

Space Station Electromagnetic Emission and Susceptibility Requirements

International Space Station

Revision C

May 31, 1996



NASDA

National Space Development
Agency of Japan



agenzia spaziale italiana
(Italian Space Agency)

National Aeronautics and Space Administration
Space Station Program Office
Johnson Space Center
Houston, Texas



Canadian Space
Agency



esa

European Space Agency

Agence spatiale
canadienne



REVISION AND HISTORY PAGE

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SSP 30237 Revision C

INTERNATIONAL SPACE STATION PROGRAM
SPACE STATION ELECTROMAGNETIC EMISSION AND SUSCEPTIBILITY
REQUIREMENTS

MAY 31, 1996

PREFACE

The Space Station Electromagnetic Emission and Susceptibility Requirements for Electromagnetic Compatibility document establishes the requirements for the control of the electromagnetic emission and susceptibility characteristics of electronic, electrical and electromechanical equipment and subsystems designed or procured for use by the International Space Station Alpha Program. The contents of this document are intended to be consistent with the requirements of SSP30243 (Space Station Requirements for Electromagnetic Effects) and SSP 41000, (System Specification for the Space Station). The Space Station Electromagnetic Emission and Susceptibility Requirements for Electromagnetic Compatibility shall be implemented on all SSP contracts and internal activities. This document is under the control of the Space Station Control Board.

SSP 30237 Revision C

INTERNATIONAL SPACE STATION PROGRAM OFFICE
SPACE STATION ELECTROMAGNETIC EMISSION AND SUSCEPTIBILITY
REQUIREMENTS

MAY 31, 1996

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ESA Concurrence: Reference SSP 50019 Joint Management Plan
and JESA 30000, Section 3, Appendix B.

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For NASDA
Caveat: Concur with, subject to completion of detailed
review and coordination of paragraph 3.2.4.2.2 with NASA.

DATE

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**INTERNATIONAL SPACE STATION PROGRAM
SPACE STATION ELECTROMAGNETIC EMISSION AND SUSCEPTIBILITY
REQUIREMENTS**

LIST OF CHANGES

MAY 31, 1996

All changes to paragraphs, tables, and figures in this document are shown below:

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
000008 R1	6-3-94	Revision B	All
	5-31-96	Revision C	All

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1.0 INTRODUCTION

1.1 PURPOSE

This requirements document establishes the design requirements for the control of the electromagnetic emission and susceptibility characteristics of electronic, electrical and electromechanical equipment and subsystems designed or procured for use by the International Space Station Program. Such equipment and subsystems may be used independently or as an integral part of other subsystems or systems.

1.2 APPLICATION

The requirements of this document are applicable to Space Station electrical and electronic equipment. The applicability of the emission and susceptibility requirements is dependent upon the intended location or installation of the equipment or subsystem. Where deviation from the test level requirements is made based on intended installation and location, the deviation shall be documented and approved by the Electromagnetics Technical Advisory Team. Waiver or deviation shall be submitted per DR: PC09 (Waiver and Deviations).

1.3 EMISSION AND SUSCEPTIBILITY DESIGNATIONS

The emission and susceptibility requirements in this document and corresponding test methods of SSP 30238, Space Station Electromagnetic Techniques, are designated in accordance with an alphanumeric coding system where:

C = Conducted

R = Radiated

E = Emission

L = Leakage

S = Susceptibility.

1.4 PRECEDENCE

SSP 41000, System Specification for the Space Station defines the design and performance requirements for the Space Station Program and invokes SSP 30243, Space Station Requirements for Electromagnetic Compatibility. SSP 30243 involves this document for electromagnetic emission and susceptibility requirements. In the event of any conflict between SSP 30243, and this document, SSP 30243 shall take precedence.

2.0 DOCUMENTS

The following documents include specifications, models, standards, guidelines, handbooks, and other special publications. The term “Current Issue” is shown in place of the specific date and issue when the document is under Space Station Control Board control.

