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Aerospace — Electrohydrostatic actuator (EHA) — Characteristics to be defined in procurement specifications

Aéronautique et espace — Actionneurs électrohydrostatiques (EHA) — Caractéristiques à définir dans les spécifications d'approvisionnement

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 22072 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 10, *Aerospace fluid systems and components*.

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This second edition cancels and replaces the first edition (ISO 22072:2005), which has been technically revised. This second edition adds requirements for electronic module hardware (4.3.5), operation under failure conditions (4.4.5), electrical power consumption and regeneration (4.5) and fatigue wear life (4.7.2).

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Introduction

Electrohydrostatic actuators (EHAs) are integrated, electrically powered, hydraulic actuators that are used to power aircraft control surfaces or other moving parts.

This International Standard provides requirements that should be included in a Procurement Specification for this type of actuator.

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Aerospace — Electrohydrostatic actuator (EHA) — Characteristics to be defined in procurement specifications

1 Scope

This International Standard defines the general characteristics, requirements and design data to be included in the procurement technical specification of an electrohydrostatic actuator (EHA) to be used to power aircraft control surfaces or other moving parts of an aerospace vehicle.

This type of actuator is an alternative to the hydraulically powered servo-control actuators that are currently used. It is intended that this International Standard cover the unique requirements of EHAs.

2 Normative references

The following referenced documents are indispensable for the application 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.

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ISO 7137, *Aircraft — Environmental conditions and test procedures for airborne equipment*

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DO-178B, *Software Considerations in Airborne Systems and Equipment Certification*[1)]

DO-254, *Design Assurance Guidance for Airborne Electronic Hardware*[1)]

SAE ARP1383B, *Impulse Testing of Aerospace Hydraulic Actuators, Valves, Pressure Containers, and Similar Fluid System Components*[2)]

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
electrohydrostatic actuator
EHA
an electrically powered actuator that includes one or several hydraulic rams

NOTE 1 The chambers of each ram are connected to an integrated hydraulic fluid reservoir and to a bidirectional, fixed-displacement pump driven by a variable-shaft-speed, bidirectional electric motor controlled by an electronic module including power electronics, mounted on the actuator or remotely, and considered a part of the actuator.

NOTE 2 The motor/pump/power electronics assembly may be incorporated into a standard Electrohydrostatic Module (EHM).

1) RTCA – Radio Technical Commission for Aeronautics, www.rtca.org.

2) SAE – Society of Automobile Engineers, www.sae.org.

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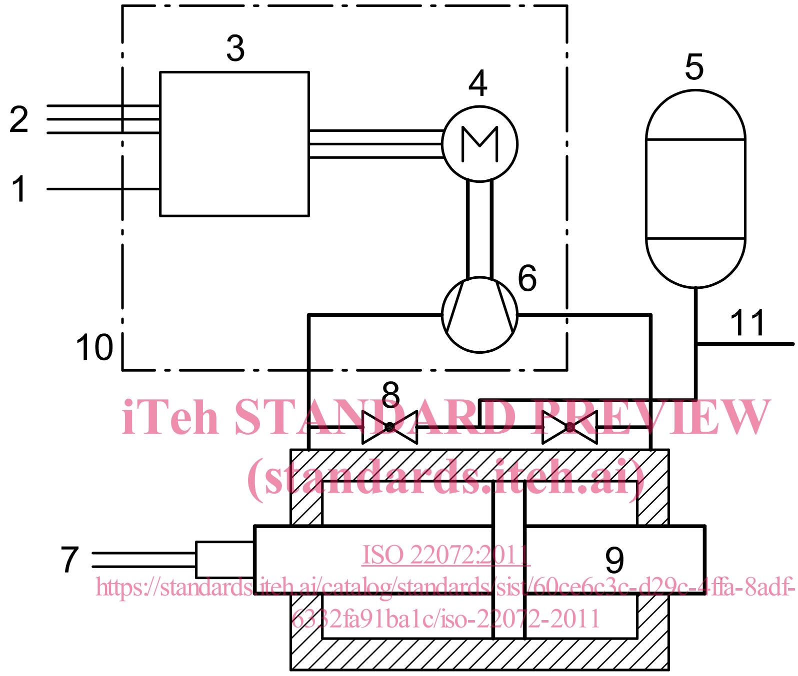
NOTE 3 A manifold, in which components necessary for additional functions can be installed, interconnects the mechanical elements; see Figure 1. The additional functions may include, for example, allowing the operation of other actuators installed in parallel, or ensuring the damping of movement of the load in case of loss of all electric power.

NOTE 4 This assembly is part of the position control loop of the surface, or of any other load, in which the error signal, difference between the commanded and achieved positions determines the command of the speed and direction of rotation of the motor. Other components of the position servo-loop, e.g. position transducer, control electronics, generating the error signal and control laws, do not necessarily form part of this assembly.

NOTE 5 The electronic module function may be limited to Motor Drive Electronics (MDE), higher-level functions such as closing the position loop, control laws, failure detection and isolation, and built-in-test being implemented in a central computer, or these functions can be included as an Electronics Control Unit (ECU).



