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TECHNICAL REPORT

Universal Mobile Telecommunications System (UMTS);
LTE;
Measurements of User Equipment (UE)
radio performances for LTE/UMTS terminals;
Total Radiated Power (TRP)
and Total Radiated Sensitivity (TRS) test methodology
(3GPP TR 37.902 version 12.1.0 Release 12)

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Contents

Foreword

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Introduction

In this technical report, the needed modifications to measurement parameters for LTE devices will be studied and applicability of the existing measurement procedures, e.g. TRP and TRS will be evaluated for LTE devices with multiple receive antennas TDD-LTE and FDD-LTE terminals (as it is expected that the same issues are applicable independent of RAT). As UMTS devices with multiple receive antennas are still needing test methodology, it is easy to extend to this study item contribution to UMTS terminals with, due to similar situation and technical issue. UMTS TRP and TRS test methods should also be updated in the same way.

1 Scope

The present document is a Technical Report of the Study Item for OTA TRP and TRS requirement of LTE terminals, which was approved at TSG RAN #55 [2]. The report provides the measurement procedure of Over The Air TRP and TRS requirements for LTE terminals. It will make a simple extension to the UE OTA TRP and TRS test methods TS34.114[3] for LTE UE with multiple receive antennas, without considering all of the aspects associated with spatial channels. The work should utilise the existing environments in TR25.914[4]. The results of the UE OTA test method with Head and Hand Phantoms study item can be considered later on once finalized. The report also provides some future extensions and work items after LTE TRP and TRS methods mature.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
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- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document in the same Release as the present document.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] RP-120412, "New study item proposal: Measurements of radio performances for LTE terminals - conformance testing methodology".

[3] 3GPP TS 34.114: "User Equipment (UE) / Mobile Station (MS) Over The Air (OTA) antenna performance".

[4] 3GPP TR 25.914: "Measurements of radio performances for UMTS terminals in speech mode".

[5] 3GPP TS 36.101: "Evolved Universal Terrestrial Radio Access (E-UTRA) User Equipment (UE) radio transmission and reception".

[6] 3GPP TS 36.521-1: "Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: conformance testing".

[7] RP-120368, "Verification of radiated multi-antenna reception performance of UEs in LTE/UMTS WID".

3 Definitions, symbols and abbreviations

3.1 Definitions

Void

3.2 Symbols

For the purposes of the present document, the following symbols apply:

θ Zenith angle in the spherical co-ordinate system
ϕ Azimuth angle in the spherical co-ordinate system
Ω Solid angle defined at the phase centre of the DUT

Gψ(θ,ϕ,f)	Antenna gain pattern in the ψ-polarization as function of the spherical co-ordinates and the carrier frequency
F	Carrier frequency
Ptr	Transmitted power
Qψ(θ,ϕ,f)	Angular power distribution in the ψ-polarization as function of the spherical co-ordinates and the carrier frequency
dB	decibel
dBm	dB referenced to one milliwatt
m	meter
mm	millimetre
kbps	kilobit per second
ms	millisecond
MHz	megahertz

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

3G	3rd Generation
3GPP	3G Partnership Project
3-D	Three Dimensional
16QAM	16 Quadrature Amplitude Modulation
A-MPR	Additional Maximum Power Reduction
BS	Base Station
CN	Core Network
DL	Downlink
DUT	Device Under Test
ETSI	European Telecommunications Standards Institute
E-UTRA	Evolved Universal Terrestrial Radio Access
LME	Laptop Mounted Equipment
LEE	Laptop Embedded Equipment
LTE	Long Term Evolution
MPR	Maximum Power Reduction
MS	Mobile Station
NB	Node B
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying (modulation)
RAB	Radio Access Bearer
RAN	Radio Access Network
RB	Resource Block
RF	Radio Frequency
Rx	Receiver
RBstart	RB number where a RB allocation begins within the channel
SAM	Specific Anthropomorphic Mannequin
Tx	Transmitter
TRP	Total Radiated Power
TRS	Total Radiated Sensitivity (also: Total Isotropic Sensitivity)
UL	Uplink
UE	User Equipment
UTRA	Universal Terrestrial Radio Access

