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Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2013-12-06 wird der Öffentlichkeit zur Prüfung und Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfes besonders zu vereinbaren.

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Nationales Vorwort

Dieses Dokument (FprEN 16603-20-07:2013) wurde vom Technischen Komitee CEN/TC 5 „Raumfahrt“ erarbeitet, dessen Sekretariat vom DIN (Deutschland) gehalten wird.

Dieses Dokument ist derzeit zum einstufigen Annahmeverfahren vorgelegt.

Dieses Dokument (FprEN 16603-20-07:2013) beruht auf ECSS-E-ST-20-07C Rev.1.

Dieses Dokument wurde speziell für die Behandlung von Raumfahrtsystemen erarbeitet und hat daher Vorrang vor jeder anderen EN, die denselben Anwendungsbereich behandelt, allerdings mit erweitertem Bereich der Anwendbarkeit (z. B. Luft- und Raumfahrt).

Diese Norm gilt speziell für Raumfahrtanwendungen und hat Vorrang vor allen anderen möglicherweise bestehenden Normen mit weiterem Anwendungsbereich, die ebenfalls die Raumfahrt behandeln.

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Nationaler Anhang NA
(informativ)

Einleitung, Anwendungsbereich, Begriffe

Einleitung

Elektromagnetische Verträglichkeit (EMV) eines Raumfahrtsystems oder -geräts ist die Fähigkeit, in deren elektromagnetischer Umgebung zufrieden stellend zu funktionieren, ohne in diese Umgebung, zu der auch andere Einrichtungen gehören, unzulässige elektromagnetische Störgrößen einzubringen.

Das Raumfahrtsystem ist für die Verträglichkeit mit seiner äußeren natürlichen, induzierten oder vom Menschen erzeugten elektromagnetischen Umgebung ausgelegt. Natürliche Komponenten sind Blitzschlag bei Trägerraketen und das Erdmagnetfeld bei Raumfahrzeugen. Die Aufladung von Raumfahrzeugen wird definiert als Spannungsaufbau bei Raumfahrzeugen oder deren Baugruppen, die vollständig von Plasma umgeben sind. Aus der Aufladung resultieren elektrostatische Entladungen mit möglicherweise nachteiligen Auswirkungen. Vom Menschen – absichtlich oder unabsichtlich – verursachte äußere Störungen resultieren aus Radar- oder Telekommunikationsstrahlen während des Bodenbetriebs und der Startsequenz. Intersystem-EMV besteht ebenfalls zwischen der Trägerrakete und deren Nutzlast oder zwischen Raumfahrzeugen.

Intrasystem-EMV wird als zwischen allen elektrischen, elektronischen, elektromagnetischen und elektromechanischen Geräten innerhalb des Raumfahrzeugs bestehend sowie durch das Vorhandensein seiner selbstinduzierten elektromagnetischen Umgebung definiert. Sie umfasst die absichtliche Aussendung elektromagnetischer Felder und parasitäre Störaussendung von fahrzeuginternen Geräten. Sowohl leitungsgeführte als auch gestrahlte Störaussendungen sind betroffen. Ein Sicherheitsfaktor für elektromagnetische Störungen wird an systemkritischen Punkten durch Vergleich von Störpegel und Empfindlichkeit an jenen Punkten definiert.

1 Anwendungsbereich

EMV-Grundsätze und allgemeine Systemanforderungen sind in ECSS-E-ST-20 festgelegt.

Diese Norm ECSS-E-ST-20-07 behandelt detaillierte Systemanforderungen (Abschnitt 4), allgemeine Prüfbedingungen, Verifizierungsanforderungen auf Systemebene und Prüfverfahren auf Untersystem- und Geräteebene (Abschnitt 5) sowie informative Grenzwerte (Anhang A).

ECSS-E-ST-20-06 „Aufladung von Raumfahrzeugen“ steht in Zusammenhang mit der vorliegenden Norm und behandelt Überwachung und Risiken der Aufladung aufgrund umgebungs- und fahrzeuginduzierter Aufladung von Raumfahrzeugen, während ECSS-E-ST-20-07 elektromagnetische Auswirkungen elektrostatischer Entladungen behandelt.

Die Anhänge A bis C der ECSS-E-ST-20 dokumentieren EMV-Vorgänge in Zusammenhang mit ECSS-E-ST-20-07: der EMV-Überwachungsplan (Anhang A) legt Vorgehensweise, Verfahren, Verfahrensweisen, Ressourcen und Organisation fest, im Prüfplan für elektromagnetische Auswirkungen (Anhang B) sind Prüfprozesse, Analysen und Prüfungen definiert und festgelegt, und der Prüfbericht für elektromagnetische Auswirkungen (Anhang C) dokumentiert die Prüfergebnisse. Der EMEVP und der EMEVR sind die Grundmittel für die Auslegung dieser Norm.

