



**International
Standard**

ISO 19683

**Space systems — Design
qualification and acceptance tests of
small spacecraft and units**

*Systèmes spatiaux — Qualification de la conception et essais de
réception des petits véhicules spatiaux*

**Second edition
2026-05**

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 19683:2017), which has been technically revised.

The main changes are as follows:

- updated terms and definitions;
- added [5.10](#) on testing of satellite constellation program;
- added [Clause 8](#) on satellite constellation tests;
- updated [Clause 9](#) on test requirements;
- updated [Annex C](#).

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

There is an increasing demand for small, micro, nano or pico satellite development and utilization worldwide; yet, there is no clear and globally accepted definition of what is considered “small”, “micro”, “nano” or “pico” satellites. These satellites are often built with emphasis on low cost and fast delivery. They are characterized by extensive use of non-space-qualified commercial-off-the-shelf (COTS) units (component). For the sake of convenience, the term “small spacecraft” is used throughout this document as a generic term to refer to these satellites.

A small spacecraft is a satellite that utilizes non-traditional risk-taking development and management approaches to achieve low cost and fast delivery with a small number of team. To achieve these two points, low cost and fast delivery, satellite design relies on the use of non-space-qualified COTS units (components), making satellite size inherently smaller. The design accepts a certain level of risk associated with the use of COTS. Because of the risk taking approach, small spacecraft often fails in orbit. But the replacement spacecraft is quickly built and launched reflecting the lessons obtained in the previous spacecraft. As the launch cost depends on the spacecraft size and/or mass, the spacecraft size becomes “small”.

[Figure 1](#) illustrates the applicability of this document.

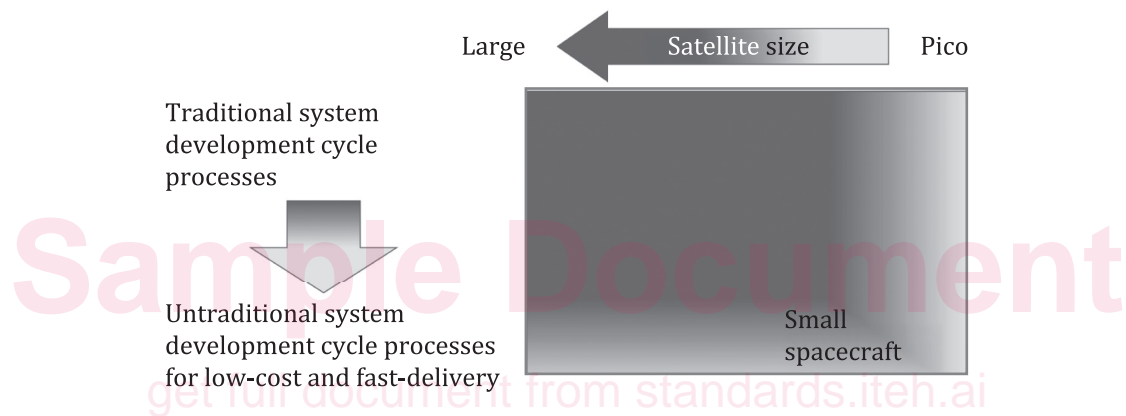


Figure 1 — Applicability of this document

A certain set of tests is necessary to ensure the mission success of small spacecraft. Applying the same test requirements and methods as those applied to traditional large or medium satellites, however, nullifies the low-cost and fast-delivery advantages possessed by small spacecraft.

This document is meant to improve the reliability of small spacecraft, especially those with commercial purpose, with emphasis on achieving reliability against infant mortality after satellite launch to orbit, while maintaining the low-cost and fast-delivery nature of small spacecraft.

This document intends to promote worldwide trade of small spacecraft products by providing a minimum level of assurance that a product made of non-space-qualified commercial-off-the-shelf parts and units can work in space. This document also aims to serve as a testing guideline for those who intend to enter satellite manufacturing through development of small spacecraft products.

Space systems — Design qualification and acceptance tests of small spacecraft and units

1 Scope

This document provides test methods and test requirements for design either qualification or acceptance, or both of small spacecraft or units. It provides the minimum test requirements and test methods to qualify the design and manufacturing methods of commercial small spacecraft and their units and to accept the final products.

This document is applicable to satellites whose development methods are different from the ones used for traditional satellites that have little room for risk tolerance. The scope of this document encompasses different categories of small spacecraft, so-called mini-, micro-, nano-, pico- and femto spacecraft.

