc. (*see* Docket No. FAA−2014−0507), 11112 to VDOS Global, LLC (*see* Docket No. FAA−2014−0382), and 11213 to Aeryon Labs, Inc. (*see* Docket No. FAA−2014−0642), the FAA found that the enhanced safety achieved using an unmanned aircraft (UA) with the specifications described by the petitioner and carrying no passengers or crew, rather than a manned aircraft of significantly greater proportions, carrying crew in addition to flammable fuel, gives the FAA good cause to find that the UAS operation enabled by this exemption is in the public interest.

Having reviewed your reasons for requesting an exemption, I find that—

- They are similar in all material respects to relief previously requested in Grant of Exemption Nos. 11062, 11109, 11112, and 11213;
- The reasons stated by the FAA for granting Exemption Nos. 11062, 11109, 11112, and 11213 also apply to the situation you present; and
- A grant of exemption is in the public interest.

Our Decision

In consideration of the foregoing, I find that a grant of exemption is in the public interest. Therefore, pursuant to the authority contained in 49 U.S.C. 106(f), 40113, and 44701, delegated to me by the Administrator, Black and Veatch Corporation is granted an exemption from 14 CFR §§ 61.23(a) and (c), 61.101(e)(4) and (5), 61.113(a), 61.315(a), 91.7(a), 91.119(c), 91.121, 91.151(a)(1), 91.405(a), 91.407(a)(1), 91.409(a)(1) and (2), and 91.417(a)

[1] Aerial data collection includes any remote sensing and measuring by an instrument(s) aboard the UA. Examples include imagery (photography, video, infrared, etc.), electronic measurement (precision surveying, RF analysis, etc.), chemical measurement (particulate measurement, etc.), or any other gathering of data by instruments aboard the UA.

and (b), to the extent necessary to allow the petitioner to operate a UAS to perform aerial data collection. This exemption is subject to the conditions and limitations listed below.

Conditions and Limitations

In this grant of exemption, Black and Veatch Corporation is hereafter referred to as the operator.

Failure to comply with any of the conditions and limitations of this grant of exemption will be grounds for the immediate suspension or rescission of this exemption.

1. Operations authorized by this grant of exemption are limited to the DJI S100 when weighing less than 55 pounds including payload. Proposed operations of any other aircraft will require a new petition or a petition to amend this exemption.

2. Operations for the purpose of closed-set motion picture and television filming are not permitted.

3. The UA may not be operated at a speed exceeding 87 knots (100 miles per hour). The exemption holder may use either groundspeed or calibrated airspeed to determine compliance with the 87 knot speed restriction. In no case will the UA be operated at airspeeds greater than the maximum UA operating airspeed recommended by the aircraft manufacturer.

4. The UA must be operated at an altitude of no more than 400 feet above ground level (AGL). Altitude must be reported in feet AGL.

5. The UA must be operated within visual line of sight (VLOS) of the PIC at all times. This requires the PIC to be able to use human vision unaided by any device other than corrective lenses, as specified on the PIC's FAA-issued airman medical certificate or U.S. driver's license.

6. All operations must utilize a visual observer (VO). The UA must be operated within the visual line of sight (VLOS) of the PIC and VO at all times. The VO may be used to satisfy the VLOS requirement as long as the PIC always maintains VLOS capability. The VO and PIC must be able to communicate verbally at all times; electronic messaging or texting is not permitted during flight operations. The PIC must be designated before the flight and cannot transfer his or her designation for the duration of the flight. The PIC must ensure that the VO can perform the duties required of the VO.

7. This exemption and all documents needed to operate the UAS and conduct its operations in accordance with the conditions and limitations stated in this grant of exemption, are hereinafter referred to as the operating documents. The operating

documents must be accessible during UAS operations and made available to the Administrator upon request. If a discrepancy exists between the conditions and limitations in this exemption and the procedures outlined in the operating documents, the conditions and limitations herein take precedence and must be followed. Otherwise, the operator must follow the procedures as outlined in its operating documents. The operator may update or revise its operating documents. It is the operator's responsibility to track such revisions and present updated and revised documents to the Administrator or any law enforcement official upon request. The operator must also present updated and revised documents if it petitions for extension or amendment to this grant of exemption. If the operator determines that any update or revision would affect the basis upon which the FAA granted this exemption, then the operator must petition for an amendment to its grant of exemption. The FAA's UAS Integration Office (AFS−80) may be contacted if questions arise regarding updates or revisions to the operating documents.

8. Any UAS that has undergone maintenance or alterations that affect the UAS operation or flight characteristics, e.g., replacement of a flight critical component, must undergo a functional test flight prior to conducting further operations under this exemption. Functional test flights may only be conducted by a PIC with a VO and must remain at least 500 feet from other people. The functional test flight must be conducted in such a manner so as to not pose an undue hazard to persons and property.

9. The operator is responsible for maintaining and inspecting the UAS to ensure that it is in a condition for safe operation.

10. Prior to each flight, the PIC must conduct a pre-flight inspection and determine the UAS is in a condition for safe flight. The pre-flight inspection must account for all potential discrepancies, e.g., inoperable components, items, or equipment. If the inspection reveals a condition that affects the safe operation of the UAS, the aircraft is prohibited from operating until the necessary maintenance has been performed and the UAS is found to be in a condition for safe flight.

11. The operator must follow the UAS manufacturer's maintenance, overhaul, replacement, inspection, and life limit requirements for the aircraft and aircraft components.

12. Each UAS operated under this exemption must comply with all manufacturer safety bulletins.

13. Under this grant of exemption, a PIC must hold either an airline transport, commercial, private, recreational, or sport pilot certificate. The PIC must also hold a current FAA airman medical certificate or a valid U.S. driver's license issued by a state, the District of Columbia, Puerto Rico, a territory, a possession, or the Federal

government. The PIC must also meet the flight review requirements specified in 14 CFR § 61.56 in an aircraft in which the PIC is rated on his or her pilot certificate.

14. The operator may not permit any PIC to operate unless the PIC demonstrates the ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption, including evasive and emergency maneuvers and maintaining appropriate distances from persons, vessels, vehicles and structures. PIC qualification flight hours and currency must be logged in a manner consistent with 14 CFR § 61.51(b). Flights for the purposes of training the operator's PICs and VOs (training, proficiency, and experience-building) and determining the PIC's ability to safely operate the UAS in a manner consistent with how the UAS will be operated under this exemption are permitted under the terms of this exemption. However, training operations may only be conducted during dedicated training sessions. During training, proficiency, and experience-building flights, all persons not essential for flight operations are considered nonparticipants, and the PIC must operate the UA with appropriate distance from nonparticipants in accordance with 14 CFR § 91.119.

15. UAS operations may not be conducted during night, as defined in 14 CFR § 1.1. All operations must be conducted under visual meteorological conditions (VMC). Flights under special visual flight rules (SVFR) are not authorized.

16. The UA may not operate within 5 nautical miles of an airport reference point (ARP) as denoted in the current FAA Airport/Facility Directory (AFD) or for airports not denoted with an ARP, the center of the airport symbol as denoted on the current FAA-published aeronautical chart, unless a letter of agreement with that airport's management is obtained or otherwise permitted by a COA issued to the exemption holder. The letter of agreement with the airport management must be made available to the Administrator or any law enforcement official upon request.

17. The UA may not be operated less than 500 feet below or less than 2,000 feet horizontally from a cloud or when visibility is less than 3 statute miles from the PIC.

18. If the UAS loses communications or loses its GPS signal, the UA must return to a pre-determined location within the private or controlled-access property.

19. The PIC must abort the flight in the event of unpredicted obstacles or emergencies.

20. The PIC is prohibited from beginning a flight unless (considering wind and forecast weather conditions) there is enough available power for the UA to conduct the intended operation and to operate after that for at least five minutes or with the reserve power recommended by the manufacturer if greater.

21. Air Traffic Organization (ATO) Certificate of Waiver or Authorization (COA). All operations shall be conducted in accordance with an ATO-issued COA. The

exemption holder may apply for a new or amended COA if it intends to conduct operations that cannot be conducted under the terms of the attached COA.

22. All aircraft operated in accordance with this exemption must be identified by serial number, registered in accordance with 14 CFR part 47, and have identification (N−Number) markings in accordance with 14 CFR part 45, Subpart C. Markings must be as large as practicable.

23. Documents used by the operator to ensure the safe operation and flight of the UAS and any documents required under 14 CFR §§ 91.9 and 91.203 must be available to the PIC at the Ground Control Station of the UAS any time the aircraft is operating. These documents must be made available to the Administrator or any law enforcement official upon request.

24. The UA must remain clear and give way to all manned aviation operations and activities at all times.

25. The UAS may not be operated by the PIC from any moving device or vehicle.

26. All Flight operations must be conducted at least 500 feet from all nonparticipating persons, vessels, vehicles, and structures unless:
    a. Barriers or structures are present that sufficiently protect nonparticipating persons from the UA and/or debris in the event of an accident. The operator must ensure that nonparticipating persons remain under such protection. If a situation arises where nonparticipating persons leave such protection and are within 500 feet of the UA, flight operations must cease immediately in a manner ensuring the safety of nonparticipating persons; and
    b. The owner/controller of any vessels, vehicles or structures has granted permission for operating closer to those objects and the PIC has made a safety assessment of the risk of operating closer to those objects and determined that it does not present an undue hazard.

    The PIC, VO, operator trainees or essential persons are not considered nonparticipating persons under this exemption.

27. All operations shall be conducted over private or controlled-access property with permission from the property owner/controller or authorized representative. Permission from property owner/controller or authorized representative will be obtained for each flight to be conducted.

28. Any incident, accident, or flight operation that transgresses the lateral or vertical boundaries of the operational area as defined by the applicable COA must be reported to the FAA's UAS Integration Office (AFS−80) within 24 hours. Accidents must be

reported to the National Transportation Safety Board (NTSB) per instructions contained on the NTSB Web site: www.ntsb.gov.

If this exemption permits operations for the purpose of closed-set motion picture and television filming and production, the following additional conditions and limitations apply.

29. The operator must have a motion picture and television operations manual (MPTOM) as documented in this grant of exemption.

30. At least 3 days before aerial filming, the operator of the UAS affected by this exemption must submit a written Plan of Activities to the local Flight Standards District Office (FSDO) with jurisdiction over the area of proposed filming. The 3-day notification may be waived with the concurrence of the FSDO. The plan of activities must include at least the following:
    a. Dates and times for all flights;
    b. Name and phone number of the operator for the UAS aerial filming conducted under this grant of exemption;
    c. Name and phone number of the person responsible for the on-scene operation of the UAS;
    d. Make, model, and serial or N−Number of UAS to be used;
    e. Name and certificate number of UAS PICs involved in the aerial filming;
    f. A statement that the operator has obtained permission from property owners and/or local officials to conduct the filming production event; the list of those who gave permission must be made available to the inspector upon request;
    g. Signature of exemption holder or representative; and
    h. A description of the flight activity, including maps or diagrams of any area, city, town, county, and/or state over which filming will be conducted and the altitudes essential to accomplish the operation.

31. Flight operations may be conducted closer than 500 feet from participating persons consenting to be involved and necessary for the filming production, as specified in the exemption holder's MPTOM.

Unless otherwise specified in this grant of exemption, the UAS, the UAS PIC, and the UAS operations must comply with all applicable parts of 14 CFR including, but not limited to, parts 45, 47, 61, and 91.

This exemption terminates on September 30, 2017, unless sooner superseded or rescinded.

Sincerely,

/s/
John S. Duncan
Director, Flight Standards Service

Enclosures

BLACK & VEATCH
Building a world of difference.

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June 10, 2015

U.S. Department of Transportation, Docket Operations
West Building Ground Floor, Room W12-140
1200 New Jersey Ave, SE
Washington, DC 20590

Re: *Petition of Black & Veatch Corporation for an Exemption Pursuant to Section 333 of the FAA Modernization and Reform Act of 2012 to Operate an Small Unmanned Aircraft System.*

Dear Sir or Madam:

Pursuant to Section 333 of the FAA Modernization and Reform Act of 2012 (the Reform Act) and 14 C.F.R. Part 11, Black & Veatch Corporation (Black & Veatch) a global engineering, consulting, and construction company, hereby applies for an exemption from the listed Federal Aviation Regulations (FARs) to allow commercial operation of small unmanned aerial systems (sUAS), for aerial imaging for safety and monitoring of secured and controlled project sites, so long as such operations are conducted within and under the conditions outlined herein or as may be established by the FAA as required by Section 333.

This exemption is in accordance with protocols outlined in this petition for exemption and incorporates the material contained in the following:

- Appendix A: Black & Veatch sUAS Operation, Inspections, and Maintenance Manual
- Appendix B: Black & Veatch sUAS Pilot Operating Handbook
- Appendix C: Black & Veatch sUAS Training Manual
- Appendix D: DJI S1000 User Manual
- Appendix E: A2 Flight Control System User Manual

The Appendices are submitted as confidential under 14 C.F.R. § 11.35(b), because they contain commercial and proprietary information that Black & Veatch has not and will not share with others, is not available to the public, and is protected from release under the Freedom of Information Act, 5 U.S.C. § 552 et seq.

As described more fully below, the requested exemption would permit the operation of sUAS under controlled conditions in airspace that is 1) limited 2) predetermined 3) controlled as to access and 4) would provide safety enhancements to the already best practices safety protocols followed by Black & Veatch. Approval of this exemption would therefore create no safety concerns regarding national airspace and would fulfill the Secretary of Transportation's (the FAA Administrator's) responsibilities to "...establish requirements for the safe operation of such aircraft systems in the national airspace system." Section 333(c) of the Reform Act.

The contact information for the applicant is as follows:

Black & Veatch Corporation
Attn: Ryan Baker
Email: bakerrl2@bv.com
11401 Lamar Avenue
Overland Park, KS 66211
(913) 458-7823

Regulations from which the exemption is requested:

14 CFR Part 21 Subpart H
14 CFR 91.203(a)(1)
14 CFR Part 27
14 CFR 45.23(b)
14 CFR 61.113(a)&(b)
14 CFR 91.7(a)
14 CFR 91.9(b)(2)
14 CFR 91.103
14 CFR 91.109(a)
14 CFR 91.119
14 CFR 91.121
14 CFR 91.151(a)
14 CFR 91.203(a) & (b)
14 CFR 91.405(a)
14 CFR 91.407(a)(1)
14 CFR 91.409(a)(2)
14 CFR 91.417(a) & (b)

STATUTORY AUTHORITY FOR EXEMPTIONS

The Federal Aviation Act expressly grants the FAA the authority to issue exemptions. This statutory authority by its terms includes exempting civil aircraft, as the term is defined under §40101 of the Act, that includes sUASs, from the requirement that all civil aircraft must have a current airworthiness certificate.

The Administrator may grant an exemption from a requirement of a regulation prescribed under subsection (a) or (b) of this section or any sections 44702-44716 of this title if the Administrator finds the exemption in the public interest. 49 U.S.C. §44701(f) *See also* 49 USC §44711(a); 49 USC §44704; 14 CFR §91.203 (a) (1).

Section 333(b) of the Reform Act assists the Secretary in determining whether sUAS may operate in the National Airspace System (NAS) without creating a hazard to the user, the public, or a threat to national security. In making this determination, the Secretary must consider:

- The sUAS's size, weight, speed, and operational capability;
- Operation of the sUAS in close proximity to airports and populated areas; and
- Operation of the sUAS within visual line of sight of the operator.

Reform Act § 333 (a). Lastly, if the Secretary determines that such vehicles "may operate safely in the national airspace system, the Secretary shall establish requirements for the safe operation of such aircraft in the national airspace system." Black & Veatch interprets this provision to place the duty on the Administrator to not only process applications for exemptions under Section 333, but for the Administrator to craft conditions for the safe operation of the sUAS, if it should be determined that the conditions set forth herein do not fulfill the statutory requirements for approval.

Black & Veatch's sUAS is a multirotor vehicle, weighing 55 or fewer lbs. including payload. The sUAS operates, under normal conditions, at a speed of no more than 50 knots and has the capability to hover, and move in the vertical and horizontal plane simultaneously. The sUAS will operate only in the Pilot's visual line of sight at all times and will operate only within the sterile area described in the Appendices. Such operations will insure that the sUAS will "not create a hazard to users of the national airspace system or the public."

Given the small size of the sUAS and the restricted and sterile environment within which it will operate, Black & Veatch falls squarely within that zone of safety (an equivalent level of safety) in which Congress envisioned that the FAA must, by exemption, allow commercial operations of sUAS to commence immediately. Also due to the small size of the sUASs and the low altitudes and restricted areas in which the sUAS will operate, approval of the application presents no national security issue.

Given the clear direction in Section 333 of the Reform Act, the authority contained in the Federal Aviation Act, as amended; the strong equivalent level of safety surrounding the proposed operations, and the significant public benefit, including enhanced safety, the grant of the requested exemption is in the public interest. Accordingly, Black & Veatch respectfully requests that the FAA grant the requested exemption without delay.

PUBLIC INTEREST

This exemption application is expressly submitted to fulfill Congress' goal in passing Section 333(a) through (c) of the Reform Act. This law directs the Secretary of Transportation to consider whether certain unmanned aircraft systems may operate safely in the NAS before completion of the rulemaking required under Section 332 of the Reform Act. By granting an exemption the FAA will fulfill Congress's intent of allowing UAS to operate with significant safety precautions in low risk environments.

The use of sUAS on Black & Veatch project sites can significantly reduce the risk to workers of falls while inspecting, surveying, or monitoring site construction progress. sUAS can inspect, photograph, and collect data in hard to reach areas that otherwise would require worker inspection. Falls are a leading source of workplace fatality and injury (www.osha.gov). With

the use of the proposed sUAS Black & Veatch could minimize the need to expose it's professionals to high fall risk activities, which in turn could save lives.

Additionally, sUAS could replace the use of helicopters and small aircraft to monitor sites. The sUAS Black & Veatch proposes to fly in this application is less than 55 lbs. and carries no combustible material on board, as opposed to the much larger conventionally powered small aircraft. Shifting to sUAS from helicopters presents a marked safety increase for our workers and the public.

Lastly, sUAS reduce the environmental impact by dramatically decreasing the energy used for aerial imaging and data collection over a project site. The proposed sUAS uses rechargeable lithium ion batteries, as opposed to fossil fuels burned in operation of much heavier small aircraft.

EQUIVALENT LEVEL OF SAFETY

Black & Veatch proposes that the exemption requested herein apply to sUAS that have the characteristics and that operate with the limitations listed herein. These limitations provide for an exceptional level of safety to operations. These limitations and conditions to which Black & Veatch agrees to be bound when conducting commercial operations under an FAA issued exemption include:

1. The sUAS will weigh less than 55 lbs.
2. Flights will be operated within line of sight of Pilot in Command or Visual Observer.
3. Maximum total flight time for each operational flight will be 20 minutes. Flights will be terminated at 20% battery power reserve should that occur prior to the 20 minute limit.
4. Flights will normally be operated at an altitude below 200 feet AGL, never exceeding 400 feet AGL
5. The sUAS pilot will be trained and certified in the proper safety and operations of the sUAS.
6. The sUAS will only operate within a controlled area as defined in the Appendices.
7. The sUAS pilot will post advisory notices where people are located around the controlled area.
8. A briefing will be conducted in regard to the planned sUAS operations prior to each day's production activities. It will be mandatory that all personnel who will be performing duties within the boundaries of the safety perimeter be present for this briefing.
9. All onsite personnel will consent to the sUAS flyover by waiver, and the operator will obtain additional verbal or written consent of all persons who will be allowed within 100 feet of the flight operation.
10. Operator will have been trained in operation of sUAS generally and will have received up-to-date information on the particular sUAS to be operated as required by the Appendices.
11. Written and/or oral permission from the relevant property holders will be obtained.

12. If the sUAS loses communications or loses its GPS signal, the UAS will have the capability to return to a pre-determined location within the Security Perimeter and land.
13. The sUAS will have the capability to abort a flight in case of unpredicted obstacles or emergencies.

DESCRIPTION OF SPECIFIC REGULATIONS

14 C.F.R. Part 21, Subpart H: Airworthiness Certificates & 14 C.F.R. §91.203 (a) (1)

Subpart H, entitled Airworthiness Certificates, establishes the procedural requirements for the issuance of airworthiness certificates as required by FAR §91.203 (a) (1).

Given the size and limited operating area associated with the sUAS to be utilized by Black & Veatch, an exemption from Part 21 Subpart H meets the requirements of an equivalent level of safety under Part 11 and Section 333 of the Reform Act. The Federal Aviation Act (49 U.S.C. §44701 (f)) and Section 333 of the Reform Act both authorize the FAA to exempt aircraft from the requirement for an airworthiness certificate, upon consideration of the size, weight, speed, operational capability, and proximity to airports and populated areas of the particular sUAS. In all cases, an analysis of these criteria demonstrates that the sUAS operated without an airworthiness certificate, in the restricted environment and under the conditions proposed will be at least as safe, or safer, than a conventional aircraft (fixed wing or rotorcraft) operating with an airworthiness certificate without the restrictions and conditions proposed.

The proposed sUAS to be operated is less than 55 lbs. fully loaded, carries neither a pilot nor passenger, carries no explosive materials or flammable liquid fuels, and operates exclusively within a controlled area as set out in the Appendices. Unlike other civil aircraft, operations under this exemption will be tightly controlled and monitored by the sUAS pilot, pursuant to the requirements set out in the Appendices. Lastly, application of these same criteria demonstrates that there is no credible threat to national security posed by the sUAS, due to its size, speed of operation, location of operation, lack of explosive materials or flammable liquid fuels, and inability to carry a substantial external load.

14 C.F.R. Part 27: Airworthiness Standards: Normal Category Rotorcraft

This regulation sets forth the procedural requirements for airworthiness certification of normal category rotorcraft. To the extend the S1000 would otherwise require certification under Part 27, Black & Veatch seeks an exemption from Part 27's airworthiness standards for the same reasons identified in the request for exemption from 14 C.F.R. Part 21, Subpart H.

14 C.F.R. § 45.23 (b): Marking of the Aircraft

The regulation requires when marks include only the Roman capital letter "N" and the registration number is displayed on limited, restricted or light-sport category aircraft or experimental or provisionally certificated aircraft, the operator must also display on that aircraft near each entrance to the cabin, cockpit, or pilot station, in letters not less than 2 inches nor more than 6 inches high, the words "limited," "restricted," "light-sport," "experimental," or "provisional," as applicable.

Even though the sUAS will have no airworthiness certificate, an exemption may be needed as the UAS will have no entrance to the cabin, cockpit or pilot station on which the word "Experimental" can be placed.

Given the size of the sUAS, two-inch lettering will be impossible. The word "Experimental" will be placed on the fuselage in compliance with §45.29 (f). The equivalent level of safety will be provided by having the sUAS marked on its fuselage as required by §45.29 (f) where the operator working with the sUAS will see the identification of the sUAS as "Experimental." The FAA has issued the following exemptions to this regulation to Exemptions Nos. 10700, 8738, 10167 and 10167A.

14 CFR 61.113(a) & (b): Private Pilot Privileges and Limitations: Pilot in Command

Sections 61.113 (a) & (b) limit private pilots to non-commercial operation. Because the sUAS will not carry a pilot or passengers, the proposed operations can achieve the equivalent level of safety of current operations by requiring the Pilot operating the aircraft to have completed a sUAS flight training course as detailed in the Appendices. Unlike a conventional aircraft that carries the pilot and passengers, the sUAS is remotely controlled with no living thing or cargo on board. Black & Veatch's sUAS can also be operated by an autopilot, which greatly reduces the danger of human error. The area of operation is controlled and restricted, and all flights are planned and coordinated in advance as set forth in the Appendices.

The sUAS to be operated hereunder is less than 55 lbs. fully loaded, carries neither a pilot nor passenger, carries no explosive materials or flammable liquid fuels, and operates exclusively within a secured area as set out in the Appendices. Like other civil aircraft, operations under this exemption will be tightly controlled and monitored by the operator and in compliance with local public safety requirements.

The risks associated with the operation of the sUAS are therefore diminished from the level of risk associated with commercial operations contemplated by Part 61 when drafted, and allowing operations of the sUAS as requested with a Pilot who has met the minimum requirements stated in the Appendices and achieves the level of safety contemplated by 14 C.F.R. § 61.113 (a) & (b).

14 C.F.R. §91.7(a): Civil Aircraft Airworthiness

The regulation requires that no person may operate a civil aircraft unless it is in airworthy condition. As there will be no airworthiness certificate issued for the aircraft, should this exemption be granted, no FAA regulatory standard will exist for determining airworthiness.

Given the size of the aircraft and the requirements contained in the Appendices for maintenance and use of safety check lists prior to each flight, an equivalent level of safety will be provided.

14 CFR 91.9(b)(2): Civil Aircraft Flight Manual in the Aircraft

Section 91.9 (b) (2) provides:

No person may operate a U.S.-registered civil aircraft ...

(2) For which an Airplane or Rotorcraft Flight Manual is not required by §21.5 of this chapter, unless there is available in the aircraft a current approved Airplane or Rotorcraft Flight Manual, approved manual material, markings, and placards, or any combination thereof.

The sUAS, given its size and configuration has no ability or place to carry such a flight manual on the aircraft, not only because there is no pilot on board, but because there is no room or capacity to carry such an item on the aircraft.

The equivalent level of safety will be maintained by keeping the flight manual at the ground control point where the operator flying the sUAS will have immediate access to it. The FAA has issued the following exemptions to this regulation: Exemption Nos. 8607, 8737, 8738, 9299, 9299A, 9565, 95658, 10167, 10167A, 10602, 32827, and 10700.

14 CFR 91.103: Preflight Action

This regulation requires each operator to take certain actions before flight to insure the safety of flight. As FAA approved rotorcraft flight manuals will not be provided for the aircraft an exemption will be needed. An equivalent level of safety will be provided as set forth in the Appendices. The operator will take all actions including reviewing weather, flight battery requirements, landing and takeoff distances and aircraft performance data before initiation of flight.

14 CFR 91.109: Flight Instruction

Section 91.109 provides that no person may operate a civil aircraft (except a manned free balloon) that is being used for flight instruction unless that aircraft has fully functioning dual controls.

sUAS's and remotely control piloted aircraft, by their design do not have fully functional dual controls. Flight is accomplished through the use of a control box that communicates with the aircraft via radio communications. The FAA has approved exemptions for flight training without fully functional dual controls for a number of aircraft and for flight instruction in experimental aircraft. See Exemption Nos.5778K & 9862A. The equivalent level of safety provided by the fact that neither a pilot nor passengers will be carried in the aircraft and by the size and speed of the aircraft.

14 CFR 91.119: Minimum Safe Altitudes

Section 91.119 establishes safe altitudes for operation of civil aircraft. Section 91.119 (d) allows helicopters to be operated at less than the minimums prescribed, provided the person operating the helicopter complies with any route or altitudes prescribed for helicopters by the FAA.

As this exemption is for a sUAS that is a helicopter and the exemption requests authority to operate at altitudes up to 400 AGL, an exemption may be needed to allow such operations. As set forth herein the sUAS will never operate at higher than 400 AGL.

The equivalent level of safety will be achieved given the size, weight, speed of the sUAS as well as the location where it is operated. In addition, the low-altitude operations of the sUAS will ensure separation between these sUAS operations and the operations of conventional aircraft that must comply with Section 91.119.

14 CFR 91.121: Altimeter Settings

This regulation requires each person operating an aircraft to maintain cruising altitude by reference to an altimeter that is set "... to the elevation of the departure airport or an appropriate altimeter setting available before departure." As the sUAS may not have a barometric altimeter, but instead a GPS altitude read out, an exemption may be needed. An equivalent level of safety will be achieved by the operator, pursuant to the Appendices, confirming the altitude of the launch site shown on the GPS altitude indicator before flight.

14 CFR 91.151(a): Fuel Requirement for Flight in VFR Conditions

Section 91.151 (a) prohibits an individual from beginning "a flight in an airplane under VFR conditions unless (considering wind and forecast weather conditions) there is enough fuel to fly to the first point of intended landing, and, assuming normal cruising speed - (1) During the day, to fly after that for at least 30 minutes; or (2) At night, to fly after that for at least 45 minutes."

Given the technological limitations on the sUAS battery power means that no meaningful flight operations can be conducted while still maintaining a 30 minute reserve. The aircraft is battery powered with a maximum flight time of 30 minutes. Black & Veatch proposes that the maximum flight time for each operational flight will be 20 minutes. The aircraft will be safely landed with no less than the greater of (a) 20% battery life remaining or (b) five minutes of flight time remaining.

Applicant believes that an exemption from 14 CFR §91.151(a) falls within the scope of prior exemptions. See Exemption 10673 (allowing Lockheed Martin Corporation to operate without compliance with FAR 91.151 (a)). Operating the small UAS, in a tightly controlled area, with less than 30 minutes of reserve fuel, does not create the type of risks that Section 91.151 (a) was intended to alleviate given the size and speed of the sUAS.

The FAA has stated that an equivalent level of safety is provided if the sUAS flight is conducted under daytime VFR flight conditions using visual line of sight (VLOS), and terminated with at least 25% reserve battery power still available. See Grant of Exemption No. 11062, p. 21-22. The Appendices requires an equivalent level of safety by safely landing with no less than the greater of (a) 20% battery life remaining or (b) five minutes of light time remaining and otherwise complying with the flight restrictions above.

14 CFR 91.203(a) & (b): Carrying Civil Aircraft Certification and Registration

The regulation provides in pertinent part:

(a) Except as provided in § 91.715, no person may operate a civil aircraft unless it has within it the following:

(1) An appropriate and current airworthiness certificate...

(b) No person may operate a civil aircraft unless the airworthiness certificate required by paragraph (a) of this section or a special flight authorization issued under §91.715 is displayed at the cabin or cockpit entrance so that it is legible to passengers or crew.

The sUAS fully loaded weighs no more than 55 lbs. and is operated without an onboard pilot. As such, there is no ability or place to carry certification and registration documents or to display them on the sUAS.

An equivalent level of safety will be achieved by keeping these documents at the ground control point where the operator flying the sUAS will have immediate access to them, to the extent they are applicable to the sUAS. The FAA has issued numerous exemptions to this regulation. A representative sample of other exceptions includes Exemption Nos. 9565, 9665, 9789, 9789A, 9797, 9797A, 9816A, and 10700.

14 CFR 91.405(a); 407(a)(1); 409(a)(2); 417(a) & (b): Maintenance Inspections

These regulations require that an aircraft operator or owner "shall have that aircraft inspected as prescribed in subpart E of this part and shall between required inspections, except as provided in paragraph (c) of this section, have discrepancies repaired as prescribed in part 43 of this chapter...," and others shall inspect or maintain the aircraft in compliance with Part 43. Given that these sections and Part 43 apply only to aircraft with an airworthiness certificate, these sections will not apply to the Applicant. Maintenance will be accomplished by the operator pursuant to the flight manual and operating handbook as referenced in the Appendices. An equivalent level of safety will be achieved because the sUAS is limited in size and will carry a small payload and operate only in controlled areas for limited periods of time from no higher than 400 feet AGL.. If mechanical issues arise the sUAS can land immediately. As provided in the Appendices, the operator will ensure that the sUAS is in working order prior to initiating flight, perform required maintenance, and keep a log of any maintenance performed. Moreover, the operator is the person most familiar with the aircraft and best suited to maintain the aircraft in an airworthy condition to provide the equivalent level of safety.

FEDERAL REGISTER PULICATION SUMMARY

Pursuant to 14 C.F.R. Part 11, the following summary is provided for publication in the Federal Register, should it be determined that publication is needed:

> *Black & Veatch Corporation seeks an exemption from the following rules: 14 CFR Part 21 Subpart H; 14 CFR 91.203(a)(1); 14 CFR Part 27; 14 CFR 45.23(b); 14 CFR 61.113(a)&(b); 14 CFR 91.7(a); 14 CFR 91.9(b)(2); 14 CFR 91.103; 14 CFR 91.109(a); 14 CFR 91.119; 14 CFR 91.121; 14 CFR 91.151(a); 14 CFR 91.203(a) & (b); 14 CFR 91.405(a); 14 CFR 91.407(a)(1); 14 CFR 91.409(a)(2); 14 CFR 91.417(a) & (b) to commercially operate a small unmanned aerial system (sUAS, 55 lbs. or less) for the purpose of inspection, monitoring, mapping and photographing equipment and engineering studies.*

Approval of exemptions allowing commercial operations of sUASs will create a level of safety by reducing risk. Conventional inspections and construction monitoring tasks involve extreme risks to personnel physically climbing structures and/or utilizing high rise equipment both of which create numerous and extreme risk to such personnel. In contrast, a sUAS weighing fewer than 55 lbs. and powered by batteries eliminates virtually all of that risk. The sUAS will carry no passengers or crew and, therefore, will not expose personnel to any of the risks described above.

Privacy

All flights will occur over private or controlled access property with the property owner's prior consent and knowledge. The granting of this exemption request will provide innovative safety operations.

Satisfaction of the criteria provided in Section 333 of the Reform Act of 2012--size, weight, speed, operating capabilities, proximity to airports and populated areas and operation within visual line of sight - provide more than adequate justification for the grant of the requested exemptions allowing commercial operation of applicant's sUAS in and pursuant to the Procedures appended hereto.

Sincerely,

Ryan Baker, Director of sUAS Flight Operations
Black & Veatch Corporation

Enclosures

Appendix A: Black & Veatch sUAS Operations, Inspection, and Maintenance Manual

FLIGHT OPERATIONS

Company Organization and Authority

1. Black & Veatch (B&V) will conduct flight operations using a small unmanned aerial system (sUAS) as described in these Operations, Inspection, and Maintenance Manual (hereafter, "Manual") for the purpose of inspection, monitoring, mapping and photographing equipment and engineering studies.

2. B&V will designate a Director of sUAS Flight Operations (Director).

3. The Director will ensure this Manual is revised to contain all current information.

4. The Director will ensure that this Manual is distributed to all personnel involved with sUAS operations as well as any revisions to this manual.

5. The Director will ensure all sUAS pilots are trained according to the Black & Veatch sUAS Training Manual and the Black & Veatch sUAS Pilot Operating Handbook.

B&V sUAS Platform

1. sUAS operations will be conducted using a DJI S1000 Plus with the A2 Flight Control System, manufactured by DJI Innovations (the "S1000").

2. The S1000 weighs approximately 8.8 pounds with a maximum takeoff weight of approximately 24 pounds including payload.

3. Operation of the S1000 is described in Appendix B. Black & Veatch sUAS Pilot Operating Handbook.

4. A complete description of the S1000 is contained in Appendix D. DJI S1000 Plus User Manual and Appendix E. A2 Flight Control System User Manual.

Aircraft Registration, Log Book, and Manuals

1. The S1000 will be identified by serial number, registered with the FAA, and have identification (N-Number) markings as large as practicable.

2. The S1000 will have a Log Book to record inspections, maintenance, and flight operations.

3. All required paperwork including Registration, Log Book, and Manuals will be located at the ground control station in close proximity to the pilot in command.

Required Crew Members and Qualifications

1. sUAS operations will require a minimum crew of a pilot in command (PIC) and a visual observer (VO)

2. The PIC will possess at least a sport pilot license and an airman medical certificate or U.S. driver's license and will be trained according to the Black & Veatch sUAS Training Manual (Appendix C).

Flight Areas

1. The sUAS will only operate within private or controlled-access property with permission from the property owner/controller or authorized representative. Permission from the property owner/controller or authorized representative will be obtained for each flight to be conducted.