Diese Norm darf auf die speziellen Merkmale und Vorgaben eines Raumfahrtprojekts nach ECSS-S-ST-00 ausgelegt werden.

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3 Begriffe und Abkürzungen

3.1 Begriffe aus anderen Normen

Für die Anwendung dieser Norm gelten die Begriffe nach ECSS-S-ST-00-01, insbesondere die folgenden Begriffe.

kritische Einheit

Kunde

Gerät

Einheit

Trägerrakete, Trägerfahrzeug

Mission

Anforderung

sicherheitskritische Funktion

Lieferant

Raumfahrzeug

Untersystem

System

Prüfung

Verifizierung

Für die Anwendung dieser Norm haben die folgenden Begriffe eine spezifische Definition nach ECSS-E-ST-20:

leitungsgeführte Störaussendung

elektromagnetische Verträglichkeit

Überwachung der elektromagnetischen Verträglichkeit

elektromagnetische Störung

Sicherheitsfaktor für elektromagnetische Störung

Störaussendung

Hochspannung

indirekte Blitzauswirkungen

gestrahlte Störaussendung

Hochfrequenz

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Empfindlichkeit

Empfindlichkeitsschwelle

Für die Anwendung dieses Dokuments haben die folgenden Begriffe eine spezifische Definition nach ECSS-E-ST-20-06:

elektrostatische Entladung (ESD)

Sekundärbogen

Für die Anwendung dieses Dokuments hat der folgende Begriff eine spezifische Definition nach ECSS-E-ST-33-11:

elektrische Anzünd- und Zündmittel (EED)

3.2 Für diese Norm spezifische Begriffe

3.2.1
Umgebungspegel
gestrahlter und leitungsgeführter Signal- und Rauschpegel, der am festgelegten Prüfort zur festgelegten Prüfzeit vorliegt, wenn das zu prüfende Gerät nicht in Betrieb ist

ANMERKUNG Der „Umgebungspegel“ setzt sich beispielsweise aus atmosphärischen Störungen, von anderen Quellen ausgehenden Störungen und Leitungsrauschen oder anderen, innerhalb des Messgeräts erzeugten Störungen zusammen.

3.2.2
Antennenfaktor
Faktor, der bei richtiger Anwendung auf die Spannung an den Eingangsschlüssen des Messgeräts die elektrische oder magnetische Feldstärke ergibt

ANMERKUNG 1 Dieser Faktor beinhaltet die Auswirkungen von effektiver Länge der Antenne, Fehlanschlüssen und Übertragungsverlusten.

ANMERKUNG 2 Die elektrische Feldstärke wird gewöhnlich in V/m angegeben und die magnetische Feldstärke in A/m oder T.

3.2.3
asymmetrische Spannung
Spannungsdifferenz zwischen Quelle und festgelegtem Bezugspunkt des Empfängers

3.2.4
Verfahren der Kontaktentladung
Prüfverfahren, bei dem der Kontakt der Elektrode des Hochspannungs-Prüfgenerators mit dem Entladungskreis beibehalten und die Entladung durch einen Entladungsschalter ausgelöst wird

3.2.5
elektromagnetische Umgebungseinflüsse
Einfluss der elektromagnetischen Umgebung auf Geräte, Systeme und Plattformen

ANMERKUNG Dies umfasst alle elektromagnetischen Teilbereiche, einschließlich elektromagnetischer Verträglichkeit, elektromagnetischer Störung, elektromagnetischer Anfälligkeit, Gefährdungen von Personal durch elektromagnetische Strahlung, elektrisch initiierter Anzünd- und Zündmittel, flüchtiger Stoffe sowie Auswirkungen von natürlichen Phänomenen.

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3.2.6
Feldstärke
Resultierende aus Strahlung, Induktion und quasistatischen Komponenten des elektrischen oder magnetischen Feldes

ANMERKUNG Die Verwendung des Begriffs „elektrische Feldstärke“ oder „magnetische Feldstärke“ ist abhängig davon, ob das resultierende elektrische bzw. magnetische Feld gemessen wird.

