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Vesoljska tehnika - Smernice za električno načrtovanje in zahteve vmesnikov za prožilnike

Space engineering - Guidelines for electrical design and interface requirements for actuators

Raumfahrttechnik - Richtlinien für die elektrische Auslegung und Schnittstellenanforderungen für Antriebe

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Space engineering - Guidelines for electrical design and interface requirements for actuators

Raumfahrttechnik - Richtlinien für die elektrische Auslegung und Schnittstellenanforderungen für Antriebe

This draft Technical Report is submitted to CEN members for Vote. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

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CEN-CENELEC Management Centre:
Rue de la Science 23, B-1040 Brussels

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Table of contents

Figures

Tables

European Foreword

This document (FprCEN/TR 17603-20-21:2021) has been prepared by Technical Committee CEN/CLC/JTC 5 “Space”, the secretariat of which is held by DIN.

It is highlighted that this technical report does not contain any requirement but only collection of data or descriptions and guidelines about how to organize and perform the work in support of EN-16602-20.

This Technical report (FprCEN/TR 17603-20-21:2021) originates from ECSS-Q-HB-20-21A.

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

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document has been developed to cover specifically space systems and has therefore precedence over any TR covering the same scope but with a wider domain of applicability (e.g.: aerospace).

This document is currently submitted to the CEN CONSULTATION.

Introduction

The present handbook, and the relevant standard ECSS-E-ST-20-21, have been produced in a general context to provide stable electrical interface specifications (both for the source and the load, for functional and performance aspects).

The convergence within ECSS among agencies, of Large System Integrators and of a representative group of electronic manufacturers on the identified requirement set can provide an effective way to get more recurrent products for generic use, both for the actuator electronics (power source), and for the actuators themselves, in a rather independent way from the final application.

The standard ECSS-E-ST-20-21 has therefore to be intended as a standard for product development, and the present handbook as a guideline to understand the relevant requirements, the typical issues of the actuators interfaces both at system and at equipment level.

This handbook complements ECSS-E-ST-20-21, and it is directed at the same time to power system engineers, who are specifying and procuring units supplying and containing electrical actuators, to power electronics design engineers, who are in charge of designing and verifying actuator electronics, and to electrical actuators designers.

For the system engineers, this document explains the detailed issues of the interface and the impacts of the requirements for the design of the actuator chain.

For design engineers, this document gives insight and understanding on the rationale of the requirements on their designs.

It is important to notice that the best understanding of the topic of Actuators Electrical Interfaces is achieved by the contextual reading of both the present handbook and the ECSS-E-ST-20-21.

1 Scope

In general terms, the scope of the consolidation of the electrical interface requirements for electrical actuators in the ECSS-E-ST-20-21 and the relevant explanation in the present handbook is to allow a more recurrent approach both for actuator electronics (power source) and electrical actuators (power load) offered by the relevant manufacturers, at the benefit of the system integrators and of the European space agencies, thus ensuring:

- Better quality,
- Stability of performances, and
- Independence of the products from specific mission targets.

A recurrent approach enables manufacturing companies to concentrate on products and a small step improvement approach that is the basis of a high quality industrial output.

In particular, the scope of the present handbook is:

- To explain the type of actuators, the principles of operation and the typical configuration of the relevant actuator electronics,
- To identify important issues relevant to electrical actuators interfaces, and
- To give some explanations of the requirements set up in the ECSS-E-ST-20-21.

2 References

EN Reference	Reference in text	Title
EN 16601-00-01	ECSS-S-ST-00-01	ECSS system - Glossary of terms
EN 16603-20-21	ECSS-E-ST-20-21	Space engineering - Electrical design and interface requirements for actuators
EN 16603-33-11	ECSS-E-ST-33-11	Space engineering - Explosive subsystems and devices
EN 16602-30-11	ECSS-Q-ST-30-11	Space product assurance - Derating – EEE components
EN 16602-40	ECSS-Q-ST-40	Space product assurance - Safety
	CSG-NT-SBU-16687-CNES Ed/Rev 01/01	Payload safety handbook

3
Terms, definitions and abbreviated terms

3.1 Terms from other documents

a. For the purpose of this document, the terms and definitions from ECSS-S-ST-00-01 apply, in particular for the following terms:

1. redundancy
2. active redundancy
3. hot redundancy
4. cold redundancy
5. fault
6. fault tolerance

b. For the purpose of this document, the terms and definitions from ECSS-E-ST-33-11 apply, in particular for the following terms:

1. no fire
2. all fire

c. For the purpose of this document, the terms and definitions from ECSS-E-ST-20-21 apply.

