International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Series K

Supplement 10

(11/2017)

SERIES K: PROTECTION AGAINST INTERFERENCE

Analysis of electromagnetic compatibility aspects and definition of requirements for 5G systems

ITU-T K-series Recommendations – Supplement 10

Supplement 10 to ITU-T K-series Recommendations

Analysis of electromagnetic compatibility aspects and definition of requirements for 5G systems

Summary

Supplement 10 to ITU-T K-series Recommendations provides guidance on the electromagnetic compatibility (EMC) compliance assessment considerations for 5G systems. Given the 5G radio access network (RAN) technical standards are still being finalised, the first version of this Supplement focuses on possible emission and immunity requirements for 5G systems. This Supplement will be revised, if needed, to address the more specific EMC requirements when technical standards of 5G systems are published.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T K Suppl. 10	2017-11-22	5	11.1002/1000/13474

Keywords

5G, electromagnetic compatibility, EMC, wireless.

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this publication, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this publication is voluntary. However, the publication may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the publication is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the publication is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this publication may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the publication development process.

As of the date of approval of this publication, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this publication. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Table of Contents

Supplement 10 to ITU-T K-series Recommendations

Analysis of electromagnetic compatibility aspects and definition of requirements for 5G systems

1 Scope

This Supplement provides an analysis of the electromagnetic compatibility (EMC) requirements for 5G systems to ensure operation of these systems and avoid interference with other devices/systems.

This Supplement covers:

– Analysis of the present available EMC ITU-T Recommendations and standards and works in IEC/CISPR and ETSI EMC technical committees;

– Definition of the requirements for EMC management in the scenario of 5G systems

This Supplement does not address the co-existence of 5G systems with other radio systems because this subject is being addressed by ITU-R.

The EMC specifications proposed in this Supplement will be revised when the 5G transmitter and receiver specifications are published and with consideration of the ongoing work done in other standardization organizations such as IEC/CISPR and ETSI.

2 References

[ITU-T K.48] Recommendation ITU-T K.48 (2006), *EMC requirements for telecommunication equipment – Product family Recommendation.*

[CISPR 11] CISPR 11 (06/2015), A1 (06/2016), *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*.
https://webstore.iec.ch/publication/22643

[CISPR 16-2-1] CISPR 16-2-1:2014, A1 (06/2017), *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*.
https://webstore.iec.ch/publication/40

[CISPR 16-2-3] CISPR 16-2-3:2016, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*.
https://webstore.iec.ch/publication/25877

[CISPR 32] CISPR 32:2015, *Electromagnetic compatibility of multimedia equipment – Emission requirements*.
https://webstore.iec.ch/publication/22046

[CISPR 35] CISPR 35:2016, *Electromagnetic compatibility of multimedia equipment – Immunity requirements*.
https://webstore.iec.ch/publication/25667

[ETSI EN 300 386] ETSI EN 300 386 V2.1.1 (2016), *Electromagnetic compatibility and Radio spectrum Matters (ERM); Telecommunication network equipment; ElectroMagnetic Compatibility (EMC) requirements*.
http://www.etsi.org/deliver/etsi_en/300300_300399/300386/02.01.01_60/en_300386v020101p.pdf

[ETSI EN 301 489-1] ETSI EN 301 489-1 V2.1.1 (2017), *ElectroMagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements; Harmonised Standard covering the essential requirements of article 3.1(b) of the Directive 2014/53/EU and the essential requirements of article 6 of the Directive 2014/30/EU*; *Part 1: Common technical requirements*.
http://www.etsi.org/deliver/etsi_en/301400_301499/30148901/02.01.01_60/en_30148901v020101p.pdf

[IEC 61000-2-5] IEC 61000-2-5:2017, *Electromagnetic compatibility (EMC) – Part 2-5: Environment – Description and classification of electromagnetic environments*.
https://webstore.iec.ch/publication/59812

[IEC 61000-4-2] IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*.
https://webstore.iec.ch/publication/4189

[IEC 61000-4-3] IEC 61000-4-3:2006), AMD1:2007 and AMD2:2010, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*.
https://webstore.iec.ch/publication/4212

[IEC 61000-4-4] IEC 61000-4-4 (04/2012), *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*.
https://webstore.iec.ch/publication/22271

[IEC 61000-4-5] IEC 61000-4-5:2014, AMD1:2017, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*.
https://webstore.iec.ch/publication/61166

[IEC 61000-4-6] IEC 61000-4-6:2013, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*.
https://webstore.iec.ch/publication/4224

[IEC 61000-4-8] IEC 61000-4-8:2009, *Electromagnetic compatibility (EMC) – Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test*.
https://webstore.iec.ch/publication/22272

[IEC 61000-4-11] IEC 61000-4-11:2004, AMD1:2017, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests*.
https://webstore.iec.ch/publication/60729