DOCUMENT NO.	TITLE
SSP 30238 Rev. C	Space Station Electromagnetic Techniques
Reference	Paragraphs 1.3, 3.1, 3.2 and 3.4.1
SSP 30243 Rev. D	Space Station Requirements for Electromagnetic Compatibility
Reference	Paragraph 1.4 and 3.3
SSP 41000 Rev. A	System Requirements for the Space Station
Reference	Paragraph 1.4
SSP 41173 Rev. Basic	Space Station Quality Assurance Requirements
Reference	Paragraph 4.0

3.0 REQUIREMENTS

3.1 DEFINITION OF ELECTROMAGNETIC EMISSION AND SUSCEPTIBILITY REQUIREMENTS

Electronic, electrical, electromechanical equipment and subsystems emissions and susceptibilities shall comply with these requirements. Testing of the equipment to ensure compliance to the requirements of this document shall be performed using the test methods given in SSP 30238, Space Station Electromagnetic Techniques.

3.1.1 SELF-COMPATIBILITY

The EUT, designed in accordance with the Space Station EMC requirements, shall not malfunction and performance shall not be degraded during EMI testing.

3.2 EQUIPMENT EMISSION AND SUSCEPTIBILITY LIMITS

This paragraph defines emission and susceptibility test limits for Space Station flight equipment and subsystems, including payloads. General EMI test techniques are contained in SSP 30238, Space Station Electromagnetic Techniques. Approval of design procedures and techniques does not relieve the supplier of the responsibility of meeting the emission, and susceptibility test limits. A waiver is required for equipment which cannot meet the emission and susceptibility test requirements. The threshold of susceptibility shall be determined for equipment unable to meet the susceptibility test limits.

3.2.1 CONDUCTED EMISSIONS

Wiring between two or more ORUs shall be exempt from the conducted emission test requirements provided the specific ORUs are tested as a single unit. Wiring external to the group of ORUs tested as a unit shall meet the test limit requirements of this document.

3.2.1.1 CE01, CONDUCTED EMISSIONS

Direct current power, low frequency, 30 Hz to 15 kHz.

3.2.1.1.1 APPLICABILITY

CE01 is applicable only for narrowband emissions between 30 hertz (Hz) and 15 kilohertz (kHz) on direct current (dc) leads which obtain power from or provide power to other equipment, distribution panels or subsystems.

3.2.1.1.2 CE01 LIMITS

Electromagnetic emissions shall not appear on dc leads in excess of the following values as shown below. The emission limit shown below is for equipment drawing one amp or less. For equipment drawing more than one amp, the limit, in dB shown below shall be raised by $20 \times \log I$, where I equals the total dc current used by the equipment under test.

Frequency	Emissions
30Hz–200Hz	110 decibels (dB) above 1 microampere
200Hz–15kHz	Decreasing log–linearly with increasing frequency from 110 to 74 dB above 1 microampere

The limits shall be measured with an effective bandwidth not exceeding 100 Hz.

3.2.1.2 CE03, CONDUCTED EMISSIONS

Direct current power leads, 15 kHz to 50 MHz.

3.2.1.2.1 APPLICABILITY

CE03 is applicable only for narrowband emissions between 15 kHz and 50 megahertz (MHz) on dc leads which obtain power from other sources or provide power to other equipment, distribution panels or subsystems.

3.2.1.2.2 CE03 LIMITS

Electromagnetic emissions shall not appear on dc power leads in excess of the following values as shown below for narrowband emissions: The limit shown below is for equipment drawing one amp or less. For equipment drawing more than one amp, the limit shown below shall be raised by $20 \times \log I$, where I equals the total dc current used by the equipment under test.

Frequency	Emissions
15kHz–500kHz	Decreasing log–linearly with increasing frequency from 74 to 45 dB above 1 microampere
500kHz–50MHz	45 dB above 1 microampere

3.2.1.3 CE07, CONDUCTED EMISSIONS

Direct current power leads, spikes, time domain.

3.2.1.3.1 APPLICABILITY

CE07 is applicable for dc input power leads.

3.2.1.3.2 CE07 LIMITS

CE07 on/off and mode switching transients shall not exceed the envelope defined by the following values listed below. Repetitive on/off and mode switching transients shall not occur more frequently than every 100 milliseconds.