2. Flight operations will not be conduct within 5 nautical miles of an airport reference point (ARP) as denoted in the current FAA Airport/Facility Directory (AFD) or for airports not denoted with an ARP, the center of the airport symbol as denoted on the current FAA-published aeronautical chart unless a letter of agreement with that airport's management is obtained or otherwise permitted by a certificate of waiver or authorization (COA).

3. All flight operations will be conducted at least 500 feet from all nonparticipating persons (the PIC, VO, operator trainees or essential persons will not be considered nonparticipating persons), vessels, vehicles, and structures unless:

    a. Barriers or structures are present that sufficiently protect nonparticipating persons from the sUAS and/or debris in the event of an accident.

    b. The owner/controller of any vessels, vehicles, or structures has granted permission for operating closer to those objects and the PIC has made a safety assessment of the risk of operating closer to those objects and determined that it does not present an undue hazard.

Flight Operating Parameters

1. Flights will be operated within visual line of sight (VLOS) of the PIC or VO during daylight and under visual meteorological conditions (VMC).

2. The sUAS will not be operated if wind gust greater than 30 mph.

3. Prior to each flight, a zero altitude initiation point will be established and confirmed for accuracy by the PIC.

4. Maximum flight time for each operational flight will be 20 minutes.

5. The sUAS will be safely landed with no less than the greater of (a) 20% battery life remaining or (b) five minutes of flight time remaining.

6. Flights will be operating at or below 400 feet above ground level (AGL).

7. Flights will be limited to a groundspeed of 25 mph and vertical ascent will be limited to 20 mph.
8. The flight operations will yield the right of way to other manned aircraft operations.
9. The flight will be aborted in case of unpredicted obstacles or emergencies.
10. Each flight will be recorded in the Log Book.

Lost GPS/Communication Procedures

1. Flight recovery following lost gps/communications will be performed according to Appendices B, C, and D.

INSPECTION AND FUNCTIONAL TEST FLIGHT

Preflight Inspection Procedures

1. Before each flight, either the PIC or the VO will conduct a preflight inspection of the sUAS.
2. The sUAS and ground control station will be inspected for signs of damage. Screws will be checked and tightened if necessary.
3. The ground control station will be inspected to ensure they are not damaged, loose, or misaligned.
4. Motors will be inspected to ensure they are not loose and the supports are not cracked.
5. Batteries for both sUAS and ground control station will be checked to ensure they are fully charged.
6. The S1000 batteries will be charged and maintained according to Appendix D.
7. A preflight maintenance inspection will be recorded in the aircraft log book.

Post-Flight Inspection Procedures

1. After each flight, either the PIC or the VO will conduct a post-flight inspection of the sUAS.
2. The sUAS and ground control station will be inspected for signs of damage. Screws will be checked and tightened if necessary.
3. Propellers will be inspected to ensure they are not damaged, loose, or misaligned.
4. Motors will be inspected to ensure they are not loose and the supports are not cracked.
5. Batteries will be charged and maintained according to Appendix D.

MAINTENANCE

Maintenance Procedures

1. The S1000 will be maintained in accordance with Appendices B, D, and E.
2. The S1000 will have a log book to record inspections, maintenance, and flight operations.
3. Batteries will be charged in accordance with Appendix D.

Functional Test Flight

1. After a flight critical component, such as a propeller or motor, has undergone maintenance or been repaired or replaced, the aircraft will undergo a functional test flight.
    a. The PIC will conduct the test flight in accordance with Appendix D.
    b. The PIC will make an entry in the log book of the functional test flight
2. Every 500 hours of flight time, the PIC will conduct a functional test flight regardless of the maintenance activities.
3. The PIC will make an entry in the log book of the functional test flight.

Appendix B: Black & Veatch sUAS Pilot Operation Handbook

KEY PARAMETERS

Max Takeoff Weight	24 lbs
Weight with Zenmuse and all other equipment – no camera, no battery	13.4 lbs
Weight of Nex5/6/7 camera	1 lb
Weight of Canon 5D camera	1.75 lbs
Max Battery Weight with Zenmuse/Nex Camera:	9.5 lbs
Max Battery Weight with Zenmuse/Canon 5D:	9 lbs

Flight Times using 90% of battery:

16,000 mah battery Nex 7:	17 min
20,000 mah battery Nex 7:	20 min
32,000 mah battery Nex 7:	22 min

Flight times using the Canon 5D or other cameras similar in weight will reduce the flight times by about 1 minute. These times are averages. An operator may get longer or shorter flight times based on weight and flying style.

DJI S-1000 Plus

CHECKLISTS

DJI S-1000 PLUS BENCH SET UP & TESTS

- All screws/bolts are tight
- Timer alarm for flight time to not exceed 80% battery capacity set properly
- Batteries are secure
- Antennas are secure
- Props balanced
- Props aligned
- Props not chipped
- Check blades, arms, etc. for cracks/damage
- Wiring Tight
- No excessive flexing of motors or booms
- Booms/motors will not twist
- Center of gravity is correct
- Warning lights set for low battery if used
- Batteries charged. Replace any battery which cycles below 80% of rated capacity
    - Laptop Battery
    - Flight Battery
    - Copter RC Transmitter Battery
    - Video RC Transmitter Battery
    - Spare Laptop Battery

DJI S-1000 PLUS INVENTORY CHECKLIST

- Load Flight plan
- Aircraft
- Camera with SD card
- Spare parts/tools
- Spare batteries
- Two RC transmitters (Copter & Video)
- Laptop
- Battery Charger
- Flight Controller Cable
- Video monitor, stand, battery, antennas
- Datalink & cable

DJI S-1000 PLUS PREFLIGHT CHECKLIST

- Determine emergency flight plan and alternate landing zones avoiding power lines and obstacles
- Check wind direction
- Set a perimeter of 500 feet – area must be clear of non-participants
- All antennas installed and all pointing in correct directions
- Engage GCS, monitor, laptop, etc. (bring up flight plan)
- Remove lens cap / Clean lens
- Camera On
- Ensure camera has SD card installed.
- Check battery voltage
- Install battery on copter.
- Check center of gravity
- Level copter with front pointing in correct direction for course lock – do not turn on
- Copter RC Transmitter - Set switches - Throttle Down, Return to Home switch Off, Manual Flight Mode
- Switch On, Flight Path Switch Off – Not Course or Home Lock
- Copter Transmitter On
- Check Model Selection on Tx
- Check Tx battery voltage (above 7.4v)
- On PhVideo Tx – set switches - HDMI switch Off, Freestyle switch On
- Video Transmitter On
- Check Model Selection on Tx
- Check Video Tx battery voltage (above 7.4v)
- Plug in battery black lead first.
- Calibrate GPS/Compass if necessary
- If calibrated, cycle battery with correct heading for course lock.
- Do not touch the Copter until 30 seconds after full GPS Lock. Initial 3 red blinks is normal meaning no GPS lock. Wait until no flashes. Continue with checklist.
- Check Copter Voltage from GCS
- Engage Attitude Mode – Must Achieve Double Amber Flash
- Engage GPS Mode – Must Achieve Double Purple Flash
- While in GPS mode engage "Course Lock" mode. Must achieve green Flash

- Do not engage motors. Set throttle to center position. Must achieve single amber flash in Attitude Mode and single purple flash in GPS mode
- HDMI switch On (video on camera itself should go off)
- Freestyle switch On (FPV Off)
- Verify camera operation (If problems, check Drive Mode – Remote Cmdr must be "on", manual focus, intelligent auto)
- Verify data link if installed – rolling copter manually should change gauges
- Upload flight plan
- Verify altitude is about 0 via gauge on computer/GCS/video monitor
- Timers set properly

TAKEOFF CHECKLIST

- Engage GPS mode – Double purple flash
- Engage Course Lock mode (double green flash)
- Announce loudly: "CLEAR PROP"
- Position the sticks in the lower left hand corners, then immediately raise the throttle 2 clicks, and center the right stick.
- Advance throttle to 1/4 power for 5 seconds. Assure all motors are operating.
- Verify that left/right and forward/back stick movement engages the proper motors
- Verify data and video links are still operational
- Announce loudly: "TAKING OFF"
- Advance throttle to full. Copter must jump off of the ground.
- Ascend to 10 feet. Center throttle stick. Should be single green flash. Verify wireless link, GPS hold, camera operation, gauges, etc. are working properly.
- Verify course lock is operational by rotating 90 degrees and pushing forward on stick.
- Verify copter stability. If unstable, land and reset gains, recalibrate, or retest as necessary.
- Raise landing gear
- Proceed with manual mission
- For autopilot operation
  - Ascend to 30 feet manually
  - Engage autopilot
- PIC/VO must monitor the informational LED and be ready to take over in manual mode when necessary.
- PIC to request copter flight battery voltage readout from camera operator periodically.

QUICK PREFLIGHT CHECKLIST

- Landing zone clear
- Level copter with correct heading
- Battery 4.1+ full, 3.8 depleted
- Camera on. SD card in.
- Both TX on
- Copter on
- Check GPS and Course lock checks
- Video check
- Photo check
- Timers ready
- Takeoff
- Raise Landing Gear
- Unplug batteries upon landing

ERROR MESSAGES

- White flashes
  - IMU malfunction. Land and determine cause. Possibilities:
    - GPS/Compass not pointing forward
    - IMU not pointing forward
    - Set up of X, Y, Z for location of IMU and Compass is incorrect
- Excessive rocking/instability possible causes:
  - Weak motor
  - Structure flexing from fatigue or cracks
    - Motor mount
    - Main frame
    - Booms
  - Loose Bolts causing flexing or misalignment
    - Props
    - Mounts
  - Props out of balance
  - Props misaligned
  - Excessive wind speeds or gusts
  - Excessive Gains
  - Excessive motor power. Max motor power must be a little more than typical ascent power.
- Red Flashes (1, 2 or 3 flashes with pauses) – GPS loss (3 is more serious). Land if loss lasts for more than 30 seconds. Possible causes:
  - Clouds
  - Structures
  - GPS mal-function
  - GPS too close to electrical components
  - GPS vibration

LANDING CHECKLIST

- Landing area clear
- Lower landing gear
- Note obstacles in flightpath
- Announce loudly: "LANDING"
- First cut power to the aircraft
- Note elapsed time of flight
- Adjust any parameters (camera servo speed, exponential, etc)
- Turn power off to transmitters, camera, goggles, monitors, Rxs, etc.
- Touch motors to verify temperatures are similar
- Complete flight log
    - Date and time of flight
    - Batteries used
    - Time of Flight

TABLE OF CONTENTS

SECTION 1
GENERAL

NOTE: In an effort to minimize costs and maximize spare parts availability, many COTS (commercial off the shelf) components have been utilized. Some may have slight modifications to better suit this application. Most COTS products have separate data sheets, assembly manuals and instruction manuals. They are reference in this document, with key factors being emphasized.

As with all high technology products utilizing constantly evolving software, it is important to periodically check for online upgrades to the COTS components, including hardware, firmware and software.

WARNING: Great care must be taken with the batteries. Much of this manual and supplemental information is devoted to the use and care of the batteries, especially the flight batteries. They are less volatile than gasoline, though they should be treated with the same respect. Become very familiar with proper techniques of their use.

GENERAL CHARACTERISTICS

- Primarily for ISR (Intelligence, Surveillance, and Reconnaissance)
- Economical due to extensive use of COTS products
- Low Visual Signature
- Low Aural Signature
- Quick Launch and Recovery
- Short Training Period
- Simple Operation
- Waypoint Navigation
- Backpackable
- VTOL
- Quick Repairs
- Redundant Flight Systems
- Safety Return to Home during lost link or low battery
- High Degree of Mission Success
- GPS navigation aid
- Various sensors
- 24 lb max takeoff weight
- Operating Temp Range: -5°C to +60°C
- Flight Modes: Manual and GPS aided waypoint navigation

- Maximum Operating Altitude: 1000 meters
- Maximum Operation Wind Conditions: 10 m/s
- Propulsion System: LiPoly batteries
- Takeoff: Manual or Automatic
- Landing: Manual or Automatic
- Takeoff/Recovery Area: 5m square

IMPORTANT DIMENSIONS

- Distance rotor to rotor across the center: 41"
- Height with GPS/Compass folded down: 21"
- Height with GPS/Compass up: 25"
- Length of landing gear skids: 18"
- Distance between landing gear skids: 21"

IMPORTANT WEIGHTS

- Weight including Nex 7 camera, Zenmuse gimbal, A2 autopilot system, landing gear, data transceiver, RC transceiver, video transmitter, regulators and all wiring – everything except battery: 13.4 lbs
- Maximum Takeoff Weight: 24 lbs
- Battery Weight: up to 9.5 lbs with Nex camera and Zenmuse Gimbal

MOTORS

- Manufacturer: DJI-Innovations
- Number of motors: 8
- Motor type: 41mm x 14mm
- Motor Model Number: 4114-11
- Motor KV/RPM: 400
- Motor max @ 25.2V: 10,000 rpm
- Motor Max Power: 500 Watts
- Power rating: 4000 Watts maximum power consumption for all 8 motors
- Current Max: 100 amps
- Amp Draw Typical Average: 65 amps

PROPELLERS

- Manufacturer: DJI-Innovations
- Material: Composite
- Number of propellers: 8
- Propeller model number: DJI 15 x 5.2
- Number of blades: 2 - folding
- Propeller Diameter: 15"
- Propeller Pitch (fixed): 5.2"
- Max rpm: 10,000 rpm

ELECTRONIC SPEED CONTROLS

- Manufacturer: DJI-Innovations
- Number of speed controls: 8
- Speed control model number: DJI 40A Opto
- Rating in amps: 40 Amps continuous
- Signal Frequency: 30 - 450 Hz
- Drive PWM Frequency: 8 KHz

AUTOPILOT

- Manufacturer: DJI-Innovations
- Autopilot Model Number: DJI A2
- Components: GPS/Compass, IMU, Master Controller, Power Distribution System, LED Indicator Lighting System, Data Transceiver, GCS Software
- Power Consumption: 5W
- Operating Temp Range: -5°C to +60°C
- Software Compatible: Windows XP sp3 / Windows 7
- Hovering Accuracy: Vertical : ± 0.5m; Horizontal: ± 2m

WIRELESS LINKS

- Distributor: DJI-Innovations
- Frequencies:
  - 2.4 Ghz datalink with WiFi
  - 2.4 Ghz Command & Control
  - 5.8 Ghz Video
- Power Consumption: 1 watt
- Usable Range: Less than 2 km.

FUEL/FLIGHT BATTERY

- Manufacturers: Various COTS suppliers
- Battery chemistry recommended: Lithium Polymer
- Battery Capacity: 16,000 - 42,000 mah
- Battery cell count required: 6S (6 cells in series)
- Battery Voltage: 21 V minimum during hover, 22.2V nominal, 25.2V maximum
- Battery Minimum Rated Discharge Rate: 20C minimum
- Battery Minimum Charge Rate: 1C (3C preferable)
- Battery Rest Time between discharging and charging: 0-30 minutes
- Batteries used simultaneously: 1-4
- Recommended Battery Discharge Amount: 80-90%

FLIGHT PARAMETERS

- Flight Time: up to 30 minutes
- Payload Max: 11 lbs
- Power Consumption in a Hover at 21 lb takeoff weight: 1500 Watts, 65 amps

WARNINGS

- Never power a video transmitter or receiver without an antenna connected or overload failure will occur.
- Read all information regarding batteries contained in this manual and supplements.
- Batteries are highly flammable and can explode, especially when fully charged. Improper charging, vibration, impact, high discharge, etc. can lead to explosion and fire. Batteries must be charged under constant supervision and using proper precautions.
- Batteries fully charged must be handled with extreme care.
- Store batteries between 20% - 50% charged state. Fully charge just before use.
- Fully charged batteries which are not to be used within 24 hours should be discharged to 20% - 50% charged state.
- Discharging LiPoly batteries in excess of 80% of their rated capacity can cause harm to the batteries.
- Using more than one battery at a time requires the proper wiring harness so that the voltage is no more than 25.2V. Over voltage will cause serious damage to electrical equipment.
- Using more than one battery at a time requires weight and balance checks. Proper CG is critical to performance. Airframe must not be overloaded.
- Propellers must be balanced to avoid excessive vibration.
- GPS/Compass must be facing forward.
- Do not use GPS Mode without GPS lock.
- Use low strength thread locking compound on all screws.
- Wireless Video and Data ranges vary considerably on many factors including weather, equipment, and obstructions. Be prepared for com failures.

SECTION 2
LIMITATIONS

AIRSPEED LIMITATIONS

- Vne – Velocity to Never Exceed: 15 m/s
- Va – Typical Maneuvering Speed: 5 m/s

POWER & POWERPLANT LIMITATIONS

- 40 Amps max per motor
- 40 Amps max per speed control
- 320 Amps max total
- Do not exceed 80-90% discharge of rated battery capacity
- Do not charge batteries which are warmer than air temperature
- Allow batteries to cool after use before charging
- Leave an air gap between batteries when multiple batteries are used simultaneously

WEIGHT LIMITS

- Takeoff Weight Max: 24 lbs
  - Must be checked prior to takeoff if any change in equipment is made

CENTER OF GRAVITY LIMITS

- 3mm from the center of any of the three pairs of arms
  - Must be checked before every flight to ensure batteries were installed in the proper location.
  - Check all 4 pairs of arms before flight

MANEUVER LIMITS

- This aircraft is intended for non-aerobatic operations
- G-loading maximum: 2G

TEMPERATURE LIMITS

- Operating Temp Range: -10°C to +40°C
- In cold temperatures
  - Keep IMU at room temperature if possible before the flight
  - Keep Batteries above 5°C before flight
  - Do not fly with any frost or ice on the propellers
- In warm temperatures
  - Batteries heat up when discharged
  - The higher the discharge rate the higher the temperature increase during use
  - At temperatures above 45°C, use of 2 or more batteries is required to lower the load on any one battery pack to keep it cooler.

WEATHER LIMITS

- Light dust and light rain require the use of a shield for the electronics in the center section.
- Light dust and light rain are acceptable for the unshielded motor and ESC.

RANGE LIMITS

- FUEL
  - Fuel capacity is a primary limiting factor.
  - Flying into the wind will use more battery power to travel the same ground distance. Higher air speeds will be required to penetrate the wind which used more battery power. Take this into account when flying a mission.
  - Where possible, fly upwind at the start of a mission and downwind at the end to avoid depleting the battery before returning to base. Have alternative landing sites available in case of emergency landing.
- WIRELESS LINK
  - Wireless links will be stable in LOS (line of sight) in most conditions
  - Wireless links are always susceptible to shorter ranges due to
    - Atmospheric conditions
    - Other transmission devices in the area
    - Jamming
    - Antennas not aligned properly

- Improper voltage
- Antenna blockage from Aerial Vehicle (AV) in certain positions
- Multipath – reflection off buildings or ground which cause multiple signals to arrive at different times and/or phase.

SECTION 3
EMERGENCY PROCEDURES

MOTOR FAILURE

- Operation is possible with one motor/ESC/propeller failure
  - The two adjacent motors/ESCs will be increased in thrust automatically by the flight controller to overcome the loss
  - In cases where the airframe is highly loaded the maximum rating of 40 amps may be exceeded by these two motors/ESCs
  - Operation should be terminated as soon as possible to reduce the possibility of damage to the remaining motors

COMMUNICATION FAILURE

- Video link failure
  - 5.8 Ghz being the shortest wavelength in general AV use has the least ability to penetrate. This link should be the first to be lost.
  - It is best to lose video first! It is the least likely to cause a crash when it fails. 5.8 Ghz can lose link with little warning.
  - Ensure that the GCS station antennas are perpendicular to the AV. Do not point the antenna at the AV.
  - Yaw the AV to change the antenna position
  - Other links should still be good. Return back to the GCS until link is restored. Transmitters produce heat when in operation. When overheated they may have thermal protection which interrupts use temporarily. Use of a heat sink or fan may be required especially with high ambient temperatures.
  - Higher gain antennas may be used, but do so with caution. High gain antennas are directional.
  - Multiple antennas using "diversity" can be used. Diversity is a device which determines the best signal, and uses that.
  - 5.8 Ghz even at high wattages theoretically has less range than lower frequencies. Changing to 1.3 Ghz is an option, though there are other issues to be considered.
- RC link failure
  - 2.4 Ghz antennas can lose link with little warning.
  - Anything in between the two antennas can cause temporary signal loss especially a person.

- Hold the transmitter up in the air and walk in the general direction of the AV.
- Ensure that the antenna is vertical. Do not point the antenna at the AV.
- The failsafes on the RC link should be set so that the AV returns to home. Should this require a heading change, the antenna may move into a more desirable position and link will be restored.
- The onboard equipment may block the signal. Yaw the AV so that the antennas point towards the GCS.
- A LRS (long range system) can be used as a permanent solution. This is higher in wattage and usually on 433 Mhz.

Data Link Failure

- 900 Mhz do not lose link without some warning. When drop outs are noticed to increase in frequency that is the limit of the range.
- If using 900 Mhz, this is on cell phone frequency. If a cell tower is nearby it can swamp the signal. 900 Mhz may not be usable in that area. Change to a different freq. or remain closer to the AV

LOW BATTERY POWER

- Fail-safes can be set such that in the event of low battery power, either due to a failure or too long of a flight, the warning light on the AV will constantly flash amber. This is the first level of warning.
- The second warning level is red flashing lights
- Auto landing will occur when battery power is low. It may land in a tree or a lake, so this is not desirable.
- Landing with 80-90% of battery depleted is best. Therefore landing with 17,000 mah used and 3,000 mah remaining of a 20,000 mah battery is desirable. Batteries should be drawn down equally when in use if they are both charged equally and both in relatively the same condition/age.
- Do not mix partially charged batteries. Only use completely charged batteries.
- Over discharging a battery below 19.8V can permanently damage the battery.

GCS FAILURE

- Takeover by the external pilot should happen ASAP using the RC link.
- Most often happens due to a low battery.
- Keep a spare 3 cell LiPoly battery with the appropriate plug to plug into the charge jack for emergency use. Most chargers are 19V output which is roughly equivalent to a 4-cell battery. 3-cell batteries may work.

COMPASS CALIBRATION ERROR

- If the compass is out of calibration the warning light will flash red. This is the same signal as low voltage. If the voltage is correct, there is a calibration error.
- Recalibrate the compass following the instruction manual

FIRE

- Fires can occur due to a short circuit or battery failure.
- Disconnect the battery ASAP unless there is danger in doing so if there is any electrical issue.
- It is not possible to put out a battery fire.
- Do not attempt to put out a battery fire. Use a fire extinguisher to put out fires surrounding the battery. A CO2 fire extinguisher is better than the powder or chemical type. CO2 does not leave a residue. Water can be used though it may cause other electrical component failures.

FORCED LANDINGS

- If alternate emergency landing zones should be chosen ahead of time.
- Be sure that the LZ is clear of people to avoid any incidents.
- Land in the nearest LZ which is clear of people.
- Announce your intentions of landing as loud as necessary to alert people of the incoming AV.

SECTION 4
SET UP SUGGESTIONS

ELECTRONICS BURN IN

- We recommend that you put weights onto the landing skids to keep the copter on the ground and run the copter at about 70% throttle for about 2 hours to burn in the electronics. Most electronic failures occur in the first 2 hours of operation.

GPS/COMPASS MAST LENGTH

- We found that the higher the mast, the better the GPS reception

Nex5N vs. Nex7 vs. Canon 5D vs. Panasonic GH3

- These cameras are excellent for stills, and very good for video. The best for video is the Panasonic GH4 with 4k capabilities.
- We found that the Nex 5N takes exceptional quality stills and video, though most professionals use the Nex 7. The Canon 5D is better than the Nex7 due to its larger sensor.
- Use the Panasonic GH4 if you primarily shoot video

RADIO SET UP

- Follow the instructions in the manual
- We prefer the switch assignment as shown in the checklists above though feel free to modify to your liking

COPTER COMMAND AND CONTROL

- We recommend the use of a dual rate switch for main copter operation.
  - High rate – used to initialize the motors. The flight controller will not engage unless it sees full down throttle, full left rudder, full left cyclic and full back cyclic. However, these may be too high for normal flying. On high rate it is helpful to utilize fairly high exponential to make the stick feel soft around center. Adjust to your preference.
  - Low rate – used for typical flying. Set the end point adjustments such that full stick deflection offers the maximum speed required in normal flying. If conditions require higher flight speeds, switch to high rate. On low rate it is also helpful to utilize a small amount of exponential to make the stick feel soft around center. Adjust to your preference.

ZENMUSE COMMAND AND CONTROL

- We recommend the use of a dual rate switch for gimbal operation.
  - High rate – used to initialize the gimbal. The gimbal may not engage unless it sees full motion. However, these may be too high for shooting video smoothly. This is best for still photography so as to put the camera on target quickly. On high rate it is helpful to utilize fairly high exponential to make the stick feel soft around center. Adjust to your preference.
  - Low rate – used for videography. Set the end point adjustments such that full stick deflection offers the maximum speed required for videography. If conditions require higher gimbal speeds, switch to high rate. On low rate it is also helpful to utilize a small amount of exponential to make the stick feel soft around center. Adjust to your preference.

TIMERS

- Use of the countdown timer is a good backup method to ensure landing with battery power.
  - Set the timer for 20 minutes (or what you deem appropriate) and have it start when the throttle is over 1/4. Then adjust the timer upwards until the amount of battery used is about 80-90% of the total available. If using 20,000 mah batteries, a total of 17,000 mah would be the target. Set the timer such that you have a minute or so to land after the alarm sounds so that you have adequate time to return to base. Adjust to your preference.

BATTERIES

- Replace the transmitter standard battery with a Lipoly battery to extend use times to 8 hours. Supplied batteries often last about 2 hours.

NORMAL PROCEDURES

PREFLIGHT CHECKLIST

- Confirm all communication radios are operational
  - Radios with others in the group
- Set a perimeter of 500 feet
  - Area must be clear of people to avoid collision
- Check for overhead power lines and other obstacles to avoid
- Check structural integrity
  - In event of prior crash, inspect all booms, props and motor mounts for excessive flex indicating structural fatigue/failure
- Have a manual flight plan avoiding obstacles.
- Load auto flight plan if using one
  - Be sure that the total flight time is under 15 minutes to avoid low battery
- Clean lens
  - Remove lens cap
- Ensure camera has SD card installed
- Install batteries
  - Ensure that the straps are tight and the Velcro keeps the batteries from moving which will avoid a shift in the CG (Center of Gravity – or that it balances evenly)
- Check CG (Center of Gravity)
  - Lift the copter on each of the 3 pairs of arms. The copter should balance properly. If not, do not fly. Rearrange the equipment to achieve proper CG
- IMU pointing forward
  - The Inertial Measurement Unit is set so that it must face forward
- GPS/Compass installed, limited free play, pointing forward
  - This device must be installed with a screw to hold it in place. It cannot vibrate easily. If it does not point forward, the corrections in ATTI and GPS mode will be incorrect and it will crash. The FC will provide a warning with constant flashing white lights.
- Level copter using a bubble level with front pointing in correct direction for course lock – do not turn on
  - Keep in mind the best angle for pointing the landing gear in the direction that will keep the landing gear out of the shot when flying.

- Turn on Pilot Tx
- If using the rate gyro, set it at the correct position. This is usually a slider switch. Gains should have the range set from 200 – 350. Use the highest gain possible which does not cause oscillation.
- Check Model Selection on Tx to be S1000
- Throttle on Tx Down
- Return to Home switch Off
- Adjust gain to correct position (if required)
- Manual Flight Mode Switch to manual (not ATTI or GPS mode)
- Flight Path Switch Off – Not Course or Home or POI
- Check Tx battery voltage (above 7.5v)
    - These settings above are required to initialize the copter properly. If the switches are in the incorrect position, it will not initialize properly which may cause some of the functions like course lock or GPS mode to not operate properly.
    - If the copter does not function properly after takeoff, land immediately and disconnect the copter power. Then put all the switches in the proper position for initialization and turn the power back on to the copter.
- Count down timer should be set to 20 minutes. This can be adjusted to your flying style. The timer should engage at 1/4 throttle and trigger an alarm at the proper time. This is a backup alarm in case the indicator lights on the copter are not visible.
- Turn on Video Tx
- Check Model Selection on Tx – should read Zenmuse
- Check Tx battery voltage (above 7.5v)
- HDMI switch Off
- Freestyle switch Off (FPV On)
    - These settings above are required to initialize the Zenmuse properly. If the switches are in the incorrect position, it will not initialize properly which may cause some of the functions like live video or gimbal operation to not operate properly.
    - If the camera or gimbal do not function properly, disconnect the copter power. Then put all the switches in the proper position for initialization and turn the power back on to the copter.
- Engage power to copter
    - Plug in the battery pack.

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        - 6 quick chirps should be heard confirming 6S LiPoly batteries are recognized by the ESCs.
            - Hearing less than 6 chirps indicates fewer cell battery packs are being recognized which is incorrect. Check for improper or damaged batteries.
    - Do not move or vibrate the copter until 30 seconds after full GPS Lock
        - Initial 3 red blinks is normal meaning no GPS lock. No red flashes indicates full GPS lock.
        - Continue with checklist as you are waiting for full GPS lock, but do not move the copter.
        - If the GPS takes more than 5 minutes to lock, there is a problem with the area. It is not receiving the proper signals from the satellites. GPS signals are weak, so trees, people, buildings, terrain, weather, have an effect. Move the copter into a more open area where it can more easily see the satellites.
    - Check Copter Voltage from both Tx's (transmitters)
        - The transmitters receive a signal from the corresponding receivers. The voltages are regulated to about 5v. If the voltage is below 4.4v or above 6v do not fly. There may be power regulation issues. The receivers cannot work outside this voltage consistently. Also there is some issue if the voltage is outside that range which should be resolved before flying.
    - Engage Attitude Mode – Must achieve double amber flash
    - Engage GPS Mode – Must achieve double purple flash
    - Engage course cock mode – Must achieve double green flash
    - Disengage course lock mode. Must achieve double purple flash. Stay in this mode until just prior to takeoff, after takeoff at any time, or do not use.
    - Do not engage motors. Set throttle to center position. Must achieve single purple flash when in GPS mode.
        - To verify that the sticks are all centered properly:
        - With throttle in the center position, use the trim buttons on the transmitter to check that the sticks are centered. Trim the roll (the stick located on the right side of the transmitter when moved to the right and left) to the right, counting the number of clicks until a double flash occurs. Then center the trim. Then move the trim to the left, counting the number of clicks until a double flash occurs. An equal number of clicks should be counted each side of center.
        - Do this check for the 3 stick movements other than throttle.
        - Center the trim such that when the stick is in the neutral position that there are equal numbers of clicks in each direction. This ensures that when the sticks are neutralized that the flight controller will recognize this signal and engage GPS mode.

- Calibrate GPS/Compass before the first flight each day or if receiving continuous red blinks or continuous white blinks.
    - Flip the GPS mode switch 7 times very quickly from manual to GPS. End with the switch in the manual position. The indicator light will be blue. Rotate the copter about 1.5 turns in a horizontal position. A green flashing light indicates that this is complete. Then hold the copter vertically and rotate about 1.5 turns. A white flashing light indicates that this is complete. Repeat if necessary until this is completed.
- After calibration, reset the copter by cycling battery with copter pointed in the correct heading for course lock.
- Engage Camera
- HDMI switch On
    - This will stop video from playing on the back of the camera and will send the video signal to the video transmitter via the HDMI connection.
- Freestyle switch On (FPV Off)
    - This allows the camera to be operated freely through the transmitter
- Verify camera operation
    - Operate the shutter
    - Set the focus to auto or manual. Manual setting is usually set to infinity to stop constant focusing of the camera.
- Verify data link if installed
    - Roll the copter about 45 degrees on its side by lifting one side of the copter and resting one side of the landing gear on the ground
    - A corresponding roll should be seen on the gauge.
    - If the copter is rolled to the right, it will appear on the gauge that the horizon rolls to the left – not the right because the view from inside the copter is that the horizon rolls the opposite direction of the copter.
- Verify altitude is about 0 via gauge on computer
    - If it is not about 0, the altitude settings for the waypoints will be off by this amount. This could cause the copter to fly at 10 meters or 30 meters if the waypoint is set for 20 meters and the altitude is off by 10 meters one way or another. If the copter thinks it is at 10 meters when it is on the ground, then it will only rise 10 meters above the ground to achieve what it believes it to be 20 meters above the ground.
    - The altitude can be reset using the ground control software by going to altitude offset.
- Alternate Emergency Landing Sites Established

NORMAL TAKEOFF

- Engage GPS mode – Double purple flash when the throttle is down.
- Switch to Course Lock flight mode if required. Purple flashes are replaced with green flashes. Flying in course lock is not required, but helpful in many instances.
- Announce loudly: "CLEAR PROP"
- Move both of the sticks to the bottom left corners to engage the motors. Within 1 second move the throttle up 1/8 – 1/4. The copter should not lift off until about 50% stick is reached.
- Verify data and video links before lifting off. If anything is not working properly, move the throttle stick to low to disengage the motors and determine a solution.
- If all flight checks are passed, announce loudly: "TAKING OFF"
- Advance throttle to about 3/4. Copter must jump off of the ground to avoid one skid coming up before the other skid, and the skid on the ground getting caught and flipping the copter over sideways.
- Ascend to 3 meters. Then decrease throttle to 50% to engage the GPS hold.
- Verify links, GPS, Attitude, etc. Should be single purple flash.
- Verify that the copter is holding position within .5m in all directions.
- Verify camera operation
- Verify course lock is operational by rotating 90 degrees and pushing forward on stick.
- Verify copter stability. If unstable, land and reset gains, recalibrate, or retest as necessary.
- Proceed with manual mission or
- For autopilot operation
    - Ascend to 30 feet
    - Command aerial vehicle observer (AVO) to proceed with mission.
        - Pilot should say "It's yours"
        - Response from AVO "I have it"
- Manual pilot/observer must monitor the informational LED and be ready to take over in manual mode when necessary.
    - White flashes indicates flight controller issue
    - Amber flashes indicates low battery
    - Red flashes indicate loss of GPS or severe battery condition
        - Quick decisions are required when red flashes are indicated
        - 10 seconds or more of loss of GPS signal will stop waypoint guidance and any GPS hold and put into manual mode.

        - Red indicator light battery warning requires immediate landing
    - Manual pilot to request copter flight battery voltage readout from AVO periodically.
        - Reset the first and second indicator lights as required for your set up.
        - Also use the countdown timer on the transmitter. This gives a good indication of battery level because the current used is fairly constant from flight to flight.

POST LANDING

- Note flight time from transmitter. Write this down in the log book.
- Note battery power used during the flight. Write this down in the log book.
- ALWAYS disconnect the main power to the AV first, then turn off the transmitter.
- Check motor temperatures by touching them with your fingers. Any motors which are excessively hot should be further inspected and possibly replaced.
- Check battery temperatures by touching them with your fingers. Battery temperatures should not be hot to the touch. Battery temperatures should be slightly above ambient.
- Inspect all components especially the propellers for wear.
- Note in logbook which batteries were used to calculate life cycle.

