IEC/TR 62002-4

Edition 1.0 2009-04

TECHNICAL REPORT

Mobile and portable DVB-T/H radio access –
Part 4: Measurement methods for total radiated sensitivity in hand-held broadcast terminals

IEC/TR 62002-4:2009(E)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland
Email: inmail@iec.ch
Web: www.iec.ch

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 It also gives information on projects, withdrawn and replaced publications.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

IEC/TR 62002-4

Edition 1.0 2009-04

TECHNICAL REPORT

Mobile and portable DVB-T/H radio access – Part 4: Measurement methods for total radiated sensitivity in hand-held broadcast terminals

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE **M**

ICS 33.060.99 33.170

ISBN 2-8318-1035-9

CONTENTS

FOREWORD 3
INTRODUCTION 5
1 Scope 6
2 Normative references 6
3 Abbreviations 7
4 Basic concepts 7
4.1 Effective Isotropic Sensitivity (*EIS*) 7
4.2 Total Radiated Sensitivity (*TRS*) 7
5 Measurement conditions 8
5.1 Initial conditions 8
5.2 Measurement chamber 9
5.3 Frequencies 9
5.4 Sampling grid 9
6 Measurement procedure 9
6.1 Set-up 9
6.2 Calibration 9
6.3 *TRS* measurements 10
6.4 *EIS* measurement 10
6.5 Calculation of the *TRS* at other channels 10
Annex A (informative) *TRS* and the peak antenna gain defined in IEC 62002-1 11
Bibliography 12

Table A.1 – Typical TRS for terminal category c for QPSK 1/2, MPE-FEC 3/4 11

INTERNATIONAL ELECTROTECHNICAL COMMISSION

MOBILE AND PORTABLE DVB-T/H RADIO ACCESS –

Part 4: Measurement methods for total radiated sensitivity in hand-held broadcast terminals

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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
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.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 62002-4, which is a technical report, has been prepared by technical area 1: Terminals for audio, video and data services and content, of IEC technical committee 100: Audio, video and multimedia systems and equipment.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
100/1498/DTR	100/1525/RVC

Full information on the voting for the approval of this technical report 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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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.

A bilingual version of this publication may be issued at a later date.

INTRODUCTION

This Technical Report describes a measurement method to asses the radio performance of a DVB-T/H hand-held terminal by measuring the radiated sensitivity of the terminal. It is a simplified version of the method described in 3GPP TR 25.914 [1] [1], and is adopted to be suitable for a broadcast receiver supporting a wide range of reception frequencies.

1 The figure in square brackets refers to the Bibliography.

MOBILE AND PORTABLE DVB-T/H RADIO ACCESS –

Part 4: Measurement methods for total radiated sensitivity in hand-held broadcast terminals

1 Scope

This part of IEC 62002 gives a standard method to test Total Radiated Sensitivity (*TRS*) of a category c) terminal specified in IEC 62002-1. This is a practical measure of the radiated sensitivity as it takes into account both the terminal antenna efficiency and possible terminal generated additional noise. Moreover, it can be used directly in the link budget calculations for the network coverage predictions. The motivation for the TR has been the lack of suitable measurement methods to characterise the terminal antenna in a common and practical way. As the 3GPP TR 25.914 method is in many ways suitable for the task, it was decided to develop a simplified version of this method by taking into account the special requirements for broadcast terminals. The test method applies to terminals in terminal category c) with either internal or external antennas. The effect of the user on the antenna radiation pattern is not taken into account.

The method is based on a 3-D radiation pattern measurement. At first a full 3-D 4π sensitivity measurement is performed at three frequencies with both polarisations. From this measurement the *TRS* at these frequencies can be calculated. The best direction for sensitivity at the middle frequency is observed and then the Effective Isotropic Sensitivity (*EIS*) is measured in this direction at all specified reception channels. It is assumed that the average difference between the measured *EIS* and *TRS* is valid also for the other frequencies and thus the *TRS* at all specified channels can be calculated.

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.

IEC 62002-1:2008, *Mobile and portable DVB-T/H radio access – Part 1: Interface specification*

IEC 62002-2:2008, *Mobile and portable DVB-T/H radio access – Part 2: Interface conformance testing*

IEC/TR 62002-3, *Mobile and portable DVB-T/H radio access – Part 3: Measurement interface*

3 Abbreviations

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

η	Antenna efficiency
λ	Wavelength in meters
Ω	Direction angle
Ψ	Polarisation
C	Carrier power [in band carrier power including any echoes]
C/N	Carrier-to-noise ratio
dB	Decibel
dB(mW)	Power in dB compared to 1 mW
DVB, DVB-T	Digital video broadcasting, terrestrial digital video broadcasting
DVB-H	Digital video broadcasting to hand-held terminals
EIS	Effective Isotropic Sensitivity
F, f	Frequency in Hz
MHz	Megahertz
P_{min}	Minimum power
PI	Pedestrian Indoor
TRS	Total Radiated Sensitivity

