Atacama Large Millimeter Array

# *ALMA System*
# Electromagnetic Compatibility (EMC) Requirements

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# 1 INTRODUCTION

## 1.1 Scope

This part of the ALMA System Wide Requirements provides a formal guideline for Electromagnetic Compatibility (EMC) requirements to be applied in the ALMA project. It has been prepared to assure with reasonable confidence that:

- Sub-systems and all other components that constitute the complete ALMA instrument can operate together without having their designated functionality affected by the EMC environment. This objective is achieved by having all these sub-systems and components confirm to a well specified maximum level for generation of Electromagnetic Interference (EMI) and assure that their functionality is not affected up to a corresponding level of external EMI.
- EMI levels at the AOS on Chajnantor are sufficiently low to permit high sensitivity radio astronomical observations not only in the current ALMA bands but also in other parts of the frequency spectrum that are allocated to the radio astronomy service.
- Susceptibility of sub-systems against EMI satisfies internationally accepted EMC criteria so that it precludes or limits hazards to personnel and equipment.

The requirements in this guideline shall be applied to all electrical and electronic hardware products that constitute the ALMA instrument as stated in the ALMA product structure and all other subsystems with its installed equipment part of the ALMA project. The EMC requirements are primarily intended to be enforced on equipment at the AOS used during observation. However, as the other locations may also suffer from non-compliance, less stringent EMC requirements are enforced for all electrical systems used on these locations (like the OSF).

## 1.2 Applicable Documents

The following Applicable Documents of the exact issue shown form a part of the present document to the extent specified herein. Where no issue or date is indicated, the latest editions/revisions thereof and any amendments or supplements thereto in effect on the date of enforcement of the present document shall be taken as valid. In the event of conflict between the Applicable Documents referenced herein and the contents of the present document, the contents of the present document shall be considered a superseding requirement.

### 1.2.1 General

AD [1] ALMA Environmental Specification
ALMA-80.05.02.00-001-B-SPE

AD [2] ALMA Product Assurance Requirements
ALMA-80.11.00.00-011-B-GEN

AD [3] IEC 61000
Electromagnetic compatibility (EMC) (the entire series as applicable)

AD [4] MIL-STD-461E
Requirements for the control of electromagnetic interference characteristics of subsystems and equipment

AD [5] ITU-R RA. 769-1 Recommendation
Protection criteria used for radio astronomical measurements

AD [6] IEC 61204-3
Low-voltage power supplies, d.c. output – Part 3: Electromagnetic Compatibility

AD [7] IEC 61326-1
Electrical equipment for measurement, control and laboratory use - EMC requirements

AD [8] IEC 61543
Residual current-operated protective devices (RCDs) for household and similar use - Electromagnetic compatibility

AD [9] IEC 61547
Equipment for general lighting purposes - EMC immunity requirements

AD [10] IEC 61587-3
Mechanical structures for electronic equipment – Electromagnetic shielding performance tests for cabinets, racks, subracks

AD [11] IEC 61800-3
Adjustable speed electrical power drive systems - EMC product standard including specific test methods

AD [12] IEC 62040-2
Uninterruptible power systems – EMC requirements

AD [13] ETS 300 329
Radio Equipment and Systems (RES); EMC for Digital Enhanced Cordless Telecommunications (DECT) equipment

AD [14] ETS 300 447
Radio Equipment and Systems (RES); EMC standard for VHF FM broadcasting transmitters

AD [15] ETS 300 682
Radio Equipment and Systems (RES); EMC standard for On-Site Paging equipment

AD [16] EN 300 386-2
Electromagnetic compatibility and Radio spectrum Matters (ERM); Telecommunication network equipment; EMC requirements; Part 2: Product family standard

AD [17] CISPR 11
Industrial, scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement

AD [18] CISPR 22
Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement

## 1.3 Reference documents

RD [1] ALMA Product Tree
ALMA-80.03.00.00-001-L-LIS

## 1.4 Abbreviations and Acronyms

| | |
|---|---|
| AC/a.c. | Alternating Current |
| ALMA | Atacama Large Millimeter Array |
| AOS | Array Operation Site |
| CE | Conformite Europeenne |
| CEN | European Standards Coordinating Committee |
| CENELEC | European Committee for Electrotechnical Standardisation |
| CISPR | Comité International Spécial des Perturbations Radioélectriques |
| COTS | Commercial Off-The-Shelf |
| DC/d.c. | Direct Current |
| EIRP | Effective Isotropic Radiated Power |
| ELV | Extra-Low Voltage |
| EM | Electromagnetic |
| EMC | Electromagnetic Compatibility |
| EMP | Electromagnetic Pulse |
| EN | European Norm |
| ESD | Electrostatic Discharge |
| ESO | European Southern Observatory |
| EUT | Equipment Under Test |
| HF | High Frequency |
| IEC | International Electrotechnical Commission |

