INTERNATIONAL STANDARD

ISO 24637

First edition
2009-02-15

Space systems — Electromagnetic interference (EMI) test reporting requirements

Systèmes spatiaux — Exigences pour l'enregistrement de l'essai d'interférences électromagnétiques (EMI)

Reference number
ISO 24637:2009(E)

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Published in Switzerland

Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

ISO 24637 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

Throughout this International Standard, the minimum essential criteria are identified by the use of the key word “shall”. Recommended criteria are identified by the use of the key word “should”, and while not mandatory, are considered to be of primary importance in providing serviceable, economical and practical designs. Deviations from the recommended criteria are only permissible after careful consideration, extensive testing and thorough service evaluation have shown alternative methods to be satisfactory.

Space systems — Electromagnetic interference (EMI) test reporting requirements

1 Scope

This International Standard provides specific requirements for the content of equipment-level electromagnetic interference (EMI) test report documentation to ensure that sufficient data is provided for subsequent integration analysis of complex space systems. Emphasis is placed on necessary test report augmentation to include additional test data reporting when specifically needed to document any EMI test limit failures for spaceflight hardware.

The requirements presented in this International Standard apply only to EMI test reports at the equipment level. These requirements are particularly important when an EMI test limit non-conformance waiver is requested for spaceflight equipment in lieu of re-design.

2 Normative references

The following referenced documents are indispensable for the application 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 14302, *Space systems — Electromagnetic compatibility requirements*

ISO 15864, *Space systems — General test methods for space craft, subsystems and units*

ISO/IEC 17025:2005, *General requirements for the competence of testing and calibration laboratories*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

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

3.1.1
degradation criteria
minimum performance criteria required for acceptance of the product as specified in the electromagnetic interference test plan

3.1.2
hard upset
degradation of product performance that requires manual (non-automatic) issuance of a reset command or intervening procedure to restore product nominal performance without removal from the system

3.1.3
onset of susceptibility
degradation in product performance of at least one functional characteristic beyond equipment under test parameter tolerance

3.1.4
product specification
equipment under test functional minimum performance requirements with associated accuracy parameters

3.1.5
soft upset
degradation in product performance where that product returns to normal with no operator intervention immediately following the removal of the immunity test stimulus

3.2 Abbreviated terms

EMI electromagnetic interference

EMC electromagnetic compatibility

EUT equipment under test

IF intermediate frequency

LISN line impedance stabilization network

NE network equivalent

4 Equipment-level EMI test reporting requirements

4.1 General reporting requirements

4.1.1 General

The general content of the EMI test report shall be in accordance with ISO/IEC 17025:2005, 5.10.

System-level electromagnetic compatibility (EMC) test reporting shall comply with ISO 15864 and ISO 14302.

4.1.2 Description of the test article

The test article shall be identified by model and serial number. A short functional description of the EUT shall be provided to enable the EMC systems analyst to understand the criticality of function, operating modes and, if known, the significance of interfaces with other equipment in the complete operating system.

This requirement may be met with an associated reference which includes the equipment's functional design description, containing an explanation of nominal signal parameters such as data rate, clock speed, frequency list, IF with bandwidths, and voltage input and output characteristics. A complete description of the test setup shall be supplied in the form of photos and individual wiring harness schematics, including shielding, twisting and grounding/isolation with respect to structure for primary power, secondary power and signal wiring including that of external test loads.

It is expected that the EUT will be tested using cabling and connectors either pre-defined by the test method or that agreed to by the customer, i.e. flight harness configuration. Any deviation from either standard test method wiring configuration or flight harness configuration shall be noted in the test report. Setup, operation, and control settings of any video display that is part of the EUT shall be described.

4.1.3 Supporting documentation

The standard(s) to which the EUT was tested shall be clearly described in the test report. The EMI test report shall reference other supporting documentation containing the functional description and interface wiring, the EMI test plan, EMI test specifications, techniques, "as run" procedures and the daily test log.

4.1.4 Signature information

The EMI test report shall contain the names of the EUT product engineer and the EMI test engineer, including sufficient information so that they may be contacted by telephone or e-mail. The location of the test site shall be identified in the test report.

4.1.5 Summary conclusions

The EMI test report shall contain a summary conclusion narrative, stating either complete compliance with each of the EMI test requirements, or describing any non-conformance with the test limits or approved test procedure, in such cases giving a list of non-conformance reports issued throughout the test.

4.1.6 Modifications to the EUT

A description shall be provided to explain any modification to the EUT during the course of performing the test plan. It shall be made clear in the test report which corrective actions (modification of the EUT during the test) will become part of the flight article, with those test results clearly marked as such.

4.1.7 Procedure variation

A description shall be provided to explain any modification to the test procedure during the course of performing the test plan. Procedure variations shall be made clear in the test report to differentiate between multiple test results, and clearly marked as such.

4.2 Specific reporting requirements

4.2.1 General

The test report shall contain:

a) all the information necessary to reproduce the test;

b) the EUT operating modes in which the emission and susceptibility tests have been performed.