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Key

1 command signal
2 power supply
3 electronic module
4 electric motor
5 reservoir
6 pump
7 position transducer signal
8 anti-cavitation check valve (two places)
9 piston
10 EHM
11 filling port

Figure 1 — Typical arrangement of an electrohydrostatic actuator

3.2
digital signal processor
DSP
integrated circuit designed for processing signals by digital means as opposed to analogue means

3.3
field-programmable gate array
FPGA
integrated circuit designed to be configured by the designer or user after manufacturing

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4 Requirements

4.1 General

The requirements defined in 4.2 to 4.13 shall be met under all rated operating conditions and during the service life specified.

4.2 Brief description of the system

The EHA is one component of a system. The various configurations or reconfigurations typical of this system involve specific modes of EHA operation which shall be described. Normal and failure modes of operation for the EHA shall be defined.

4.3 Description and interfaces

4.3.1 General description

The unit shall be described in terms of functions and the associated terminology defined.

The following are examples:

- control/electrical/mechanical/structural redundancy;
- local or remote fluid level indication/monitoring;
- filling, either from a ground support equipment or a central hydraulic system;
- draining;
- bleeding;
- internal fluid filtering;
- anti-back-driving device;
- local dissipation of generated energy;
- force and/or pressure and/or speed limitation;
- stops;
- temperature monitoring;
- heating of stand-by unit; etc.

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4.3.2 Mechanical interface

The specification, or a separate interface control document, shall define:

- allocated space envelope;
- dimensions and tolerances of the mechanical connections or the dimensional standards if connections are achieved through standardized components;
- line replaceable units;
- access once installed on aircraft;
- interfaces with specific items (such as hoisting devices or “jack catchers”) intended to hold the unit in place in the event of attachment rupture or disconnection, to avoid secondary damage to surrounding structures or equipment, etc., as required.

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4.3.3 Electrical interface

The specification, or a separate interface control document, shall include:

— wiring schematics defining the electrical connections with power supply, control and monitoring systems, standards, sizes and pin allocation of interface connectors;

— any particular requirements or limitation on use of connectors for the line replaceable units;

— segregation rules to comply with, including signal separation requirements;

— descriptions of signals exchanged, definition of input and output impedances;

— power interruption capability and definition of the strategy for longer interruptions (see 5.3);

— bonding interface;

— shielding requirements;

— specific insulation requirements associated with the use of high voltage d.c.

4.3.4 Hydraulic interface

The hydraulic interface requirements shall include definition and location of possible filling, bleeding, filtering and draining features.

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4.3.5 Electronic module hardware, software/firmware

Various control and monitoring functions, such as listed below, can be implemented locally in the embedded electronic module, which is primarily intended to host the motor drive electronics, or shared with central computers:

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— loop closure;

— monitoring and redundancy management;

— status information;

— built-in test;

— allowable type of processor such as DSP or FPGA may be specified; etc.

The level of criticality and of the associated development, verification and validation methods, configuration control, applicable to the software and firmware shall be specified with reference to DO-178B and DO-254.

Memory capacity extension and processing power shall be specified.

Implementation of monitoring functions may require physical segregation, independent hardware, possible hardware and software dissimilarity, depending on criticality.

4.4 Performance

4.4.1 General

The EHA should meet the performance requirements when operating in conjunction with the other servo-loop components.

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4.4.2 Mechanical performance

The definition of the requirements for output force or mechanical power shall take into account the thermal behaviour. These mechanical requirements shall therefore be associated with their duration and environmental conditions. They shall take into account any included force, pressure or speed limitation functions. Thus the following shall be specified.

a) Maximum operating output force: the maximum driving force to be generated by the unit at very low speed (to be defined), for a short time duration (to be defined), under specified supply and environmental conditions, and the associated tolerances.

b) Maximum continuous output force: the maximum holding force, with no movement, or the maximum driving force, at very low speed (to be defined), to be generated under given supply and environmental conditions with no time limitation, with and without its possible no-back device engaged, and the associated tolerances.

c) “Worst case” scenarios: operational sequences, or series of sequences, described as functions of time in terms of position, force, environmental conditions, identified as sizing cases in terms of instantaneous power absorbed or rejected, or in terms of heat generated. Force fighting shall be considered, depending on system configuration.

d) Maximum rate and associated loading conditions, or expressed as the time necessary to reach a given position under a specified load. The rate versus load characteristic shall be identified.

e) Run-up time: time from activation of stand-by actuator to being able to achieve maximum rate with a maximum rate demand.

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Dynamic performance as specified below may also be a sizing consideration:

— working stroke, stop-to-stop stroke;

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— possible acceptable temporary degradation of performance at start-up, following cold soak in particular;

— possible acoustic noise requirements;

— possible allowed performance degradation under extreme conditions.

4.4.3 Servo-loop static performance

The following characteristics, with and without the possible anti-back-driving device, shall be specified either as the complete servo-loop requirement or as the part allocated to the actuator, taking into account data under 5.6:

— overall accuracy;

— hysteresis;

— resolution;

— stiffness;

— freeplay;

— force fighting, depending on system configuration;

— possible allowed performance degradation under extreme conditions.

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