International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

K.123

(08/2022)

SERIES K: PROTECTION AGAINST INTERFERENCE

Electromagnetic compatibility requirements for electrical equipment in telecommunication facilities

Recommendation ITU-T K.123

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Electromagnetic compatibility requirements for electrical equipment in telecommunication facilities

Summary

Recommendation ITU-T K.123 describes the requirements for radiated and conducted emissions from electrical systems installed in telecommunication facilities. Electrical systems in the scope of this Recommendation include inverter driven electrical equipment including the air conditioners needed for the operation of telecommunication systems, personal computers, displays, printers, maintenance robots, and security systems including surveillance cameras. Their electrical systems include power conversion devices and electronic circuits which may generate conducted and radiated electromagnetic disturbances and cause degradation of the performance of nearby telecommunication systems.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T K.123	2016-12-14	5	11.1002/1000/13139
2.0	ITU-T K.123	2019-07-14	5	11.1002/1000/13958
3.0	ITU-T K.123	2022-08-13	5	11.1002/1000/15040

Keywords

Conducted emission, electrical system, power conversion device, radiated emission, telecommunication facility.

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Introduction

Recently, an increasing number of electrical devices that involve power switching circuits have been installed in telecommunication facilities. These include rectifiers that supply DC voltages up to 400 V, power conditioning systems (PCSs) including grid connected power converters (GCPCs), uninterruptible power supplies (UPSs) and air conditioners. Moreover, the power dealt with in these electrical devices has been increasing due to the increase in the numbers of these devices and the increase in the consumption requirements of the information and communication technology (ICT) equipment installed in the facilities of growing telecommunication companies. Consequently, the possibility of interference with telecommunication systems due to emissions from these electrical systems is increasing.

Even though [ITU-T K.136] and [ITU-T K.137] specify emission requirements for telecommunication equipment, including power equipment, such as rectifier units, UPSs and DC distribution systems, the emission requirements for electrical and electric systems equipment that are not integral parts of telecommunication systems are not clearly specified in either Recommendation.

[CISPR 11] specifies emission requirements for switching power equipment, however, it does not specify requirements above 1 GHz and below 150 kHz. Also, the emission level limit in [CISPR 11] from photovoltaic power generating systems with a rated power from 20 kVA to 75 kVA is about 20 dB higher than the requirements for the telecommunication equipment regulated in [CISPR 32].

The systems installed in a telecommunication centre are sensitive to electromagnetic disturbances, since their immunity is designed and tested to meet the requirements of the controlled electromagnetic environment of the centre. Therefore, the telecommunication systems are at risk of malfunction if large power electrical or electronic appliances are installed in such centres without limiting their electromagnetic emissions appropriately.

Consequently, the limits of emission levels from electrical systems equipment installed in telecommunication facilities should be the same as the levels required for class A equipment in [CISPR 32].

Recommendation ITU-T K.123

Electromagnetic compatibility requirements for electrical equipment in telecommunication facilities

Editorial note: This document includes the modifications to Figures 3 and 4 introduced by ITU-T K.123 (2022) Cor.1 (2022).

1 Scope

This Recommendation defines the emission requirements for electrical equipment that is installed inside or adjacent to telecommunication facilities.

This Recommendation applies to electrical equipment such as air conditioning systems, personal computers, displays, printers, maintenance robots, and security systems including surveillance cameras which are not the part of telecommunication network. Lighting equipment and power equipment are not covered by this Recommendation.

Telecommunication equipment that directly provides telecommunication services are excluded from the scope of this Recommendation as they are covered by specific electromagnetic compatibility (EMC) Recommendations.

This Recommendation specifies measurement methods and limits for conducted emissions in the frequencies from 9 kHz to 30 MHz and for radiated emissions from 30 MHz to 6 GHz.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T K.38] Recommendation ITU-T K.38 (1996), *Radiated emission test procedure for physically large systems*.

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

[ITU-T K.76] Recommendation ITU-T K.76 (2022), *EMC requirements for DC power ports of telecommunication network equipment in the frequency range below 150 kHz*.

[ITU-T K.132] Recommendation ITU-T K.132 (2018), *Electromagnetic compatibility requirements of electromagnetic disturbances from lighting equipment located in telecommunication facilities*.