| | |
|---|---|
| IEV | International Electrotechnical Vocabulary |
| IPT | Integrated Product Team |
| ISM | Industrial, Scientific and Medical (Equipment) |
| ITE | Information Technology Equipment |
| ITU | International Telecommunication Union |
| LAN | Local Area Network |
| LISN | Line Impedance Stabilization Network |
| LV | Low Voltage |
| OPD | Overcurrent Protective Device |
| OSF | Operations Support Facility |
| PBC | Protective Bonding Circuit |
| PCB | Printed Circuit Board |
| RCCB | Residual Current Circuit Breaker |
| PE | Protective Earth |
| PELV | Protective Extra-Low Voltage |
| PLC | Programmable Logic Controller |
| QP | Quasi Peak |
| RF | Radio Frequency |
| RFI | Radio Frequency Interference |
| SE | System Engineering |
| SELV | Safety Extra-Low Voltage |
| SPD | Surge Protective Device |
| SPFD | Spectral Power Flux Density |
| TBC | To Be Confirmed |
| THD | Total Harmonic Distortion |
| TNV | Telecommunication Network Voltage |
| UPS | Uninterruptible Power Supply |
| VDE | Verband Deutscher Elektrotechniker |

## 1.5 Verb Convention

"Shall" is used whenever a specification expresses a provision that is binding. The verbs "should" and "may" express non-mandatory provisions. "Will" is used to express a declaration of purpose on the part of the design activity.

## 1.6 Definitions

Definitions related to EMC may be found in the EEC Directive 89/336/EEC, in chapter 161 of IEC 60050 ("International Electrotechnical Vocabulary") and in CISPR publications. Some of these definitions are given in this chapter.

Where the terms 'voltage' and 'current' are used, they imply the r.m.s. values, unless otherwise specified.

**Burst**
A sequence of a limited number of distinct pulses or an oscillation of limited duration.

**(Electromagnetic) compatibility level**
The specified maximum electromagnetic disturbance level expected to be impressed on a device, equipment or system operated in particular conditions.
Note. In practice the electromagnetic compatibility level is not an absolute maximum level, but may be exceeded with a small probability.

**Disturbance level**
The value of a given electromagnetic disturbance, measured in a specified way.

**Electromagnetic compatibility (EMC)**
The ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

**Electromagnetic disturbance**
Any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter.
Note. An electromagnetic disturbance may be an electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

**Electromagnetic environment**
The totality of electromagnetic phenomena existing at a given location.

**Electromagnetic interference (EMI)**
Degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance.
Note. Disturbance and interference are respectively cause and effect.

**Emission level (of a disturbing source)**
The level of a given electromagnetic disturbance emitted from a particular device, equipment or system in a specified way.

**Emission limit**
The specified maximum emission level of a source of electromagnetic disturbance.

**Enclosure port**
The physical boundary of the apparatus through which electromagnetic fields may radiate or impinge.

**Harmonic (component)**
A component of order greater than one of the Fourier series of a periodic quantity.

**(Total) harmonic factor**
The ratio of the r.m.s. value of harmonic content to the r.m.s. value of an alternating quantity.

**Immunity (to a disturbance)**
The ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance.

**Immunity level**
The maximum level of a given electromagnetic disturbance incident on particular device, equipment or system for which it remains capable of operating at a required degree of performance.

**Immunity limit**
The specified minimum immunity level.

**Mains signaling**
Use of the distribution network for the transmission of signals.

**Port**
Particular interface of the specified apparatus with the external electromagnetic environment.

**(Electromagnetic) susceptibility**
The inability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance.

**Interharmonics**
Discrete or wide-band spectrum frequencies which are not integer multiples of the power frequency fundamental.

**Short (supply) voltage interruption**
The disappearance of the supply voltage for a period of time not exceeding 1 min.

**Voltage dip**
A sudden reduction of the voltage at a point in an electrical system, followed by voltage recovery after a short period of time, from half of a cycle to a few seconds.

**Voltage fluctuation**
A cyclical variation of the voltage envelope or a series of random voltage changes, the magnitude of which does not normally exceed the range of operational voltage changes mentioned in IEC Publication 60038 (up to ±10%).

