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IEEE Standard Interface Requirements and Performance Characteristics of Payload Devices in Drones

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Access and Core Networks Standards Committee

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IEEE Standard Interface Requirements and Performance Characteristics of Payload Devices in Drones

Developed by the

Access and Core Networks Standards Committee
of the
IEEE Communications Society

Approved 24 September 2020

IEEE SA Standards Board

Abstract: General interface requirements and performance characteristics of payload devices in drones are presented. The drone payload interfaces are described in three categories: mechanical interface, electrical interface, and data interface. Mechanical interface is used to fix the payload to the drone. Electrical interface is an electromechanical device used to join electrical terminations. The electrical interface includes the power supply interface and the two-way communication interface. Data interface refers to the communication protocol. The requirements and performance characteristics of the drone payload interface are detailed from the aspect of protection from temperature extremes, humidity, water, dust, vibration/shock, mold, salt spray, etc. Typical drone payloads, interface requirements, and performance characteristics of specific payloads are illustrated.

Keywords: adapter, attitude adjustment function, communication, communication protocol, compatible, configuration, conformity assessment, connectors, control, data interface, dissimilar connector, drone, drone payload, electrical interface, electromechanical, electromechanical device, extendibility, framework, gimbal, humidity, IEEE 1937.1™, infrared, interface, LiDAR, mechanical interface, mildew, mold, mold resistance, mounting holes, optical, performance characteristics, power consumption, power supply, protocol, pulse per second, removable, requirements, salt spray, scalability, sensors, shock, shockproof, stabilizing, synchronization, temperature, temperature range, test plan, unauthorized access, useful life, voltage, wireless interface, waterproof

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Participants

At the time this standard was completed, the P1937.1 IPDD Working Group had the following entity membership:

Haiying Lu, *Chair*
Liangliang Yang, *Vice Chair*
Ying Mai, *Secretary*
Wenjun Han, *Editor*
Yang Zhang, *Co-Editor*

Organization Represented	*Name of Representative*
0xSenses Corporation	Yu Yuan
Beijing GreenValley Technology Co., Ltd.	Qinghua Guo
Beijing TT Aviation Technology Co., Ltd.	Yi Yang
China Electronics Standardization Institute (CESI)	Haiying Lu
Chengdu Aeronautic Polytechnic (CAP)	Xianding He
Chengdu UAV Industry Association	Bin Ren
China Energy Engineering Group Planning & Engineering Co., Ltd.	Yang Zhang
China Mobile Chengdu Institute of Research and Development	Yu Su
China Southern Power Grid Co., Ltd.	Chigang Peng
China TOPRS Technology Co., Ltd.	Yanli Xue
CTRS Loading Jiangsu Technology Co., Ltd.	Ying Su
Hebei Tianhai Surveying and Mapping Service Co., Ltd	Chunhai Hao
Huawei Technologies Co., Ltd.	Gang Li
Institute of Geographical Sciences and Nature Resources Research (IGSNRR)	Ying Mai
Peking University Collaborative Innovation Center for Geospatial Big Data	Fuhu Ren
Shenzhen Keweitai Enterprise Development Co., Ltd.	Hongliang Ding
Skysys Intelligent Technology (Suzhou) Co., Ltd.	Haibin Wang
State Grid Economic and Technological Research Institute Co., Ltd.	Wenjun Han
SZ DJI Technology Co., Ltd.	Liangliang Yang
The Second Research Institute of Civil Aviation Administration of China	Jianping Zhang
Tianjin WOMOW S&T Co., Ltd.	Shuangli Han
Xiaomi Communications Co., Ltd.	Xiandong Dong

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Meng Cai
Pingping Chen
Yiyou Chen
Chengqi Cheng
Hongliang Ding
Pengxin Ding
Xiandong Dong
Qinghua Guo
Shuangli Han
Chunhai Hao
Lijing Hao
Xianding He
Wei Hong
En Jin
Gang Li
Renwen Li
Yingcheng Li
Xiaohan Liao
Hong Liu
Pingyuan Liu
Chenguang Ma
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Bin Ren
Fuhu Ren
Yafeng Ren
Jingguo Rong
Zhen Song
Ying Su
Yu Su
Xiang Tan
Bin Tang
Haibin Wang
Qingfa Wang
Wenfeng Wang
Guangcai Xu
Zhihai Xu
Yanli Xue
Yi Yang
Yong Yang
Shulin Yu
Guowu Yuan
Yu Yuan
Weixin Zhai
Zhiyun Zhai
Jianping Zhang
Minrui Zhang
Xiaoxia Zhou
Xiang Zou

The following members of the entity Standards Association balloting group voted on this guide. Balloters may have voted for approval, disapproval, or abstention.

0xSenses Corporation
Beijing GreenValley Technology Co., Ltd.
Beijing TT Aviation Technology Co., Ltd.
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Yokosuka Telecom Research Park, Inc.

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Introduction

This introduction is not part of IEEE Std 1937.1-2020, IEEE Standard Interface Requirements and Performance Characteristics of Payload Devices in Drones.

Unmanned aircraft (UA), commonly known as drones, are aircraft without human pilots aboard. Civil UA have been developing rapidly worldwide in recent years. UA have attracted enthusiasts in the fields of personal entertainment and professional aerial photography, promoted quality of life, and inspired the potential of the UA industry. As an efficient tool, UA have promoted the work efficiency of many industries with wide application demand, such as agriculture, infrastructure, public safety, energy, film and television media, and other industries. The drone industry has developed rapidly in recent years. Capabilities and functionalities of drones have increased and the drone industry continues to expand. Well accepted standards for interface requirements and performance characteristics of payload devices in drones are critical and necessary. Drone manufacturers and users have gained insight, experience, and knowledge that can be shared with the world.