[ITU-T K.136] Recommendation ITU-T K.136 (2018), *Electromagnetic compatibility requirements for radio telecommunication equipment*.

[ITU-T K.137] Recommendation ITU-T K.137 (2022), *Electromagnetic compatibility requirements and measurement methods for wireline telecommunication network equipment*.

[CISPR 11] IEC CISPR 11:2015, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*.

[CISPR 14-1] IEC CISPR 14-1:2020, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*.

[CISPR 16-1-2] IEC CISPR 16-1-2:2014, A1:2017, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-2: Radio disturbance and immunity measuring apparatus – Coupling devices for conducted disturbance measurements*.

[CISPR 16-1-4] IEC CISPR 16-1-4:2019, A1:2020, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Antennas and test sites for radiated disturbance measurements*.

[CISPR 16-2-1] IEC CISPR 16-2-1:2014 and Cor1, A1:2017, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-1: Methods of measurement of disturbances and immunity – Conducted disturbance measurements*.

[CISPR 16-2-3] IEC CISPR 16-2-3:2016, A1:2019, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements*.

[CISPR 32] IEC CISPR 32:2015, A1: 2019, *Electromagnetic compatibility of multimedia equipment – Emission requirements*.

[IEC 60050-161] IEC 60050-161:1990, *International Electrotechnical Vocabulary – Chapter 161: Electromagnetic compatibility*.

[IEC 61000-3-2] IEC 61000-3-2:2018, A1:2020, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)*.

[IEC 61000-3-3] IEC 61000-3-3: 2013, A1:2017, A2: 2021, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current up to and including 16 A per phase and not subject to conditional connection*.

[IEC 61000-3-11] IEC 61000-3-11:2017, *Electromagnetic compatibility (EMC) – Part 3-11: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems – Equipment with rated current ≤ 75 A and subject to conditional connection*.

[IEC 61000-3-12] IEC 61000-3-12:2011, ISH1: 2012, *Electromagnetic compatibility (EMC) – Part 3-12: Limits – Limits for harmonic currents produced by equipment connected to public low-voltage systems with input current >16 A and 75 A per phase*.

[IEC 61000-6-6] IEC 61000-6-6:2014, *Electromagnetic compatibility (EMC) – Part 6-6: Generic standards – HEMP immunity for indoor equipment.*

[IEC TS 62578] IEC TS 62578:2015, *Power electronics systems and equipment – Operation conditions and characteristics of active infeed converter (AIC) applications including design recommendations for their emission values below 150 kHz*.

[IEC 62040-3] IEC 62040-3:2021, *Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 AC mains power port [CISPR 11]: Port used to connect to a public low voltage AC mains power distribution network or other low voltage AC mains installation.

3.1.2 artificial mains network (AMN) [CISPR 11]: Network that provides defined impedance to the equipment under test (EUT) at radio frequencies, couples the disturbance voltage to the measuring receivers and decouples the test circuit from the supply mains.

3.1.3 DC artificial mains network (DC-AN) [CISPR 11]: Artificial network that provides defined termination to the EUT's DC power port under test while also providing the necessary decoupling from conducted disturbances originating from the laboratory DC power source or from the load.

3.1.4 DC power port [CISPR 11]: Port used to connect to a low voltage DC power generating system or energy storage, or to another source/load.

3.1.5 electromagnetic disturbance [IEC 60050-161]: Any electromagnetic phenomenon which may degrade the performance of a device, equipment or system, or adversely affect living or inert matter.

3.1.6 electromagnetic interference (EMI) [IEC 60050-161]: Degradation of the performance of an equipment, transmission channel or system caused by an electromagnetic disturbance.

3.1.7 enclosure port [IEC 61000-6-6]: A physical boundary of the apparatus which electromagnetic fields may radiate through or impinge upon. The equipment case is normally considered the enclosure port.

3.1.8 continuous disturbance [ITU-T K.48]: Electromagnetic disturbance whose effects on a particular device or piece of equipment cannot be resolved into a succession of distinct effects.