AIRCRAFT FLIGHT LOG BOOK

- Keep a log of all flights.
    - Date
    - Time of Day
    - Time in Operation (in hours)
    - Battery serial numbers
    - Mah used in flight
    - Location
    - Pilot, Observer, Sensor Operator Names
    - Flight Objective
    - Remarks

AIRCRAFT MAINTENANCE LOG BOOK

- Keep a log of significant inspections, tests, repairs, alterations, equipment changes.
  - Date maintenance is performed
  - Accumulated hours of operation
  - Remarks

PILOT LOG BOOK

- Keep a log of all flights. Include the following:
  - Aircraft flown
  - Aircraft serial number
  - Date
  - Time of Day
  - Time in Operation (in hours)
  - Location
  - Flight Objective
  - Remarks

SECTION 5
PERFORMANCE

FLIGHT TIMES

- The AV is designed to hover at high efficiency. Hovering is much less efficient than flying on a wing, thus flight times are low compared to fixed wing aircraft.
- All the weight of the AV is supported by power from the batteries. As the batteries are used in a flight, the amount of power available decreases. Therefore the power reserve is constantly decreasing as the battery is being used. Thus loading a rotorcraft above its limit is not recommended. While the AV may have enough power to lift off initially on a full charge, the power reserve at partial charge may be too low to allow for maneuvering and will result in a crash.
- High lateral speeds will add lift to slightly improve efficiency. The rotors act similar to fixed wings at higher speeds. This increase in efficiency may be negated by the increased power consumption of forward flight.
- High winds or gusts decrease efficiency/flight time. The motors work harder to hold position.
- As weight increases flight times decrease.

WIRELESS TRANSMISSION

- Refer to the specific manuals for performance ratings.
- Wireless communications utilized provide acceptable communication for line of sight (LOS).
- In general:
  - LOS is required
  - The higher the GCS antennas, the better the range
  - RSSI (Received Signal Strength Indication) should be monitored for indication of communication drop out.

SECTION 6
WEIGHT AND BALANCE EQUIPMENT LIST

Center of Gravity (CG)

- CG is critical to the efficient operation of any AV
- When components are shifted, the CG will be altered.
- The main components which are moved on a regular basis are the sensors and the batteries.
- The sensors are typically in the front of the AV, and the batteries are located in the correct position to offset all the components on the AV.
- The CG must be tested after any change to the components or their placement.
- The CG should be tested by lifting the UV with fingers on the bottom of the arms. Check all 4 pairs of arms. The CG should be no more than 2mm off in any on the 3 checks. The closer the CG is to the centerlines of the arms the more efficient and the more stable the AV will be.

WEIGHT

- Weight is critical to the operation of any aircraft
- Weight is especially critical to a rotor wing aircraft. At full throttle the motors have a finite amount of thrust. All the weight is lifted by the battery power, there is no wing to assist in providing lift.
- As the batteries are operated, they lose power. At full charge they have about 25v. At 20% remaining capacity they have about 21v. This is a loss of 8% of the power available which is significant.
- Do not overload the aircraft or there will not be sufficient reserve power to maneuver at low battery levels.

SECTION 7
AIR VEHICLE AND SYSTEMS DESCRIPTION

FUEL/BATTERY REQUIRED

- Manufacturers: Various COTS suppliers.
- Refer to manufacturer data sheet.
- Battery chemistry required: Lithium Polymer
- Battery Capacity: 16,000 mah (minimum)
- Battery cell count required: 6S (6 cells in series)
- Battery Voltage: 21 V minimum at hover, 22.2V nominal, 25.2V maximum
- Battery Minimum Rated Discharge Rate: 20C minimum
- Batteries used simultaneously: 1-4 typical
- Recommended Battery Discharge Amount: 80-90%

WIRELESS COMMUNICATIONS

- Refer to the specific manuals for performance ratings.
- Never power a video transmitter or receiver without an antenna connected or overload failure will occur.
- Wireless communications utilized provide acceptable communication for LOS.
- In general:
    - LOS is required.
    - Lower frequencies penetrate objects such as trees better than higher frequencies.
    - Lower frequencies have longer range than high frequencies
    - Higher frequencies can transfer more data than lower frequencies
    - Higher frequencies use smaller/shorter antennas
    - The higher the GCS antennas, the better the range and reception
- Frequencies may have severe degradation due to location to other admitters such as cell towers
- Range must be constantly monitored.
- Alternate antenna types may be utilized to improve link/range. Patch, helical, omni, etc. can be substituted. They must be verified before use.
- Alternate frequencies may be utilized to improve link/range.

SECTION 8
HANDLING, SERVICE AND MAINTENANCE

PROPELLER CARE

- Propellers must be checked each flight for nicks or cracks
- Propellers are designed to last indefinitely if they do not impact dust, dirt or more.

BATTERY CARE AND USE

- Refer to instruction sheet included from the battery manufacturer. Typical information follows.
- Batteries are highly flammable and can explode, especially when fully charged. Improper charging, vibration, impact, high discharge, etc. can lead to explosion and fire. Batteries must be charged under constant supervision and using proper precautions.
- Batteries fully charged must be handled with extreme care.
- Any battery which puffs up is considered damaged and must not be used. It is in a dangerous state. Never charge a puffed up battery.
- Any battery which holds less than 80% of its rated capacity should be discarded.
- Cycle test each battery after every 50 cycles or if a battery is suspected to have lost as significant amount of its capacity to determine the current capacity.
- Properly dispose of batteries. First discharge the battery fully using a battery cycler. Bring to a recycler such as a home improvement store.
- Always charge flight batteries under "balance" mode.
- Flight Battery Recommended Charge Rate: 1 C
- Flight Battery Maximum Charge Rate: May exceed 5C. Charge rates higher than 1C will decrease life cycles. Maximum charge rating per the manufacturer will provide 300+ cycles. Use the lowest charge rate which is practical.
- Battery Rest Time between discharging and charging: 30 minutes minimum, 1 hour maximum.
- Do not charge if the battery is more than 2°C warmer than ambient, especially if the temperature is above 20°C. The outer surface is cooler than the inner core after use. Damage will occur when charging a warm battery.
- Recommended Battery Discharge Amount: 80%. Using more of the capacity of the battery will decrease the life cycles
- As battery temperature approaches freezing the capacity of Lithium Polymer batteries decrease. Keep warmer than 5°C before installing into the UV (unmanned vehicle).

- Battery capacity decreases at higher discharge rates. Using more batteries decreases the discharge rate of each battery thereby extending individual battery capacity slightly.
- Lower discharge rates improve the life cycles.
- Batteries are rated at greater than 300 life cycles. 1,000+ life cycles are possible.
- Batteries must not be stored above 60% charged state for extended periods.
- Batteries should be stored below 25°C for extended periods
- Store batteries between 40% - 60% charged state. Fully charge just before use.
- Fully charged batteries which are not to be used within 24 hours should be discharged to 40% - 60% charged state using the battery discharger.

PREVENTATIVE MAINTENANCE

- ANNUAL INSPECTION
  - If the airframe has in excess of 300 hours in a one year period, an annual inspection must be completed.
  - Disassemble the AV and inspect all components for wear and replace any components as required.
  - Test all batteries for capacity.
  - Upgrade firmware and software to latest revisions
- 500 HOUR Preventative Maintenance
  - Disassemble the AV and inspect all components for wear and replace any components as required.
  - Replace all 8 motors.
  - Test all batteries for capacity.
  - Upgrade firmware and software to latest revisions.

SECTION 9
SUPPLEMENTS

COTS components have been utilized in the construction of this AV. All instruction manuals, operating handbooks, warning notices, and more are available as separate documents. Keep these significant documents and keep in a notebook with the copter at all times.

AIRFRAME

AUTOPILOT SYSTEM

BATTERIES

BATTERY CHARGER

CAMERA MANUAL

CAMERA GCS

DATA WIRELESS LINK

GIMBAL CAMERA MOUNT

GIMBAL CAMERA MOUNT SERVOS

LAPTOP COMPUTER

MOTORS

ONBOARD REGULATOR

PROPELLERS

RC/MANUAL COMMAND & CONTROL SYSTEM SPEED CONTROLS (ESCs)

VIDEO CAPTURE HARDWARE

VIDEO CAPTURE SOFTWARE

VIDEO WIRELESS LINK

Appendix C: Black & Veatch sUAS Training Manual

I. Black & Veatch Pilot In Command (PIC) Training Requirements

A. The PIC will have the following qualifications.

1. Sport Pilot License

2. Third Class Medical Certificate or U.S. Driver's License

3. Completion of DJI Factory-Certified Basic Operator Course

B. Description of DJI Factory-Certified Basic Operator Course

1. Ground Training

16 hour webinar topics

- *General UAV characteristics, types, uses*
- *Principals of Flight*
- *Weight and Balance - Center of Gravity calculations and methods*
- *Operational limitations (vertical speed, horizontal speed, weight, horizontal distance, altitude, endurance, weather, etc.)*
- *Subsystem Operation and Maintenance (Flight controller, IMU, GPS, Compass, Gyros, Accelerometers, Brushless motors, Speed controllers, Propeller, Retractable landing gear, Airframe, Video Transmission and Reception, Antennas, Video displays, etc.)*
- *Battery care*
- *Transponder operation*
- *Maintenance*
- *Record Keeping, Logbooks, and other Documentation*
- *Insurance Requirements*
- *Remote sensing theory and practical application*
- *Autopilot operation and Mission Planning*
- *Aircraft flight simulation*
- *Federal, State, and Local laws, rules, regulations, policies, and good practice*
- *Right of Way rules*
- *FAA Certificate of Authority (COA) process*
- *Pilot in Command (PIC) qualifications and responsibilities*
- *Observer qualifications and responsibilities*
- *Sensor Operator qualifications and responsibilities*
- *Recognizing and setting Early Warning Alarms/Signals*
- *Emergency Procedures*

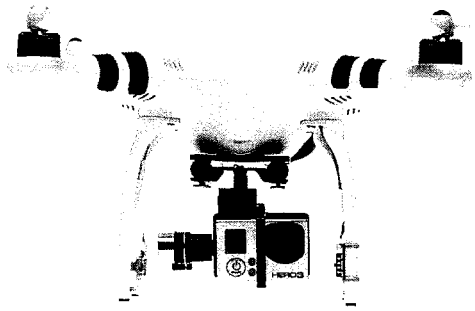
- *Integration with other aircraft in the national airspace*
- *Reading a sectional map for aircraft*
- *Preflight Checklist*
- *In flight Checklist*
- *Post flight Checklist*
- *Autonomous Flight*
- *Preflight briefing*
- *Checklist reviews*
- *Flight*
- *Certification Testing*
- *How to start a UAV business*
- *Typical income for UAV businesses*
- *Typical charges for photography*

2. Flight Training

a) Flight Training Day 1 – Quadcopters

- *Preflight briefing on quadcopter operation*
- *LOS (Line of Sight) and FPV (First Person View) pilot flight training using quadcopters*

Equipment Used: DJI Phantom



b) Flight Training Day 2 – Fixed Wing Aircraft

- *Preflight briefing on fixed wing operation*
- *LOS (Line of Sight) and FPV (First Person View) pilot flight training using fixed wing aircraft*

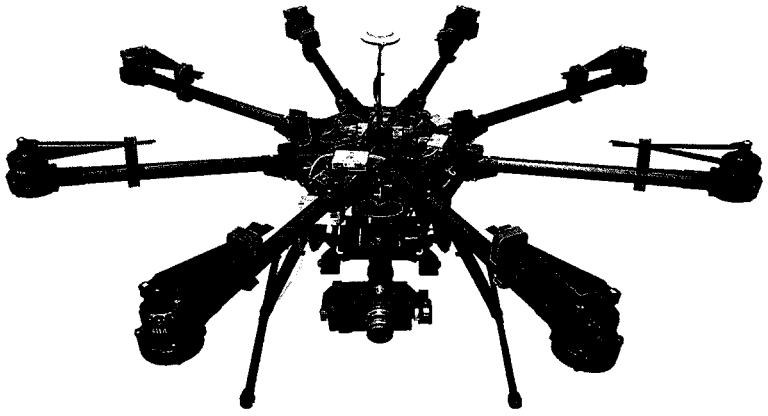
Equipment Used: TBM Skyhunter, MyFlyDream Antenna Tracker

SKYHUNTER

c) Flight Training Day 3 – Autopilot Operation

- *Autopilot Mission Training*
- *Create autopilot missions*
- *Pilot flight training via autopilot missions created by the student*

Equipment Used: DJI S1000 fully equipped

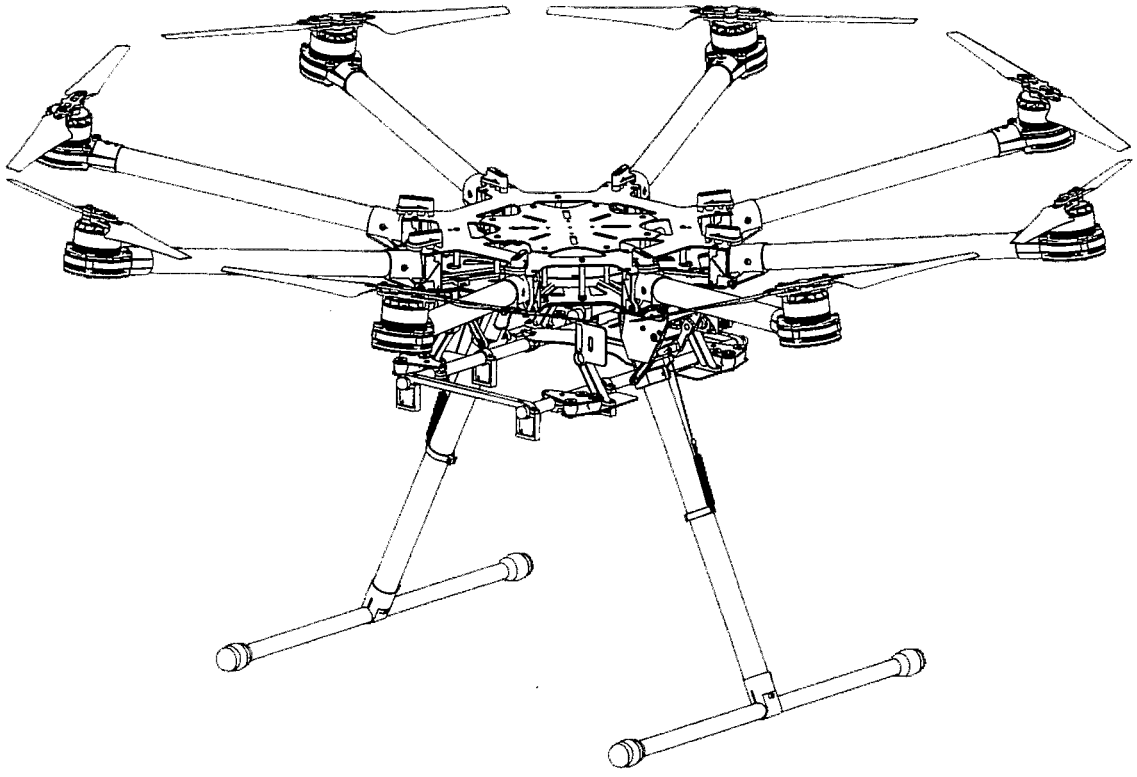


Appendix D: DJI S1000 Plus User Manual

Spreading Wings S1000+

User Manual V1.2

2014.12



Disclaimer

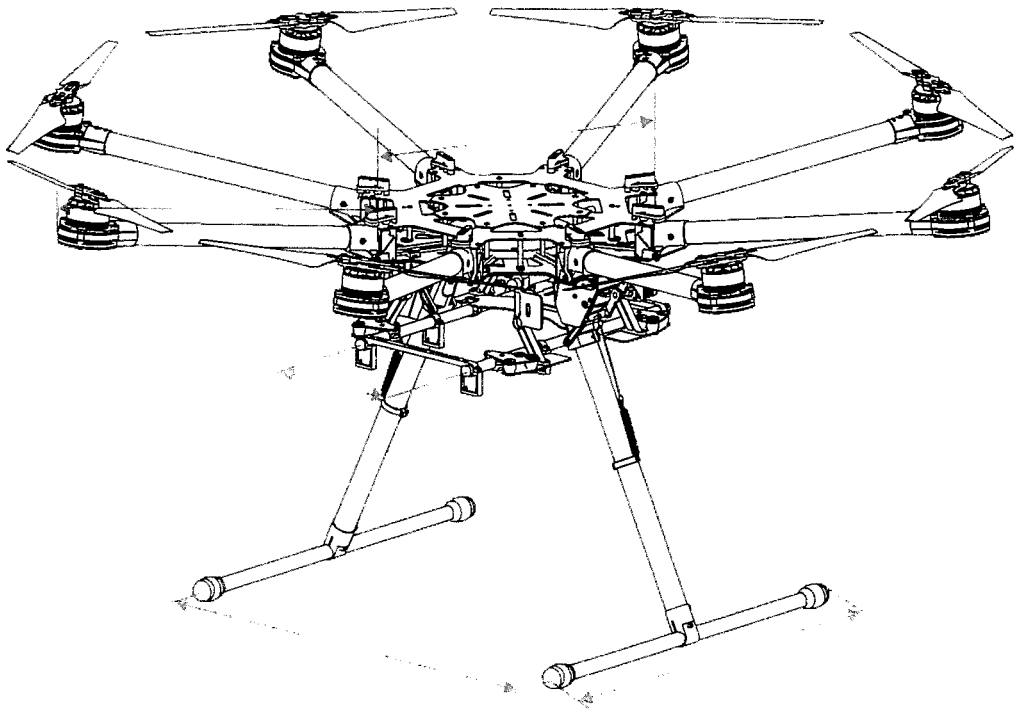
Thank you for purchasing the S1000+. Please visit the Spreading Wings S1000+ page on www.dji.com regularly to keep up to date with product information, technical updates and manual corrections. Information in this manual is subject to change without notice.

In using this product, you hereby agree to this disclaimer and signify that you have understood all points completely. When assembling this product, follow all instructions carefully. The manufacturer and seller assume no liability for any damage or injury arising from the use of this product.

This is a class A product of the FCC certification. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

About

The S1000+ is designed for professional aerial photography and cinematography. It is user friendly, safe, stabilized and easy to fly while its integrated design makes assembly and configuration simple and fast. Retractable landing gear, vibration dampers, slightly angled arms and a minimalized gimbal mount allow for a clear 360 degree view from the camera. A patented power distribution board, built-in high-speed ESCs and motors with high efficiency propellers ensure dynamic stability and maximized power efficiency. Used with a professional DJI multi-rotor autopilot system, the S1000+ can hover and fly reliably making it ideal for photography and cinematography.



Contents

Cautions

When flying, the rotating propellers may cause serious damage and injury. Please fly safe at all times.

Assembly Cautions

1. Use a bracket to mount the GPS module on the center frame to avoid interference with the power board.
2. Ensure the IMU is mounted with the arrow pointing toward the nose of the aircraft.
3. If using a receiver, attach it under the bottom board of the center frame with the end of the antenna facing downwards and away from obstructions to avoid signal loss.
4. Ensure frame arms are mounted correctly.
   a) Motor mounts with CCW marks should be mounted to the center frame positions with the following marks: M1, M3, M5 and M7.
   b) Motor mounts with CW marks should be mounted to the center frame positions with the following marks: M2, M4, M6 and M8.
5. Do not remove any glued-in screws.
6. Screws that already have blue glue can be used once without thread locker. On other occasions, apply appropriate thread locker first.
7. The S1000+ should be lifted off the ground when testing landing gear or recalibrating servo travel.

Flight Cautions

1. ESCs are not water-proof, please do not fly in rain or snow.
2. **Ensure all soft dampers and vibration absorbers are in good condition before every flight. If not, replace immediately. Otherwise, the flight performance of your aircraft will be adversely affected.**
3. Ensure all parts are in good condition before each flight. Do not fly with worn or broken parts.
4. Ensure propellers and motors are installed correctly and propellers are unfolded before flying.
5. Ensure ESC signal connectors and power cable connectors are tight before every flight.
6. When flying, maintain a safe distance away from people, buildings, high-voltage lines, tall trees, water and other hazards.
7. Use only 6S LiPo batteries for the power supply.
8. Ensure all output signals from M1 to M8 are in proper working order when using the DJI A2 flight control system to avoid damage or injury.
9. Do not overload the system.
10. Do not get close to or touch motors or propellers when they are spinning as this can cause serious injury.
11. Disconnect the battery and remove the camera during transportation to avoid damage or injury.
12. We strongly recommend using as many DJI manufactured parts as possible.

Others

If you have any problems you cannot resolve, contact your dealer or DJI customer service.

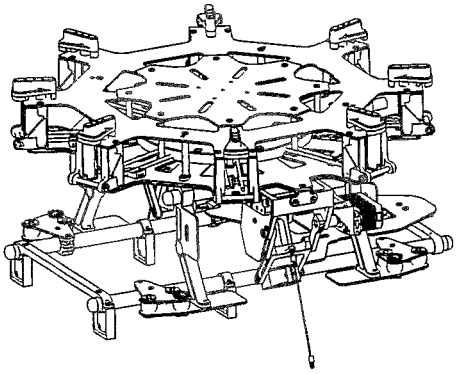
Legend

⚠ Important

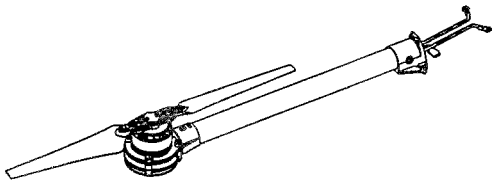
Hints and Tips

In The Box

Center Frame ×1

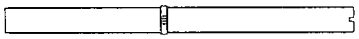


Frame Arms ×6

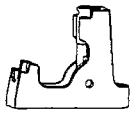


Landing Skid Tubes ×2
(with Silicone Rubber Dampers)

Landing Gear Legs ×2



GPS Collapsible Mount ×1



Springs ×2

Connection Cable

Connector Set ×1

or

3-PIN Connection Cables ×8

Accessories Package ×1

CW propellers ×2
CCW propellers ×2
Magic tapes ×4
The red knobs ×8
Soft dampers ×50

Screw Package ×1

For frame arms mount: M4×35
For landing gear mount: M3×8, M2.5×8 (socket cap), M3×22 (socket cap)

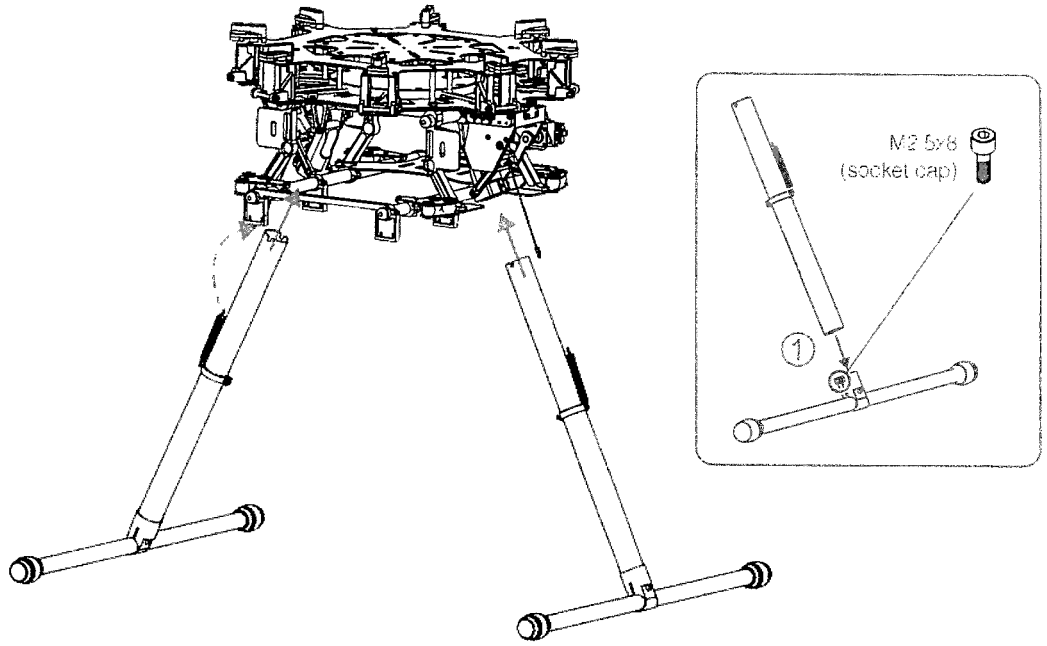
Tools Required

Tools	Usage
2.0mm Hex Wrench, 2.5mm Hex Wrench	Mounting screws.
Thread Locker	Fastening screws.
Nylon Cable Tie, Scissors, Cutting Pliers/Dykes	Binding devices and wires.
Foam Double Sided Adhesive Tape	Mounting receiver, controller and other modules.

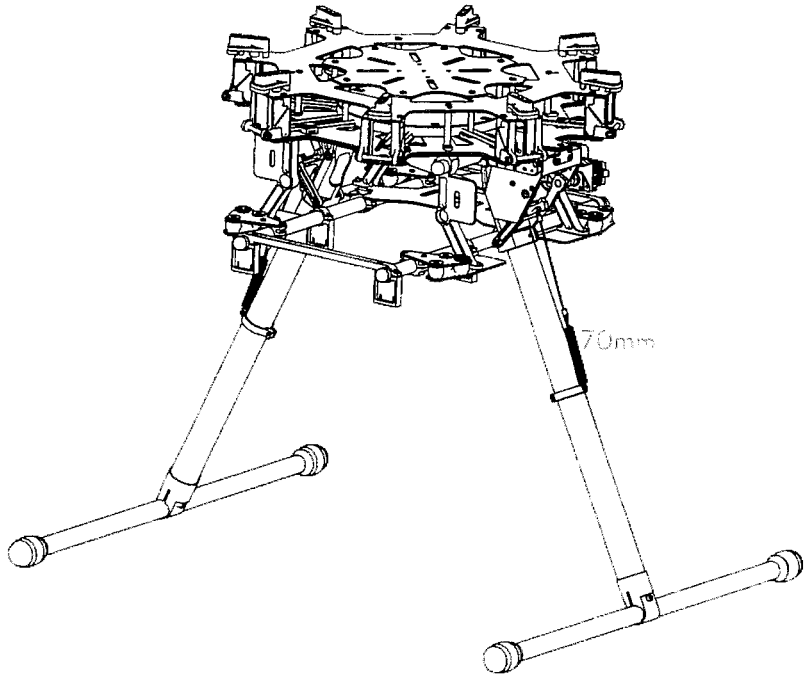
Mounting the Landing Gear

Instructions

1. Insert one landing gear leg into each landing skid tube and secure it in place by tightening the M2.5x8 (socket cap) screw. Ensure silicone rubber dampers are attached to each end.
2. Insert the landing gear leg into connection point on the center frame. Affix in place with M3x8 screws.
3. Connect both springs on the legs to the center frame.



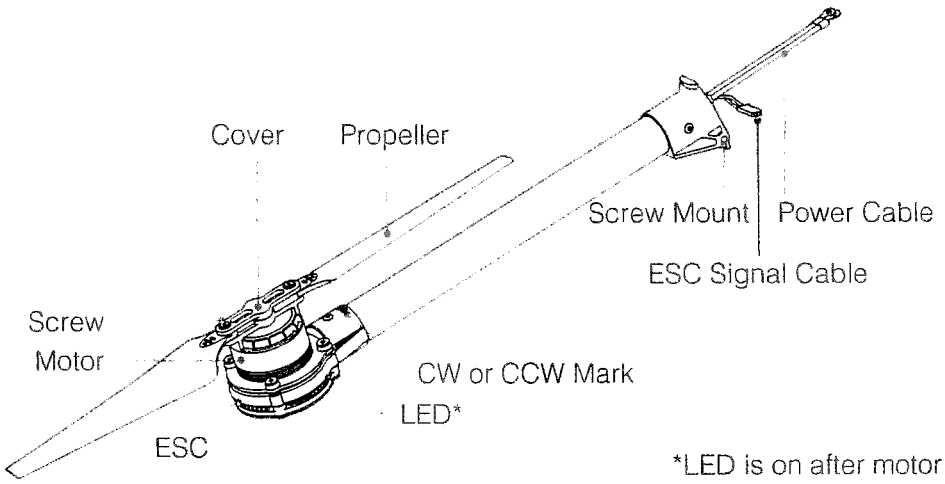
Note the springs are 58.5mm before connecting to the center frame, and are stretched to 70mm when mounting is completed.



Mounting Frame Arms

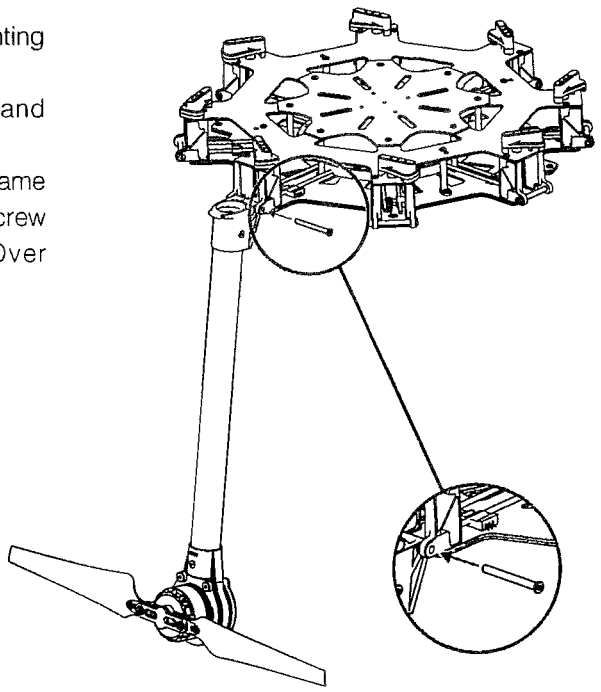
Instructions

1. Prepare the arms.
   (1) Check all propellers for cracks, then install and screw each propeller cover on tightly.
   (2) Ensure all motors are mounted firmly and rotate freely.
   (3) Mount all arms with red propeller covers to M1 and M2 to indicate the nose of the S1000+.
   (4) Identify the CW and CCW marks on the arms. Mount the arms with the CCW mark to the M1, M3, M5 and M7 positions of the center frame. The arms with the CW mark should be mounted to the M2, M4, M6 and M8 positions of the center frame.

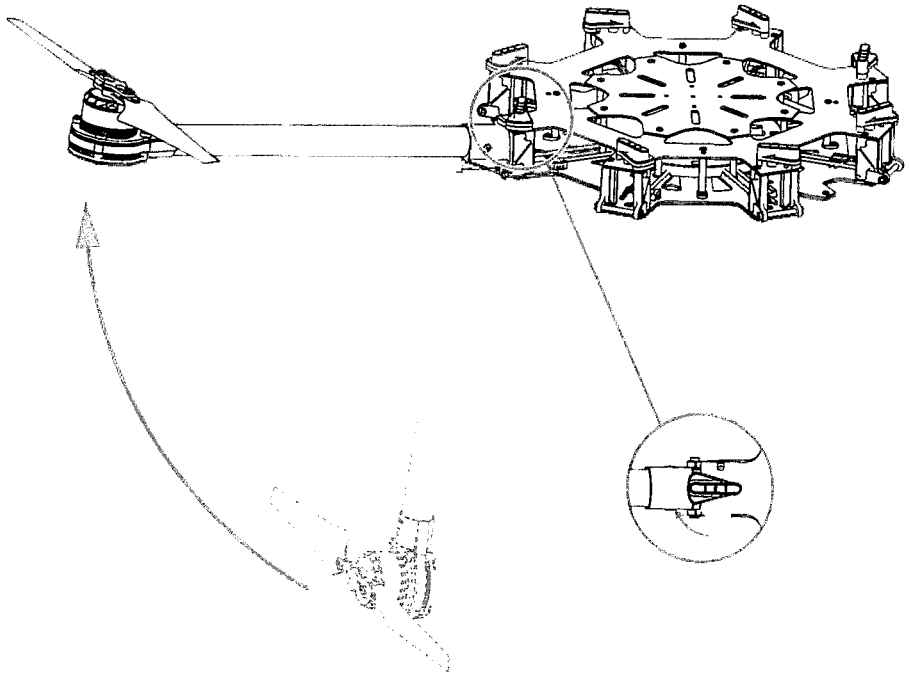


*LED is on after motor started.

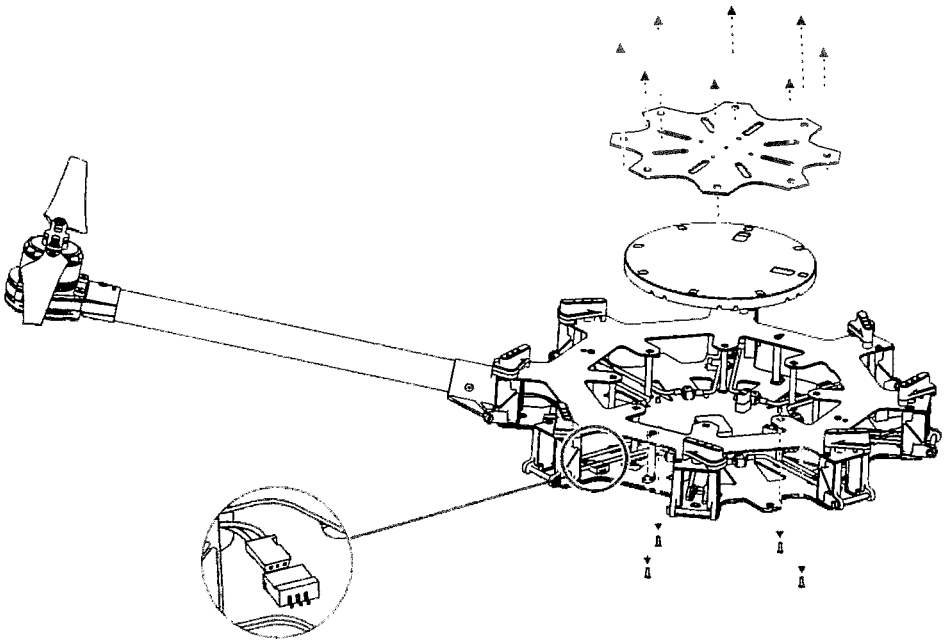
2. Insert each frame arm vertically into the mounting area on the center frame.
3. Line up the screw holes of the frame arm and center frame.
4. Insert the M4x35 screw from the right of the frame arm (the thread is located on the left of the screw mount). Tighten each screw correctly. Over tightening may lead to connector abrasion.



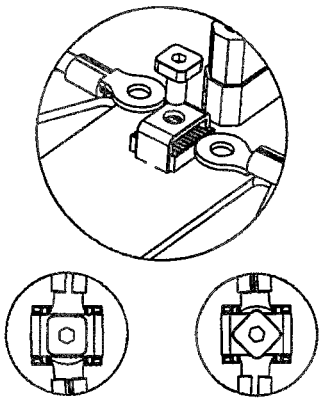
5. Gently lift the frame arm.
6. Twist the red knob to lock each arm in place. Be sure there is an audible click, which indicates a proper lock. Check the arm for movement. To store, untwist the knob and lower the frame arm.

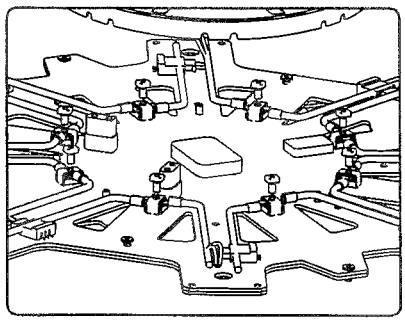


7. Now unscrew 8 screws (M2.5x8 cheese) on the upper plate of the center frame and remove the upper plate. Then unscrew the 4 screws (M3x8 self-tapping, found under the center frame) of the round cover and remove it to gain access to the ESC and power cable installation area.
8. Plug each ESC signal cable into the slot near each arm on the center frame.