**Voltage surge**
A transient voltage wave characterized by a rapid increase followed by a slower decrease.

**Voltage unbalance (imbalance)**
In a polyphase system, a condition in which the r.m.s. values of the phase voltages or the phase angles between consecutive phases are not all equal.

# 2 REQUIREMENTS

## 2.1 Numbering

The requirements within the present document are numbered according to the following code

***EEMC-XXXXX-YY/Z(ZZ)***

where

***EEMC*** stands for 'Engineering Specification: EMC Requirements';

***XXXXX*** is the consecutive number 00010, 00020, … (the nine intermediate numbers remaining available for future revisions of this document);

***YY*** describes the requirement revision and starts with 00;

***Z(ZZ)*** describes the verification method(s) where T stays for test, I for inspection, R for review of design, A for analysis.

## 2.2 General

**EEMC-00010-00/R,T** A basic set of general requirements for EMC is formulated in the following sections and is to be conformed to for each *subsystem* (with this it is meant the highest level in document RD [1]: ALMA Product Tree) and its *equipment* (parts with lower levels in that document) operational at the AOS, OSF or any other ALMA facility.

**EEMC-00020-00/R,T** Verification of the requirements that are mentioned in sections 2.3 'Immunity requirements' and 2.4 'Emission requirements' shall only be done on complete subsystems and/or parts of such subsystem.

In exceptional cases, based on an evaluation of the EM environment and on the peculiarities of the subsystem or of parts of it, specific requirements may have to be added or relaxed.

A contractor shall consult the ALMA SE IPT on EMC related issues in case it is uncertain whether a device, equipment or system will be able/has to comply with the requirements stated in this document.

### 2.2.1 Commercial equipment

**EEMC-00030-00/R,T** Commercial Off-The-Shelf (COTS) equipment shall conform to the applicable EMC product or product family standard(s) (e.g., AD [17] 'CISPR 11' for industrial, scientific and medical equipment or AD [18] 'CISPR 22' for information technology equipment, AD [6] 'IEC 61204-3' for low-voltage power supplies, etc.). Should no such product or product family standard(s) exist, COTS equipment shall conform to the applicable EMC emission and immunity generic standard(s) (AD [3], in particular 'IEC 61000 - Part 6: Generic standards') or US equivalent.

**EEMC-00040-00/R,T** As far as emission requirements are concerned (see section 2.4 'Emission requirements'), when the applicable standard specifies multiple emission limits, the lowest one shall be fulfilled (e.g., the Class B limits of AD [17] 'CISPR 11', the Class B of AD [18] 'CISPR 22', etc.).

**EEMC-00050-00/R,T** The verifications by test that are set in sections 2.3 'Immunity requirements' and 2.4 'Emission requirements' shall only be applied to complete subsystems and/or parts of such subsystems.

**EEMC-00060-00/R,T** Commercial equipment shall have a CE mark or FCC compliance.

**EEMC-00070-00/R,I** Individual commercial equipment may be verified by inspecting the relevant information on EMC conformity (manufacturer's Declaration of Conformity, and/or type-test, and/or CE-marking, etc.)

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## 2.3 Immunity requirements

### 2.3.1 Performance criteria

As a general rule for all immunity tests, the test result is positive if the equipment shows its immunity, based on the applicable performance criterion given in the following table, for the entire period of application of the test. At the end of the tests the equipment under test (EUT) functions as it is supposed to under normal conditions.

Performance criteria are:

| Performance Criterion | Description |
|---|---|
| **A** | Normal performance within limits specified by the manufacturer, requestor or purchaser. |
| **B** | Temporary loss of function or degradation of performance which ceases after the disturbance ceases, and from which the EUT recovers its normal performance, without operator intervention. |
| **C** | Temporary loss of function or degradation of performance, the correction of which requires operator intervention[1]. |
| **D** | Loss of function or degradation of performance which is not recoverable, owing to damage to hardware or software, or loss of data. |

**Table 2-1: Performance criteria for immunity tests**

### 2.3.2 Conducted immunity

#### 2.3.2.1 Rectangular (step) voltage fluctuations

**EEMC-00080-00/R,T** The immunity limit for rectangular (step) voltage changes on a.c. mains voltage lines shall be

Voltage change $\Delta U = \pm 12\%$ of supply voltage $U_n$

with repetition period T = 5-10 s and duration t = 2-3 s.

Performance criterion: A (see Table 2-1)

Verification may be made by producing the manufacturer's data sheet.