This document includes CubeSat, as long as it is developed with the untraditional processes.

This document does not cover satellite deployment mechanisms, such as picosatellite orbital deployer (POD), as the verification requirements are defined in the interface control document (ICD) with the launcher, such as ISO 26869^[1].

This document does not cover software testing, although some tests such as functional test, mission test and end-to-end test are inherently used to test the software installed in the hardware being tested. General requirements and processes of satellite software testing can be found in various references, such as ECSS-E-ST40^[2].

This document does not cover requirements regarding safety nor debris mitigation. Appropriate documents such as ISO 14620-1^[3] or ISO 24113^[4] can be referred to. Other common requirements for small spacecraft can be found in ISO 20991^[5].

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

ISO 11221:2011, *Space systems — Space solar panels — Spacecraft charging induced electrostatic discharge test methods*

ISO 14302, *Space systems — Electromagnetic compatibility requirements*

ISO 15864:2021, *Space systems — General test methods for spacecraft, subsystems and units*

ISO 17566:2011, *Space systems — General test documentation*

ISO 24411:2022, *Space systems — Micro-vibration testing*

3 Terms and definitions

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

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

— IEC Electropedia: available at <https://www.electropedia.org/>

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

3.1

1U CubeSat

single CubeSat

satellite measuring 100 mm × 100 mm × 113,5 mm and weighing 1,33 kg or less

Note 1 to entry: For the exact external dimension, see ISO 17770^[6].

3.2

3U CubeSat

triple CubeSat

satellite measuring 100 mm × 100 mm × 340,5 mm and weighing 4,00 kg or less

Note 1 to entry: For the exact external dimension, see ISO 17770^[6].

3.3

batch

group of satellites with the same design produced with the same process at the same time

Note 1 to entry: The *units* (3.14) contained in the satellites share the same design.

3.4

CubeSat

picosatellite measuring 100 mm cubic and weighing 1,33 kg or less

[SOURCE: ISO 17770:2017, 3.1, modified — Note 1 to entry has been removed.]

3.5

flat-sat

configuration where only *units* (3.14), sometimes bare circuit boards only, are laid out in atmosphere on a table while not being mounted to the satellite structure

3.6

flight model

spacecraft, subsystem or *unit* (3.14) model dedicated to being launched and operated in orbit and subjected to acceptance testing

3.7

formation flight

multiple satellites flying in close proximity and operated under precise coordination and control to achieve a specific mission by maintaining relative positions

Note 1 to entry: Typically, all the satellites are deployed at the same time.

3.8

pathfinder

satellites launched before the full deployment of *satellite constellation* (3.10) to validate the satellite missions and verify the satellite design in orbit

3.9

picosatellite orbital deployer

POD

box housing *CubeSats* (3.4) during launch

3.10

satellite constellation

group of satellites with mostly the same design working together in coordination to achieve specific missions

Note 1 to entry: After *pathfinder* (3.8) missions, the satellites may be deployed in several stages with incremental improvements of the satellite design.

3.11

satellite fleet

group of satellites operated together to achieve specific missions without maintaining relative positions precisely

Note 1 to entry: The satellite designs are not necessarily the same. The satellites are often deployed at different times.

3.12

satellite swarm

group of satellites deployed simultaneously or in close succession to achieve a specific mission through dynamic interaction among the satellites taking advantage of having a large number of satellites

3.13

test article

spacecraft, subsystem or *unit* (3.14) on which a test is conducted

3.14

unit

lowest level of hardware assembly that works with specified complex electrical, either thermal or mechanical, or both functions.

Note 1 to entry: An example is a radio transceiver unit.

4 Abbreviated terms

AT	acceptance test
BRDF	bidirectional reflectance distribution function
COTS	commercial-off-the-self
CVCM	collected volatile condensable materials
EED	electroexplosive devices
EM	engineering model
EMC	electromagnetic compatibility
EMI	electromagnetic interference
ESD	electrostatic discharge
ESS	environment stress screening
FM	flight model
FMEA	failure mode and effects analysis
FMECA	failure mode, effects, and criticality analysis
IC	integrated circuit
ICD	interface control document
LEO	low Earth orbit
LET	linear energy losses
MEMS	micro electro mechanical systems

MMA	moving mechanical assembly
PFT	proto-flight test
PFM	proto-flight model
POD	picosatellite orbital deployer
QM	qualification model
QT	qualification test
QCM	quartz crystal microbalance
RF	radio frequency
PSD	power spectral density
SAA	South Atlantic Anomaly
SE	single event
SEE	single event effect
SRS	shock response spectrum
SSO	Sun synchronous orbit
STM	structural thermal model
TID	total ionization dose
TML	total mass loss

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5 General requirements

5.1 Tailoring

Specifications described in this document are tailorable upon agreement between the customer, the manufacturer and the launch provider. [Annex A](#) provides tailoring and waiver guides of test requirements.