3.2 Abbreviated terms

For the purpose of this document, the abbreviated terms from ECSS-S-ST-00-01 and the following apply:

Abbreviation	Meaning
AIT	assembly, integration and test
CEO	chief executive officer
CSG	Centre Spatial Guyanais
DC	direct current
DIS	disable
EEE	electric, electro-mechanic and electronic
EMC	electro-magnetic compatibility
EMI	electro-magnetic interference

Abbreviation	Meaning
EN	enable
FO	fail operational
FMEA	failure mode effect analysis
FMECA	failure mode effect and criticality analysis
FPGA	field programmable logic array
FS	fail safe
N	nominal
NEA	non-explosive actuators
OBC	on-board computer
PCB	printed circuit board
PCDU	power conditioning and distribution unit
R	redundant
SCSW	spacecraft central software
SMA	shape memory alloy
SW	software
TM	telemetry
WC	worst case

4 Explanations

4.1 Explanatory note

The present handbook refers to the electrical interface requirements defined in the ECSS-E-ST-20-21.

The ECSS-E-ST-20-21 requirements are referred to in this handbook by using following convention and are indicated in italic font:

[requirement number]

For example:

Requirement 5.2.3.2.1a.

→ [Req. 5.2.3.2.1.a.]

See also, for more information, Annex A of ECSS-E-ST-20-21.

In addition:

- each requirement (i.e. any statement containing a "shall" in the standard) is marked with red text.
- each recommendation (i.e. any statement containing a "should" in the standard) is marked with blue text.

Keywords are highlighted in **bold**. A keyword is a word that either has a special meaning in the contest of the section in which it appears, or highlight a concept.

4.2 How to use this document

For the best utilisation of this document, it is recommended to print it together with the ECSS-E-ST-20-21 and to consult both of them contextually.

In this way, the discussion and the rationale explanation of each individual requirement are clearer and there is the minimum risk of misunderstanding.

5
Actuators Interface

5.1 Type of actuators

Electro-mechanic actuators of different types are used for space applications as part of hold down and release mechanisms and deployment mechanisms.

The technologies used in electro-mechanic actuators are varied:

a. Based on pyrotechnic devices (release nuts/bolt cutter, separation nut, cutters, brazing melt, wire cutter, cable cutter, valves),

b. Split spool devices (Fusible wire, SMA wires),

c. Solenoid actuated nuts,

d. SMA triggered release nuts,

e. SMA actuators (pin pullers and pushers),

f. Paraffin actuators (pin pullers and pushers),

g. Electro-magnetic, solenoid pin puller and pusher actuators,

h. Electromagnets, and magnetic clamps,

i. Thermal cutters and knife,

j. Piezoelectric actuators.

The actuation can be performed by provision of heat thanks to a hot head or a filament, causing mechanical action, ignition of explosive powder, deformation of SMA or paraffin expansion, or by direct electro-magnetic action (solenoids, electro-magnets), or by effects induced by piezo-electric means.

Interfaces to electrical motors (for example solar array drive mechanisms, reaction wheels, and other mechanisms) are not covered by the present handbook and standard ECSS-E-ST-20-21.

Actuators can be classified according to different criteria: from electrical point of view, they can be classified as voltage-driven or current-driven types.

A typical example of voltage-driven actuator is a thermal knife, a typical example of current-driven actuator is a pyro device.

Another interesting classification of actuators is according to their level of reusability, according to Table 5-1.

Table 5-1: Actuators reusability

NON-REUSABLE	PARTIALLY REUSABLE (need for refurbishment)	REUSABLE (manually resettable)	REUSABLE (self-resetting)
Pyro cutters Initiators Pyrotechnic bolt, wire cutters and pyro-cutters	Pyro nuts Fusible wire actuated nuts SMA direct actuators Spool based devices separation nut Thermal cutters	Solenoid actuated nuts SMA actuated nuts Paraffin actuators SMA actuators Wire triggers Thermal cutters	Electro-magnetic actuators and triggers Magnetic clamps

The database of actuators used for the drafting of the ECSS-E-ST-20-21 is reported in Annex A.

Some figures of actuators are hereby provided.

Figure 5-1: Dassault pyro initiator

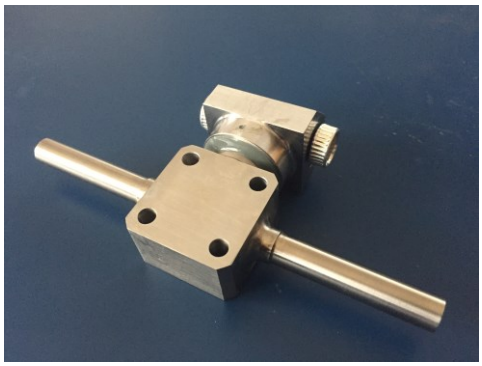

Figure 5-2: Pyro-valve (to be equipped with pyro initiators)