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Title: SAR Evaluation Considerations for LTE Devices

Short Title: SAR for LTE Devices

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First Category: Administrative Requirements

Second Category: Measurement Procedures

Third Category:

Question: What are the current SAR test procedures for 3G devices?

Answer:

Attached document- [941225 D05 SAR for LTE Devices v02](#)- provides SAR test procedures for devices incorporating Long Term Evolution (LTE) capabilities.

These procedures must be used for applications submitted to TCBs for approval. Questions about using alternative procedures should be submitted to <http://www.fcc.gov/labhelp> and then use the link "[Submit An Inquiry](#)" to access the form to submit your question.

Attachment List:

[941225 D05 SAR for LTE Devices v02](#)

Attachment 941225 D05 SAR for LTE Devices v02

**SAR Evaluation Considerations
for
LTE Devices**

I. Introduction

This document provides SAR test guidance for devices incorporating Long Term Evolution (LTE) capabilities. The procedures in this revision are based on experiences from the earlier preliminary version of the LTE procedures. As device implementations continue to improve and emerge, further revisions to the SAR test requirements for LTE products may be necessary. These test considerations have taken into consideration the different factors and parameters of recent implementations and the associated influences to SAR compliance. Some of the factors are related to variations in maximum output power for different number of resource blocks (RB) allocated with different RB offsets within the channel bandwidth frequency range, and across the channels in a frequency band. It is expected that as more LTE frequency bands and channel bandwidth configurations are implemented in devices, that revisions to these procedures will be necessary. Furthermore, these procedures are for Frequency-Division Duplex (FDD) systems only. For Time-Division Duplex (TDD) systems, a KDB inquiry is required to determine the SAR test requirements.

There have been concerns relating to the test configurations required for handsets that implement various forms of fixed and dynamic power reduction schemes to satisfy SAR compliance for simultaneous voice and data transmission; for example, SVLTE and SVDO, etc.¹ In some cases, the power reduction is implemented to address internal interference issues within the device. For products that require power reduction to manage the maximum output power of selected operating modes to satisfy SAR compliance or other equipment certification and operating requirements, a KDB inquiry detailing the power reduction implementations is necessary to determine the SAR test configurations required for the antenna configurations and simultaneous transmission conditions. There are also other testing concerns that are associated with simultaneous transmission SAR measurements and how to apply test reduction to the complex combinations of transmission configurations without compromising compliance. While some guidance is available for these, many of the implementations are product or manufacturer specific; therefore, a KDB inquiry is necessary to determine the SAR test requirements for the different circumstances.

These LTE procedures are applied in conjunction with the other *published KDB procedures* to test specific products; for example, USB dongles and wireless handsets. As LTE implementations continue to mature, and the test guidance in this document is not sufficient to address the SAR test concerns; a KDB inquiry must be submitted.

The PBA procedure is to be followed if either of the following conditions exist:

- a properly configured basestation simulator is not used to configure the test device for SAR testing
- power reduction is implemented or required; except for the MPR defined by 3GPP

¹ See KDB 648474 for additional discussions on SVLTE and SVDO etc.

Applicants are reminded to ensure that all LTE testing and approval issues have been fully addressed through prior KDB inquiries and that copies are provided to the TCB to support review and approval. The TCB will verify that all LTE test requirements have been satisfied.

II. General LTE SAR test and reporting considerations

In addition to the requirements in KDB 865664 for reporting RF exposure compliance, the following should be documented in SAR test reports to identify the wireless operating parameters and test configurations for LTE.

- A. List the frequency range and channel bandwidths used in each LTE band; 1.4, 3, 5, 10, 15, 20 MHz, etc.
- B. Identify the high, middle and low (H, M, L) channel numbers and channel frequencies for each LTE bandwidth and frequency band;² these are referred to in this document as the *required test channels*.³
- C. Include descriptions of the LTE transmitter and antenna implementation, and identify if the transmitter operates independently of the other wireless transmitters in the device; i.e., whether the LTE hardware, components and/or antenna(s) are shared with other transmitters.
- D. Identify the voice and data transmission requirements for all LTE operating modes and exposure conditions, for standalone and simultaneous transmission, with respect to the required head and body test configurations, antenna locations, handset flip or slide cover positions, antenna diversity requirements, etc.

