IEC 61000-4-22

Edition 1.0 2010-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

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

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)

IEC 61000-4-22:2010

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

- Catalogue of IEC publications: www.iec.ch/searchpub

The IEC on-line Catalogue enables you to search by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: www.iec.ch/online_news/justpub

Stay up to date on all new IEC publications. Just Published details twice a month all new publications released. Available on-line and also by email.

- Electropedia: www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: www.iec.ch/webstore/custserv

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:
Email: csc@iec.ch
Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) est la première organisation mondiale qui élabore et publie des normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications CEI

Le contenu technique des publications de la CEI est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

- Catalogue des publications de la CEI: www.iec.ch/searchpub/cur_fut-f.htm

Le Catalogue en-ligne de la CEI vous permet d'effectuer des recherches en utilisant différents critères (numéro de référence, texte, comité d'études,…). Il donne aussi des informations sur les projets et les publications retirées ou remplacées.

- Just Published CEI: www.iec.ch/online_news/justpub

Restez informé sur les nouvelles publications de la CEI. Just Published détaille deux fois par mois les nouvelles publications parues. Disponible en-ligne et aussi par email.

- Electropedia: www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International en ligne.

- Service Clients: www.iec.ch/webstore/custserv/custserv_entry-f.htm

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions, visitez le FAQ du Service clients ou contactez-nous:
Email: csc@iec.ch
Tél.: +41 22 919 02 11
Fax: +41 22 919 03 00

IEC®

IEC 61000-4-22

Edition 1.0 2010-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

BASIC EMC PUBLICATION

PUBLICATION FONDAMENTALE EN CEM

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

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)

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

PRICE CODE
CODE PRIX **XA**

ICS 33.100.10; 33.100.20

ISBN 978-2-88912-229-5

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INTERNATIONAL SPECIAL COMMITTEE ON RADIO INTERFERENCE

ELECTROMAGNETIC COMPATIBILITY (EMC) –

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

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 61000-4-22 has been prepared by CISPR subcommittee A: Radio interference measurements and statistical methods, in cooperation with subcommittee 77B: High frequency phenomena, of IEC technical committee 77: Electromagnetic compatibility.

This standard has the status of a basic EMC publication in accordance with IEC Guide 107, *Electromagnetic compatibility – Guide to the drafting of electromagnetic compatibility publications*.

The text of this standard is based on the following documents:

Enquiry draft	Report on voting
CISPR/A/912/FDIS	CISPR/A/923/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

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

A list of all parts of the IEC 61000 series can be found on the IEC website under the general title Electromagnetic compatibility (EMC), and of all parts of the CISPR 16 series under the general title Specification for radio disturbance and immunity measuring apparatus and methods.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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
$\overline{C}_{\mathrm{dB}}$
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
$P_{\mathrm{f},x}$
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
$d_{measurement}$
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
$P_{fn,x}$
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
$d_{reference}$
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
$d_{validation}$
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 $\overline{C}_{\mathrm{dB}}$ at $d_{\mathrm{measurement}}$. 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 $d_{\mathrm{measurement}}$ by the use of a linearly-polarized antenna and applying the average system transducer factor, $\overline{C}_{\mathrm{dB}}$, 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, $d_{\mathrm{reference}}$, specified in product standards.