3.2.7
Grundebene
Metallblech oder -platte, verwendet als gemeinsamer Bezugspunkt für Rückleitungen sowie elektrische oder magnetische Signalpotenziale

3.2.8
fehlerhafte Antwort
entweder unbeabsichtigte oder unzulässige Antwort eines Untersystems oder Geräts

3.2.9
unbeabsichtigte Antwort
funktionell ordnungsgemäße Antwort eines Untersystems (innerhalb des normalen Grenzbereichs), die durch elektromagnetische Störung ausgelöst wird, aber bei einem anderen als dem normalen Betriebszyklus auftritt, was wiederum zu einer fehlerhaften Antwort des gesamten Raumfahrtsystems führt

3.2.10
Netznachbildung (LISN)
Netzimpedanz-Stabilisierungsnetzwerk
in die Stromversorgungsleitungen eines zu prüfenden Geräts eingefügtes Netzwerk, welches in einem gegebenen Frequenzbereich eine festgelegte Quellenimpedanz für die Messung von Störströmen und -spannungen bereitstellt und durch welches das Gerät in diesem Frequenzbereich als vom Stromversorgungsnetz getrennt betrachtet werden kann

3.2.11
außer Betrieb
Zustand, in welchem das Gerät nicht mit Energie gespeist wird

3.2.12
umgebende Abschirmung
Abschirmung, die ein gebündeltes oder geschirmtes Kabel umgibt

3.2.13
passives Intermodulationsprodukt
Erzeugung eines Signals bei Frequenz $f = n \times f_1 + m \times f_2$ aus zwei Signalen bei den Frequenzen f_1 und f_2, wobei n und m positive oder negative ganzzahlige Werte sind, mittels einer passiven Einrichtung, gewöhnlich mit einem elektrischen Kontakt

3.2.14
Anschluss
Stelle für den Zugriff auf ein Gerät oder Netz, an der Energie eingespeist oder entnommen werden kann oder die Geräte- oder Netzvariablen beobachtet oder gemessen werden können

3.2.15
Anforderungen an die Qualität der Versorgungsspannung
Anforderungen, welche das/die leitungsgeführte Spannungsrauschen oder Impedanz definieren, die der Spannungsnutzer erwarten kann

ANMERKUNG Rauschen aufgrund von beispielsweise Lastregulierung, Spitzen und Einbrüchen.

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3.2.16
weichmagnetisches Material
ferromagnetisches Material mit einer Koerzivität < 100 A/m

3.2.17
Nebenwellen-Aussendung
elektromagnetische Störaussendung vom vorgesehenen Ausgangsanschluss eines elektronischen Geräts, jedoch außerhalb der vorgesehenen Aussendungsbandbreite

3.2.18
Prüfantenne
Antenne mit festgelegten Eigenschaften, die für die Verwendung unter festgelegten Bedingungen bei der Durchführung von Prüfungen vorgesehen ist

3.2.19
Einheit
Gerät, das als Einheit für Zwecke der Analyse, Herstellung, Instandhaltung oder das Führen von Aufzeichnungen angesehen wird

ANMERKUNG Beispielsweise hydraulische Stellantriebe, Armaturen, Batterien und einzelne Elektronikkästen, wie z. B. fahrzeuginterne Computer, Trägheitsmesseinheiten, Reaktionsrad, Sternensensor, Leistungsregler, Sender, Empfänger oder Multiplexer.

3.3 Abkürzungen

Für die Anwendung dieser Norm gelten die Abkürzungen nach ECSS-S-ST-00-01 und die folgenden Abkürzungen:

AC	Wechselstrom (en: alternating current)
ACS	Lageregelungssystem (en: attitude control system)
AM	Amplitudenmodulation (en: amplitude modulation)
AWG	amerikanische Norm für Drahtquerschnitte (en: American wire gauge)
BCI	Stromeinspeisung in den Kabelbaum (en: bulk cable injection)
CE	leitungsgeführte Störaussendung (en: conducted emission)
CS	leitungsgeführte Empfindlichkeit (en: conducted susceptibility)
CW	Dauerstrich (en: continuous wave)
DC	Gleichstrom (en: direct current)
EED	elektrische Anzünd- und Zündmittel (en: electro-explosive device)
EGSE	elektrisches Bodendienstgerät (en: electrical ground support equipment)
EHF	extrem hohe Frequenz (en: extremely high frequency) (30 GHz bis 300 GHz)
EMV	elektromagnetische Verträglichkeit (EMC, en: electromagnetic compatibility)
EMCAB	beratender Ausschuss für elektromagnetische Verträglichkeit (en: electromagnetic compatibility advisory board)

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EMCCP Überwachungsplan für elektromagnetische Verträglichkeit (en: electromagnetic compatibility control plan)

EMEVP Prüfplan für elektromagnetische Auswirkungen (en: electromagnetic effects verification plan)

EMEVR Prüfbericht für elektromagnetische Auswirkungen (en: electromagnetic effects verification report)

EMI elektromagnetische Störung (en: electromagnetic interference)

