SMC Tailoring SMC-T-008
6 March 2019

Supersedes:
SMC-S-008 (2008)

Air Force Space Command

SPACE AND MISSILE SYSTEMS CENTER TAILORING

TAILORING FOR AIAA S-121A-2017, ELECTROMAGNETIC COMPATIBILITY REQUIREMENTS FOR SPACE EQUIPMENT AND SYSTEMS

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FOREWORD

1. AIAA S-121A-2017 as tailored by this document defines the Government's requirements and expectations for contractor performance in defense system acquisitions and technology developments.

2. This new-issue SMC tailoring comprises the text of The Aerospace Corporation report number TR-RS-2020-00029, entitled *Tailoring for AIAA S-121A-2017, Electromagnetic Compatibility Requirements for Space Equipment and Systems*. Jointly, AIAA S-121A-2017 and SMC Tailoring number SMC-T-008 (2020) replaces SMC standard number SMC-S-008 (2008).

3. Beneficial comments (recommendations, changes, additions, deletions, etc.) and any pertinent data that may be of use in improving this standard should be forwarded to the following addressee using the Standardization Document Improvement Proposal appearing at the end of this document or by letter:

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4. This tailoring has been approved for use on Space and Missile Systems Center/Air Force Program Executive Office - Space development, acquisition, and sustainment contracts.

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1. Scope

1.1 Purpose

This document is a tailoring of the American Institute of Aeronautics and Astronautics (AIAA) Standard S-121A-2017 to provide an effective space vehicle (SV) program technical baseline for electromagnetic compatibility (EMC) and national security space mission success.

1.2 Application

This document is intended for use in acquisition and study contracts for SVs. The AIAA standard tailored by this document (hereafter referred to as the "tailored AIAA standard") supersedes all revisions of the following documents:

1. AIAA S-121A-2017. *Electromagnetic Compatibility Requirements for Space Equipment and Systems*. Reston, VA: American Institute of Aeronautics and Astronautics.
2. SMC-S-008, *Electromagnetic Compatibility Requirements For Space Equipment And Systems*. Los Angeles Air Force Base, CA: USAF Space and Missile Systems Center.
3. TOR-2005(8583)-1 Rev A., *Electromagnetic Compatibility Requirements For Space Equipment And Systems*. El Segundo, CA: The Aerospace Corporation.
4. MIL-STD-461, *Requirements for the Control of Electromagnetic Interference Characteristics of Subsystem and Equipment,* all revisions.

This tailoring document, together with AIAA S-121A, is intended to be used as a compliance document to specify EMC requirements for SVs.

1.3 Background

EMC standards like MIL-STD-461G have historically been broad to cover to a diversity of applications, including ships, submarines, airplanes, helicopters, tanks, ground stations, launch vehicles and satellites. Such broad standards impose requirements that are unnecessary or extreme for a specific procurement. For example, MIL-STD-461G and SMC-S-008/TOR-2005(8583)-1 Rev A have 494 and 434 requirements, respectively. The large number of requirements, unless carefully tailored for the mission needs and risk posture of a specific acquisition, drives cost and schedule in terms of requirements management, requirements flow, design and verification.

AIAA S-121 limited the application scope to only cover satellites, launch vehicles and their associated ground systems. The total number of requirements in AIAA S-121A is 246 as compared to larger number of requirements MIL-STD-461G and SMC-S-008/TOR-2005(8583)-1 Rev A, as shown in Figure 1-1. This document further tailors AIAA S-121A to contain 142 requirements as shown in Figure 1-1. The goal was to provide a set of EMC requirements that are more efficiently applied and verified while maintaining a low risk design for a typical national security space system. The requirement reduction was accomplished by assigning a risk to each requirement and tailoring out those that are low risk. In projects where the risk tolerance is extremely low, it would be prudent to consider the value of using some/all of the low-risk requirements that were tailored out of AIAA S-121A by this document.

To be fair, MIL-STD-461G contains both requirements and verification methods whereas the other two documents will often point to MIL-STD-461G for verification methods. All three documents contain multiple "shalls" for a single requirement. For example, AIAA S-121A contains four "shalls" for the CE101 in the requirements section (8.4.1) and three "shalls" in the verification section (8.4.2) even though it references MIL-STD-461G for the verification method. It is also interesting that the RE102 requirement contains no "shalls" in Section 8.20. SMC-S-008 contains 10 "shalls" for CE101/CE102A in the requirements section (6.01c1-c4) and five "shalls" in the verification section (6.01d1-d3) even though

it references MIL-STD-461G for the verification method. Eight of the "shalls" are labeled "P" for procurement-specific and are generally only applied to missions with severe or unique requirements.

Figure 1-2 contains the number of unit EMC requirements per document ignoring the multiple "shalls", verification methods, and general or system requirements. It is not surprising that SMC S-008 has the most unit EMC requirements at 43 as it contains several requirements that are normally carried in the power user's specification, 12 procurement-specified requirements and five non-unit, material requirements. S-121A has four procurement-specified requirements. This document has three procurement-specified and one non-unit, materials requirement.

The detailed unit requirements have been tailored to bound most contractor requirements yet are often less severe than the same requirements in MIL-STD-461G, SMC-S-008/TOR-2005(8583)-1 Rev A or AIAA S-121A. This may lead to cost reduction, less tailoring by the contractors, and to use of off-the-shelf units that can fly on a wide variety of platforms.

Digital requirements management tools, such as Rational Dynamic Object-Oriented Requirement Systems (DOORS), are generally used for requirements management. All effective requirements management tools address one requirement or "shall" per element/line. AIAA S-121A sometimes has multiple requirements or "shalls" in each paragraph, which requires additional hand parsing of the requirements into separate elements/lines. When requirements were tailored in this document, paragraphs with multiple "shalls" were given a separate paragraph or line for each "shall" to support more effective requirements management. In addition, the requirements, themselves, has been streamlined for crispness, clarity, and exactness.

The tailoring herein combines a table and figure together where both contain the same requirement. This not only saves space but helps reduce conflicting requirements.

The table in Section 2.2 contains a comprehensive list of changes imposed on AIAA S-121A. In many of the sections with changes, a note has been appended to provide rationale or an explanation of why the change was made. These notes may be deleted before the document is released. The Annex has not been tailored as it was only intended to provide a rationale for requirements as well as additional information that was deemed useful to the user.

The organization of this tailoring document is fully consistent with AIAA S-121A.

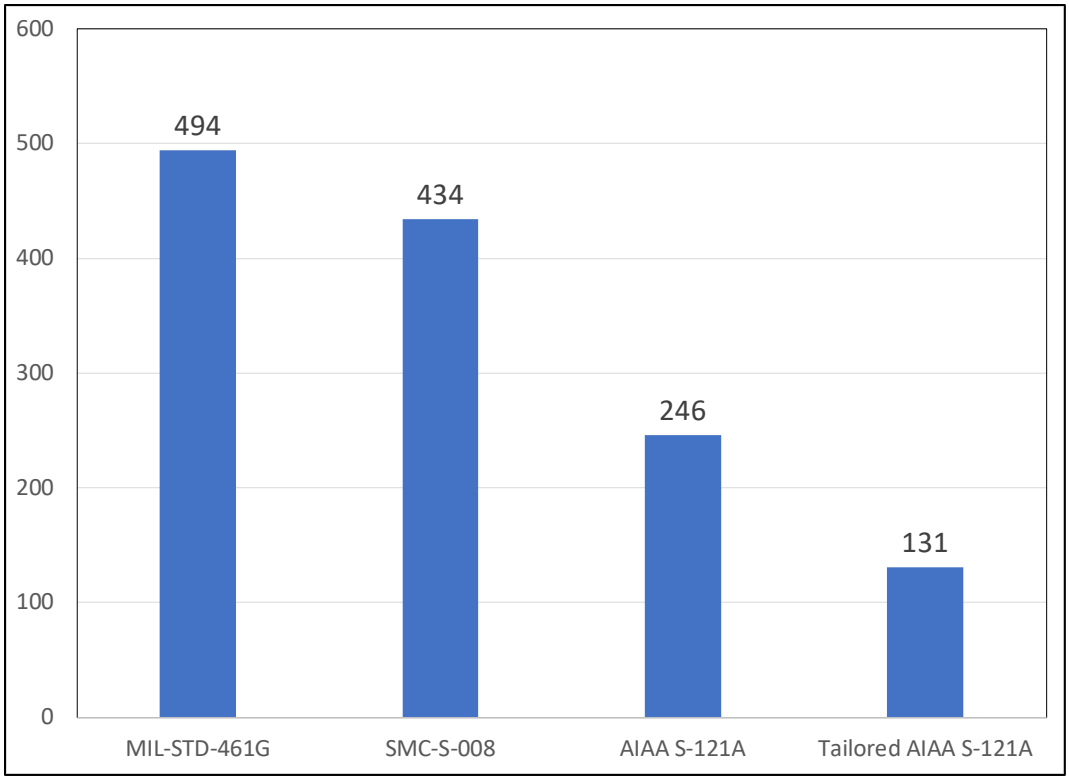


Figure 1-1. Total requirement ("shall") comparison between various standards.

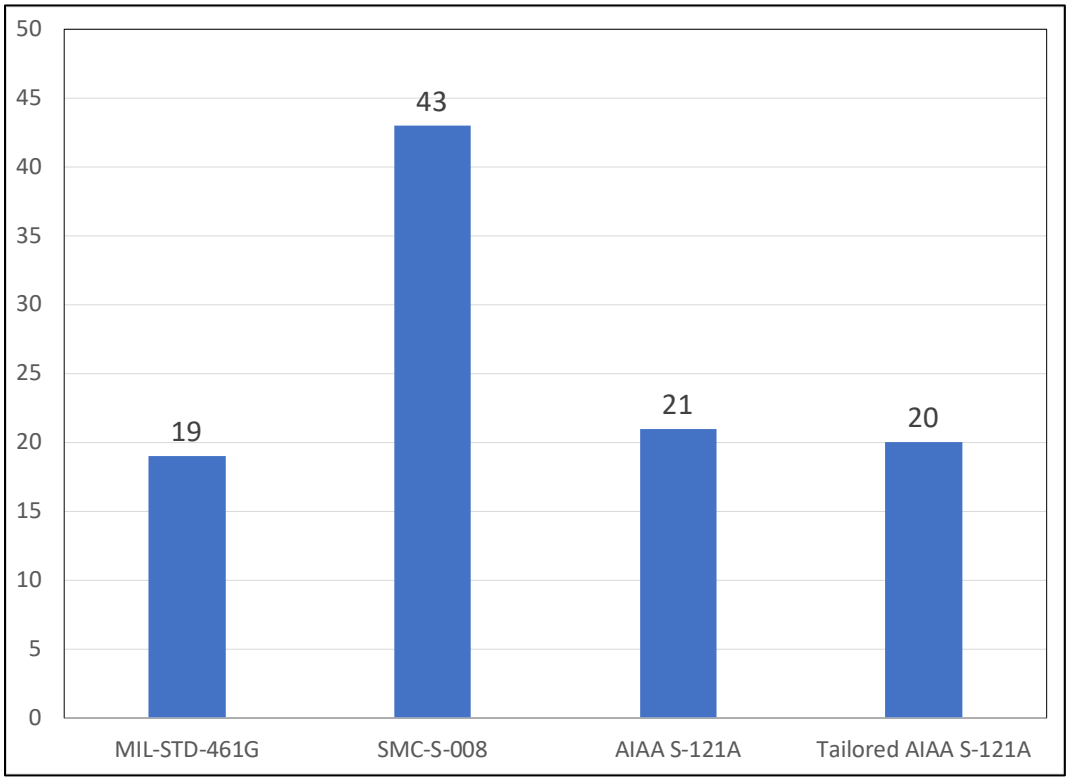


Figure 1-2. Unit EMC requirement comparison between various standards.