These LTE test procedures must be applied separately to each device operating configuration and exposure condition, in each frequency band and channel bandwidth; for example, different test positions are required for head SAR and various surfaces and edges may be required by the *published KDB procedures*.⁴

- E. Identify if Maximum Power Reduction (MPR) is implemented as an optional or permanent feature, i.e., built-in by design.
 1. MPR may be considered during SAR testing only when the maximum output power is permanently limited by the MPR implemented within the device, according to the RB (resource block) configurations specified in 3GPP/LTE standards.
 2. Regardless of network requirements, only those RB configurations allowed (see 3GPP standards) for the channel bandwidth and modulation combinations may be tested with MPR active. Configurations with RB allocations less than the RB thresholds required by 3GPP must be tested without MPR.
 3. A-MPR (additional MPR) must be disabled during SAR testing.
- F. When power reduction is required for one or more LTE modes to satisfy SAR compliance for simultaneous transmission or other equipment certification and operating requirements, maximum

² For LTE bands that do not support at least 3 channels in certain channel bandwidths, test the available channels instead. Also note that the channel plan may enable devices to support overlapping channels in each channel bandwidth configuration, which should be taken into consideration to determine the test channels.

³ If a transmission band is > 100 MHz, the channel selection criteria in KDB 447498 must be applied.

⁴ See KDB 447498 for *published KDB procedures*.

average conducted output power measurement results for each power reduction mode applicable to the simultaneous voice/data transmission configurations for such wireless configurations and frequency bands are required.

1. Details of the power reduction implementation and measurement setup are required.
2. There must be supporting data to demonstrate that the power reduction mechanisms are operating reliably and consistently; for example, according to power measurements in the applicable simultaneous transmission and power reduction modes.
 - (i) If applicable, the sensing conditions required to activate and deactivate power reduction, such as antenna or transmitter output conditions, user proximity, etc. must be explained and verified accordingly.
 - (ii) When SAR scaling techniques are applied in the power reduction implementation, applicable analyses, SAR and other measurement verifications are required to demonstrate that a conservative SAR margin is available for each device operating configuration and exposure condition to satisfy compliance.

The scaling requirement for SAR vs. power generally varies from transmitter to transmitter due to SAR distribution and design differences. The power reduction provided by one transmitter may not necessarily allow or provide the same magnitude of SAR reduction for another transmitter operating within the device; therefore, the power increase required for one transmitter may not be supported by an equal amount of power reduction in another transmitter; especially for different frequency bands.

- (iii) For certain dynamic power reduction configurations, if a device is unable to reduce the maximum output power of one transmitter according to the output or other conditions of another transmitter(s) during SAR testing, the power reduction conditions may need to be manually simulated through test software to perform the SAR measurements.
 3. Descriptions of the test equipment, test software, built-in test firmware etc. required to support device testing when power reduction is applied to one or more transmitters/antennas for simultaneous voice/data transmission are required.
- G. Based on the design specifications and other information available to the manufacturer, through measurement and analysis during product development, when the maximum output power for different RB allocations and RB offset conditions within a channel bandwidth, modulation, or across the channels in a frequency band varies by more than 1 dB, a KDB inquiry is required to confirm if the [required test channels](#) are appropriate for SAR testing or if a different set of required test channels is necessary.
- H. The maximum average conducted output power should be measured for the [required test channels](#), for each channel bandwidth and uplink modulation, in each frequency band, using the following configurations to support the SAR test reduction and exclusion applied in the evaluation:
1. 100% RB allocation
 2. 1 RB and also 50% RB allocation, offset to the upper and lower edges of each [required test channel](#) and also to the middle of the channel bandwidth

- I. Spectrum plots should be included in SAR reports to demonstrate the tested RB allocations have been established correctly at the maximum output power conditions.⁵

III. SAR test procedures for LTE devices

A. SAR testing for LTE voice and data operations

The general test requirements for VoIP support are described in KDB 648474. The head, body-worn accessory and other required test considerations in KDB 447498 and other *published KDB procedures* should be applied to configure LTE devices for standalone and simultaneous transmission in voice and data modes for the required exposure conditions.