5 FAR validation/calibration procedure

5.1 General

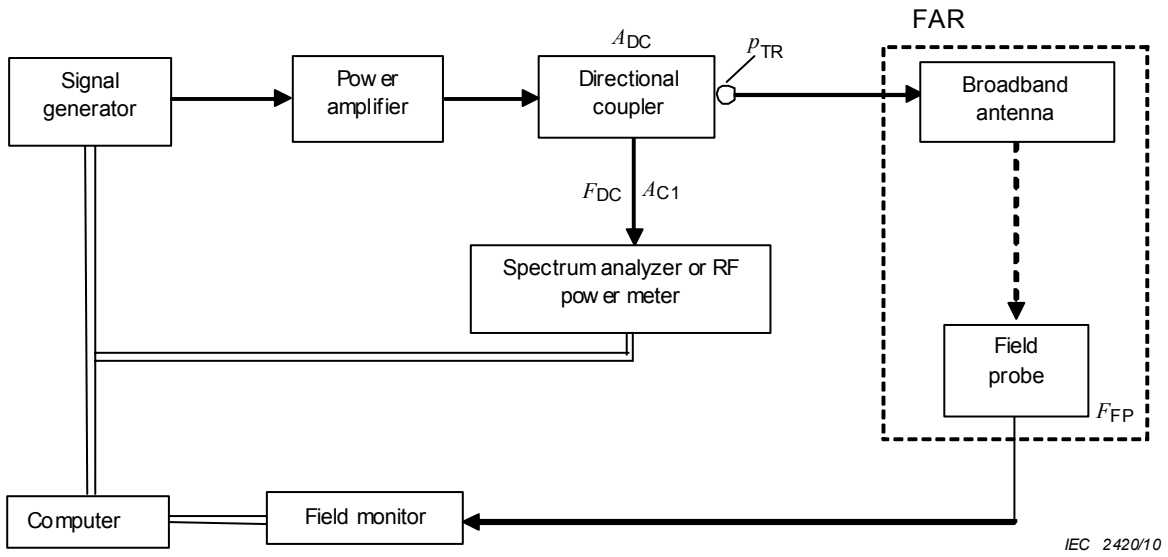
This clause provides the performance requirements and harmonized FAR validation procedure for both radiated emission measurements and radiated immunity tests.

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)

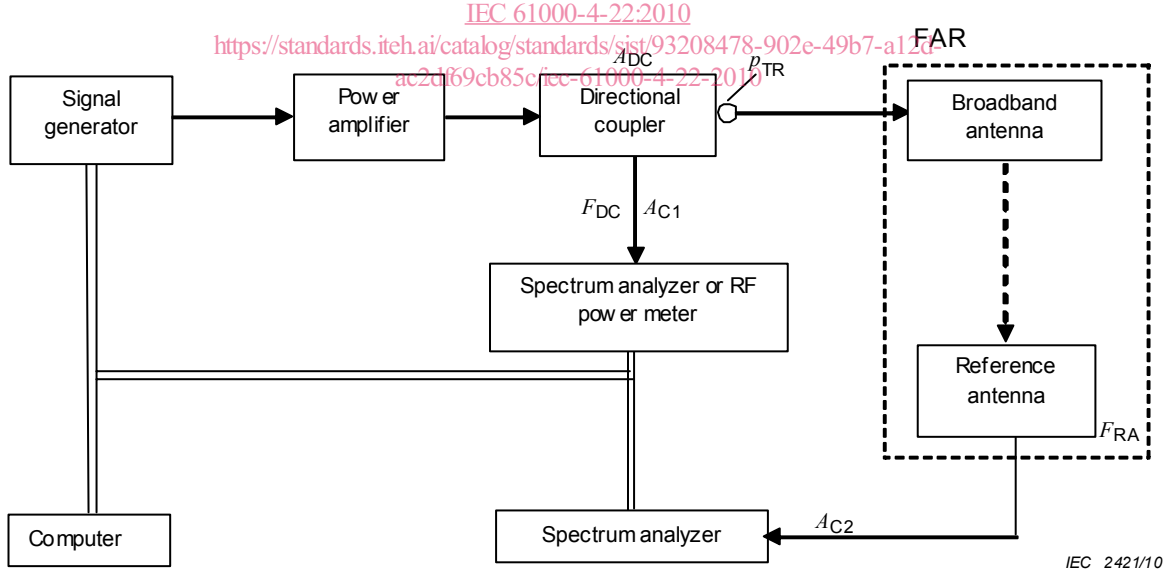
F_{FP} Calibration factor of the field probe (in linear scale)

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)