EMISM Sicherheitsfaktor für elektromagnetische Störungen (en: electromagnetic interference safety margin)

ESD elektrostatische Entladung (en: electrostatic discharge)

EUT zu prüfendes Gerät (en: equipment under test)

HV Hochspannung (en: high voltage)

ICD Schnittstellenkontrolldokument (en: interface control document)

LEO erdnahe Umlaufbahn (en: low Earth orbit)

LF Niederfrequenz (en: low frequency)

LISN Netznachbildung (en: line impedance stabilization network)

MGSE mechanisches Bodendienstgerät (en: mechanical ground support equipment)

PAM Pulsamplitudenmodulation (en: pulse amplitude modulation)

PCM Puls-Code-Modulation (en: pulse coded modulation)

RE gestrahlte Störaussendung (en: radiated emission)

RF Hochfrequenz (en: radio frequency)

r.m.s. Effektivwert (en: root-mean-square)

RS Empfindlichkeit gegenüber gestrahlter Störaussendung (en: radiated susceptibility)

SHF Ultrahochfrequenz (en: super-high frequency)

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Raumfahrttechnik - Elektromagnetische Kompabilität

This draft European Standard is submitted to CEN members for unique acceptance procedure. It has been drawn up by the Technical Committee CEN/CLC/TC 5.

If this draft becomes a European Standard, CEN and CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Foreword

This document (FprEN 16603-20-07:2013) has been prepared by Technical Committee CEN/CLC/TC 5 "Space", the secretariat of which is held by DIN (Germany).

This document (FprEN 16603-20-07:2013) originates from ECSS-E-ST-20-07C Rev. 1.

This document is currently submitted to the Unique Acceptance Procedure.

This document has been developed to cover specifically space systems and will the-refore have precedence over any EN covering the same scope but with a wider do-main of applicability (e.g. : aerospace).

This standard is specific for space applications and takes precedence over any other possible existing standards with a wider scope and covering also the space area.

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Introduction

Electromagnetic compatibility (EMC) of a space system or equipment is the ability to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

The space system is designed to be compatible with its external natural, induced, or man-made electromagnetic environment. Natural components are lightning for launchers, the terrestrial magnetic field for space vehicles. Spacecraft charging is defined as voltage building-up of a space vehicle or spacecraft units when immerged in plasma. Electrostatic discharges result from spacecraft charging with possible detrimental effects. External man-made interference, intentional or not, are caused by radar or telecommunication beams during ground operations and the launching sequence. Intersystem EMC also applies between the launcher and its payload or between space vehicles.

Intrasystem EMC is defined between all electrical, electronic, electromagnetic, and electromechanical equipment within the space vehicle and by the presence of its self-induced electromagnetic environment. It comprises the intentional radiated electromagnetic fields and parasitic emission from on-board equipment. Both conducted and radiated emissions are concerned. An electromagnetic interference safety margin is defined at system critical points by comparison of noise level and susceptibility at these points.

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1 Scope

EMC policy and general system requirements are specified in ECSS-E-ST-20.

This ECSS-E-ST-20-07 Standard addresses detailed system requirements (Clause 4), general test conditions, verification requirements at system level, and test methods at subsystem and equipment level (Clause 5) as well as informative limits (Annex A).

Associated to this standard is ECSS-E-ST-20-06 "Spacecraft charging", which addresses charging control and risks arising from environmental and vehicle-induced spacecraft charging when ECSS-E-ST-20-07 addresses electromagnetic effects of electrostatic discharges.

Annexes A to C of ECSS-E-ST-20 document EMC activities related to ECSS-E-ST-20-07: the EMC Control Plan (Annex A) defines the approach, methods, procedures, resources, and organization, the Electromagnetic Effects Verification Plan (Annex B) defines and specifies the verification processes, analyses and tests, and the Electromagnetic Effects Verification Report (Annex C) document verification results. The EMEVP and the EMEVR are the vehicles for tailoring this standard.