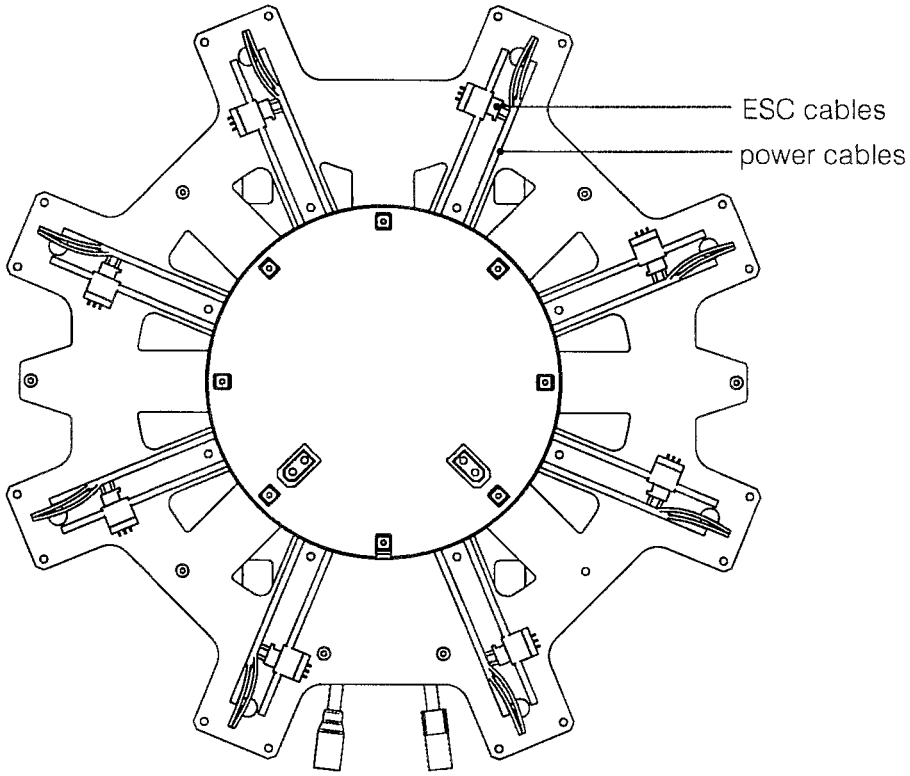


9. Connect the power cables to the center frame. Each cable must be screwed into a positive (+) or negative (-) gold bracket. Each bracket will have two cables of the same color screwed into it. Red cables are positive and black cables are negative.
10. To ensure a reliable connection, rotate the screw until it is both tight and parallel to the connecting bracket.

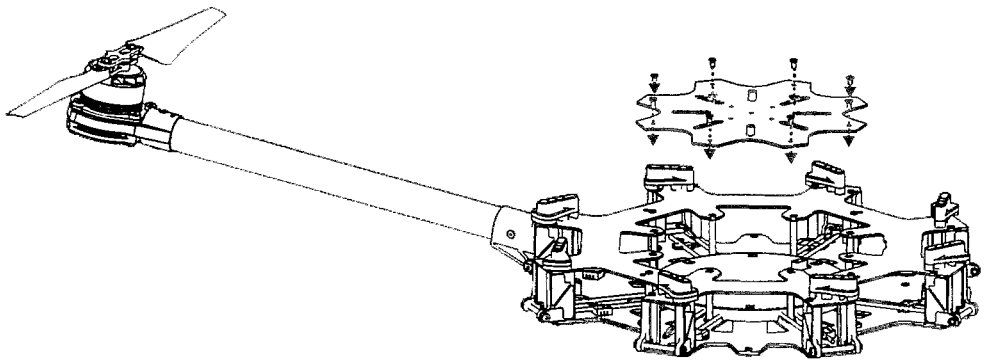




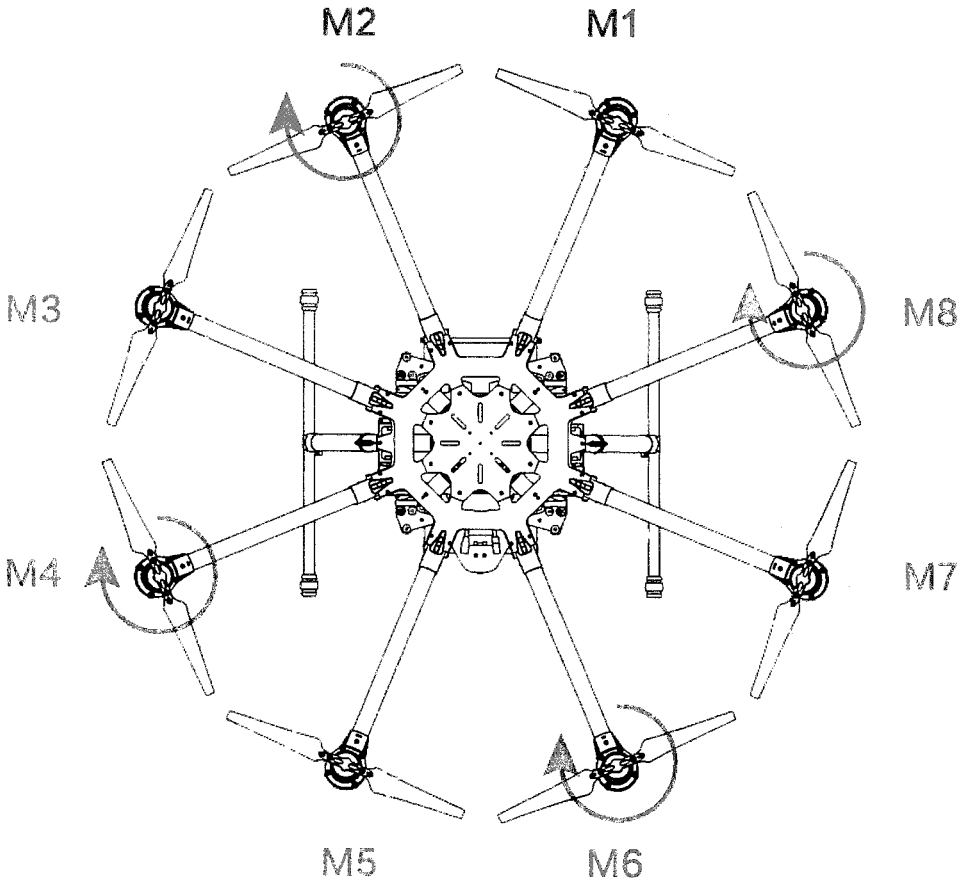
11. Ensure all ESC cables, and power cables are correctly installed onto the center frame.



12. Replace the round cover of the center plate, and re-tighten the 4 screws (M3x8 self-tapping). Then replace the upper plate of the center frame, and re-tighten the 8 screws (M2.5x8 cheese).



13. Double check all frame arms. Arms M1 and M2 are the forward facing (nose), arms M5 and M6 are the tail. Seen from the top, motors on arms M1, M3, M5 and M7 rotate counter clockwise while those on arms M2, M4, M6 and M8 rotate clockwise.

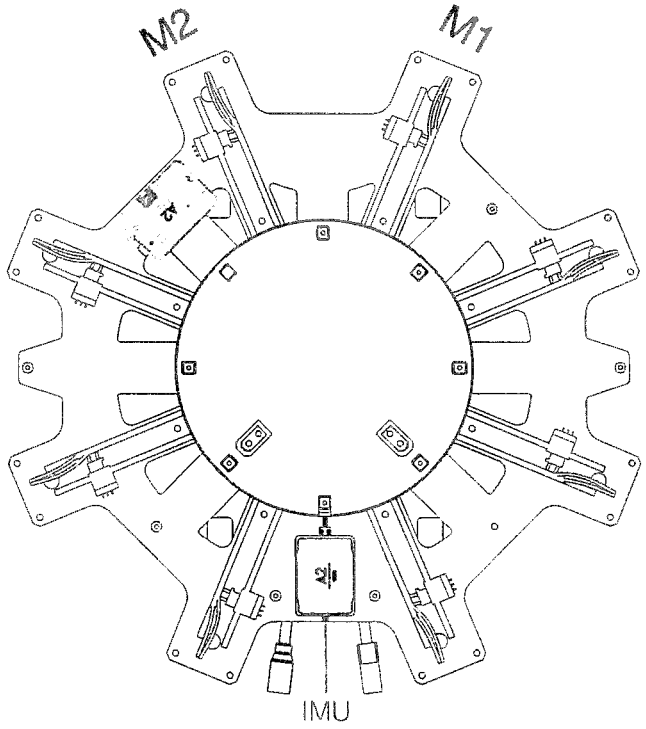


Mounting Electronics and Wiring

Eight positions are reserved for mounting a flight control system, wireless video transmission module, receiver, and other accessories. The DJI A2 flight control system has been used here as an example. If using an A2, follow mounting and wiring instructions found in the A2 flight control system user manual. If using the DJI WK-M flight control system, please refer to the WK-M user manual for connections. Also be sure the firmware on your DJI flight controller has been updated to the latest version.

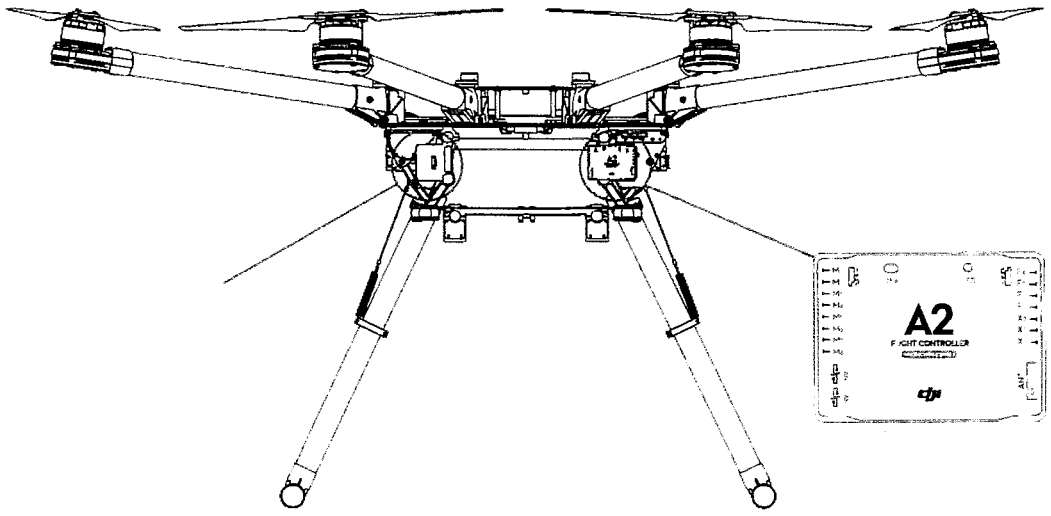
Instructions

1. Attach IMU module to the IMU area of the center frame. Ensure that it points toward the nose.
2. Attach the PMU module to the center frame.

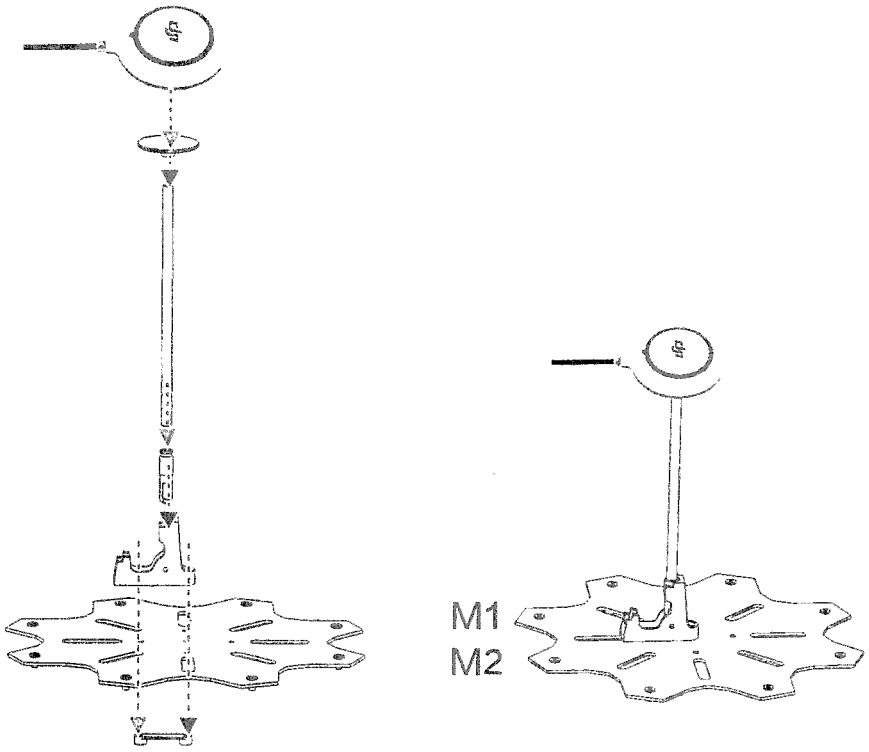


⚠ Only mount the IMU in the IMU position of the center frame.

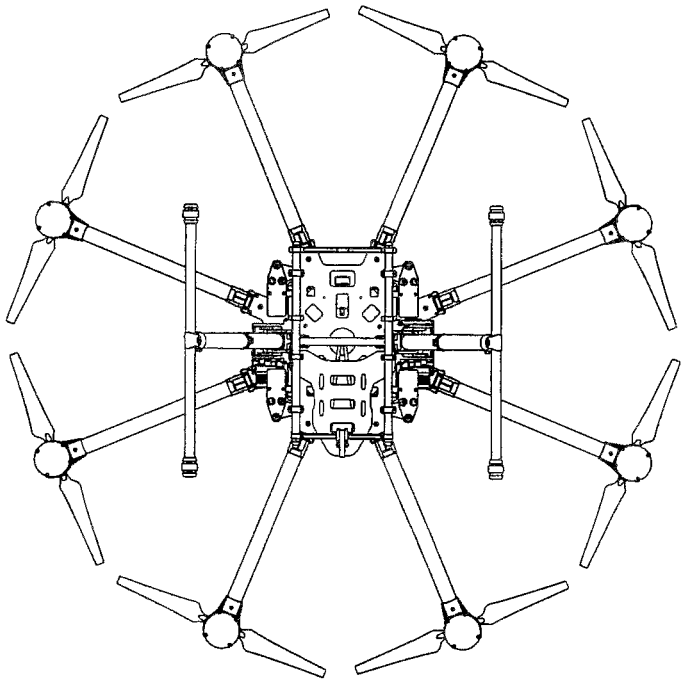
3. Mount the flight controller in the reserved position near the PMU module.



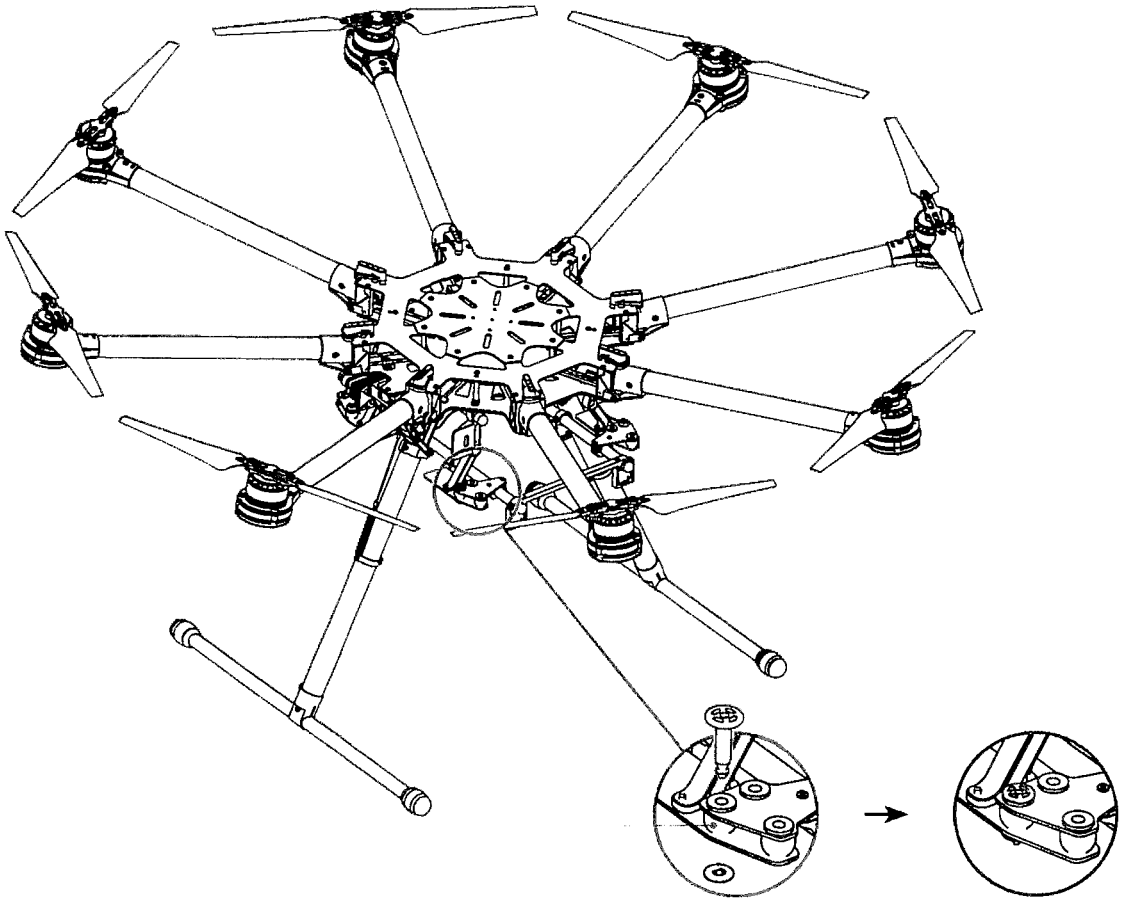
4. Attach the GPS collapsible mount to the center frame using M2.5×8 screws.
5. Mount a GPS module to the GPS mount with a bracket. Ensure the arrow points toward the nose and avoid catching your fingers in the bracket when folding for transportation.



6. The other reserved positions are indicated in the diagram below and can be used for mounting a receiver, LED flight indicator, iOSD module and wireless video transmission module.



7. Check that each Anti-drop Kit has been firmly installed in the reserved positions.
8. Note that the dampers are 45° silicon rubber. If you use other dampers or vibration absorbing balls, the quality of your aerial photography may be affected.



⚠
- Mount the GPS with a bracket to avoid interference from the center frame power board.
- Use glue to install the GPS bracket. Ensure it is firm and stable before every flight.
- Once the Anti-drop Kit is installed and the pin is inserted into the washer, the Anti-drop Kit cannot be disconnected and reused.
- Always test motors using the Assistant after installation. Refer to your flight control system user manual for details.

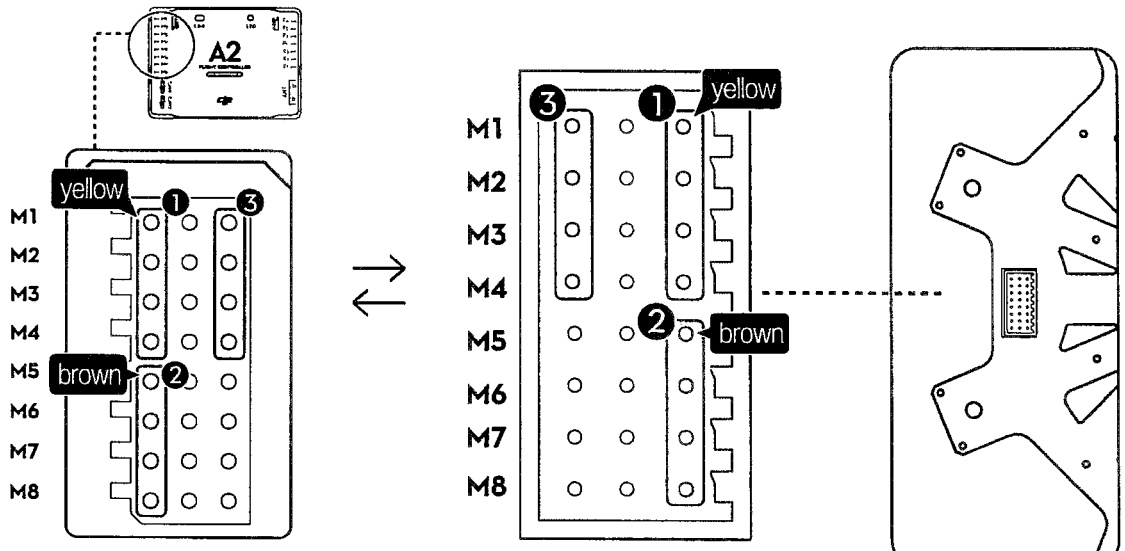
Connecting the flight controller to the center frame

1. Connect the flight control system according to your flight control system user manual.
2. Connect the flight controller to the center frame with the connection cables.
   There are two kinds of connection cables. Choose the corresponding connection mode according to the connection cable in the box.

Using the connector set:

Plug in the connector set to the ESC signal outlet on the center frame. Then plug in the connector set to flight controller as shown below.

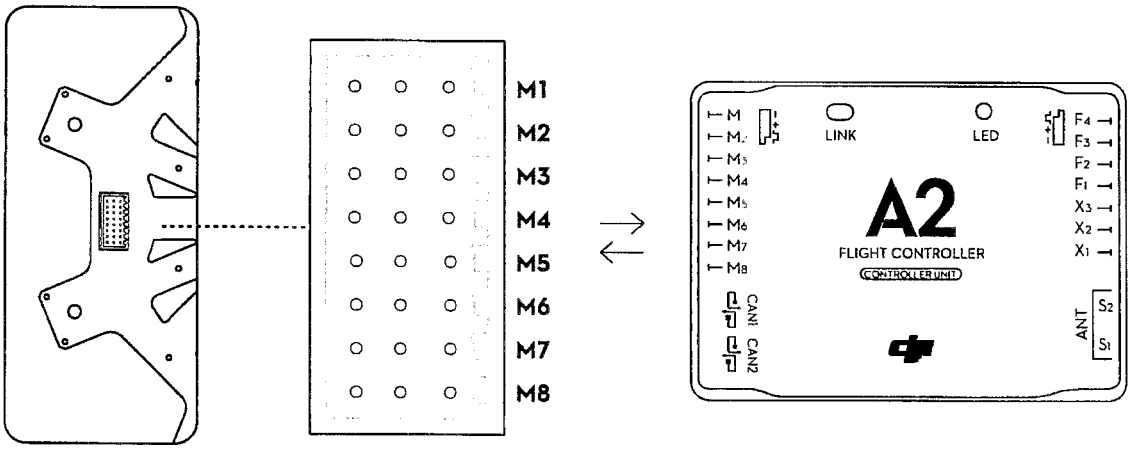
(1) Yellow 4-pin cables are for M1~ M4 connections. The yellow cable should be connected to M1.
(2) Brown 4-pin cables are for M5~ M8 connections. The brown cable should be connected to M5.
(3) Black 4-pin cables are for four continuous ground pins connections. M1~M4 are connected as the following diagram shows.



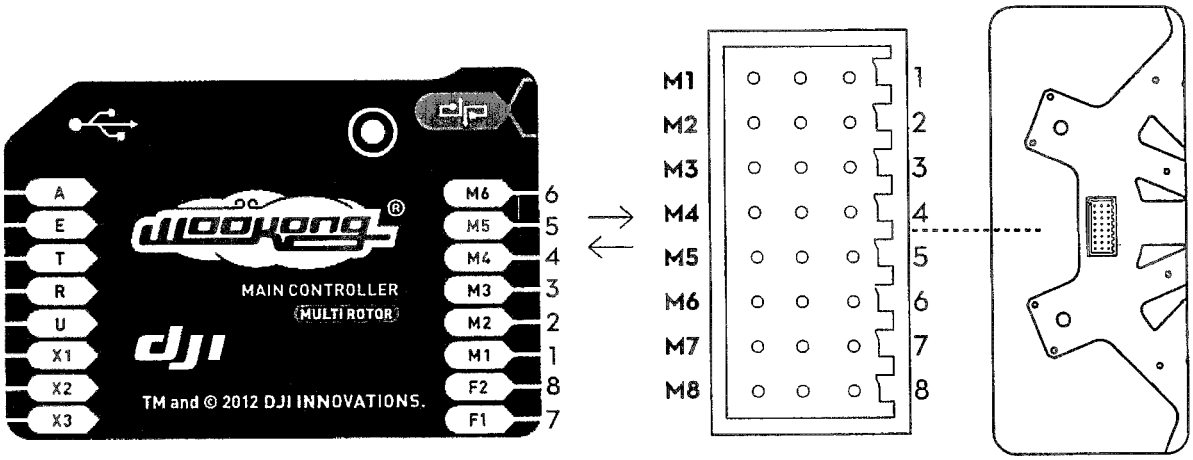
troller

Using the 3-pin connection cable:

M1 through M8 correspond to each motor number.



⚠ If using a DJI WK-M flight control system, you must use the wires that came with the WK-M. M1 through M6 correspond to each motor number. M7 corresponds to F1 and M8 corresponds to F2 on the WK-M.

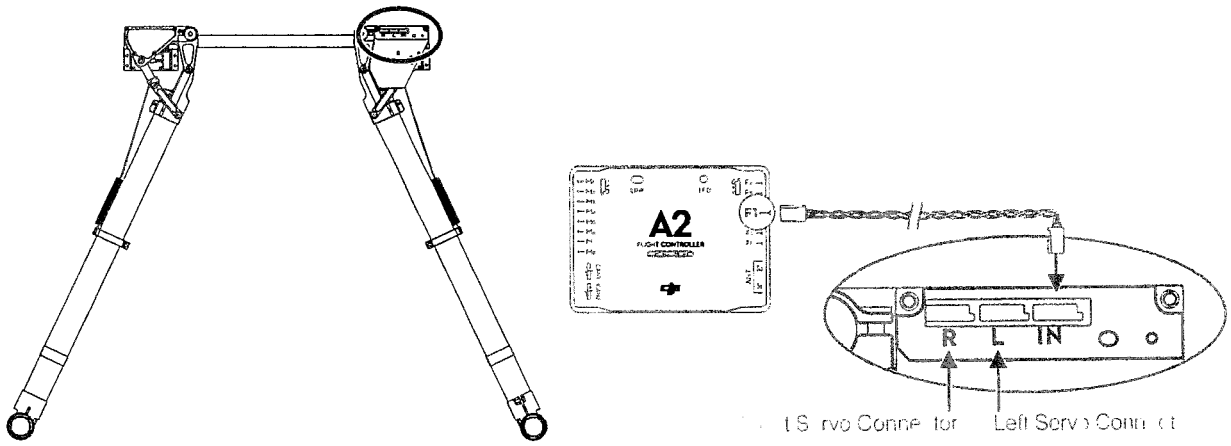


WKM Flight Controller

the ESC Signal Outlet

Connecting the flight controller and landing gear

1. Connect the left servo (between M3 and M4) cable to the "L" port of the landing gear control board.
2. Connect the right servo (between M7 and M8) cable to the "R" port of the landing gear control board.
3. For the A2 flight control system, connect the F1 port of the flight controller to the "IN" port of the landing gear control board. Other flight control systems connect a 2-position channel receiver to the "IN" port.



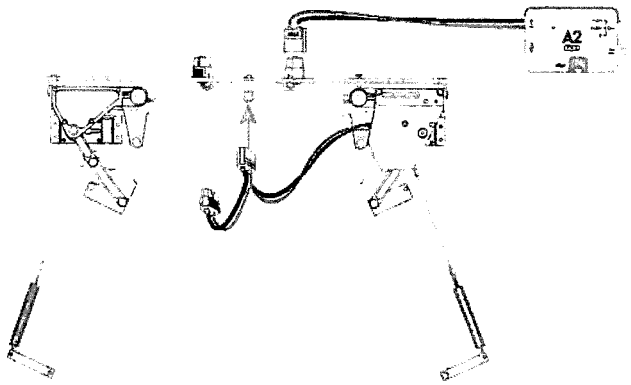
⚠
- If right and left servo cables are reversed, the landing gear will not function properly.
- Connect all wires carefully and neatly to avoid cable damage caused by frame edges.

Connecting XT60 Ports on the Center Frame

The bottom board is a power distribution board with three XT60 connectors for battery power.

Instructions

1. Connect the PMU power cable to the XT60 connector on top of the bottom board.
2. Connect the landing gear control board cable to the XT60 connector on the bottom of the bottom board.
3. Other connectors can supply power for other DJI devices, as required.

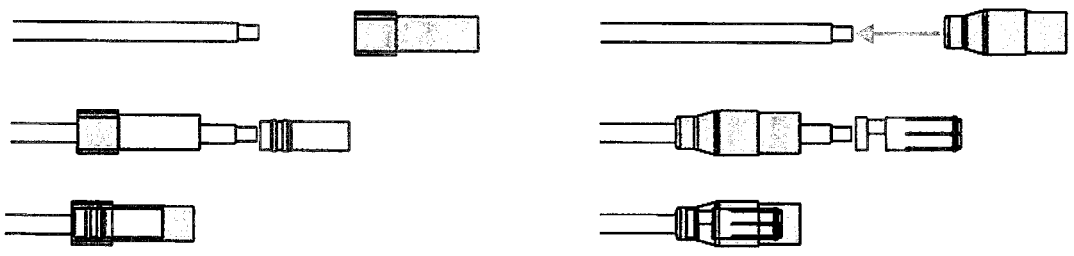


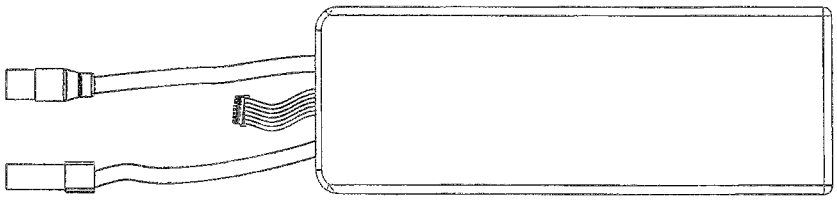
Installing Battery

Soldering battery connectors

AS150 spark-proof connectors are used. They must be soldered to your battery power cables.

1. Remove the original battery connectors. Avoid cutting the power and ground cables at the same time, as this can cause a short circuit. We recommend wrapping unsoldered cables with insulating tape to prevent accidental connections.
2. Pass the black ground wire through the black housing. After passing the wire through, solder the female bullet connector to the ground wire. Wait for the soldered connection to cool, then pull the housing back over the bullet connector.
3. Screw and pass the red power wire through the red housing. After passing the wire through, solder the male bullet connector to the power wire. Wait for the soldered connection to cool, and then screw and pull the housing back over the bullet connector.

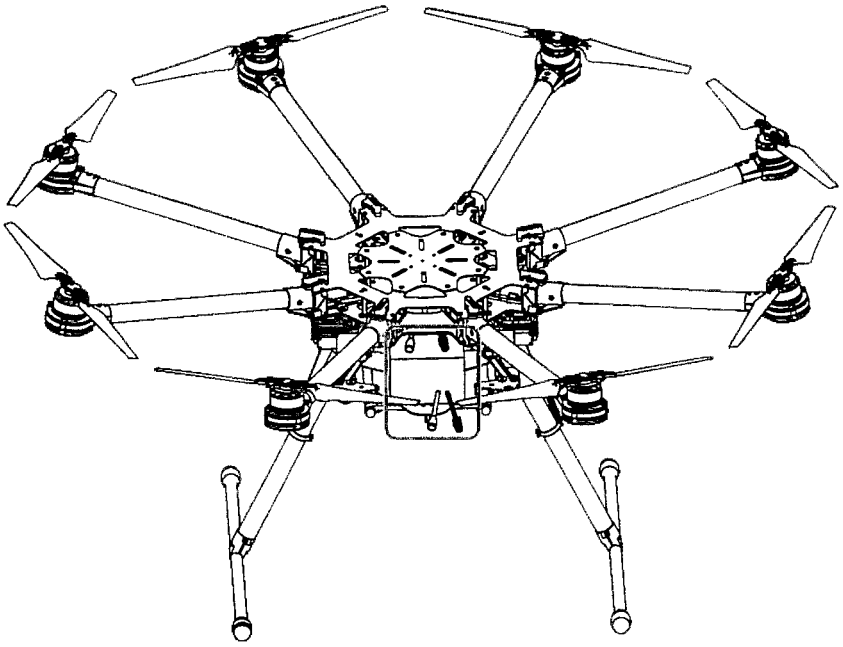


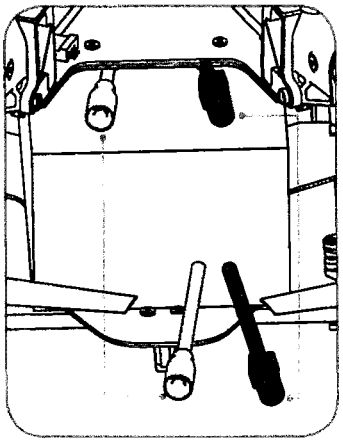


Connectors are s der 1

Installing and connecting battery

1. Attach battery to battery tray. Do not use an oversized battery. Maximum installation dimension is 80mm×120mm×200mm.
2. Connect the black connector and then the red connector to power on. Disconnect the red connector then black connector to power off.



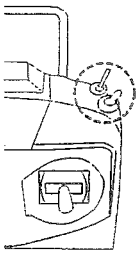


Setting Up the Landing Gear

Using a 2-position RC transmitter switch, landing gear retraction can be carried out remotely.

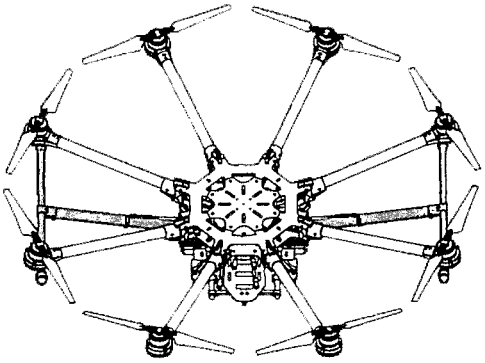
Setting up the transmitter

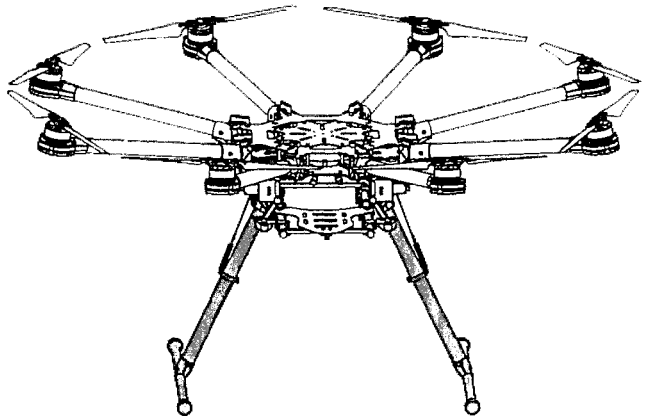
Select a 2-position switch (default setting is OK) as the control input for the landing gear. Ensure the corresponding receiver port is connected to the "IN" port on control board. For the A2 flight control system, connect the flight controller's F1 port to "IN" port on control board.



Upper: Toggle the switch to this position to raise the landing gear.

Lower: Toggle the switch to this position to lower the landing gear.





⚠
- If the transmitter switch has a FailSafe function, set the FailSafe value to the [Lower] position. This ensures that the landing gear will lower automatically when the receiver enters FailSafe mode.
- To avoid accidental switch triggering, slide levers or other controls can be used for landing gear control.