2. Tailoring

The requirements in this document have been derived to bound most contractor's requirements. Thus, portions of these requirements may either be too strict, too lenient or unnecessary to provide the appropriate electromagnetic interference safety margin (EMISM) for more/less stressing missions. Therefore, it is essential for each requirement to be tailored for the specific mission to maintain the proper EMISM as specified in Section 6.1.3. Tailoring of requirements shall be undertaken in consultation with the procuring agency where applicable.

2.1 Definition

Tailoring is a process by which individual requirements from specifications, standards, or related documents are evaluated and applied to a specific program by deletion, modification, or addition of requirements. Tailoring of requirements shall be undertaken with consultation and approval of the procuring authority to align the standard with the acquisition authority's requirements and the mission needs. The diversity of missions, buses, payloads, environments, and unique approaches of contractors makes tailoring of standard requirements mandatory.

This tailored AIAA Standard establishes a baseline for requirements, which in turn may be tailored or revised with rationale upon approval by the procuring authority.

2.2 Changes from AIAA S-121A-2017

The following is a comprehensive list of all the changes that this document imposes on AIAA S-121A-2017.

Section	Title	Change Type
3	Applicable Documents	Reference documents updated
4.1	Acronyms and Abbreviated Terms	Remove EMV
4.2	Terms and Definitions	Remove/update terms
5.6	Service Life (Lifecycle)	Added new section
6.1.2	Applicability	Application expanded
6.1.3	Basic Requirement	Application expanded, and Table 1 updated
6.2.2	Multipaction	Remove applicability
6.2.4	Plugs-Out Test	Clarify test method
6.2.5.1	RF Front-End Margin Assessment	Clarify requirement
6.2.5.2	Base Band Margin Assessment	Clarify requirement
6.3	External Electromagnetic Environment	Remove duplicate requirement and Tables 2 and 3
6.4	Lightning	Requirement clarification and enhancement
6.5	Electromagnetic Pulse (EMP)	Remove applicability
6.7	NDI, GFE, and Commercial Items	Clarify requirement
6.8	Magnetic Field Environment	Remove applicability
6.9	Electrostatic Charge Control	Remove mother statement
6.9.1	Triboelectric Charging	Clarify requirement
6.9.2	Electrically-Initiated Explosive Device (EED)	Remove applicability
6.9.3	Spacecraft Charging	Clarify requirement

6.10	Electromagnetic Radiation Hazards (EMRADHAZ)	Remove applicability
6.10.1	Hazards of Electromagnetic Radiation to Personnel (HERP)	Remove applicability
6.10.2	Hazards of Electromagnetic Radiation to Fuel (HERF)	Remove applicability
6.10.3	Hazards of Electromagnetic Radiation to Ordnance (HERO)	Remove applicability
6.11	Lifecycle, E3 Hardness	Remove applicability
6.12	Electrical Bonding	Remove portions
6.12.1	Power Current Return Path	Remove applicability
6.12.2	Antenna Installations	Clarify and enhance requirement
6.12.3	Prevention of Shock and Safety Hazard	Remove applicability
6.12.4	Control of RF Potentials	Remove applicability
6.12.5	Bonding for Static Control	Clarify requirement
6.12.6	Bonding in Explosive Atmospheres	Remove applicability
6.12.7	External Grounds	Remove applicability
6.12.8	Servicing and Maintenance Equipment Grounds	Remove applicability
6.13	TEMPEST	Remove applicability
6.14	EM Spectrum Compatibility	Remove applicability
6.15	System Circuit and Structure Reference	Remove applicability
6.16	Return Current Control	Remove applicability
6.18	Material Properties	Remove applicability
6.19	Data Formats	Remove applicability
6.20	Tailoring Guidance for Contractual Applications	Remove applicability
7.0	General Requirements-Units and Subsystems	Clarify requirement
7.2	Non-Developmental Item (NDI)	Remove duplicate applicability
7.3	Selected by Contractor	Remove applicability
7.9	Power Source Impedance	Clarify requirement
7.10	Input Power Leads	Clarify requirement
7.11.2	Additional Reporting	Remove applicability
7.12	Detector	Clarify requirement
7.13.1	Bandwidths	Clarify requirement
7.13.2	Measurements	Clarify requirement
7.14	Emission Identification	Clarify requirement
7.15	Frequency Scanning	Enhance requirement
7.17	Susceptibility Scanning	Clarify requirement
7.19	Operating Modes	Move requirement from Section 8
7.20	Operating Voltages	Add requirement
8.0	Detailed Requirements-Unit and Subsystems	Move requirement from Section 8.3
8.1	Operating Modes	Move requirement to Section 7.19
8.3	Emission and Susceptibility Requirements, Limits, and Test Procedures	Move requirement to Section 8.0
8.4	Power Bus Conducted Interference, Load Induced, Frequency Domain	Enhance requirement

8.5	RF Common Mode Conducted Emissions, Power and Signal Cables	Remove applicability
8.6	Conducted Emissions, Antenna Terminal	Enhance requirement
8.7	Conducted Emissions, Differential Mode, Time Domain, Load-Induced Voltage Transients	Enhance requirement
8.8	Audio Frequency Conducted Susceptibility, Power Leads	Enhance requirement, remove some subsections
8.9	Conducted Susceptibility, Antenna Port, Intermodulation	Enhance requirement
8.10	Conducted Susceptibility, Antenna Port Rejection of Undesired Signals	Enhance requirement
8.11	Conducted Susceptibility, Antenna Port, Cross Modulation	Enhance requirement
8.12	Conducted Susceptibility, Bulk Cable Injection, Swept Frequency	Enhance requirement
8.13	Conducted Susceptibility, Bulk Cable Injection, Impulse Excitation	Enhance requirement
8.14	Conducted Susceptibility, Damped Sinusoidal Transients, Cables and Power Lead	Enhance requirement
8.15	Conducted Susceptibility, Ground Plane Injection, Spike	Remove applicability
8.16	Conducted Susceptibility, Ground Plane Injection, Audio Frequency	Remove applicability
8.17	Conducted Susceptibility, Ground Plane Injection, Radio Frequency	Remove applicability
8.18	Susceptibility to Switching Transients, Power Leads, Time Domain	Enhance requirement
8.19	Radiated Emissions, Magnetic Field	Remove applicability
8.20	Radiated Emissions, Electric Field	Enhance requirement, remove subsections
8.21	Radiated Emissions, Antenna Spurious and Harmonic Outputs, 10 kHz to 40 GHz	Remove applicability
8.22	Radiated Susceptibility, Magnetic Field	Remove applicability
8.23	Radiated Susceptibility, Electric Field	Enhance requirement
8.24	Conducted Susceptibility, Lightning Inducted Transients, Cables and Power leads	Enhance requirement
8.25	Electrostatic Discharge Susceptibility, Personnel Borne	Enhance requirement
8.26	CS106, Conducted Susceptibility, Aperiodic Transient	Add new requirement
Annex A	Requirements Rationale	Remove all “shalls”

3. Applicable Documents

Add the following references to AIAA S-121A-2017, Section 3:

1. MIL-STD-461F, *Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment,* Department of Defense, December 10, 2007.
2. IEC 61000-4-2, *Testing and Measurement Techniques - Electrostatic Discharge Immunity Test*, International Electrotechnical Commission.
3. NSTISSAM TEMPEST/1-92, Compromising Emanations Laboratory Test Requirements Electromagnetics.
4. SMC-T-006, AFSPC Space and Missile System Center Tailoring: Specialty Engineering Supplement to IEEE-15288, May 15, 2015.

Replace ECSS-E-20-01A, May 5, 2003 with the ANSI/AIAA S-142-2016, Standard/Handbook for Multipactor Breakdown Prevention in Spacecraft Components, October 21, 2016.

4. Vocabulary

4.1 Acronyms and Abbreviated Terms

Delete “EMV Electromagnetic vulnerability” as it is not used in the document.

4.2 Terms and Definitions

Add “Electro-Explosive Device (EED)” and the following definition from AIAA S-113-2005:

“First and most sensitive element of an explosive train which has a bridgewire and that transforms electrical energy into explosive output.”

Delete “Electromagnetic Vulnerability (EMV)” and its definition as it is not used in this document.

Replace “Safety Margin” and its definition with “Electromagnetic Interference Safety Margin (EMISM) and the following definition:

“The difference between the unit level susceptibility and the total emissions, including on and off platform sources.”

Add “Meet performance requirements: Susceptibility testing requires the unit to meet performance requirements during the test. To the extent that not all performance can be verified during the susceptibility test, the performance testing may continue after the susceptibility test until the performance is verified.”

Note, in some cases, the performance test is longer than the susceptibility test or a significant portion of the last frequency tested. This is because damage is a lesser requirement (could need ground intervention such as being put into safehold), which is a lesser requirement than functioning (may be out-of-specification), versus performance which is required to meet all specifications.

5. General Requirements

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

5.1 System

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

5.2 Units and Subsystem

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

5.3 Ground Equipment

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

5.4 Limits

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

5.5 EMC Planning

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

Add Section 5.6 as follows:

5.6 Service Life (Lifecycle)

All requirements of this document shall be met for the entire service life (development to retirement) of the respective unit, subsystem, system or vehicle which will be used in space or directly support space system operations. Service life shall be verified by identifying the life-limiting parts, materials, and processes and including additional margin from the results of life testing.

Note: For example, conductive adhesives' shielding effectiveness can be reduced over a life of radiation and thermal cycling. In that case coupon life testing would be done to show what the degradation is. The degradation would be included in the Faraday cage allocation. The radiated emissions would be measured with and without a panel closed to the Faraday cage and be adjusted by the end-of-life degradation from the life test. For example, if there is 10 dB of degradation shown, the Faraday cage allocation would be reduced by 10 dB. At the vehicle level EMC test, the measured external radiated emissions would be increased by 10 dB to show the end-of-life expected radiated emissions.

Another example is pulse derating of components. If a power supply will be turned on an off many times, it will likely need a pulse derating for the filter and transient protection components. The inrush and outrush measurements will have to be below the pulse derating of the parts to meet their mission reliability requirements.

6. Detailed Requirements – System

6.1 EMI Safety Margins (EMISMs)

6.1.1 Purpose

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

6.1.2 Applicability

Insert ", subsystem, and unit" between "system" and "level" in the first sentence of AIAA S-121A-2017, Section 6.1.2.

Note: EMISM requirements also apply at the unit and subsystem level as identified in 6.1.3. Section 6 is for system requirements but an EMISM requirement *is not contained in Sections 7 or 8.*

6.1.3 Basic Requirement

Replace the sentence in 6.1.3 with the following: "All systems, subsystems, and units shall have EMISMs as given in Table 6-1, unless otherwise specified.

Note: The unit EMC requirements in Section 8 contain an initial baseline limit that may be modified to achieve the requirements in Table 1 EMISM for a specific procurement."