[IEC 61000-4-20] IEC 61000-4-20:2010, *Electromagnetic compatibility (EMC) – Part 4-20: Testing and measurement techniques – Emission and immunity testing in transverse electromagnetic (TEM) waveguides*.
https://webstore.iec.ch/publication/4190

[IEC 61000-4-21] IEC 61000-4-21:2011, *Electromagnetic compatibility (EMC) – Part 4-21: Testing and measurement techniques – Reverberation chamber test methods*.
https://webstore.iec.ch/publication/4191

[IEC 61000-6-1] IEC 61000-6-1:2016, *Electromagnetic compatibility (EMC) – Part 6-1: Generic standards – Immunity for residential, commercial and light-industrial environments*.
https://webstore.iec.ch/publication/25628

[IEC 61000-6-2] IEC 61000-6-2 (08/2016), *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards. Immunity standard for industrial environments*. https://webstore.iec.ch/publication/25629

[IEC 61000-6-3] IEC 61000-6-3:2006, AMD1:2010, *Electromagnetic compatibility (EMC) – Part 6-3: Generic standards – Emission standard for residential, commercial and light-industrial environments*. https://webstore.iec.ch/searchform&q=IEC%2061000-6-3

[IEC 61000-6-4] IEC 61000-6-4:2006, AMD1:2010, *Electromagnetic compatibility (EMC) – Part 6-4: Generic standards – Emission standard for industrial environments*. https://webstore.iec.ch/publication/4251

3 Definitions

3.1 Terms defined elsewhere

This Supplement uses the following terms defined elsewhere:

3.1.1 AC mains power port [CISPR 32]: Port used to connect to the mains supply.

3.1.2 analogue/digital data port [CISPR 32]: Signal/control port, antenna port, wired network port, broadcast, receiver tuner port, or optical fibre port with metallic shielding and/or metallic strain relief member(s)

3.1.3 antenna port [CISPR 32]: Port, other than a broadcast receiver tuner port (3.1.8), for connection of an antenna used for intentional transmission and/or reception of radiated RF energy

3.1.4 auxiliary equipment (AE) [IEC 61000-4-4]: Equipment necessary to provide the equipment under test with the signals required for normal operation and equipment to verify the performance of the EUT.

3.1.5 broadcast receiver turner port [CISPR 32]: 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

3.1.6 DC network port [CISPR 32]: Port, not powered by a dedicated AC/DC power converter and not supporting communication, that connects to a DC supply network

3.1.7 electromagnetic compatibility (EMC) [b-IEC 60050-161]: Ability of equipment to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment.

3.1.8 enclosure port [CISPR 32]: Physical boundary of the EUT through which electromagnetic fields may radiate.

3.1.9 immunity (to a disturbance) [b-IEC 60050-161]: The ability of a device, equipment or system to perform without degradation in the presence of an electromagnetic disturbance.

3.1.10 immunity test level [b-IEC 60050-161]: The level of a test signal used to simulate an electromagnetic disturbance when performing an immunity test.

3.1.11 information technology equipment (ITE) [CISPR 32]: Equipment having a primary function of either (or a combination of) entry, storage, display, retrieval, transmission, processing, switching, or control of data and/or telecommunication messages and which may be equipped with one or more ports typically for information transfer.

3.1.12 multimedia equipment [CISPR 32]: Equipment that is information technology equipment, audio equipment, video equipment, broadcast receiver equipment, entertainment lighting control equipment or combinations of these.

3.1.13 optical fibre port [CISPR 32]: Port at which an optical fibre is connected to an equipment

3.1.14 port [CISPR 32]: physical interface through which electromagnetic energy enters or leaves the equipment under test.

3.1.15 residential location [IEC 61000-6-1]: Location which exists as an area of land designated for the construction of domestic dwellings, and is characterized by the fact that equipment is directly connected to a low-voltage public mains network or connected to a dedicated DC source which is intended to interface between the equipment and the low-voltage mains network.

3.1.16 signal/control port [CISPR 32]: Port intended for the interconnection of components of an equipment under test, or between an equipment under test and local auxiliary equipment and used in accordance with relevant functional specifications (for example for the maximum length of cable connected to it)

3.1.17 wired network port [CISPR 32]: Port for the connection of voice, data and signalling transfers intended to interconnect widelydispersed systems by direct connection to a single-user or multi-user communication network

3.2 Terms defined in this Supplement

This Supplement defines the following term:

3.2.1 telecommunication network: A network operated under a licence granted by a national telecommunications authority which provides telecommunications between network termination points (NTPs) (i.e., excluding terminal equipment beyond the NTPs).