Time (Micro–Seconds)	Percentage of Nominal Line Voltage
0.1–10	± 50 percent
10–50	Decreasing log–linearly with increasing time from ± 50 percent to ± 20 Percent
50–1000	Decreasing log–linearly with increasing time from ± 20 percent to ± 5 Percent or ± 6 volts(V), whichever is greater
1000–10,000	Decreasing log–linearly with increasing time from ± 5 percent or ± 6 volts (V) to ± 0.5 percent or ± 0.5 V, whichever is greater
10,000–100,000	± 0.5 percent or ± 0.5V, whichever is greater

3.2.2 CONDUCTED SUSCEPTIBILITY**3.2.2.1 CS01, CONDUCTED SUSCEPTIBILITY**

Direct current power leads, 30 Hz to 50 kHz.

3.2.2.1.1 APPLICABILITY

CS01 is applicable to equipment and subsystems using dc power.

3.2.2.1.2 CS01 LIMITS

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when subjected to electromagnetic energy injected onto its power leads less than or equal to the values as shown on the following page.

Frequency	Voltage
30Hz–2kHz	5 V root mean square (rms) or 10 percent of the supply voltage (E1), whichever is less
2kHz–50kHz	Decreasing log–linearly with increasing frequency from 5 V rms, or E1 whichever is less, to either 1 V rms or 1 percent of the supply voltage, whichever is less

3.2.2.1.3 ALTERNATE CS01 LIMITS

The requirement is also met when the audio power source specified in SSP 30238 adjusted to dissipate 50 W in a 0.5–ohm load, cannot develop the required voltage at the EUT power input terminals, and the EUT is not susceptible to the output of the signal source.

3.2.2.2 CS02, CONDUCTED SUSCEPTIBILITY

Direct current power leads, 50 kHz to 50 MHz.

3.2.2.2.1 APPLICABILITY

CS02 is applicable between 50 kHz and 50 MHz for equipment and subsystem dc power leads, including power returns which are not grounded internally to the equipment or subsystem.

3.2.2.2.2 CS02 LIMITS

The equipment a subsystem shall not exhibit any malfunction, degradation of performance or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when subjected to 1 V rms from a 50–ohm source. The test signal shall be applied to the equipment power line near the equipment input terminals. The requirement is also met under the following condition: a 1 Watt source of 50–ohms impedance cannot develop the required voltage at the EUT power input terminals, and the EUT is not susceptible to the output of the signal source.

3.2.2.3 CS06, CONDUCTED SUSCEPTIBILITY

Spikes, power leads.