Replace Table 1 with the following:

Table 6-1. EMI Safety Margins

Applicability	Test	Analysis[a]
Equipment, subsystems and systems, the degraded performance of which could cause serious injury or loss of life, damage to property, or major loss or delay of mission capability)	6 dB	12 dB
EED interfaces, RF level referenced to DC no-fire level[b]	20 dB	20 dB
EED interfaces, RF level referenced to RF no-fire level[c,d]	12 dB	12 dB
All other equipment, subsystems and systems	0 dB	0 dB

[a]When verification is based only on analysis, the procuring agency will define the acceptable level of EMISM required and approve the analysis method that is used.

[b]MIL-STD-1576, para. 4.4.1a; JSC-28596A, para. 11.0a; AFSPCMAN 91-710 Vol. 3, para. 13.3.1.6; AIAA S-113-2005, paras. 5.3.4.2.4, 5.3.5.3, 5.3.5.4, 5.3.5.5

[c]Thresholds from JSC-28596A or measured values based on Military Standard Methodology shall be used.

[d]Method 4303, MIL-STD-1576, FB-2210 Monograph on Computation of RF Hazards, July 1968, is an acceptable method. Results greater than 0 dBs using this method are acceptable, as described in the monograph.

Note: See the note in 6.1.2 for text change. The categories were replaced by the applicable equipment in the table for clarity.

6.2 Intrasystem EMC

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

6.2.1 Passive Intermodulation (PIM)

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

6.2.2 Multipaction

Not applicable.

6.2.3 Deployment, Staging, and Separation Events

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

6.2.4 Plugs-Out Test

Append "(test like you fly per Annex A.3 or operationally relevant per SMC-T-006)" to the end of the first sentence.

6.2.5 Demonstration of Receiver Safety Margin

Receiver performance shall be verified by test at the integrated space vehicle through an air link in accordance with 6.2.5.1 or 6.2.5.2.

6.2.5.1 RF Front-End Margin Assessment

Replace the entire section with the following:

"The receiver in-band radiated emissions shall be measured directly. An EMI receiver/spectrum analyzer shall be used to measure the in-band radiated emissions connected to the flight antenna, where possible, and using an EMI antenna, where not possible to use the flight antenna. The measured emissions shall be analyzed to show the receiver shall meets its performance with the ratio of the minimum on-orbit/ascent received power to received interference power.

Note: Margin is against degrading performance such as bit-error-rate and not against sensitivity."

6.2.5.2 Base Band Margin Assessment

Replace the entire section with the following:

"The receiver performance margin shall be measured directly by showing it can acquire and remain locked through an air link that has a received power 6 dB below the minimum on-orbit/ascent received power. Receivers shall be receiving through their flight antennas without antenna hats. Transmitters shall be transmitting through their flight antennas without antenna hats."

6.3 External Electromagnetic Environment

Replace reference to "Tables 2 and 3" with "Section 8.23" in paragraph five.

Remove Tables 2 and 3 or make them not applicable.

Note: This change points to the radiated susceptibility requirement in Section 8.23 (RS103) instead of carrying two sets of requirements.

6.3.1 Electrical Ground Support Equipment (EGSE)

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

6.4 Lightning

Replace the entire section with the following:

"Immunity from indirect lightning effects may be evaluated by calculating the transients coupled to equipment pins and comparing to the pin I/O susceptibility, either analytically or via test. This requirement only applies to the pre-launch configuration and not during launch. The individual equipment lightning susceptibility is covered in Section 8.24."

Note: The vehicle lightning retest criteria is developed at the unit level. The MIL-STD-464C lighting requirement was removed because of its severity.

6.5 Electromagnetic Pulse (EMP)

Not applicable.

Note: This requirement has a very limited applicability and will reside in a classified document.

6.6 Subsystem and Equipment Electromagnetic Interference (EMI)

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

6.7 Non-Developmental Items (NDI), Government Furnished Equipment (GFE), and Commercial Items

Replace the entire section with "NDI, GFE and commercial items shall be verified by test to meet the EMC requirements in Section 8. Any qualification by analysis or similarity shall require approval by the procuring agency."

Note: This requirement should reside in Section 8 but at least it points there. Ensuring operational performance is insufficient and has been removed. Meeting EMC requirements is sufficient. Contractors have often analyzed NDI and GFE without customer approval. This language warns the contactors that they need to get approval for analysis or QBS.

6.8 Magnetic Field Environment

Not applicable.

Note: Magnetic field requirements are typically only applied at the unit level except for the magnetic dipole moment listed in the following section. There may be some weather satellites that require system analysis or test for magnetic field compliance. Magnetic fields are generally considered low risk.

6.8.1 Magnetic Dipole Moment

Use AIAA S-121A-2017 verbatim. Future tailoring may want to consider replacing "platform" with "space vehicle" to be consistent with the rest of the document.

6.9 Electrostatic Charge Control

Remove the entire text of this section.

Note: There are four requirements for ESD in this top-level section. They are to prevent 1) personnel from shock hazards, 2) unit damage/performance, 3) fuel ignition and 4) ordnance pre-firing. Some of the four are also contained in the subsection. Fuel and personnel safety belong in a different document.

6.9.1 Triboelectric Charging

Reword the first sentence as "The system, subsystems and units shall meet performance requirements when exposed to ESD due to triboelectric charging, including p-static interference to antenna connected receivers and other subsystems onboard the space vehicle."

Reword the second sentence as “Exterior materials and finishes shall not be damaged or punctured when exposed to ESD due to triboelectric charging”.

Retain the third sentence as presently stated.

Note: These changes make the requirements more readable and add applicability to subsystems and units.

6.9.2 Electrically-Initiated Explosive Devices (EED)

Not applicable.

Note: EED requirements are contained in AIAA S-113A-2016.

6.9.3 Spacecraft Charging

Replace the first sentence with “The system, subsystems and units shall meet performance requirements when exposed to ESD due to spacecraft charging.”

Note: These changes make the requirements more readable and add applicability to subsystems and units.

6.10 Electromagnetic Radiation Hazards (EMRADHAZ)

Not applicable.

Note: EMRADHAZ requirements are contained in MIL-STD-464C.

6.10.1 Hazards of Electromagnetic Radiation to Personnel (HERP)

Not applicable.

Note: HERP requirements are contained in AFSPCMAN 91-710, Volumes 3-4.

6.10.2 Hazards of Electromagnetic Radiation to Fuel (HERF)

Not applicable.

Note: HERF requirements are contained in MIL-STD-464C.

6.10.3 Hazards of Electromagnetic Radiation to Ordnance (HERO)

Not applicable.

Note: HERO requirements are contained in AFSPCMAN 91-710, Volumes 3, 4 and 6.

6.11 Lifecycle, E3 Hardness

Not applicable.

Note: The original wording had no requirement and belongs in the General Requirements section, 5.6.

6.12 Electrical Bonding

Replace the “shall” statements with “are to” statements. Remove the last sentence.

Note: The detailed requirements in this higher-level section are contained in the subsections below. The “shall”s have been replaced by “are”s to avoid DOORS flowing this section as a requirement. The two verification requirements in the removed sentence are already contained in the subsections so they have been removed.

6.12.1 Power Current Return Path

Not applicable.

Note: The requirement itself indicates it belongs in the power quality standard AIAA S-122. See section 6.4.2a of that standard.

6.12.2 Antenna Installations

Replace the section with the following: "RF grounds for antenna installations shall meet a DC resistance of ≤ 2.5 milliohms per interface for metal and ≤ 1 ohm per interface for composites.

Ground strap impedance shall be controlled by maintaining a length-to-width ratio of ≤ 5/1.

Compliance of the grounding requirement shall be verified by test.

Compliance of the ground strap impedance shall be verified by inspection."

Note: Using 2.5 milliohms per interface instead of flowing 10 milliohms and 15 milliohms over multiple interfaces is less complicated and more effective. Composites used on booms and other places cannot meet 2.5 mohms per interface. The 5/1 ratio is a verifiable requirement to minimize bond impedance.

6.12.3 Prevention of Shock and Safety Hazard

Not applicable.

Note: This requirement is contained in AFSPCMAN 91-710, Volume 3.

6.12.4 Control of RF Potentials

Change the title to "RF Grounding" make the section not applicable.

Note: Section 6.12.2 contains composite material grounding requirements.

6.12.5 Bonding for Static Control

Insert "with a resistance ≤ 1E9/A ohms, where A is the material surface area in cm2," between "subsystem" and "in".

Replace the second sentence with "Compliance shall be verified by test."

Note: This change provides a measurable requirement. MIL-B-5087B, 3.3.6 requires 1 ohm.

6.12.6 Bonding in Explosive Atmospheres

Not applicable.

Note: This requirement is contained in AFSPCMAN 91-710, Volume 3.

6.12.7 External Grounds

Not applicable.

Note: This requirement belongs in a safety document.

6.12.8 Servicing and Maintenance Equipment Grounds

Not applicable.

Note: This requirement belongs in a safety document.

6.13 TEMPEST

Not applicable.

Note: This requirement is contained in a mission assurance requirements specification or NSTISSAM TEMPEST/1-92.

6.14 EM Spectrum Compatibility

Not applicable.

Note: This requirement belongs to the frequency spectrum management group.

6.15 System Circuit and Structure Reference

Not applicable.

Note: This requirement is not actionable and is partially covered by the grounding requirements in Section 6.12. It is also addressed in AIAA S-122-2007.

6.16 Return Current Control

Not applicable.

Note: This requirement is covered by the grounding requirements in Section 6.12.

6.17 Wiring

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

Note: It is recommended to enhance this section with a requirement to separate wires by signal category or use shielding via SMC S-020.

6.18 Material Properties

Not applicable.

Note: There are no "shalls" in this section and the surface and bulk resistivity requirements are covered in 6.12 and NASA-HDBK4002A.

6.19 Data Formats

Not applicable.

Note: There are no "shalls" in this section, making it of questionable value. We are also trying to reduce the scope of this specification.

6.20 Tailoring Guidance for Contractual Application

Not applicable.

Note: There are no "shalls" in this section, making it of questionable value. We are also trying to reduce the scope of this specification.

7. General Requirements—Units and Subsystems

Delete the second sentence and Table 5.

Note: Table 5 is redundant of Sections 7.1 to 7.18. In addition, Table 5 can always be referenced in the original S-121A.

7.1 Filtering (Navy Only)

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

Note: This requirement is not applicable in Section 7.1, i.e., MIL-STD-461G, Section 4.2.2 is not applicable.

7.2 Non-Developmental Items (NDI)

Replace with "See Section 6.7."

Note: This requirement is redundant of Section 6.7.

7.3 Selected by Contractor

Not applicable.

Note: Failures are dispositioned through the failure review board.

7.4 Procurement of Equipment or Subsystems Having Met Other EMI Requirements

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

Note: This requirement is not applicable in Section 7.4, i.e., MIL-STD-461G, Section 4.2.4.2 is not applicable.

7.5 Government Furnished Equipment (GFE)

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

Note: This requirement is not applicable in Section 7.5, i.e., MIL-STD-461G, Section 4.2.5 is not applicable.

7.6 Switching Transients

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

Note: This requirement may also belong in Section 8 but since it is a requirement on the actual transient and not the unit, it rightfully belongs here. In most application, there are no manually actuated switching functions and can be tailored out. Manned space systems is the exception.