3.1.9 industrial, scientific and medical applications [CISPR 11]: Operation of equipment or appliances designed to generate and use locally radio frequency energy for industrial, scientific, medical, domestic or similar purposes, excluding applications in the field of telecommunications.

3.1.10 signal/control port [CISPR 32]: 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).

3.1.11 photovoltaic power generating system [CISPR 11]: Electric power generating system which used the photovoltaic effect to convert solar power into electricity.

3.1.12 power supply [ITU-T K.48]: A power source to which telecommunication equipment is intended to be connected.

3.1.13 minimum representative system [ITU-T K.38]: A system which contains the minimum number of units needed to perform all functions specified for the system.

3.2 Terms defined in this Recommendation

This Recommendation defines the following term:

3.2.1 telecommunication facility: A building or place that provides telecommunication services or is used for telecommunication equipment and is controlled by a telecommunication operator.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AAN Asymmetric Artificial Network

AC Alternating Current

AE Auxiliary Equipment

AMN Artificial Mains Network

CISPR International Special Committee on Radio Interference

CMAD Common Mode Absorption Device

DC Direct Current

DC-AN D.C. Artificial Network

EMC Electromagnetic Compatibility

EMI Electromagnetic Interference

EUT Equipment Under Test

FSOATS Free Space Open Area Test Site

GCPC Grid Connected Power Converters

ICT Information and Communication Technology

IPT Inductive Power Transfer

IEC International Electrotechnical Commission

OATS Open Area Test Site

PCS Power Conditioning System

POTS Plain Old Telephone Service

SAC Semi Anechoic Chamber

UPS Uninterruptible Power Supply

WPT Wireless Power Transfer

5 Conventions

None.

6 Connection of power line in a telecommunication centre

Figure 1 illustrates an example of the configuration of equipment and connection of power lines in telecommunication centres.

Network equipment and power supplies integrated in telecommunication equipment usually conform to the electromagnetic compatibility (EMC) requirements specified for telecommunication systems in telecommunication centres in [ITU-T K.136] and/or [ITU-T K.137]. Separated power equipment usually conforms to the specific Recommendation.

On the other hand, devices such as air conditioners, vacuum cleaners, electric power tools, general-purpose PCs, monitors, maintenance robots and monitoring cameras, are not covered by [ITU-T K.136] and/or [ITU-T K.137], even though they may be used in the same room or adjacent places of telecommunication equipment.

Multimedia equipment including information technology (IT) equipment such as general-purpose PCs, monitors, surveillance cameras, etc. are required to satisfy the requirements of [CISPR 32]. For small air conditioners, vacuum cleaners, electric power tools, etc., [CISPR 14-1] is applicable. However, there is no product family CISPR standard to be applied for large air conditioners and maintenance robots, and these generally follow the generic standards.

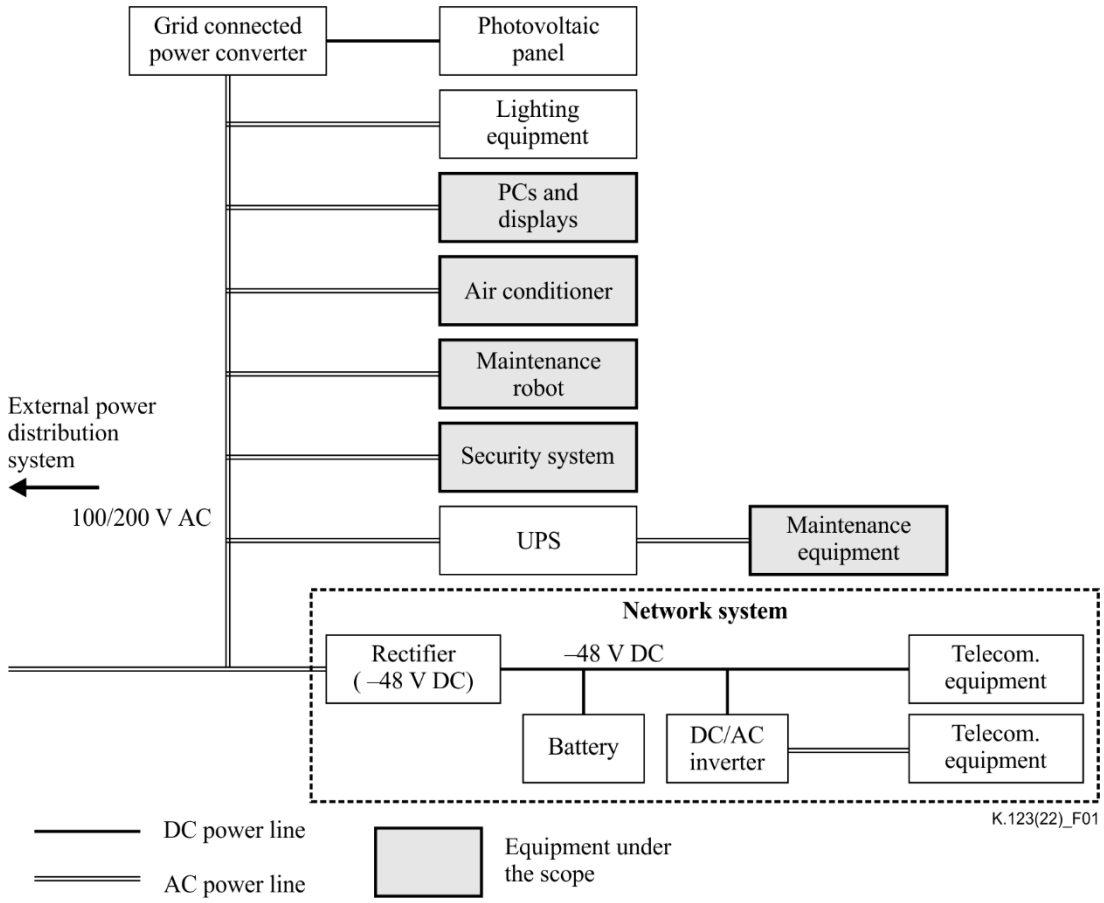


Figure 1 – An example of electrical equipment in a telecommunication facility

7 Emissions from 9 kHz to 6 GHz

7.1 Test methods and limits

Basically, both conducted and radiated emission from electrical and electronic equipment including the air conditioners, maintenance robots and security systems, installed in the same room or adjacent to telecommunication systems should be tested in accordance with [CISPR 14-1], [CISPR 32] and [ITU-T K.76]. In order to demonstrate compliance with the radiated emission requirement for physically large systems, [ITU-T K.38] applies to such systems. A minimum representative system is defined in [ITU-T K.38] and it is representative of installed systems in terms of function (which includes at least one of each functional unit type) and electromagnetic radiation characteristics.

Equipment employing inductive power transfer (IPT) or wireless power transfer (WPT) functions intended for use in telecommunication facilities are excluded from this Recommendation for these devices.

7.1.1 Conducted emission from multimedia equipment

7.1.1.1 Conducted emission at AC and DC power input ports

The conducted emission above 150 kHz on the AC power input port (mains) should be measured in accordance with clause A.3 in Annex A of [CISPR 32] for multimedia equipment.

Equipment under test (EUT), local auxiliary equipment (AE) and associated cabling should be arranged in accordance with Annex D of [CISPR 32]. The conducted emission at DC power input ports should be measured using DC-AN. Table 1 shows measurement method and limits of conducted emission at AC and DC mains ports. The requirements conducted emission limits below 150 kHz are tentative conducted emission limits and are not, for the time being, normative requirements. These limits will be aligned with IEC/CISPR limits when available.

Table 1 – Measurement method and limits of conducted emission at AC and DC mains ports

Coupling device	Frequency	Quasi-peak limit (dBµV)	Average limit (dBµV)	Basic standard	Validation method
AC mains power input ports					
AMN	9 to 50 kHz (Note 1)	138 to 127.5 (120.5 to 110) (Note 2)	125 to 114.5	C Clause 7 of [CISPR 16-2-1]	C Clause 4 of [CISPR 16-1-2]
	50 to 150 kHz (Note 1)	127.5 to 100 (104 to 80) (Note 2)	114.5 to 87		
	0.15 to 0.5 MHz	79	66		
	0.5 to 30 MHz	73	60		
DC mains power input ports (Note 4)					
DC-AN	9 to 50 kHz (Note 1, Note 3)	148 to 137.5	135 to 124.5	Clause 7 of [CISPR 16-2-1] [ITU-T K.76]	Clause 4 of [CISPR 16-1-2]
	50 to 150 kHz (Note 1, Note 3)	137.5 to 110	124.5 to 97		
	0.15 to 0.5 MHz	89	76	Clause 7 of [CISPR 16-2-1]	Clause 4 of [CISPR 16-1-2]
	0.5 to 30 MHz	83	70		

NOTE 1 – The limit shall decrease linearly with the logarithm of the frequency in the range of 9 kHz to 150 kHz.

NOTE 2 – These limits are derived from TS 62578. Limits in parenthesis are not normative but they should be considered for electrical equipment directly connected to low voltage public network, where smart meters can be present, and without transformer on the AC power input and without an uninterruptible power supply (UPS)).

NOTE 3 – Requirement of [ITU-T K.76] shall apply to electrical equipment that may be connected to the same DC power distribution of telecommunication equipment.

NOTE 4 – There is no requirement in [CISPR 14-1] and [CISPR 32] for DC mains ports. The limit value for a DC mains power input port is tentative. The value is determined assuming that the emission is from a current source and considering the impedance difference of AMN according to CISPR 16-1-2 and DC-AN according to CISPR 16-1-2, i.e., 50 ohms and 150 ohms.

7.1.1.2 Conducted emission at signal ports

The conducted emission at a signal port such as an interface to control equipment should be measured in accordance with Annex C and clause A.3 in Annex A of [CISPR 32] using the asymmetric artificial network (AAN). EUT, local AE and associated cabling should be arranged in accordance with Annex D and clause C.4.1.1 in Annex C of [CISPR 32].

The measurement method and limit can be applied to a port which is intended to be connected to a cable longer than 3 m. Table 2 shows measurement method and limits of conducted emission from signal ports.

Table 2 – Measurement method and limits of conducted emission from signal ports

Coupling device	Frequency	Quasi-peak limit (dBμV)	Average limit (dBμV)	Basic standard	Validation method
Signal ports					
AAN	0.15 to 0.5 MHz	79	66	Clause 7 of [CISPR 16-2-1]	Clause 7 of [CISPR 16-1-2] Table C.2. of [CISPR 32]
	0.5 to 30 MHz	73	60		

7.1.1.3 Radiated emission at enclosure port

The test methods for radiated emission are based on [CISPR 32]. Refer to [CISPR 11] for measurement of radiated emission from specific features of electrical systems. Table 3 shows measurement methods and limits of radiated emission from enclosure ports.

Table 3 – Measurement methods and limits of radiated emission from enclosure ports

Frequency	Measurement facility	Validation method	Measurement procedure	Quasi-peak limit (dB μV/m)	Average limit (dB μV/m)	Peak limit (dB μV/m)
30 to 230 MHz	SAC or OATS 10 m distance	5.3 of [CISPR 16-1-4]	7.3 of [CISPR 16-2-3]	40	–	–
230 to 1000 MHz				47	–	–
1000 to 3000 MHz	FSOATS 3 m distance	8.3 of [CISPR 16-1-4]	7.6.6 of [CISPR 16-2-3]	–	60	80
3000 to 6000 MHz				–	60	80

7.1.2 Conducted emission from appliances and electric tools

7.1.2.1 Conducted emission at AC and DC power input ports

The conducted emission at an AC power input port (mains) should be measured in accordance with [CISPR 14-1] for equipment other than multimedia equipment, such as appliances and electric tools.

Conducted emission

EUT, local AE and associated cabling should be arranged in accordance with 5.2 of [CISPR 14-1].

NOTE – The CISPR Requirements are defined to protect radio communications but do not consider impact of inrush current on the power line, due to switching of non ICT equipment, that may impact the normal operation of telecommunication equipment. Application of the limit of transient current in [ITU-T K.132] is recommended to eliminate the impact of switching and discontinuous emission from electrical equipment other than ICT equipment.

The limit for transient currents that arise at the mains port when an electrical equipment is turned on and off is shown in Table 4.

Table 4 – Test method and limit for transient current

Test methods	Limit
Annex A of [ITU-T K.132]	5 A_{p-p}

7.1.2.2 Conducted emission at signal ports

The conducted emission at a signal port such as an interface to control equipment should be measured in accordance with Annex C and clause A.3 in Annex A of [CISPR 32] using the AAN. EUT, local AE and associated cabling should be arranged in accordance with Annex D and clause C.4.1.1 of [CISPR 32].

The measurement method and limit can be applied to a port which is intended to be connected to a cable longer than 3 m. Table 2 shows measurement method and limits of conducted emission from signal ports.

7.1.2.3 Conducted emission at auxiliary port

The conducted emission at auxiliary port should conform to the requirements in accordance with 4.3.3.1 of [CISPR 14-1].

7.1.2.4 Radiated emission at enclosure port

The test methods for radiated emission are based on [CISPR 14-1]. Table 3 shows measurement method and limits of radiated emission from enclosure ports.

7.2 Operational conditions

All measurements should be made in the operating mode that produces the largest emissions consistent with normal use. The operating conditions and power consumption level of the EUT shall be selected to maximize the emission level.

If the emission spectrum changes depending on the operation mode, measurement should be conducted in more than one mode, so as not to overlook the maximum emission at different frequencies.

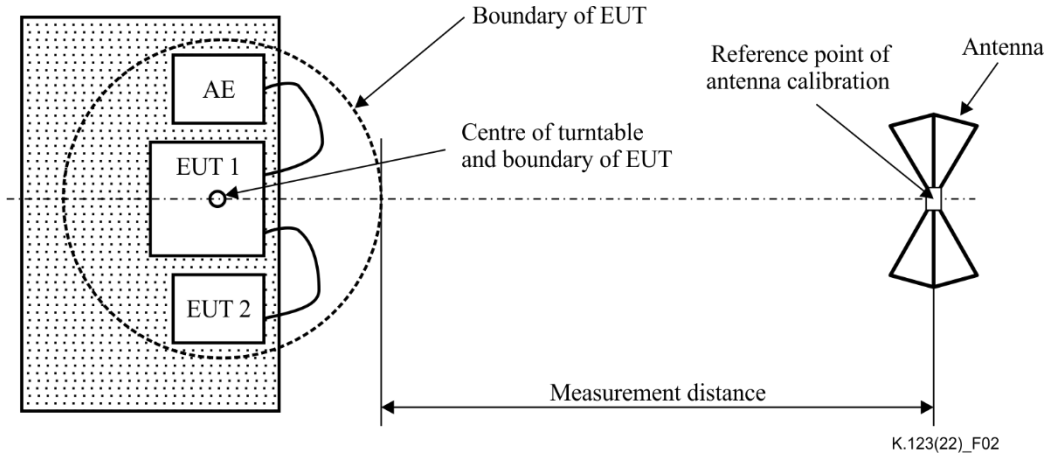
Details of operating conditions during the emission measurement are provided in [CISPR 14-1].

7.3 Test configuration

Conducted emission is measured with an artificial mains network (AMN) on the power input and an AAN on one signal/control interface of each type found on the equipment. The configuration of the EUT shall be precisely documented in the test reports.

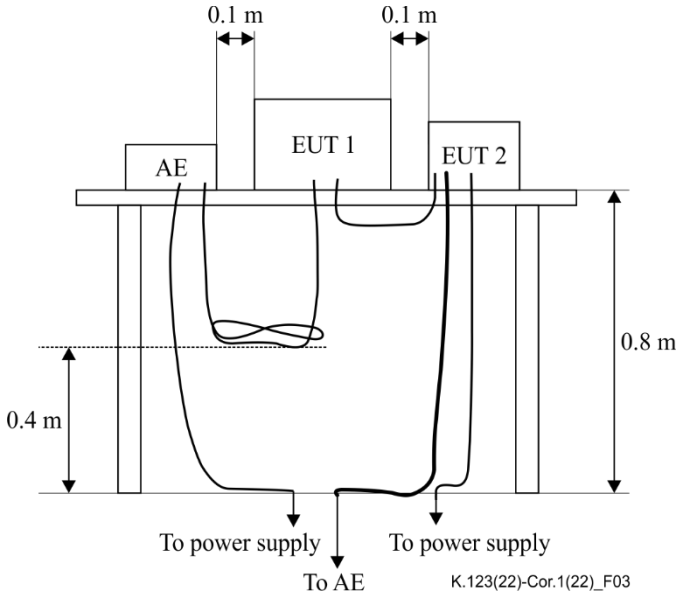
An example of a typical set-up for measurement of radiated disturbances from table-top EUTs is provided in Annexes C and D in [CISPR 32] (examples of the setup are shown in Figures 2 and 3).

An example of a typical unified test set-up for floor-standing equipment suitable for measurement of conducted as well as radiated disturbances is shown in Figure 4. Further examples of typical arrangements of the EUT and associated peripherals are given in [CISPR 16-2-1] and [CISPR 16-2-3].



Modified from Figure C.1 in [CISPR 32][1]

Figure 2 – Example of a set-up for measurement of radiated disturbances



Modified from Figure D.7 in [CISPR 32][2]

Figure 3 – Example of a typical set-up for measurement of radiated disturbances from a table-top EUT

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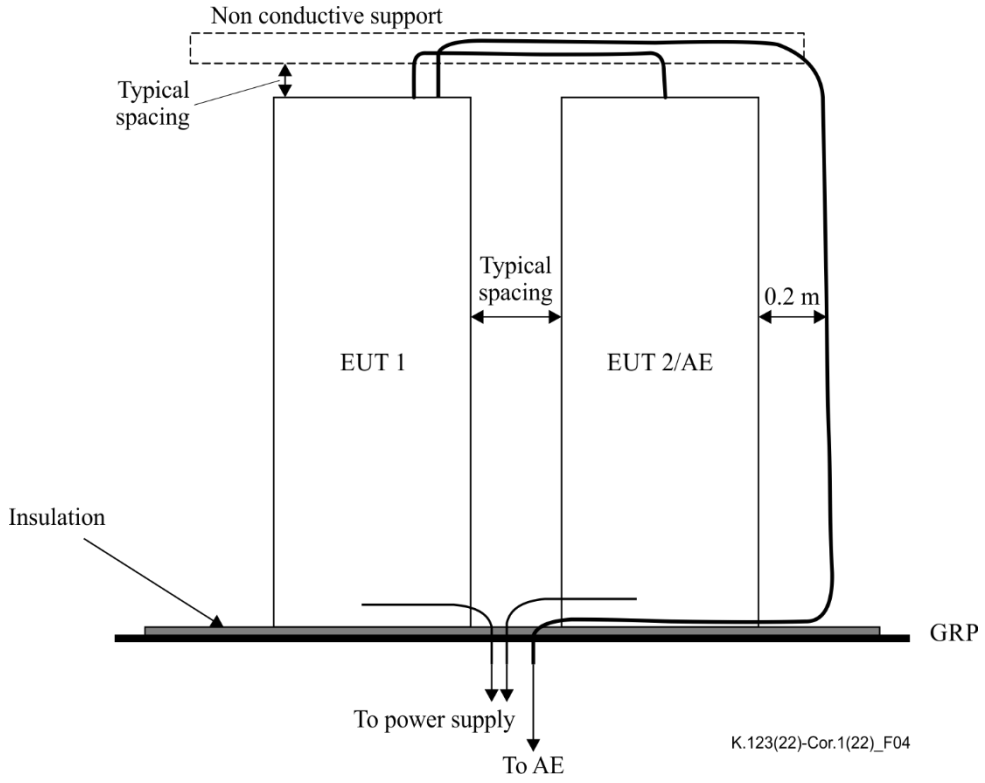

Modified from Figure D.9 in [CISPR 32][3]

Figure 4 – Example of arrangement of floor-standing EUT for radiated emission measurement

8 Requirements for harmonic currents

Harmonic currents on AC mains input ports can influence power distribution systems connected to the equipment. The requirements in [IEC 61000-3-2] or [IEC 61000-3-12] should be referred to for high power equipment.

The requirements in [IEC 61000-3-3] or [IEC 61000-3-11] should be referred to for voltage fluctuations on the AC mains port.

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Published in Switzerland
Geneva, 2023