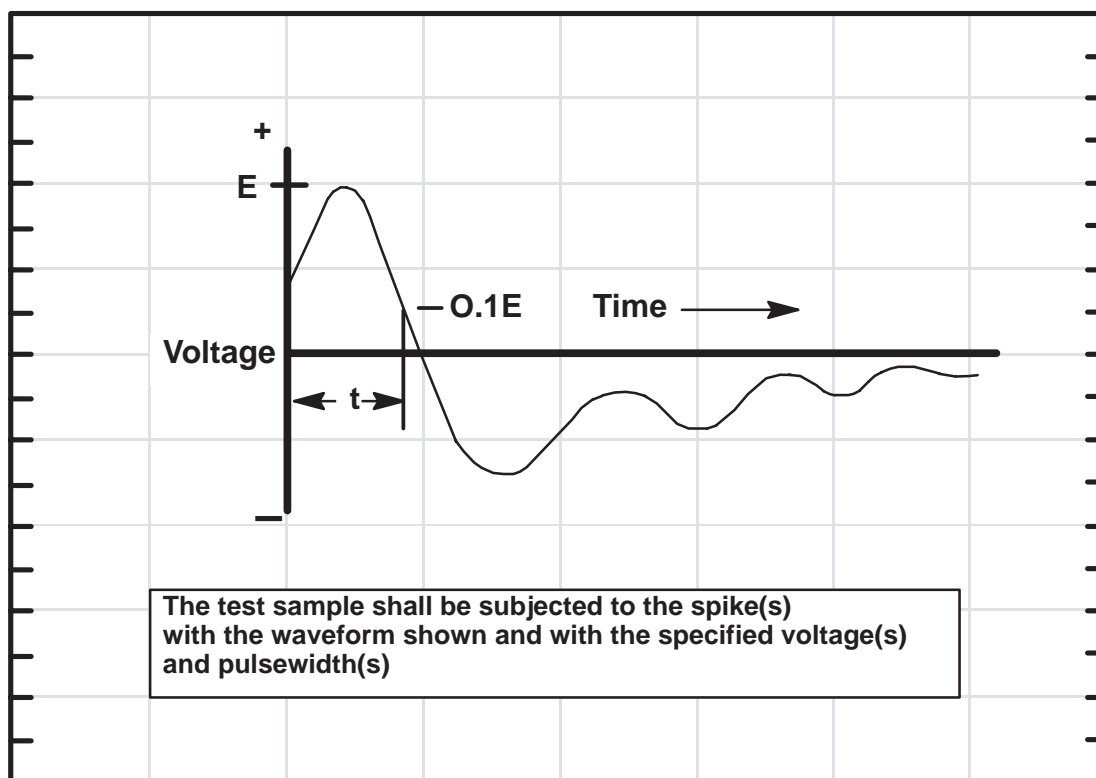
3.2.2.3.1 APPLICABILITY

CS06 is applicable to equipment and subsystem dc power leads, including grounds and returns which are not grounded internally to the equipment or subsystem.

3.2.2.3.2 CS06 LIMITS

The EUT shall not exhibit any malfunction, degradation of performance or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when the test spikes, each having the waveform shown on figure 3–1, are applied sequentially to the dc power input leads. The values of E and t are given below. Each spike shall be superimposed on the powerline voltage waveform.

- Spike #1 E = \pm Twice the nominal line voltage, t = 10 microseconds \pm 20 percent
- Spike #2 E = \pm Twice the nominal line voltage, t = 0.15 microseconds \pm 20 percent.



SPIKE #1 E = \pm Twice the nominal line voltage, t=10 microseconds \pm 20 percent

SPIKE #2 E = \pm Twice the nominal line voltage, t=0.15 microseconds \pm 20 percent

FIGURE 3–1 CS06 AND RS02 EQUIPMENT LIMIT

3.2.3 RADIATED EMISSIONS

3.2.3.1 RE02, RADIATED EMISSIONS

Electric field, 14 kHz to 10 GHz (narrowband), 13.5–15.5 GHz.

3.2.3.1.1 APPLICABILITY

RE02 is applicable for radiated emissions from equipment and subsystems, cables (including control, pulse, IF, power and antenna transmission lines) and interconnecting wiring of the test sample; for narrowband emissions, it applies at the fundamental frequencies and all spurious emissions including harmonics, but does not apply for radiation from antennas. This requirement is applicable for narrowband emissions from 14 kHz to 10 GHz, 13.5–15.5 GHz.

3.2.3.1.2 RE02 LIMITS

E-field emissions shall not be radiated in excess of those specified in the following paragraphs. Above 30 MHz, the limits shall be met for both horizontally and vertically polarized waves. Measurement shall be made in the peak detector mode.

3.2.3.1.2.1 NARROWBAND ELECTRIC FIELD EMISSIONS

Narrowband E-field emissions shall not be radiated in excess of the following values as shown below and in figure 3–2 at the required test distance, 1 m.

Frequency	Emissions
14kHz–10MHz	56 dB μ V/m
10MHz–259MHz	Increasing log-linearly with increasing frequency from 56 to 86 dB μ V/m (16dB per decade)
259MHz–10 GHz	Increasing log-linearly with increasing frequency from 46 to 72 dB μ V/m (16dB per decade)
13.5–15.5 GHz	76 dB μ V/m

