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Flight control system for ~~Civil Small~~civil small and ~~Light~~light multicopter unmanned aircraft system (UAS) — General requirements

FDIS stage

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Foreword

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Field Code Changed

This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 16, *Unmanned aircraft systems*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Field Code Changed

Flight ~~Control System~~control system for ~~Civil Small~~civil small and ~~Light~~light multicopter unmanned aircraft system (UAS) — General requirements

1 Scope

This document specifies the composition, functional and performance requirements of flight controls for civil multicopter unmanned aircrafts (UAs) with the maximum take-off mass (MTOM) less than ~~25kg~~or equal to 25 kg corresponding to unmanned aircraft systems (UAS) at ~~Level~~levels I, II, III and IV as graded in ISO 21895~~:2020~~ which does not include fully autonomous flights.

The flight control system in this document consists of flight control unit, navigation unit, fault diagnosis and management unit, flight planning, flight recorder, etc. This document is applicable ~~for~~to the design and manufacture ~~for~~of other UA flight control systems or subsystems.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

~~ISO 21895:2020, Categorization and classification of civil unmanned aircraft systems~~

~~ISO 21384-2:2021 Unmanned aircraft systems — Part 2: UAS components~~

~~ISO 21384-4:2020~~ISO 21384-4, *Unmanned aircraft systems — Part 4: Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 21384-4 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ~~—~~ISO Online browsing platform: available at https://www.iso.org/obp

— ~~—~~IEC Electropedia: available at https://www.electropedia.org/

3.1
attitude control mode
flight control system mode that controls the attitude of the aircraft, but not the position of the aircraft

3.2
hover ~~mode~~state
function~~/~~ or mode of keeping the position and height of an aircraft relatively unchanged in position mode without receiving any external control instructions

4 ~~List of abbreviated~~Abbreviated terms

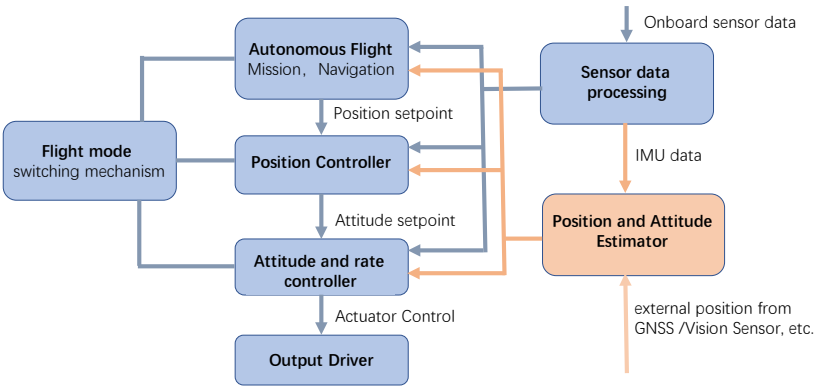
AGL	above ground level
C2	command and control
FCS	flight control system
GNSS	global navigation satellite system
~~AGL~~	~~Above Ground Level~~
~~C2~~	~~Command and Control~~
~~FCS~~	~~Flight Control System~~

~~GCS~~	~~Ground Control Station~~
~~GNSS~~	~~Global navigation satellite system~~
ICAO	International Civil Aviation Organisation
~~IMU~~	~~Inertial measurement unit~~
~~IEC~~	~~International Electrotechnical Commission~~
~~MTOM~~	~~Maximum Take-off Mass~~
~~RTK~~	~~Real Time Kinematic~~
~~RPS~~	~~Remote Pilot Station~~
~~UA~~	~~Unmanned Aircraft~~
~~UAS~~	~~Unmanned Aircraft System~~
IMU	inertial measurement unit
MTOM	maximum take-off mass
RNP	required navigation performance
RTK	real time kinematic
RPS	remote pilot station
UA	unmanned aircraft
UAS	unmanned aircraft system

5 Systems and functions

5.1 System composition

The ~~flight control system (~~FCS~~)~~ of multicopter UAS usually includes aircraft motion control unit, navigation unit, fault diagnosis and management unit, power management unit and flight recorder. The typical information flow of the FCS is described in Figure 1~~Figure 1.~~