4 Abbreviations and acronyms

This Supplement uses the following abbreviations and acronyms:

AC Alternating Current

AE Auxiliary Equipment

AM Amplitude Modulation

AMN Artificial Mains Network

AAN Artificial Asymmetric Network

CDN Coupling and Decoupling Network

CISPR International Special Committee on Radio Interference

CVP Capacitive Voltage Probe

DC Direct Current

DSL Digital Subscriber Line

EM Electromagnetic

EMC Electromagnetic Compatibility

ESD Electrostatic Discharge

EUT Equipment Under Test

FAR Fully Anechoic Room

FDD Frequency Domain Duplex

FSOATS Free Space Open Area Test Site

IoT Internet of Things

LTE Long Term Evolution

MIMO Multiple-Input and Multiple-Output

NTP Network Termination Point

OATS Open Area Test Site

RF Radio Frequency

TDD Time Domain Duplex

TEM Transverse Electromagnetic

xDSL Generic term covering the family of all DSL technologies

5 Conventions

None.

6 Overview of 5G networks

5G is the fifth generation of mobile networks and a significant evolution of the 4G long term evolution (LTE) networks. 5G has been designed to meet the very large growth in data and connectivity of today's modern society, the Internet of things (IoT) with billions of connected devices and tomorrow's innovations.

5G will initially operate in conjunction with existing 4G networks before evolving to fully standalone networks in subsequent releases and coverage expansions.

6.1 5G spectrum

5G will predominately use additional spectrum in the 3-100 GHz range to add significantly more capacity compared to the current mobile technologies. The additional spectrum and greater capacity will enable more users, more data and faster connections. It is also expected that there will be future reuse of existing low band spectrum for 5G as legacy networks decline in usage and to support future use cases.

The increased spectrum also includes the millimetre (mm) wave band above 30 GHz. The mmWave frequencies provide localised coverage as they mainly operate over short line of sight distances.

6.1.1 5G frequency band summary

– Low frequency (less than 1GHz) – providing widespread coverage across urban, suburban and rural areas and supporting IoT for low data rate applications.

– Medium frequency (1–6GHz) – providing good coverage and high speeds and including the expected initial 5G range of 3.3–3.8GHz which has been identified as the most likely band for launching 5G globally.

– High frequency (above 6GHz) – providing ultra-high broadband speeds for advanced mobile broadband applications and most suitable for applications in dense traffic hotspots. The 26-28GHz band has been identified for future 5G applications

Spectrum for mobile telecommunication services including 5G is determined by the World Radiocommunication Conferences (WRC) which are held every three to four years. It is the job of WRC to review and, if necessary, revise the Radio Regulations, the international treaty governing the use of the radio-frequency spectrum and the geostationary-satellite and non-geostationary-satellite orbits. Revisions are made on the basis of an agenda determined by the ITU Council, which takes into account recommendations made by previous world radiocommunication conferences.

The 5G standards are expected to support both frequency domain duplex (FDD) and time domain duplex (TDD). Research is also underway on full duplex systems for 5G to transmit and receive simultaneous on the same channel. Full duplex effectively doubles the spectrum efficiency.

6.2 How 5G works

Most operators will initially integrate 5G networks with existing 4G networks to provide a continuous connection.

A mobile network has two main components, the 'radio access network' and the 'core network'.

6.2.1 Radio access network

The radio access network consists of various types of facilities including small cells, towers, masts and dedicated in-building and home systems which connect mobile users and wireless devices to the main core network.

Small cells will be a major feature of 5G networks particularly at the new mmWave frequencies where the connection range is very short. To provide a continuous connection, small cells will be distributed in clusters depending on where users require connection and this will complement the macro network.

5G macro cells will use multiple input, multiple output (MIMO) antennas that have multiple elements or connections to send and receive more data simultaneously. The benefit to users is that more people can simultaneously connect to the network and maintain high throughput. MIMO antennas for 5G are often referred to as 'massive MIMO' due to the number of multiple elements and connections however the physical size is similar to existing 3G and 4G base station antennas.

6.2.2 Core network

The core network is the mobile exchange and data network that manages all of the mobile voice, data and Internet connections. For 5G, the 'core network' is being redesigned to better integrate with the Internet and cloud based services and also includes distributed servers across the network improving response times (reducing latency).

Many of the advanced features of 5G including network virtualization and network slicing for different applications and services, will be managed in the core.

When a 5G connection is established, the user equipment (or device) connects to the 4G network to provide the control signalling and to the 5G network to help provide the fast data connection by adding to the existing 4G carriage.

Where there is limited 5G coverage, the data is carried as today on the 4G network providing the continuous connection. Essentially with this design, the 5G network is complementing the existing 4G network.

6.3 5G working with 4G

When a 5G connection is established, the user equipment (or device) connects to the 4G network to provide the control signalling and to the 5G network to help provide the fast data connection by adding to the existing 4G carriage.