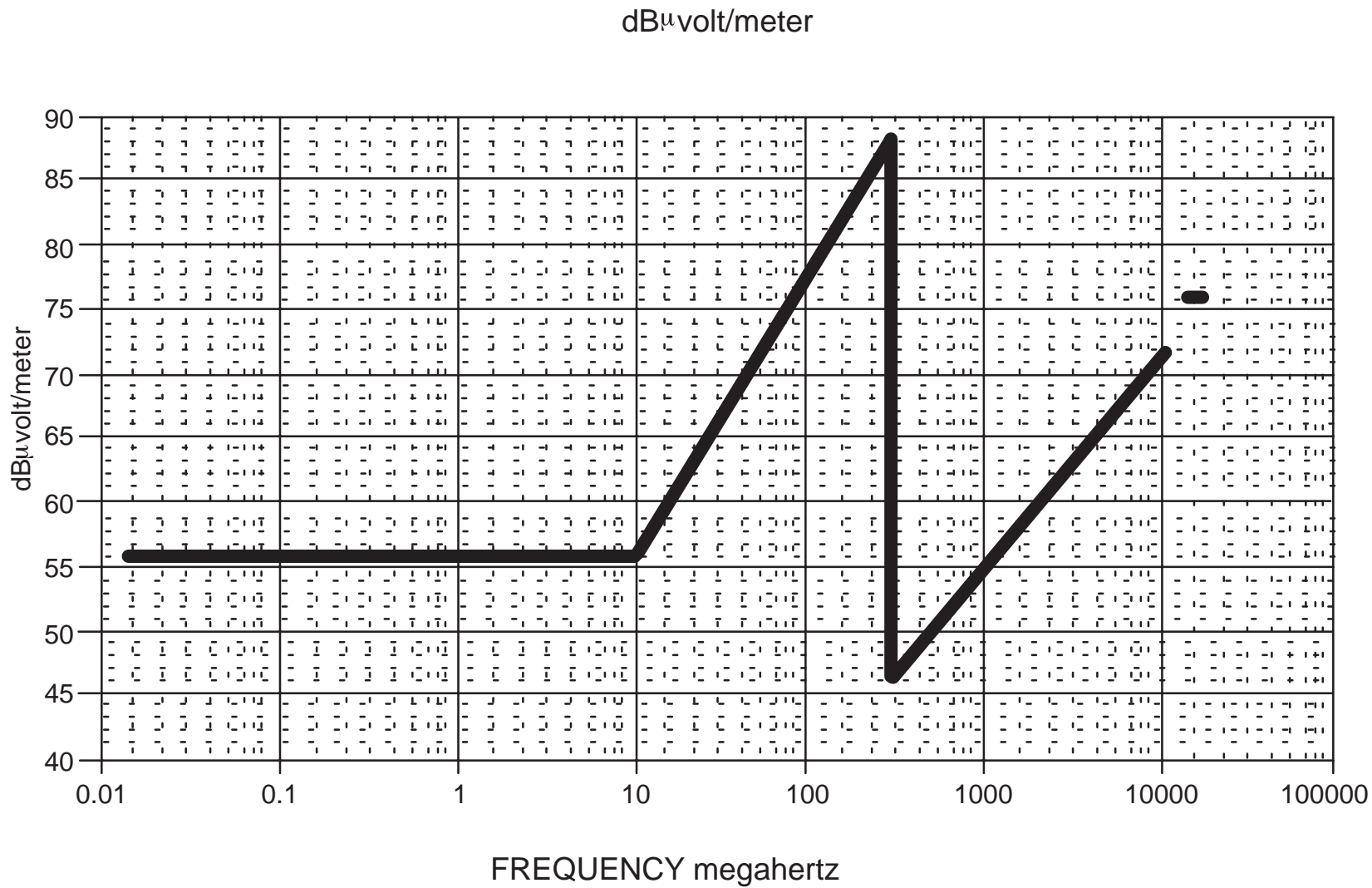


FIGURE 3-2 ISSA EMISSION LIMITS

3.2.4 RADIATED SUSCEPTIBILITY

3.2.4.1 RS02, RADIATED SUSCEPTIBILITY

Magnetic induction field.

3.2.4.1.1 APPLICABILITY

RS02 is applicable for all equipment and subsystems. These susceptibility signals are electromagnetically coupled into the equipment and/or subsystem wiring.

3.2.4.1.2 RS02 LIMITS

The EUT shall not exhibit any malfunction, degradation of performance, or deviation from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when subjected sequentially to the test spikes, shown in figure 3–1 each having the waveform with the values of E and t are given below:

- Spike #1 E = \pm Twice the nominal line voltage, t = 10 microseconds \pm 20 percent
- Spike #2 E = \pm Twice the nominal line voltage, t = 0.15 microseconds \pm 20 percent.

3.2.4.2 RS03, RADIATED SUSCEPTIBILITY

Electric field, 14 kHz to 20 GHz.

