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**INTERNATIONAL ELECTROTECHNICAL COMMISSION**

**INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE (CISPR)  
STEERING COMMITTEE**

**CISPR Guidance document on EMC of equipment  
connected to the SmartGrid**

This document has been prepared by CISPR/S WG1 taking into account the comments received on CISPR/1252/DC which was circulated in July 2013.

Smart grid is composed of many subsystem and equipment. The most important concern is to ensure that the complex smart grid system will work well as a system in the environment in which it is intended to operate. One key aspect of system working is EMC and this guidance document is intended to ensure proper EMC performance of the smart grid

This guidance document suggests definitions and requirements of EMC on equipment to be used in the smart grid. For example, definitions of port and requirements in the existing standards of CISPR and TC 77 are introduced.

CISPR will continuously update this guidance document to keep pace with technology development. CISPR welcomes suggestions and proposals for the update of this guideline.

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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### **CISPR Guidance document on EMC of equipment connected to the SmartGrid**

#### FOREWORD

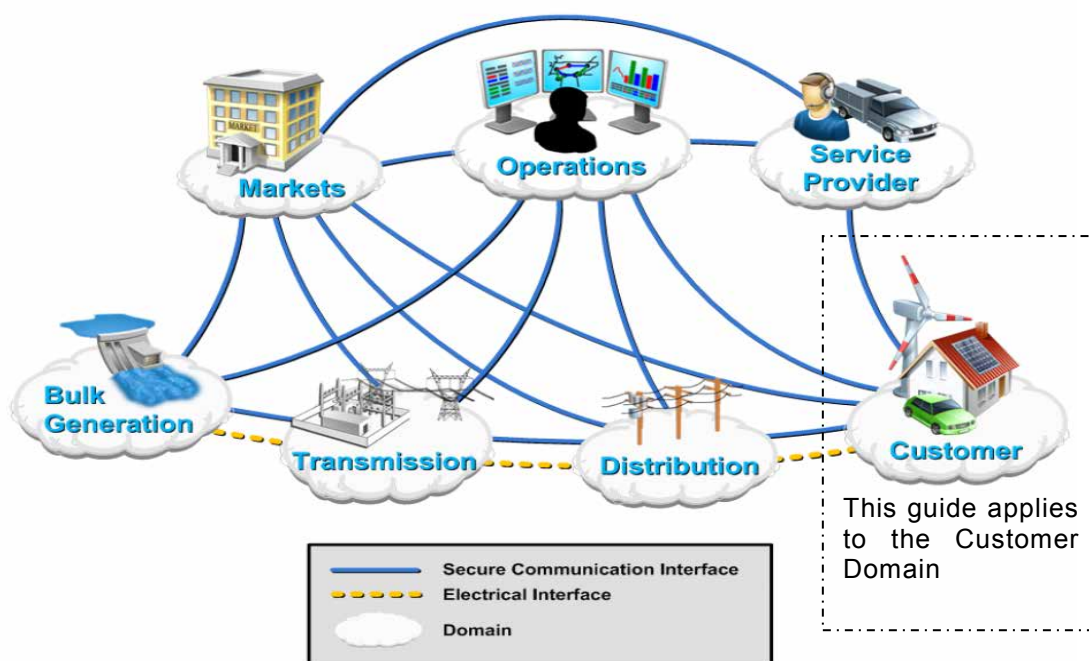
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This document has been prepared by the Steering Committee of CISPR.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

## INTRODUCTION

The emergence of plans for and implementation of the SmartGrid has risen to a high priority as nations look to make their power infrastructure more efficient. The IEC itself has expended much time and effort on a continuing basis in citing its standards which apply to the SmartGrid and equipment connected to the SmartGrid used between the power generation source and the power users. As standards are applied it is important that all equipment connected to the SmartGrid is designed with electromagnetic compatibility (EMC) in mind. EMC is primarily intended to prevent such equipment from causing interference to radio services, as well as to allow such equipment to operate properly in the EM environment where it is installed. In addition, this equipment should not cause conducted or radiated interference to nearby electronics which could include adjacent SmartGrid equipment.



**Figure 1 A Conceptual Model of SmartGrid domains**

Note: This figure is general but this guideline is limited to the customer domain

In 2011 CISPR set up a special working group reporting directly to the CISPR steering committee. This working group is focussed on seeing where CISPR can contribute to preventing RF interference from affecting the equipment connected to the SmartGrid in its EM environment. To that end, the steering committee decided that a guidance document should be prepared to clarify the applicability of emissions standards from equipment connected to the SmartGrid. The guide will also indicate which immunity standards are applicable (further information on basic immunity standards is available from IEC TC77).