Where there is limited 5G coverage, the data is carried as today on the 4G network providing the continuous connection. Essentially with this design, the 5G network is complementing the existing 4G network.

7 Currently defined EMC requirements

The EM compatibility level among various devices and networks is ensured by the fact that each device shall not generate disturbances above a defined level and that the devices will have a minimum immunity level from disturbances.

Therefore, EMC standards include requirements for emission and immunity.

The emission requirements are based on the limits defined by CISPR that are widely used to protect radio services. Generic emission requirements are defined in [IEC 61000-6-3] and [IEC 61000-6-4] while product specific emission requirements are defined in product standards.

Generic immunity requirements are defined in the standards [IEC 61000-6-1] and [IEC 61000-6-2] while specific product standards have been produced taking into account the generic requirements, the electromagnetic environmental classification given in [IEC 61000-2-5] and the specific product functionality. The immunity requirements for multimedia equipment are defined in the [CISPR 35] but there are also other product specific standards. [CISPR 35] also covers immunity requirements of equipment with telecommunication functions.

The emission and immunity requirements considered in the present document to identify the most suitable EMC requirements for 5G systems are the one published in the publications [CISPR 32] and [CISPR 35] as these standards apply to multimedia equipment including also information technology equipment. A summary of the requirements in [CISPR 32] and [CISPR 35] is provided in the following clauses.

7.1 Emission requirements in [CISPR 32]

In Tables 1 to 6 is provided the summary of the emission requirements that are published in [CISPR 32].

Table 1 – Class A limits for radiated emissions in [CISPR 32]

Phenomena	Frequency range	Measurement distance	Limits	Detector type	Reference test method
Radiated emissions	30 MHz – 200 MHz	10 m (FAR/OATS)	40 dBµV/m	Quasi-Peak	[CISPR 16-2-3]
	200 MHz – 1000 MHz	10 m (FAR/OATS)	47 dBµV/m		
	1000 MHz – 3000 MHz	3 m (FSOATS)	56 dBµV/m	Average	
			76 dBµV/m	Peak	
	3000 MHz – 6000 MHz	3 m (FSOATS)	60 dBµV/m	Average	
			80 dBµV/m	Peak	

Table 2 – Class A limits for conducted emissions on AC mains ports in [CISPR 32]

Phenomena	Frequency range	Limits	Detector type	Reference test method
Conducted emissions on AC port	0.15 MHz – 0.5 MHz	79 dBµV	Quasi-Peak	[CISPR 16-2-1]
	0.5 MHz – 30 MHz	73 dBµV		
	0.15 MHz – 0.5 MHz	66 dBµV	Average	
	0.5 MHz – 30 MHz	60 dBµV		

Table 3 – Class A limits for conducted emissions on wired network ports in [CISPR 32]

Phenomena	Frequency range	Voltage limits	Current limits	Detector type	Reference test method
Conducted emissions on wired network ports	0.15 MHz – 0.5 MHz	97 to 87 dBµV	Not applicable	Quasi-Peak	[CISPR 16-2-1] (with AAN)
	0.5 MHz – 30 MHz	87 dBµV			
	0.15 MHz – 0.5 MHz	84 to 74 dBµV		Average	
	0.5 MHz – 30 MHz	74 dBµV			
	0.15 MHz – 0.5 MHz	97 to 87 dBµV	53 to 43 dBµA	Quasi-Peak	[CISPR 16-2-1] (with CVP and Current Probe)
	0,5 MHz – 30 MHz	87 dBµV	43 dBµA		
	0,15 MHz – 0,5 MHz	84 to 74 dBµV	40 to 30 dBµA	Average	
	0,5 MHz – 30 MHz	74 dBµV	30 dBµA		
	0,15 MHz – 0,5 MHz	Not applicable	53 to 43 dBµA	Quasi-Peak	[CISPR 16-2-1] (with Current Probe)
	0,5 MHz – 30 MHz		43 dBµA		
	0,15 MHz – 0,5 MHz		40 to 30 dBµA	Average	
	0,5 MHz – 30 MHz		30 dBµA		

Table 4 – Class B limits for radiated emissions in [CISPR 32]

Phenomena	Frequency range	Measurement distance	Limits	Detector type	Reference test method
Radiated emissions	30 MHz – 200 MHz	10 m (FAR/OATS)	30 dBµV/m	Quasi-Peak	[CISPR 16-2-3]
	200 MHz – 1000 MHz	10 m (FAR/OATS)	37 dBµV/m		
	1000 MHz – 3000 MHz	3 m (FSOATS)	50 dBµV/m	Average	
			70 dBµV/m	Peak	
	3000 MHz – 6000 MHz	3 m (FSOATS)	54 dBµV/m	Average	
			74 dBµV/m	Peak	

Table 5 – Class B limits for conducted emissions on AC mains ports in [CISPR 32]

