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Specific absorption rate (SAR) measurement procedure for long term evolution (LTE) devices

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INTRODUCTION

LTE technology shows an added complexity over previously available radio schemes and in order to configure and test LTE devices, many signal parameters have to be taken into account. The combinations of parameters in a given frequency band can result in hundreds of LTE Modes and SAR test configurations. The main purpose of this protocol is to support the demonstration of DUT compliance with applicable exposure limits based on a reasonable number of SAR evaluations.

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SPECIFIC ABSORPTION RATE (SAR) MEASUREMENT PROCEDURE FOR LONG TERM EVOLUTION (LTE) DEVICES

1 Scope

This Publicly Available Specification (PAS) applies to measurement procedures of Specific Absorption Rate (SAR) generated by devices with LTE (Long Term Evolution) technology specified by 3rd Generation Partnership Project (3GPP), Rel. 8 and 9 [1] where the devices are intended to be used with the radiating part in close proximity to the human head and body. This document supports both FDD and TDD modes. The objective of this document is to define the number of test conditions with respect to basic radio frequency aspects, i.e. channel bandwidths, number and offset of allocated resource blocks (RB), modulation, and maximum power reduction (MPR) for IEC 62209-1 and IEC 62209-2.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 62209-1:2016, *Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Part 1: Devices used next to the ear (Frequency range of 300 MHz to 6 GHz)*

IEC 62209-2, *Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)*

ETSI TR 121 905, *Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; Vocabulary for 3GPP Specifications*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ETSI TR 121 905 and the following apply.

3.1
LTE Mode
specific operational characteristics of the DUT

Note 1 to entry: LTE Mode is the combination of channel frequency, channel bandwidth, modulation, number of resource blocks, the offset of the resource blocks within the bandwidth, and the MPR.

3.2
Device Position
orientation and position of the DUT with respect to the phantom

3.3
Test Condition
Test Condition refers to the combination of both the LTE Mode and Device Position

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4 Symbols and abbreviated terms

For the measurement procedures specified in this document, the symbols and abbreviated terms of IEC 62209-1 and IEC 62209-2 shall apply.

5 Protocol for SAR assessment

5.1 General LTE SAR testing considerations

LTE technology shows an added complexity over previously available radio schemes. In order to configure and test LTE devices, many signal parameters have to be taken into account: frequency band, channel bandwidth (from 1.4 MHz to 20 MHz), modulation (QPSK and 16-QAM), number of resource blocks allocated, offset of the resource blocks within the channel bandwidth as well as MPR. The combinations of parameters in a given frequency band can result in hundreds of LTE Modes and SAR test configurations. In order to address this a specific protocol is necessary for SAR assessment of LTE devices. The main purpose of this protocol is to support demonstration of DUT compliance with applicable limits based on a reasonable number of SAR evaluations.

For a given LTE Mode and Device Position (Test Condition), the peak spatial-average SAR is related to the maximum RF output power. As a consequence, RF conducted power measurements can be used to quickly identify high SAR LTE Mode. SAR and RF conducted power are however not directly proportional because:

i) RF conducted power is measured with a 50 Ohms load impedance;

ii) the antenna impedance of a DUT is generally not 50 Ohms and varies over frequency;

iii) the antenna impedance can be affected by Device Position and phantom coupling conditions.

Because of this, a single SAR measurement using the LTE Mode with the highest measured maximum conducted output power in a frequency band may not be sufficient to demonstrate compliance unless the SAR value is significantly lower than the applicable compliance limit. In the following, the required Test Conditions are established by applying the protocol in 5.2.

The LTE Test Conditions are measured according to the SAR measurement protocols in IEC 62209-1 for devices used next to the ear and in IEC 62209-2 for hand-held and body-mounted devices. This document only specifies the procedures to identify the LTE Test Conditions that will most likely result in SAR levels closest to the highest and conservative SAR result obtained from an up-scaling procedure.

For the above reasons, studies on the relationship between RF conducted power and SAR were conducted by MT1 using handsets operating in Band 1, 4 and 17. The results in Annex A show that:

- QPSK modulation with 1 RB allocation generally produces the highest peak spatial-average SAR – MPR does not apply in this case.
- Peak spatial-average SAR has good correlation with the measured RF conducted output power. The relationship deviates from proportionality by less than 25 % (k = 2).
- For LTE Modes with maximum conducted power lower than 85 % of P_{max}, where P_{max} is the highest measured maximum RF conducted output power across all LTE Modes in the frequency band, it is highly unlikely that highest SAR results would be expected.

5.1.1 Description of LTE Mode selection

Conducted power shall be measured for the largest channel bandwidth supported by the LTE Modes in each frequency band, using QPSK modulation with 1 RB allocation. The required test channels shall be determined by 6.2.5 of IEC 62209-1:2016. If the number of required channels is 1, the 1 RB shall be allocated at offset = centre; if the number of required

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channels is 3, the 1 RB shall be allocated at offset = 0, centre, and max within the channel bandwidth. If the number of required channels is 5, the 1 RB shall be allocated at offset = 0, centre, centre, centre and max within the channel bandwidth, respectively, for channels from lowest to highest.

Other LTE Modes besides “QPSK modulation with 1 RB allocation” shall also be measured for the different channel bandwidth configurations using the modulations and RB allocations described in Table C.1 (without MPR) and C.2 (with MPR), which are specified by 3GPP for conformance testing. Conducted maximum output power shall be measured using the following test channel and RB offset configurations.

- When MPR does not apply, the configurations in Table C.1 are measured for the low and middle channels with RB offset = 0 and RB offset = max for the high channel.
- When MPR applies, the configurations in Table C.2 are measured
  - for the low channel with RB offset = max,
  - for middle channel with RB offset = 0 and max,
  - for high channel with RB offset = 0.

For “QPSK modulation with 1 RB allocation” in smaller channel bandwidth configurations, when the same RB offset has already been measured in the highest channel bandwidth, such RB offset configurations may be omitted. These correspond to RBs allocated next to the channel edges; for example, offset = 0 for the low channel and max for the high channel for 5 MHz, 10 MHz, 15 MHz channel bandwidths in Band 1 may be omitted.

The conducted maximum output power measurements are illustrated in Figure 1 for 5 MHz, 10 MHz, 15 MHz, and 20 MHz channel bandwidths in Band 1 (1 920 MHz to 1 980 MHz) and 5 MHz and 10 MHz channel bandwidths in Band 17 (704 MHz to 716 MHz). The orange and blue colour RBs correspond to test configurations that are specified by 3GPP for conformance testing. The red colour RBs are the additional configurations required for QPSK and 1 RB allocation in the largest channel bandwidth configuration, not specified for 3GPP conformance testing. The low, middle and high channels are determined according to the IEC 62209-1 requirements. Annex E lists the LTE Modes to be tested in Band 3, 7 and 20.

NOTE Conducted power testing for additional LTE Modes is allowed, when the results form a superset of above requirements (e.g. conducted power testing according to FCC requirements). When such a conducted power superset is reported, all results shall be taken into account in following SAR test procedures.

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