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TECHNICAL REPORT

colour inside

Case studies supporting IEC 62232 – Determination of RF field strength, power density and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure

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FOREWORD

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IEC TR 62669, which is a Technical Report, has been prepared by IEC technical committee 106: Methods for the assessment of electric, magnetic and electromagnetic fields associated with human exposure.

This second edition cancels and replaces the first edition published in 2011. This edition constitutes a technical revision.

The text of this Technical Report is based on the following documents:

Enquiry draft	Report on voting
106/473/DTR	106/482A/RVDTR

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

When referring to subdivisions of IEC 62232:2017, the number of the subdivision is followed by "(IEC 62232:2017)" in order to differentiate from subdivisions of the current document. For example:

- "defined in 6.4 (IEC 62232:2017)" should be read as "defined in 6.4 of IEC 62232:2017";
- "see 8.2" should be read as "see 8.2 of IEC TR 62669:2019".

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

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- withdrawn,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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

This document contains a series of case studies for the evaluation of electromagnetic (EM) sources transmitting in the frequency range 110 MHz to 100 GHz (including consideration of ambient sources from 100 kHz to 300 GHz) to support the methods specified in IEC 62232:2017.

Case studies presented in this document have been chosen to illustrate typical RF exposure assessments for the most common types of base stations (BS) deployed in mobile and wireless networks, such as small cells, street cells, macro base stations, and parabolic dish antennas used for wireless transmission or mobile backhaul.

The methodologies and approaches described in this document can be useful for the assessment of early 5G products and networks. Clause 13 is dedicated to the introduction, rationale and guiding principles for the implementation of RF exposure assessment using the actual maximum transmitted power or EIRP. While this approach is applicable to any type of BS, it is particularly important for BS using massive MIMO, which are intended to be introduced more predominantly in 5G networks. Multiple examples of case studies with BS using massive MIMO are provided in Clause 13 to Clause 16.

This document is informative. Each use case is described in the main body of the document and includes “lessons learned” and recommendations for improving IEC 62232:2017. More details, rationale and examples of reports are included in annexes.

CASE STUDIES SUPPORTING IEC 62232 – DETERMINATION OF RF FIELD STRENGTH, POWER DENSITY AND SAR IN THE VICINITY OF RADIOCOMMUNICATION BASE STATIONS FOR THE PURPOSE OF EVALUATING HUMAN EXPOSURE

1 Scope

This document, which is a Technical Report, presents a series of case studies in which electromagnetic (EM) fields are evaluated in accordance with IEC 62232:2017. The case studies presented in this document involve intentionally radiating base stations (BS). The BS transmit on one or more antennas using one or more frequencies in the range 110 MHz to 100 GHz and RF exposure assessments take into account the contribution of ambient sources at least in the 100 kHz to 300 GHz frequency range.

Each case study has been chosen to illustrate a typical BS evaluation scenario and employs the methods detailed in IEC 62232:2017. The case studies are provided for guidance only and are not a substitute for a thorough understanding of the requirements of IEC 62232:2017. Based on the lessons learned from each case study, recommendations about RF assessment topics to be considered in the next revision of IEC 62232 are proposed. The methodologies and approaches described in this document are useful for the assessment of early 5G products introduced for consumer trials or deployments.

This document provides background and rationale for applying a compliance approach based on the actual maximum transmitted power or EIRP. Guidance for collecting and analysing information about the transmitted power of a base station and evaluating its actual maximum RF exposure based on modelling studies or measurement studies on operational sites (in networks, sub-networks or field trials) is also presented.

2 Normative references

IEC 62232:2017, *Determination of RF field strength, power density and SAR in the vicinity of radiocommunication base stations for the purpose of evaluating human exposure*

IEC 62479, *Assessment of the compliance of low-power electronic and electrical equipment with the basic restrictions related to human exposure to electromagnetic fields (10 MHz to 300 GHz)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62232:2017 and the following apply.