7.7 Measurement Tolerances

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

7.8 Ambient Electromagnetic Level

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

7.9 Power Source Impedance

Replace the entire section with the following: "MIL-STD-461G, Section 4.3.6 shall apply with either a 10 uF feedthrough capacitor per previous versions of MIL-STD-461 or the LISN specified in Figure 3

with impedance shown in Figure 4. It is preferable to replace the LISN with one that more closely matches the power bus source impedance with the procuring agency approval."

Note: The 5 uH-LISN's impedance in Figure 4 is a better match to the space power bus source impedance than the 50 uH-LISN in MIL-STD-461G, Figure 7 as it is lower below 5 MHz as shown in Figure 7-1.

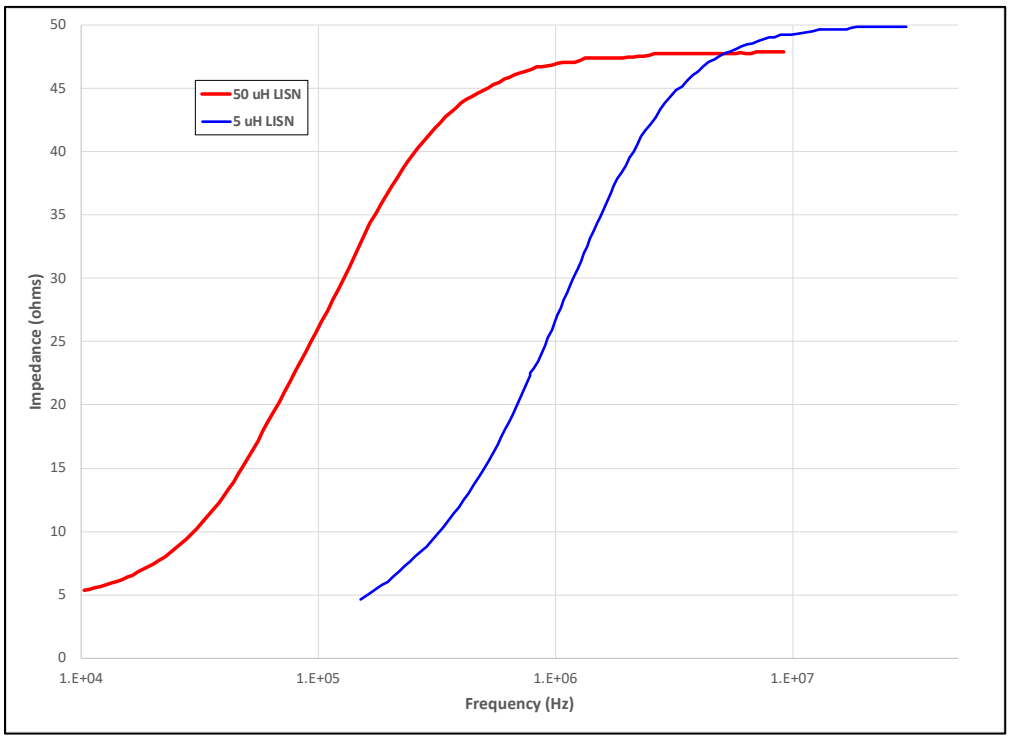


Figure 7-1. LISN impedance curves.

7.10 Input Power Leads

Remove the second sentence.

Note: Many engineers are in favor of following MIL-STD-461G for test cable lengths of 2–2.5 meter (m). 1 m of power cable may not be flight-like in length for some applications. MIL-STD-461G's 2–2.5 m more closely matches most space vehicle applications. In conducted testing, it was standard to use 1 m of power cable. In radiated testing, it was standard to use 2–2.5 m of power cable. This 1 m for both conducted and radiated appears to be a way to conserve time required to switch the cable when transitioning between conducted and radiated testing. If an engineer wants to conserve schedule and cost, they can make a case to the procuring authority for a 1 m harness for both CE and RE.

7.11 Susceptibility Monitoring

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

7.11.1 Thresholds of Susceptibility

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

7.11.2 Additional Reporting

Not applicable.

Note: The additional reporting requirement is not necessary to protect sensitive hardware.

7.12 Detector

Remove the last sentence.

7.13 Test Procedure **Computer-Controlled Receivers**

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

7.13.1 Bandwidths

Append the following note to this section:

Note: Exercise caution when using FFT measurement techniques to verify accuracy. The procuring authority will require the verification of Note 2, Table II for FFT measurement test methods.

7.13.2 Measurements

Insert “and there is an exceedance” after “platform receiver” in the first sentence.

Note: The committee recognizes this section is worded poorly as it seems to require 2x RE102 testing in every notch. The intent was to only rerun RE102 in receiver notches when there is a failure, and then with the appropriate resolution bandwidth.

7.14 Emission Identification

Remove the last sentence.

Note: The last sentence concerning narrowband and broadband identification not being applicable is already contained in MIL-STD-461G.

7.15 Frequency Scanning

Append the following note to this section.

Note: See the note in section 7.13.1.

7.16 Emission Data Presentation

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

7.17 Susceptibility Scanning

Replace “shall be modified to 3 seconds or the EUT response time, whichever is greater.” with “shall apply.”

Note: MIL-STD-461G, Section 4.3.10.4.1 already specifies the dwell time to be 3 seconds or the EUT response time, whichever is greater.

7.18 Calibration of Measuring Equipment

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

Note: ISO/IEC 17025:2017 has been released as an update to ISO/IEC 17025:2005.

Add the following new sections 7.19 and 7.20:

7.19 Operating Modes

During emissions/susceptibility testing, the unit shall be placed in an operating mode which produces the maximum emissions/susceptibility. If a worst-case mode cannot be determined, all modes shall be tested.

Note: This requirement was moved from Section 8.1 because it is considered a general unit requirement.

7.20 Operating Voltages

During emissions/susceptibility testing, the unit shall be placed at a voltage which produces the maximum emissions/susceptibility. If a worst-case voltage cannot be determined, the unit shall be tested at the minimum, nominal, and maximum voltages.

8. Detailed Requirements-Units and Subsystems

Replace this entire section with the following:

"The requirement applicability is defined in each individual requirement's section. By default, all requirements apply to launch vehicles and satellites. The requirements may be applied to ground equipment if specified in the procurement documentation.

The unit EMC requirements in this section contain an initial baseline limit which may be too severe and/or not severe enough and may be modified to achieve the EMISM requirements in Section 6.1.3."

Note: The original text in this section contained no "shalls" and were not value added. The intent of Section 8.3 has been moved here because it is a more appropriate location.

8.1 Operating Modes

Remove this section and heading.

Note: This section now resides in 7.19 in the general unit requirements section.

8.2 EMI Control Requirements, Intended Installations

There are no changes to this section. Use AIAA S-121A-2017 verbatim.

8.3 Emission and Susceptibility Requirements, Limits, and Test Procedures

Not applicable.

Note: The intent of this section has been moved to Section 8.0.

8.4 Power Bus Conducted Interference, Load Induced, Frequency Domain

Replace this heading, section and all subsections with the following text:

"**8.4 CE101/CE102A, Conducted Emissions, Frequency Domain**

- Application: Primary and secondary power users.
- Requirement: Conducted emissions shall not exceed the limit in Figure 5.
- Verification: Test methods shall be in accordance with (IAW) MIL-STD-461G, CE101."
- Note: the "A" in CE102A indicates the limit is in amperes instead of volts."

Replace Figures 5 and 6 with Figure 8-1 below.

Note: The requirement has been replaced with one that bounds most contractors but contains less margin. The limit also extends out to cover frequencies between 150 kHz and 50 MHz for completeness. In addition, the variable conducted emissions (CE) requirement based on unit load current creates 50-100 different CE limits and is complex to flow and track.

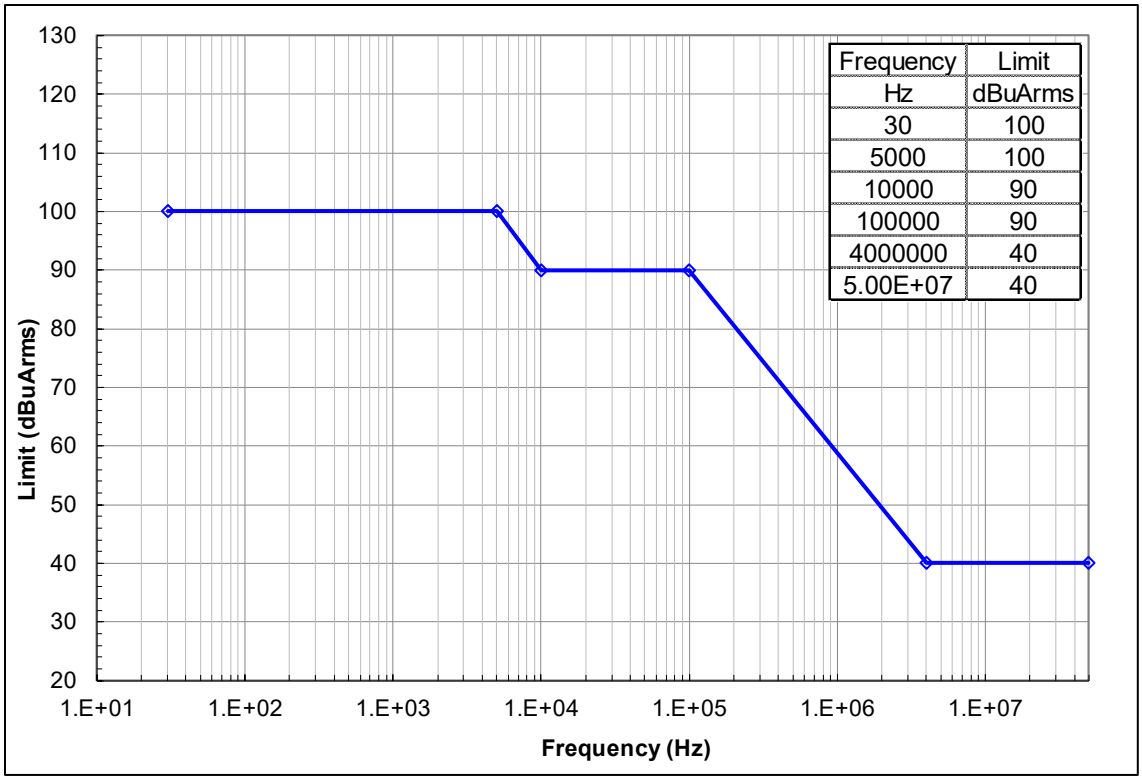


Figure 8-1. CE101/102A limit.

8.5 RF Common Mode Conducted Emissions, Power and Signal Cables

Not applicable.

Note: This requirement is considered lower risk.

8.6 Conducted Emissions, Antenna Terminal (CE106)

Replace the entire section and heading with the following:

"**8.6 CE106, Conducted Emissions, Antenna Terminal**

- Application: Amplifiers, receivers, transmitters with antenna ports.
- Requirement: Conducted emissions on antenna ports shall not exceed Table 8-1 and Table 8-2, where the notches in Table 8-2 shall be tailored to match the on and off platform receiver notches similar to the radiated emissions requirement in Section 8.20.
- Verification: Test method shall be IAW MIL-STD-461G, CE106."