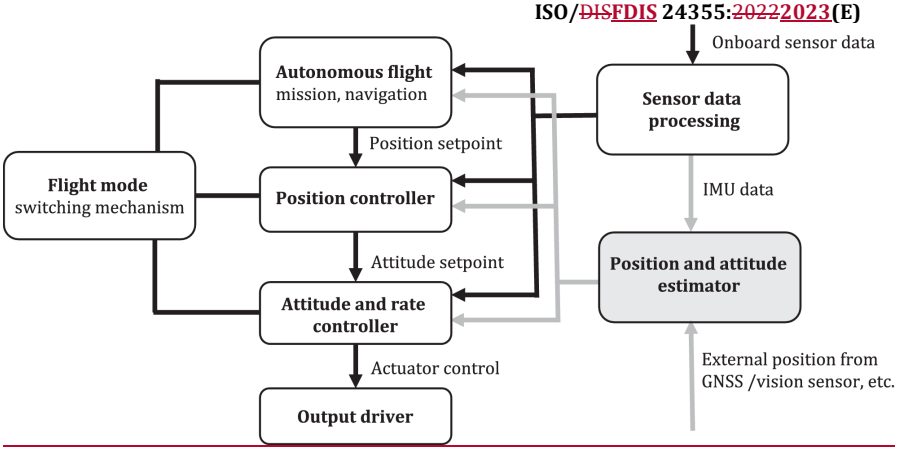


Figure 1 — Typical information flow of the FCS

5.2 Flight control unit

5.2.1 Angular velocity control

The FCS shall have the following angular velocity control functions:

a) ~~a) Respond~~respond to angular velocity commands in pitch, roll and yaw directions based on navigation information;

b) ~~b) Control~~control the UA angular velocity to reach the target angular velocity within the allowable time;

c) ~~c) When~~when the angular velocity control command is zero, the system should maintain current attitude angle unchanged.

NOTE ~~:~~ Angular velocity control is also called rate control in many cases.

5.2.2 Attitude control

The FCS shall have the following attitude control functions:

a) ~~a) Adjust~~adjust the aircraft attitude to the target value in a certain time according to the attitude angle command;

b) ~~b) Withstand~~withstand the unexpected change of aircraft attitude angle caused by external forces during the flight.

5.2.3 Velocity control

When equipped with navigation sensors for velocity measurements/estimation, the FCS shall have the following velocity control functions:

a) ~~a) Adjust~~adjust the aircraft velocity to the target value in a certain time according to the velocity command;

b) ~~b) Withstand~~withstand the unexpected change of aircraft speed caused by external forces during the flight.

5.2.4 Position control

When equipped with navigation sensors for position measurements/estimation, position control should have the following functions:

a) a) Controlcontrol the aircraft to the target position;

b) b) Keepkeep the position of the aircraft when the position control command remains unchanged.

5.3 Navigation unit

5.3.1 Subclause 5.3General

This subclause applies to the FCS with navigation capability.

5.3.15.3.2 General requirements

The navigation unit shall have the following functions:

a) a) Calculatecalculate all or some of other values such as the longitude and latitude, altitude, acceleration, ground speed, vertical speed, heading, pitch, roll and other navigation information of UA;

b) b) Sensorsensor calibration;

c) c) Diagnosediagnose sensor faults;

d) d) Provideprovide angular rate, orientation and acceleration information, such as IMU information;

e) e) Provideprovide continuous altitude information, such as barometric altitude information;

f) f) Provideprovide positioning information, such as GNSS information.

5.3.25.3.3 Optional function

The navigation unit should have the following functions:

a) a) Provideprovide AGL (Above Ground Level) information, such as ultrasonic AGL information;

b) b) Provideprovide relative positioning information;

c) c) Interfacinginterfacing with geo-fencing information;

d) d) Monitormonitor environmental information such as temperature, air pressure and magnetic field;

e) e) Estimateestimate the accuracy of navigation information (e.g. in the form of covariance);

f) f) Alignmentalignment or calibration function to improve the performance of the sensor;

g) g) Managemanage critical sensor redundancy;

h) h) Receivereceive position of other aircraft;

i) i) flight-path deviation warning from pre-programmed flight-path for For automatic or semiautomatic mode.;

j) j) Receivereceive key information during the departure phase from the vertiport infrastructure.

Note: NOTE Information exchanges between the UA and the vertiport are standardised in ISO 5491.

5.3.35.3.4 Flight management

5.3.3.15.3.4.1 General requirements

Flight management shall have the following functions:

a) a) Manualmanual control mode, semi-automatic and automatic control switching;

b) ~~b) Identify~~identify whether the UAS is on the ground or in the air;

c) ~~c) Provide~~provide the remaining endurance time or distance in real-time;

d) ~~d) Fault~~fault detection of components;

e) ~~e) Protective~~protective measures such as flight envelope limits and flying altitude limitations;

f) ~~f) Provide~~provide effective control and maintain smooth flight process.