Usage procedures

1. Ensure transmitter and receiver batteries are fully charged.
2. Toggle the switch to the [Lower] position, and then turn on the transmitter.
3. Ensure the "R", "L" and "IN" connections are correct.
4. Ensure the landing gear is in the [Lower] position, then power on the system. If a solid green LED on the landing gear control board lights up, everything is normal. If it flashes green slowly, re-calibrate the system according to instructions in "Recalibrating Servo Travel".
5. Toggle the switch to the [Upper] position ONLY AFTER takeoff.
6. Toggle the switch to the [Lower] position for landing.

- Servo power will shut off 3 seconds after the landing gear has reached its target position.
- When powering on the system, if the transmitter switch is in the [Upper] position, the LED will flash red quickly as a warning. Toggle the switch to the [Lower] position to continue.
- If there is an abnormal signal or no signal input into the "IN" port, the LED will slowly flash red. Check receiver and connections for problems.
- If servo power consumption is too high, the LED will light up red. If this lasts more than 4 seconds, the landing gear will lower and the LED will flash green slowly. Re-calibration is needed before flying.
- A2 flight control system users can use the A2 Assistant to set intelligent gear on the "Advanced" page. Refer to the "A2 user manual" for details.

LED Control Board Indicator

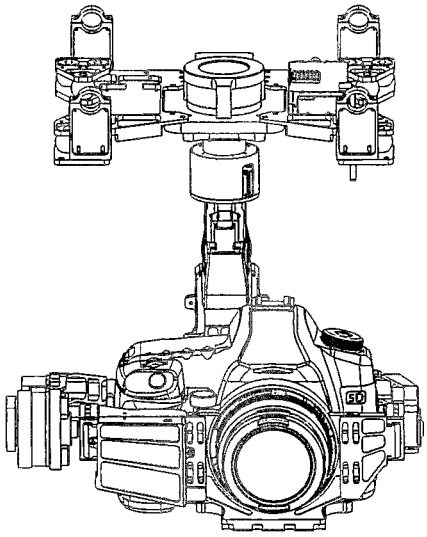
System normal	Ⓖ —— Solid green.
Calibration required	Ⓖ ····· Blinks rapid green.
Recalibration required	Ⓖ ····· Blinks slow green.
Calibration failed	Ⓨ Solid yellow.
Enter calibration mode	Ⓨ ····· Blinks rapid yellow.
System calibrating	Ⓨ ····· Blinks slow yellow.
Motor stalled	Ⓡ —— Solid red.
Unsafe startup alert	Ⓡ ····· Blinks rapid red.
Input signal abnormal	Ⓡ ····· Blinks slow green.

Landing Gear Specifications

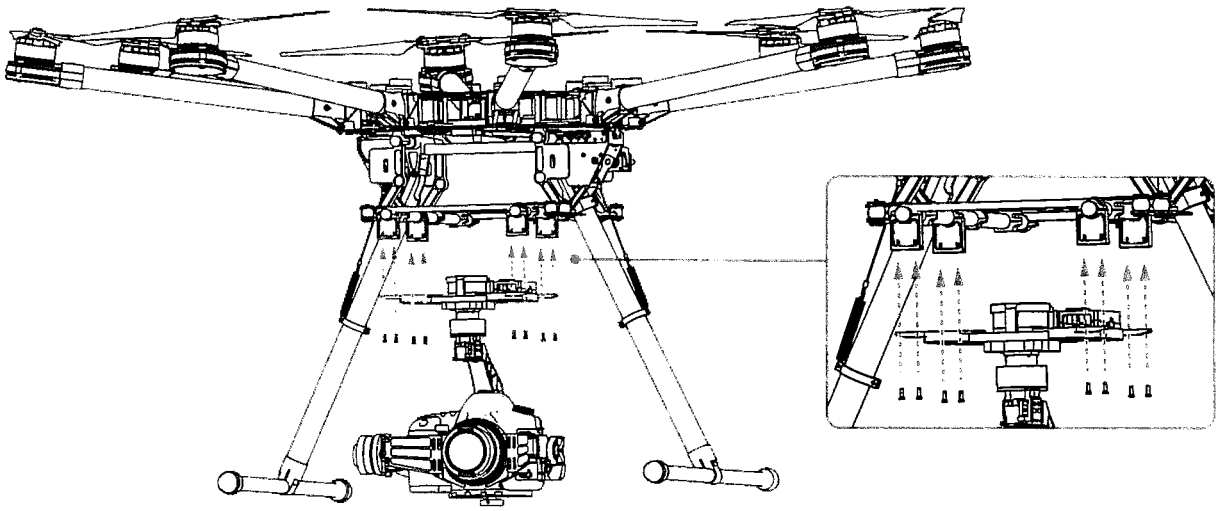
Parameter	Range	Parameter	Range
Working Voltage	3S~6S (LiPo)	Input Signal	PWM (High-Pulse Width 800us~2200us)
Working Current	Max 1A@6S	Output Signal	PWM (Mid Position is 1520us) in 90Hz
Working Temperature	-20~70° C	Output Voltage	6V
Total Weight	875g	Servo Travel	150° (Minimum 120°)

Mounting the Gimbal

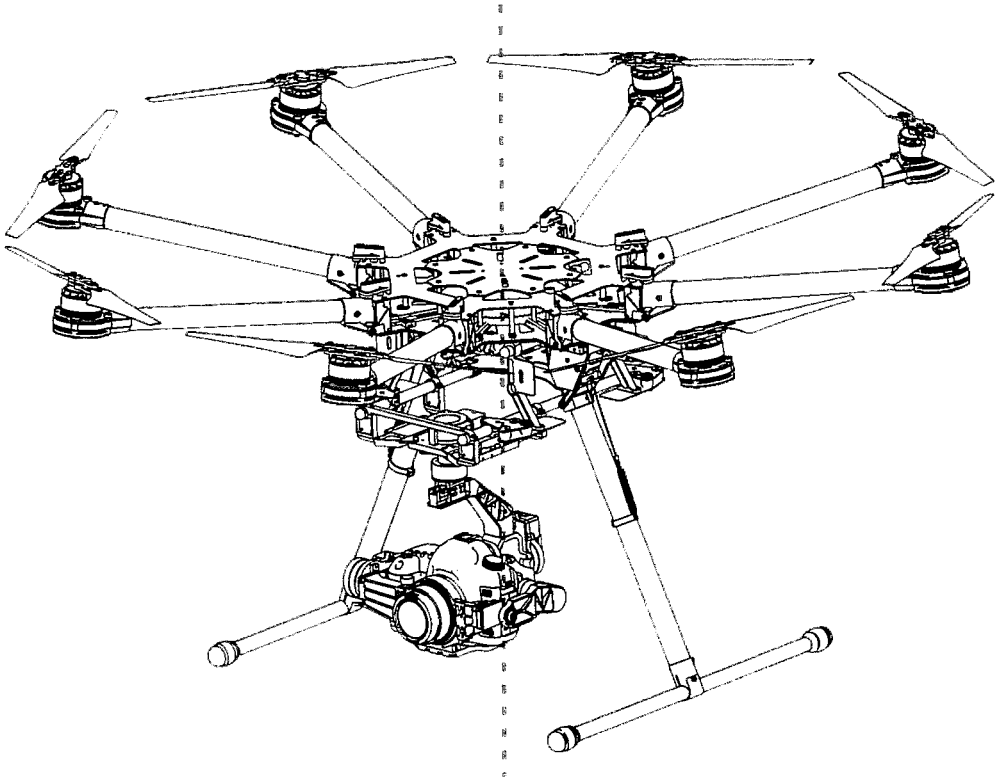
Before assembling the gimbal, install the GCU as shown below. Be sure to install on the side as shown below. A DJI Z15-5D MARK III (HD) gimbal has been used as an example in the following diagrams.



The connectors on gimbal should be removed for better performance, then the gimbal can be mounted to the lower connection points.



Check that the system's center of gravity is on the line as shown in the diagram below.



Appendix

ESC Sound

ESC State	Sound
Ready	♪1234567--B--B
Throttle stick is not at bottom	BBBBBB...
Input signal abnormal	B·····B·····B...
Input voltage abnormal	BB···BB···BB···BB...

ESC LED

ESC State	LED
Standby	Off
Motor rotating	Solid Red or Green On
Motor rotating at full throttle position	Solid Yellow On

⚠ DJI ESCs are specifically designed for multi-rotors. When used with DJI autopilot systems parameters and travel ranges do not have to be calibrated.

Specifications

Frame	
Diagonal Wheelbase	1045mm
Frame Arm Length	386mm
Frame Arm Weight (with Motor, ESC, Propeller)	325g
Center Frame Diameter	337mm
Center Frame Weight (with Landing Gear Mounting Base, Servos)	1520g
Landing Gear Size	460mm(Length)×511mm(Width)×305mm(Height)
Motor	
Stator Size	41×14mm
KV	400rpm/V
Max Power	500W

Weight (with Cooling Fan)	158g

ESC

Working Current	40A
Working Voltage	6S LiPo
Signal Frequency	30Hz ~ 450Hz
Drive PWM Frequency	8KHz
Weight (with Radiators)	35g

Foldable Propeller (1552/1552R)

Material	High strength performance engineered plastics
Size	15x5.2 inch
Weight	13g

Flight Parameters

Takeoff Weight	6.0Kg ~ 11.0Kg
Total Weight	4.4Kg
Power Battery	LiPo (6S,10000mAh~20000mAh,15C(Min))
Max Power Consumption	4000W
Hovering Power Consumption	1500W (@9.5Kg Takeoff Weight)
Hovering Time	15min (@15000mAh & 9.5Kg Takeoff Weight)
Working Environment Temperature	-10° C ~ 40° C

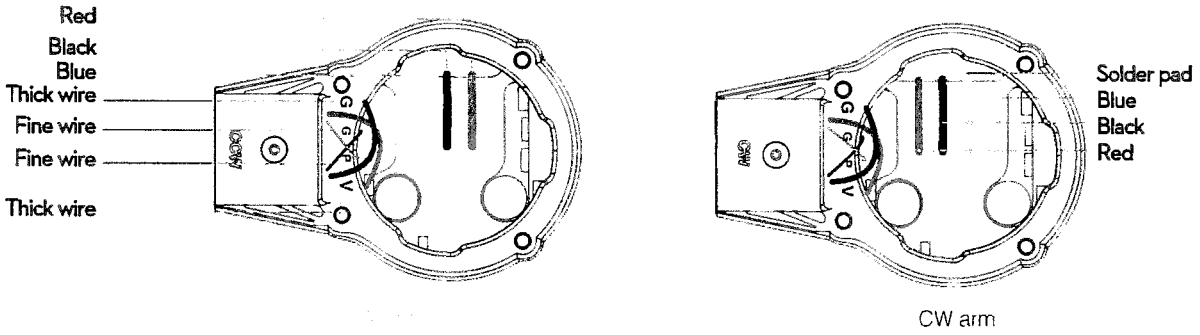
Gain Value Settings

Flight Control	Basic			Attitude		
	Pitch	Roll	Yaw	Pitch	Roll	Vertical
A2	120%	120%	120%	170%	170%	120%
WooKong-M	130%	130%	100%	180%	180%	100%

FAQ

Soldering the ESC

Be sure to solder the thick wires and fine wires correctly when soldering an ESC to the frame arm. Clockwise (CW) and counter clockwise (CCW) motors have a different arrangement of the colored wires.



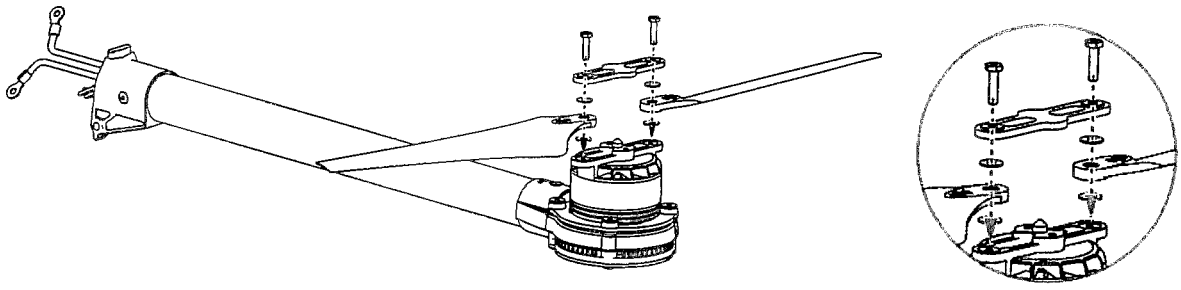
Remounting the Propellers

Instructions

1. Use two M3x12.3 screws and four washers to remount propellers.
2. Apply thread locker to the thread of the propellers mount first.
3. Affix screws with 3Kg · cm (0.3N · m) torque.

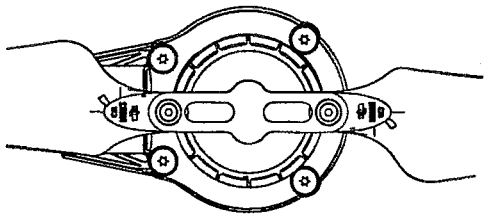
Refer to original screw tensions if you are unfamiliar with torque measurements. Applying thread locker to the propeller mount first avoids getting thread locker into the holes of the plastic propeller.

Loose screws cannot be securely locked with thread locker.



Propeller Precautions

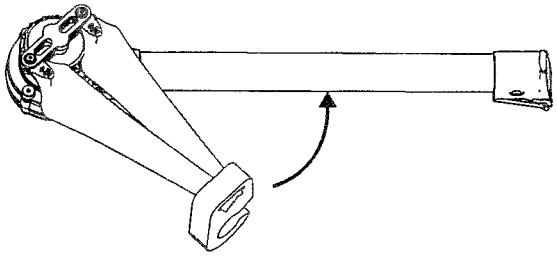
Torque markers on the screws and propeller covers will give you a visual cue to check whether the propellers are loose. Check the torque markers before every flight.

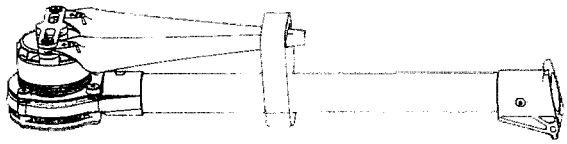


Using the Propeller Holder

Instructions

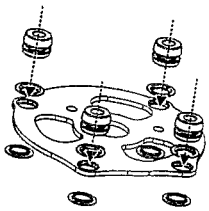
1. Insert the propeller blades into the propeller holder.
2. Attach the propeller holder to the frame arm.

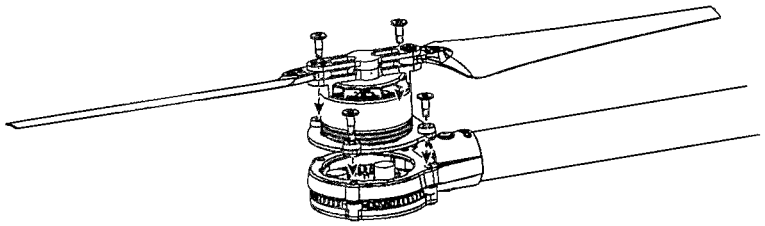




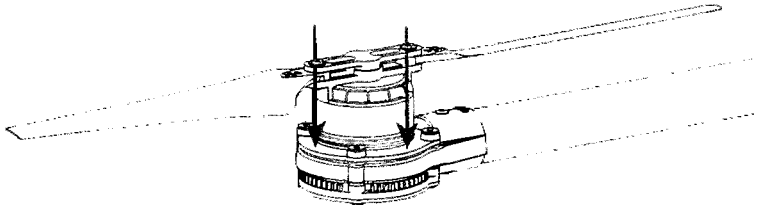
Assembling Motor Vibration Absorbers

A soft damper is part of the vibration absorber. Assemble soft dampers as shown below. Assembly is the same for CCW and CW propellers.





⚠
- Ensure all soft dampers and vibration absorbers are in good condition before every flight. If not, replace immediately. Otherwise, the flight performance of your aircraft will be adversely affected.
- Before installing the soft dampers, put the copper gaskets onto the four mounting holes on the carbon plate. Then put the soft dampers into the mounting holes.
- After tightening the screws, the vibration absorbers may be twisted. If this is the case, hold the motor with your thumbs under the base plate and fingers on the top carbon plate, and squeeze the plates together to make the vibration absorbers flat and parallel with the plates.

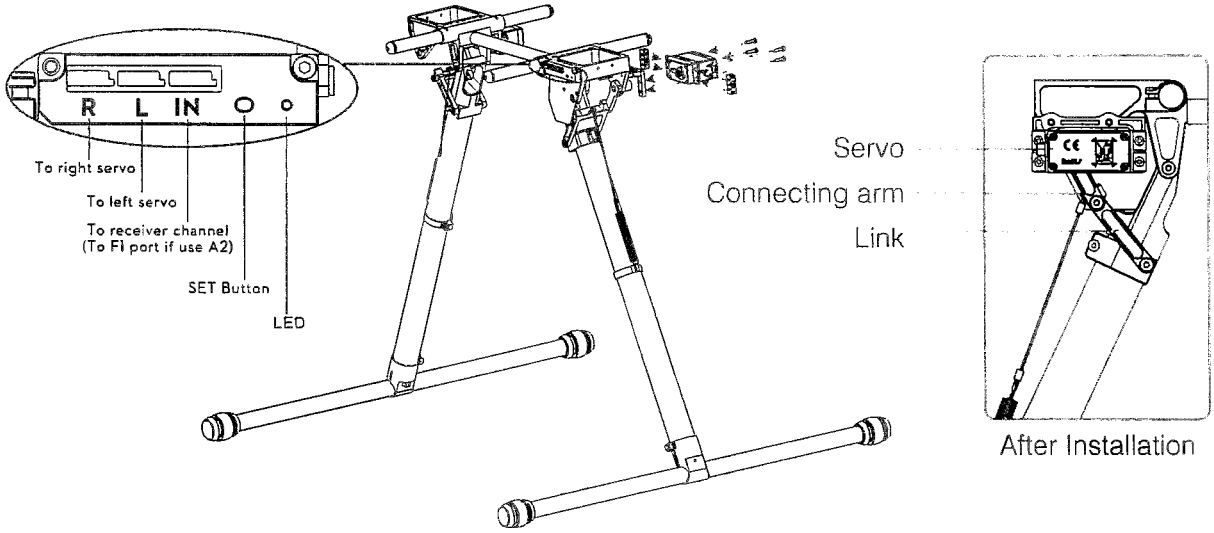


Remounting the Landing Gear Servo

Remounting servos is not recommended as they are pre-installed.

Instructions

1. Connect the left servo cable to the "L" port of the landing gear control board.
2. Connect the right servo cable to the "R" port of the landing gear control board.
3. Press and hold the SET button using a pin then power on. You will see a yellow LED beside the SET button flashing quickly. Wait as servos complete position initialization.
4. Make sure the arm connecting to the servo is parallel to the link as shown in the following diagram.
5. Assemble the left and right servos to the left (between M3, M4) and the right (between M7, M8) parts of the landing gear. Power off.



Recalibrating Servo Travel

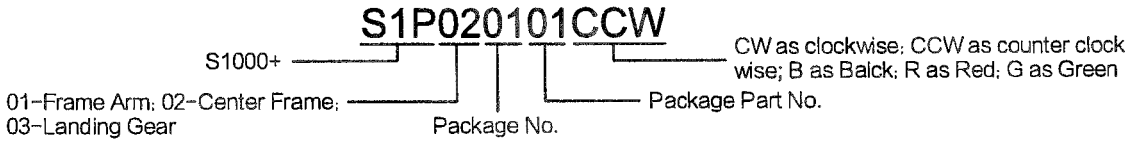
Instructions

1. Keep your hands away from all moving parts.
2. Ensure the "R", "L" and "IN" connections are correct.
3. Keep the whole aircraft off of the ground during calibration, as landing gear will move.
4. Press and hold the SET button using a pin while powering on, then release. An LED will flash yellow quickly. Press the SET button again. Auto calibration will begin and the LED will flash yellow slowly. DO NOT obstruct any moving parts during auto calibration.
5. During calibration, the left landing gear will raise and lower, followed by the right landing gear.
6. After calibration, both the left and right landing gears will be lowered and the LED will display a solid green light. This indicates that the landing gear is working properly.

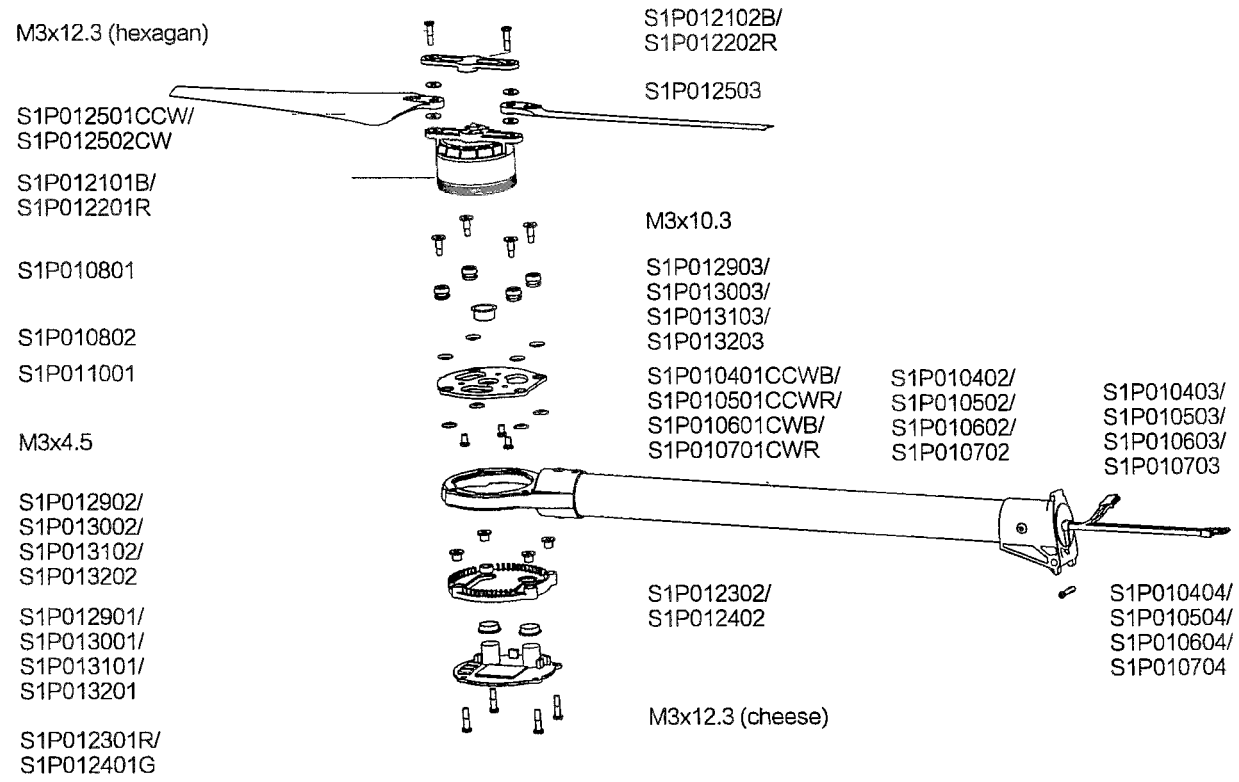
⚠
- If the LED is solid yellow after calibration, a problem has occurred. Carry out the instructions in "Remounting the Landing Gear Servo" then try again.
- Avoid obstructions during calibration. If the landing gear was obstructed, recalibration will be required, per the above steps.
- If the "R" and "L" servo cables are reversed, travel will not be measured correctly. Fix the connections and recalibrate the landing gear using the above steps.
- Landing gear travel has been pre-calibrated. Mechanical adjustment of the gear travel is not recommended.

Part List

If you require a replacement part, locate the part that you wish to replace in the following tables. Then order the package that comes with the specified part. The numbering of the part is defined as follow:



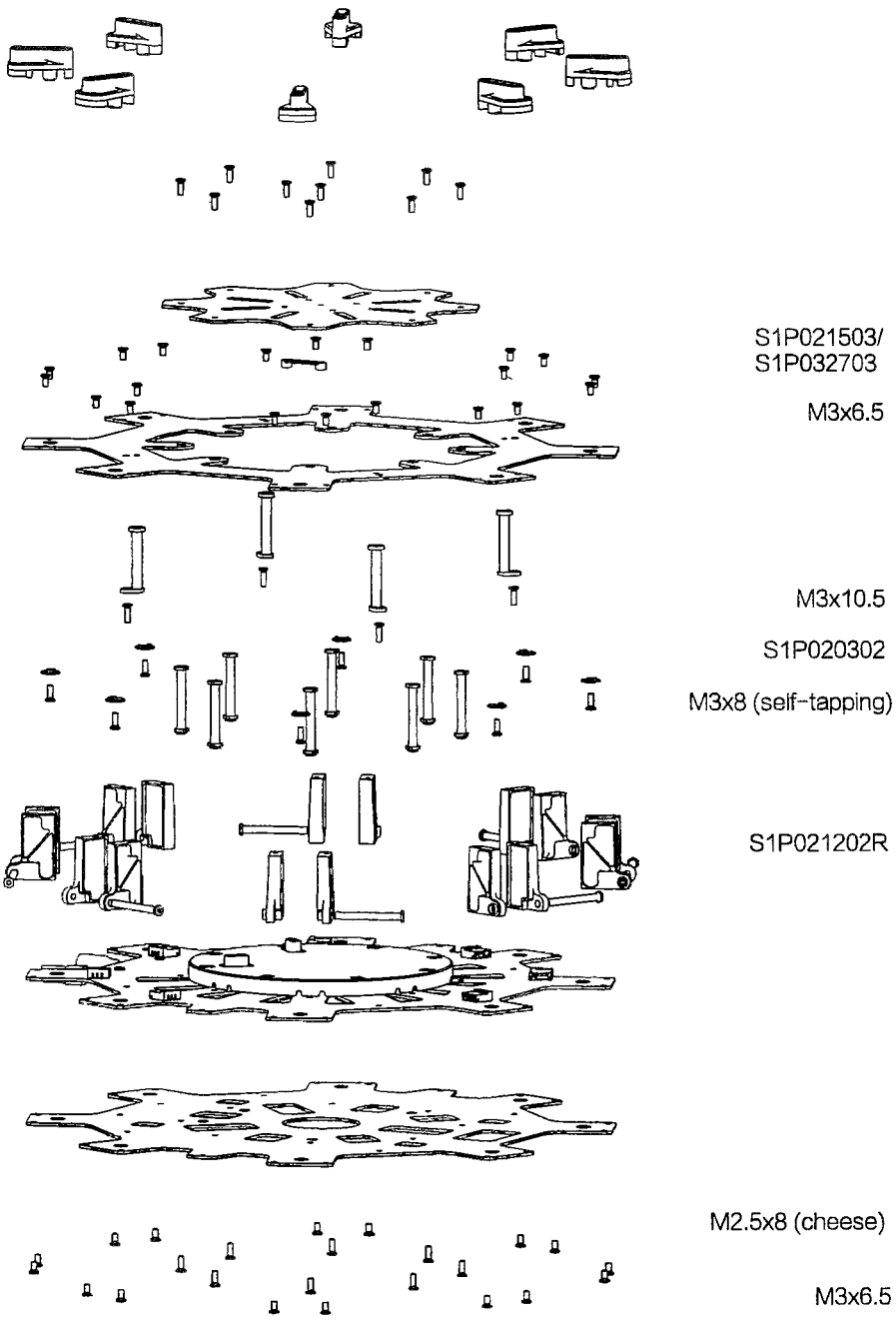
Frame Arm



Package No.	Name	Part No.
4	S1000+ Frame Arm CCW - Black	S1P010401CCWB, S1P010402, S1P010403, S1P010404, M3x12.3 (cheese)
5	S1000+ Frame Arm CCW - Red	S1P010501CCWR, S1P010502, S1P010503, S1P010504, M3x12.3 (cheese)
6	S1000+ Frame Arm CW - Black	S1P010601CWB, S1P010602, S1P010603, S1P010604, M3x12.3 (cheese)
7	S1000+ Frame Arm CW – Red	S1P010701CWR, S1P010702, S1P010703, S1P010704, M3x12.3 (cheese)
8	S1000+ Motor Damping Unit	S1P010801, S1P010802, M3x10.3
10	S1000+ Motor Mount Carbon Board	S1P011001, M3x4.5

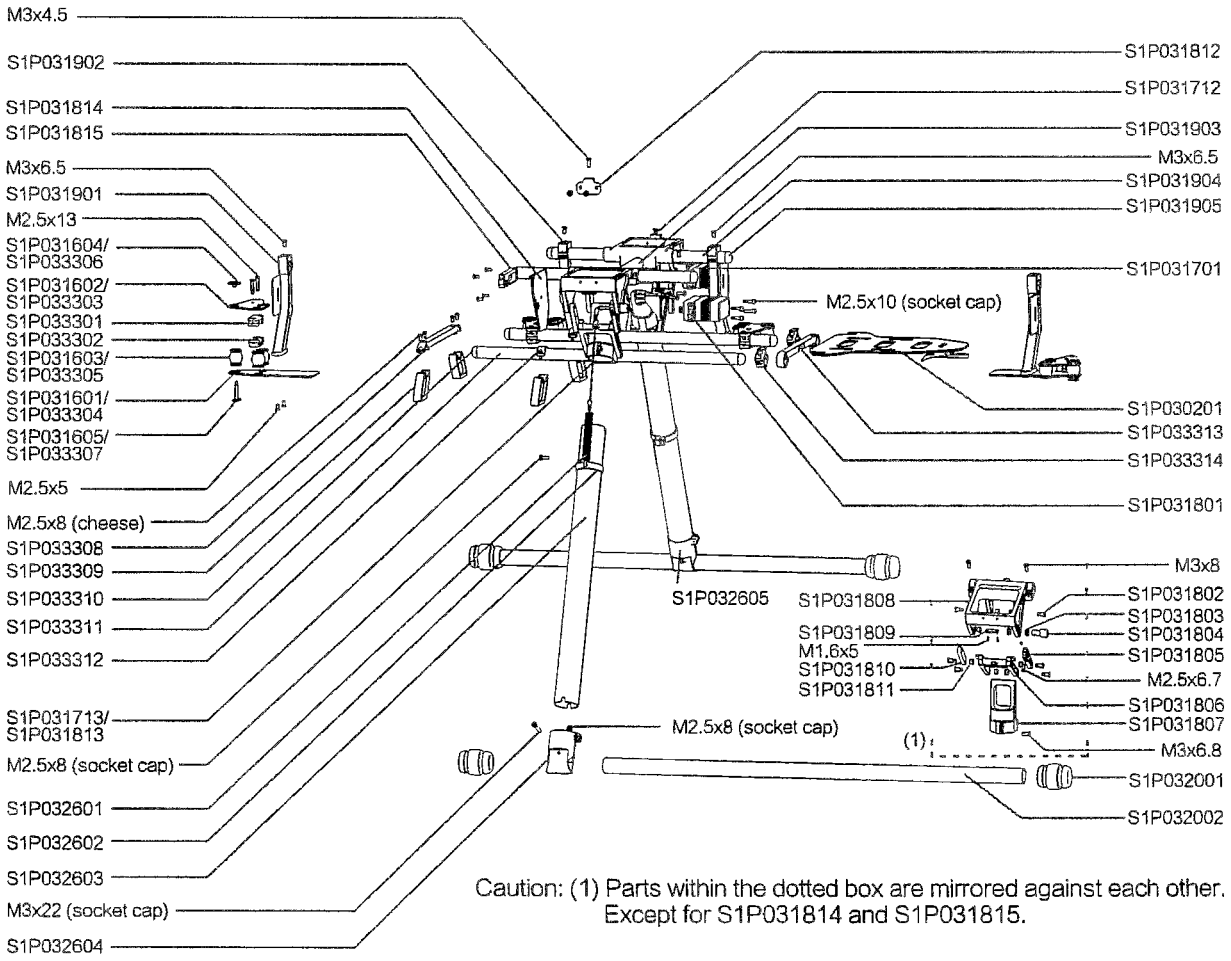
21	S1000+ 4114 Motor with black Prop cover	S1P012101B, S1P012102B, M3x4.5
22	S1000+ 4114 Motor with red Prop cover	S1P012201R, S1P012202R, M3x4.5
23	S1000+ ESC with Red LED	S1P012301R, S1P012302, M3x12.3 (cheese)
24	S1000+ ESC with Green LED	S1P012401G, S1P012402, M3x12.3 (cheese)
25	S1000+ Propeller Pack	S1P012501CCW, S1P012502CW, S1P012503, M3x12.3 (hexagan)

Center Frame



Package No.	Name	Part No.
3	S1000+ Lock Knob	S1P020301, S1P020302, M3x8 (self-tapping)
9	S1000+ Center Frame Support Pillar	S1P020901, M2.5x8 (cheese)
12	S1000+ Arm Mounting Bracket	S1P021201L, S1P021202R, S1P021203, M3x6.5
14	S1000+ Center Frame Bottom Board	S1P021401, M3x4.5 (cheese), M3x8 (self-tapping), M3x6.5, M3x5.5
15	S1000+ Center Frame Top Board	S1P021501, S1P021502, S1P021503, M3x6.5, M2.5x8 (cheese)
11	S1000+ Frame Arm Mounting Steel Shaft	S1P021101

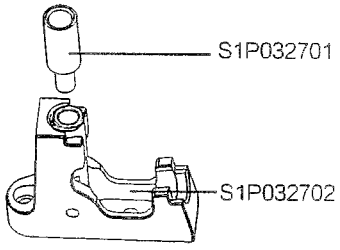
Landing Gear

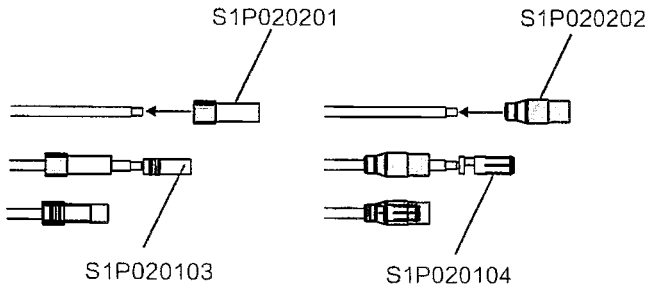


Caution: (1) Parts within the dotted box are mirrored against each other. Except for S1P031814 and S1P031815.