Table 8-1. CE106 Limit

Unit Type	Mode	Harmonics	Limit	Limit
			dBuV	dBm
Receiver	All	Spurious	34	-73
Transmitter	Standby	Spurious	34	-73
Amplifier	Standby	Spurious	34	-73
Transmitter	Transmit	2nd, 3rd	>of 87 or V_{fo}-80dB	>of -20dBm or P_{fo}-80dB
Amplifier	Transmit	2nd, 3rd	>of 87 or V_{fo}-80dB	>of -20dBm or P_{fo}-80dB
Transmitter	Transmit	>3rd	V_{fo}-80dB	P_{fo}-80dB
Amplifier	Transmit	>3rd	V_{fo}-80dB	P_{fo}-80dB

Table 8-2. CE106 Notches to Match RE102

Frequency	Limit	Frequency	Limit
MHz	dBuV	MHz	dBuV
10-1780	22	17000-18500	29
1780-2310	12	18500-24500	62
2310-5750	39	24500-25300	29
5750-8400	12	25300-27000	57
8400-12750	44	27000-27500	44
12750-14600	22	27500-31000	29
14600-17000	52		

Note: This rewrite enhances the requirement clarity and includes potential receiver notches, which are to be tailored for the exact receivers, similar to RE102.

8.7 Conducted Emissions, Differential Mode, Time Domain, Load-Induced Voltage Transients

Replace the entire section and heading with the following (this section moves above CE106):

"8.7 CE07, Conducted Emissions, Differential Mode, Time Domain Transients

- "Application: Primary and secondary power users.
- Requirement: Conducted transients with a duration less than 50 uS shall not exceed the range of -6.25V to +12.5 V, having respective impulse strengths greater than 31.25 uV-S and +62.5 uV-S.
- Verification: Test method shall be IAW MIL-STD-461G, CE102, but with the measurement receiver displaying in the time domain with a minimum bandwidth of 400 MHz."

Note: There was no definitive time domain CE requirement in MIL-STD-461G and therefore, the CE07 requirement was brought back.

8.8 Audio Frequency Conducted Susceptibility, Power Leads

Add the following text replace the 8.8.1 and 8.8.2 and heading with the following:

"8.8 CS101/02, Conducted Susceptibility, Frequency Domain

- Application: Primary and secondary power users.

- Requirement: Units shall meet performance requirements during exposure to the differential mode conducted susceptibility (CS) level on power leads in Figure 8-2. The requirement is also met if the CS level cannot be established without exceeding the unit safe current limit.
- Verification: Test method shall be IAW 8.8.3-8.8.5 for CS101 and 8.8.6 for CS02.
- Tailoring: The limit shall be tailored to include special vehicle modes like TDMA where applicable."
- Note: During setup operations, if the EUT is powered on while the injection equipment is off, and the coupling transformer secondary is in the power line to the EUT, the EUT may be damaged by a resonance interaction between the EUT power converter and the coupling transformer secondary inductance. One way to mitigate this is to shunt the primary or secondary coil with a resistance. Values which have been used include 2 to 50 ohms in the primary, or one quarter of this in the secondary. Analyses of stability and allowable power consumption/voltage drop (before setting up the test) can determine the optimum value and help avoid damaging valuable hardware. NASA JPL has developed an alternative test setup without transformers, but circuitry to modulate the line voltage directly on the power line. For them, this has proven to be a more-satisfactory solution than damped transformer coils. In addition, test risk may be further controlled by monitoring injection current with a broadband current monitor."

Add the following Figure 8-2.

Note: This requirement has been replaced with one that bounds most contractors but contains less margin than most standards. The limit also extends out to cover frequencies between 150 kHz and 50 MHz for completeness.

8.8.1 Applicability
Not applicable.

Note: The applicability is contained in Section 8.8.

8.8.2 Limit
Not applicable

Note: The requirement limit is contained in Section 8.8.

8.8.3 Test Procedure
There are no changes to this section and its subsections. Use AIAA S-121A-2017 verbatim.

8.8.4 Audio Frequency Conducted Susceptibility, Power Leads – Alternate Test Procedure 1
There are no changes to this section. Use AIAA S-121A-2017 verbatim.

8.8.5 Audio Frequency Conducted Susceptibility, Power Leads – Alternate Test Procedure 2
There are no changes to this section. Use AIAA S-121A-2017 verbatim.

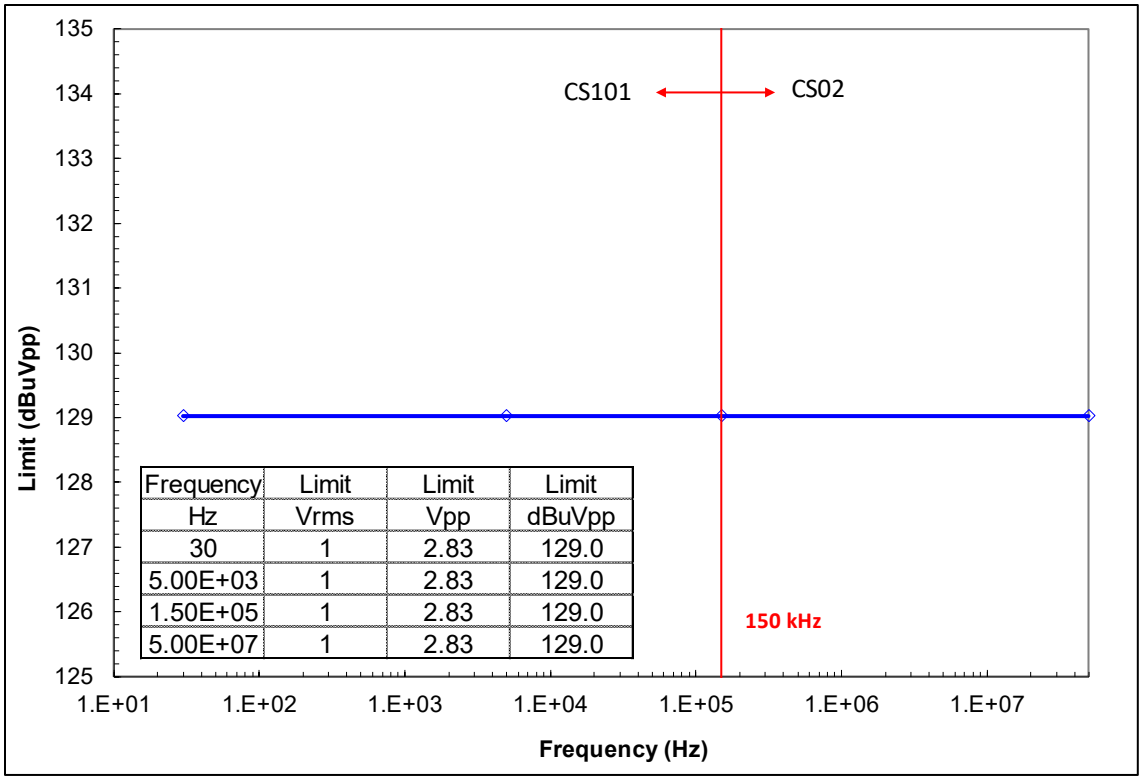


Figure 8-2. CS101/02 limit.

Add the following Section 8.8.6 and its subsections:

"8.8.6 CS02 Test Procedure

8.8.6.1 CS02 Test Equipment
The CS02 test equipment or equivalent is as follows:

Test Equipment
Signal generator
EMI Meter
Current probe amplifier
LISN, 5 uH
Power amplifier

8.8.6.2 CS02 Test Procedure
(1) Use the CS02 test setup as shown in Figure 8-New.
(2) The LISN is installed backwards with respect to how it is installed for conducted emissions. The LISN internal blocking capacitor serves as the coupling capacitor.
(3) The 1 meter line length is preferred as 2 meters is too long at higher frequencies. The LISN injector location should not be more than $1/10^{th}$ of a wavelength from the EUT.
(4) Increase the applied voltage until the EMI meter reads the associated CS02 voltage amplitude or the maximum allowable safety current, whichever comes first. If the unit safety current is unavailable, use the current developed by 1 W across a 50 ohm load. Verify the output waveform is sinusoidal and record the frequency, amplitude and current or power level.

(5) If the test sample is susceptible to the applicable limit level, reduce the signal level to determine and record the threshold of susceptibility."

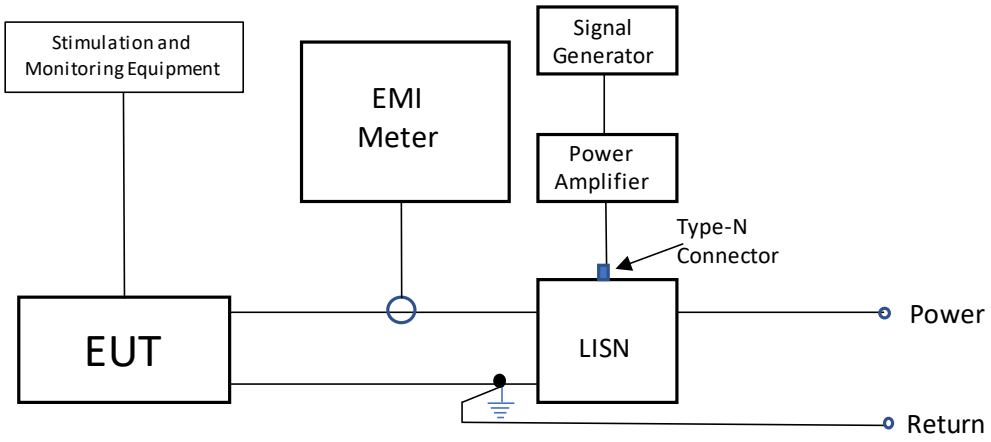


Figure 8-NEW. CS02 test setup.

8.9 Conducted Susceptibility, Antenna Port, Intermodulation

Replace the entire section and heading with the following:

"8.9 CS103, Conducted Susceptibility, Antenna Port, Intermodulation

- Application: Receivers.
- Requirement: Units shall meet performance requirements when intermodulation products from transmitters fall in the unit passband according to $f_o = mf_1 +/- nf_2$, where f_o is the unit passband, m and n are integers, and f_1 and f_2 are transmitter signals with levels specified in Table 8-3.
- Verification: Test method shall be IAW MIL-STD-461G, CS103."

Table 8-3. CS103 Limit

Transmitter	Transmitter Frequency Range	Transmitter Power	Transmitter Power	Max Transmitter Power
	(MHz)	(dBm)	(dBc)	(dBm)
f_1	2-25, 200-400	pf_o+80	80	10
f_1	0.015-2, 25-200, 400-40000	pf_o+66	66	10
f_2	0.015-40000	pf_o+66	66	10
pf_o = receiver standard reference or carrier level				

Note: The table was derived from MIL-STD-461G, A.5.8. The addition of the CS103 limit was done to give the user a starting point. It is very likely that the limit will have to be tailored to the particular system.

8.10 Conducted Susceptibility, Antenna Port Rejection of Undesired Signals

Replace the entire section and heading with the following:
"8.10 CS104, Conducted Susceptibility, Antenna Port Rejection of Undesired Signals

- Application: Receivers and low noise amplifiers.

- Requirement: Receivers and amplifiers shall meet performance requirements when subjected to the requirement provided in the individual procurement specification or in Table 8-4 over the range of 30 Hz to 40 GHz.
- Verification: Test method shall be IAW MIL-STD-461G, CS104."

Note: The CS104 limit in Table 8-4 is an example and placeholder until the actual limit can be derived for the specific payload.