[1] Reset buttons shall have provisions for parallel contact closure.

#### 2.3.2.2 Voltage dips

**EEMC-00090-00/R,T** The immunity limit for voltage dips on a.c. mains voltage lines shall be

$\Delta U_1$ = -30% of $U_n$ for 10 ms – performance criterion B

$\Delta U_2$ = -50% of $U_n$ for 100 ms – performance criterion C

Verification may be made by analyzing the manufacturer's data sheet.

#### 2.3.2.3 Voltage interruptions

**EEMC-00100-00/R,T** The immunity to short voltage interruptions ($\Delta U \leq$ -95%) on a.c. mains voltage lines shall be up to 5000 ms with performance criterion C (see Table 2-1). This requirement only applies to non-UPS supplied equipment. Verification may be made by analyzing the manufacturer's data sheet.

#### 2.3.2.4 Electrostatic Discharge (ESD) requirements

##### 2.3.2.4.1 Introduction

The object of this requirement is to establish a common and reproducible basis for evaluating the performance of equipment when subjected to ESD.
Test locations are any accessible points outside of a closed cabinet (e.g. door handles or panels that are used for the operation of equipment). It is necessary that personnel, when opening a cabinet, wear wrist bands to prevent the occurrence of ESD to equipment inside the cabinet.

Compliance levels according to IEC 61000-4-2 are:

| Level | Contact discharge test voltage (kV) | Air discharge test voltage (kV) |
|---|---|---|
| 1. Relative humidity as low as 35%, anti-static material | 2 | 2 |
| 2. Relative humidity as low as 10%, anti-static material | 4 | 4 |
| 3. Relative humidity as low as 50%, synthetic material | 6 | 8 |
| 4. Relative humidity as low as 10%, synthetic material | 8 | 15 |

#### 2.3.2.4.2 Requirements

**EEMC-00110-00/R,T** For AOS and OSF the following values are required:

| Method | Level | Criteria |
|---|---|---|
| Air-Discharge | 4: 2 to 15 kV in 2kV increments | Criterion A up to 8 kV, B above 8 kV |
| Contact | 4: 2 to 8 kV in 2kV increments | Criterion A up to 4 kV, B above 4 kV |

**Table 2-2: ESD requirements at AOS and OSF**

### 2.3.2.5 Voltage (current) surges

#### 2.3.2.5.1 Introduction

The object of this requirement is to evaluate the performance of equipment when subjected to high-energy disturbances on power and inter-connection lines caused by overvoltages from switching and lightning transients.

Switching transients can be separated into transients associated with:

- major power system switching disturbances, such as capacitor bank switching;
- minor switching activity near the instrumentation;
- load changes in the power distribution system;
- resonating circuits associated with switching devices, such as thyristors;
- system faults such as short circuits or arcing faults to the earthing system.

Major mechanisms by which lightning produces surge voltages are:

- a direct lightning stroke to an external circuit (outdoor) injecting high currents which produce high voltages by either flowing through earth resistance or flowing through the impedance of the external circuit;
- An indirect lightning stroke (e.g. between or within clouds) that induces voltages / currents on the conductors outside and/or inside a building;
- lightning earth current flow resulting from nearby direct-to-earth discharges coupling into the common earth paths at the earthing system of the installation.

The rapid change of voltage and flow of current, which may occur when a protector is excited, may couple into internal circuits.

The following classes of installation are defined (as given in annex B of IEC 61000-4-5).

| Class | Description |
|---|---|
| 0 | Well-protected electrical environment, often within a special room. |
| 1 | Partly protected electrical environment. |
| 2 | Electrical environment where cables are well separated, even at short runs. |
| 3 | Electrical environment where cables run in parallel. |
| 4 | Electrical environment where the interconnections are running as outdoor cables along with power cables, and cables are used for both electronic and electric circuits. |
| 5 | Electrical environment for electronic equipment connected to telecommunication cables and overhead power lines in a non-densely populated area. |

**Table 2-3: Installation classes for electrical environments**

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#### 2.3.2.5.2 Requirements

Compliance levels are selected according to these installation classes that vary among the various ALMA subsystems.
Next table gives the required levels according to the installation classes mentioned in section 2.3.2.5.1.