NOTE The additional terms and definitions given below will be added in the next edition of IEC 62232.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
actual maximum
<value of transmitted power or EIRP or exposure or RF compliance boundary> value reached during operations at a given percentile of the cumulative distribution function (CDF) of a statistical evaluation taking into account the averaging time t_{avg} and the variation of the BS load for the whole duration of the statistical evaluation

3.2
averaging time
t_{avg}
appropriate time over which exposure is averaged for purposes of determining compliance

3.3
broadcast control channel
BCCH
logical broadcast channel used by the base station in a GSM network to send information about the identity of the network

3.4
cumulative distribution function
CDF
<of a real-valued random variable X evaluated at x> probability that X will take a value less than or equal to x

3.5
drive test
series of measurements performed for assessing the coverage, capacity and quality of service of a base station or BS cluster

3.6
high speed downlink packet access
HSDPA
enhanced mobile communications protocol, which allows UMTS networks to have higher data speeds and capacity

3.7
massive multiple-input, multiple-output
massive MIMO
mMIMO
method used for multiplying the capacity of a radio link in a multicarrier cellular network in which a BS j is equipped with M_j >> 1 antennas and communicates with K_j single-antenna UEs simultaneously on each time/frequency sample, with antenna-UE ratio M_j/K_j > 1

Note 1 to entry: Each BS operates individually and processes its signals using linear receive combining and linear transmit precoding (from [1][1]).

3.8
maximum transmitted power
P_{TXM}
maximum total power transmitted by a base station under test measured during the transmitter ON period

[1] Numbers in square brackets refer to the Bibliography.

3.9
new radio
NR
name used by 3rd Generation Partnership Project (3GPP) for the specification of 5G mobile networks

Note 1 to entry: See, for example, 3GPP 38.104 [2] for the specification of NR base stations.

3.10
network manager
NM
system providing a package of end-user functions with the responsibility for the management of a network, mainly as supported by the element managers but also involving direct access to the network elements in a mobile network

[SOURCE: 3GPP TS 21.905 [3]]

3.11
physical broadcast channel
PBCH
transmission channel that is used to transfer information to all mobile devices that are operating in a radio coverage area

Note 1 to entry: See 3GPP 36.211 [4] for LTE and 3GPP 38.211 [5] for NR.

3.12
physical downlink control channel
PDCCH
channel that carries scheduling assignments and other control information

Note 1 to entry: See 3GPP 36.211 [4] for LTE and 3GPP 38.211 [5] for NR.

3.13
physical downlink shared channel
PDSCH
downlink data channel for users

Note 1 to entry: See 3GPP 36.211 [4] for LTE and 3GPP 38.211 [5] for NR.

3.14
physical resource block
PRB
<LTE> seven consecutive OFDM symbols in the time domain and 12 consecutive subcarriers in the frequency domain

Note 1 to entry: A physical resource block thus consists of 7 × 12 resource elements, corresponding to one slot in the time domain and 180 kHz in the frequency domain.

Note 2 to entry: In 5G NR, different number of symbols and subcarriers are possible. (from 3GPP 38.211 [5]).

3.15
power combination factor
multiplication factor that is applied to the power reduction factor in case of combination of multiple independent signals

3.16
power reduction factor
multiplication factor that is applied to the time-averaged maximum transmitted power in order to obtain its actual maximum value from its CDF

Note 1 to entry: The power reduction factor can also be applied to EIRP; see Equation (3) in 13.1.3.

3.17
rated maximum
<value of transmitted power or EIRP> value as declared by the manufacturer

3.18
resource block
RB
<LTE and 5G-NR> series of N = 12 consecutive subcarriers in the frequency domain

[SOURCE: 3GPP TS 36.211 [4] and 3GPP TS 38.211 [5]]

3.19
technology duty cycle factor
TDC
multiplication factor that is applied to the maximum transmitted power to get the time-averaged transmitted power at full load considering the time slots reserved for reception in Time Division Duplex (TDD) systems

Note 1 to entry: For Frequency Division Duplex (FDD) systems, the technology duty cycle is 1.

3.20
time-averaged
<value of transmitted power or EIRP> value taking into account the technology duty cycle factor of the signal and the averaging time t_{avg}

3.21
transmitted power
P_{TX}
total power transmitted by a base station under test during the transmitter ON period assessed either at the antenna input port(s) for passive antennas or as the total radiated power for base stations with built-in antennas

3.22
urban macro
UMa
BS configuration used for mobile network channel model simulations according to 3GPP TS 36.873 [6] and 3GPP TS 38.901 [7], where the BS antenna is installed at a height of 25 m corresponding to rooftops

3.23
urban micro
UMi
BS configuration used for mobile network channel model simulations according to 3GPP TS 36.873 [6] and 3GPP TS 38.901 [7], where the BS antenna is installed at a height of 10 m corresponding to poles

3.24
user equipment
UE
device used directly by an end-user to communicate in a mobile network

3.25
voice over LTE
VoLTE
high-speed mobile communication technology for mobile phones and data terminals with specific profiles for control and media planes to deliver voice service using LTE