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Space systems — Requirements of launch vehicle (LV) to electrical ground support equipment (EGSE) interfaces

Systèmes spatiaux - Exigences d'interface entre le lanceur et les équipements électrique de support au sol

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Foreword

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

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.

Introduction

This document provides design requirements of electrical interfaces between launch vehicles (LV) and electrical ground support equipment (EGSE) for launch system or interface designers. The defined interface type and requirements constitute the LV to EGSE interface control document (ICD).

The purpose of this document is to specify standardized requirements and help the designer specify the LV to EGSE ICD and subsequently help users to clearly understand the designer's intentions, and hence minimize costs and reduce risk from errors resulting from miscommunication. This document does not consider interface design details and does not limit LV or EGSE organizational requirements to specify a unique interface.

Space systems — Requirements of launch vehicle (LV) to electrical ground support equipment (EGSE) interfaces

1 Scope

This document provides requirements for launch system designers or interface designers regarding interfaces between LV and EGSE, which is used to support on-line processing. It defines electrical interface types, design requirements, environment requirements, verification methods (analyses and tests), and interface check operation requirements.

This document is intended to minimize design costs and reduce risks from errors resulting from miscommunication. It does not limit LV or EGSE organizational requirements to specify a unique interface.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
electrical ground support equipment
EGSE
non-flight electrical equipment or system used to support on-line processing and associated launching services

3.2
interface control document
ICD
formal means of describing the inputs and outputs of a system, the interfaces among systems, or the protocols among physical or electronic elements of an entity

[SOURCE: ISO/TR 16158:2013, 3.6]

4 Abbreviated terms

The following abbreviations are used in this document.

LV	Launch vehicle
EMC	Electromagnetic compatibility
IRD	Interface requirements document
I/O	Input/Output

AC	Alternating current
DC	Direct current
RF	Radio frequency
CAN	Controller area network
FC	Fibre channel
TM	Telemetry
TC	Telecontrol

5 Interface design principles

5.1 General

The LV to EGSE interface requirements presented in this standard may be tailored depending on negotiations between LV contractor and EGSE contractor.

In general, the LV to EGSE interface design shall include the following requirements:

a) control requirements for the LV electrical system;

b) test requirements for the LV electrical system;

c) power supply requirements for the LV electrical system.

5.2 Design process

The design shall be based on an LV to EGSE interface requirement analysis. The design process shall follow the general workflow shown in Figure 1.

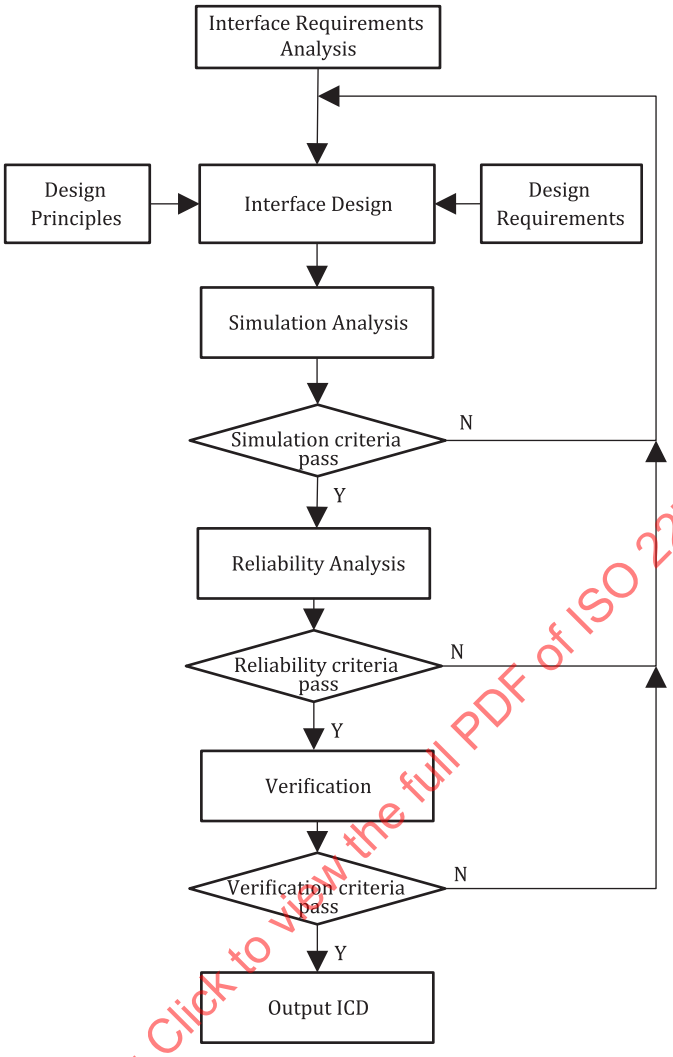

Figure 1 — Launch vehicle to electrical ground support equipment interface design process