Phenomena	Frequency range	Limits	Detector type	Reference test method
Conducted emissions on AC port	0,15 MHz – 0,5 MHz	66 to 56 dBµV	Quasi-Peak	[CISPR 16-2-1]
	0,5 MHz – 5 MHz	56 dBµV		
	5 MHz – 30 MHz	60 dBµV		
	0,15 MHz – 0,5 MHz	56 to 46 dBµV	Average	
	0,5 MHz – 5 MHz	46 dBµV		
	5 MHz – 30 MHz	50 dBµV		

Table 6 – Class B limits for conducted emissions on wired network ports in [CISPR 32]

Phenomena	Frequency range	Voltage limits	Current limits	Detector type	Reference test method
Conducted emissions on wired network ports	0,15 MHz – 0,5 MHz	84 to 74 dBµV	Not applicable	Quasi-Peak	[CISPR 16-2-1] (with AAN)
	0,5 MHz – 30 MHz	74 dBµV			
	0,15 MHz – 0,5 MHz	74 to 64 dBµV		Average	
	0,5 MHz – 30 MHz	64 dBµV			
	0,15 MHz – 0,5 MHz	84 to 74 dBµV	40 to 30 dBµA	Quasi-Peak	[CISPR 16-2-1] (with CVP and Current Probe)
	0,5 MHz – 30 MHz	74 dBµV	30 dBµA		
	0,15 MHz – 0,5 MHz	74 to 64 dBµV	30 to 20 dBµA	Average	
	0,5 MHz – 30 MHz	64 dBµV	20 dBµA		
	0,15 MHz – 0,5 MHz	Not applicable	40 to 30 dBµA	Quasi-Peak	[CISPR 16-2-1] (with Current Probe)
	0,5 MHz – 30 MHz		30 dBµA		
	0,15 MHz – 0,5 MHz		30 to 20 dBµA	Average	
	0,5 MHz – 30 MHz		20 dBµA		

7.2 Immunity requirements in [CISPR 35]

In Tables 7 to 10 is provided the summary of the immunity requirements that are published in [CISPR 35]. For the immunity requirements, the following generic performance criteria are defined:

Performance criterion A

The equipment shall continue to operate as intended without operator intervention. No degradation of performance, loss of function or change of operating state is allowed below a performance level specified by the manufacturer when the equipment is used as intended.

The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, then either of these may be derived from the product description and documentation and by what the user may reasonably expect from the equipment if used as intended.

Performance criterion B

During the application of the disturbance, degradation of performance is allowed. However, no unintended change of actual operating state or stored data is allowed to persist after the test.

After the test, the equipment shall continue to operate as intended without operator intervention; no degradation of performance or loss of function is allowed, below a performance level specified by the manufacturer, when the equipment is used as intended.

The performance level may be replaced by a permissible loss of performance.

If the minimum performance level (or the permissible performance loss), or recovery time, is not specified by the manufacturer, then either of these may be derived from the product description and documentation and by what the user may reasonably expect from the equipment if used as intended.

Performance criterion C

Loss of function is allowed, provided the function is self-recoverable, or can be restored by the operation of the controls by the user in accordance with the manufacturer's instructions. A reboot or re-start operation is allowed.

Information stored in non-volatile memory, or protected by a battery backup, shall not be lost.

Table 7 – Immunity requirements on enclosure port in [CISPR 35]

Phenomenon	Reference test method	Test level	Performance criterion
Electrostatic discharges	[IEC 61000-4-2]	Contact: 4 kV Air: 8 kV	B B
Radio frequency electromagnetic field amplitude modulated	[IEC 61000-4-3] Or [IEC 61000-4-20] Or [IEC 61000-4-21]	80 MHz – 1 GHz 3 V/m (80% AM modulation at 1 kHz)	A
		Spot frequencies: 1,8 GHz 2,6 GHz 3,5 GHz 5 GHz 3 V/m (80% AM modulation at 1 kHz)	A
Power frequency magnetic field (only applicable to EUT with devices susceptible to magnetic field)	[IEC 61000-4-8]	50 Hz 1 A/m	A

Table 8 – Immunity requirements for analogue/digital signal ports in [CISPR 35]

Phenomenon	Reference test method	Test level	Performance criterion
Continuous induced RF disturbances	[IEC 61000-4-6]	0,15 – 10 MHz 3 V	A
		10 MHz – 30 MHz 3 V to 1 V	
		30 MHz 80 MHz 1 V	
Broadband impulse noise disturbances, repetitive (only applicable to CPE)	[CISPR 35]	0,15 to 0,5 MHz 107 dbµV	A
		0,5 MHz to 10 MHz 107 to 36 dBµV	
		10 MHz – 30 MHz 36 to 30 dBµV	
		Burst duration: 0,7 ms Burst period: 10 ms	
Broadband impulse noise disturbances, isolated (only applicable to CPE)	[CISPR 35]	0,15 to 30 MHz 110 dbµV Burst duration: 0,24 ms, 10 ms, 300 ms	B
Electrical Fast transients	[IEC 61000-4-4]	0,5 kV Rep. freq: 5 kHz and 100 kHz on xDSL ports	B
Surges (outdoor lines)	[IEC 61000-4-5]	Unshielded symmetrical lines: Pulse: 10µs/700µs Lines to Ground: 1 kV without primary protections	B
		Lines to Ground: 4 kV with primary protections	C