B. Standalone SAR test requirements

1. The SAR test reduction and exclusion provisions in KDB 447498 should be applied.
2. These test procedures apply to all exposure conditions – head, body-worn accessories and other use conditions.
3. For each LTE frequency band:
 - (i) Start with the largest channel bandwidth and measure SAR on the *required test channels* in QPSK with 100% RB allocation.
 - (a) when the maximum output power variation across the *required test channels* is $\leq \frac{1}{2}$ dB, begin SAR measurement with the middle channel; otherwise, begin with the highest output power channel
 - (b) then apply the test reduction provisions in KDB 447498 to determine if testing is required for the remaining channels
 - (ii) For QPSK with 50% RB allocated at the upper and lower edges of the channel, and also in the middle of the channel⁶
 - (a) when the highest SAR measured in [III.B.\(i\)](#) is > 1.2 W/kg, repeat [III.B.\(i\)](#) using QPSK with 50% RB allocation for the three RB offset configurations
 - (b) when the highest maximum output power for the *required test channels* in QPSK with 50% RB allocation in each of the three RB offset configurations is more than $\frac{1}{2}$ dB higher than that in QPSK with 100% RB allocation, repeat [III.B.\(i\)](#) for that RB offset configuration in QPSK with 50% RB allocation.
 - (iii) For QPSK with 1 RB allocated at the upper and lower edges of the channel, and also in the middle of the channel
 - (a) when the highest SAR measured in [III.B.\(i\)](#) or [III.B.\(ii\)](#) is > 1.2 W/kg, repeat [III.B.\(i\)](#) using QPSK with 1 RB allocation for the three RB offset configurations

⁵ Throughout this document, maximum output power means maximum average conducted output power.

⁶ Use 3, 8, 12, 25, 36 and 50 RB allocations, respectively, for 1.4, 3, 5, 10, 15 and 20 MHz channel bandwidths.

- (b) when the highest maximum output power for the *required test channels* in QPSK with 1 RB allocation in each of the three RB offset configurations is more than ½ dB higher than that in QPSK for both 50% and 100% RB allocations, repeat [III.B.\(i\)](#) for that RB offset configuration in QPSK with 1 RB allocation.
 - (iv) For each modulation besides QPSK (e.g., 16-QAM, 64-QAM)

Apply the procedures in [III.B.\(i\)](#), [III.B.\(ii\)](#) and [III.B.\(iii\)](#) to determine the channels and configurations (channel bandwidth, RB allocation, RB offset etc.) that need SAR testing and measure SAR only when the maximum output power for a channel and configuration combination is more than ½ dB higher than the same channel and configuration in [III.B.\(i\)](#), [III.B.\(ii\)](#) and [III.B.\(iii\)](#) or the SAR measured in [III.B.\(i\)](#), [III.B.\(ii\)](#) and [III.B.\(iii\)](#) is > 1.2 W/kg.
4. For the other channel bandwidths used by the device in each LTE frequency band
- (i) Apply all the procedures in [III.B.\(3\)](#) to determine the channels and configurations that need SAR testing and
 - (a) only measure SAR when the maximum output power of a configuration in the smaller channel bandwidth is more than ½ dB higher than the equivalent channel configurations in [III.B.\(i\)](#), [III.B.\(ii\)](#) and [III.B.\(iii\)](#) or the measured SAR in [III.B.\(i\)](#), [III.B.\(ii\)](#) and [III.B.\(iii\)](#) for the equivalent condition is > 1.2 W/kg.
 - (b) The equivalent channel configuration for the RB allocation, RB offset and modulation etc. is determined for the smaller channel bandwidth according to the same number of RB allocated in the largest channel bandwidth. For example, 50 RB in 10 MHz channel bandwidth does not apply to 5 MHz channel bandwidth; therefore, this cannot be tested in the smaller channel bandwidth. However, 50% RB allocation in 10 MHz channel bandwidth is equivalent to 100% RB allocation in 5 MHz channel bandwidth; therefore, these are the equivalent configurations to be compared to determine the specific channel and configuration in the smaller channel bandwidth that need SAR testing.
 - (ii) The configurations and conditions that qualify for SAR test exclusion or require testing must be clearly describe in the SAR report.

C. Simultaneous transmission SAR test considerations for LTE

1. The standalone SAR results of individual transmitters and transmitting antennas in the frequency bands, operating modes, device operating configurations and exposure conditions are required to determine simultaneous transmission SAR test requirements, with respect to the applicable *published KDB procedures*; for example, voice and data modes in LTE, 1xRTT, WCDMA, GSM, EvDo, HSPA, GPRS/EDGE, WiMax, Wi-Fi, Bluetooth etc.

The SAR test reduction and exclusion provisions in KDB 447498 must be applied separately to the exposure conditions for head, body-worn accessory and other use test configurations for the channel bandwidths, modulations, RB offsets and allocations in each frequency band.

The conditions and configurations that qualify for test exclusion or reduction must be clearly described in a tabulated format in the SAR report.

2. When simultaneous transmission SAR measurement is required, the enlarged zoom scan measurement and volume scan post-processing procedures in KDB 865664 must be applied, in conjunction with the *published KDB procedures* required for the product platform and wireless technologies, to each device operating configuration and exposure condition.

Change Notice:

05/tbd/2012 941225 D05 SAR for LTE Devices v02 replaces 941225 D05 SAR for LTE Devices v01