Generally speaking, drones should carry different kinds of payloads to accomplish different purposes.

There are many drone manufacturers producing different kinds of drones, including fixed-wing drones, multi-copter drones, electrically powered drones, and gas powered drones. No matter how big or small, drones have to carry specific payloads to complete specific functions. On the other hand, there are many payloads manufacturers producing different kinds of payloads. Various kinds of payloads need different support from the drones, for fixing the payload, for power supply, and for data transmission. Payload interface standards are needed for the interfaces to allow different payloads to be used in different drones produced by different manufacturers, and so that different drones can carry different payloads made by different manufacturers.

As emerging technology is developing and demands are also growing to develop new solutions for drone payload interfaces—even for one payload interface that can be used for many kinds of payloads—the related standards should be developed accordingly.

The IEEE P1937.1 working group consists of many important and experienced stakeholders in the drone industry, including DJI, State Grid Corporation of China (SGCC), China Southern Power Grid Co., Ltd. (CSG), China Academy of Sciences (CAS), and CESI. As working group members, they are pursuing the common goal of promoting the drone industry by rapidly developing good services for clients.

The standard working group is preparing to carry out the IEEE Conformity Assessment Program (ICAP), including conformity assessment for the drone payload interface, to help the industry develop better and help customers acquire qualified products.

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IEEE Standard Interface Requirements and Performance Characteristics of Payload Devices in Drones

1. Overview

1.1 Scope

This standard establishes a framework for drone interface to payload. It defines the interfaces, performance metrics, provisioning, operation control, and management for drone payload devices.

This standard specifies payload interface requirements for drones that have a maximum take-off mass (MTOM) less than 25 kg, the drones' built-in payload not included.

1.2 Purpose

IEEE Std 1937.1™ describes the general interface requirements and performance characteristics of payload devices in drones.

1.3 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (*shall* equals is *required to*).[1, 2]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (*should* equals is *recommended that*).

The word *may* is used to indicate a course of action permissible within the limits of the standard (*may* equals is *permitted to*).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (*can* equals is *able to*).

[1]The use of the word *must* is deprecated and cannot be used when stating mandatory requirements; *must* is used only to describe unavoidable situations.
[2]The use of *will* is deprecated and cannot be used when stating mandatory requirements; *will* is only used in statements of fact.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEC 60068-2-10, Environmental testing—Part 2-78: Tests—Test J and guidance: Mold growth.[3]

IEC 60068-2-52, Environmental testing—Part 2-52: Tests—Test Kb: Salt mist, cyclic (sodium chloride solution).

IEC 60068-2-78, Environmental testing—Part 2-78: Tests—Test Cab: Damp heat, steady state.

IEC 60529, Degrees of protection provided by enclosures (IP codes).

IEC 61000-4-2, Electromagnetic compatibility (EMC)—Part 4-2: Testing and measurement techniques—Electrostatic discharge immunity test.

3. Definitions, acronyms, and abbreviations

3.1 Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.[4]

drones: Vehicles without human pilots aboard, operated remotely.

gimbal: The mechanical component installed on the drone to mount the payload.

NOTE—Generally, a gimbal can meet the three degrees of freedom of the payload: rotate around the X, Y, and Z axes, and each axis is equipped with a motor. It can also cooperate with the gyroscope to strengthen the power of the corresponding platform motor in the opposite direction when the drone tilts, so as to prevent the payload from "tilting" with the drone to avoid payload jitter.[5]

infrared thermal imager: An imaging system mainly composed of a protective casing, optical system, optical scanning mechanism, photo detector, signal amplifier, and processor.

NOTE—The optical mechanical system is used to perform line scan detection on the infrared radiation of the target to be measured, and after receiving the conversion and signal processing by the photo detector, the infrared radiation of the target surface to be measured is converted into a device to obtain a quantitative temperature distribution image.

LiDAR: An optical remote-sensing technology that measures distance to a target by illuminating the target by laser light and measuring the reflected light with a sensor.

NOTE—Differences in laser return times and wavelengths can then be used to make a digital 3-D point representation of the target.

[3]IEC publications are available from the International Electrotechnical Commission (https://www.iec.ch) and the American National Standards Institute (https://www.ansi.org/).
[4]*IEEE Standards Dictionary Online* is available at: http://dictionary.ieee.org. An IEEE Account is required for access to the dictionary, and one can be created at no charge on the dictionary sign-in page.
[5]Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

payload: All elements of the drone that are not necessary for flight but are carried for the purpose of fulfilling specific mission objectives.

drone payload interface: The hardware and software entity with specific mechanical structure and electrical characteristics, which is used to realize reliable physical connection and data interaction between the drone and payload.

pulse per second (PPS): An electrical signal that has a width of less than one second and a sharply rising or abruptly falling edge.

NOTE—PPS signals are generally provided by global navigation satellite system (GNSS) receivers.