4 General

The present document is a Technical Report of the Study Item for OTA TRP and TRS requirement of LTE terminals, which was approved at TSG RAN #55 [2]. The report provides the measurement procedure of Over The Air TRP and TRS requirements for LTE terminals. It will make a simple extension to the UE OTA TRP and TRS test methods TR 25.914[4] for LTE UE with multiple receive antennas, without considering all of the aspects associated with spatial channels. The work should utilise the existing environments in TR 25.914[4]. The results of the UE OTA test method

with Head and Hand Phantoms study item can be considered later on once finalized. The report also provides some future extensions and work items after LTE TRP and TRS methods mature.

4.1 Scope

The measurement procedure explained in this document applies to all LTE devices, which are already satisfied the standard 3GPP LTE RF minimum performance requirements and conformance testing defined in 3GPP TS 36.101: Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception[5] and 3GPP TS 36.521-1: Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: conformance testing[6], respectively.

The testing methodology applies to any 4G LTE handset, USB-dongle and LEE etc, with internal or external antenna. 3GPP TR 25.914[4] has done many meaningful studies for evaluating antenna performance of UMTS and GSM terminals. In this document, the majority work will be focus on the LTE TRP and TRS test. A simple test methodology for LTE devices without channel emulator will be studied.

The radio tests considered here are:

1. The measurement of the radiated output power (TRP)
2. The measurement of the radiated sensitivity (TRS)

The test procedure described in this document measures the performance of the transmitter and the receiver, including the antenna and also the effects of the user.

The purpose of this document is to serve as a standard test procedure for radio performance testing of 4G LTE mobile terminals. It is the intention that this procedure is going to be used by test houses, network operators, mobile terminal and antenna manufacturers, research institutes etc. The motivation for the development of this document is the lack of standards in this area in 3GPP.

During RAN4 #62bis following proposal were agreed.

> **Proposal 1**: LTE TRP test method is the same for all LTE UEs independent of release, including e.g. LTE CA, UL TX Div or UL MIMO capable UEs
>
> **Proposal 2**: LTE TRS test method is the same for all LTE UEs independent of release, including e.g. LTE CA, UL TX Div or UL MIMO capable UEs
>
> **Proposal 3**: In the first phase re-use test environments including phantoms available already in TS34.114 for LTE TPR and TRS purposes as well. Once new methods like hand phantom based test environments are defined for UTRA TRP and TRS, then also LTE TRP and TRS testing should be extended to these additional environments.

During RAN4 #63 following proposal were agreed.

> **WF 1**: Select one channel bandwidth per band for TRP and TRS tests for LTE FDD and TDD. Default channel bandwidth is 10 MHz but another bandwidth can be considered on case by case basis.
>
> **WF2**: For TRS select the reference measurement channel configuration for LTE FDD and TDD as defined for the conducted REFSENS minimum requirements and adopt UL allocation per band as defined in 36.101 Table 7.3.1-2 [5]. TRS is measured on low, mid and high channel.
>
> **WF3**: For TRP select the UL reference measurement channel configuration as in conductive maximum output power test and the UL allocation for LTE FDD and TDD per band as shown in a table 1 below. Bands that are not covered in Table 1 will be addressed as well.
>
> **WF4**: Select combined LTE TRS measurement in order to make the test method available for all LTE devices starting from Release 8. (Note: further enhancements for radiated UE receiver verifications are developed under the MIMO OTA WI in RP-120368 [7] and therefore combined LTE TRS test method may eventually be revisited.)
>
> **WF5**: Given that existing TRP and TRS measurement procedures for UMTS terminals in speech mode specify two alternate testing methodologies (i.e. anechoic and reverb) [4], the standardization of two TRP/TRS testing

methodologies for LTE UEs may be one eventual outcome, and RAN4 shall take the view to avoid differences in the absolute test results.