Package No.	Name	Part No.
16	S1000+ Gimbal Damping Bracket	S1P031601, S1P031602, S1P031603, S1P031604, S1P031605, M2.5x5, M2.5x13
17	S1000+ Retractable Module (Right)	S1P031701, S1P031702, S1P031703, S1P031704, S1P031705, S1P031706, S1P031707, S1P031708, S1P031709, S1P031710, S1P031711, S1P031712, S0031713, M1.6x5, M2.5x10 (socket cap), M2.5x8 (cheese), M2.5x5, M3x8, M3x4.5, M3x6.8
18	S1000+ Retractable Module (Left)	S1P031801, S1P031802, S1P031803, S1P031804, S1P031805, S1P031806, S1P031807, S1P031808, S1P031809, S1P031810, S1P031811, S1P031812, S1P031813, S1P031814, S1P031815, M1.6x5, M2.5x10 (socket cap), M2.5x8 (cheese), M2.5x5, M3x8, M3x4.5, M3x6.8
19	S1000+ Gimbal Damping Connecting Brackets	S1P031901, S1P031902, S1P031903, S1P031904, S1P031905, M2.5x5, M3x6.5
20	S1000+ Landing Skid	S1P032001, S1P032002
26	S1000+ Landing Gear Leg	S1P032601, S1P032602, S1P032603, S1P032604, S1P032605, M2.5x8 (socket cap), M3x22 (socket cap)
2	S1000+ Battery Tray	S1P030201
33	S1000+ Gimbal Mounting Accessories	S1P033301, S1P033302, S1P033303, S1P033304, S1P033305, S1P033306, S1P033307, S1P033308, S1P033309, S1P033310, S1P033311, S1P033312, S1P033313, S1P033314, M2.5x5, M2.5x13, M2.5x8 (cheese)

Miscellaneous





Package No.	Name	Part No.
13	S1000+ Center Frame	Package 3, 9, 12, 14, 15, S1P021301
29	S1000+ Complete Arm [CW-RED]	Package 7, 8, 10, 11, 22, 23, 25, S1P012901, S1P012902, S1P012903
30	S1000+ Complete Arm [CW-Green]	Package 6, 8, 10, 11, 21, 24, 25, S1P013001, S1P013002, S1P013003
31	S1000+ Complete Arm [CCW-RED]	Package 5, 8, 10, 11, 22, 23, 25, S1P013101, S1P013102, S1P013103
32	S1000+ Complete Arm [CCW-Green]	Package 4, 8, 10, 11, 21, 24, 25, S1P013201, S1P013202, S1P013203
27	S1000+ GPS Holder	S1P032701, S1P032702, S1P032703, M2.5x8 (cheese)
28	S1000+ Screw Pack	Assorted screws
1	S1000+ Power Cord Plug	S1P020101, S1P020102, S1P020103, S1P020104

FCC Statements

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

User manual is subject to change without prior notice.

You may visit DJI offical website to obtain the latest version of user manual.

http://www.dji.com/product/spreading-wings-s1000-plus

Appendix E: DJI A2 Flight Control System User Manual

A2 Flight Control System

User Manual V1.20

April 2015 Revision

Thank you for purchasing DJI products. Please strictly follow these steps to mount and connect this system on your aircraft, install the PC Assistant Software on your computer, as well as installing the DJI Assistant App on your mobile device.

Please regularly check the web page of corresponding products on our website **www.dji.com**, which is updated regularly. Product information, technical updates and manual corrections will be available on this website. Due to unforeseen changes or product upgrades, the information contained in this manual is subject to change without notice.

* This manual is for basic assembly and configuration; you can obtain more details and advanced instructions when using the Assistant Software. To assure you have the latest information, please visit our website and download the latest manual and current software version.

If you have any problems that you cannot solve during usage, please contact your authorized dealer.

Content

Introduction

Product Introduction

The DJI A2 Multi-Rotor stabilization controller is a complete flight system for various multi-rotor platforms for commercial and industrial aerial photography. Based on the technology and design philosophy of DJI's Ace series of high-performance controllers, the A2 offers you a brand new flight experience. Its flight mode provides a seamless transition for current Ace One, WKM AP professionals. A2 features includes:

(1) Integrated with high-precision sensor components and a high-performance GPS Receiver.

(2) Utilizes high quality components precisely calibrated with temperature compensation in all gyros and sensors, industry renowned flight algorithm in autopilot and UAV field.

(3) Designed with built-in vibration absorption, no extra mount frame or vibration absorption pad is required.

(4) Provide high precision control and high performance handling experience.

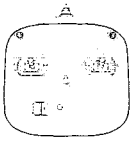
(5) Based on the DESST technology, it has a built-in 16-channel Receiver, and supports DSM2 satellite receiver.

(6) Optional DJI D-BUS Adapter can be used with a traditional Receiver.

In the Box

Controller Unit (Built-in Receiver DR16)	PMU(Power Management unit)	IMU(Inertia Measurement Unit)
		
LED-BT-I	GPS-COMPASS PRO PLUS	Accessories
		Micro-USB Cable (1) Servo Cables (2) GPS Bracket Double side sticky pads.

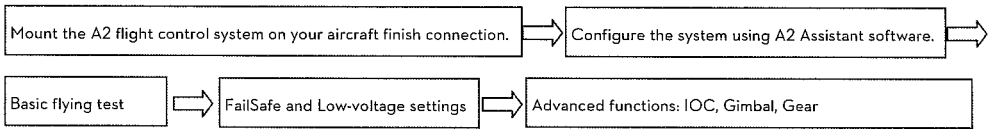
Equipment Prepared by Users

Aircraft (Take Quad-rotor for example: Red is nose, and Black is rear)	Transmitter (Take Mode2 for example)	Others
		Battery DJI D-BUS Adapter Mobile Device

System Introduction

The A2 flight control system uses the Controller Unit at its core, which is connected with the IMU, GPS-COMPASS PRO PLUS、LED-BT-I、PMU and ESCs to complete the system. The system can achieve the height-lock and position-lock functions by using the IMU and the GPS, to control the aircraft.

Please carry out the following procedures to finish assembly, configuration and flight-testing.



Symbol Instruction

General Symbol

	Forbidden(Important)		Cautions		Tips		Reference
GPS	GPS Satellite number		Distance		TX signal good		TX signal lost
	Roll to left		Roll to right		Pitch up		Pitch down

LED Symbol

○(N)	N=1	N=2	N=3	N=4	N=6	N=20	N=∝
Meaning	One Blink	Two Blinks	Three Blinks	Four Blinks	Six Blinks	Twenty Blinks	Continuous Blinks

e.g. ●(3) means three Red blinks.

●(∝)LED blinks yellow and green alternatively.

□ (N)	N=∝
Meaning	Continuous Solid on

e.g. ■(∝) means Continuous Blue Solid on.

1 Assembly and Configuration

For hardware installation, software configuration and compass calibration please adhere to the following sections.

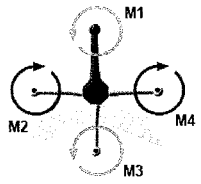
1.1 Hardware Installation and Connection

(1) Please adhere to "1.1.1 Mixer Type Supported" to choose a mixer type and assemble your aircraft.

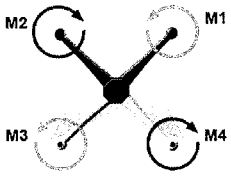
(2) Please adhere to both "1.1.2 Hardware Connection Diagram" and "1.1.3 Important for Assembly and Connection" to install and connect all units on your aircraft.

1.1.1 Mixer Type Supported

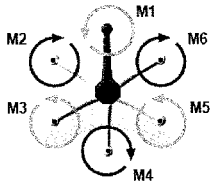
Following Mixer Types are supported.



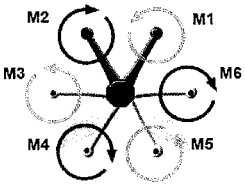
Quad-rotor I



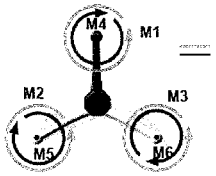
Quad-rotor X



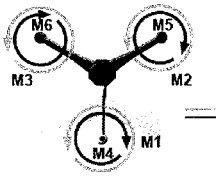
Hexa-rotor I



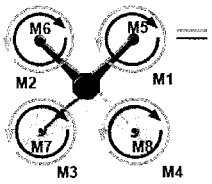
Hexa-rotor V



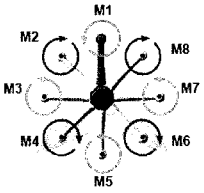
Hexa-rotor IY



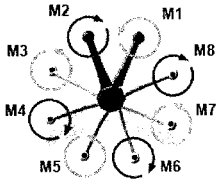
Hexa-rotor Y



Octo-rotor X



Octo-rotor I

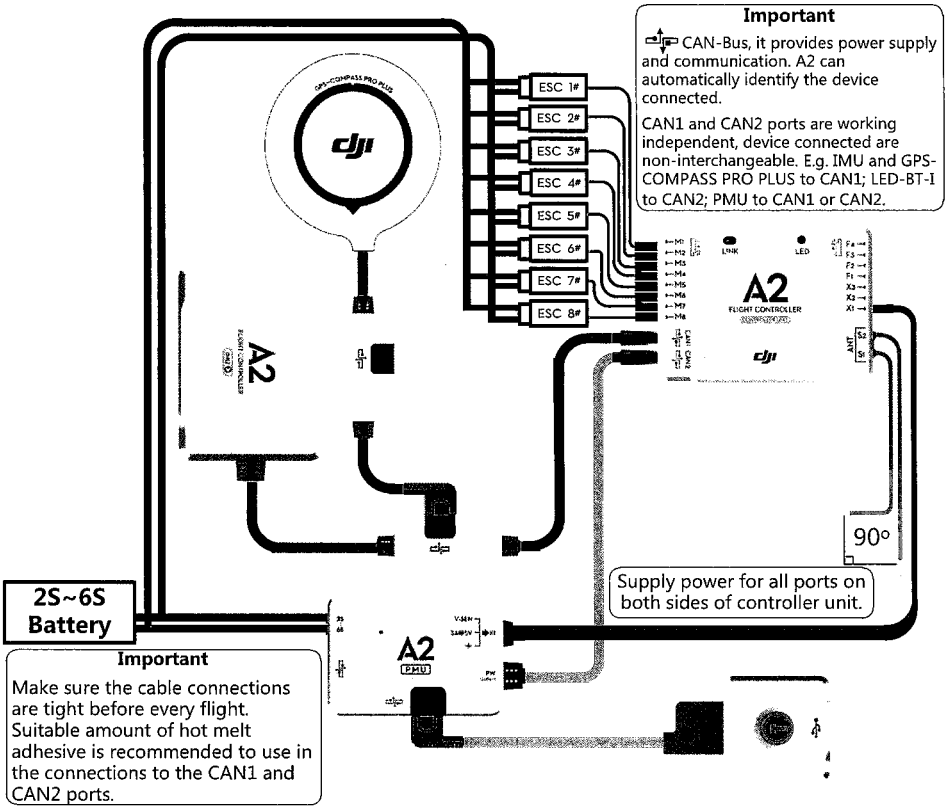


Octo-rotor V

The direction of the arrow in diagram indicates the rotation direction of the motor/propeller.

For coaxial propellers: [illegible] propeller is at [illegible]; Red propeller is at Bottom. Otherwise all propellers are at top.

1.1.2 Hardware Connection Diagram



1.1.3 Important for Assembly and Connection

This section describes all device port functions, assembly requirements, connection requirements and tips during usage. Also the linking procedures between the built-in Receiver DR16 and your Transmitter. Please read all information below carefully, especially if you are a first time user.

(1) Controller Unit

The Controller Unit is the core component of the A2 flight control system:

(1) M1-M8 are used to connect to the ESCs of the aircraft.

(2) The built-in Receiver DR16 is based on DJI DESST technology, which can be used with the Futaba FASST series and DJI DESST series Transmitter.

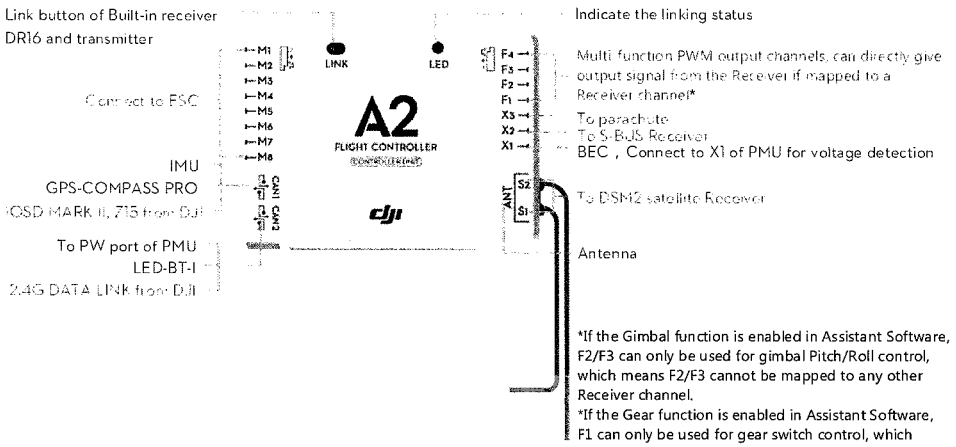
(3) CAN1 and CAN2 ports are working independently and should connect to different modules.

(4) 4 independent and configurable outputs.

(5) It is compatible with the external Receiver, e.g. DSM2 satellite Receiver.

(6) Use the optional DJI DBUS Adapter to support the traditional receiver.

Port Description



Mounting Requirements:

Install the Controller Unit in the proper position to make sure the ports are accessible. No specified direction is required.

⊘	Place the antennas in an open space under the aircraft, DO NOT block them. Position the heads of two antennas at a 90-degree angle. DO NOT bend or wind them.

Receiver System

The A2 flight control system can use its own built-in Receiver, and also can support external receivers. Whatever type of Receiver is used, please make sure that the Receiver and Transmitter is linked correctly before use.

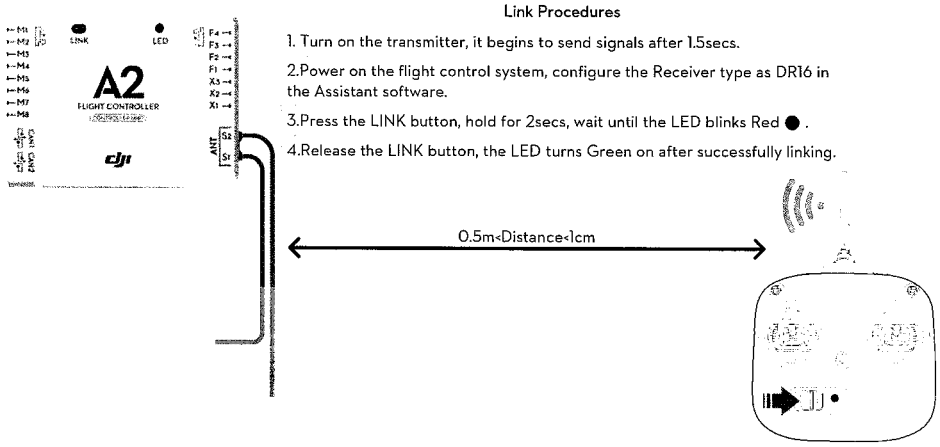
A. Built-in Receiver

For enhancing the system integration and reliability, the A2 is integrated with a 2.4G receiver based on frequency hopping technology. The built-in Receiver can be used with the Transmitter of Futaba FASST series or DJI DESST series after linking. For users, you are only asked to carry out the link procedures, no extra requirement for connection.

Please carry out the following procedures to finish the Link process, and the configuration in the **A2 Assistant software->Basic ->R/C ->Receiver Type**. Select the **DR16** option.

During use, you may see the following LED indication, please do the operation according to the table below.

LED	Description	Operation
●(∝)	Signal from Transmitter has been detected by the Receiver, but not matched.	Link operation required
■(∝)	No Transmitter signal is received, e.g. the flight control system is powered on but the Transmitter is powered off.	Switch on
■(∝)	The Receiver and Transmitter have been linked to each other successfully.	Can work normally



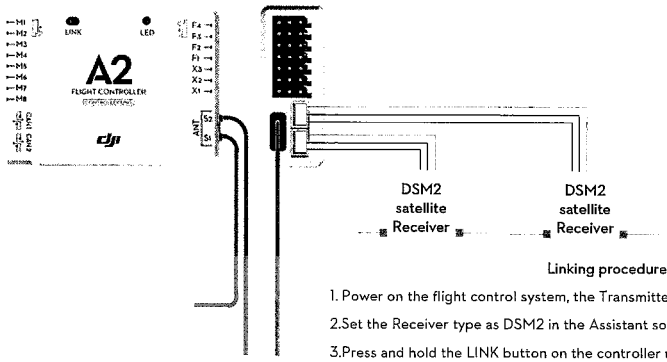
Link Procedures

1. Turn on the transmitter, it begins to send signals after 1.5secs.
2. Power on the flight control system, configure the Receiver type as DR16 in the Assistant software.
3. Press the LINK button, hold for 2secs, wait until the LED blinks Red ●.
4. Release the LINK button, the LED turns Green on after successfully linking.

The DR16 Receiver is compatible with the Futaba transmitters which have optional FASS MODE MULT, MLT2 or 7CH. Users can find out more available Futaba transmitters and configuration requirements refer to the FAQ->The Transmitter setup of FUTABA.

B. DSM2 Satellite Receivers

If using DSM2 satellite Receivers, please follow the diagram for connection, set the Receiver referring to your Receiver manual, and select the Receiver type as **DSM2** in the **Assistant software->Basic->R/C-> Receiver Type.**



Linking procedures

1. Power on the flight control system, the Transmitter should be turned off.
2. Set the Receiver type as DSM2 in the Assistant software.
3. Press and hold the LINK button on the controller unit the LED blinks red ● and the indicators on the Receivers blink too. Then release the LINK button the Receiver will be ready for linking.
4. Press and hold the linking button on the Transmitter then turn on the Transmitter to start linking, release the button after the Transmitter is displayed Linked or the indicators on the Receivers are solid on.
5. The LED on the controller unit will be solid green on after linking successfully.

Notes for the DSM2 users:

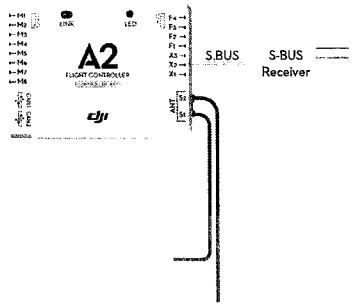
- There is no need to enable the FailSafe function in the Transmitter. If the Receiver loses the signal from the Transmitter, the controller unit will enter into FailSafe automatically, and the aircraft will

hover or Go-home as configure in the FailSafe in the Assistant software.

- When using the dual-mode Transmitter, please set the transmiting mode as DSM2 in SYSTEM SET UP->FRAME RATE ->MODE, which should not be DSMX.
- Support DSM2 satellite Receivers used with all SPEKTRUM Transmitters, e.g. DX6I DX7S DX8 DX18 etc., as well as JR Transmitters, e.g. DXS9II DXS11.

C. S-BUS Receivers

If using S-BUS Receivers please follow the diagram for connection, set the Receiver referring to your Receiver manual, and select the Receiver type as **D-BUS** in the **Assistant software->Basic->R/C-> Receiver Type**.

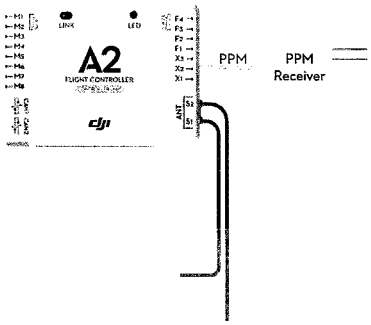


Notes for the S-BUS users:

- It is no need to enable the FailSafe function in the Transmitter. Once the Receiver loses the signals from the Transmitter, the controller unit will enter into FailSafe automatically, and the aircraft will hover or Go-home as configurations of the FailSafe in the Assistant software.

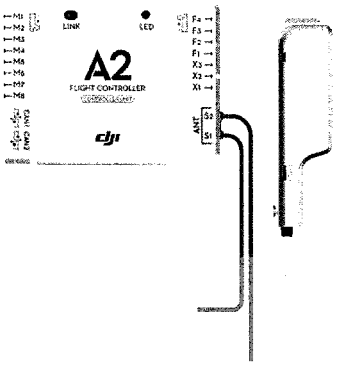
D. PPM Receivers

If using PPM Receivers please follow the diagram for connection, set the Receiver referring to your Receiver manual, and select the Receiver type as **PPM** in the **Assistant software->Basic->R/C-> Receiver Type**.



E. Traditional Receivers

If using Traditional Receivers, the DJI D-BUS Adapter is required. Please follow the diagram for connection, set the Receiver referring to your Receiver manual, and select the Receiver type as **D-BUS** in the **Assistant software->Basic->R/C-> Receiver Type.**



Traditional Receiver

Important

- When you use a traditional receiver, DJI D-BUS ADAPTER is required. Put the switch to the "I" stop, and power on the system, the LED should be red on; otherwise, keep the switch at "I" stop and then power cycle the system.
- At the "I" stop, the D-BUS ADAPTER is converting the PWM signal from traditional receiver to S-BUS signal.

Notes for the traditional receiver users:

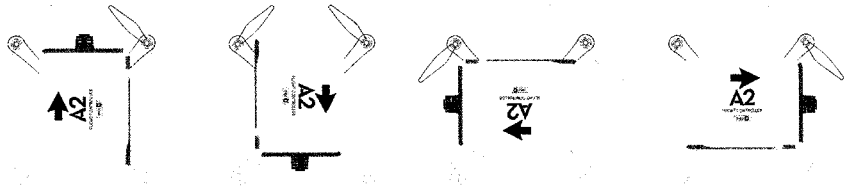
- When using the traditional receiver which doesn't have endpoint adjustment operations to set FailSafe in the U channel, the Go-Home switch is recommended and users can use it to trigger the FailSafe.
- Configure the FailSafe function of your transmitter and receiver according to its instructions, set the FailSafe position of the Go-Home switch in the position triggering the FailSafe function. If it is configured correctly as mentioned above, the FailSafe function will be activated automatically if the receiver loses the signal from the transmitter.
- Users can get more information about the FailSafe function referring to 3.1 FailSafe in this manual and the help text in the Assistant software.

(2) IMU (Inertial Measurement Unit):

Built-in inertial sensors, for the measurement of aircraft attitude; built-in pressure sensor for the detection of aircraft altitude. Should be connected to the CAN1 port of the Controller Unit, and be mounted according to the required location and orientation. The IMU has been calibrated before delivery, it should be used under the specified temperature; otherwise the temperature may have an effect on the IMU performance.	
Working environment temperature: -5°C ~60°C	Storage environment temperature:<60°C

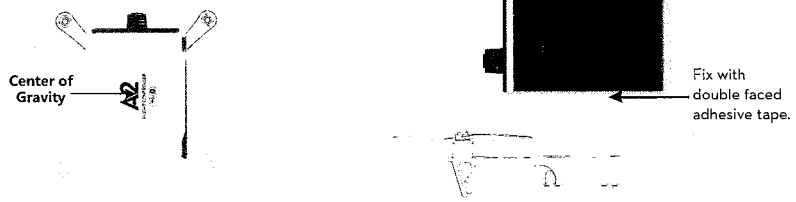
Orientation Requirements:

Please mount the IMU as one of the following options. Configure in the **A2 Assistant software ->Basic ->Mount -> IMU**, and select the matched option.



Pointing Forward **Pointing Backward** **Pointing to Left** **Pointing to Right**

Location Requirements:



⊘	(1)	The top side should be facing up. DO NOT mount upside-down.
	(2)	DO NOT cover the ventilation holes, keep them unblocked and clean.
	(3)	Take heat preservation measures if working in cold weather.
⚠	(1)	Mount the IMU at a low vibration position and the sides of the IMU should be precisely parallel to the aircraft body. Based on our experience, there is less vibration near the aircraft's center of gravity.
	(2)	NOT water-proof or oil-proof.
	(3)	Check the double faced adhesive tape regularly to make sure that the IMU is fixed firmly.

There is a CAN-Bus connector, which can be used to connect to the GPS-COMPASS PRO PLUS or other DJI product.

(3) GPS-COMPASS PRO PLUS

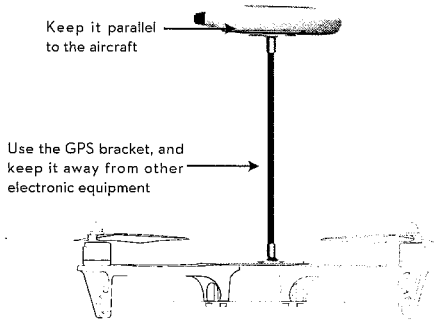
GPS-COMPASS PRO PLUS module has a built-in GPS and compass. The compass is used for geomagnetic field measurement. It should be mounted according to the required location and orientation. Compass calibration is required before use. DO NOT use and store the compass in the ferromagnetic material environment.

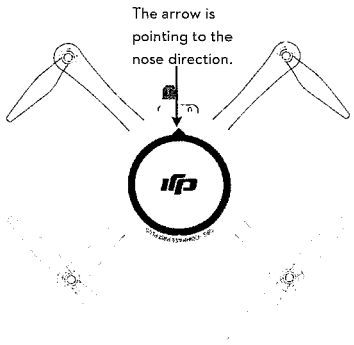
Mounting Procedure:

a) Use the epoxy resin AB glue to assemble the GPS bracket first. The longest one is recommended.

b) Mount the bracket on the aircraft first, and then fix the GPS-COMPASS PRO PLUS on the plate of the bracket (using the 3M sticky pads provided).

Mounting Position:





Usage Requirements

(1) The DJI logo should be facing the sky, with the orientation arrow pointing directly to the nose direction; otherwise it may lead to take off failure.

(2) Fly the aircraft in an open space without buildings or trees; otherwise it may have an effect on the GPS.

(3) The compass is sensitive to magnetic interference, should be far away from electronic devices, otherwise it may lead to abnormal flying.

(4) Please always keep the compass module away from magnet fields. Otherwise it may damage the compass module and lead the aircraft to work abnormally or even be out of control.

(4) PMU (Power Management Unit)

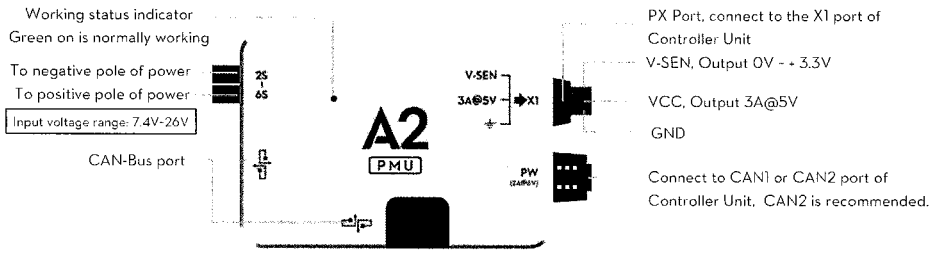
The PMU provides dual BECs (Battery Eliminator Circuit):

(1) PW port outputs power for the whole Flight Control System with current no more than 2A.

(2) PX port outputs power (3A@5V) and V-SEV signal using the low voltage protection function.

In addition, there are two CAN-Bus ports for LED-BT-I connection and other DJI products (e.g. DJI 2.4G Data Link).

Port Description



Mounting Requirements:

Choose a ventilated place to mount the PMU for cooling, no mounting orientation requirement.

(5) LED-BT-I

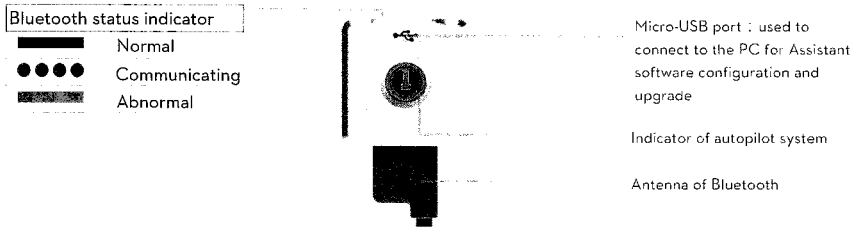
The LED-BT-I has integrated LED Indicator, Bluetooth and USB port:

(1) The LED is mainly for flight control system status indication during flying (e.g. Control Mode).

(2) Bluetooth is used for real-time communication with your mobile device (e.g. iPhone), to realize parameter configuration on a mobile device. For parameter configuration using a mobile device, it is required to install the DJI Assistant App on the mobile device. When you mount the LED-BT-I, please make sure the side with ANT LOGO is unsheltered after mounting.

(3) In addition, there is a Micro-USB port, make sure it is mounted for convenient connection.

Port Description:



Mounting Requirements:

Mount in a good place to make sure the LED is visible during flying. Antenna of Bluetooth should be unobstructed.

1.2 Software Installation and Configuration

Please configure the A2 flight control system in the Assistant Software according to the following instructions. Users are required to configure every item within the "Basic" page when use the A2 flight control system for the first time.

1.2.1 Installing Driver and Assistant Software

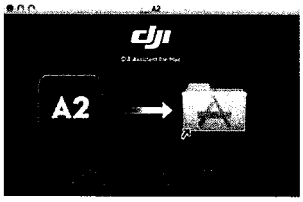
Installing and running on Windows

1. Download driver installer and Assistant Software installer in EXE format from the download page of A2 on the DJI website.
2. Connect the A2 flight control system to a PC via a Micro-USB cable. The Micro-USB port of the A2 flight control system is on the LED-BT-I module.
3. Run the driver installer and follow the prompts to finish installation.
4. Next, run the assistant software installer and follow the prompts to finish installation.
5. Double click the A2 icon on your Windows desktop to launch the software.

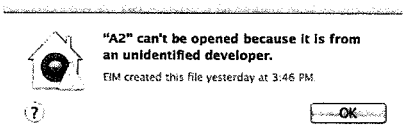
⚠ The installer in EXE format only supports Windows operating systems (Win XP, Win7, Win8 (32 or 64 bit)).

Installing and running on Mac OS X

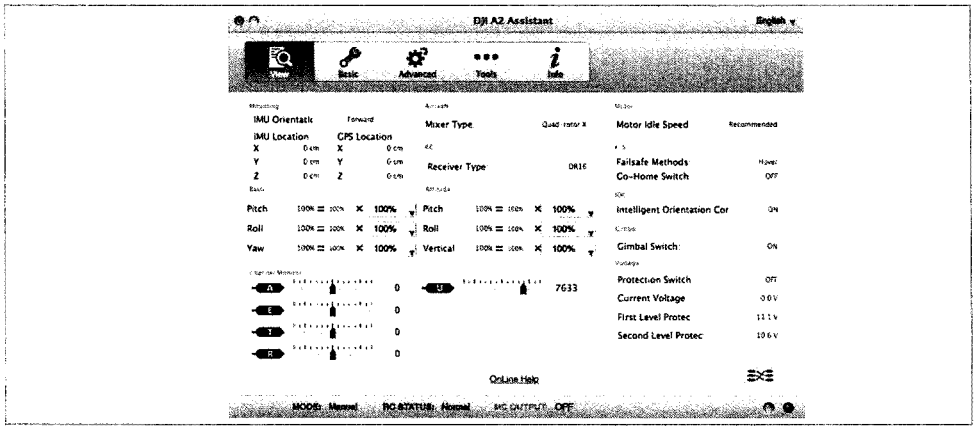
1. Download the Assistant Software installer in DMG format from the download page of A2 on the DJI website.
2. Run the installer and follow the prompts to finish installation.



3. When launching for the first time if use Launchpad to run the A2 Assistant software, Launchpad will not allow access because the software has not been reviewed by Mac App Store.



4. Locate the A2 icon in the Finder, press the Control key and then click the A2 icon (or right-click the A2 icon using a mouse). Choose Open from the shortcut menu, click Open in the prompt dialog box and then the software will launch.
5. After the first successful launch, direct launching of the software can be achieved by double-clicking the A2 icon in the Finder or using Launchpad.



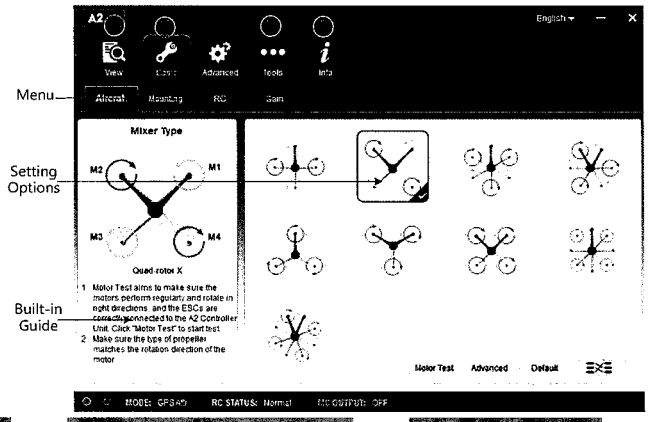
Installer in DMG format supports only Mac OS X 10.9 or above.

Usage of A2 Assistant software on Mac OS X and Windows are exactly the same. The Assistant software pages appear in other places of this manual are on the Windows for example.

1.2.2 Configure using Assistant Software on a PC

A2 flight control system can takes power via the USB port during configuration, no additional battery is required. Note that the USB port can supply power no more than 500mA, an additional battery is necessary if connection failure or intermittent working.

Run the assistant software, and follow the built-in guide to carry out the configuration. Note that you may be asked to register for first time use.



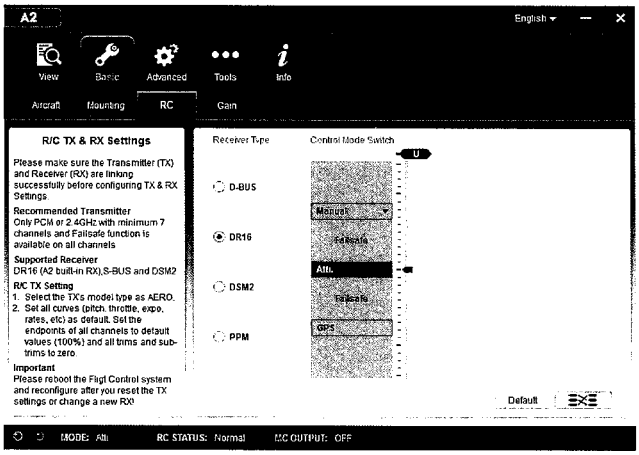
1. View	2. Restore &Upgrade	3.Set	4.Check
Click "Info" to view user information and software version etc.	Enter "Tools" to restore default settings. And check whether the firmware is the latest.	Enter "Basic" page. Set the Aircraft, Mounting, RC, Gain" in each tab.	Enter "View" page to check all basic settings.

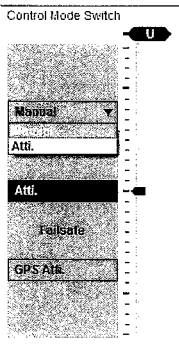
	"RC STATUS" description	**Normal:** the transmitter and receiver are linked and communicating well.
		Disconnect: the A2 Flight Control System is powered on, but the transmitter is powered off.
		RC-LOST: RC signal is lost (e.g. the transmitter is turned off after power on) or the receiver is sending F/S signals (e.g. the aircraft flies out of the range which transmitter is controllable).

	The firmware version and the Assistant Software version should be matched when using the software to configure the A2 flight control system, otherwise the software will not work. It's recommended to keep the firmware version and Assistant Software version up to date to avoid this issues.

1.2.3 Configure the control mode switch

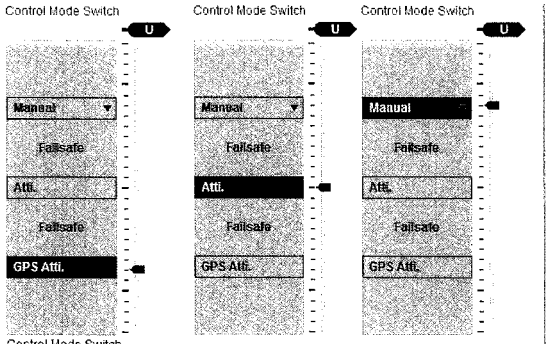
Users should configure the control mode switch in the Assistant software in the following page. Only the control mode switch has been set correctly, the control mode displayed in the left bottom corner will be the same to the control mode pointed by the cursor on the channel U.