This document is intended to provide guidance to IEC committees and others dealing with standards covering EMC aspects that apply to equipment connected to the SmartGrid. This document has been written taking into account IEC Guide 107 and the report on IEC web site: <http://www.iec.ch/emc/smartgrid/>

Annex A describes in more detail the relevance of CISPR standards to SmartGrid including examples.

## 1 Scope

This document provides guidance on the use of CISPR standards that apply to equipment connected to the SmartGrid and intended to operate in the customer domain (see IEC SmartGrid roadmap). It will also indicate which immunity standards are applicable. It does not apply to EMC in other domains.

This guidance document refers to all customer premises equipment intended to be connected to the SmartGrid including, but not limited to;

- Equipment intended to be connected to the SmartGrid
- Equipment designed to participate in the SmartGrid functionality or control (for example: Smart meters or ancillary equipment intended for installation in the customer premise)
- Equipment which is used for local electricity generation and storage in the customer domain (for example Grid Connected Power Converters)

This guide is not intended to apply to equipment that is outside the customer domain including equipment that comprises part of the SmartGrid itself

Note 1 Editors of standards for other domains should realise that protection from interference is optimal when equipment in interconnected domains meets similar emission requirements.

Note 2 CISPR standards are not applicable to the control of intentional emissions from a radio transmitter as defined by the ITU-R, nor to any spurious emissions related to these intentional emissions.

The objectives of this publication are then to identify CISPR standards that focus on emissions and that contain requirements:

- 1) which provide an adequate level of protection allowing radio services to operate as intended ;
- 2) allowing equipment connected to the SmartGrid to operate as intended in the expected EM environment
- 3) Helping in reproducibility of measurement results.

Note: there are other non CISPR product standards instead of, or in addition to the CISPR standards referred to here, that are applicable to equipment connected to the SmartGrid.

## 2 Normative References

This document provides guidance and is intended to be informative, there are no normative references but there are several documents cited in the bibliography at the end of this guide that are useful in this discussion.

## 3 Definitions, acronyms and abbreviations

### 3.1 Terms and definitions

For the purpose of this document, the following terms and definitions apply. The definitions are given in groups and may later be reordered in alphabetic manner.

### 3.1.1

#### **SmartGrid**

an electricity network that can intelligently integrate the actions of all users connected to it – generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies

NOTE 1 to entry: A SmartGrid employs innovative products and services together with intelligent monitoring, control, communication, and self-healing technologies to:

- facilitate the connection and operation of generators of all sizes and technologies;
- allow consumers to play a part in optimizing the operation of the system;
- provide consumers with greater information and choice of supply;
- significantly reduce the environmental impact of the whole electricity supply system;
- deliver enhanced levels of reliability and security of supply

NOTE 2 to entry: Equipment connected to the SmartGrid is any equipment that is connected to a mains network that has SmartGrid functionality.”

[sg3\_roadmap.pdf]

### 3.1.2

#### **Customer Domain**

the domain that includes Smart power consumption, local production, home and building automation

### 3.1.3

#### **port**

physical interface through which electromagnetic energy enters or leaves the EUT

[CISPR 32 ed. 1.0, definition 3.1.25]

### 3.1.4

#### **AC/DC mains power port**

port used to connect to the AC or DC mains supply network

NOTE 1 to entry: Equipment with a DC power port which is powered by a dedicated AC/DC power converter is considered to be AC mains powered equipment.

NOTE 2 to entry: DC power ports supporting communications are considered to be wired networks ports, for example Ethernet ports which include Power Over Ethernet (POE).

### 3.1.5

#### **analogue/digital data port**

signal/control port (3.1.12), antenna port (3.1.6), wired network port (3.1.13), broadcast receiver tuner port (3.1.7), or optical fibre port (3.1.10) with metallic shielding and/or metallic strain relief member(s)

[CISPR 32 ed. 1.0, definition 3.1.2]

### 3.1.6

#### **antenna port**

port, other than a broadcast receiver tuner port (3.1.7), for connection of an antenna used for intentional transmission and/or reception of radiated RF energy

[CISPR 32 ed. 1.0, definition 3.1.3]

### **3.1.7**

#### **broadcast receiver tuner port**

port intended for the reception of a modulated RF signal carrying terrestrial, satellite and/or cable transmissions of audio and/or video broadcast and similar services

NOTE to entry: This port may be connected to an antenna, a cable distribution system, a VCR or similar device.

