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Space systems — Launch-vehicle-to-spacecraft interfaces

Systèmes spatiaux — Interfaces entre le lanceur spatial et le véhicule spatial

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 14303 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Annexes A to E of this International Standard are for information only.

Introduction

ISO 14303 together with ISO 15863 and ISO 17401 forms a set of International Standards that describes fully the process for communicating information about launch vehicle (LV) to spacecraft (SC) interfaces.

Clauses 4 to 8 of this International Standard identify the parameters of an LV–SC interface, while clauses 9 and 10 define the methodology for verification of the interface by analyses, testing or both. Clause 11 defines the operations performed on the SC to prepare it for launch and the joint operations performed until it is installed on the LV.

Some sections of this document may refer to elements of the LV or SC, or elements of both, that are not applicable to their design characteristics. These sections should therefore only be considered if applicable.

The annexes give examples of the typical presentation format of the various interface parameters, as appropriate.

Space systems — Launch-vehicle-to-spacecraft interfaces

1 Scope

This International Standard specifies the interfaces between a launch vehicle (LV) and the spacecraft (SC) being launched, to provide LV and SC organizations with the necessary format for presenting the required technical data on existing and future interfaces. Its intended purpose is to minimize costs and reduce the risks from errors resulting from miscommunication. It does not limit the ability of LV or SC organizations to specify unique requirements.

2 Terms and definitions

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

2.1
spacecraft system
SC system
spacecraft bus, payload and all items supplied by the SC contractor in support of the launch effort

2.2
launch vehicle system
LV system
launch vehicle and associated launch services supplied by the launch services contractor or subcontractors or both

2.3
separation plane
plane where launch vehicle and spacecraft separation occurs

2.4
mating plane
interface between the spacecraft, or the spacecraft-provided payload adapter, and the launch vehicle

2.5
payload adapter
PLA
structure that mates the spacecraft to the launch vehicle, including the SC–LV separation system

NOTE The PLA is a part of the LV and does not separate with the SC.

2.6
usable volume
volume available to the payload within the launch-vehicle fairing or carrying structure

3 Abbreviated terms

The following abbreviations are used in this International Standard.

ACS	Attitude control system
CG	Centre of gravity
CLA	Coupled loads analysis
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
GSE	Ground support equipment
GTO	Geosynchronous transfer orbit
ICD	Interface control document
IRD	Interface requirements document
LEO	Low Earth orbit
LV	Launch vehicle
LVS	Launch vehicle system
MEO	Medium Earth orbit
PLA	Payload adapter
PLF	Payload fairing
RF	Radio frequency
SC	Spacecraft
SPF	Spacecraft processing facility
SPM	Solid propellant motor
SSO	Sun synchronous orbit
TBD	To be determined
TM	Telecommand

4 Mechanical interfaces

4.1 General

This clause identifies the mechanical interfaces between the SC and the LV. The methodology for verifying these interfaces is discussed in clauses 9 and10.

4.2 Mechanical configurations

The SC shall be mated to the LV by a payload adapter (PLA). If the LV provides the PLA, it shall include a pyrotechnically activated separation system. If the SC provides its own separation system, then a static bolted interface to the LV in accordance with 4.4 shall be used. During final launch processing and launch ascent, the SC shall be contained in a structure provided by the LV contractor.

4.3 SC characteristics

4.3.1 SC fundamental natural frequency

The SC's fundamental natural frequency in the longitudinal and lateral axes shall not be less than a value specified by the LV with the SC cantilevered from the mating plane.

4.3.2 SC mass properties

The SC-CG location, and the inertia properties for the x, y and z axes, shall be defined, and shall include the SC propellant-tanking characteristics to be used for the LV provider's sloshing analysis.

4.4 Usable volume

The SC shall be accommodated in the LV's usable volume, as characterized in annex A, without interference. The static envelope of the SC shall not exceed the usable volume, in order to ensure that there is no physical contact between the SC and the LV in a dynamic environment. Protrusions outside this usable volume may be allowed by mutual agreement between SC and LV contractors.