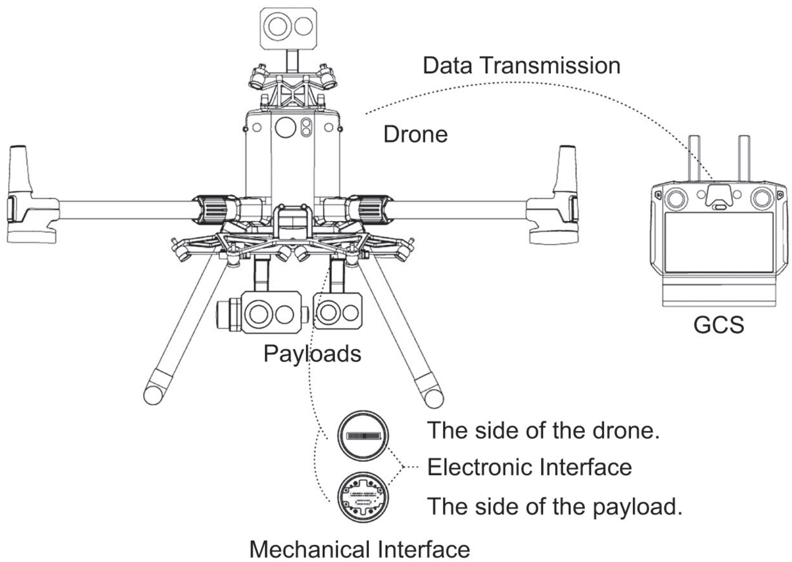
unmanned aircraft (UA): Aircrafts without human pilots aboard, operated remotely.

3.2 Acronyms and abbreviations

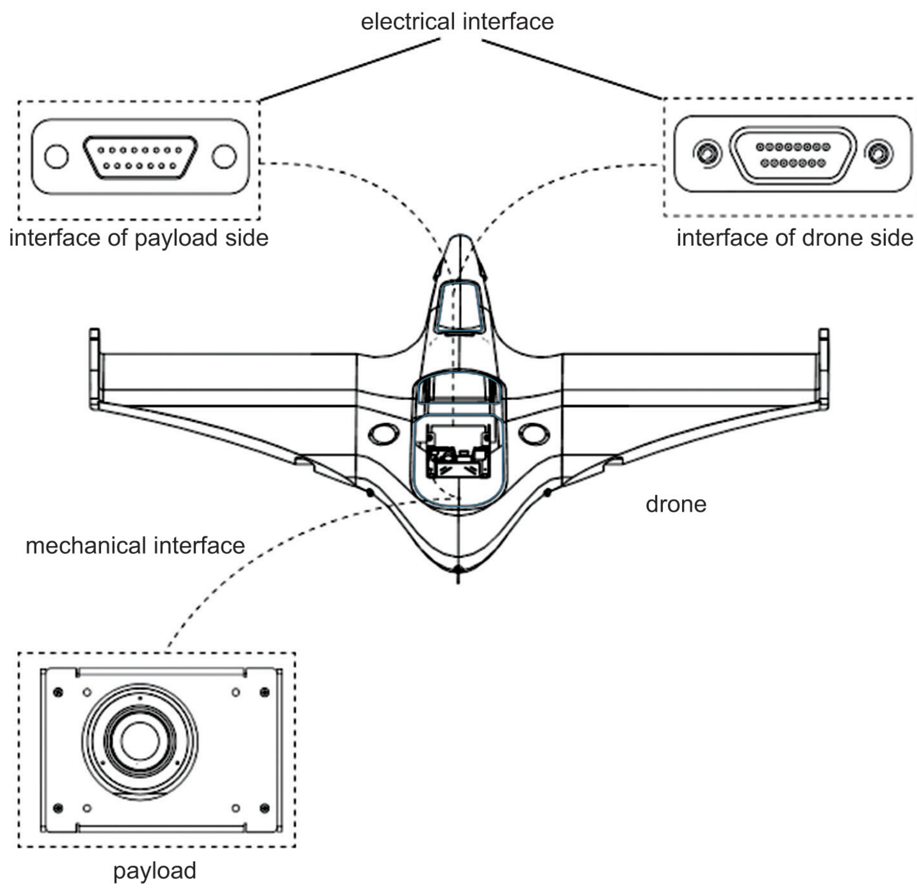
C2	command and control
CAN	controller area network
GCP	ground control station
GNSS	global navigation satellite system
HDMI	high definition multimedia interface
IMU	inertial measurement unit
INS	integrated navigation system
LiDAR	light detection and ranging
MTOM	maximum take-off mass
PPS	pulse per second
RMS	root mean square
RTK	real time kinematic
UA	unmanned aircraft
UART	universal asynchronous receiver-transmitter
UAS	unmanned aircraft system
USB	universal serial bus
VSYNC	vertical synchronization
VTOL	vertical take-off and landing

4. System architecture

Figure 1 shows a typical drone system. The payload device is fixed to the drone through the mechanical interface. The drone supplies power for the payload though the electrical interface. The electrical interface also provides the connection between the drone and the payload for communication and control. The data interface provides the communication protocol which defines the rules, syntax, semantics, and synchronization of communication and possible error-recovery methods.



(a)



(b)

Figure 1—Drone system with typical interfaces

Figure 2 shows the interfaces with the gimbal. The gimbal not only integrates the mechanical interface, electrical interface, and the data interface together, but also provides the attitude adjustment function.