[CISPR 32 ed. 1.0, definition 3.1.8]

### **3.1.8**

#### **PLC port (Power and telecommunications)**

port that connects to the low voltage AC mains power network for the purpose of data transfer and communication, and may also supply electrical energy to the EUT

Note 1 to entry: PLC ports are also called PLT ports.

### **3.1.9**

#### **enclosure port**

physical boundary of the EUT through which electromagnetic fields may radiate

[CISPR 32 ed. 1.0, definition 3.1.14]

### **3.1.10**

#### **optical fibre port**

port at which an optical fibre is connected to an equipment

[CISPR 32 ed. 1.0, definition 3.1.24]

### **3.1.11**

#### **RF modulator output port**

port intended to be connected to a broadcast receiver tuner port in order to transmit a signal to the broadcast receiver

[CISPR 32 ed. 1.0, definition 3.1.27]

### **3.1.12**

#### **signal/control port**

port intended for the interconnection of components of an EUT, or between an EUT and local AE and used in accordance with relevant functional specifications (for example for the maximum length of cable connected to it)

NOTE to Entry: Examples include RS-232, Universal Serial Bus (USB), High-Definition Multimedia Interface (HDMI), IEEE Standard 1394 ("Fire Wire").

[CISPR 32 ed. 1.0, definition 3.1.28]

### **3.1.13**

#### **wired network port**

point of connection for voice, data and signalling transfers intended to interconnect widely dispersed systems by direct connection to a single-user or multi-user communication network (for example CATV, PSTN, ISDN, xDSL, LAN and similar networks)

NOTE to entry: These ports may support screened or unshielded cables and may also carry AC or DC power where this is an integral part of the telecommunication specification.

[CISPR 32 ed. 1.0, definition 3.1.30]

**3.1.14**

**Electromagnetic compatibility**

the ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

[IEV 702-08-66]

**3.1.15**

**electromagnetic disturbance**

any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter

NOTE to entry: An electromagnetic disturbance may be an electromagnetic noise, an unwanted signal or a change in the propagation medium itself.

[IEV 702-08-04]

**3.1.16**

**electromagnetic interference**

**EMI**

degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance

NOTE to entry: In English, the terms “electromagnetic disturbance” and “electromagnetic interference” designate respectively the cause and the effect, but they are often used indiscriminately.

[IEV 702-08-29]

**3.2 Abbreviations**

For the purposes of this document, the following abbreviations apply.

NOTE: Abbreviations not shown here are defined at their first occurrence in this document.

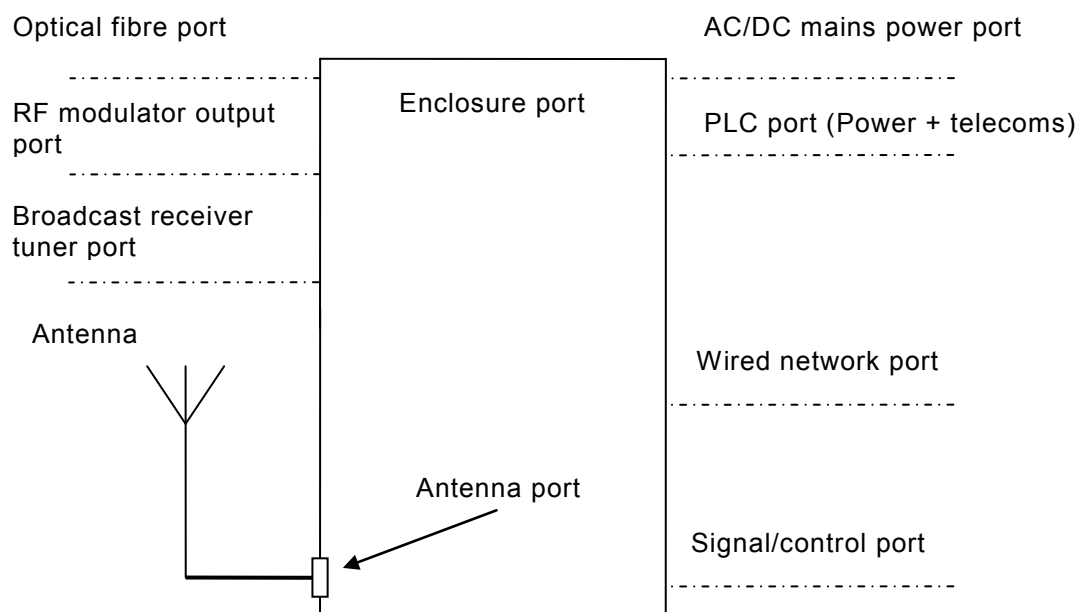
EM	Electro-Magnetic
EMC	Electro-Magnetic Compatibility
ITE	information technology equipment
LV	Low Voltage
NIST	National Institute of Standards and Technology, Boulder, CO, USA
PLC	power Line Communication
RF	Radio Frequency
SGIP	SmartGrid Interoperability Panel (NIST)