Configuration steps	Exambles
Step 1. Power on your Transmitter, map a 3-position switch on the transmitter to the U channel of Controller Unit as the control mode switch, of which two positions are default as Atti. Mode and GPS Atti. Mode and the third position is optional, users can set as Atti. Mode or Manual Mode.	

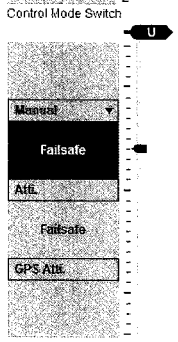
Step 2.

Toggle the control mode switch to its three positions, accordingly the cursor will move to some control mode.



Step 3.

Power off the Transmitter, the FailSafe will be enabled and the cursor will point to any area out of the control modes.

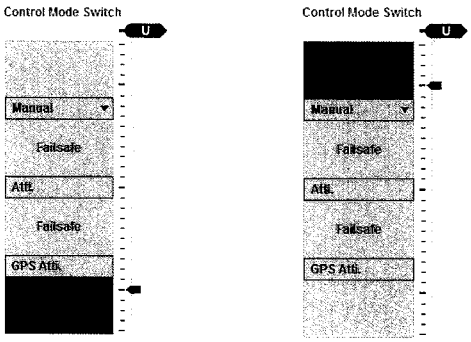


Step 4.

If all steps above are realized, that indicates the control mode switch is set successfully.

Important

In step 2, if the cursor doesn't point to the correct control mode area (e.g. the following figures), that indicates abnormal control mode switch configuration. Users must re-configure the Endpoint and FailSafe functions in the Transmitter to make the cursor point to the right control mode and the according areas become blue.



1.2.4 Configuration Checking

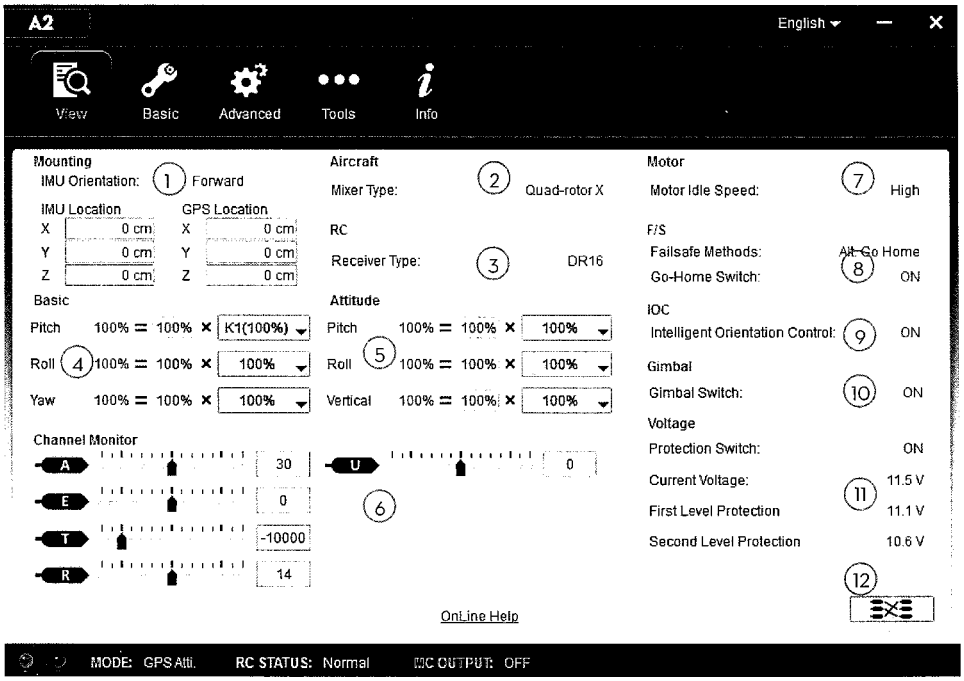
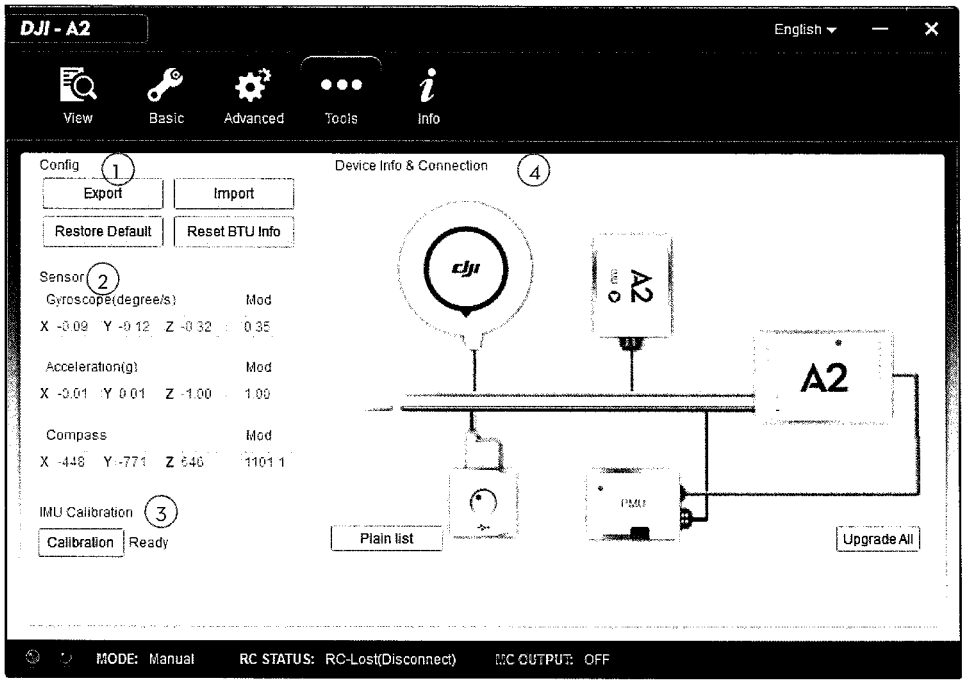


*Fig. above for reference only, please adhere to actual GUI.

Check List	Description
①	Check the IMU orientation direction.
②	Check the Mixer Type of aircraft. Make sure the motors are rotating normally, and propeller installation is in correct direction.
③	The Receiver type is correct.
④、⑤	Check the basic and attitude gains.
⑥	Move the sticks to test whether the cursors moves following the sticks. Toggle the "U" switch to test the control mode setting.
⑦~⑪	Advanced configuration, users can configure it according to their requirements after reading the manual.
⑫	Check the Channel Map between the Transmitter and A2 flight control system.

1.2.5 Tools



① **Config**

Export or import the tuning parameters and restore the default setting and reset the BTU module.

② **Sensors**

Read gyroscope, acceleration and compass sensor value.

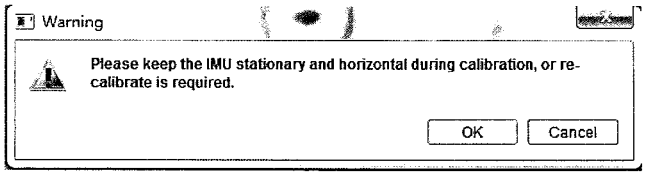
③ **IMU Calibration**

Calibrate IMU based on the gyroscope and acceleration sensor readings from Assistant. Calibrate is needed, when:

- Gyroscope Mod value exceeds 1.5.
- Acceleration Mod value below 0.98 or exceeds 1.02.

Steps to follow when calibrating IMU:

1. Go to IMU Calibration section after powering on A2, wait until A2 enters "Ready" status.
2. Click "**Calibration**", take note of the following warning message:



   Place the IMU on a stationary and horizontal surface and ensure A2 logo faces upward.

3. Click "**OK**" to proceed.

④ **Device Information and Connection Status**

All devices that connected to the A2 flight controller are highlighted, however, disconnected devices appear grey. Single click a highlighted device to upgrade its firmware. You can also upgrade all firmware by clicking the "**Upgrade All**" button.

1.3 Compass Calibration

The Compass can assistant the GPS to position the aircraft, which is very important during flight. As we know, the compass is very sensitive to electromagnetic interference, which will cause abnormal compass data, and lead to poor flight performance or even flight failure. Compass Calibration MUST be done for first time use.

It is recommended to calibrate the compass outdoors after the Controller Unit finds 7 or more GPS satellites. Regular calibration enables the compass to keep optimal performance.

Calibration Cautions

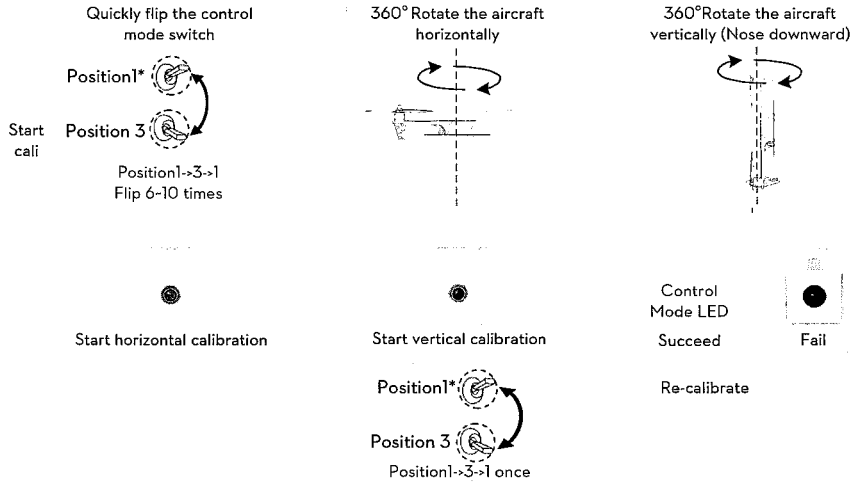
(1) DO NOT calibrate your compass where there is strong magnetic interference, such as magnetite, car park, and steel reinforcement under the ground.

(2) DO NOT carry ferromagnetic materials with you during calibration, such as keys or cell phones.

(3) Compass Calibration is very important; otherwise the flight control system cannot work.

Calibration Procedures

Choose an open space to carry out the following procedures.



Situations that require recalibration

Situations	Descriptions
Compass Data abnormal	LED blinks yellow and green alternatively(●(∝)).
Flying field altered	Flying field has changed over a long distance.
Mechanical alteration	The mounting position of GPS-COMPASS PRO PLUS module changes. Electronic units such as Controller Unit, CAN-HUB, battery etc. have been added, removed, remounted or other alterations. Mechanical structures of the aircraft has changed
Drifting during flying	Evident drifts occurred in flight such as the aircraft doesn't fly straight
Attitude errors	LED often blinks error indicator when the aircraft turns around.

2 Basic flying

Read this section before basic flight testing.

2.1 Control Mode Instruction

The aircraft performs differently when using different control modes. Please read the following table to know the different control modes, which may help you to achieve a more involved flight experience.

Control Mode	GPS ATTI. Mode	ATTI. Mode	Manual Mode
Command Linearity	YES		
Yaw	Control the aircraft to rotate in clockwise and counter clockwise direction. Maximum rudder angular velocity 150°/s		
Roll and Pitch	Aircraft attitude control; Mid point of stick is for 0° attitude, and its endpoint is 35°.		Max-angular velocity is 150°/s. No attitude angle limit.
Throttle	Aircraft height control. Maintain the altitude best above 1 meter from ground when the throttle stick is in mid position.		No altitude locking when the throttle stick is in mid position.
All Sticks Released	Lock position if GPS signal is adequate.	Only attitude stabilizing. No position locking.	Keep original attitude.
GPS Lost	Once GPS signal lost the flight control system will enter ATTI. Mode automatically. Return to GPS ATTI. Mode after GPS signal has recovered for 2 seconds.	---	---
IOC Supported	CL/HL/POI/BTM	CL	None

Assign a 3-position switch of the transmitter as the control mode switch. The position-1 is defaulted as "GPS ATTI. Mode" and the position-2 is "ATTI. Mode". The position-3 can be set as "Manual Mode" or "ATTI. Mode" in A2 assistant software.

Control Mode Switch	 position-1	 position-2	 position-3	
Configurable Control Mode	GPS ATTI. Mode	ATTI. Mode *	ATTI. Mode *	Manual Mode
FailSafe Protection	The flight control system will enter FailSafe Mode if the Transmitter signal is lost and no matter if Transmitter signal recovers or not, system will not exit FailSafe mode automatically.		The flight control system will enter FailSafe Mode if the Transmitter signal is lost and the system will exit FailSafe once the signal recovers.	

GPS Involved	YES		NO
Low-voltage Protection	LED alert with Descending or Go Home & Landing precautions		Only LED alert
Environment recommended	Open flying field; Good GPS signal	Narrow Space; GPS signal bad	Regain control in emergency

The difference between ATTI. Mode of position-2 and ATTI. Mode of position-3 is that they are working differently in protection situations.

2.2 Flying Environment Requirements

(1) Before use of the product, please accept some flight training (Using a simulator to practice flying, getting instruction from a professional person, etc.).

(2) DO NOT fly in bad weather, such as rain or wind (more than moderate breeze) or fog.

(3) The flying field should be open without tall buildings or other obstacles; the buildings of steel structure will interfere with the compass.

(4) Keep the aircraft away from obstacles, crowds, power lines, trees, lakes and rivers etc.

(5) Try to avoid interference between the remote control Transmitter and other wireless equipment. (No base station or cell tower around)

(6) The flight control system can't work at the South Pole and the North Pole.

(7) All parts must be kept out of the reach of children to avoid CHOKE HAZARD; if a child accidentally swallows any part you should immediately seek medical assistance.

2.3 Check List before Flying

Double check the following list, otherwise, if any one of the following items is wrong it may lead to flight accident.

(1) All parts are in good condition, no ageing or damaged components

(2) Motor rotating direction

(3) Propeller mounting direction

(4) Mixer Type set in assistant software

(5) IMU and GPS-COMPASS PRO PLUS mounting direction

(6) Transmitter channel mapping and sticks movement direction correct

(7) Compass calibration

(8) ESC connection

(9) IMU and GPS-COMPASS PRO PLUS firmly mounted

In addition, check the following items to make sure the system can work.

(1) The Transmitter battery is fully charged.

(2) The aircraft battery is fully charged.

(3) Do not over load the aircraft.

2.4 Power on and Check

(1) Control mode LED indicator

Power on the Transmitter then the flight control system. Toggle the control mode switch to different positions.

Control Mode LED indicator			
Control Mode Switch	GPS ATTI. Mode	ATTI. Mode	Manual Mode
LED	● (Stick not in midpoint ●(2))	(Stick not in midpoint (2))	No LED indicator
Set	Put the Control Mode switch to GPS position for basic flying test. **Note:** when the GPS signal LED indicator is bad or worst (●(2) or ●(3)) and lasts for more than 3secs, the flight control system will enter into ATTI. Mode.		

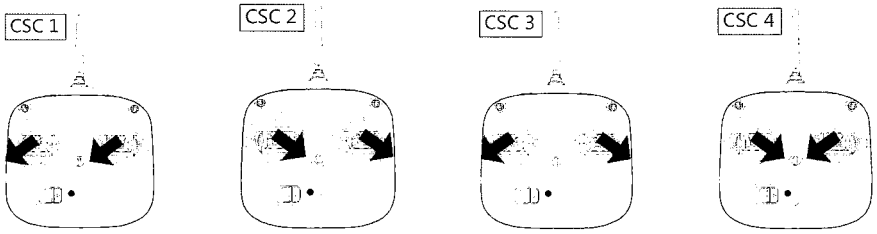
(2) GPS signal LED indicator

GPS signal indication blinks after every Control mode indication. We suggest flying when GPS satellites are more than 5.

GPS signal LED indicator			
Worst (GPS < 5) : ●(3)	Bad (GPS = 5) : ●(2)	Well (GPS = 6) : ●(1)	Best (GPS > 6) : No indicator

2.5 Start Motors Methods

CSC (Combination sticks commands) is used to start motors instead of just pushing the throttle stick. One of the following methods can be used to start/stop motors.



Under the conditions stated below, the motors will stop in ATTI. Mode/GPS ATTI. Mode:

(1) The throttle sticks is under 10% for more than 3secs after motors start.

(2) The throttle sticks is under 10% for more than 3secs after landing.

(3) The throttle sticks is under 10% for more than 3secs and the inclined angle of aircraft exceeds 70°.

If motors fail to start, please refer to the following list for trouble shooting.

(1) The Controller Unit fails to obtain the firmware version of IMU and GPS, please check the connection or upgrade the IMU and GPS.

(2) The firmware version of IMU and Controller Unit is mismatched; please upgrade the firmware of IMU or Controller Unit.

(3) The firmware version of GPS and Controller Unit is mismatched; please upgrade the firmware of GPS or Controller Unit.

(4) The transmitter calibration has exited abnormally, please recalibrate.

(5) The transmitter calibration results with big bias, please recalibrate.

(6) The transmitter calibration results with big mid point bias, please recalibrate.

(7) Incorrect channel mappings, please make sure the basic channels A/E/T/R/U are mapped correctly.

(8) Invalid SN or SN error; please contact your dealer or DJI custom service.

(9) The Controller Unit is locked, please unlock the Controller Unit and reconfigure all the parameters in the Assistant software.

(10) IMU disconnected, please check the connection.

(11) Compass data abnormal, please eliminate magnetic interference and recalibrate the compass.

(12) When Flight limit function is enabled, if the aircraft fly out of the max-radius in ATTI. mode and the motors are stalling, the motors will fail to spool up in GPS ATTI. mode cause the Flight limit function works.

(13) The attitude status is bad and the LED indicator blinks white, the motors will fail to spool up.

(14) The Transmitter disconnected, the motors will fail to spool up.

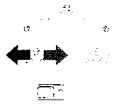
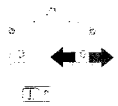
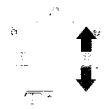
(15) The A2 flight control system is connecting and communicating with the Assistant software, the motors will fail to spool up.

2.6 Basic Flying Test

Carry out the following procedures to complete the basic flight test.

1. Wait the GPS signal to be well	LED
Place the aircraft away from you and others at least 3 meters and wait the GPS ≥6 (about 30 seconds).	● or no Red LED

2. Start motors and takeoff aircraft.	LED
Execute CSC to start motors; all sticks back to midpoint as soon as motors start, then push the throttle stick to take off the aircraft, meanwhile the home point is recorded. NOTE: 36secs after power on; 10secs after GPS ≥6; Motors have been started, auto-record the position as home point at the first time the throttle stick is raised	●(∝)
After the home point is recorded successfully and the distance from aircraft is less than 8m, LED indicator will blink 6 violet continually. Note: only when GPS signal is good (no Red LED) LED indicator will blink 6 violet continually.	●(6)

3.Operate sticks to control the flying attitude of the aircraft during flight			
Transmitter (Mode2)		Aircraft	Operations
Throttle Stick			Push Throttle sticks to control the aircraft to elevate and descend. The aircraft can lock to an altitude when the throttle stick is at midpoint.
Yaw Stick			Push the yaw stick to rotate the aircraft in clockwise or counter clockwise direction.
Roll Stick			Push roll stick to control the aircraft left or right, pitch stick to control forward or backward. When both roll and pitch sticks are at midpoint： (1) GPS ATTI. Mode: the aircraft will be stabilized and locked in horizontal position. (2) ATTI. Mode: the aircraft will be stabilized but unlocked in horizontal position.
Pitch Stick			

4.Hover

In GPS ATTI. Mode , the aircraft will hover when the throttle/yaw/roll/pitch sticks are all released at mid-point.

5.Landing

Use the throttle stick to control the landing speed, try to land your aircraft gently to avoid shock or crash.

Please refer to the next section "Protection Functions Setting" to take precautions.

(1) Low voltage alert: yellow quick flashes or red quick flashes.

(2) FailSafe: LED indicator blinks blue.

Moreover, you may come across the following abnormal situation, please carry out the operation below.

(3) Compass data is abnormal; the LED blinks yellow and green alternatively. Please re-calibrate the Compass.

(4) IMU data is abnormal, the LED blinks four green. Please contact your dealer.

3 Protection Functions Setting

Set protection in the Assistant software ->Advanced page. FailSafe and Low voltage protections are required.

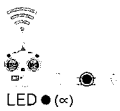
3.1 FailSafe

FailSafe works when the Transmitter (TX) signal is lost, the flight control system will automatically control the aircraft to reduce injuries or damage.

	TX signal	GPS	Descriptions
Home Point (HP)			Home point will be recorded: - After 30 seconds of strong GPS signal - 10 seconds later after green LEDs have stopped blinking, when throttle sticks are moved away from mid point.
FailSafe		GPS ≥ 6	Customize the failsafe to define what happens if remote control signal is lost. Choose from either auto hovering, RTH or "RTH at a preset altitude in the A2 Assistant"
One-Key Go Home			A switch can be set to trigger RTH without signal loss. If One-Key RTH is enabled during flight, aircraft control will cease and LED lights will indicate Control Mode. Release the RTH switch to regain control. If the Failsafe has been triggered the switch will not work. With One-Key RTH in progress, aircraft orientation can be controlled while the aircraft returns.

FailSafe and Go Home procedures

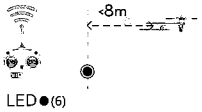
1 Record Home Point (HP)



LED ● (∝)

2 Confirm Home Point

GPS ≥7



LED ● (6)

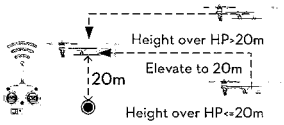
3 Transmitter Signal Lost

LED ● (∝)

4 Signal Lost Lasts 3secs.

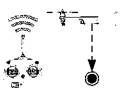
LED ● (∝)

5 Go Home(20m can be customized)



LED ● (∝)

6 Landing after Hovering 15secs



LED ● (∝)

⚠	(1)	The aircraft will not go home (only attitude stabilizing) in the condition that GPS <6 or GPS is not working, even if Transmitter signal is lost or Go Home switch is triggered.
	(2)	It is recommended to set the Go Home switch in the Assistant software. Users are suggested to

enter FailSafe and go home by using the Go Home switch rather than turning off the Transmitter in emergency situations. (3) Make sure there are no obstacles during aircraft go home and users are familiar with the methods to regain control.

How to regain control in FailSafe

3-position Switch	Position-1	Position-2	Position-3	
	GPS ATTI. Mode	**ATTI. Mode**	**ATTI. Mode**	**Manual Mode**
Regain control	You have to toggle the control mode switch once to regain control if the signal recovers.		Regain control as soon as signal recovers.	

3.2 Low Voltage Protection

Low voltage protection is used to alert low battery voltage during flight; in this case, users should promptly fly back the aircraft and land to avoid unexpected damages.

To use this function please set in **Assistant software->Advanced->Voltage** page to configure two voltage levels.

Protections		Option Selected	Conditions	LED	Aircraft
	First level	LED	----	(∝)	None
		GH & Landing	Make sure the home point is recorded and no obstacles in going home and landing path.	(∝)	Go-Home & Landing
	Second level	LED	----	●(∝)	None
		Descending	----	●(∝)	Descending directly

Go-Home & Landing Usage Tips

(1) The home point recorded is the same in both FailSafe and Low voltage protection. The aircraft will not go home in the following cases :

a) Control mode switch is at the position-3 (Manual Mode or ATTI. Mode)

b) GPS signal is bad (GPS<6)

c) The distance between aircraft and the home point is less than 25m, and the height over the Home point less than 20m.

Descending Usage Tips

The aircraft will not hover when the throttle stick is at the mid point. Push the throttle stick to 90% of its endpoint, the aircraft will still ascend slowly if you continue to pull the throttle stick, and the control of Pitch, Roll and Yaw are the same as before.

(1) Please pay attention to the LED alert of low voltage and make sure the power is enough for go home and landing. Insufficient power reserve will cause the aircraft to crash as well as other consequences.

(2) If the second level low voltage alert occurs in below procedures, the aircraft will descend automatically.

a) When the aircraft is in FailSafe and Go Home process。

b) When the aircraft is controlled by the Ground Station.

4 Advanced Features

The advanced features of A2 include IOC (intelligent orientation control), gimbal control, parachute activation and so on. It also enable users to tweak the A2 configuration via the A2 Assistant wirelessly through the Bluetooth connection.

4.1 IOC (Intelligent Orientation Control) function

4.1.1IOC

IOC	Help users to set the Flying direction; Should be enabled in Assistant software.
Flying direction	The flying direction of aircraft when pushing the Roll and Pitch sticks.
Forward direction	The flying direction of aircraft when the pitch stick is pushed forward.
Normal flying	IOC is disabled. Forward direction is pointing to the nose direction and changes along with the nose.
CL(course lock) mode	Its forward direction is pointing to the nose direction when recording, which is fixed until you re-record it or exit from CL.
HL (home lock) mode	Record a Home Point (HP), push Pitch stick to control the aircraft far from or near to the HP.
POI mode	Point of Interest. Record a point of interest (POI), the aircraft can circle around the POI, and the nose always points to the POI.
BTM (Banked Turn) mode	In this mode, the roll and yaw sticks are combined to help you perform banked turns with only one hand.

Conditions of IOC function

Flying	IOC Setting	Control Mode	GPS-COMPASS PRO PLUS Required	GPS Satellites	Distance Limits
Normal	----	----	----	Basic to control mode	None
CL	Enabled	Not Manual Mode	Compass	None	None
HL	Enabled	GPS ATTI. Mode	GPS	GPS ≥6	Aircraft ≥10m HP
POI	Enabled	GPS ATTI. Mode	GPS	GPS ≥6	Aircraft 5m-500m POI
BTM	Enabled	GPS ATTI. Mode	GPS	GPS ≥6	None

Step 1 IOC switch setting

Please enable the IOC function in **Advanced->IOC** page of Assistant software. Then choose a 3-positon switch on the Transmitter to set as IOC switch, which is used to select the different IOC modes and manually record the

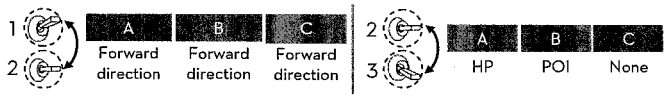
Forward direction, HP and POI recording.

There are six types of IOC switch setting. Below are the three recommended options of IOC switch setting which may be configured in the Assistant software.

Switch positions		A	B	C
1		OFF	OFF	OFF
2		CL	CL	CL
3		HL	POI	BTM

Step 2 Forward Direction, HP and POI Recording

After you enable the IOC in assistant software, the flight control system will record the forward direction and home point automatically after power on, if the recording conditions are met. You can manually re-record the forward direction, home point and POI during flying. Note that no BTM recording is required. Read the following table for the recording method details.

	CL	HL	POI
Recorded Orientation	Aircraft's nose as forward direction	Home point	The position that the user wish to fly around.
Conditions	36 secs after power on	10secs later after GPS≥6; Motors have been started.	10secs later after GPS≥6.
Automatically	Automatically record at 36 secs after power on	Automatically record at the first time you push the throttle stick	No Automatic record method
Manual	According to any option of IOC switch setting, quickly toggle the switch between adjacent positions 3-5 times to record manually. 		
Successful	●(20)	●(20)	(20)

(1) DO NOT toggle the switch between the position 1 and 3 frequently, which may re-record the position 2.

(2) The new Home Point and Forward Direction can be set only after one has already been recorded automatically.

(3) HP is not only used in IOC, but also in FailSafe and Low voltage as go home and landing destination. The flight control system will automatically record the HP even if IOC function is disabled in Assistant software but Forward direction and POI can be recorded only after IOC is enabled.

(4) Once the Home Point is recorded successfully, LED will blink ●(6) continually under the following conditions. All conditions must be true.

1. GPS≥6.
2. Distance between aircraft and the recorded home point is less than 8m.
3. Current control mode is in GPS ATTI. Mode or ATTI. Mode of switch position-2.

Step 3 CL, HL and POI flying test

Please study the following diagram then make an IOC flying test. IOC LED indicator blinks ●(●(2) means not all stick(s) at the midpoint)

HP POI Flying direction Forward direction Route Auxiliary line

Flying	IOC switch	Record	Pitch stick control of aircraft		Roll stick control of aircraft	
Normal	OFF	None				
CL	CL					
HL	HL		>10m	>10m	>10m	>10m
POI	POI		5~500m	5~500m	5~500m	5~500m

DO NOT toggle the IOC switch frequently in HL flying to avoid re-recording the HP unwittingly.

IOC function is available only when all the required conditions are satisfied. If any condition is omitted the flight control system will exit IOC. Please keep an eye on the LED to know the current control mode.

(1) It is recommended to start the HL flight when the aircraft is >10m away from the HP. If starting the HL when the distance between aircraft and HP is less than 10m and it' s the first time you start HL after power on, then the flight control system will only enter HL after flying out of the

10m range.

(2) During HL flying if one of the following conditions occur, the flight control system will exit HL and enter into CL: the aircraft is within of 10m from HP; the control mode is changed to ATTI. Mode; GPS<6(LED ●(2) or ●(3)).

Step 4 Banked Turn mode flying test

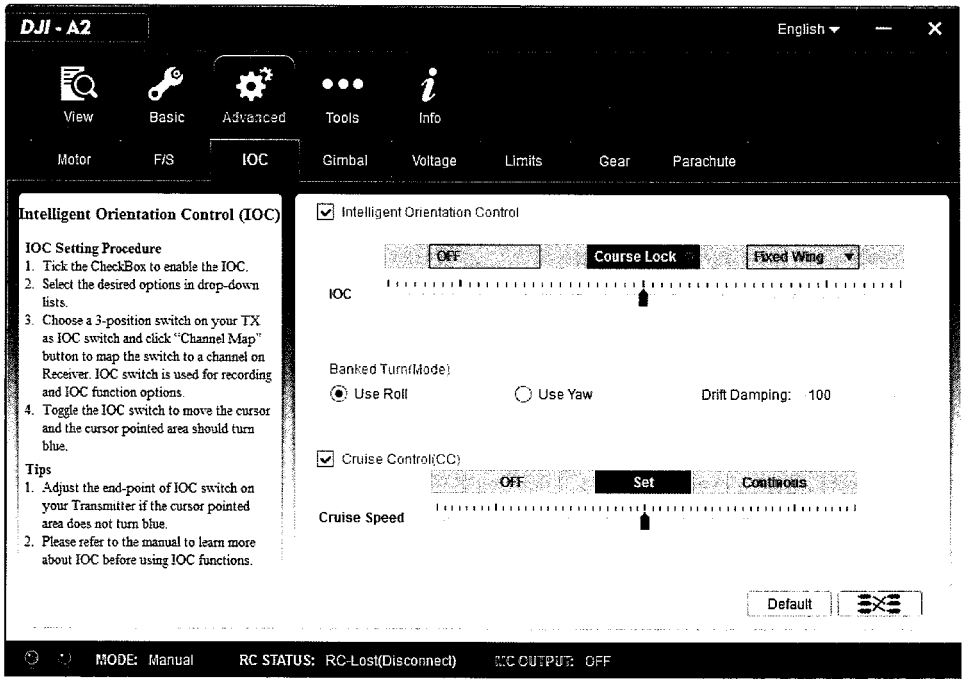
Banked Turn Mode is useful when you want to perform banked turns one handed. It allows you to pitch and roll to turn without using the yaw stick.

Application examples:

1. Normal and FPV aerial photography in this mode is smooth and simple, giving a different visual feel to your work.
2. In this mode, the roll and yaw sticks are combined to help you perform banked turns with only one hand.

Setting steps (Mode 2):

1. To enable Banked Turn Mode, replace the POI gear of the IOC switch with Banked Turn gear.
2. With Banked Turn Mode activated, you can circle the aircraft with just one stick. To do this, Mode 2 (throttle on the left stick) users should select the "Use Roll" option while Mode 1 (throttle on the right stick) users should select the "Use Yaw" option.



Using Banked Turn Mode (Mode 2):

1. Select "Use Roll" to disable the yaw stick or select "Use Yaw" to disable the roll stick.
2. Push pitch stick to move the aircraft forward or backward.
3. After that, Push roll stick left or right to perform banked turn as the following diagram shown. No yaw stick required.
4. When the aircraft is hovering, yaw is controlled by the roll stick instead.
5. Rapidly pull the pitch stick to the mid-point to stop the aircraft.

Flying	IOC switch	Record	Pitch stick	Roll stick	Pitch stick	Roll stick	Pitch stick	Roll stick	Pitch stick	Roll stick
BTM	BTM	None								

	(1) Banked Turn Mode works only with GPS-ATTI mode (GPS ≥6). The aircraft will stop and hover when less than 6 satellites are found. (2) Once the aircraft performs side slip, adjust the drift damping value. Note that too big value may lead to aircraft vibration.

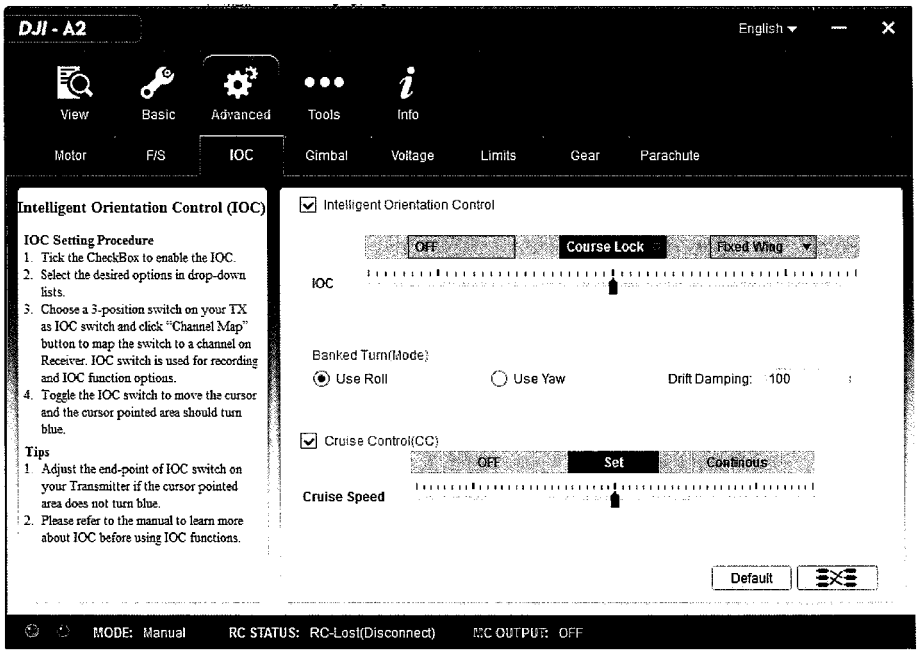
4.1.2 Cruise Control

Cruise Control allows you to lock the speed of the aircraft, freeing you to control the gimbal while maintaining flight.

Application examples:

1. By maintaining steady flight, you can focus more on your shots and gimbal control, and your total flight time is increased by eliminating unnecessary speed changes.
2. Activate Cruise Control to lock your aircraft into its current horizontal speed when you release the control sticks.

Cruise Control only works when IOC has been enabled. Tick the Cruise Control box in the A2 Assistant to enable it.



Assign a 3-gear switch on the remote control for Cruise Control. Follow the steps below to use Cruise Control.

Use the control sticks to accelerate the aircraft to your target speed then toggle the assigned Cruise Control switch to "Set" or "Continues".

The action of three different gears of the cruise speed is defined as follow:

- **Close**

  Deactivate Cruise Control.

- **Set**

  Move the switch to this position in flight to "Set" the cruising speed. The speed at the point that the switch is toggled will be maintained. If you use the control sticks to adjust aircraft speed, the aircraft will return to its original speed once the control sticks return to center.