| ⇕ Installation class | Test Voltage Levels | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Power supply coupling mode | | Unbalanced operated circuits/lines, LDB coupling mode | | Balanced operated circuits/lines coupling mode | | SDB, DB[1)] coupling mode | |
| | Line to line kV | Line to earth kV | Line to line kV | Line to earth kV | Line to line kV | Line to earth kV | Line to line kV | Line to earth kV |
| 0 | NA | NA | NA | NA | NA | NA | NA | NA |
| 1 | NA | 0.5 | 0.5 | 0.5 | NA | 0.5 | NA | NA |
| 2 | 0.5 | 1.0 | 1.0 | 1.0 | NA | 1.0 | NA | 0.5 |
| 3 | 1.0 | 2.0 | 2.0 | 2.0[3)] | NA | 2.0[3)] | NA | NA |
| 4 | 2.0 | 4.0[3)] | 2.0 | 4.0[3)] | NA | 2.0[3)] | NA | NA |
| 5 | [2)] | [2)] | 2.0 | 4.0[3)] | NA | 4.0[3)] | NA | NA |

Acronyms : DB = copper data bus/line (e.g. telephone, Ethernet, etc.), SDB = short-distance bus, LDB = long distance bus, NA = not applicable

[1)] Limited distance, special configuration, special layout, 10-30 m max. : no test up to 10 m, class 2
[2)] Depends on the class of the local power supply system
[3)] Normally tested with primary protection

**Table 2-4: Compliance levels for surge immunity test**

**EEMC-00120-00/R,T** For the AOS environment class 4 with performance criterion B shall be required.

**EEMC-00130-00/R,T** Equipment installed at the OSF shall have class 3 severity levels with the same performance criterion.

It is typically necessary to install surge protective devices to meet this requirement.

A test to verify the ability to be immune to surges according to the above said classes involves the injection of surges with a rise time $T_r$ is1,2 µs and hold time $T_h$ is 50 µs (8/20 µs for current injection) and the above mentioned voltage levels.

### 2.3.2.6 Electrical Fast Transient (EFT)/Burst

#### 2.3.2.6.1 Introduction

The requirement is intended to demonstrate the immunity of electrical and electronic equipment when subjected to types of transient disturbances such as those originating from switching transients (interruption of inductive loads, relay contact bounce, etc.)[2].
This repetitive fast transient test is a test with bursts consisting of a number of fast transients, coupled into the power supply, control and signal ports of electrical and electronic equipment.

#### 2.3.2.6.2 Requirements

The recommended selection of required levels noted down in the following table shall be done according to the characteristics of the electromagnetic environment the system is in (e.g. well-protected environments like computer control rooms versus industrial environments where higher levels are applicable). For I/O, control, signal and data ports it is required to choose half the test voltage value applied on power supply ports.

| Environment level | Voltage level (kV) |
|---|---|
| 1 (well–protected environment[1)]) | 0.5 |
| 2 (protected environment) | 1.0 |
| 3 (typical industrial environment) | 2.0 |
| 4 (severe industrial environment) | 4.0 |
| [1)] See IEC 61000-4-4 for a detailed description on levels 1-4 | |

**Table 2-5: EFT environment levels**

**EEMC-00140-00/R,T** For the AOS -in the case of a.c. power ports and PE terminals- level 4, performance criterion B shall be taken. At the OSF level 3, performance criterion B is to be taken. Different requirements may apply on some specific subsystem and may be applied once it is considered necessary.

A test to verify the ability to be immune to surges according to the above said classes involves the injection of surges with rise time $T_r$ = 5 ns, hold time $T_h$ = 50 ns and repetition rate = 5 kHz.

[2] Designers shall of course follow good design practice to avoid such disturbances being emitted from their equipment.

#### 2.3.2.7 Immunity to conducted disturbances induced by RF fields

The source of disturbance covered by this requirement is basically an EM field, coming from intended RF transmitters (e.g. hand-held radios), that may act on the whole length of cables connected to installed equipment. Cables then may act as passive receiving antenna networks of several wavelengths.

**EEMC-00150-00/R,T** The frequency range shall be from 150 kHz – 80 MHz and levels shall be similar to section 2.3.3.1 according to the appropriate class.

The test method to verify immunity to such conducted disturbances can be found in IEC 61000-4-6 and typically involves the use of a ferrite clamp to inject RF signals into cables to verify the EUT performance.