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

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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 revision 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 more 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 16603-20	ECSS-E-ST-20	Space engineering - Electrical and electronic
EN 16603-20-06	ECSS-E-ST-20-06	Space engineering - Spacecraft charging
EN 16603-33-11	ECSS-E-ST-33-11	Space engineering - Explosive systems and devices
EN 16603-50-14	ECSS-E-ST-50-14	Space engineering - Spacecraft discrete interfaces
	IEC 61000-4-2 (Edition 1.2)	Electromagnetic compatibility (EMC) - Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test

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3 Terms, definitions and abbreviated terms

3.1 Terms from other standards

For the purpose of this Standard, the terms and definitions from ECSS-S-ST-00-01 apply, in particular for the following terms:

critical item

customer

equipment

item

launcher, launch vehicle

mission

requirement

safety critical function

supplier

spacecraft, space vehicle

subsystem

system

test

verification

For the purposes of this Standard, the following terms have a specific definition contained in ECSS-E-ST-20:

conducted emission

electromagnetic compatibility

electromagnetic compatibility control

electromagnetic interference

electromagnetic interference safety margin

emission

high-voltage

lightning indirect effects

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radiated emission

radiofrequency

susceptibility

susceptibility threshold

For the purposes of this document, the following terms have a specific definition contained in ECSS-E-ST-20-06:

electrostatic discharge (ESD)

secondary arc

For the purposes of this document, the following term has a specific definition contained in ECSS-E-ST-33-11:

electro-explosive device (EED)

3.2 Terms specific to the present standard

3.2.1 ambient level

level of radiated and conducted signal, and noise that exist at the specified test location and time when the equipment under test is not operating

NOTE E.g. atmospherics, interference from other sources, and circuit noise or other interference generated within the measuring set compose the "ambient level".

3.2.2 antenna factor

factor that, when properly applied to the voltage at the input terminals of the measuring instrument, yields the electric or magnetic field strength

NOTE 1 This factor includes the effects of antenna effective length, mismatch, and transmission losses.

NOTE 2 The electric field strength is normally expressed in V/m and the magnetic field strength in A/m or T.

3.2.3 common mode voltage

voltage difference between source and receiver ground references

3.2.4 contact discharge method

method of testing in which the electrode of the high-voltage test generator is held in contact with the discharge circuit, and the discharge actuated by a discharge switch

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3.2.5 electromagnetic environmental effects

impact of the electromagnetic environment upon equipment, systems, and platforms

NOTE It encompasses all electromagnetic disciplines, including electromagnetic compatibility; electromagnetic interference, electromagnetic vulnerability, hazards of electromagnetic radiation to personnel, electro-explosive devices, volatile materials, and natural phenomena effects.

3.2.6 field strength

resultant of the radiation, induction and quasi-static components of the electric or magnetic field

NOTE The term "electric field strength" or "magnetic field strength" is used, according to whether the resultant, electric or magnetic field, respectively, is measured.

3.2.7 ground plane

metal sheet or plate used as a common reference point for circuit returns and electrical or signal potentials

3.2.8 improper response

subsystem or equipment response which can be either inadvertent or unacceptable

3.2.9 inadvertent response

proper subsystem functional response (within normal range of limits) actuated by electromagnetic interference, but occurring at other than the normal operational cycle, which in turn causes improper response to the total space system

3.2.10 line impedance stabilization network (LISN)

network inserted in the supply leads of an apparatus to be tested which provides, in a given frequency range, a specified source impedance for the measurement of disturbance currents and voltages and which can isolate the apparatus from the supply mains in that frequency range

3.2.11 not operating

condition wherein no power is applied to the equipment

3.2.12 overshield

shield surrounding a bundle or a shielded cable

3.2.13 passive intermodulation product

generation of a signal at frequency $f = n*f_1 + m*f_2$ from two signals at frequencies f_1 and f_2 where n and m are positive or negative integers, by a passive device, usually an electrical contact

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3.2.14 port

place of access to a device or network where energy can be supplied or withdrawn, or where the device or network variables can be observed or measured

3.2.15 power quality requirements

requirements which define the conducted voltage noise or impedance the power user can expect

NOTE Noise e.g. from load regulation, spikes, and sags.

3.2.16 soft magnetic material

ferromagnetic material with a coercivity smaller than 100 A/m

3.2.17 spurious emission

electromagnetic emission from the intended output terminal of an electronic device, but outside of the designed emission bandwidth

3.2.18 test antenna

antenna of specified characteristics designated for use under specified conditions in conducting tests

3.2.19 unit

equipment that is viewed as an entity for purposes of analysis, manufacturing, maintenance, or record keeping

NOTE E.g. hydraulic actuators, valves, batteries, and individual electronic boxes such as on-board computer, inertial measurement unit, reaction wheel, star tracker, power conditioning unit, transmitters, receivers, or multiplexers.