Table 8 – Immunity requirements for analogue/digital signal ports in [CISPR 35]

Phenomenon	Reference test method	Test level	Performance criterion
		Coaxial or shielded lines: Pulse: 1,2µs/50µs Shield to Ground: 0,5 kV	B
Surges (indoor lines)		None	

Table 9 – Immunity requirements for AC power ports in [CISPR 35]

Phenomenon	Reference test method	Test level	Performance criterion
Continuous induced RF disturbances	[IEC 61000-4-6]	0,15 – 10 MHz 3 V	A
		10 MHz – 30 MHz 3 V to 1 V	
		30 MHz 80 MHz 1 V	
Electrical Fast transients	[IEC 61000-4-4]	1 kV Rep. freq: 5 kHz	B
Surges	[IEC 61000-4-5]	Pulse: 1,2µs/50µs Shield to Ground: 2kV Line to Line: 1 kV	B B
Voltage dips	[IEC 61000-4-11]	Residual voltage < 5% Number of cycles: 0,5	B
		Residual voltage < 70% Number of cycles: 25	C
Voltage interruptions	[IEC 61000-4-11]	Residual voltage 0% Number of cycles: 250	C

Table 10 – Immunity requirements for DC power ports in [CISPR 35] (only applicable to ports with cables that may be longer than 3 m)

Phenomenon	Reference test method	Test level	Performance criterion
Continuous induced RF disturbances	[IEC 61000-4-6]	0,15 – 10 MHz 3 V	A
		10 MHz – 30 MHz 3 V to 1 V	
		30 MHz 80 MHz 1 V	
Electrical Fast transients	[IEC 61000-4-4]	0,5 kV Rep. freq: 5 kHz	B
Surges	[IEC 61000-4-5]	Pulse: 1,2µs/50µs Line to Ground: 0,5 kV Only applicable to outdoor cables	B

8 Analysis of the published EMC requirements in respect to 5G scenario

The EMC requirements for 5G should be defined considering the following aspects:

– Products, other than 5G radio devices, should have emission requirements in the frequency range utilized by 5G systems to avoid interferences with 5G networks.

– Products, including 5G devices, should have immunity requirements in the frequency range of the 5 G networks.

– The emission requirements of 5G transmitters and receivers are covered by ITU-R recommendations.

Then, with reference to the EMC requirements defined for multimedia equipment in [CISPR 32] and [CISPR 35] and taking into account the above aspects, the following gaps have been identified:

– Radiated emission requirements in generic and product standards do not cover the entire frequency band planned for 5G systems;

– Conducted emission requirements for DC power ports are not defined in [CISPR 32] but are present in the IEC generic emission standards and in the EMC standards for radio and telecommunication equipment such as in [ITU-T K.48], [ETSI EN 300 386] and [ETSI EN 301 489-1];

– Radiated immunity requirements in generic and product standards stops at 6 GHz or at lower frequencies. This is not enough to avoid disturbances on circuits/devices with frequency clocks higher than 6 GHz;

– Conducted radio frequency (RF) immunity requirements in [CISPR 35] are lower than IEC generic immunity standards and in the EMC standards for radio and telecommunication equipment such as in [ITU-T K.48], [ETSI EN 300 386] and [ETSI EN 301 489-1];

– Surge immunity requirements for ports intended for connecting indoor cables are not defined in [CISPR 35] but they are present in the EMC standards for radio and

telecommunication equipment such as in [ITU-T K.48], [ETSI EN 300 386] and [ETSI EN 301 489-1].

9 Proposal of EMC requirements for the deployment of 5G networks

The coexistence of 5G networks with other devices and wired networks requires that the present EMC emission standards should be amended to reduce disturbances to 5G receivers. On the other hand, EMC immunity standards should also be revised to allow the correct operation of devices when subjected to RF radiation from 5G transmitters.

The requirements outlined in clauses 9.1 to 9.8 may be considered with reference to the gap analysis performed in clause 8.