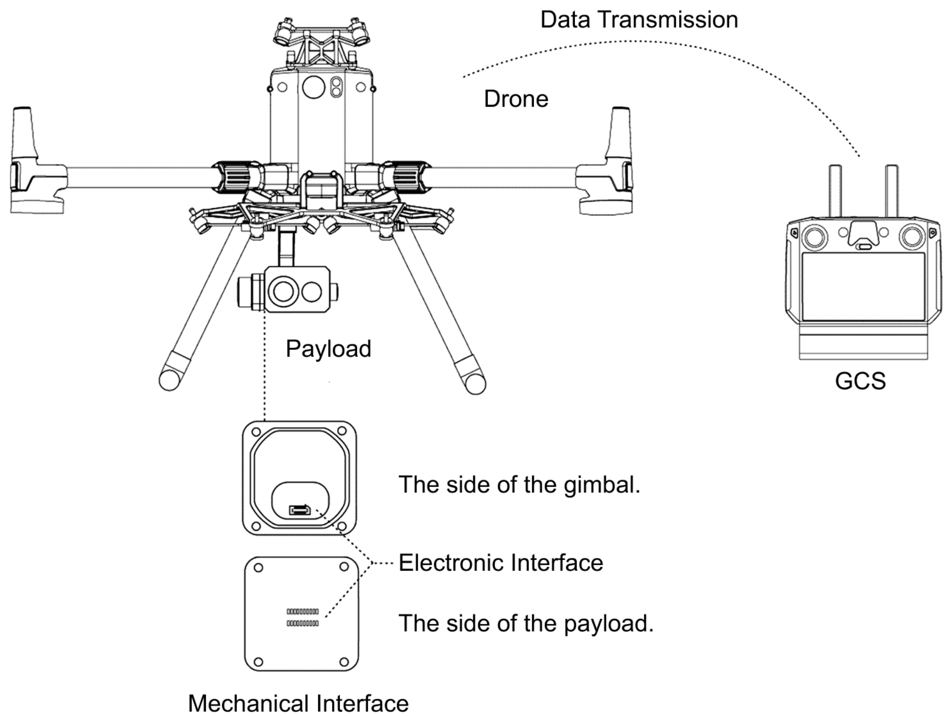


Figure 2—Drone system with integrated gimbal interfaces

5. Interface types

5.1 Mechanical interface

A mechanical interface is used to fix the payload to the drone. Figure 3 shows different kinds of mechanical interfaces.

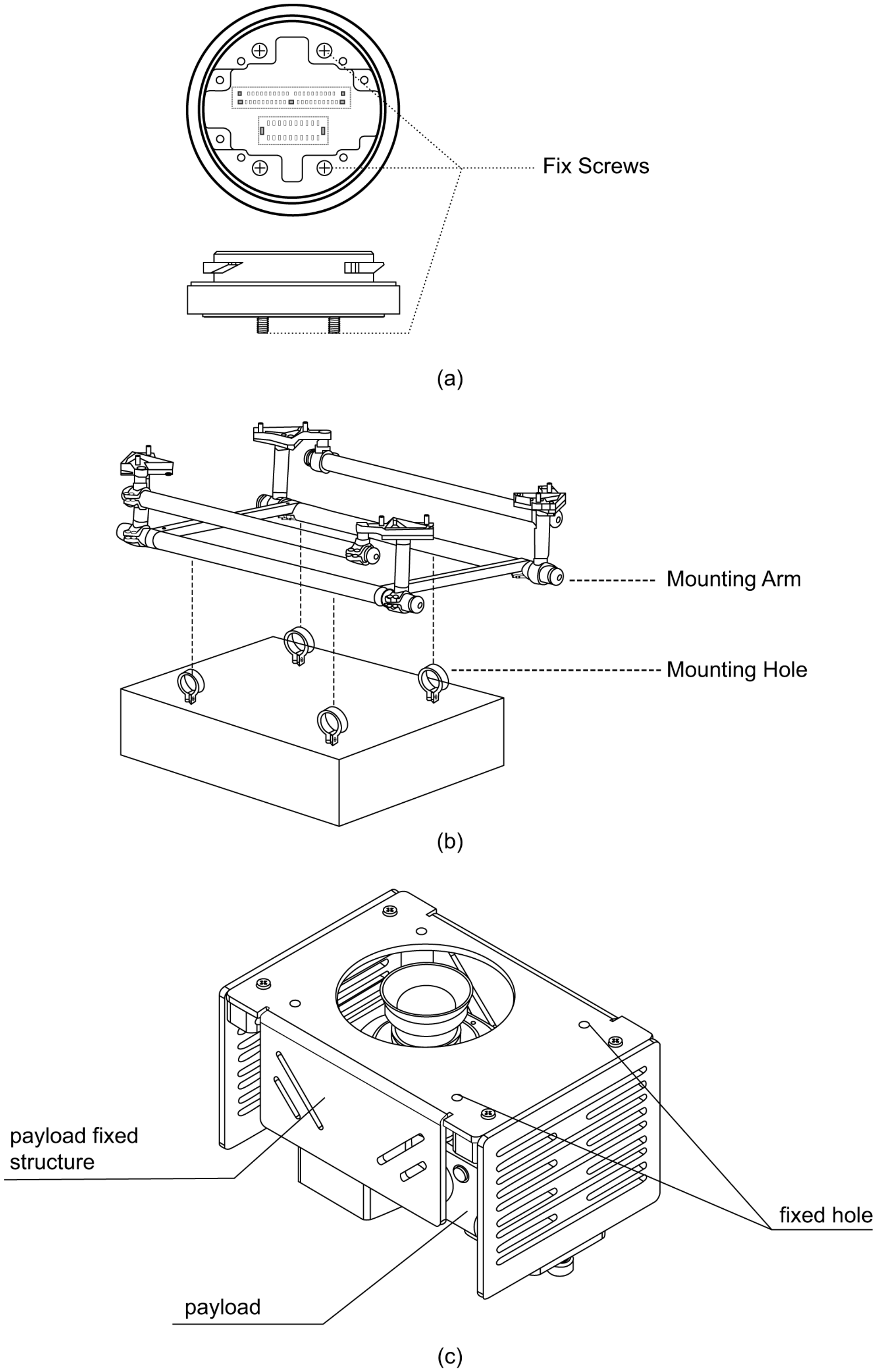


Figure 3—Mechanical interface diagram

Figure 4 shows another kind of mechanical interface. The gimbal is mounted to the drone. It is responsible for connecting the payload. The gimbal integrates the mechanical interface and the electrical interface together.

