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Technical requirements for small unmanned aircraft electric energy systems

Exigences techniques relatives aux systèmes d'énergie électrique pour petits aéronefs sans pilote

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Contents

Page

Foreword

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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.

Technical requirements for small unmanned aircraft electric energy systems

1 Scope

This document provides technical requirements and test methods for small unmanned aircraft electric energy systems (EESs).

This document applies to the EES of small unmanned aircrafts (UAs) with the maximum take-off mass (MTOM) less than 25 kg corresponding to unmanned aircraft systems (UASs) at level I, II, III and IV as graded in ISO 21895:2020, and with secondary lithium batteries. This document can apply to new type of batteries to be used in the UA electric energy system in the future.

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 21384-2, *Unmanned aircraft systems — Part 2: UAS components*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60950, *Information technology equipment - Safety*

IEC 62281:2019, *Safety of primary and secondary lithium cells and batteries during transport*

United Nations *Manual of Tests and Criteria, Seventh revised edition, Section 38.3: Lithium Batteries (*2019)

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
electric energy system
EES
software and hardware system that provides the energy required for the unmanned aircraft, and distributes, controls, detects and estimates the energy

3.2
secondary lithium battery
rechargeable unit which incorporates *secondary lithium cells* (3.3) electrically connected in series and/or parallel with or without monitoring and protection circuitry for charging and discharging

Note 1 to entry: It may incorporate adequate housing and a terminal arrangement and may have electronic control devices.

3.3
secondary lithium cell
basic functional electrochemical unit where electrical energy is derived from the reversible oxidation/reduction reaction of lithium between the negative electrode and the positive electrode

Note 1 to entry: The cell typically has an electrolyte that consists of a lithium salt and organic solvent compound in liquid, gel or solid form and has a metal or a laminate film casing. It is not ready for use in an application because it is not yet fitted with its final housing, terminal arrangement and electronic control device.

3.4
reference test current
I_t
current that can be used to discharge a battery with the rated capacity in one hour

Note 1 to entry: The rated capacity (C_2, expressed in A·h) is the quantity of electricity which the battery can deliver when discharged at the reference test current of 0,5 I_t (expressed in A) to a specified final voltage, after charging, storing and discharging under specified conditions.

3.5
state of charge
SOC
ratio of the *electric energy system (EES)* (3.1) current capacity to the full-charge capacity

4 Abbreviated terms

AFE	analogue front end
FCS	flight control system
LED	light-emitting diode
MCU	microcontroller unit
MTOM	maximum take-off mass
RPS	remote pilot station
SOH	state of health
SOP	state of power
UA	unmanned aircraft
UAS	unmanned aircraft system
UFM	unmanned aircraft flight manual

5 System requirements

5.1 General

The functions of the electric energy system (EES) shall include energy supply, signal measurement and analysis, energy estimation, system protection, energy management, control and distribution, as a minimum.

A typical schematic diagram of the EES is shown in Figure 1. The overall workflow and related functions are as follows:

a) The temperature, battery voltages and current through battery are detected by the AFE and transferred to the gauge and the MCU.

b) The gauge processes the signals and calculates the remaining energy amount in the battery, and sends signals to MCU.

c) MCU manages and controls the battery output based on the signals from the gauge, AFE and the algorithm stored in the MCU. The MCU limits the current when it is higher than expected and cuts off the charging process when the voltage is over the protection voltage. It controls also the distribution of energy and power when the temperature is higher than the protection temperature that affects the battery performance, reliability and safety.

d) Connectors between the EES and the UA send an indication of battery status to the FCS of the UA. The UA flight control system controls the flight to protect the battery and itself.

e) The interface includes buttons and visual indicators (e.g. LEDs) to turn on/off the battery and check the remaining energy.

f) When the EES temperature is abnormal (too high or low), the information is sent to the FCS and then a message is sent to the RPS to notify the remote pilot. The flight control of the UA limits the flight attitude or even make the UA to automatically return home for safety reason.