3.3 Abbreviated terms

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

Abbreviation	Meaning
AC	alternating current
ACS	attitude control system
AM	amplitude modulation
AWG	American wire gauge
BCI	bulk cable injection
CE	conducted emission
CS	conducted susceptibility
CW	continuous wave
DC	direct current

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EED	electro-explosive device
EGSE	electrical ground support equipment
EHF	extremely high frequency (30 GHz-300 GHz)
EMC	electromagnetic compatibility
EMCAB	electromagnetic compatibility advisory board
EMCCP	electromagnetic compatibility control plan
EMEVP	electromagnetic effects verification plan
EMEVR	electromagnetic effects verification report
EMI	electromagnetic interference
EMISM	electromagnetic interference safety margin
ESD	electrostatic discharge
EUT	equipment under test
HV	high voltage
ICD	interface control document
LEO	low Earth orbit
LF	low frequency
LISN	line impedance stabilization network
MGSE	mechanical ground support equipment
PAM	pulse amplitude modulation
PCM	pulse coded modulation
RE	radiated emission
RF	radio frequency
r.m.s.	root-mean-square
RS	radiated susceptibility
SHF	super-high frequency (3 GHz-30 GHz)

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4 Requirements

4.1 General system requirements

EMC policy and general system requirements, and the spacecraft charging protection program are specified in ECSS-E-ST-20 Electromagnetic Compatibility clause and EMC Plan DRD.

4.2 Detailed system requirements

4.2.1 Overview

This clause 4.2 defines the requirements for design and realization at system level. They are the basis for definition of activities of the EMC programme to ensure space-system-level compatibility with minimum impact to programme, cost, schedule, and operational capabilities.

4.2.2 EMC with the launch system

4.2.2.1 Overview

General system requirements for "EMC with the launch system" are defined in ECSS-E-ST-20.

4.2.2.2 Detailed system requirements

a. Overload capability of the spacecraft RF receivers during the pre-launch and launch phases with or without fairing, shall be demonstrated by the spacecraft supplier.

NOTE 1 It is expected the electromagnetic environment generated by companion payloads is assessed by the launching company and addressed in the User's Manual.

NOTE 2 A conductive fairing is likely to cause resonances and cavity effects.

b. Spacecraft equipment shall not exhibit any malfunction, degradation of performance or deviation beyond the tolerance indicated in its individual

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specification after being exposed, even not operating, to the electromagnetic environment from the launcher and launch site.

NOTE Most of spacecraft equipment is not operating during launch. During the launching sequence spacecraft transmitters and receivers (platform and payload) can be either in OFF- or ON-state depending on the launch vehicle.

c. The electromagnetic interference safety margin (EMISM) of safety critical equipment shall be applied to equipment in ON-state during prelaunch and launch phase and to EEDs.

4.2.3 Lightning environment

4.2.3.1 Overview

Protection of the space system against both direct and indirect effects of lightning can be a combination of operational avoidance of the lightning environment and electrical overstress design techniques.

4.2.3.2 Requirements to the space system

a. Assessment of risk, on the launch pad inside the protected area, for the space system and its equipment against direct and indirect effects of lightning before lift-off, shall be performed.

b. The spacecraft supplier shall obtain from the launching company the electromagnetic environment imposed on the launcher payloads in case of lightning.

4.2.4 Spacecraft charging and effects

4.2.4.1 Overview

Mitigation of risks related to spacecraft charging results of a combination of rules and methods preventing voltage build-up and so minimizing the occurrence of ESD, and techniques for controlling EMI from residual ESD.

ECSS-E-ST-20 addresses management of spacecraft charging protection and system-level performance under effects of spacecraft charging and related ESD or secondary arcs.

ECSS-E-ST-20-06 addresses charging control and risks arising from spacecraft charging and other environmental effects on the spacecraft's electrical behaviour.

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4.2.4.2 EMI control requirements to system and equipment in relation with ESD

a. Analysis or tests at system level shall be performed for assessing the threat at subsystem or equipment level.

NOTE Analysis or tests can be defined in the time or frequency domain. They are expected to evaluate the coupling level from the ESD source to critical points.

b. EMI control from residual ESD shall be performed by a combination of shielding and passive or active filtering techniques, implemented on the main structure, at subsystem level or inside equipment.

c. EMI control efficiency shall be verified by test at subsystem or equipment level.

4.2.5 Spacecraft DC magnetic emission

4.2.5.1 Spacecraft with susceptible payload

a. As part of the EMCCP, a magnetic cleanliness control plan shall document:

1. magnetic control guidelines
2. emission limits to magnetic sources
3. a magnetic budget
4. specific test methods applied to equipments for emission measurement and characterization

NOTE The test method described in 5.4.5 providing a dipole model can be inadequate and replaced by a multiple dipole model or a spherical harmonics model.

4.2.5.2 Attitude control system (ACS)

a. As part of the EMCCP, a magnetic budget shall be maintained providing:

1. Three-axes components of the space vehicle magnetic dipole (component decreasing with the inverse cube law with distance).