4 Basic concepts

4.1 Effective Isotropic Sensitivity (*EIS*)

Effective Isotropic Sensitivity (*EIS*) is the isotropic power needed for the terminal to reach the required degradation point (see 6.4.3.1 in IEC 62002-2). *EIS* is a function of direction Ω, frequency f and polarisation Ψ and can be denoted as

$$EIS_{\Psi}(\Omega, f), \text{ for polarisation } \Psi.$$

Typically, when a single figure is given, it is measured in the best direction of the terminal antenna. In principle, *EIS* can be measured by adjusting the power level of the transmitter until the receiver reaches the sensitivity threshold. The receiver is then replaced by an isotropic antenna and the power at the output of the antenna is measured as *EIS*. Practical measurements use a calibrated reference antenna instead of an isotropic antenna.

4.2 Total Radiated Sensitivity (*TRS*)

Total Radiated Sensitivity (*TRS*) is the integrated *EIS* power over the sphere with both polarisations:

$$TRS(f) = \frac{4\pi}{\oint \left[\frac{1}{EIS_{\text{H}}(\Omega, f)} + \frac{1}{EIS_{\text{V}}(\Omega, f)} \right] \text{d}\Omega}$$

where

Ω	is the direction angle;
EIS_H	is EIS in horizontal polarisation;
EIS_V	is EIS in vertical polarisation;
f	is the frequency.

TRS is thus the total received power at the sensitivity threshold from all directions and both polarisations. TRS can be considered to present quite well the practical receiver sensitivity at difficult reception conditions as in multipath conditions several rays arrive from different directions and with different polarisations.

A practical measurement is done with a discrete sampling grid. In this case the TRS can be defined as:

$$TSR(f) = \frac{4\pi}{\Delta_\theta \Delta_\varphi \sum_{0}^{N-1} \sum_{0}^{M-1} \left[\frac{1}{EIS_H(\theta_n, \varphi_n, f)} + \frac{1}{EIS_V(\theta_n, \varphi_n, f)} \right]}$$

where

θ	is the zenith angle;
φ	is the azimuth angle;
N	is number of samples in the zenith angle;
M	is number of samples in the azimuth angle;
$\Delta_\theta = \pi/N$	is the sampling grid in zenith angle;
$\Delta_\varphi = 2\pi/M$	is the sampling grid in azimuth angle.

The difference between the conducted sensitivity measurement (see 6.2.1 and 6.4 in IEC 62002-2) and the TRS measurement gives directly the total efficiency η of the terminal antenna. For ideal isotropic antennas $\eta = 1$ and TRS becomes the same as the conducted sensitivity P_{min}. For example, if the TRS is 10 dB higher than the conducted sensitivity P_{min}, the antenna efficiency η is 0,1. Note that this antenna efficiency definition includes possible noise contributions radiated from the terminal to the antenna.

$$TRS(f) = P_{min} - 10 \cdot \log_{10}(\eta(f)) \quad \text{(dB(mW))}$$

It should also be noted that TRS is typically measured in an anechoic chamber presenting Gaussian channel conditions and using a pure signal from the signal source. When using the TRS figures in link budget calculations a correction should be made to take into account the wanted channel conditions. For example, in Pedestrian Indoor (PI) channel conditions the difference between C/N-requirement in PI and Gaussian channel should either be measured or taken from 10.7.1 and 10.7.3 in IEC 62002-1 and then added to the measured TRS to get a TRS presenting PI-channel. Another way to measure the difference is to apply a PI channel with a channel simulator to the measurement signal used in the antenna measurement chamber and measure the real EIS with PI channel conditions.

5 Measurement conditions

5.1 Initial conditions

Other radio systems in the terminal, like GSM, WCDMA, WLAN etc. should be disabled. The BT is typically needed to read the wanted information from the terminal.

5.2 Measurement chamber

Measurements are performed in an anechoic measurement chamber with a capability for full 3-D measurements. The construction of the chamber and the positioner may vary, but care should be taken that the positioner construction (i.e. size) does not disturb the nearly omnidirectional antenna. The shielding effectiveness of the chamber should be good enough so that at least 10 dB marginal remains below the sensitivity level of the terminal. The required size of the chamber can be estimated so that far-field conditions between the radiating antenna and the terminal apply:

$$r > \max\left[\frac{2D^2}{\lambda}, 3D, 3\lambda\right]$$

where

r is distance between the radiating element and the terminal;

D is the maximum extension of the radiating element;

λ is the longest wavelength used.