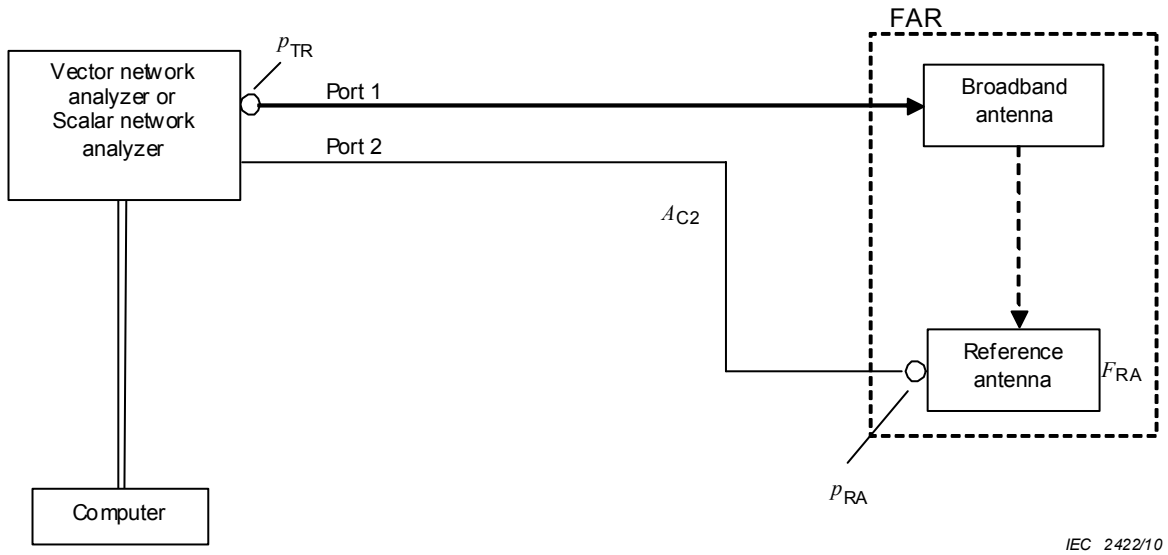
F_{RA} Antenna factor of the reference antenna [dB(1/m)]

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)]

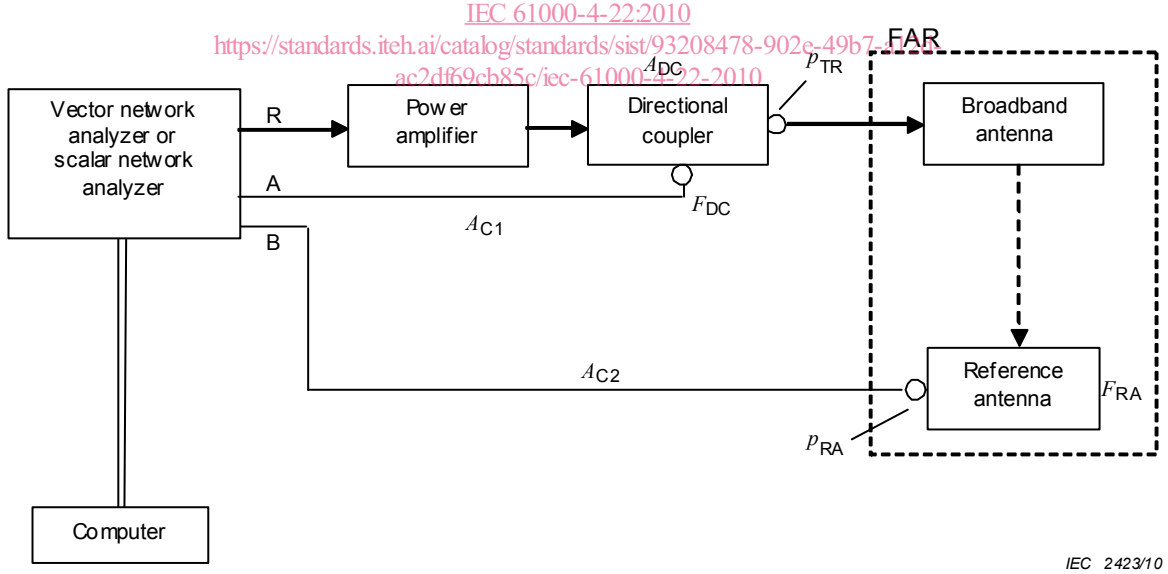
A_{C2} Attenuation of the cable between the reference antenna and the spectrum analyzer (dB)

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