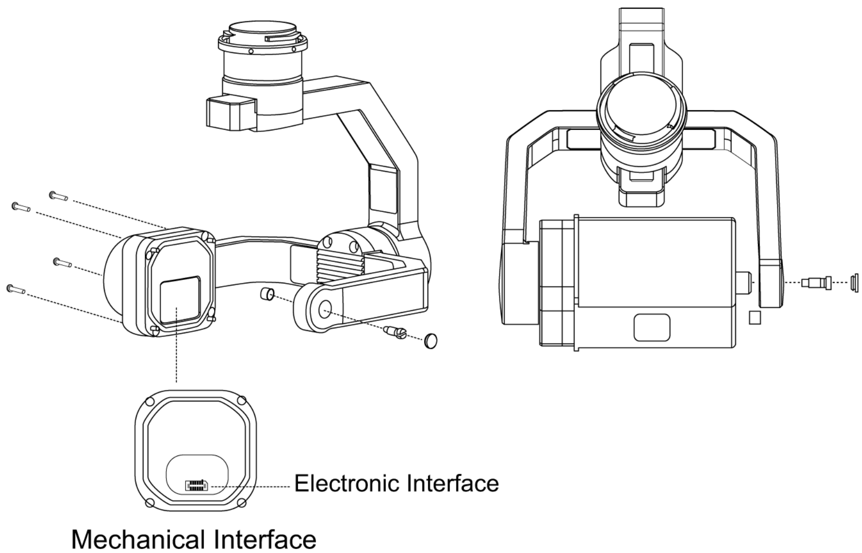


Figure 4—The mechanical interface between the gimbal and payload

The requirements of the mechanical interface are described in 6.2.

5.2 Electrical interface

The electrical interface is an electromechanical device used to join electrical terminations and create an electrical circuit. An electrical interface can also be implemented as the electrical connectors. The connection may be removable (as for portable equipment), require a tool for assembly and removal, or serve as a permanent electrical joint between two points. An adapter can be used to join dissimilar connectors. In the drone system, the electrical interface is divided into the power supply interface and the two-way communication interface.

Figure 5 shows some electrical interface examples.

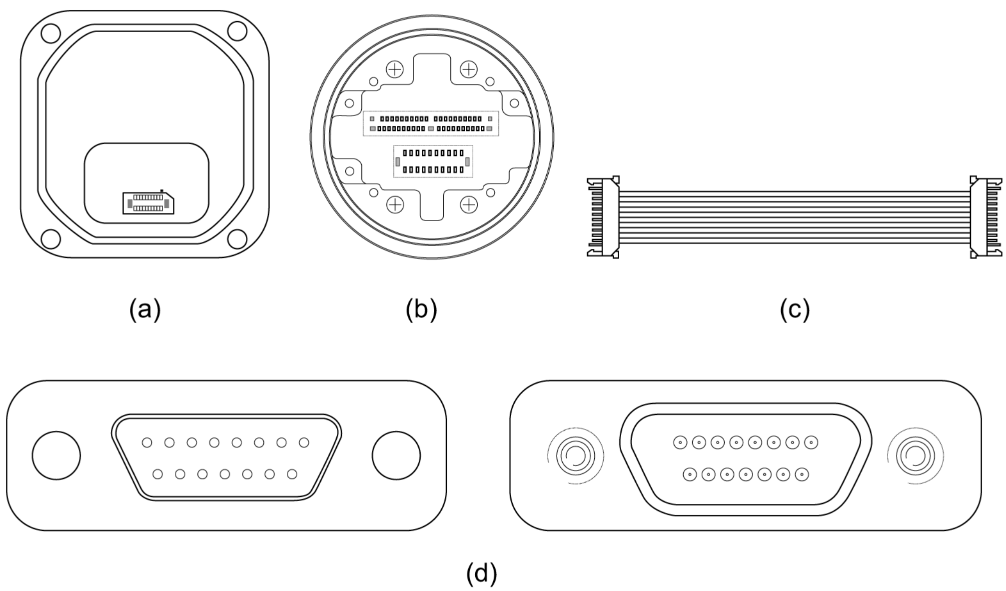


Figure 5—Electrical interface diagram

The requirements of the electrical interface are described in 6.3.

5.3 Data interface

The data interface can also be expressed as the communication protocol. In telecommunication, a communication protocol is a system of rules that allow two or more entities of a communications system to transmit information via any kind of variation of a physical quantity. The protocol defines the rules, syntax, semantics, and synchronization of communication and possible error-recovery methods.

Communicating systems use well-defined formats for exchanging various messages. Each message has an exact meaning intended to elicit a response from a range of possible responses pre-determined for that particular situation. The specified behavior is typically independent of how it is to be implemented. Communication protocols have to be agreed upon by the parties involved. The requirements of the data interface are described in 6.4.