### 2.3.3 Radiated immunity

#### 2.3.3.1 RF field immunity

Different types of environments may be encountered. The following environment classes are defined by IEC 61000-4-3:

| Class | Description |
|---|---|
| 1 | Low-level EM radiation environment. Levels typical of local radio/television stations located at more than 1 km, and transmitters/receivers of low power. |
| 2 | Moderate EM radiation environment. Low power portable transceivers (typically less than 1 W rating) are in use, but with restrictions on use in close proximity to the equipment. A typical commercial environment. |
| 3 | Severe EM radiation environment. Portable transceivers (2 W rating or more) are in use relatively close to the equipment but not less than 1 m. High power broadcast transmitters are in close proximity to the equipment and ISM equipment may be located close by. A typical industrial environment. |
| x | Special cases of EM radiation environment. |

**Table 2-6: Classes of EM radiation environments**

The related field strength the system shall be immune to (according to the appropriate class) is denoted in the next table.

| Class | Field strength (V/m) |
|---|---|
| 1 | 1 |
| 2 | 3 |
| 3 | 10 |
| x | - |

**Table 2-7: RF field immunity levels**

**EEMC-00160-00/R,T** Both AOS and OSF shall be considered to represent a class 3 environment so that requirements of 10V/m shall apply, with performance criterion B. The frequency range of the field shall be chosen from 80-1000 MHz and the signal shall be a 1 kHz sinewave which is 80 % amplitude modulated. Dependant on the location, an extra requirement may be placed for protection against RFI from cellular phones or similar devices typically operating in the frequency range from 800-960 MHz and from 1.5 – 2.0 GHz keeping the same values as in Table 2-7.

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## 2.4 Emission requirements

The radiated and conducted electromagnetic disturbances emitted shall not exceed the limits set in the sections below.

### 2.4.1 Conducted emission

#### 2.4.1.1 Harmonic currents

**EEMC-00170-00/R,T** The harmonic currents injected into the power distribution system shall not exceed the percent ratios indicated by the following table where $I_1$ = rated fundamental current and $I_n$ = harmonic current component.

| Harmonic number n | Admissible harmonic current $I_n/I_1$ (%) | Harmonic number n | Admissible harmonic current $I_n/I_1$ (%) |
|---|---|---|---|
| 3 | 21.6 | 21 | $\leq 0.6$ |
| 5 | 10.7 | 23 | 0.9 |
| 7 | 7.2 | 25 | 0.8 |
| 9 | 3.8 | 27 | $\leq 0.6$ |
| 11 | 3.1 | 29 | 0.7 |
| 13 | 2 | 31 | 0.7 |
| 15 | 0.7 | $\geq 33$ | $\leq 0.6$ |
| 17 | 1.2 | | |
| 19 | 1.1 | Even | $\leq 8/n$ or $\leq 0.6$ |

**Table 2-8: Harmonic current emission limits**

#### 2.4.1.2 Conducted RF disturbance voltage

**EEMC-00180-00/R,T** Conducted radio-frequency terminal disturbance voltages on mains lines shall not be emitted in excess of the values given by Table 2-9.

| Mains terminal disturbance voltage limits dB(μV) | | |
|---|---|---|
| **Frequency band (MHz)** | **Quasi-peak** | **Average** |
| 0.009 – 0.15 | Limits under consideration by CISPR, except for induction cooking appliances | |
| 0.15 – 0.50 | 66<br>Decreasing linearly with logarithm of frequency to<br>56 | 56<br>Decreasing linearly with logarithm of frequency to<br>46 |
| 0.50 – 5 | 56 | 46 |
| 5 – 30 | 60 | 50 |

**Table 2-9: Mains terminal RF disturbance voltage limits**

It is typically necessary to install power line filters to meet this requirement.

The test method to verify emission of such conducted disturbances can be found in AD [17] 'CISPR 11' and typically involves the use of a ferrite clamp or LISN and a spectrum analyzer to measure such a RF disturbance on power line cables.

#### 2.4.1.3 Voltage fluctuations and flicker

**EEMC-00190-00/R** Voltage fluctuations and flicker injected into a power distribution system shall not exceed the limits in current industrial practice to avoid misoperation of monitors and the like.

### 2.4.2 Radiated emission

#### 2.4.2.1 Radiated field emission limits

**EEMC-00200-00/R,T** Electromagnetic radiation shall not be emitted by subsystems or equipment that exceeds the limits in Table 2-10 below.

| Frequency band (MHz) | Emission limit dB(μV/m) | Possible test according to: |
|---|---|---|
| 30 – 230 | 30 Quasi-peak (at 10 m) | CISPR 11 |
| 230 – 1000 | 37 Quasi-peak (at 10 m) | CISPR 11 |
| 1000 – 18000 | Limits under consideration by CISPR | |

**Table 2-10: Electromagnetic radiation disturbance limits**

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