- **Continues**

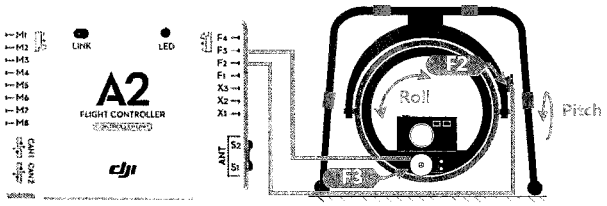
  In this position the aircraft will maintain its speed of flight however if you accelerate or slow down, it will continue flying at the new speed once the control sticks return to center.

⚠	(1) Cruise Control only works in GPS-ATTI mode (GPS > 6). (2) The aircraft will exit Cruise Control mode and hover at its current altitude when less than 6 GPS satellites are detected, switches to ATTI. mode or enters auto go home mode. To enter"Set" and "Continue" modes, you must first go into "OFF" mode. (3) Cruise Control is disabled during Banked Turn mode flying. (4) Maximum speed is 15m/s under Cruise Control mode.

4.2 Servo Gimbal function

Connect the servos of your gimbal to the Controller Unit as the fig. below , roll servo connects to F3 port and pitch servo connects to F2, and configure in **Advanced->Gimbal** page in the Assistant software. No Receiver channel is asked to be mapped for the F2 or F3 port if gimbal function is enabled in the Assistant Software.

Note: Even you map Receiver channels to F3 and F2 (Which are shown as D3 and D2 in the Assistant Software -> Channel Mapping), the F3 and F2 will not give output signals from the mapped Receiver channels.



4.3 Flight Limits

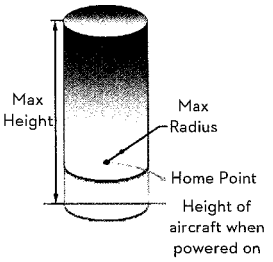
All unmanned aerial vehicle (UAV) operators should abide by all regulations from such organizations as the ICAO (International Civil Aviation Organization) and their own national airspace regulations. For safety reasons, the flight limits function is enabled by default to help users use this product safely and legally. The flight limits function includes height, distance limits and safety zone.

In Ready to Fly mode, height, distance limits and No Fly Zones work together to manage flight. In Ready to Fly (non-GPS) status, only height limits applies and flights cannot go higher than 120m.

Default parameters in Assistant Software are compliant within the definitions of class G ruled by ICAO. (Refer to Airspace Classification to get more details). As each country has its own rules, make sure to configure these parameters to comply with these rules before flying.

4.3.1 Max Height, Radius Limits & Home Fence

The Max Height & Radius restricts the flying height and distance. Configuration can be done in the A2 Assistant. Once complete, your aircraft will fly in a restricted cylinder.



GPS ATTI mode		
	Limits	**Ground Station Tips**
Max Height	Flight height must be under the set height.	Warning: Height limit reached.
Max Radius	Flight distance must be within the max radius.	Warning: Distance limit reached.

ATTI mode		
	Flight Limits	**Ground Station Tips**
Max Height	Flight height restricted to 120m and under.	Warning: Height limit reached.
Max Radius	No limits	

(1) If you fly out of the limit, you can still control the aircraft, but cannot fly it further.

(2) If the aircraft flies out of the max radius in ATTI mode, it will fly back within range automatically.

Home fence is a safety feature that prevents the aircraft from coming in too close to an operator. When enabled, the aircraft will not be able to enter a safe area defined by the user.

Application examples:

1. Supply safe guard for new users in case of damage from wrong operation.
2. Keep users safe when aircraft flies close in a high speed.

The safety radius can be set in the A2 Assistant as shown below:

Assign a switch on the remote control to turn the home fence feature on and off. The safety radius range can be set between 12m and 100m.

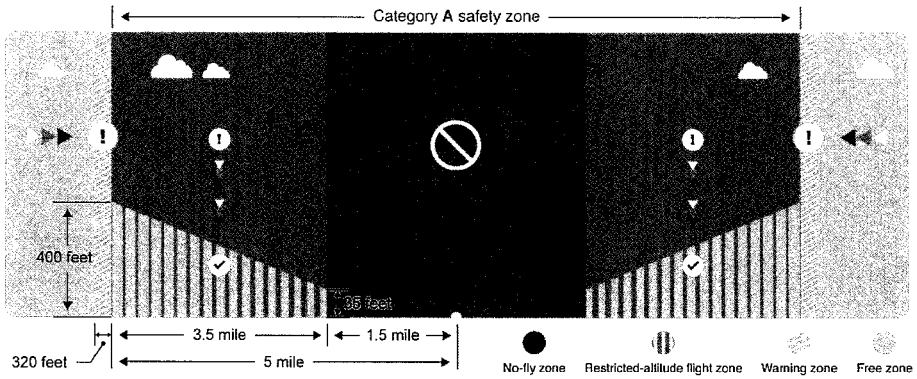
(1)	Home fence feature works only with GPS-ATTI mode. NO home fence limit for ATTI mode and navigation mode.
(2)	Failsafe procedure overrides the home fencing feature.

4.3.2 Flight Limits of Special Areas

Restricted areas include airports worldwide. All restricted areas are listed on the DJI official website at http://www.dji.com/fly-safe/category-mc. Restricted areas are divided into category A and category B. Category A areas cover major international airport such as LAX and Heathrow, while category B areas includes smaller airports.

Category A Safety Zone

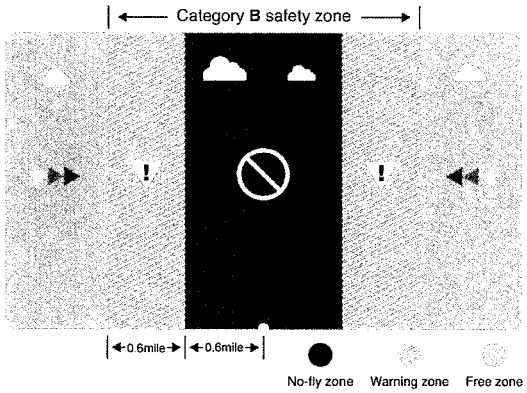
- The category A "safety zone" is comprised of a small "no-fly zone" and a range of "restricted-altitude zones". Flight is prevented in the "no-fly zone" but can continue with height restrictions in the restricted-altitude zone.
- 1.5 miles (2.4 km) around a designated safety zone is a no-fly zone, inside which takeoff is prevented.
- 1.5 miles (2.4 km) to 5 miles (8 km) around restricted areas are altitude restricted, with maximum altitude going from 35 feet (10.5 m) at 1.5 miles (2.4 km) to 400 feet (120 m) at 5 miles (8 km).
- A "warning zone" has been set around the safety zone. When you fly within 320 feet (100m) of the safety zone, a warning message will appear on the DJI Ground Station.



Category A

Category B Safety Zone

- Category B "safety zone" is comprised of a "no-fly zone" and a "warning zone".
- 0.6 miles (1 km) around the safety zone is a designated "no-fly zone".
- A "warning zone" has been set around the safety zone. When you fly within 0.6 miles (1Km) of this zone, a warning will appear on the DJI Ground Station.



Category B

GPS ATTI mode		
Zone	**Restriction**	**Rear LED Flight Indicator**
No-fly Zone ●	Motors will not start. If the aircraft enters the restricted area in ATTI mode but GPS ATTI mode activates, the aircraft will automatically descend to land then stop its motors after landing.	Blink red quickly and continue for 3 seconds before normal blinks.

Restricted-altitude flight zone 	If the aircraft enters a restricted area in ATTI mode and GPS ATTI mode activates, it will descend to a safe altitude and hover 15 feet below the safe altitude.	Blink yellow quickly and continue for 3 seconds before normal blinks.
Warning zone 	No flight restriction applies, but there will be warning message.	
Free zone 	No restrictions.	None.

	Semi-automatic descent: All stick commands are available except the throttle stick command during the descent and landing process. Motors will stop automatically after landing. Users must toggle the S1 switch to regain control. This is the same as regaining control during Failsafe. Please refer to regain control during failsafe procedure.
	(1) When flying in the No-fly Zone, LED flight indicators will blink red quickly and continue for 3 seconds, then switch to indicate current flying status and continue for 5 seconds at which point it will switch back to red blinking. (2) When flying in the Restricted-altitude flight zone and Warning zone, LED flight indicators will blink yellow quickly and continue for 3 seconds, then switch to indicate current flying status and continue for 5 seconds at which point it will switch back to red blinking. (3) For safety reasons, please do not fly close to airports, highways, railway stations, railway lines, city centers and other special areas. Try to ensure the aircraft is visible.

4.3.3 Conditions of Flight Limits

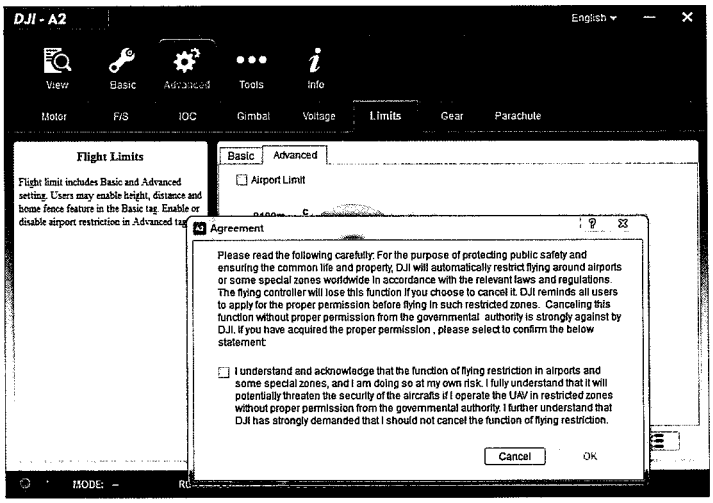
In different working modes and flight modes, flight limits will differ according to number of GPS satellites found. The following table demonstrates all the cases(√: available; ×:unavailable).

All flights are restricted by height, distance and special areas simultaneously. The Failsafe and Ground Station operations are not restricted to flight limits, but if Ground Station function is used, the flight will be restricted the special area limits built in to Ground Station. Refer to the Ground Station manual for details.

Control Mode	number of GPS found	Limits of Special Area	Max Height	Max Radius
GPS	≥6	√	√	√
	<6	×	√	×
ATTI.	≥6	√	√	×

	<6	×	√	×
Manual	≥6	×	×	×

Flight Limits can be disabled in the Assistant as below.



Users cannot take off the aircraft in some Special Areas even the Flight Limits is disabled in the Assistant.

4.4 Parachute Function

The A2 now supports the DJI Dropsafe parachute system which can be enabled in the A2 Assistant. The X3 and F4 ports should be connected. There are two methods to deploy the parachute.

1. Motors will automatically stop and the parachute will deploy by using switch on the remote control.
2. In the event of an emergency (aircraft descends faster than 10 m/s), motors will automatically stop and the parachute will deploy.

(1) Parachute will deploy once the aircraft descends faster than 10 m/s in manual mode.

(2) Once parachute function enabled, motors will automatically stop and the parachute will deploy.

(3) Refer to DJI Dropsafe user manual for more details.

4.5 Gear function

Once enable the Intelligent Gear function, the gear is default down on the ground or in case of emergency (e.g. motor failure tolerance, auto landing); you can control it to be up or down by a switch when the aircraft altitude

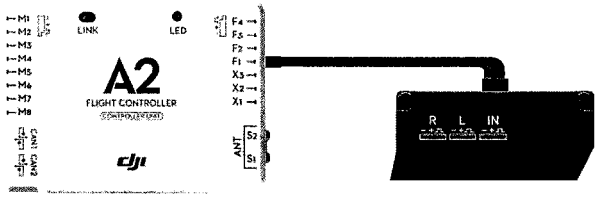
is above 5m during flight.

Please configure in the **Advanced->Gear** page in the Assistant software. Connect the landing gear of S800 EVO to the Controller Unit as fig. below.

(1) Make sure to enable and configure the Intelligent Gear function in the Assistant software first, and then connect the gear to the F1 port.

(2) The Gear channel is required to be mapped with a channel on Receiver if the Intelligent Gear function is enabled in Assistant Software, and the F1 port will give outputs for retracting control.

(3) Once you map the Gear channel, F1 port will give output signals from the controller for retract control. Otherwise, even the Intelligent Gear function is enabled; F1 will give output from D1 (it's necessary to map the D1 channel with a channel on Receiver as your demands).



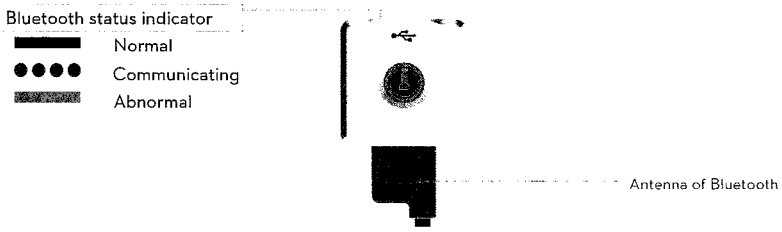
4.6 Attitude Control When One Motor Output Fails

For Hexa-rotor, including Hexa-rotor I, Hexa-rotor V, Hexa-rotor IY and Hexa-rotor Y, the aircraft with A2 flight control system is attitude controllable when one motor output fails.

Select Course lock or home lock mode for flying the aircraft into a safe area to land when the aircraft is far away or the attitude can't be recognized.

4.7 DJI Assistant App Usage

There is a built-in Bluetooth in the A2 LED-BT-I module. With a DJI Assistant App installed on your mobile device, remote parameter configuration can be obtained via Bluetooth communication between the A2 Flight Control System and the mobile device.



Supported iOS devices

iPhone 4s, iPhone 5, iPhone 5s, iPod Touch 5, iPad 3, iPad 4, iPad air, iPad mini,

iOS6.1 or above is required. Bluetooth version is required to be 4.0 or above.

Required versions of DJI Assistant App & Firmware

Require DJI Assistant App version 1.1.14 or above and the firmware of A2 Controller Unit version 2.1 or above, as well as the firmware of LED-BT-I module version 2.0 or above.

Specifications

Bluetooth version	4.0	Environment temperature	-10℃~+50℃
Communication distance	50m	Consumption	240mw(0.04A@6V)

DJI Assistant App Usage

Step 1 Download and installation

1. Search the **DJI Assistant** in App store on mobile device and install it.

Step 2 Connect the A2 Controller Unit and the DJI Assistant App

1. Prepare an iOS device supported 4.0 Bluetooth, and then enable the Bluetooth function on the mobile device.
2. Power on the transmitter and the A2 Flight Control System, make sure the Bluetooth Status Indicator is solid Red[redacted].
3. Run the DJI Assistant App. You may be asked to register through internet when first login (the account of PC Assistant software is OK for login); follow the tips to set Main Controller name and password.
4. Observe the indicators ●● on the left bottom of the software. (● connection indicator and ● communication indicator) On the DJI Assistant App, if the communication indicator is ●, please double check the connections and driver installation; otherwise if the indicator is blinking ◉, go to next step.
5. Select the "Basic" option. Please follow step-by-step for your first-time-configuration. Basic configuration is necessary. Click the icon ⓘ to get the configuration details.
6. You can click the "Advanced" option for more parameter settings. Advanced setting is optional. There are Motor, F/S, IOC, Gimbal, Voltage, Limits, Gear, etc.
7. Check all parameters in the View page.
8. Select "More" to obtain more details. Including: Restore MC default settings, Accounts, Main Controller List, Information, wiki, Rate DJI Assistant, FAQ, Feedback, About.

1. Make sure to upgrade the LED-BT-I module to the latest firmware via the PC Assistant software on a PC before you use the DJI Assistant App with the A2 Flight Control System.

2. Every time you run the DJI Assistant App, the App will search the Controller Unit automatically.
3. The gain value displayed on Mobile Device and PC may be a little different, that is OK for use.

Step 3 Flying Test Procedures

1. Get the aircraft ready, run the DJI Assistant and make sure it is connected with the main controller. (The indicators on the DJI Assistant are)
2. Start the motors.
3. The "View" page shows the relative parameters real-time when flying.
4. Go to the "Basic" and click into the "Gain" page to set the values of all gains real-time during flying.
5. Go to the "Basic" and click into the "Tool" page to view the values of IMU & Compass real-time during flying.
6. Finish the flying and land your aircraft.

Only the parameter referred above can be changed during flying. Others can be configured after landing.

Appendix

LED indicator descriptions

Control mode	GPS signal
Manual Mode: No indicator	Best (GPS > 6): No indicator
ATTI. Mode: (1) (sticks not in mid-point (2))	Good (GPS = 6): ●(1)
GPS ATTI. Mode: ●(1) (sticks not in mid-point ●(2))	Bad (GPS = 5) : ●(2)
Ground Station: ●(1)	Worst (GPS < 5): ●(3)

Flight Attitude	
Attitude good: No indicator	Attitude status bad: (3)
IMU data lost, calibrate IMU needed : ●(4)	

Compass calibration	
Horizontal calibration ■(∝)	Calibration Failed ●(∝)
Vertical calibration ■(∝)	Abnormal Compass Data ●(∝)

Low voltage alert	
First level alert (∝)	Second level alert ●(∝)

FailSafe mode	
During the FailSafe ● (∝)	Compass Abnormal after power on ●(∝)

Errors	
System Error ●(4)	Compass Abnormal after power on ●(∝)

IOC Recording	
Record home-point successfully	●(20)
Aircraft is in the 8m range of HP	●(6)
Record forward direction successfully	●(20)
Record a Point Of Interest successfully	(20)

Bluetooth	
A2 Assistant is connected / disconnected to the flight control system ● (∝)	

When the LED blinks (3), please hover or land the aircraft and wait for the white LED to go off.

When the LED blinks ●(3), it is not recommended to fly.

When the LED blinks ●(4), please contact your dealer.

Specifications

General

Built-In Functions

- Built-in Receiver
- External Receiver Supported
- Multiple Control Modes
- 9 Types of Supported Multi-rotor
- 2-axle Gimbal Supported
- Other DJI Products Supported
- Enhanced FailSafe
- Low Voltage Protection
- Intelligent Orientation Control
- 4 Configurable Outputs
- Dynamical Systems Protection
- Sound Alarm
- PC & Bluetooth Ground Station
- Configure Parameters Via Bluetooth

Peripheral

Supported Multi-rotor	• Quad-rotor: I4, X4 • Hexa-rotor: I6, V6, Y6, IY6 • Octo-rotor: X8, I8, V8
Supported ESC output	400Hz refresh frequency.
Supported Transmitter for Built-in Receiver	Futaba FASST (MULT, MLT2, 7CH) Series and DJI DESST Series
External Receiver Supported	Futaba S-Bus, DSM2, PPM
Recommended Battery	2S ~ 6S LiPo
Other DJI Products Supported	Z15, iOSD Mark II, D-BUS Adapter, S1000,S900 EVO, 2.4G Data Link, H3-2D, H3-3D, DJI Dropsafe Parachute

Electrical & Mechanical

Power Consumption	MAX 5W (Typical Value: 0.3A@12.5V)
Operating Temperature	-5°C to +60°C
Total Weight	<= 224g (overall)
Dimensions	• MC: 54mm x 39mm x 14.9mm • IMU: 41.3mm x 30.5mm x 26.3mm • GPS-COMPASS PRO PLUS: 62 mm (diameter) x 14.3 mm • PMU: 39.5mm×27.6mm×9.8mm • LED-BTU-I：30mm x 30mm x 7.9mm

Flight Performance (can be effected by mechanical performance and payloads)

Hovering Accuracy (In GPS ATTI. Mode)	• Vertical: 0.5m • Horizontal: 1.5m
Maximum Wind Resistance	<8m/s (17.9mph / 28.8km/h)
Max Yaw Angular Velocity	150deg/s
Max Tilt Angle	35°
Ascent / Descent	6m/s

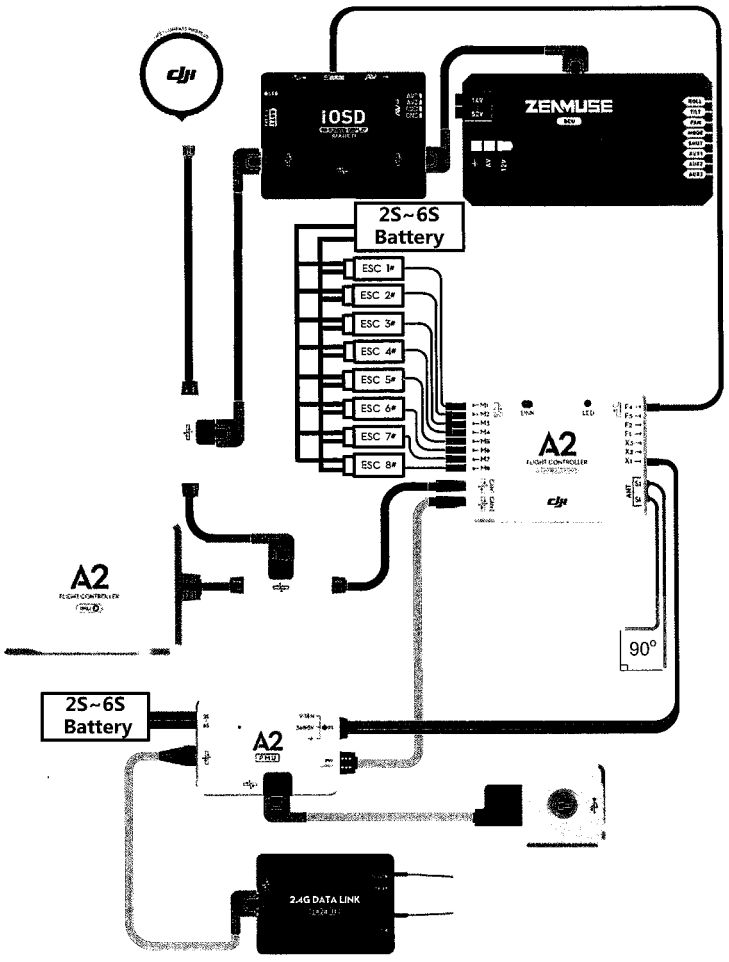
Use with other DJI products

The A2 can be used with other DJI products such as iOSD Mark II, Z15 series gimbals, S800 EVO and 2.4G Data Link(iPAD Ground Station function), H3-2D, H3-3D, etc. Users should connect them to the correct CAN-Bus port.

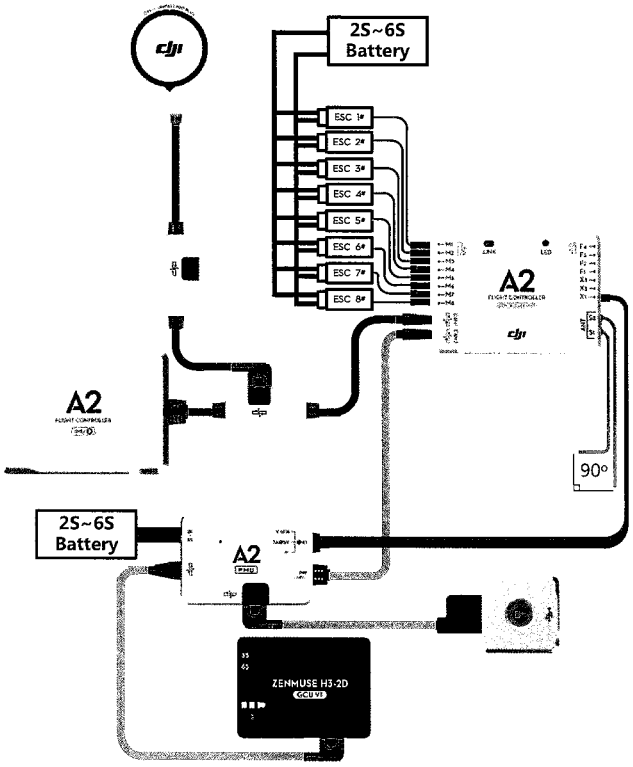
CAN1: iOSD Mark II, Z15 series.

CAN2: 2.4G Data Link (iPAD Ground Station function), H3-2D, H3-3D.

The following 2.4G Data Link connection diagram is the connection for your reference.



The following H3-2D connection diagram is the connection for your reference.



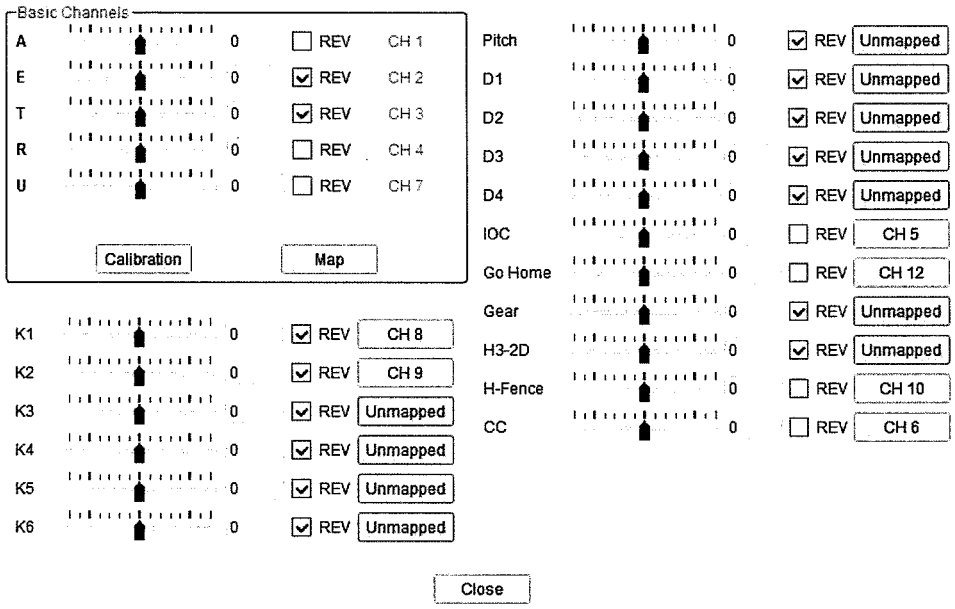
(1) H3-2D/3D users should upgrade the firmware to the latest version (GCU V1.6& IMU V1.6 or above).

(2) If the 2.4G Data Link and H3-2D/3D are used at the same time, a CAN-HUB module is required.

When using the A2 flight control system firmware version V2.1, the firmware of other DJI products used in conjunction must be matched with the requirements in the table below.

Other DJI Products	Firmware/Software Version (or above)	Assistant Software(use to upgrade)
iOSD Mark II	V3.0	iOSD V4.0 & OSD Viewer V4.0
Zenmuse H3-2D/3D	GCU V1.6 & IMU V1.6 & CMU1.0	H3-2D V1.02
Z15-GH3	GCU V0.12 & IMU V1.4	Z15-GH3 V1.00
Z15-5D	GCU V0.12 & IMU V1.4	Z15-5D V1.00
Z15-5N/7N/GH2/5R	GCU V0.0.12 & IMU V1.0.18_beta	Z15 V1.4
2.4G Bluetooth Datalink	The Ground end V1.0.1.5 & The Air End V1.0.1.1 & BTU V1.0.1.2	2.4G Bluetooth Datalink V1.0.0.6
iPAD Ground Station	V1.3.56	----

Channel Mapping Instructions for PC Assistant Software



Basic Channel	Default Settings	Usage Descriptions
A	Roll Control of the Controller Unit, mapped to the Channel 1 of Receiver	During Assistant Software usage, please click the "Calibration" button, to calibrate the Transmitter sticks travel. During calibrating, make sure to operate strictly following the prompts; otherwise may lead to calibration failure. Click the "Map" button, then you can re-do mapping for A/E/T/R/U.
E	Pitch Control of the Controller Unit, mapped to the Channel2 of Receiver	
T	Throttle Control of the Controller Unit, mapped to the Channel3 of Receiver	
R	Yaw Control of the Controller Unit, mapped to the Channel4 of Receiver	
U	Control Mode Switch of the Controller Unit, mapped to the Channel7 of Receiver	
Others	Default Settings	Usage Descriptions
K1-K6	Remote Gains Adjustment of the Controller Unit, unmapped.	Click "Unmapped" button to map K1-K6 to the channels of Receiver.
Pitch	Gimbal Pitch Control of the Controller Unit, unmapped.	Click "Unmapped" button to map Pitch to a Receiver channel for the gimbal servo control.
D1-D4	Direct Channels (The corresponding ports are F1-F4 on the Controller Unit) of	Click "Unmapped" button to map D1-D4 to the Receiver channels. If you enable the

	Controller Unit, unmapped.	Gimbal functions in Assistant Software, then the F3/F2 are used for gimbal control; even D3/D2 are mapped to channels of Receiver, and the signals from the mapped Receiver channels will be ignored. You can use F4 for switching the video channel of iOSD Mark II, then map D4 to a Receiver channel.
IOC	IOC function of the Controller Unit, unmapped.	Click "Unmapped" button to map IOC to a Receiver channel. It is recommended to use a 3-position switch channel.
Go Home	One-Key Go Home function of the Controller Unit, unmapped.	Click "Unmapped" button to map Go Home to the Receiver channel. It is recommended to use a 2-position switch channel.
Gear	Intelligent Gear function of the Controller Unit, unmapped.	If you enable the Gear function in Assistant Software, then the F1 is used for the gear control of S800 EVO landing.
H3-2D/3D	H3-2D/3D function of the Controller Unit, unmapped.	Click "Unmapped" button to map H3-2D/3D to a Receiver channel. It is recommended to use a Knob switch channel, which is only used for H3-2D/3D pitch control.
H-Fence(Home Fence)	Unmapped	Click "Unmapped" button to map Home Fence onto the Receiver channel. It is recommended to use a 2-position switch channel.
CC (Cruise Control)	Unmapped	Click "Unmapped" button to map Cruise Control to the Receiver channel. It is recommended to use a 3-position switch channel.
	The Pitch and the H3-2D/3D channels can be used at the same time. The Pitch is for the pitch control of servo gimbal, and the H3-2D/3D is for the pitch control of H3-2D/3D gimbal	

Recommended Mapping for Futaba Transmitter (Mode 2) User

Controller Unit Channel	Receiver Channel	Recommended Transmitter Switch
A	Channe 1 (AIL)	Joystick J1
E	Channe 2 (ELE)	Joystick J2
T	Channe 3 (THR)	Joystick J3
R	Channe 4 (RUD)	Joystick J4
U	Channe 7 (AUX5)	3-Position switch, e.g. SG
K1-K6	Channe 5 (GEAR)	Knob switch, e.g. LD, RD
Pitch	Channe 6 (Vpp)	Knob switch, e.g. LD, RD
D1/D3/D2	----	----
D4	Channe 9 (AUX1)	2-Position switch, e.g. SF
IOC	Channe 10 (AUX2)	3-Position switch, e.g. SG
Go Home	Channe 11 (AUX3)	2-Position switch with spring back function, e.g. SH
Gear	Channe 8 (AUX4)	2-Position switch, e.g. SF
H3-2D	Channe 12 (AUX5)	Knob switch, e.g. LD、RD

Settings of gain values for Your Reference

To set the value of basic gain and attitude gain you can refer to the following diagram. These values are only for reference and may vary in practice.

Aircraft	Configuration Information					Basic			Attitude		
	Motor	ESC	Propeller	Battery	Weight	Pitch	Roll	Yaw	Pitch	Roll	Vertical
F450	DJI-2212	DJI-30A	DJI-8 Inch	3S-2200	890 g	150	150	135	150	150	140
F550	DJI-2212	DJI-30A	DJI-8 Inch	4S-3300	1530 g	170	170	150	160	160	150
S800 EVO/Z15	DJI-4114	DJI-40A	DJI-15Inch	6S-15000	7000g	140	140	130	140	140	130
S1000/5D gimbal/ 5D camera	DJI-4114	DJI-40A	DJI-15Inch	6S-15000	9200g	120	120	120	170	170	120
S1000/5D gimbal/ 5D camera	DJI-4114	DJI-40A	DJI-15Inch	6S-15000	9300g	120	120	120	170	170	120

The Transmitter setup of FUTABA

Please configure the Frequency item on your Transmitter adhere to the table below. (The names of FASST modes here are based to the Transmitter FUTABA T8FG, please ensure to select the most similar mode as the names differs for different Transmitters)

Transmitter type	AREA	FASST
FUTABA 18MZ	Default	FASST-MULTI\FASST-7CH
FUTABA 14MZ with TM-14	Default	MULT\7CH
FUTABA 14SG	FRANCE\GENERAL	FASST-MULTI\FASST-7CH
FUTABA 12Z 2.4G FASST with TM-14	Default	MULT\7CH
FUTABA 12FG 2.4G FASST with TM-14	Default	MULT\7CH
FUTABA 10CG or 10C with TM-10	Default	7CH
FUTABA 9C SUPER with TM-7 or TM-8	Default	7CH
FUTABA 8FG SUPER	FRANCE\GENERAL	MLT2\MULT\7CH
FUTABA 8FG	FRANCE\GENERAL	MULT/7CH
FUTABA 7C 2.4G	Default	Default
FUTABA 6EX FASST	Default	Default

Disclaimer

Please read this disclaimer carefully before using this product. By using this product, you hereby agree to this disclaimer and signify that you have read it fully.

THIS PRODUCT IS NOT SUITABLE FOR PEOPLE UNDER THE AGE OF 18.

A2 flight controller is designed for experience multi-rotor enthusiasts providing excellent self-leveling and altitude holding, which completely takes the stress out of flying RC multi-rotors for both professional and hobby applications. Despite the product having a built-in flight control system and our efforts in making the operation of the controller as safe as possible when the main power battery is connected, we strongly recommend users to remove all propellers when calibrating and setting parameters. Make sure all connections are good, and keep children and animals away during firmware upgrade, system calibration and parameter setup. DJI Innovations accepts no liability for damage(s) or injuries incurred directly or indirectly from the use of this product in the following conditions:

1. Damage(s) or injuries incurred when users are drunk, taking drugs, drug anesthesia, dizziness, fatigue, nausea and any other conditions no matter physically or mentally that could impair your ability.
2. Damage(s) or injuries caused by subjective intentional operations.
3. Any mental damage compensation caused by accident.
4. Failure to follow the guidance of the manual to assemble or operate.
5. Malfunctions caused by refit or replacement with non-DJI accessories and parts.
6. Damage(s) or injuries caused by using third party products or fake DJI products.
7. Damage(s) or injuries caused by mis-operation or subjective mis-judgment.
8. Damage(s) or injuries caused by mechanical failures due to erosion, aging.
9. Damage(s) or injuries caused by continued flying after low voltage protection alarm is triggered.
10. Damage(s) or injuries caused by knowingly flying the aircraft in abnormal condition (such as water, oil, soil, sand and other unknown material ingress into the aircraft or the assembly is not completed, the main components have obvious faults, obvious defect or missing accessories).
11. Damage(s) or injuries caused by flying in the following situations such as the aircraft in magnetic interference area, radio interference area, government regulated no-fly zones or the pilot is in backlight, blocked, fuzzy sight, and poor eyesight is not suitable for operating and other conditions not suitable for operating.
12. Damage(s) or injuries caused by using in bad weather, such as a rainy day or windy (more than moderate breeze), snow, hail, lightning, tornadoes, hurricanes etc.
13. Damage(s) or injuries caused when the aircraft is in the following situations: collision, fire, explosion, floods, tsunamis, subsidence, ice trapped, avalanche, debris flow, landslide, earthquake, etc.
14. Damage(s) or injuries caused by infringement such as any data, audio or video material recorded by the use of aircraft.
15. Damage(s) or injuries caused by the misuse of the battery, protection circuit, RC model and battery chargers.
16. Other losses that are not covered by the scope of DJI Innovations liability.

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