6. Interface requirements

6.1 General requirements

General requirements of all types of payload interfaces are as follows:

a) The interface between unmanned aircraft and payload consists of two mating connectors, one located at the unmanned aircraft and the other located at the payload. The two parts of the interface are connected mechanically and electrically by a specific mechanism. For a payload with high stability requirements, the interface should support the connection to the gimbal.

b) The interface shall have error-proofing design, such as anti-reverse plug design, anti-mistake plug design, interface identification, etc.

c) The interface shall be designed to withstand abrasion, and for convenient repetitious insertion and removal.

d) The interface shall have a locking mechanism to avoid loosening and falling off.

e) The interface connection shall be able to withstand adverse mechanical environmental conditions, such as vibration, shock, and drop that may occur during normal transportation, handling, and flight. The interface should be equipped with vibration dampers.

f) The interface shall meet applicable safety requirements during installation, use, and maintenance. Its accessible surface shall be free from burr, flash, and other sharp edges.

g) The interface shall be dustproof and waterproof.

h) The interface shall be corrosion proof and rustproof.

i) The interface should be flame resistant, and produce no toxic smoke.

j) Hot swapping of payloads shall not be permitted to avoid accidental personal injury and electronics damage, unless sufficient safety designs and protection measures are made. If needed, an electrical interface capable of hot-swapping shall be designed to reduce the risk of damage or performance degradation while connecting or disconnecting the payload. Possible corruption of signal or data shall also be reliably detected.

6.2 Mechanical interface

Requirements of the mechanical interface are as follows:

a) The mechanical interface shall match the reserved structure of the unmanned aircraft interface or the gimbal, and the structure size should be as small as practical.

b) The weight of the mechanical interface should be as light as practical.

c) The structure of the mechanical interface shall be stable, not easy to deform.

d) The structure of the mechanical interface shall be easy to mount and dismount.

e) The mounting position of the mechanical interface shall not adversely affect the stability of the unmanned aircraft.

f) For the interface used on drones with gimbal, the equipped payload gravity center should be in the center line of the gimbal pitch axis.

6.3 Electrical interface

Requirements of the electrical interface are as follows:

a) If the power supply requirement of payload can be met by the drone through reliable communication, the drone shall supply power to payload devices through the electrical interface according to the requirement; if the requirement cannot be communicated or met, the power shall be supplied according to the capacity of the drone.

b) The drone should provide a regulated dc power output to payload devices through the electrical interface at a minimum.

c) The drone may provide unregulated dc power to payload devices through the electrical interface.

d) Power supply provided by the electrical interface shall have short-circuit protection. The drone should have the ability to limit the current consumption of payload devices to prevent excessive exploitation of battery power.

e) Current-carrying capacity of the electrical interface contacts shall be sufficiently derated to verify maximum temperature rise be no more than 20 °C under the highest loading situation. High-current power and ground connections should use multiple redundant contacts.

f) The design of the electrical interface should consider performance required by the drone, including, but not limited to, impedance, voltage drop, insulation/maximum leakage current, dielectric strength, power capacity, slew rate, frequency/bandwidth, duty cycle, jitter, delay, loss/attenuation, crosstalk, and isolation requirements.

g) Contacts of the electrical interface shall use anti-corrosion, anti-oxidation, and abrasion-resistant materials or relative surface-finishing technology. To help prevent electrochemical corrosion, metal materials with mismatched properties (such as copper and aluminum) shall avoid direct contact or their contact surfaces shall be covered with appropriate coatings or insulating materials.

h) The electrical interface shall have anti-shock and anti-vibration structure. Power and signals of the electrical interface shall be protected from unintentional short-circuit and mating at wrong orientation or position.

i) The electrical interface shall include one or more communication interfaces, such as asynchronous serial communication interface, controller area network (CAN) bus, high definition multimedia interface (HDMI), universal serial bus (USB) interface, Ethernet interface, etc.

j) The electrical interface supporting camera-type payload shall include frame synchronization signals, such as vertical synchronization (VSYNC).

k) The electrical interface should support the communication of timing and geographic location information, such as pulse per second (PPS) and real time kinematic (RTK) data.

l) The electrical interface should reserve an appropriate number of spare connections or general purpose inputs/outputs for future applications and expansion of definitions.

6.4 Data interface

Requirements of the data interface are as follows:

a) The data interface shall include at least low-speed communication protocol (e.g., based on universal asynchronous receiver-transmitter [UART] interface and CAN bus interface) and high-speed communication protocol (e.g., based on ETHERNET interface and USB interfaces).

b) The communication protocol shall support the control of the payload, as well as the parameter acquisition and configuration.

c) The communication protocol shall define the rules, syntax, semantics, and synchronization of communication and possible error-recovery methods.

d) The communication protocol shall support the data transmission from payload to GCS or drone. The data transmission speed shall not exceed the maximum data bandwidth of the drone.

e) In order to be compatible with unknown communication protocols, the communication protocol shall support transparent data transmission between the payload and the ground station.

f) Drones shall not be controlled with uncertified payloads to help prevent unauthorized access to the command and control functions.

g) The data transmission content should be as simple as possible to reduce the data transmission time.

h) The communication protocol should provide the attitude and position information to the payload.

i) The communication protocol should support the control to the gimbal.

j) The communication protocol should consider the specific requirements of payload time synchronization.

k) The communication protocol should support log information recording.

l) The communication protocol should support data bandwidth allocation.

m) The communication protocol should support power management.

n) The communication protocol should support high-power supply request.

o) The communication protocol should support multi-payload coordination.

7. Environmental adaptation

7.1 Introduction

The interface shall reliably meet the needs of different use environments. Users may propose evaluation requirements and test standards according to the actual use. The environmental adaption requirements of the payload interface include, but are not limited to, the conditions described in 7.2 through 7.7.

7.2 Temperature

The levels of temperature adaptation for the interface between drone and payload are shown in Table 1.