**4 Attention to Electromagnetic Compatibility**

The basic concept covered here is to map the EMC requirements from existing CISPR product standards (see IEC Guide 107) onto Equipment connected to the SmartGrid. While these publications are voluntary unless specified by a National or regional authority, if a manufacturer chooses to apply the standard that means that the requirements given within the standard are met.

The requirements for equipment connected to the SmartGrid in the customer domain are contained in the CISPR product family or generic emission standards. These requirements are applied on a port by port basis. Figure 1 shows a view of the ports that might be found on SmartGrid equipment in the customer domain.





**Figure 2 Ports that may be found in equipment connected to a SmartGrid**

While the ports may be specifically input or output, it is expected that in many cases for equipment connected to the SmartGrid, ports will be both input and output.

Emission limits and test methods relevant to equipment connected to the SmartGrid can be found in the specific product family standards (see table 1) or, where no product family standard exists, in the generic emission standard. SmartGrid is characterized by data exchange with the Grid, and about the power delivered from/to the grid

The following technologies are considered in current implementations and/or future developments of the SmartGrid:

- PLC < 150 kHz,
- PLC between 150 and 500 kHz,
- PLC > 1700 kHz,
- GPRS/UMTS,
- WiMAX/LTE,
- meshed RF,
- wired IP

## **5 CISPR standards relevant to equipment connected to the SmartGrid**

Table 1 contains a list of publications which contain the generally accepted emission requirements for equipment connected to the SmartGrid. Under normal circumstances the product family (CISPR) standards will be used but the generic standard (IEC 61000-6-3) is available where no appropriate product family standard has been published.

**Table 1 Publications containing applicable emission limits and test methods**

Publication *	Latest issue
CISPR 11	2010-05
CISPR 12	2009-03
CISPR 13	2009-01
CISPR 14-1	2009-07
CISPR 15	2013-05
CISPR 22	2008-09
CISPR 32	2012-01
CISPR 25	2008-03
IEC61000-6-3	2011-02
<b>IEC 61000-6-4</b>	<b>2011-02</b>

\* The basic publications in the CISPR 16 series (maintained by IEC CISPR SC A) are included in these standards by reference

For completeness Table 2 contains the immunity publications that are most likely to be appropriate for equipment connected to the SmartGrid in the customer domain. As for emission standards the product family standard would normally be applicable. The generic standard (IEC 61000-6-1) is available where no appropriate product family standard has been published (for further detail on IEC 61000-6-1 contact IEC TC 77).

**Table 2 Related Immunity standards**

Publication*	Latest issue
CISPR 14-2	2008-07
IEC 61547	2009-06
CISPR 20	2006-11
CISPR 24	2010-08
IEC 61000-6-1	2005-03
IEC 61000-6-2	2005-01

\* The basic standards in the IEC 61000-4 series (maintained by IEC TC77) are included in these standards by reference

## 6 Remaining areas to be studied

Following a review of the content of relevant IEC EMC standards, we conclude that although most of the EMC is well covered, some areas of concern still exist.

The remaining areas of concern for the EMC of equipment connected to a SmartGrid are:

- Frequencies below 150 kHz are not covered in the majority of the CISPR standards (where this band is used for equipment to communicate with the SmartGrid)
- Installations where the distance between fixed equipment is very short Measuring facilities will need to be fully defined

We note that there are measurement methods and limits for the frequency range below 150 kHz contained in some CISPR standards for example:

- CISPR 14-1 for induction cooking equipment
- CISPR 15 for lighting equipment

Further experience with SmartGrid will indicate whether there is sufficient need to develop new requirements in the band below 150 kHz and the equipment to which any new limits should be applied. Existing work is concentrated on analysing the current situation and describing the appropriate compatibility levels. Based on this work it will then be possible to develop new test methods and limits which could be applied in this band.

There is also a potential need to assess the impact of SmartGrid in terms of the EMC model and impact on the local environment. Specifically we need to determine whether the existing standards (which were written for the “pre- SmartGrid” environment) are still sufficient in the “with SmartGrid” environment.

