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Vesoljska tehnika - Mehanizmi

Space engineering - Mechanisms

Raumfahrttechnik - Mechanik/Mechanismen

Ingénierie spatiale - Mécanismes

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Space engineering - Mechanisms

Ingénierie spatiale - Mécanismes

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European Foreword

This document (EN 16603-33-01:2019) has been prepared by Technical Committee CEN-CENELEC/TC 5 “Space”, the secretariat of which is held by DIN.

This standard (EN 16603-33-01:2019) originates from ECSS-E-ST-33-01C Rev.1.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2019, and conflicting national standards shall be withdrawn at the latest by October 2019.

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This document has been prepared under a standardization request 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 EN covering the same scope but with a wider domain of applicability (e.g. aerospace).

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This document has been established to provide mechanism engineering teams with a set of requirements, design rules and guidelines based on the state of the art knowledge and experience in the field of space mechanisms.

The use of this document helps mechanisms developers to establish generic mechanisms designs and to derive application specific requirements.

The main objectives are to achieve reliable operation of space mechanisms in orbit and to prevent anomalies during the development phase influencing schedule and cost efficiency of space programmes.

1
Scope

This Standard specifies the requirements applicable to the concept definition, design, analysis, development, production, test verification and in-orbit operation of space mechanisms on spacecraft and payloads in order to meet the mission performance requirements.

This version of the standard has not been produced with the objective to cover also the requirements for mechanisms on launchers. Applicability of the requirements contained in this current version of the standard to launcher mechanisms is a decision left to the individual launcher project.

Requirements in this Standard are defined in terms of what shall be accomplished, rather than in terms of how to organise and perform the necessary work. This allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards. Complementary non-ECSS handbooks and guidelines exist to support mechanism design.

This standard may be tailored for the specific characteristic and constrains of a space project in conformance with ECSS-S-ST-00.

2
Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS standard. For dated references, subsequent amendments to or revisions of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references the latest edition of the publication referred to applies.

EN reference	Reference in text	Title
EN 16601-00-01	ECSS-S-ST-00-01	ECSS system – Glossary of terms
EN 16603-10-02	ECSS-E-ST-10-02	Space engineering – Verification
EN 16603-20	ECSS-E-ST-20	Space engineering – Electrical and electronic
EN 16603-06	ECSS-E-ST-20-06	Space engineering – Spacecraft charging
EN 16603-07	ECSS-E-ST-20-07	Space engineering – Electromagnetic compatibility
EN 16603-31	ECSS-E-ST-31	Space engineering – Thermal control general requirements
EN 16603-32	ECSS-E-ST-32	Space engineering – Structural
EN 16603-32-01	ECSS-E-ST-32-01	Space engineering – Fracture control
EN 16603-32-10	ECSS-E-ST-32-10	Space engineering – Structural factors of safety for spaceflight hardware
EN 16603-33-11	ECSS-E-ST-33-11	Space engineering – Explosive systems and devices
EN 16602-30	ECSS-Q-ST-30	Space product assurance - Dependability
EN 16602-40	ECSS-Q-ST-40	Space product assurance – Safety
EN 16602-70	ECSS-Q-ST-70	Space product assurance – material, mechanical part and process
EN 16602-70-36	ECSS-Q-ST-70-36	Space product assurance – Material selection for controlling stress corrosion cracking
EN 16602-70-37	ECSS-Q-ST-70-37	Space product assurance – Determination of the susceptibility of metals to stress corrosion cracking
EN 16602-70-71	ECSS-Q-ST-70-71	Space product assurance – Data for selection of space materials and processes
	ISO 76 (2006)	Rolling bearings – Static load rating
	ISO 128 (1996)	Technical drawings

EN reference	Reference in text	Title
	ISO 677 (1976)	Straight bevel gears for general engineering and for heavy engineering – Basic rack
	ISO 678 (1976)	Straight bevel gears for general engineering and for heavy engineering – Modules and diametral pitches
	ISO 6336-1 (2006)	Calculation of the load capacity of spur and helical gears — Part 1: Basic principles, introduction and general influence factors
	ISO 6336-2 (2006)	Calculation of the load capacity of spur and helical gears — Part 2: Calculation of surface durability (pitting)
	ISO 6336-3 (2006)	Calculation of the load capacity of spur and helical gears — Part 3: Calculation of tooth bending strength

3
Terms, definitions and abbreviated terms

3.1 Terms from other standards

a. For the purpose of this Standard, the term and definition from ECSS-S-ST-00-01 apply, and in particular the following:

1. cleanliness
2. component
3. interface
4. product

b. For the purpose of this Standard, the term and definition from ECSS-S-ST-32-10 apply, and in particular the following:

1. fail-safe
2. model factor (KM)
3. project factor (KP)

3.2 Terms specific to the present standard

3.2.1 actuator

component that performs the moving function of a mechanism

NOTE 1 An actuator can be either an electric motor, or any other mechanical (e.g. spring) or electric component or part providing the torque or force for the motion of the mechanism.