NOTE Typical values lie in the range 1 Am^2 or less for small spacecraft to much more than 10 Am^2 for large spacecraft.

2. If the solar array is rotating in the space vehicle axes, separate evaluation for the main body and the solar array.
3. When the space vehicle is using a magnetic sensor as part of the ACS, evaluation of the magnetic induction at its location.

NOTE The angular deviation is the basic requirement; however, the requirement is generally expressed in terms of modification of the natural field strength

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at the sensor location. For LEO spacecraft if the error on each axis is less than 1 μT, the modification of the direction is kept less than 20 milliradians.

b. The specified maximum magnetic field value shall comprise the remanent magnetization (magnets, electro-magnets in off-state, or residual perm-up due to hysteresis of soft materials), the induced magnetization of soft materials by the geomagnetic field, and the momentum of current loops.

4.2.6 Radiofrequency compatibility

a. Spurious emissions requirements at antenna ports shall be specified for RF compatibility purpose by the spacecraft supplier.

b. When specifying limits and frequency ranges, the following issues shall be included:

1. sensitivity of possible victim receiver subsystems including out-of-band response,
2. no limits apply to transmit frequencies and information carrying modulation bandwidths,
3. highest and lowest intentional frequency used by space system receivers,
4. antenna port attachments, gain/loss characteristics.

4.2.7 Hazards of electromagnetic radiation

Assessment of hazards to electromagnetic radiation is a part of the process specified in ECSS-Q-ST-40-02 “Hazard analysis”, clause “Hazard analysis requirements”.

4.2.8 Intrasystem EMC

a. Intrasystem EMC shall be achieved by:

1. allocation of equipment-level EMI requirements documented in the EMCCP, including:
   (a) limits on conducted and radiated emission,
   (b) susceptibility thresholds.

NOTE Recommended data is defined in Annex A for equipment and subsystems.

b. control of conducted and radiated propagation paths methods defined by clauses 4.2.10 to 4.2.13.

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4.2.9 EMC with ground equipment

a. The EGSE and MGSE used for spacecraft integration and ground testing shall:

   1. Not degrade the EMC performance of the spacecraft;

   2. Have no impact on grounding or isolation.

b. The EGSE shall be immune to signals used for spacecraft susceptibility tests.

4.2.10 Grounding

4.2.10.1 Overview

As specified in ECSS-E-ST-20, a controlled ground reference concept is defined for the space system. Structural elements, antenna and RF reference grounds, power and signal returns, shields and cable shields, safety grounds, EGSE grounds are considered.

4.2.10.2 Requirements

a. A system-level grounding diagram shall be established including the EGSE.

b. A ground reference shall be identified for each power, signal, or RF source or receiver.

c. An upper value of common mode voltage shall be specified considering:

   1. power quality requirements defined in ECSS-E-ST-20 for "Spacecraft bus",

   2. type of detectors and sensitivity,

   3. characteristics of analogue signal monitor receiver circuit, in accordance with ECSS-E-ST-50-14, Table 5-2 d,

   4. characteristics of bi-level signal monitor receiver circuit, in accordance with ECSS-E-ST-50-14, clause Table 6-2 e,

   5. hazards due to fault currents internal to the space vehicle or between the space vehicle and its EGSE.

d. When power and signal share common paths (wire or structure), the magnitude of ground impedance shall be limited over the affected signal spectrum.

   NOTE Non-exclusive techniques for reducing the impedance are decrease of common path length, decrease of wire and ground impedance, filters on common paths.

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4.2.11 Electrical bonding requirements

4.2.11.1 Overview

Bonding requirements are a mean for fulfilling grounding requirements.

Normative provisions are specified in clause 4.2.11.2 and illustrated in Figure 4-1.

NOTE Bonding requirements for charging control are specified in ECSS-E-ST-20-06 "Electrical continuity", including surfaces and structural and mechanical parts.