4.5 PLA interface

4.5.1 General

The LV–SC interface shall be characterized by the following elements, for each PLA type as shown in annex B, Figures B.1 and B.2.

4.5.2 LV-supplied PLA

The SC–LV mating surface for LV supplied PLA shall be defined by the following.

a) LV and PLA coordinate systems and relative angular orientation.

b) Physical configuration (including keyway location):

   1) material;

   2) coating;

   3) roughness;

   4) flatness and perpendicularity;

   5) stiffness

      — section area (mm^2)

      — applicable length (millimetres)

      — inertia (mm^4).

c) Clampband:

   1) geometry;

   2) material;

   3) roughness;

   4) allowable tension (newtons).

d) Other mating systems.

4.5.3 SC-supplied PLA

The SC–LV mating surface for SC-provided PLA shall be defined by the following.

a) LV and PLA coordinate systems and relative angular orientation.

b) Physical configuration:

   1) description of bolted interfaces (number, size, location of holes, type of bolts and torque value);

   2) material;

   3) coating;

   4) roughness;

   5) flatness and perpendicularity;

   6) stiffness

      — section area (mm^2)

      — applicable length (millimetres)

      — inertia (mm^4).

4.5.4 Separation actuators

Separation actuators (springs or pushrods) shall be characterized by

— number,

— location,

— nominal stroke (millimetres),

— reduced stroke (millimetres),

— maximum force (newtons), and

— energy per unit (joules).

4.6 Umbilical connectors and microswitches

The LV side of the interface shall have electrical connectors for electrical power and signals in accordance with clause 5. The LV connectors shall be adjustable in two planes to provide for alignment of the connectors during SC–LV mating. The SC shall have compatible connector halves. All connectors shall be characterized by

— supplier,

— number,

— location and mechanical interface,

— push-on load per connector (newtons),

— push-off load per connector (newtons),

— energy released by each plug (joules), and

— keying index.

4.7 Fluid connections

Fluid connections shall be defined to indicate

— location,

— size,

— fluid (gas or liquid) and flowrate,

— material,

— operating characteristics, and

— functional usage.

4.8 Encapsulated SC access

The LV shall provide access through the fairing or the carrying structure to the SC after encapsulation if physical access is required by the SC contractor.

A drawing shall be made with developed views of fairings and dual launch structures indicating authorized areas for access doors. The maximum number of doors authorized per SC with their corresponding size shall be defined.

5 Electrical interfaces

5.1 General

This clause identifies the parameters required to define electrical interfaces (power and signal) between the SC and LV.

5.2 Umbilical connectors

Umbilical connectors shall be defined by the following characteristics for the LV and SC sides:

— type and reference designator of connectors;

— number of pins available to the user;

— number of connectors;

— segregation between SC power and pyro-firing circuits;

— location;

— shielding;

— keying index.

5.3 Umbilical links

Umbilical links between the SC mated with the LV and the SC's electrical ground support equipment (GSE) shall be described as follows:

a) number and type of links;

b) limitations

- maximum voltage (volts)
- maximum current (amperes)
- power (watts)
- maximum one-way resistance or voltage drop (ohms or volts);

c) operating constraints

- number of functions
- types of function;

d) current at umbilical plug extraction;

e) conformance certification

- end-to-end resistance (ohms)
- line to ground insulation
- line-to-line insulation;

f) insertion of components.

5.4 Electrical commands dedicated to SC

5.4.1 General

Standard and optional commands generated by the LV and dedicated to the SC shall be listed with a description of the related characteristics.

5.4.2 Pyrotechnic commands

A general description of the electrical circuit associated with pyrotechnic commands shall be made. Optionally, a schematic drawing of the corresponding electrical circuits may be included. The following characteristics shall be indicated:

- time and number of commands;
- voltage (volts);
- pulse width (hertz);
- output insulation (ohms);
- characteristics of current delivered to pyro-charges (amperes);

— interval between two commands (seconds);

— insulation between wires and structure (ohms);

— protection of SC equipment;

— utilization constraints (inhibits) on the SC side.