9.1 Radiated emissions

The radiated emission requirements should be extended at least up to 40 GHz but later should be increased up to 100 GHz to protect the frequency band used for 5G systems. Limits above 6 GHz are defined in [b-FCC 47 CFR part 15] regulation up to 40 GHz and in [CISPR 11] up to 18 GHz. Moreover, study of the suitable limits to protect 5G systems is started in CISPR but, for the time being, there is no yet proposal. Therefore, for the time being the following preliminary emission limits are recommended for inclusion in the Generic and product emission standards (exclusions on the applicability of such limits should be defined in product specific standards) and in the EMC standards for 5G systems:

1) Frequency range 30 MHz – 6000 MHz: limits in table 1 and 4 should apply.

2) Frequency range 6000 MHz – 40000 MHz: limits in table 11 and 12 should apply.

Class B limits of tables 4 and 12 should apply to residential environments as defined in [CISPR 32]

Table 11 – Class A limits for radiated emissions above 6 GHz

Phenomena	Frequency range	Measurement distance	Limits	Detector type	Reference test method
Radiated emissions	6000 MHz – 40000 MHz	3 m (FSOATS)	60 dBµV/m	Average	[CISPR 16-2-3]
			80 dBµV/m	Peak	

Table 12 – Class B limits for radiated emissions above 6 GHz

Phenomena	Frequency range	Measurement distance	Limits	Detector type	Reference test method
Radiated emissions	6000 MHz – 40000 MHz	3 m (FSOATS)	54 dBµV/m	Average	[CISPR 16-2-3]
			74 dBµV/m	Peak	

9.2 Conducted emissions on AC mains port

This requirement is already consolidated in all EMC standards and no amendments are required. The limits in tables 2 and 5 should apply. Class B limits of table 5 should apply to residential environments as defined in [CISPR 32].

9.3 Conducted emissions on DC power port

This requirement is not defined in [CISPR 32] but is present in the IEC generic emission standards and in the following standards for radio and telecommunication equipment: [ITU-T K.48], [ETSI EN 300 386] and [ETSI EN 301 489-1]. This requirement is recommended for inclusion in

the product emission standards (exclusions should be defined in product specific standards) and in the EMC standards for 5G systems.

The limits and measurement method in tables 2 and 5 should also apply to DC power ports. Class B limits of table 5 should apply to residential environments as defined in [CISPR 32].

9.4 Conducted emissions on wired network ports

This requirement is already well defined in [CISPR 32] and no amendments are required. The limits in tables 3 and 6 should apply. Class B limits of table 6 should apply to residential environments as defined in [CISPR 32].

9.5 Immunity requirements on enclosure port

Radiated immunity requirements in generic and product standards stops at 6 GHz or at lower frequencies. This requirement should be extended up to 18 GHz considering that non-radio products might be disturbed by 5G transmitters at frequencies up to 18 GHz. No requirement above 18 GHz should be defined at the present because it is not expected that non-radio products have sensitive circuits that can be disturbed by electromagnetic field at frequencies higher than 18 GHz. Furthermore, the immunity level in the frequency bands of mobile services should be increased to 10 V/m for the products that have key functions (e.g., telecommunication network equipment).

Regarding immunity against electrostatic discharge, the present [CISPR 35] requirements should apply with no changes.

Then, the immunity requirements on enclosure port in Generic and product immunity standards should be defined according to table 13. In **bold letters** are identified the requirements deviating from [CISPR 35]

Table 13 – Immunity requirements on enclosure port

Phenomenon	Reference test method	Test level	Performance criterion
Electrostatic discharges	[IEC 61000-4-2]	Contact: 4 kV Air: 8 kV	B B
Radio frequency electromagnetic field amplitude modulated	[IEC 61000-4-3] Or [IEC 61000-4-20] Or [IEC 61000-4-21]	**80 MHz – 750 MHz** **3 V/m** **750 MHz – 18 GHz** **3 V/m or 10 V/m (higher level applies to telecommunication network equipment)** **(80% AM modulation at 1 kHz)**	A
Power frequency magnetic field (only applicable to EUT with devices susceptible to magnetic field)	[IEC 61000-4-8]	50 Hz 1 A/m	A

9.6 Immunity requirements on analogue and digital signal and network ports

The requirements of [CISPR 35] should apply with the following changes:

– Conducted RF immunity requirements should be in line with generic immunity standards

– Surge immunity requirements for ports intended for connecting indoor cables should be also considered for some products where failures can impact several users (e.g., telecommunication network equipment)

Then, the immunity requirements for analogues/digital signal port in Generic and product immunity standards should be defined according to table 14. In **bold letters** are identified the requirements deviating from [CISPR 35].