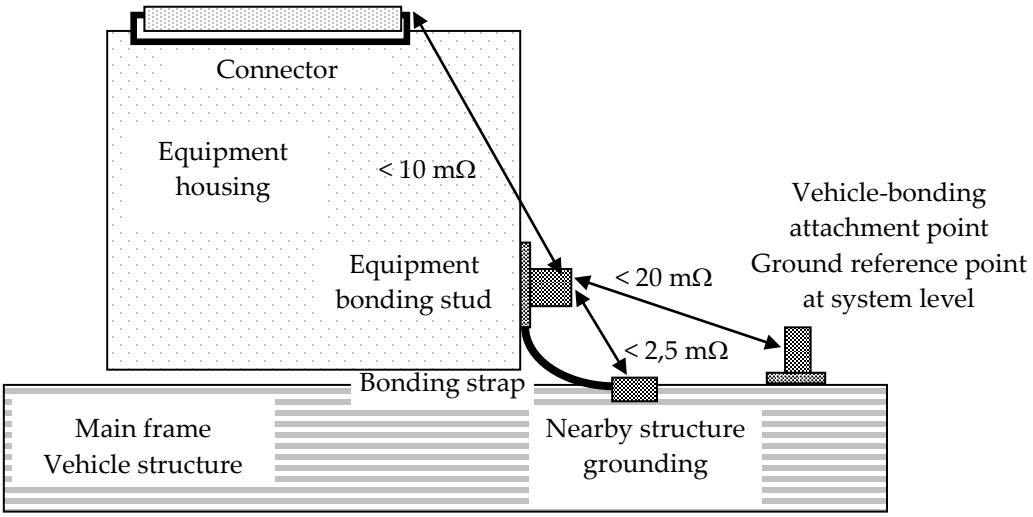

Figure 4-1: Bonding requirements

4.2.11.2 Normative provisions

a. A vehicle bonding attachment point connected to the vehicle structure shall be provided as a ground reference point at system level.

b. An equipment bonding stud connected to the unit housing shall be provided as a ground reference at equipment level.

c. Each unit housing shall be bonded to the nearby spacecraft structure from the equipment bonding stud.

d. The DC resistance between the equipment bonding stud and the nearby spacecraft structure shall be less than 2,5 mΩ.

e. The inductance between the equipment bonding stud and the nearby spacecraft structure shall be less than 30 nH.

f. The DC resistance between the unit housing and the vehicle bonding attachment point shall be less than 20 mΩ.

g. The DC resistance between the equipment bonding stud and each connector housing shall be less than 10 mΩ.

h. Bonds shall be capable to carry the fault currents determined by analysis at system level, without fusing, burning, or arcing.

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i. If the structure is used as the return current path, bonding provisions shall be such that DC and AC voltage drops along power paths comply with clause 4.2.10.2c.

4.2.11.3 External grounds

a. The functionality of connecting grounding cables for charge equalization shall be provided on space systems.

NOTE Charge equalization is needed prior to implementing other procedures or the application of power across the interface.

4.2.12 Shielding (excepted wires and cables)

4.2.12.1 Overview

When shielding is used to control EMC with the environment, it can be provided by the basic space vehicle structure designed as a “Faraday cage”, by enclosures of electronics boxes, or by cable or bundle overshields.

4.2.12.2 Requirement

a. Electronics units and cables external to the basic space vehicle structure shall have individual shields providing attenuation to EMI.

NOTE It is important to consider apertures used for pressure drop during ascent and for outgassing.

4.2.13 Wiring (including wires and cables shielding)

4.2.13.1 Classification of cables

a. Categorisation of harness and separate routings for wires of different categories shall be defined as follows:

1. applicable to critical lines as defined in ECSS-E-ST-20, Clause “Electromagnetic interference safety margin”.
2. made on the basis of the characteristics of the signals on the wire (and hence the interference generated), and on the susceptibility of the circuit to EMI.

b. Wires falling into one category shall be assembled into a same bundle.

c. Bundles of different categories shall be separated either by a separation distance of 5 cm from the outer circumference or by a metallic screen when they are routed on parallel paths.

NOTE Overshields or spacecraft walls can be used to fulfil the requirement.

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d. Wires and cables shall be marked in such a manner that personnel can visually identify the EMC category for each wire or cable.

4.2.13.2 Cable shields

a. Cable shields shall not be used as an intentional current carrying conductor, except coaxial cables in radiofrequency circuits and high-speed data links using coaxial cables.

b. Cable shields, other than overshields, shall have an insulated sheath to prevent uncontrolled grounding.

c. Connectors used to carry shielded wires shall

1. not use a nonconductive finish,

2. provide contact to the equipment housing with a resistance less than 10 mΩ through the equipment connector body as shown.

d. Bonding of cable shields shall be as following:

1. Bonding to chassis ground is performed at both ends:

(a) through the equipment connector body,

(b) using a backshell that provides for circumferential bonding of shields, or using a halo-ring.

NOTE No grounding inside the equipment through a connector ground pin in order to prevent any perturbation inside the equipment.

2. Connection to electrical reference is performed through dedicated pins.

NOTE This case typically appears in the design of detection chains.

e. Overshields shall be bonded to chassis ground:

1. at both ends,

2. using a 360° direct contact or a bond strap of less than 30 nH

NOTE See NOTE of clause 4.2.11.2e.

f. Overshields should be bonded to chassis ground at intermediary points with a separation distance less than 1m between two grounding points.

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