5.2 Qualification test

For satellite system level qualification tests, there is little difference between small spacecraft and traditional satellite qualification tests in terms of objectives and requirements. Qualification tests demonstrate that items meet design requirements and include proper margin. Qualification tests can serve as good practice for personnel who are inexperienced in testing toward acceptance tests to be carried out later. If the same design is used for many satellites, such as satellites of a satellite constellation program, the qualification tests are not necessary except for the first satellite. ISO 15864:2021, 4.4 provides additional requirements for system qualification test.

Unit level qualification tests dealt in this document is different from those done for traditional satellites. The unit QT in this document provides a minimum guarantee that a given unit sold as “a satellite unit” has a certain level of tolerance against the space environment. Therefore, the unit QT in this document does not include proper margin against the maximum predicted environment stress, which depends on each satellite. This document provides numeric values for the test level and duration of unit QTs as much as possible with their rationale given in [Annex B](#). The satellite developers who purchase the COTS-unit tested according to this document shall make consistent decisions about how to obtain the margin. The satellite developers may purchase a dedicated test model in addition to the flight model and carry out another QT with the margin.

They may carry out PFT using a flight model or only AT taking the risk of little margin. The satellite developer shall provide the test levels and duration of the additional QT, AT or PFT. See [C.1](#) for additional note.

5.3 Acceptance test

There is little difference in terms of objectives and requirements of acceptance tests between small spacecraft and traditional satellites. The acceptance test shall be in accordance with ISO 15864:2021, 4.5.

5.4 Proto-flight test

There is little difference in terms of objectives and requirements of proto-flight tests between small spacecraft and traditional satellites. The proto-flight test shall be in accordance with ISO 15864:2021, 4.6.

5.5 Retest

Situations that may require retest are described in ISO 15864:2021, 4.8.

5.6 Test documentation

5.6.1 General

In order to minimize program cost, the amount of paper work should be reduced as much as possible. The documents used inside the developing organization can only be simplified considering the small size of the team. At the same time, however, the test documentation shall be detailed enough to ensure traceability from the later stages of satellite development or operation. The importance of the test procedure document should not be underestimated, as well-prepared tests will eventually save both time and money.

For the unit QT, the test documentation shall provide the important information necessary to prove that the COTS-based units have adequate durability against the space environment. See [C.1](#) for additional notes.

5.6.2 Test plan, specification and procedure

The simplicity of a small spacecraft allows the combination of the test plan, specification and procedure documents for the system test or unit test into one document as recommended by ISO 17566. In the following cases, it is recommended to separate the test plan/specification and the test procedure into two separate documents.

- a) The test is fairly complex and requires many discussions and iterations within the development team to define the test specification.
- b) The test is carried out at a location outside the developing organization and requires consultation with the test institution well before the test.
- c) The test shall be approved by the customer. The test plan/specification may be used as the document for approval.

The contents of the test plan, specification and procedure shall be based on ISO 17566:2011, Table 2 or Table 3. Some of the content in the specification, such as test facility requirements and procedural test requirements, may be moved to the test procedure document. The documents may be revised as test preparation progresses. It is important to keep track of the version number, the revision points and the revision dates.

5.6.3 Test report

The test report content shall be based on ISO 17566:2011, Annex D. Any anomaly during the test and its disposition shall be reported in the test report. The test report shall clearly describe the following information or refer to the test documents that contain the information.

- a) Temperature measurement points and the measured temperature profile in the case of thermal tests, e.g. thermal cycle, thermal vacuum, thermal balance.
- b) Acceleration measurement points in the case of mechanical tests, e.g. vibration, shock.
- c) The points of reference (thermo-couples or accelerometers) used to control the test levels, e.g. temperature, vibration, acoustic.
- d) The measured pressure profile during the test in the case of tests conducted in a vacuum, e.g. thermal vacuum, vacuum functioning, multipaction.
- e) The power spectrum density waveform of the acceleration measured at the reference points in the case of random vibration test or modal survey.
- f) The shock response spectrum calculated from the acceleration measured at the reference points in the case of shock test with the description of the method used to give the acceleration.
- g) The source of radiation particles, their energy and the total fluence in the case of SEE test.
- h) The radiation source and energy, total dose and shielding effects considered to derive the total dose, dose rate and temperature during testing in the case of TID test.
- i) The result of functional performance measurements before, during and after the environment test.