NOTE 2 This term is defined in the present standard with a different meaning than in ECSS-S-ST-00-01. The term with the meaning defined herein is applicable only to the present standard.

3.2.2 control system

system (open or closed loop) which controls the relative motion of the mechanism

3.2.3 deliverable output torque (T_L)

torque at the mechanism or actuator output

NOTE 1 The deliverable output torque or force can be specified by the customer for an undefined purpose and not affect the actual performance of the mechanism.

NOTE 2 For example: A theoretical torque or force of a robotic mechanism (service tool) for which no specific function except torque or force provision can be specified at an early stage in the project development.

3.2.4 deliverable output force (F_L)

force at the mechanism or actuator output

3.2.5 elementary function

lowest level function

NOTE For example: One degree of freedom (rotation and translation), torque or force generation, sensing.

3.2.6 inertial resistance force (F_D)

force to accelerate the mass

3.2.7 inertial resistance torque(T_D)

torque to accelerate the inertia

3.2.8 fastener

item used to provide attachment of two or more separate parts, components or assemblies

NOTE For example: Fasteners have the function of locking the parts together and providing the structural load path between the parts or, if used as a securing part, to ensure proper locating of the parts to be secured.

3.2.9 flushing or purging

control of the mechanism environment by enclosing the mechanism in specific gaseous or fluid media which are surrounding, passing over or through the mechanism

3.2.10 latching or locking

intentional constraining of one or more previously unconstrained degrees of freedom which cannot be released without specific action

3.2.11 lubrication

use of specific material surface properties or an applied material between two contacting or moving surfaces in order to reduce friction, wear or adhesion

3.2.12 mechanism

assembly of parts that are linked together to enable a relative motion

3.2.13 off-loading

complete or partial unloading of a part or assembly from an initial pre-load

NOTE Off-loading is usually employed so as not to expose a mechanisms part or assembly to launch loads or other induced loads.

3.2.14 phase margin

indicator for the stability of dynamic control systems

3.2.15 positively locked

form-locked into a defined position from which release can only be obtained by application of a specific actuation force

3.2.16 positive indication of status

direct monitoring of the state of the primary function at the output level of the mechanism

3.2.17 primary function

high level function

NOTE For example: To hold, to release, to deploy, to track, and to point.

3.2.18 safety critical mechanism

mechanical product having a critical or catastrophic hazard potential

3.2.19 threaded fastener

fastener with a threaded portion

NOTE For example: Screws, bolts and studs.

3.2.20 tribology

discipline that deals with the design, friction, wear and lubrication of interacting surfaces in relative motion to each other

3.2.21 venting

compensation of the internal mechanism pressure environment with its surrounding pressure environment

NOTE For example: Use of dedicated venting holes or passages

3.3 Abbreviated terms

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

Abbreviation	Meaning
A/D	analogue to digital
AC	alternating current
COG	centre of gravity
CVCM	collected volatile condensable material
D/A	digital to analogue
DC	direct current
DFMR	design for minimum risk
DLL	design limits loads
EMC	electromagnetic compatibility
ESD	electrostatic discharge
F	actuation force
F_D	inertial resistance force
F_L	deliverable output force
FMECA	failure mode effects and criticality analysis
F_{min}	minimum actuator force required
FOS	factor of safety
F_R	friction torque or force
GSE	ground support equipment
H_A	harness and other torque or force resistances
H_D	adhesion torque or force
HV	hardness Vickers
H_Y	hysteresis torque or force
I	inertia resistance (linear or angular)
I/F	Interface
LEO	low Earth orbit
M	mass
MAV	mechanism analytical verification
MDD	mechanism design description
MUM	mechanism user manual
MLI	multi-layer insulation
MOI	moment of inertia
MOS	margin of safety