5.3 Design principles

The design principles are as follows.

a) The interface signal definition shall be clear and unambiguous.

b) A ready-made standard interface must be adopted to decrease the number of interface types.

c) The necessary provisions should be put in place for development and implementations of measures aimed at preventing mixes in connection between equipment communications and the same type component items.

d) Electrical performance shall be matched between sources and loads.

e) Isolation measures shall be taken to prevent mutual influences among the equipment or systems under a failure state.

f) Electromagnetic compatibility shall be considered, including but not limited to, filtering, shielding, and grounding.

g) Redundancy design shall be considered.

h) Simulation analyses and test verifications shall be performed as part of the interface design process.

i) Margins as specified by manufacturers or general safety considerations shall be preserved.

j) Extensibility shall be considered.

k) Frequency, power and other characteristics shall be considered to determine the configuration of the signal and power grounding, such as floating, single-point or multiple-point grounding, common or independent grounding, etc.

l) Grounding continuity and resistance shall be considered to meet the application requirements.

6 Interface design requirements

6.1 General

Launch vehicle to EGSE interfaces generally consist of four types, as follows:

a) control interfaces;

b) test interfaces;

c) power supply interfaces;

d) other interfaces.

The functional interface types may be implemented by bus, digital I/O,analog quantity, or AC/DC power supply interfaces.

The other types of interfaces are optional organizational unique interfaces and they will not be addressed furtherly and depended on negotiations between LV and EGSE contractors.

6.2 Types of interface implementation

6.2.1 Bus interface

The bus interface is used to obtain test information and send control instructions via the data bus, such as Digital Time Division Command/Response Multiplex Data Bus, CAN Bus, FC Bus. Requirements shall include the following details.

a) Bus type, transmission medium, and topology or structure shall be clearly defined.

b) Communication mode, rate, distance, error rate, and protocol shall be explicitly determined.

c) Timeout processing method shall be designed to ensure no crash under communication failure.

d) Bus network shall be matched when the rocket takes off.

e) Bus interface types shall be chosen according to LV to EGSE transmission distance.

6.2.2 Digital I/O interface

Digital I/O interface is used to obtain command feedback information and send key status indication to the LV. The main electrical considerations shall include the following details.

a) Types, voltages, currents, durations, signal frequencies, time sequences, and load characteristics shall be defined clearly.

b) Isolation forms shall be adopted, including, but not limited to, relays or opto-couplers.

c) Anti-interference shall be considered, including, but not limited to, threshold and filtering design.

d) Testing voltage ranges, test accuracies, and time in testing states shall be considered.

6.2.3 Analog interface

The analog interface is used to obtain AC and DC signals. The main electrical considerations shall include the following details.

a) Paths, types, voltages, currents, and signal frequencies shall be clearly defined.

b) Test modes shall be clearly defined, including, but not limited to, sampling and continuous measurement.

c) Isolation shall be considered.

d) Anti-interference shall be considered, including, but not limited to, shielding, twisted pairs, and independent routing.

6.2.4 AC/DC power supply interface

The EGSE shall provide DC or AC power for the LV. The main electrical considerations shall include the following details.

a) Power supply quality (voltage stability, load stability, surge, peak, ripple, frequency, etc.), power capacity, and line drop shall be considered. Phase shift and phase sequence shall also be taken into consideration for AC supply.

b) AC and DC power supply interfaces shall be designed separately.

c) AC power supply interface shall be insulated and shielded.

d) Power supply interface shall be designed with detection terminal to ensure that the power supply quality and insulation performance meets the requirements.

6.2.5 RF/electromagnetic interface

The RF/electromagnetic interface is used to obtain the test information or send control instructions. The requirements shall include the following details.

a) Communication modes and protocols shall be clearly defined.

b) Bandwidths, frequencies, and power (including transmitter and peak power) shall be clearly described.

c) RF window, pick-up antenna, and other equivalent methods associated with the LV shall be considered.

d) RF window shall be characterized by material, location (angular orientation and station), and insertion loss with frequency range.