4.2 Device Under Test definition

Handset: the UE/MS used under the "Speech mode" or 'Browsing mode' conditions that correspond to predefined positions (see Chapter 5.1.6 in [4] for 'Speech mode' and Chapter 5.1.7 in [4] for 'Browsing mode') for voice or data application when the handset is held close to the user.

Laptop Embedded Equipment : the equipment with a wireless device embedded inside, e.g. notebook and tablet .The corresponding predefined positions for 'data mode' application are defined in Chapter 5.3.1 in [4] for notebooks and Chapter 5.3.2 in [4] for tablets.

Laptop Mounted Equipment : the plug-in type device that host on the laptop, e.g. USB-dongle, that correspond to predefined positions (see Chapter 5.1.4 in [4]) for 'data mode' application.

5 Measurement environment condition

5.1 Chamber environment constraints

Chamber environment constraints shall be the same as described in TR25.914[4] unless otherwise defined in this TR. This TR only defines differences compared to TR25.914[4].

5.2 Positioning Requirements and Coordinate system

Positioning Requirements and Coordinate system shall be the same as described in TR25.914[4] unless otherwise defined in this TR. This TR only defines differences compared to TR25.914[4].

5.3 DUT Test Positions and Phantom Specifications

5.3.1 Phantom Specifications

Phantom Specifications shall be the same as described in TR25.914[4] unless otherwise defined in this TR. This TR only defines differences compared to TR25.914[4].

5.3.2 DUT Test Positions

DUT Test Positions shall be the same as described in TR25.914[4] unless otherwise defined in this TR. This TR only defines differences compared to TR25.914[4].

6 Measurement parameters

Measurement parameters shall be the same as described in TR25.914[4] unless otherwise defined in this TR. This TR only defines differences compared to TR25.914[4].

6.1 Definition of the Total Radiated Power

This definition will be used to calculate the TRP value of LTE DUT. See section 6.1 and E.2.1 in TR25.914[4].

6.2 Definition of Total Radiated Sensitivity

6.2.1 Total Radiated Sensitivity

This definition will be used to calculate the TRS value of LTE DUT. See section 6.5 and E.2.2 in TR25.914[4].

6.2.2 Alternate measurement parameter

6.3 Sampling grid and independent samples

For the anechoic chamber based measurement procedures the measurement of TRP is basically based on the measurement of the spherical radiation pattern of the Device Under Test . The power radiated by the DUT is sampled in far field in a group of points located on a spherical surface enclosing the DUT. The samples of TRP are taken using a constant sample step of 15° both in theta (θ) and phi (ϕ) directions.

The measurement of TRS is basically based on the measurement of the spherical sensitivity pattern of the Device Under Test. The sensitivity values of the DUT at a predefined BLER level are sampled in far field in a group of points located on a spherical surface enclosing the DUT. The samples of TRS are taken using a constant sample step of 30° both in theta (θ) and phi (ϕ) directions.

All the samples are taken with two orthogonal linear polarizations, θ- and φ-polarisations. It is also possible to measure some other polarisation components, if it is possible to recover θ- and φ-polarisations from the measured data by some technique.

For the reverberation chamber based measurement procedures the measurement of TRP is basically based on sampling the radiated power of the Device-Under-Test for a discrete number of field combinations in the chamber. The average value of these statistically distributed samples is proportional to the Total Radiated Power, and by calibrating the average power transfer function in the chamber, an absolute value of the TRP can be obtained. The samples of TRP are taken so that a minimum of 100 independent Rayleigh faded samples are measured, as per section 5.1.3 in TS34.114[3].

The measurement of TRS is basically based on searching for the lowest power received by the Device Under Test for a discrete number of field combinations in the chamber. The power received by the DUT at each discrete field combination that provides a BLER which is better than the specified target BLER level shall be averaged with other such measurements using different field combinations. By calibrating the average power transfer function, an absolute value of the TRS can be obtained when the linear values of all downlink power levels described above have been averaged. The samples of TRS are taken so that a minimum of 100 independent Rayleigh faded samples are measured, as per section 6.1.3 in TS34.114[3].

6.4 Measurement frequencies

This section defines the LTE-FDD and LTE-TDD TRP and TRS measurement frequencies allocations.