If the test results in failure, the test report shall be precise enough to assist with the root cause analysis or other investigation. See Reference [Z] for root cause analysis.

5.6.4 Datasheet for unit test results

The following information shall be included in the datasheet for unit test results.

- a) Random vibration spectrum in power spectral density, root-mean-square value of acceleration and duration for each axis if random vibration test was carried out.
- b) Vibration level, sweep rate and frequency range for each axis if sinusoidal vibration test was carried out.
- c) Radiation and conduction emission spectrum if EMC test was carried out.
- d) Temperature profile, number of cycles, hot and cold soak temperatures and their duration, temperature ramp rate (up/down) and gas environment if thermal cycle test in atmospheric pressure was carried out.
- e) Temperature profile, number of cycles, hot and cold soak temperatures and their duration, temperature ramp rate (up/down) and pressure profile if thermal vacuum cycle test was carried out.
- f) Shock response spectrum for each axis and the method of applying the shock acceleration if shock test was carried out.
- g) The source of radiation particles, their energy and the total fluence if SEE test was carried out.
- h) The radiation source and energy, total dose, shielding effects considered to derive the total dose, dose rate and temperature during testing if TID test was carried out.
- i) The power spectral density of the measured force for various rotational speeds if microvibration acceptance test was carried out.

5.7 Test conditions, tolerances and accuracies

The requirements in ISO 15864:2021, 4.10 shall apply.

5.8 Functional test

Complete functional tests shall be performed at the beginning and end of the test sequence. Partial functional tests shall be conducted before and after each environmental exposure.

5.9 Design, verification and testing philosophy

[Annex C](#) describes the difference of small spacecrafts from traditional satellites in terms of design, verification and testing philosophy. [Tables C.1](#) and [C.2](#) summarize the characteristics inherently associated with the satellite program/design and the corresponding verification strategy when low cost and fast delivery are the primary drivers.

5.10 Testing of satellite constellation program

Typically, a satellite constellation program launches pathfinder satellites to validate the satellite missions and verify the satellite design in the flight environment before initiating full satellite constellation deployment. During full deployment, multiple satellites are often produced simultaneously, forming a satellite production batch (referred to as a “batch” in this document).

Within the same batch, all satellites share an identical design, and differences between them mainly arise from variations in hardware assembly quality, including workmanship, electronic and mechanical parts, and production lot inconsistencies. Full deployment usually involves multiple launches to populate different orbital planes. Between these launches, minor modifications to the satellite design are often made based on lessons learned from the operation of earlier generations.

The satellite used for pathfinder missions undergoes extensive testing before launch. The mission itself can be considered an extension of the satellite system test, although it may not account for all environmental variations in orbit, such as the 11-year solar cycle. During the full deployment phase, qualification testing of the satellite is not required, as the design is already flight-proven.

If minor modifications are made to the satellite design—such as changes due to discontinued parts or units—qualification tests may be conducted to verify only the modified elements. This is commonly referred to as delta-qualification. If the launcher differs from that used in the pathfinder mission or previous batches, and the new launch environment exceeds the previously tested limits, delta-qualification for the new launch environment shall be done.

When the production lot of electronic parts changes, additional screening tests may be required, depending on whether the satellite system integrator adopts a conservative approach to managing lot differences. The levels and duration of acceptance testing may be relaxed compared to single-satellite programs. Some test items may be skipped or conducted only on a limited number of satellites within the same batch. However, tests that verify workmanship or individual satellite variations may need to be performed on all satellites, depending on their criticality to safety and mission success.

After the first batch of satellites is built and operated in space, operational results provide valuable insights. These insights may be used to further reduce the number of test items when building and testing the second batch. This iterative process continues for subsequent batches. Figures of merit can be introduced to compare the in-orbit performance of each batch, helping to evaluate how much testing can be relaxed.

The applicability of the satellite constellation program testing strategy to a specific satellite program depends on two criteria: whether the satellite design is identical and whether the design is flight-proven.

Formation flight missions launch multiple satellites with the same design but typically do not include a pathfinder mission before the main launch. In such cases, the single-satellite program testing strategy should be applied. To improve efficiency, methods for testing multiple satellites simultaneously should be considered.