Table 1—Levels of temperature adaptation for the interface between unmanned aircraft and payload (relative humidity is maintained between 45% and 75%)

Requirement	Level I	Level II	Level III	Level IV
Minimum operating temperature	0 °C	–10 °C	–20 °C	–40 °C
Maximum operating temperature	35 °C	45 °C	55 °C	70 °C
Minimum storage temperature	−10 °C	–20 °C	–30 °C	–55 °C
Maximum storage temperature	40 °C	50 °C	65 °C	80 °C

7.3 Humidity

The payload shall be able to work normally under the specified hot and humid conditions.

The severity of damp heat conditions for the interface between the UA and payload under steady state are shown in Table 2. Other states can refer to this standard based on the specific use requirements.

Table 2—Severity of damp heat conditions for interface between UA and payload under steady state

Severity conditions	Level I	Level II	Level III	Level IV
Temperature (°C)	35 ± 2	45 ± 2	55 ± 2	70 ± 2
Relative humidity (% RH)	80 ± 3	85 ± 3	90 ± 3	95 ± 3

The preferred test durations are: 12 h, 16 h, 24 h; 2 days, 4 days, 10 days, 21 days, or 56 days.

The tolerance of temperature and relative humidity is intended to take account of the absolute errors of measurement and experimental equipment. The test equipment and procedures shall be implemented according to IEC 60068-2-78.

7.4 Water and dust

The payload interface exposed to the outside of the drone shall be subject to waterproof and dustproof tests. The tests for the payload interface shall be taken under the relevant environmental conditions. The waterproof and dustproof tests shall be implemented according to IEC 60529.

The protection degrees for the interface shall be listed in the manual with the tested specific IP codes.

7.5 Vibration and shock

The payload interface should survive the general requirements as follows:

- Sinuous vibration of 5 g RMS vertically or 2 g RMS horizontally, frequency ranging from 5 Hz to 1500 Hz.
- Peak mechanical shock of 15 g vertically or 5 g horizontally.

7.6 Mold

The payload interface should be resistant to mildew when exposed to mildew growth in tropical climates. The test equipment and procedures shall be implemented according to IEC 60068-2-10.

The test samples should be observed by naked eye or under a high-power microscope. The levels of the mold growth influence are shown in Table 3.

Table 3—Levels of the mold growth influence

Level	Mold growth influence	Observations	
		Naked eye	Under high-power microscope
0	None	No mold	No mold
1	Micro	No mold	Sporadic mold, covering area is less than 1% of total tested area
2	Mild	Small amount	Mold plaque, covering area is less than 10% of total tested area
3	Medium	Medium	Evenly distributed mold, covering area is less than 25% of total tested area
4	Severe	Massive	Massive mildew, covering area ratio is 25% to 50%, or more

The interface should not be used if above level 2.

7.7 Salt spray

The salt spray resistance requirements of the payload interface shall be formulated. The payload interface shall not rust when exposed to the ocean salt spray atmosphere under working and non-working conditions. The test equipment and procedures shall be implemented according to IEC 60068-2-52.

The general test conditions are as follows:

— Salt solution concentration: 5% ± 1%

— Temperature of the spray stage: 35 °C ± 2 °C

8. Electromagnetic compatibility

The electromagnetic characteristics of the payload interface shall be compatible with the drone, the payload, and the environment to help avoid interference with, and avoid being interfered by, the drone, the payload, and other electronic devices in the space.

Requirements of the electromagnetic compatibility to the payload interface are as follows:

a) The drone, the payload alone, and the drone-payload system connected through the payload interface shall be compliant with applicable international and regional standards over electromagnetic compatibility.

b) The payload interface shall limit the emission of radio frequency (RF) electromagnetic fields from its power and signal lines.

c) The drone and the payload should not be susceptible to the noise and interference coupled by the payload interface.

d) Power and signals going through the payload interface should be filtered, or their slew rate limited, to help reduce or eliminate fluctuations, such as transients, spikes, sags, harmonics, and ripples, which are unnecessary or harmful to required function and performance.

e) Pairing of power and signals with their returns, and the proximity between, shall be considered.

f) It is recommended that the electrical connector(s) of the payload interface have metal housing that connects to the shielding ground of both drone and payload devices.

g) Either connected or not connected, electrostatic discharge (ESD) on the payload interface at required test level, as defined in IEC 61000-4-2, shall not result in damage or performance degradation of the drone and the payload device.

9. Other requirements

9.1 Extendibility

The interface design shall consider scalability to meet the special needs of the drone inspection system for sensors during long-term use.

Extendibility should be considered from the following perspectives:

— Some interfaces, such as pins, shall be reserved for future use.

— The interfaces with different configurations shall be reserved.

— When the drone has multiple payloads to connect simultaneously, as shown in Figure 6, mechanical, electrical, and data interface coordination should be considered.

— Wireless interface is an option when the safe and reliable operation of the drone is not sacrificed. It includes both wireless power and communication.

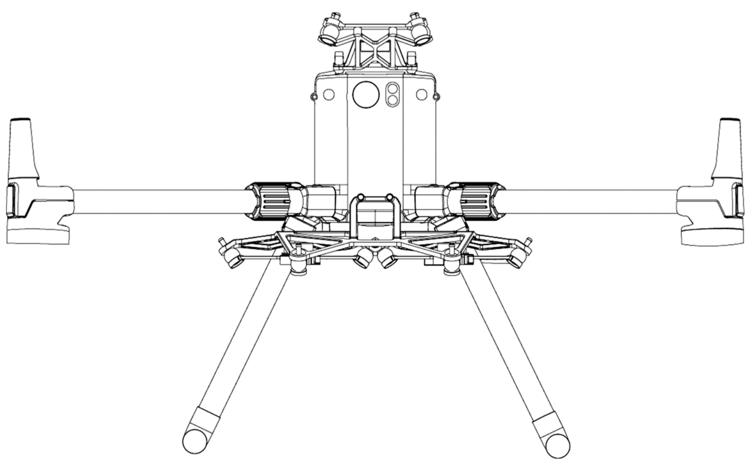


Figure 6—Multiple payload connection

9.2 Useful life

The levels of repeated insertion and removal times of the interfaces are shown in Table 4.