5.3 Frequencies

The *TRS* measurements are carried out at channels 22 (482 MHz), 45 (666 MHz) and 54 (738 MHz). *EIS* is measured at channels 21 (474 MHz) to 55 (746 MHz). In case the terminal does not include the GSM-reject filter higher channels may be used. If the terminal is intended to be used on other frequency bands, these can be added according to the need of the market area.

5.4 Sampling grid

The practical measurement is carried out by stepping the zenith and azimuth angles θ and φ with a sampling grid. A recommended value for the sampling grid is 30°. Other values like 15° can be used if higher accuracy is needed.

6 Measurement procedure

6.1 Set-up

The terminal is placed in the measurement chamber and a DVB-T/H signal source is connected to the transmitting antenna.

A measurement interface according the IEC 62002-3 using a Bluetooth (BT) link is used for

- controlling the terminal so that it can be set to the different operating modes and frequencies required by the measurement procedure,
- reading degradation information from the terminal.

A wireless link like the Bluetooth is preferred over the wired links due to the minimum effect on the terminal antenna behaviour. If desired, the whole measurement procedure can be made automatic if the measurement controller is controlling the positioner, signal source and the terminal.

6.2 Calibration

The measurement system is calibrated by replacing the terminal by a reference antenna with known characteristics. The reference antenna is connected to a power meter. The signal source power level is set to a reference value and the received power from the power meter is observed. The true isotropic power can now be calculated using the known antenna characteristics (antenna factor or antenna gain are the usual values given). The reference value of the power level in the signal source thus corresponds to this isotropic power. Note that the calibration should be done at all frequencies that will be used in the actual measurement. Also both polarisations should be calibrated.

Example:

a) The signal source power level is set to –10 dB(mW).

b) A reference dipole with a gain of 2,15 dBi is used.

c) Power meter reading is –61,5 dB(mW).

d) Isotropic power P_I = –61,5 dB(mW) – 2,15 dB = –63,65 dB(mW).

e) Power setting –10 dB(mW) corresponds to isotropic power of –63,65 dB(mW).

6.3 *TRS* measurements

After the calibration the reference antenna is replaced by the terminal. The frequency is set to the first *TRS* measurement frequency (channel 22, 482 MHz). Horizontal polarisation is selected. The terminal is set to the first position with the positioner and the power level in the signal source is adjusted until the terminal is at the sensitivity threshold. The measurement is then repeated with the vertical polarisation. After these measurements the next position is selected and the same measurements are carried out in this position. The procedure is repeated for all positions.

After completing the measurements the *TRS* can be calculated from the measured *EIS* values using the formula given in 4.2.

The *TRS* measurement is performed at all three measurement channels 22 (482 MHz), 45 (666 MHz) and 54 (738 MHz).

6.4 *EIS* measurement

From the *TRS* measurement the best direction is observed at the middle frequency, channel 45 and the terminal is set to the corresponding position, using the best polarisation. With this position the *EIS* is measured at every channel between 21 (474 MHz) and 55 (748 MHz).

6.5 Calculation of the *TRS* at other channels

To obtain a *TRS* value for all the other channels in the used frequency range the following method can be used.

a) Difference $\Delta(f) = TRS(f) - EIS(f)$ between the *TRS* and *EIS* is calculated on channels 22, 45 and 54. From the three Δ-values an average Δ_{ave} is calculated.

b) Using average Δ_{ave} *TRS* at all channels can be calculated from the *EIS* measurement. $TRS(f) = EIS(f)+\Delta_{ave}$.

Annex A
(informative)

TRS and the peak antenna gain defined in IEC 62002-1

The peak antenna gain figures given as informative values in 9.3 of IEC 62002-1 can be converted to the *TRS* values using the sensitivity figures given 10.8 of IEC 62002-1 with the following calculation.

$$TRS(f) = P_{\mathrm{min}} - G_A(f) + \Delta$$

The term Δ is the difference between the *EIS* and *TRS*. A typical value would be from 2 dB to 3 dB.

Example:

At frequency 474 MHz using QPSK 1/2, MPE-FEC 3/4 mode, the specified sensitivity is -95,6 dB(mW). Antenna gain is defined to be –10dBi. Using a Δ of 2,5 dB the *TRS* is -83,1 dB(mW).

Using the same mode and Δ, Table 3 of IEC 62002-1 becomes Table A.1 for *TRS*, as shown below:

Table A.1 – Typical TRS for terminal category c for QPSK 1/2, MPE-FEC 3/4

Frequency MHz	***TRS*** dB(mW)
474 [channel 21]	–83,1
698 [channel 49]	–86,1
858 [channel 69]	–88,1

Bibliography

[1] 3GPP TR 25.914, Technical Specification Group Radio Access Network; *Measurements of Radio Performances for UMTS Terminals in Speech Mode*

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch