



BSI Standards Publication

Electromagnetic compatibility (EMC)

Part 4-22: Testing and measurement techniques — Radiated emission and immunity measurements in fully anechoic rooms (FARs)

National foreword

This British Standard is the UK implementation of EN 61000-4-22:2011. It is identical to IEC 61000-4-22:2010.

The UK participation in its preparation was entrusted by Technical Committee GEL/210, EMC - Policy committee, to Subcommittee GEL/210/12, EMC basic, generic and low frequency phenomena Standardization.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English version

**Electromagnetic compatibility (EMC) -
Part 4-22: Testing and measurement techniques -
Radiated emission and immunity measurements in fully anechoic rooms
(FARs)
(IEC 61000-4-22:2010)**

Compatibilité électromagnétique (CEM) -
Partie 4-22: Techniques d'essai et de
mesure -
Mesures de l'immunité et des émissions
rayonnées dans des enceintes
complètement anéchoïques (FAR)
(CEI 61000-4-22:2010)

Elektromagnetische
Verträglichkeit (EMV) -
Teil 4-22: Prüf- und Messverfahren -
Messungen der gestrahlten
Störaussendung und Prüfungen der
Störfestigkeit gegen gestrahlte Störgrößen
in Vollabsorberräumen (FAR)
(IEC 61000-4-22:2010)

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Foreword

The text of document CISPR/A/912/FDIS, future edition 1 of IEC 61000-4-22, prepared by CISPR SC A, Radio-interference measurements and statistical methods, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61000-4-22 on 2011-02-01.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2011-11-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2014-02-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61000-4-22:2010 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

[2] IEC 61000-4-3:2006 + A1:2007 NOTE Harmonized as EN 61000-4-3:2006 + A1:2008 (not modified).

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
CISPR 16-1-1	2010	Specification for radio disturbance and immunity measuring apparatus and methods - Part 1-1: Radio disturbance and immunity measuring apparatus - Measuring apparatus	EN 55016-1-1	2010
CISPR 16-1-4	2010	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	EN 55016-1-4	2010
IEC 60050-161	1990	International Electrotechnical Vocabulary (IEV) - Chapter 161: Electromagnetic compatibility	-	-
IEC 60050-394	2007	International Electrotechnical Vocabulary (IEV) - Part 394: Nuclear instrumentation - Instruments, systems, equipment and detectors	-	-

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INTRODUCTION

This standard is part of the IEC 61000 series of standards, according to the following structure:

Part 1: General

- General considerations (introduction, fundamental principles)

- Definitions, terminology

Part 2: Environment

- Description of the environment

- Classification of the environment

- Compatibility levels

Part 3: Limits

- Emission limits

- Immunity limits (in so far as they do not fall under the responsibility of the product committees)

Part 4: Testing and measurement techniques

- Measurement techniques

- Testing techniques

Part 5: Installation and mitigation guidelines

- Installation guidelines

- Mitigation methods and devices

Part 6: Test set-up

Part 9: Miscellaneous

Each part is further subdivided into several parts, published either as international standards, as technical specifications or technical reports, some of which have already been published as sections. Others will be published with the part number followed by a dash and a second number identifying the subdivision (example: IEC 61000-6-1).

This part is an international standard that establishes the required test procedures for using fully anechoic rooms for performing radiated immunity testing and radiated emission measurements.

The main text of this standard provides all information that is common to both radiated emission measurements and immunity tests in a FAR (fully anechoic room). This includes the description of a FAR, a common set-up for equipment under test (EUT), and a harmonized validation/calibration procedure. The test methods described in this standard are based on the harmonized validation/calibration which verifies a FAR as a measurement system, including the room, antenna and associated cables simultaneously. The validation procedure determines a combined transducer factor for a FAR measurement system that is later applied to both emission measurements and immunity tests. If different sets of antennas and/or cables are used for emission measurements and immunity tests the validation/calibration process is performed twice.

Annex A (normative) provides the measurement procedure and any special considerations for performing radiated immunity tests.

Annex B (normative) provides the measurement procedure and any special considerations for performing radiated emission measurements.

Annex C (informative) provides background on the system transducer factor and simultaneous emissions/immunity validation method.

Annex D (informative) provides guidance for calculation of the uncertainty of measurement results obtained using a FAR and instrumentation in accordance with ISO/IEC Guide 98-3 [4]¹⁾.

¹⁾ Numbers in square brackets refer to the Bibliography.

ELECTROMAGNETIC COMPATIBILITY (EMC) –

Part 4-22: Testing and measurement techniques – Radiated emissions and immunity measurements in fully anechoic rooms (FARs)

1 Scope

This part of IEC 61000 considers immunity tests and emission measurements for electric and/or electronic equipment. Only radiated phenomena are considered. It establishes the required test procedures for using fully anechoic rooms for performing radiated immunity testing and radiated emission measurements.

NOTE In accordance with IEC Guide 107 [1], IEC 61000-4-22 is a basic EMC publication for use by product committees of the IEC. As stated in Guide 107, product committees are responsible for determining the applicability of the EMC standards. TC 77 and CISPR and their sub-committees are prepared to cooperate with product committees in the determination of the value of particular EMC tests for specific products.

This part establishes a common validation procedure, equipment under test (EUT) set-up requirements, and measurement methods for fully anechoic rooms (FARs) when both radiated electromagnetic emission measurements and radiated electromagnetic immunity tests will be performed in the same FAR.

As a basic measurement standard, this part of IEC 61000 does not intend to specify the test levels or emission limits to be applied to particular apparatus or system(s). Its main goal is to provide general measurement procedures to all concerned product committees of IEC or CISPR. Specific product requirements and test conditions are defined by the responsible product committees.

The methods described in this standard are appropriate for radiated emission measurements and immunity tests in the frequency range of 30 MHz to 18 GHz.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

CISPR 16-1-1:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-1: Radio disturbance and immunity measuring apparatus – Measuring apparatus*

CISPR 16-1-4:2010, *Specification for radio disturbance and immunity measuring apparatus and methods – Part 1-4: Radio disturbance and immunity measuring apparatus – Ancillary equipment – Radiated disturbances*

IEC 60050-161:1990, *International Electrotechnical Vocabulary (IEV) – Part 161: Electromagnetic compatibility*

IEC 60050-394:2007, *International Electrotechnical Vocabulary (IEV) – Part 394: Nuclear instrumentation – Instruments, systems, equipment and detectors*

3 Terms and definitions

For the purposes of this document, the terms and definitions in IEC 60050-161, as well as the following, apply.

3.1

ancillary equipment

transducers (e.g. current and voltage probes and artificial networks) connected to a measuring receiver or (test) signal generator and used in the disturbance signal transfer between the EUT and the measuring or test equipment

3.2

associated equipment

AE

apparatus that is not part of the system under test, but needed to help exercise the EUT

3.3

average system transducer factor

$\overline{C}_{dB}$

factor that converts a voltage at the system source/receive termination point to field strength induced or received; this parameter is calculated from the FAR validation data separately for horizontal and vertical polarization

NOTE Average system transducer factor is expressed in dB(1/m).

3.4

calibration

set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards

[IEC 60050-394, 394-40-43]

3.5

forward power

$P_{f,x}$

power to a FAR test system, recorded during the measurement of the field at a single position, x , in the test volume

NOTE Forward power is expressed in watts (W).

3.6

fully anechoic room

FAR

shielded enclosure, the entire internal surface of which is lined with radio-frequency absorbing material (RF-absorber), which absorbs electromagnetic energy in the frequency range of interest

3.7

fully anechoic room test system

FAR test system

test system comprised of a FAR and a means to generate and/or measure electromagnetic fields

NOTE Most typically this is comprised of a FAR, an antenna and other ancillary equipment and cabling.

3.8 measurement distance

$d_{\text{measurement}}$

distance used for EUT measurement/testing and measured from the reference point of the transmit/receive antenna to the periphery of the EUT at its closest point on the measurement axis

NOTE Measurement distance is expressed in metres (m) and is illustrated in Figures A.1 and B.1.

3.9 normalized forward power

$P_{\text{fn},x}$

forward power required to generate an electric field strength of 1 V/m at a position, x , in the test volume

NOTE Normalized forward power is expressed in watts (W).

3.10 polarization

orientation of the electric field vector of a linearly polarized radiated field

3.11 reference distance

$d_{\text{reference}}$

distance at which a limit is specified

3.12 test volume

maximum volume in a FAR in which the EUT and its cabling may be positioned

NOTE See Clause 6 for additional details.

3.13 validation

process of confirming that a finalized instrumentation and control system (hardware and software) complies with all of its functional, performance and interface requirements

[IEC 60050-394, 394-40-42]

3.14 validation distance

$d_{\text{validation}}$

distance used for validation/calibration measurements and measured from the reference point of the transmit/receive antenna to the test volume at its closest point on the measurement axis

4 FAR applications

4.1 Measurand for radiated immunity testing

Most electronic equipment is, in some manner, affected by electromagnetic radiation. This radiation is frequently generated by such general-purpose sources as the small handheld radio transceivers that are used by operating, maintenance and security personnel, fixed-station radio and television transmitters, vehicle radio transmitters, and various industrial electromagnetic sources.

In the frequency range covered by this standard, far-field conditions cannot be established in all cases (e.g. at the lower frequencies), and therefore the disturbance quantity simulating the real electromagnetic phenomenon is defined by the quantity “electrical field strength” in this standard.

The measurand to establish the desired disturbance quantity for immunity tests is the electric field strength (carrier) established by using the average system transducer factor $\overline{C}_{dB}$ at $d_{\text{measurement}}$. The measurand is obtained separately for the horizontal and vertical polarizations.

4.2 Measurand for radiated emission measurements

The measurand in a FAR for radiated emission measurements is the field strength radiated by the EUT and obtained at the measurement distance $d_{\text{measurement}}$ by the use of a linearly-polarized antenna and applying the average system transducer factor, $\overline{C}_{dB}$, to the maximum voltage measured at the receive termination point. The measurand is obtained separately for the horizontal and vertical polarizations of the receiving antenna, and expressed as a result at the reference distance, $d_{\text{reference}}$, specified in product standards.

5 FAR validation/calibration procedure

5.1 General

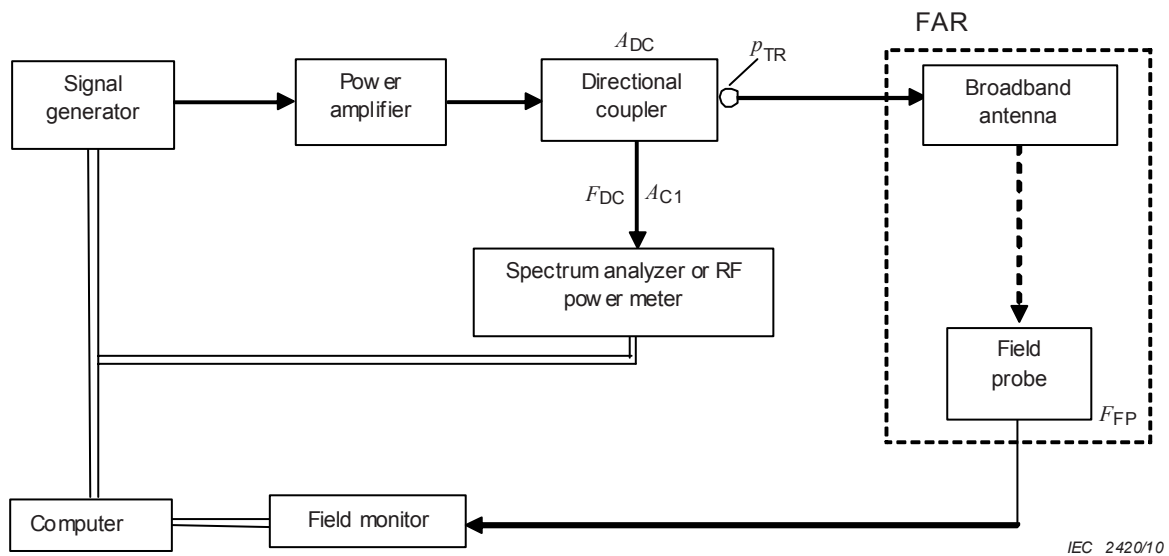
This clause provides the performance requirements and harmonized FAR validation procedure for both radiated emission measurements and radiated immunity tests.

5.2 Validation set-ups

Figures 1 to 4 show block diagrams of set-ups that can be used alternatively for the validation procedure. All set-up variants have a transducer reference point (p_{TR}) for which the average system transducer factor (see 5.4) is determined by the validation process.

The primary instrumentation required for each of these set-ups is summarized in the following bulleted list, and described further in the subsequent lettered list.

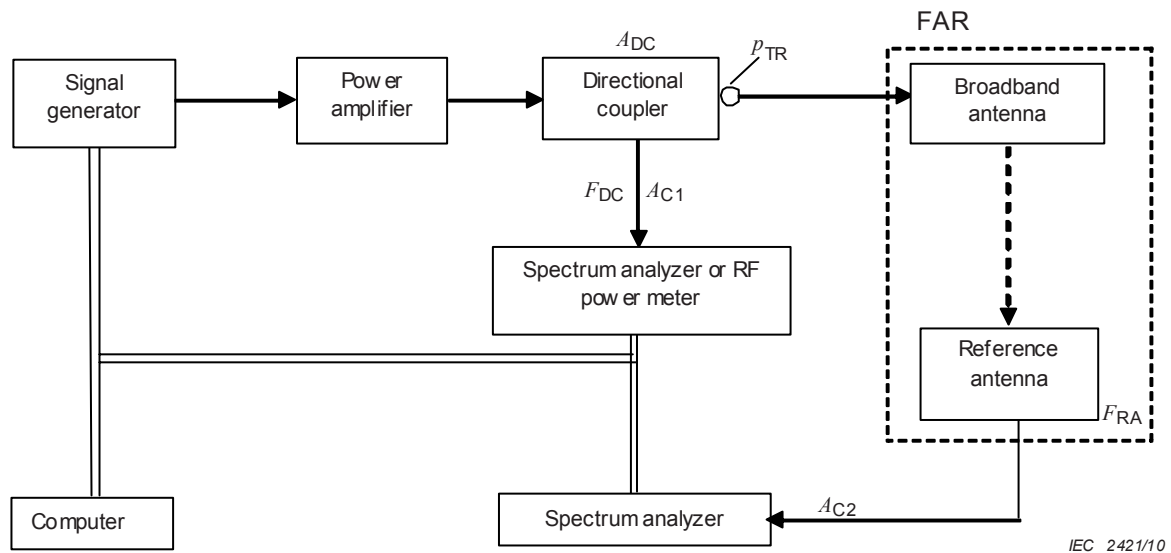
- Type 1 (Figure 1): signal generator, spectrum analyzer or power meter, field probe
- Type 2 (Figure 2): signal generator, spectrum analyzer or power meter, reference antenna
- Type 3 (Figure 3): network analyzer, reference antenna
- Type 4 (Figure 4): network analyzer, power amplifier, reference antenna



Key:

- A_{C1} Attenuation of the cable between the directional coupler and the spectrum analyzer or power meter (dB)
- F_{FP} Calibration factor of the field probe (in linear scale)
- A_{DC} Attenuation of the directional coupler between power input and power output (dB)
- F_{DC} Coupling loss of the directional coupler between power input and forward power output (dB)
- p_{TR} Transducer reference point

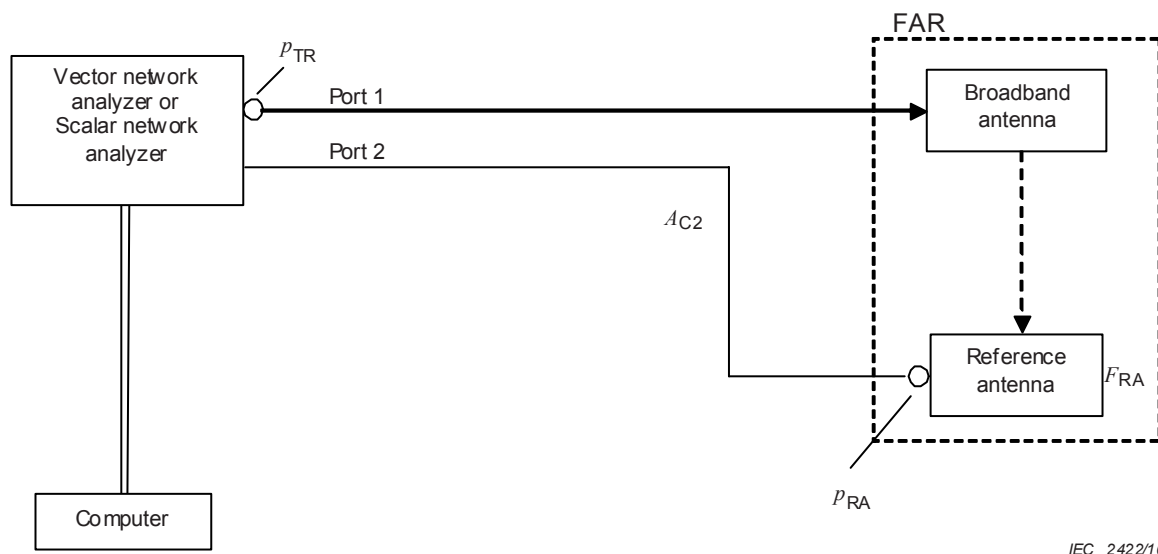
Figure 1 – Type 1 validation block diagramme



Key:

- A_{C1} Attenuation of the cable between the directional coupler and the spectrum analyzer or power meter (dB)
- A_{C2} Attenuation of the cable between the reference antenna and the spectrum analyzer (dB)
- F_{RA} Antenna factor of the reference antenna [dB(1/m)]
- A_{DC} Attenuation of the directional coupler between power input and power output (dB)
- F_{DC} Coupling loss of the directional coupler between power input and forward power output (dB)
- p_{TR} Transducer reference point

Figure 2 – Type 2 validation block diagramme

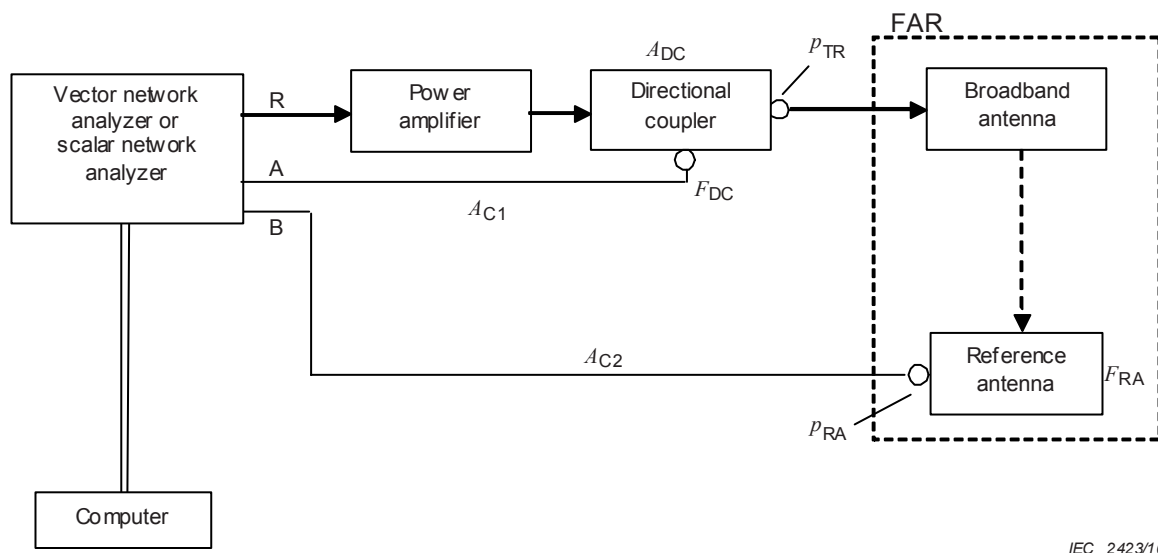


Key:

- F_{RA} Antenna factor of the reference antenna [dB(1/m)]
- A_{C2} Attenuation of the cable between the reference antenna and the spectrum analyzer (dB)
- p_{RA} Reference point of the reference antenna
- p_{TR} Transducer reference point

NOTE Alternatively, the attenuation of the cable between the reference antenna and the network analyzer may be determined by normalization of the network analyzer (p_{TR} and p_{RA} are connected for normalization).

Figure 3 – Type 3 validation block diagramme



Key:

- A_{C1} Attenuation of the cable between the directional coupler and the spectrum analyzer or power meter (dB)
- A_{C2} Attenuation of the cable between the reference antenna and the spectrum analyzer (dB)
- F_{RA} Antenna factor of the reference antenna [dB(1/m)]
- A_{DC} Attenuation of the directional coupler between power input and power output (dB)
- F_{DC} Coupling loss of the directional coupler between power input and forward power output (dB)
- p_{TR} Transducer reference point
- p_{RA} Reference point of the reference antenna
- R,A,B Network analyzer ports – output port R, input ports A and B

Figure 4 – Type 4 validation block diagramme

The following components are part of a FAR validation set-up. A summary list of the components required for the different set-up types is given in Table 1.

a) Fully anechoic room (FAR)

The test volume and the validation distance shall be previously specified according to Figure 5 (see 5.5) and definitions 3.12, 3.14.

b) Broadband antenna

The position of the broadband antenna is fixed in the room.

NOTE 1 The antenna factor normally provided with the antenna is not required because it is determined as part of the FAR test system transducer factor during this validation/calibration.

c) RF power meter, frequency selective voltmeter, or spectrum analyzer

d) Directional coupler

e) Isotropic field probe and monitor

f) Reference antenna

The reference antenna shall conform to the specifications in 5.4.2.3 of CISPR 16-1-4 for the frequency range 30 MHz to 1 GHz and 8.3.3.1 of CISPR 16-1-4 for the frequency range 1 GHz to 18 GHz.

g) Cable to broadband antenna

Routing to the broadband antenna shall be fixed in the installation.

NOTE 2 The loss of the cable to the broadband antenna is determined as part of the FAR system transducer factor during this validation/calibration.

NOTE 3 The cable to the broadband antenna is typically recommended to be installed horizontally from the antenna to the absorbers lined on the back wall, then installed vertically against the absorbers to the floor. This is to minimize the influence of the cable.

h) Other RF cables

The characteristics of other RF cables shall be determined in previous calibration. Any differences between the cables utilized for this calibration and subsequent testing may be separately characterized.

i) Signal source

RF generator, able to produce a stable signal.

j) Power amplifier

The output power shall be monitored during this validation/calibration and during immunity tests (see 5.2 c) and d)). Refer to Annex A for consideration of harmonics and compression characteristics.

k) Scalar or vector network analyzer

Instrument for the measurement of the transfer function between two points (S_{21}) or the ratio of two signals (without bridge).

Table 1 – Components required for the different validation set-up types

Component ¹⁾	Validation set-up ²⁾			
	Type 1	Type 2	Type 3	Type 4
a) Fully anechoic room (FAR)	x	x	x	x
b) Broadband antenna	x	x	x	x
c) RF power meter	x	x	–	–
d) Directional coupler	x	x	–	x
e) Isotropic field probe and monitor	x	–	–	–
f) Reference antenna	–	x	x	x
g) Cable to broadband antenna	x	x	x	x
h) Other RF cables	x	x	x	x
i) Signal source	x	x	–	–
j) Power amplifier	x	x	–	x
k) Scalar or network analyzer	–	–	x	x
¹⁾ Letters preceding a component correspond with items detailed in 5.2.				
²⁾ “x” indicates component is required; “–” indicates component is not required.				

5.3 Test facility description

5.3.1 General

For the purposes of FAR validation, the parameters of 5.3.2 through 5.3.8 shall be specified and clearly documented using text descriptions and photographs in the validation report.

5.3.2 Test volume

The test volume is a cylinder that shall encompass the EUT maximum dimensions including its associated cables, as described in Clause 6. The following parameters of the specified test volume shall be clearly defined: diameter of volume, location of the centre of the volume bottom surface, and height.

5.3.3 Broadband antenna

The broadband antenna shall be located at a fixed position outside the test volume within a FAR. The antenna height is typically set to the height of the centre of the test volume. The broadband antenna is used as the receiving antenna for emission measurements and as the transmitting antenna for the validation/calibration tests and subsequent immunity tests. The validation/calibration process shall be performed for each set of antennas (e.g. to cover various frequency ranges) used for either immunity testing or emission measurements.

5.3.4 Antenna cables

Reflections from antenna cables can affect results obtained in FAR testing, so consideration should be given to their design and placement. The lengths of antenna cables located within a FAR and leading to the broadband antenna shall be laid out in the same manner during validation of a FAR as they are during product tests in a FAR. Any ferrites placed on the antenna cable shall be present for both validation testing and subsequent EUT testing.

5.3.5 Set-up table

Set-up tables made from nonconductive and low permittivity materials are recommended. A set-up table that is designed for installation in the test volume and is removable does not need to be in-place during the facility validation described in 5.6. A set-up table that is located