6.3 Interface connectors

The characteristics of interface connectors shall be defined as follows:

a) supplier;

b) number;

c) location;

d) pin assignment;

e) signal type;

f) push-on load per connector (newtons);

g) push-off load per connector (newtons);

h) energy released by each plug (joules);

i) shielding;

j) thermal protection;

k) waterproof;

l) keying index.

7 Induced environment

7.1 General

This clause identifies the parameters required to characterize the EGSE environment.

7.2 Mechanical environment

7.2.1 Low frequency vibration

The LV contractor shall provide the maximum equivalent longitudinal sinusoidal vibration level at the base of the EGSE, considering all sine and transient longitudinal vibrations over the frequency range of interest.

The LV contractor shall provide the maximum equivalent lateral sinusoidal vibration level at the base of the EGSE, considering all sine and transient lateral vibrations over the frequency range of interest.

7.2.2 Random vibrations

The LV contractor shall provide the envelope spectrum for launch level random vibrations in longitudinal and lateral directions in terms of spectral density expressed in g^2 per Hertz.

7.2.3 Acoustic noise

The LV contractor shall provide the launch level noise spectrum under the LV fairing or carrying structure expressed in octaves or 1/3 octave. The associated fill factor shall be explicitly indicated.

7.2.4 Shock

The LV contractor shall provide the highest shock spectrum generated by the LV at the EGSE separation plane.

7.3 Thermal environment

7.3.1 General

Thermal environment operation phases shall be described as follows:

a) pre-launch phase;

b) launch phase.

7.3.2 Thermal environment during pre-launch phase

Thermal environment description shall include the following details:

a) temperature;

b) relative humidity.

7.3.3 Thermal environment during launch phase

Thermal environment description shall include the following details:

a) temperature;

b) relative humidity;

c) heat flow.

7.4 Radio and electromagnetic environment

7.4.1 Launch-vehicle-generated

The LV contractor shall describe the following radiation interference levels:

a) spurious radiation emitted by the LV's narrow-band electric field;

b) spurious radiation emitted by the LV's wide-band electric field;

c) spurious radiation emitted by the LV's narrow-band magnetic field.

The EGSE contractor shall describe radiation interference acceptability limits for the EGSE's narrow-band electric field.

7.4.2 EGSE-generated

The EGSE contractor shall describe the following radiation interference levels:

a) spurious radiation emitted by the EGSE's narrow-band electric field;

b) spurious radiation emitted by the EGSE’s wide-band electric field;

c) spurious radiation emitted by the EGSE’s narrow-band magnetic field.

The LV contractor shall describe radiation interference acceptability limits for the LV's narrow-band electric field.

7.4.3 Launch-range-generated

The LV contractor shall describe the launch range electromagnetic environment, including, but not limited to, TM, TC, and radar transponders.

8 Verification analysis and test

8.1 Verification analysis methods

Analytical verification methods may include, but are not limited to, the following methods:

a) signal model simulations;

b) interface characteristic simulations;

c) structure mode loading simulations.

8.2 Verification analysis implementation

8.2.1 Feasibility analysis

Feasibility analysis shall be decided by mutual agreement between the LV and EGSE contractors with the objective of assessing basic compatibility between LV and EGSE in specific technical areas.

8.2.2 Simulation analysis

Before each interface verification test, the LV and EGSE contractor(s) shall provide electrical signal characteristics and parameters as input data for simulation analyses.

8.2.3 Verification

Verification includes, but is not limited to, interface adaptability and interface function testing as follows.

a) Interface adaptability test

This test checks the electrical interface capability to meet the environment requirements in ICD, including vibration, shock, and so on.

b) Interface function test

This test verifies electrical signal transmission stability, electromagnetic compatibility, and separation function.

8.2.4 Launch preparation state evaluation

Before the LV launch, the LV and EGSE contractor(s) shall verify analysis results, evaluate experiments, and formulate procedures in the ICD.

9 Interface documentation requirements

9.1 Interface requirements document

The LV contractor shall propose interface requirements document, including, but not limited to, the following:

a) launch vehicle technical characteristics;

b) interface requirements;

c) constraints and limitations;

d) verification tests.

9.2 Interface control document

The ICD shall include a detailed description for all signals transmitted by electrical connectors, including name, functions, signal characteristics, and any other issues worthy of special note.

The ICD shall be prepared by the LV contractor in agreement with the EGSE contractor on the basis of the IRD. The document shall contain all technical elements required to define and verify compatibility between the LV and EGSE.