## Annex A (Informative)

### CISPR and the SmartGrid

#### A.1 Introduction

This annex gives further information as to the situations where EMC is of importance to the SmartGrid

#### A.2 Examples of possible interference cases

As background here are some examples of broad categories of potential interference cases that may need to be considered:

- Coupling of conducted RF disturbances from LV AC mains installations into equipment connected to the SmartGrid particularly in the frequency range below 150 kHz.
- Coupling of RF disturbances from intentional (such as wireless transmitters) and unintentional radiators causing interference in equipment connected to the SmartGrid.
- Commonly occurring EM events like electrostatic discharges, fast transients and power line disturbances causing interference to equipment connected to the SmartGrid.
- High level EM disturbances from natural phenomena such as lightning surges and geomagnetic storms and even by intentional terrorist acts causing interference into equipment connected to the SmartGrid.

#### A.3 Applicable CISPR standards:

Since both the use of wireless communications and communications over power/mains lines is a key part of the SmartGrid system, the use of CISPR standards is essential to minimize the risk to both radio services and to electronic products in close proximity to SmartGrid devices. Only CISPR has this international role of standardization for **RF emissions**.

Here are the standards that should be referenced in all SmartGrid planning:

- [CISPR 11](#) (Emission from industrial, scientific, and Medical devices)
- [CISPR 32](#) (Emissions from information technology and multimedia equipment as well as receivers). This is identified in the [IEC SmartGrid Standardization Roadmap](#).
- [CISPR 16](#) is the also indirectly applicable. Its various parts include basic RF measurement methods and test instrumentation specifications including measurement uncertainty and is referenced in other CISPR product committee standards
- [CISPR 24](#) for immunity of ITE in SmartGrid control and appliances/devices. This standards references much of the TC77 immunity test standards with additional information on the particular test set up and device operation
- [CISPR 12/25](#) for vehicles provides test methods for emission measurements which is considering the impact of electrical vehicles and distributed charging stations

#### A.4 Example of SmartGrid interference and application of CISPR 11

*Power inverters and/or switched mode power supplies of user equipment are likely to cause conducted disturbances on the mains cord. These disturbances will cause performance degradation of other equipment connected to the same Smart Micro-Grid or LV a.c. mains used in a structure. SmartGrid meters that would be located at the power entrance to the structure would be controlled by SmartGrid communications and used for registration of amounts of electric energy passing through the meter. Such disturbances could affect the proper operation of the meter. There is evidence that household appliances and lighting*

*equipment can be switched from stand-by mode to active mode of operation by these kinds of conducted disturbances when these disturbances triggered an unwanted event communicated falsely over the SmartGrid system. Action will also to have taken to supplementing existing immunity standards for such devices as well as the Smart meters themselves.*

CISPR 11 contains test methods and limits which if invoked would limit this undesired response.

## Bibliography

The following documents are suggested for further guidance and additional information.

- [1] CISPR 11, Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement
- [2] CISPR 12, Vehicles, boats and internal combustion engines – Radio disturbance characteristics – Limits and methods of measurement for the protection of off-board receivers
- [3] CISPR 13, Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and methods of measurement
- [4] CISPR 14-1, Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission
- [5] CISPR 14-2, Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 2: Immunity
- [6] CISPR 15, Limits and methods of measurement of radio disturbance characteristics of electrical lighting and similar equipment
- [7] CISPR 20, Sound and television broadcast receivers and associated equipment – Immunity characteristics – Limits and methods of measurement
- [8] CISPR 22, Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
- [9] CISPR 24, Information technology equipment – Immunity characteristics – Limits and methods of measurement
- [10] CISPR 32, Electromagnetic compatibility of multimedia equipment – Emission requirements
- [11] IEC 61000-6-1 Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments.
- [12] IEC 61000-6-2 Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments.
- [13] IEC 61000-6-3 Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments.
- [14] IEC 61000-6-4 Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments.
- [15] IEC 61547 Equipment for general lighting purposes – EMC immunity requirements

Further suggested reading:

- [16] CENELEC SC 205A Mains communicating systems TF EMI study report on electromagnetic interference between electrical equipment/systems in the frequency range below 150kHz (Edition 2)

- [17] NIST Report- detail to come from. [https://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/SGIPDocumentRegistry/EMII\\_WG EMC White Paper SGIP\\_2012\\_005.pdf](https://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/SGIPDocumentRegistry/EMII_WG EMC White Paper SGIP_2012_005.pdf)
  - [18] IEC Guide 107, *Electromagnetic compatibility - Guide to the drafting of electromagnetic compatibility publications*
  - [19] CISPR interest in SmartGrid (See <http://www.iec.ch/emc/smartgrid/>)
-