Table 8-4. CS104 Limit

Receiver/Amplifier Frequency Range (MHz)	Injection Power, Receiver (dBm)	Injection Power, Receiver (dBc/dBm)	Injection Power, Amplifier (dBm)
30 Hz -f_1, f_2-40000	0	0 dBm	0
f_1-(f_o-W/2), (f_o+W/2)-f_2	pf_o+80	80 dBc	0
(f_o-W/2) – (f_o+W/2)	N/A	N/A	N/A
pf_o = receiver standard reference or carrier level f_1 = lowest tunable frequency of receiver band f_2 = highest tunable frequency of receiver band W = bandwidth between the 80 dB points of the receiver selectivity curve as defined in the receiver's product specification			

8.11 Conducted Susceptibility, Antenna Port, Cross Modulation

Replace the entire section and heading with the following:

"8.11 CS105, Conducted Susceptibility, Antenna Port, Cross Modulation

- Application: Amplitude Modulated (AM) Receivers.
- Requirement: Units shall preclude undesired response, due to cross-modulation beyond tolerances when subjected to the requirement provided in the individual procurement specification or -66 dBc with a maximum level of 10 dBm over the range of 30 Hz to 40 GHz.
- Verification: Test method shall be IAW MIL-STD-461G, CS105.
- Tailoring: The CS105 requirement can be removed for receivers that are not AM."

Note: This requirement is now easily removed for everything but AM receivers.

8.12 Conducted Susceptibility, Bulk Cable Injection, Swept Frequency

Replace the entire section and heading with the following:

"8.12 CS114, Conducted Susceptibility, Bulk Cable Injection, Swept Frequency

- Application: Units with greater than 15 m-linear wire runs or platforms that contain transmitters that operate below 400 MHz.
- Requirement: Units shall meet performance requirements during exposure to the CS level in Figure 8-3.
- Verification: Test method shall be IAW MIL-STD-461G, CS114."

Note: This requirement generally is more applicable to ships or airplanes with very long linear wire runs or platforms with lower frequency transmitters.

8.13 Conducted Susceptibility, Bulk Cable Injection, Impulse Excitation

Replace the entire section and heading with the following:

"8.13 CS115, Conducted Susceptibility, Bulk Cable Injection, Impulse Excitation

- "Application: Units with cables.
- Requirement: Units shall meet performance requirements during exposure to the CS level in Figure 8-4.
- Verification: Test method shall be IAW MIL-STD-461G, CS115."

Note: It is more efficient to bring the requirement from MIL-STD-461G into this standard as opposed to having to tailor both documents. The risk level of CS115 is low making it a consideration for removal.

8.14 Conducted Susceptibility, Damped Sinusoidal Transients, Cables and Power Leads

Replace the entire section and heading with the following:

"8.14 CS116, Conducted Susceptibility, Damped Sinusoidal Transients, Cables and Power Leads

- Application: Units with cables.
- Requirement: Units shall meet performance requirements during exposure to the CS level in Figure 8-5.
- Verification: Test method shall be IAW MIL-STD-461G, CS116."

Note: It is more efficient to bring the requirement from MIL-STD-461G into this standard as opposed to having to tailor both documents.

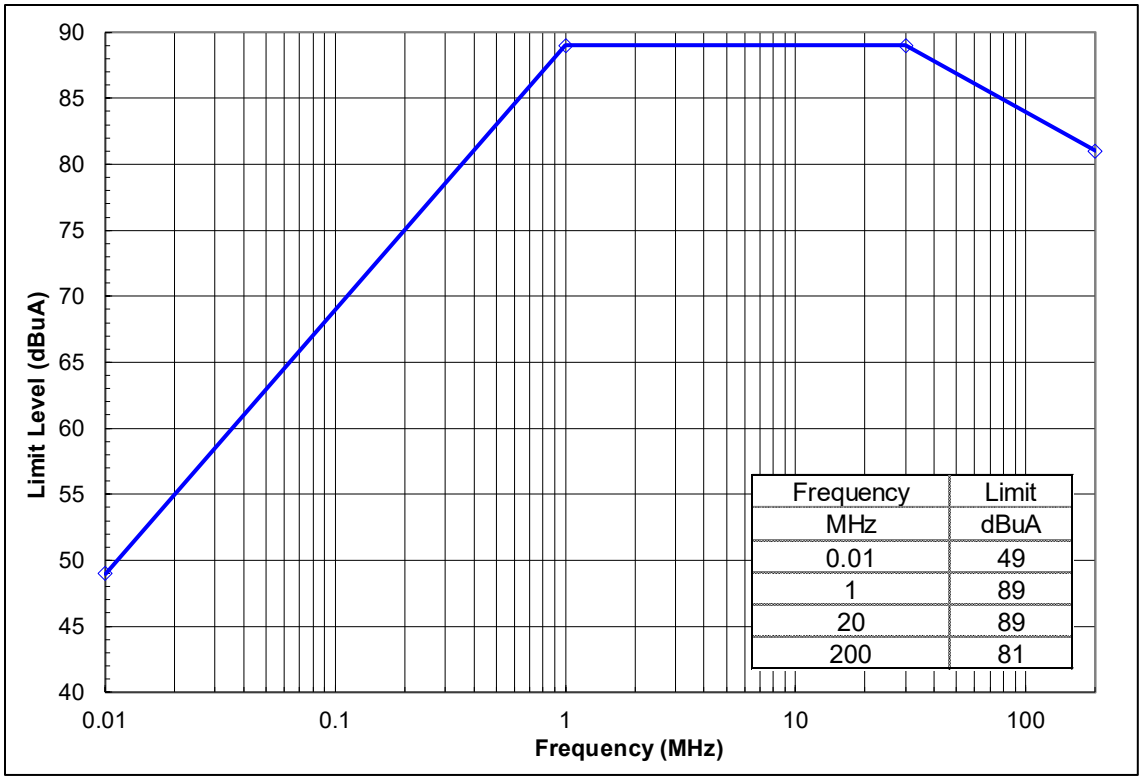


Figure 8-3. CS114 limit.

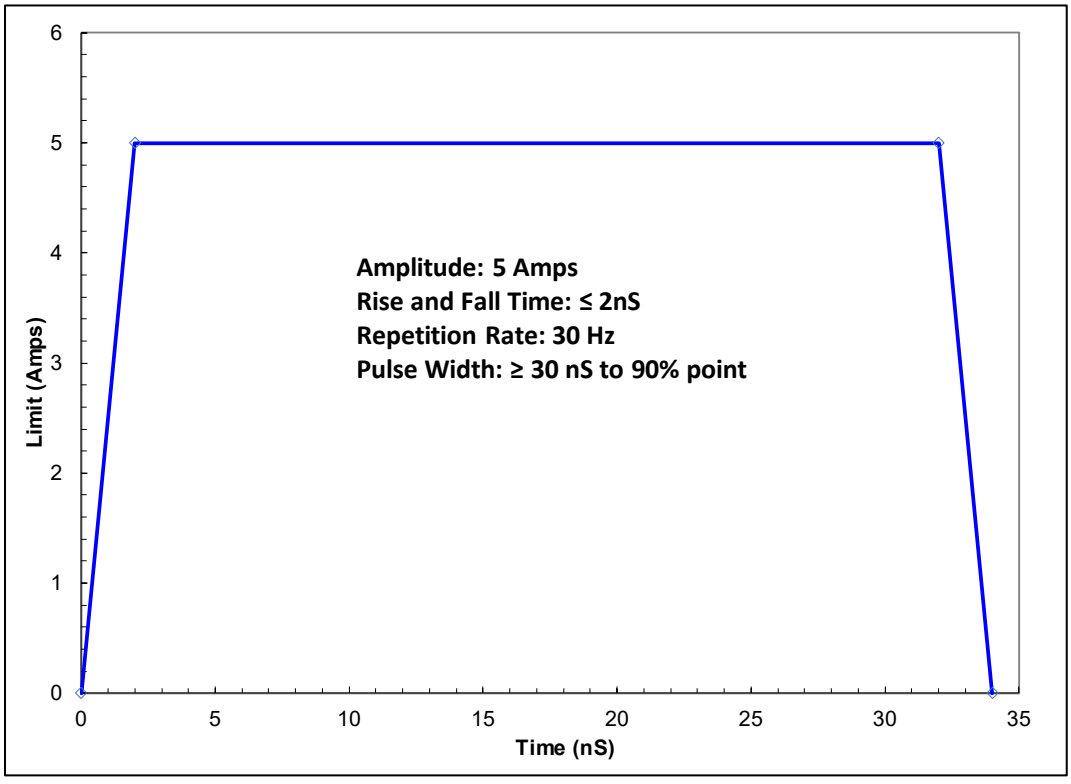


Figure 8-4. CS115 limit.

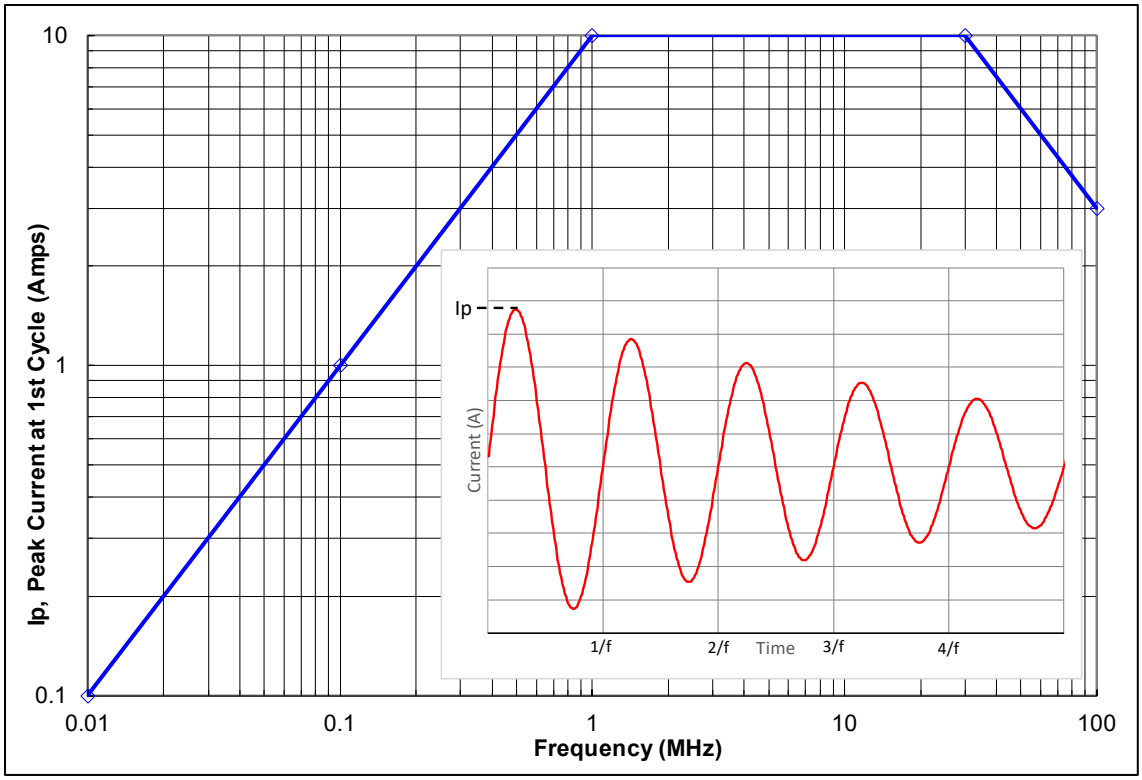


Figure 8-5. CS116 limit.