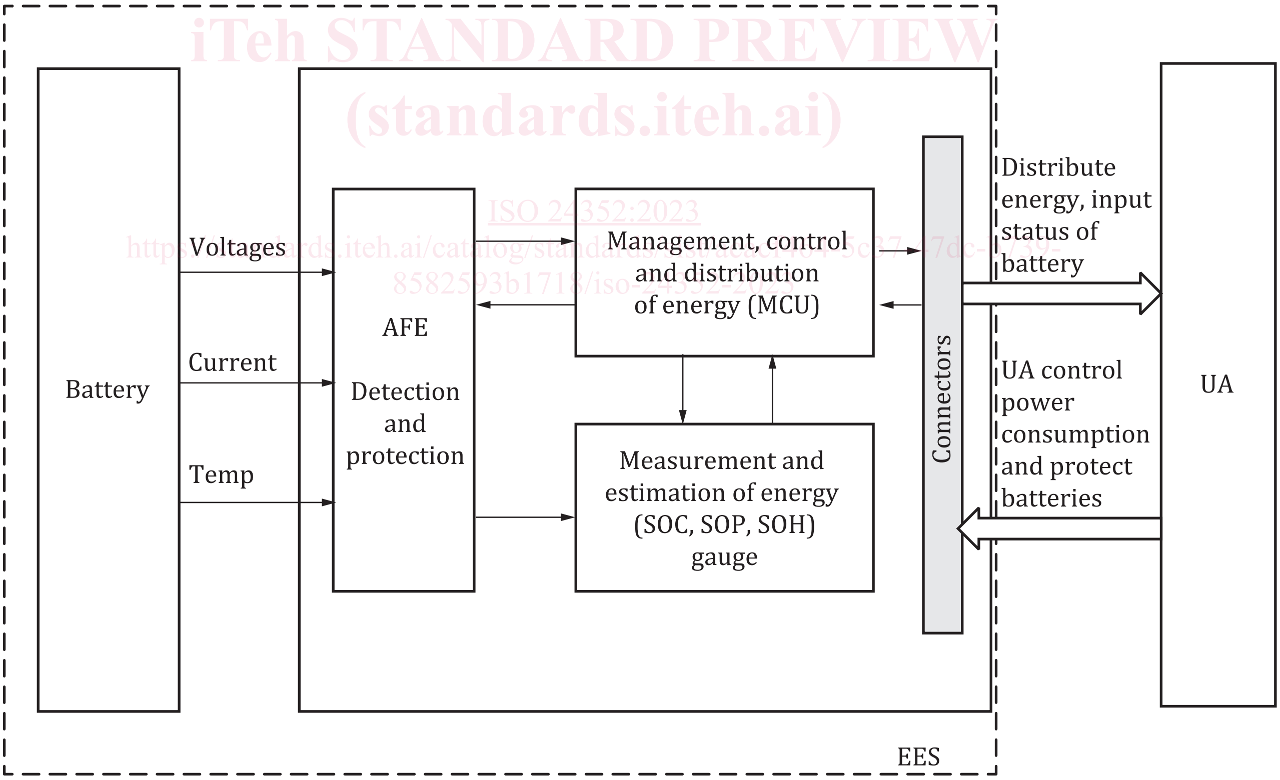

Figure 1 — Typical schematic diagram of electric energy system (EES)

As a minimum, design and installation requirements for the EES shall include:

— It shall be able to provide the necessary voltage and current required by the motor(s) and electrical equipment throughout the operational envelope.

— It shall include electrical protections.

— The electrical connection shall be guaranteed.

— The electrical components shall be designed to accommodate the expected electrical loads.

— It shall be designed to accommodate the risk from the expected operational environments.

— It shall be designed to minimize the risk of electrical shock.

— It shall be able to transmit necessary information and alerts to the UA.

Table 1 is the checklist of the EES requirements, test methods and acceptance criteria.

Table 1 — Checklist of the EES requirements, test methods and acceptance criteria

Requirements Category	Items	Requirements	Test methods and acceptance criteria
Performance	Output control	-	-
	Actuation time	5.2.2.1	5.2.2.2
	Shutdown time	5.2.3.1	5.2.3.2
	Rated output power	5.2.4.1	5.2.4.2
	Discharge capacity	5.2.5.1	5.2.5.2
	Cycle life	5.2.6.1	5.2.6.2
	Operational cycle life	5.2.7.1	5.2.7.2
	Recoverable hovering capacity after high temperature storage	5.2.8.1	5.2.8.2
Information and alert		5.3.1	5.3.2
Energy management and electric protection functions	Charge state of charge calculation	5.4.1.1	5.4.1.2
	Discharge SOC calculation	5.4.2.1	5.4.2.2
	Over voltage protection	5.4.3.1	5.4.3.2
	Under voltage protection	5.4.4.1	5.4.4.2
	Over temperature protection	5.4.5.1	5.4.5.2
	Over Current Protection	5.4.6.1	5.4.6.2
	Overload protection	5.4.7.1	5.4.7.2
	Short-circuit Protection	5.4.8.1	5.4.8.2
Structure		5.5.1	5.5.2
Electrical shock		5.6.1	5.6.2
Connector(s)		5.7.1	5.7.2
Enclosure protection		5.8	5.8
Environmental adaptability	High temperature and humidity storage	5.9.1.1	5.9.1.2
	Temperature shock	5.9.2.1	5.9.2.2
	Low pressure	5.9.3	5.9.3
	Salt spray	5.9.4.1	5.9.4.2
	Drop test	5.9.5.1	5.9.5.2
	Vibration test	5.9.6.1	5.9.6.2

5.2 Performance

5.2.1 Output control

In startup mode, the EES shall be working and providing power to the UA. In shutdown mode, the EES shall not provide power.

5.2.2 Actuation time

5.2.2.1 Requirements

The EES manufacturer shall ensure that the total time to reach the rated power shall meet the UA manufacturer's specification. The recommended actuation time should be less than 60 s.

5.2.2.2 Test method and acceptance criteria

The test shall be conducted in the normal test atmospheric conditions as specified in 6.1. The duration from issuing the startup command to the EES starting to generate output shall be recorded.

The test shall be passed if the actuation time is less than 60 s.

5.2.3 Shutdown time

5.2.3.1 Requirements

The shutdown time of EES shall be designed to meet the UA manufacturer's specification. The recommended shutdown time should be less than 2 min.

5.2.3.2 Test method and acceptance criteria

As the EES works on rated power condition, the duration between receiving the power off command and entering power off status shall be recorded.

The test shall be passed if the shutdown time is less than 2 min.

5.2.4 Rated output power

5.2.4.1 Requirements

The EES shall be continuously outputting the rated output power during the operation time declared by the UA manufacturer.

5.2.4.2 Test method and acceptance criteria

The test shall be conducted in the normal test atmospheric conditions as shown in 6.1.

The fully charged EES with the new battery(s) shall run at the rated output power after startup. The EES voltage shall be recorded once per second during the whole operation time declared by the UA manufacturer. The voltage during the whole testing process shall not be below the discharging final voltage declared by the UA manufacturer.

The test shall be passed if the operation time is higher than the UA manufacturer specified.

5.2.5 Discharge capacity

5.2.5.1 Requirements

Nominal capacity shall be included in the specification and be either tested using charge/discharge current at the reference test current of 0,5 I_t or stated by the UA manufacturer.

When the unmanned aircraft is hovering, the discharge capacity shall not be less than 90 % of the nominal capacity.