5.4.3 Dry loop command

A general description of electrical circuits associated with dry loop commands shall be made. Optionally, a schematic drawing of the corresponding electrical circuits may be included. The following main electrical characteristics shall be indicated:

— number of commands available on-ground or in-flight;

— voltage (volts);

— resistance (ohms);

— insulation of the onboard circuit;

— protection on the SC side;

— utilization constraints on the SC side — maximum voltage and current (volts and amperes).

5.4.4 LV-generated SC electrical commands

A general description of the electrical circuits associated with LV-generated SC electrical commands shall be made. Optionally, a schematic drawing of the corresponding electrical circuits may be included. The following main electrical characteristics shall be indicated:

— number of commands available on-ground or in-flight;

— output voltage (volts);

— protection on the SC side;

— insulation between circuit and structure;

— Electromagnetic compatibility (EMC) — compliance with international specifications;

— utilization constraints on the SC side.

5.5 Separation status transmission

The separation status shall be indicated through the LV telemetry (TM) system modes of transmission available for separation status transmission as determined by

— microswitch or microswitches,

— break wires,

— dry loop,

and others.

5.6 In-flight telemetry

A description shall be made of the type of SC data that can be transmitted to the LV ground stations via LV TM on a standard basis or as options:

— dynamic, acoustic and thermal environment at the SC interface;

— specific internal SC measurements.

5.7 Power supply

A general description of electrical circuits associated with the electrical power supply shall be made. Optionally, a schematic drawing of the corresponding electrical circuits may be included. The following main electrical characteristics shall be indicated, together with the tolerances:

— voltage (volts);

— current (amperes);

— insulation on the SC side;

— protection on the SC side;

— EMC.

5.8 Earth potential (ground) continuity

The SC requirements for electrical continuity with respect to the Earth potential (ground) shall be expressed as follows:

— location of SC reference point or points;

— maximum resistance between SC metallic elements and the closest reference point;

— maximum resistance of SC interface separation plane.

6 RF/electromagnetic interface

6.1 General

This clause identifies the interface parameters required to define the RF interface and electromagnetic interfaces between the SC and LV. SC, LV and LV range RF emissions shall be jointly evaluated to determine compatibility and possible restrictions. For the methodology for verifying these interfaces, see clauses 9 and 10.

6.2 RF telemetry and command link

The LV contractor shall provide TM and command links between the corresponding antennae of the encapsulated SC and the SC system test equipment located in the SPF.

The link shall be enabled by RF window, pick-up antenna or other equivalent methods associated with the LV PLF. The link shall be available from the time of encapsulation of the SC on the LV until launch, except when RF transmission is limited by LV activities. The SC TM and command frequency bands shall not overlap the LV frequencies.

The following items shall be described by the LV:

a) TM

- bandwidth
- frequency
- transmitter power;

b) command destruct receiver (CDR)

- bandwidth
- frequency;

c) radar transponder (RT)

- bandwidth
- frequency
- peak power.

The RF window shall be characterized by

a) material,

b) location

- angular orientation
- station, and

c) insertion loss with frequency range.

6.3 LV-generated electromagnetic environment

The SC shall be compatible with the electric and magnetic fields generated by the LV (for the LV electromagnetic environment, see 8.6.1).

6.4 SC-generated electromagnetic environment

The SC-generated electric and magnetic fields shall be compatible with the electromagnetic susceptibility of the LV (for the SC electromagnetic environment, see 8.6.2).

7 Mission performance

7.1 General

This clause identifies the parameters used to define the LV performance as a function of the mission. Performance figures shall be associated with the necessary propellant reserve in the LV upper stage so that the injection of the vehicle into the required orbit or orbits is ensured before depletion of the upper-stage tanks, with a probability level to be defined by the LV contractor.