Table 4—Levels of repeated insertion and removal times of the interfaces

Level	I	II	III	IV
Minimum insertion and removal times	2500	5000	7500	10 000

9.3 Markings

The payload interface should be marked clearly as follows:

a) The payload interface shall have corresponding insertion and alignment marks on the interconnected ports to clearly indicate the mounting direction and position.

b) The electrical interface should indicate its type or pin sequence at an appropriate place or in the product manual.

c) The payload interface should be marked clearly in graphic or text.

Annex A

(informative)

Typical interface requirements and performance characteristics of cameras in drones

Basic information	**Payload type**	Visible light camera	Visible light camera
	Drone type	Fixed wing	Multi-rotor
	Drone classification	Light-small	Light-small
Mechanical interface	**Payload weight (g)**	Less than 2500	449
	Installation position	Overlap requirement of equipment and drone center of gravity	Overlap requirement of equipment and drone center of gravity
	Interface dimensions (length [mm] × depth [mm] × height [mm])	90 × 70 × X	151 × 108 × 132
Electrical interface	**Power supply**	Direct current (dc)	DC
	Voltage (V)	25.2	12.7
	Power consumption (W)	300	≤ 50
	Power interface type	One positive and one negative	Eight positive and eight negative
	Control interface	Universal serial bus (USB)	Universal asynchronous receiver-transmitter (UART)
	Communication interface	USB	UART
	Baud rate	30 MB/S	500 B to 4 MB/S
Useful life	**Insertion and removal time**	No less than 10 000 times	No less than 5000 times
Environmental adaptation	**Minimum to maximum temperature**	–20 °C to 60 °C	–20 °C to 40 °C

Annex B

(informative)

Typical interface requirements and performance characteristics of light detection and ranging (LiDAR) in drones

Basic information	**Payload type**	LiDAR	LiDAR
	Drone type	Multi-rotor	Multi-rotor Fixed-wing Vertical take-off and landing (VTOL) Helicopter
	Drone classification	Light-small	Light-small
Mechanical interface	**Payload weight (g)**	< 4000	< 6000
	Installation position	Overlap requirement of equipment and drone center of gravity	Overlap requirement of equipment and drone center of gravity
	Interface dimensions (length [mm] × depth [mm] × height [mm])	Less than 350 × 120 × 180	Less than 400 × 180 × 170
Electrical interface	**Power supply**	Direct current (dc)	DC
	Voltage (V)	Wide voltage supply 9 to 36	Wide voltage supply 9 to 36
	Power consumption (W)	28 to 55	75
	Power interface type	Two positive and two negative	Two positive and two negative
	Control interface	RS232 serial interface	RS232 serial interface
	Communication interface	RS232 serial interface	RS232 serial interface
	Baud rate	9600/115 200/230 400	9600/115 200/230 400
Data interface	**Communication protocol**	RS232 serial communication protocol	RS232 serial communication protocol
	Operation and control protocol	Power on Power off Speed Pulse transmission frequency Scanning angle Angle resolution, etc.	Power on Power off Speed Pulse transmission frequency Scanning angle Angle resolution, etc.
Useful life	**Insertion and removal time**	No less than 10 000 times	No less than 10 000 times
Environmental adaptation	**Minimum to maximum temperature**	–10 °C to 40 °C	–10 °C to 40 °C
Extendibility		Provide external image sensor power supply Trigger Feedback recording and other functions	Provide external image sensor power supply Trigger Feedback recording and other functions

Annex C

(informative)

Typical interface requirements and performance characteristics of other payloads in drones

Basic information	**Payload type**	Thermal infrared camera	Multispectral camera	Laser methane detector	Oblique photography
	Drone type	Multi-rotor	Multi-rotor	Multi-rotor	Multi-rotor
	Drone classification	Light-small	Light-small	Light-small	Light-small
Mechanical interface	**Payload weight (g)**	270	375	560	580
	Installation position	Overlap requirement of equipment and drone center of gravity	Overlap requirement of equipment and drone center of gravity	Overlap requirement of equipment and drone center of gravity	Overlap requirement of equipment and drone center of gravity
	Interface dimensions (length [mm] × depth [mm] × height [mm])	103 × 74 ×102	145 × 70 × 68	130 × 70 × 97	356 × 138 × 95
Electrical interface	**Power supply**	Direct current (dc)	DC	DC	DC
	Voltage (V)	12.7	13.6	13.6	13.6
	Power consumption (W)	< 50	< 50	< 50	< 50
	Power interface	Two positive and two negative	Two positive and two negative	Two positive and two negative	Two positive and two negative
	Measure and control interface	Universal asynchronous receiver-transmitter (UART)	UART	UART	UART
	High-speed interface	100 Mbps LAN	100 Mbps LAN	UART	100 Mbps LAN
Useful life	**Insertion and removal time**	No less than 5000 times	No less than 5000 times	No less than 5000 times	No less than 5000 times
Environmental adaptation	**Relative humidity**	5% to 95%	5% to 95%	5% to 95%	5% to 95%
	Minimum to maximum temperature	–10 to 40 °C	–10 to 40 °C	–10 to 40 °C	–10 to 40 °C

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