4.2.2 EMI measurement system information

The following EMI measurement system detail shall be included in the EMI test report:

a) test equipment used, software support programme, and calibration certification;

b) photograph and drawings of each unique test setup, including EUT and interfacing cabling;

c) antenna factors and frequency ranges of magnetic and electric field antennas;

d) antenna distance from EUT;

e) transfer impedance of current probes and/or termination impedances provided by LISNs;

f) LISN (NE) transfer function as a function of frequency;

g) description of software operations/calculations used to produce measurement output (scan averaging or peak-hold, antenna factors, cable loss, attenuators, and amplifiers): this description shall include the means used to verify each test method’s end-to-end accuracy; if data quality has been compromised due to test conditions, the reason and impact on results shall be stated;

h) measurement system scan speeds, step sizes, and measurement bandwidths as a function of frequency;

i) antenna polarizations used;

j) EUT power source frequency, voltage, nominal operating current, and facility temperature and relative humidity;

k) compression level of active devices (amplifiers) in measurement chain;

l) facility limitations from that requested or required by the test plan and procedures;

m) method of radiated susceptibility field determination and modulation type;

n) grounding configuration of EUT and test support equipment.

4.2.3 EMI measurement reporting resolution

EMI test data shall be reported in graphic form with frequency resolution of 1 %, and decibel notation within 1 dB. For test limit failure conditions, improved data resolution shall be provided as further explained in 4.3.

4.3 Reporting emissions test results

4.3.1 General

Data output of the EUT test result shall be in the form of amplitude over time (for the time domain plots) and amplitude over frequency (for frequency domain plots), superimposed with the EMI test limit. Conducted and radiated interference background plots shall be included for each test configuration unless all emission data are 6 dB below the limit. Test data shall include X and Y legend, date and time recorded and the respective EUT operational mode.

4.3.2 Conducted interference test results

4.3.2.1 General

Each conducted interference test measurement result shall be clear in its intent to measure common-mode or differential-mode current or voltage.

4.3.2.2 Power bus conducted interference, load induced, frequency domain

Data presentation shall be a graphic output of amplitude versus frequency. Units of measurement for frequency domain conducted emissions measurements shall be reported in units of dB referenced to one microvolt (dBuV), or referenced to one microampere (dBuA), depending on which transducer is specified by the test method and its associated limit.

4.3.2.3 Power bus conducted interference, load induced, time domain ripple

Data presentation shall be a graphic output of amplitude versus time, at a time base that best displays the voltage ripple frequency. Oscilloscope plots shall include the amplitude physical unit (V or A) conversion factors V into A, if applicable, and the oscilloscope sensitivity, time base settings and measurement bandwidth. Amplitude resolution shall be within 3 % and time base within 5 %.

4.3.2.4 Power bus load induced switching transients

Data presentation shall be a graphic display of voltage amplitude versus time, or current versus time for in-rush at a time base that best displays the transient characteristic with respect to the applicable limit. Amplitude resolution shall be within 3 % and time base within 5 %.

4.3.2.5 Antenna connection port spurious emissions

4.3.2.5.1 Receivers and transmitters (in standby mode)

Data presentation shall be a graphic output of amplitude versus frequency. Minimum frequency resolution shall be twice the measurement receiver bandwidth, with a minimum amplitude resolution of 1 dB for each graph.

4.3.2.5.2 Transmitters (in transmit mode)

Data presentation shall be graphical, indicating power amplitude within ±1 dB for fundamental transmit frequency, and frequencies of all harmonics and spurious emissions detected by the applicable test method.

4.3.3 Radiated emissions test results

4.3.3.1 Steady state radiated emissions

4.3.3.1.1 a.c. magnetic field

Data presentation shall be a graphic output of amplitude versus frequency. Magnetic field radiated emissions measurements shall be reported in units of dB relative to one picotesla (dBpT). In the event of a non-conformance, the distance at each face shall be recorded at which the EUT meets the emissions limit.

4.3.3.1.2 Electric field

Data presentation shall be a graphic output of amplitude versus frequency. Electric field radiated emissions measurements shall be reported in units of dB relative to one microvolt per metre (dBuV/m). In the event of any emissions test result above 100 MHz that is over the EMI test limit, greater accuracy of its frequency shall be reported with resolution equal to twice the measurement bandwidth.

4.3.3.2 Transient radiated emissions

If an EUT is capable of creating short-duration transients, data output shall report the transient pulse repetition rate, and the broadband frequency distribution over the steady state limit. For a single-event pulse exceeding the steady state limit, the pulse duration at the failed frequency with highest amplitude shall be reported.

4.3.3.3 d.c. magnetic field

For applications requiring a d.c. magnetic cleanliness programme to protect an attitude control system or scientific instruments, static magnetic field test results shall be included in the test report. The data shall be presented graphically in units of magnetic field strength for a 360° rotation about each of the three axes of the EUT, with resolution of 1° (20 mrad).

4.4 Reporting immunity test results

4.4.1 General

A description shall be provided explaining which EUT functional outputs were monitored to verify immunity, including a list of the degradation criteria. If the EUT uses a built-in-test for this function, its operation and thresholds shall be described. The susceptibility criteria defined in the EMI test procedure shall be repeated in the test report, or the “as run” EMI test procedure shall be an annex to the EMI test report. If or when susceptibility is observed, multiple levels of susceptibility shall be determined and recorded in the EMI test report in accordance with 4.4.2 to aid the systems analysis.