3.2.4.2.1 APPLICABILITY

RS03 is applicable for all equipment and subsystems between 14 kHz and 20 GHz. Above 10 GHz, this requirement applies only at specific frequencies and amplitudes known to be present at the Space Station. Below 10 GHz, this requirement shall be increased only at specific frequencies and amplitudes known to be present at the ISSA. Module shielding effectiveness can be used to limit the levels applied.

3.2.4.2.2 RS03 LIMITS

The EUT shall not exhibit any malfunction, degradation of performance, or deviation, from specified indications beyond the tolerances indicated in the individual equipment or subsystem specification when subjected to the radiated electric fields less than or equal to those specified herein. Above 30 MHz, the requirement shall be met for both horizontally and vertically polarized waves. As a minimum, the levels on the following page apply at either the specific frequencies stated or across the ranges stated:

Frequency/Range	Radiated Electric Field Level
14kHz–200MHz	5 V/m
200MHz–8GHz	60 V/m
8GHz–10GHz	20 V/m
2.2GHz	161 V/m
8.5GHz	79 V/m
13.7GHz–15.2GHz	250 V/m

3.2.5 LEAKAGE EMISSIONS

3.2.5.1 LE01, AC POWER USER LEAKAGE CURRENT

3.2.5.1.1 APPLICABILITY

LE01 is applicable for all equipment and subsystems that use ac power.

3.2.5.1.2 LE01 LIMITS

The leakage current for all equipment and subsystems using ac power, as measured between chassis and input power, at the power frequency, shall not exceed 5 milliamperes.

3.3 DOCUMENTATION

Documentation shall be per the requirements of SSP 30243.

3.4 VERIFICATION

3.4.1 TESTING REQUIREMENTS

The test requirements and techniques of SSP 30238 shall be used to determine compliance with the applicable emission and susceptibility test limit requirements of this document. When an EUT susceptibility is noted, the thresholds of susceptibility shall be determined. Equipment that is intended to be operated as a subsystem shall be tested as such to the applicable emission and susceptibility limits whenever practical.

4.0 QUALITY ASSURANCE PROVISIONS

All quality assurance provisions shall be in accordance with the Space Station Program Quality Assurance Program Requirements as specified in SSP 41173.

4.1 RESPONSIBILITY FOR INSPECTION

Unless otherwise specified, the supplier is responsible for the performance of inspection requirements as specified herein. Except as otherwise specified, the supplier may use his own facilities or any other commercial laboratory acceptable to National Aeronautics and Space Administration (NASA) or responsible IP agencies. NASA or IP agencies reserves the right to perform any of the inspections set forth in the requirements document where such inspections are deemed necessary to assure supplies and/or services conform with prescribed requirements.

APPENDIX A ABBREVIATIONS AND ACRONYMS

ac	Alternating Current
dB	Decibel
dBm	Decibel relative to one milliwatt
dBmV	Decibel relative to one millivolt
dc	Direct Current
EMI	Electromagnetic Interference
EUT	Equipment Under Test
GHz	Gigahertz
Hz	Hertz
IF	Intermediate Frequency
kHz	Kilohertz
m	Meter
MHz	Megahertz
NASA	National Aeronautics and Space Administration
RF	Radio Frequency
rms	Root Mean Square
μ V	Microvolt
μ V/MHz	Microvolt per megahertz
V	Volt
W	Watt

APPENDIX B GLOSSARY

CABLE, ELECTRICAL

Two or more solid or stranded conductors insulated from each other and routed together or enclosed by a common covering; or one conductor enclosed by but insulated from another conductor or a metallic shield.

EQUIPMENT

Any electrical, electronic, or electromechanical device or collection of devices intended to operate as a single unit and to perform a single function. As used herein, equipment includes but is not limited to the following: receivers; transmitters; transponders; power supplies; hand tools; processors; test apparatus; and test instruments.

SUBSYSTEM

A collection of equipment designed and integrated to perform a single function where in any equipment within the subsystem is not required to function as an individual equipment.

SYSTEM

A collection of equipment, subsystems, skills, and techniques capable of performing or supporting an operational role. A complete system includes related facilities, equipment, subsystems, materials, services, and personnel required for its operation to the degree that it can be considered self-sufficient within its operational environment.

WIRE, ELECTRICAL

A single current-carrying conductor of one or more strands covered with a suitable insulating material.