Table 14 – Immunity requirements for analogue/digital signal ports

Phenomenon	Reference test method	Test level	Performance criterion
Continuous induced RF disturbances	[IEC 61000-4-6]	**0,15 – 80 MHz** **3 V**	A
Broadband impulse noise disturbances, repetitive (only applicable to CPE)	[CISPR 35]	0,15 to 0,5 MHz 107 dbµV	A
		0,5 MHz to 10 MHz 107 to 36 dBµV	
		10 MHz – 30 MHz 36 to 30 dBµV	
		Burst duration: 0,7 ms Burst period: 10 ms	
Broadband impulse noise disturbances, isolated (only applicable to CPE)	[CISPR 35]	0,15 to 30 MHz 110 dBµV Burst duration: 0,24 ms, 10 ms, 300 ms	B
Electrical Fast transients	[IEC 61000-4-4]	0,5 kV Rep. freq: 5 kHz and 100 kHz on xDSL ports	B
Surges (outdoor lines)	[IEC 61000-4-5]	Unshielded symmetrical lines: Pulse: 10 µs/700 µs Lines to Ground: 1 kV without primary protections	B
		Lines to Ground: 4 kV with primary protections	C

Table 14 – Immunity requirements for analogue/digital signal ports

Phenomenon	Reference test method	Test level	Performance criterion
		Coaxial or shielded lines: Pulse: 1,2 µs/50 µs Shield to Ground: 0,5 kV	B
Surges (indoor lines)	[IEC 61000-4-5]	**Unshielded symmetrical and asymmetrical lines:** **Pulse: 1,2 µs/50 µs** **Lines to Ground:** **0,5 kV without primary protections**	B
	[IEC 61000-4-5]	**Coaxial or shielded lines:** **Pulse: 1,2 µs/50 µs** **Shield to Ground:** **0,5 kV**	B

9.7 Immunity requirements on AC mains port

The requirements of [CISPR 35] should apply but conducted RF immunity requirements should be change in line with generic immunity standards.

The immunity requirements for AC mains port in Generic and product immunity standards should be defined according to table 15. In **bold letters** are identified the requirements deviating from [CISPR 35]

Table 15 – Immunity requirements for AC power ports

Phenomenon	Reference test method	Test level	Performance criterion
Continuous induced RF disturbances	[IEC 61000-4-6]	**0,15 – 80 MHz** **3 V**	A
Electrical Fast transients	[IEC 61000-4-4]	1 kV Rep. freq: 5 kHz	B
Surges	[IEC 61000-4-5]	Pulse: 1,2 µs/50 µs Shield to Ground: 2kV Line to Line: 1 kV	B B
Voltage dips	[IEC 61000-4-11]	Residual voltage < 5% Number of cycles: 0,5	B
		Residual voltage < 70% Number of cycles: 25	C

Table 15 – Immunity requirements for AC power ports

Phenomenon	Reference test method	Test level	Performance criterion
Voltage interruptions	[IEC 61000-4-11]	Residual voltage 0% Number of cycles: 250	C

9.8 Immunity requirements on DC power port

The requirements of [CISPR 35] should apply with the following changes:

– Conducted RF immunity requirements should be in line with generic immunity standards;

– Surge immunity test should apply to indoor cables too

The immunity requirements for DC power port in Generic and product immunity standards should be defined according to table 16. In **bold letters** are identified the requirements deviating from [CISPR 35].

Table 16 – Immunity requirements for DC power ports (only applicable to ports with cables that may be longer than 3 m)

Phenomenon	Reference test method	Test level	Performance criterion
Continuous induced RF disturbances	IEC 61000-4-6	**0,15 – 80 MHz** **3 V**	A
Electrical Fast transients	IEC 61000-4-4	0,5 kV Rep. freq: 5 kHz	B
Surges	IEC 61000-4-5	**Pulse: 1,2 µs/50 µs** **Line to Ground: 0,5 kV**	B

10 Recommendation for future work

The EMC requirements recommended in this document for the coexistence of 5G networks with other devices and wired networks are provided as preliminary requirements. These requirements shall be revised considering:

– The 5G specifications when published.

– The radiated emission limits above 6 GHz that will be defined by CISPR (if different from the limits proposed in this document).

– The possibility to define single radiated emission limits for radio and non-radio devices. This item shall be discussed and coordinated with ITU-R.

– The radiated immunity requirements that might be identified when 5G specification are published.

– Specific test setups and performance criteria for 5G systems.

Bibliography

[b-IEC 60050-161] IEC 60050-161:1990, *International Electrotechnical Vocabulary. Chapter 161: Electromagnetic compatibility*.
https://webstore.iec.ch/publication/181

[b-FCC 47 CFR part 15] Federal Communications Commission (FCC), *Code of Federal Regulations, Title 47, Part 15 (47 CFR 15)*;
https://www.fcc.gov/general/rules-regulations-title-47

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	Tariff and accounting principles and international telecommunication/ICT economic and policy issues
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	**Protection against interference**
Series L	Environment and ICTs, climate change, e-waste, energy efficiency; construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling, and associated measurements and tests
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects, next-generation networks, Internet of Things and smart cities
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2018