8.15 Conducted Susceptibility, Ground Plane Injection, Spike

Not applicable for the entire section and subsections.

Note: This requirement is being removed because it is low risk.

8.16 Conducted Susceptibility, Ground Plane Injection, Audio Frequency

Not applicable for this section and all subsections.

Note: This requirement is being removed because it is low risk.

8.17 Conducted Susceptibility, Ground Plane Injection, Radio Frequency

Not applicable for this section and all subsections.

Note: This requirement is being removed because it is low risk.

8.18 Susceptibility to Switching Transients, Power Leads, Time Domain

Replace the entire section and heading with the following:

"8.18 Conducted Susceptibility, Aperiodic Switch Transients

- Application: Primary and secondary power users.
- Requirement Operate: The unit shall meet performance requirements when subjected the transients specified in Table 8-5.

- Requirement Survive: The unit shall remain undamaged when subjected to the transients specified in Table 8-6.
- Verification: Test method shall be IAW methods and procedures approved by the procuring authority."

- Note for Requirement Operate: In case of conflicting requirement parameters (e.g., the surge, in meeting its 20% requirement, would need to start below the unit minimum operational voltage or exceed the unit maximum operational voltage by more than 5% of the unit mean operational voltage), the surge starting voltage shall be the unit minimum operational voltage, and the surge height (the 20% value) must be reduced such that its upper voltage shall exceed the unit maximum operational voltage by 5% of the unit mean operational voltage.

Note: This requirement should reside in a power standard like AIAA S-122A and is typically verified in the unit area instead of the EMC laboratory.

Table 8-5. Operational Aperiodic Transient Limits

Characteristic	Positive Transient	Negative Transient
Initial Voltage	Within the unit's steady-state operational voltage range	Within the unit's steady-state operational voltage range
Step Change	+20% of the unit's mean operational voltage	-20% of the unit's mean operational voltage
Rise/Fall Time	5 uS	5 uS
Duration	40 mS	40 mS
Fall/Rise Time	0.5 mS	0.5 mS
	Exceeds the unit's maximum operational voltage by 5% of the mean operational voltage	Goes below the unit's minimum operational voltage by 5% of the mean operational voltage

Table 8-6. Survival Aperiodic Transient Limits

Characteristic	Positive Transient	Negative Transient
Initial Voltage	Unit's maximum steady-state operational voltage	Unit's maximum steady-state operational voltage
Step Change	2x the unit's maximum steady-state operational voltage	0 V
Rise/Fall	5 uS+/-10%	5 V/uS+/-10%
Duration	10 mS+/-10%	200 mS+/-10%
Fall/Rise	100 mV/uS+/-10%	100 mV/uS+/-10%

8.19 Radiated Emissions, Magnetic Field (RE101)

Not applicable for the entire section.

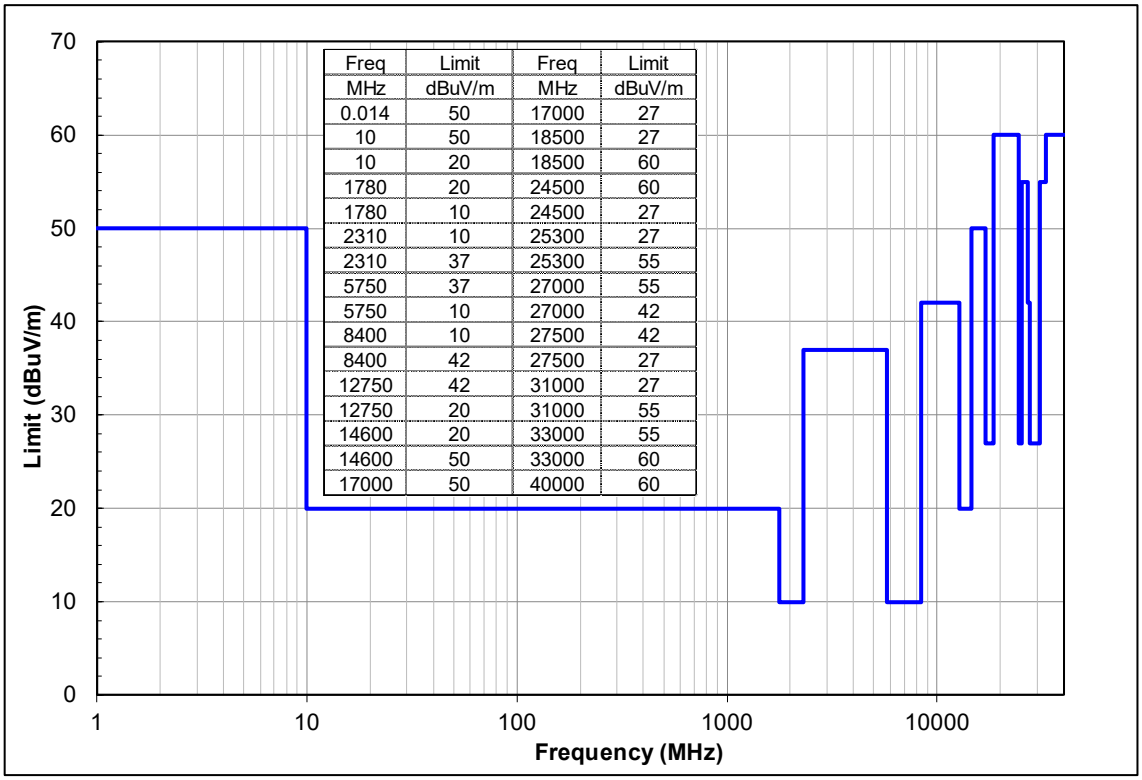
Note: This requirement is being removed because it is low risk.

8.20 Radiated Emissions, Electric Field (RE102)

Replace the heading and entire section and subsections with the following:

"**8.20 RE102, Radiated Emissions, Electric Field**

- Application: Primary and secondary power users.
- Requirement: Electric field radiated emissions shall not exceed Figure 8-6. Units in the intentional RF transmit path may relax Figure 8-6 to 20 dB below the RS103 limit listed in Section 8.23 in the operational transmit band.
- Verification: Test method shall be IAW MIL-STD-461G, RE102 with resolution bandwidths tailored from MIL-STD-461G, Table II as necessary to represent potential narrower channels."



Freq MHz	Limit dBuV/m	Freq MHz	Limit dBuV/m
0.014	50	17000	27
10	50	18500	27
10	20	18500	60
1780	20	24500	60
1780	10	24500	27
2310	10	25300	27
2310	37	25300	55
5750	37	27000	55
5750	10	27000	42
8400	10	27500	42
8400	42	27500	27
12750	42	31000	27
12750	20	31000	55
14600	20	33000	55
14600	50	33000	60
17000	50	40000	60

Figure 8-6. RE102 limit.

Note: This requirement has been replaced with one that bounds most contractors but contains less margin than most standards. This new limit also contains launch vehicle notches. The original requirement contained no "shalls."

8.21 Radiated Emissions, Antenna Spurious and Harmonic Outputs, 10 kHz to 40 GHz (RE103)

Not applicable for this section and all subsections.

Note: This requirement is being removed because it is also covered by CE106.

8.22 Radiated Susceptibility, Magnetic Field (RS101)

Not applicable for this section and all subsections.

Note: This requirement is being removed because considered low risk.

8.23 Radiated Susceptibility, Electric Field (RS103)

Replace the heading entire section and subsections with the following:

"8.23 RS103, Radiated Susceptibility, Electric Field

- Application: Primary and secondary power users.
- Requirement: Units shall meet performance requirements/survive during exposure to the electric field limits in Figure 8-7/Figure 8-8. Units in the intentional RF receive path may relax Figure 8-7 and Figure 8-8 to 20 dB above the RE102 limit listed in Section 8.20 in the operational receive band.
- Verification: Test method shall be IAW MIL-STD-461G, RS103.
- Tailoring: The large GEO on-orbit RS103 chimneys in Figure 8-7 are typically driven by on-platform transmitters and are intended to cover most applications with example UHF, L, S, C, X, Ku and K-band transmitters. The chimneys may be relaxed or removed based on the actual on-platform transmitter's characteristics if approved by the procuring authority."

Note: The ground operations requirement has been enhanced with Eastern and Western range worst case emitter levels. The on-orbit requirement has been tailored to include two different on-orbit operational levels and example S, C, X, Ku, and K-band space vehicle transmitter chimneys. The transmitter chimneys must be tailored for the specific payload.

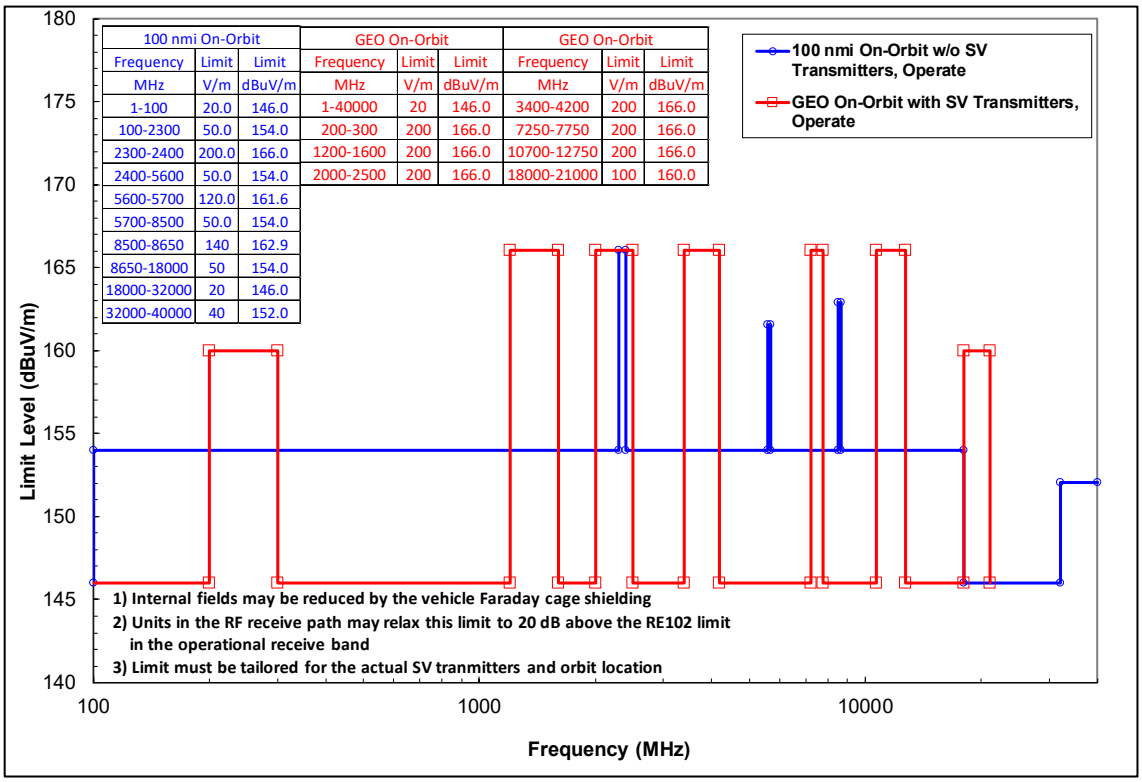


Figure 8-7. RS103 operate limit external to the vehicle, on-orbit.