~~5.3.3.2~~5.3.4.2 Take-off management

UAS take-off phase management should have the following functions:

a) ~~a) Detect~~detect the status of safety-related modules such as sensors, energy sources and power units and the flight restriction area before take-off, and send warnings and prevent the take-off;

b) ~~b) The~~the take-off point position, home point position and altitude information should be recorded when the position information is known;

c) ~~d) Monitor~~monitor the key environmental information of take-off point (such as temperature, altitude, geomagnetic interference~~),~~) and take protective measures in case of poor environment.

~~5.3.3.3~~5.3.4.3 Navigation management

UA navigation management should have the following functions:

a) ~~a) When~~when automatically planning a flight mission, the constraints of energy, flight environment, flight capability and other factors should be considered.

b) ~~b) For~~for the system have UTM interface, support the UAS remote pilot to plan the flight as a sequence of way points defined in 2, 3 or 4 dimensions, considering the intended mission as well as constraints of energy, ground and airspace environment, flight capability and other factors;

~~Note: the Fleet Manager~~NOTE 1 The fleet manager of the UAS remote pilot ~~,~~ can use the ~~Operational Plan Preparation~~operational plan preparation (OPP) service in ISO 23629-12.

c) ~~c) Provide~~provide effective control and guide the unmanned aircraft through subsequent waypoints along the pre-planned flight path.

~~Note 1: waypoints~~NOTE 2 Waypoints can be defined in two (i.e. latitude and longitude), three (plus geodetic or barometric altitude) or four (plus desired time to reach the waypoint) dimensions.

~~Note 2: the~~NOTE 3 The RNP in the horizontal and vertical plane is not standardised in this document.

~~5.3.3.4~~5.3.4.4 Landing management

UAS landing phase management shall have the following functions ~~requirements~~:

a) ~~a) When~~when the remaining energy level is enough only for safety landing, the landing mode shall be immediately switched on;

b) ~~b) When~~when altitude level is less than critical value, the descent speed shall be reduced to prevent hitting the ground;

c) ~~c) During~~during landing, the position of UA should have the function to be manually adjusted to select the appropriate landing point;

d) ~~d) Safe~~safe landing speed should be configurable to prevent landing damage;

e) ~~e) When~~when the vertiport is include in the landing process, the FCS can receive key information during the arrival phase from the vertiport infrastructure;

Note: NOTE Information exchanges between the UA and the vertiport are standardised in ISO 5491.

f) f) When when the UA has limited landing space, landing accuracy shall be meet for safety landing;

g) g) The the landing operation shall have the capability to be stopped manually.

5.4 Flight recorder

The FCS shall be able to record the following information at the specific frequency determined by the manufacturer:

a) a) Navigation navigation data;

b) b) Flight flight control mode;

c) c) Remote remote control information;

d) d) Flight flight status information;

e) e) System system fault information;

f) f) System system warning information;

g) g) Other other required information.

5.5 Safety and emergency management

This section 5.5 applied subclause is applicable to FCS with navigation capability. When the UA encounters an emergency, to increase safety and reduce damage, the FCS should support the following functions:

a) a) Lost lost link protection: when the C2 link is lost and the UA is unreachable by any communication method, the FCS should take the specified action under this situation. It; it should, for example, continue the mission, stop the mission, land, return to home. These; these actions should be software configurable;

b) b) Emergency emergency flight termination and/or emergency recovery: FCS shall support flight termination or recovery procedure in an emergency;

c) c) Low low battery protection: when the remaining battery is lower than the specified minimum value, the FCS should take action specified by the user or manufacturer. For; for example, send a warning to the remote pilot, return home or land;

d) d) The the FCS should support the motor arm and disarm function., When; when the motors are in the disarmed state, they are prevented from starting by the FCS;

e) e) When when the UA encounters GNSS failure, the FCS shall reduce the automatic control level and switch to attitude control mode or manual control mode and send warning to remote pilot with sound, light and RPS warning message, etc.,.;

f) f) The the FCS shall have a maximum attitude angle limitation function to ensure the safe operation of the UA;

g) g) The the tuning of the control parameters should consider enough gain margin to handle uncertainties and dynamic model changes due to condition variation;

h) h) The the communication protocol of the FCS shall have methods such as package sequence number, to prevent out of order and duplicate reception of commands into the communication interface;

i) i) The the FCS shall have the function to track and display communication errors;