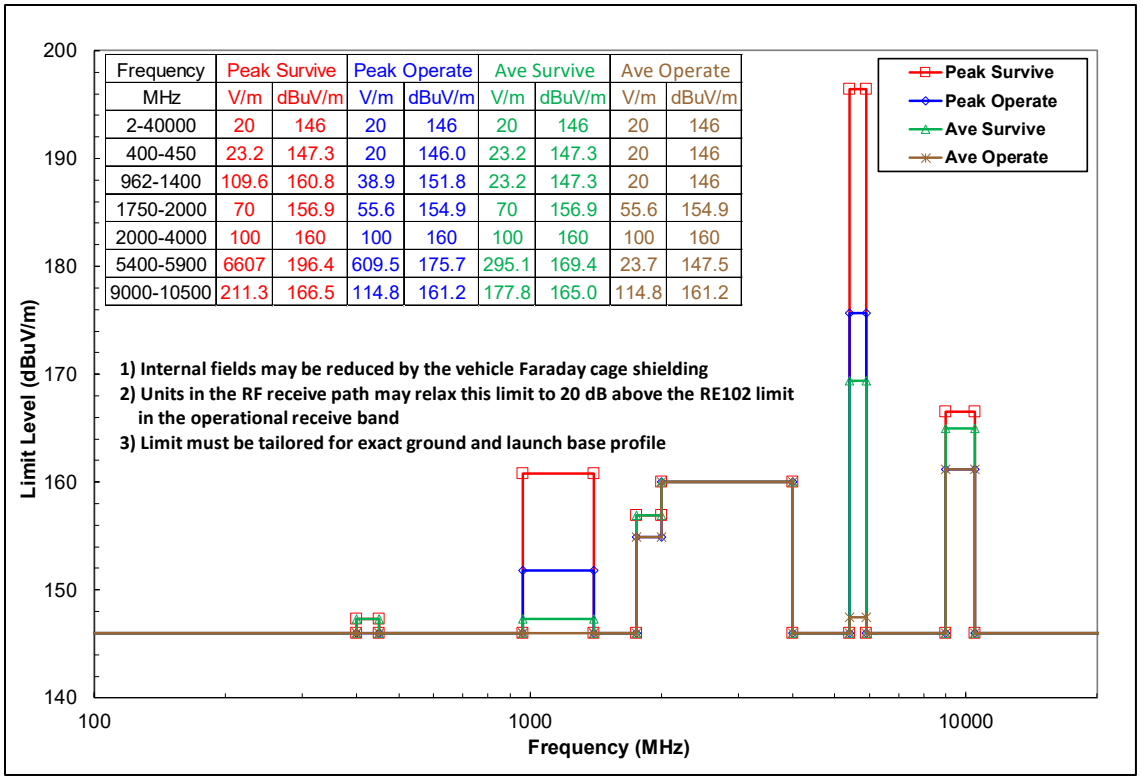


Figure 8-8. RS103 limit external to the vehicle, ground operations and launch.

8.24 Conducted Susceptibility, Lightning Induced Transients, Cables and Power leads

Replace the entire section and heading with the following:

"**8.24 CS117, Conducted Susceptibility, Lightning Induced Transients**

- Application: All active interfaces.
- Requirement: Units lightning retest levels shall be developed based on the following criteria:
  1) Unit pin susceptibility at lightning frequencies
  2) Harness and umbilical length, loop area, shielding, and termination
  3) Vehicle, building, and/or fairing Faraday cage shielding effectiveness at lightning frequencies
  4) Receiver susceptibility through stowed or deployed antenna at lightning frequencies
  5) Calculated Efield and dB/dt at the vehicle based on accepted lightning stroke models
- Verification: Verification shall be by analysis, test, or a combination thereof. The unit susceptibility can be established via test using MIL-STD-461G, CS117 levels, CS115/CS116 levels, ESD levels, or via analysis using a detailed Spice model of each unit I/O."

- Note 1: The lightning retest level is typically specified as lightning column current versus distance between the strike and the unit. Where localized field and current probes are available, the retest levels are specified in kV/m, Tesla/sec and Amps.
- Note 2: All weather launch vehicles require indirect and direct lightning protection as specified by the procuring authority."

Note: This update helps the contractor develop a complete set of unit retest levels. The unit susceptibility can be established via test using MIL-STD-461G, CS117 levels, CS115/CS116 levels, ESD levels, or via analysis using a detailed Spice model of each unit I/O.

8.25 Electrostatic Discharge Susceptibility, Personnel Borne

Replace this section and heading with the following:

"8.25 CS118, Electrostatic Discharge Susceptibility

- Application: All active interfaces.
- Requirement: Units shall meet performance requirements after exposure to the ESD generated CE and RE from materials. This general requirement shall be met by applying the design and test requirements in Table 8-7. The air discharge is only required where the contact discharge cannot be applied.
- Verification: Unit test method shall be IAW with MIL-STD-461G, CS118.
- Verification: Material verification shall be by test of the material under space conditions (vacuum baked-off, vacuum temperature) or by inspection of the material vendor specification sheets demonstrating test results under space conditions."

Table 8-7. ESD Requirements

Item	Parameter
Uncoated material resistivity	≤1E9 ohm-cm or ≤1E9 ohm/square
Partially conductive coating resistivity on a conductor	≤1E11 ohm-cm
Partially conductive coating resistivity on a dielectric	≤1E9 ohm/square
Two partially conductive coatings on a dielectric	Outer: ≤1E12ohm-cm, thickness ≤5 mils; Inner: ≤5E7 ohm/square
Dielectric surface area exposed to plasma	≤ 6.4516 cm^2 (1 in^2)
Plasma exposed material grounding	1E9/A ohms, where A is the exposed area in cm^2
Dielectric surface area inside unit	Orbit dependent flux allocation (GEO>MEO>LEO)
Floating metal inside unit	≤ 0.01 cm^2; 0.01-0.2 cm^2 if > 100 mils from ESDS parts
Unit air discharge	IEC 61000-4-2 Level 4 air discharge at 30 cm from each unit surface & cable @1pps for 30 sec
Unit contact discharge	IEC 61000-4-2 Level 4 at each unit corner @1pps for 30 sec
Unit mounting discharge	IEC 61000-4-2 Level 4 at unit mounting surface @1pps for 30 sec

Note: ESD requirements for units and materials have been added to this section because on-orbit ESD anomalies are prolific and high risk.

Insert new section as follows:

"**8.26 CS106, Conducted Susceptibility, Short Duration, High Level, Aperiodic Transient**

- Application: Primary and secondary power users.
- Requirement: Units shall meet performance requirements during exposure to CS levels in applied in both polarities. The requirement is also met if the CS level cannot be established without exceeding the unit safe current limit.
- Verification: Test method shall be IAW MIL-STD-461F, CS106."

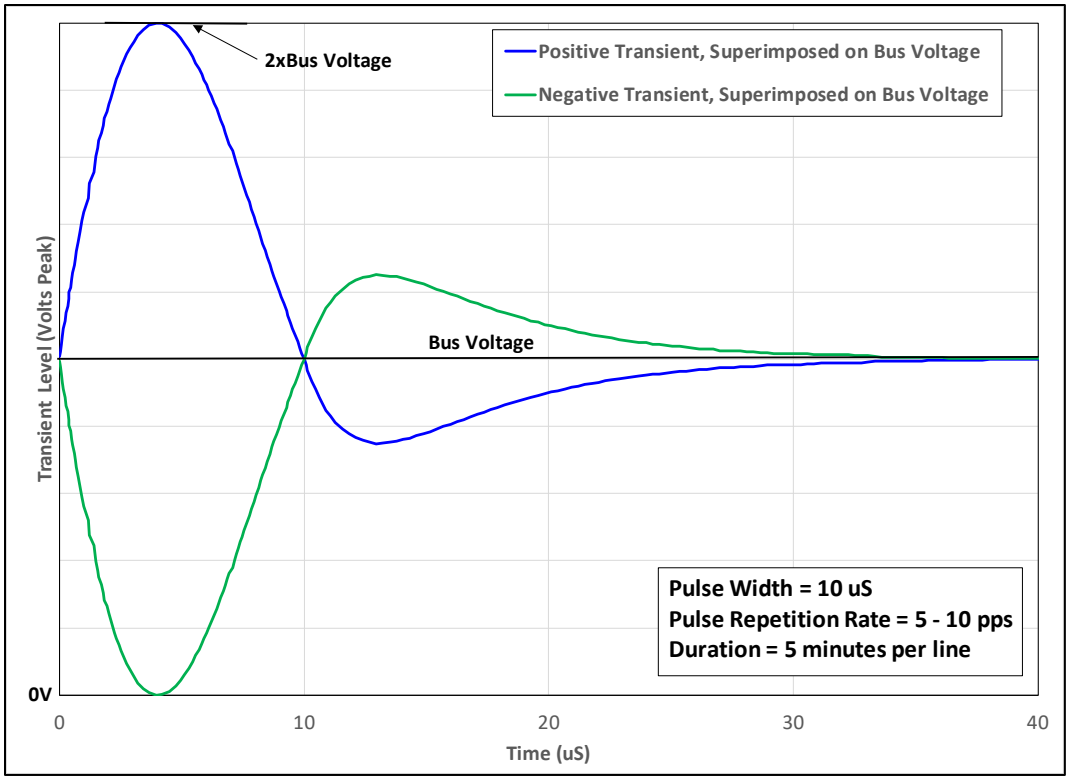


Figure 8-9. CS106 limit.

A.9 Plugs-Out Test
Replace the “shall” in the last sentence for paragraph 1 with “should”.

A.42 Power Source Impedance
Replace the “shall” in the first sentence of paragraph 3 with “should”.

A.49 Emission Identification
Replace the “shall” in the first sentence of paragraph 1 with “should”.

A.60 Audio Frequency Conducted Susceptibility, Power Leads
Replace the “shall” in the second paragraph on page 80 with “should”.

A.75 Lightning Susceptibility
Replace the “shall” in the last sentence in paragraph 3 with “should”.

Bibliography

Replace the “shall” in the second reference with “may”.

SMC Standard Improvement Proposal

INSTRUCTIONS

1. Complete blocks 1 through 7. All blocks must be completed.
2. Send to the Preparing Activity specified in block 8.

NOTE: Do not use this form to request copies of documents, or to request waivers, or clarification of requirements on current contracts. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements. Comments submitted on this form do not constitute a commitment by the Preparing Activity to implement the suggestion; the Preparing Authority will coordinate a review of the comment and provide disposition to the comment submitter specified in Block 6.

SMC STANDARD CHANGE RECOMMENDATION:	**1. Document Number** SMC-T-008 (2020)	**2. Document Date** 13 March 2020

3. Document Title	Tailoring for AIAA S-121A-2017, Electromagnetic Compatibility Requirements for Space Equipment and Systems

4. Nature of Change
(Identify paragraph number; include proposed revision language and supporting data. Attach extra sheets as needed.)

5. Reason for Recommendation

6. Submitter Information

a. Name	**b. Organization**
c. Address	**d. Telephone**
e. E-mail address	**7. Date Submitted**

8. Preparing Activity

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