



**Federal Communications Commission  
Office of Engineering and Technology  
Laboratory Division**

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**REL. 10 LTE SAR TEST GUIDANCE AND KDB INQUIRIES**

**A. General Information**

Rel. 10 LTE features are being implemented in LTE products based on wireless carrier requirements and network infrastructure migration schedules. OET plans to provide appropriate test guidance through a KDB Publication based on its review of various product implementations. This document identifies:

- The features of Rel. 10 LTE that are expected to introduce additional SAR testing issues for equipment certification.
- Clarifies that devices incorporating certain network related enhancement features and downlink only carrier aggregation conditions can be excluded from SAR testing and PAG requirements.
- Provides power measurement procedures to determine SAR test exclusion for downlink only carrier aggregation.

As LTE products continue to incorporate additional Rel. 10 features, manufacturers and test laboratories are encouraged to seek SAR test guidance through KDB inquiries. SAR guidance will need to be given according to individual product implementations, on a case-by-case basis, until standardized procedures can be established. A KDB inquiry is only needed when SAR evaluation is required in order to determine what procedures are to be used.

Based on our evaluations, the SAR measurement issues for Rel. 10 LTE consumer devices are mostly related to carrier aggregation, enhanced SC-FDMA and multiple uplink antenna requirements. We expect that the initial implementation of individual products will vary due to wireless carrier and product design requirements; for example, the number of frequency bands, FDD vs. TDD, SVLTE and VoLTE. At the present time, mostly network related enhancements and downlink only carrier aggregation have been implemented in early products. Besides the LTE specific issues, there are other product specific concerns that are indirectly associated with LTE (for example, power reduction, dynamic antenna tuning, envelop tracking PA designs, etc.) which may introduce additional SAR testing difficulties and must be taken into consideration collectively.

**B. Pre-Approval Guidance (PAG)**

At the present time a PAG is not required for those devices which implement network related enhancement features and downlink only carrier aggregation configurations that are excluded from SAR testing, as discussed below. A PAG should be submitted for all LTE devices which implement other Rel. 10 features: uplink carrier aggregation, enhanced SC-FDMA and uplink MIMO or other antenna diversity configurations.<sup>1</sup> Applications for such devices must clearly include a description of the Rel. 10 limitations, inclusion of certain higher release or other ad hoc features and device support restrictions in an attestation letter from the grantee to confirm LTE implementation status of the device and SAR test

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<sup>1</sup> There are already devices applying for equipment certification that use carrier aggregation features established for Rel. 11 or higher, including variant configurations that are not defined in existing 3GPP documents. When unclear, a KDB inquiry should be submitted to confirm the SAR evaluation requirements for these types of configurations to avoid issues.

exclusion conditions. This should be included in the attestation exhibit of Form 731 along with applicable grant comments.

### C. KDB Inquiries

The following list, as appropriate, should be used to prepare an inquiry seeking SAR test guidance for Rel. 10 LTE products or to quantify downlink only carrier aggregation SAR test exclusion in SAR reports. It should be noted that sufficient implementation details are necessary to clearly identify the SAR testing concerns and to facilitate identifying solutions. If available, a proposed summary test plan may be provided with the inquiry to help expedite the process.

- 1) FCC ID of the specific device(s) covered by the KDB inquiry.<sup>2</sup>
- 2) Provide references to the standards used in the design of the product for each device (FCC ID) in the KDB inquiry, to help identify product implementation and testing requirements, including:
  - a) The LTE release and version numbers of the 3GPP documents used to implement the specific device(s).
  - b) The associated 3GPP release and version numbers required for power measurements and RF test setup conditions.
- 3) When carrier aggregation applies, implementation and measurement details for the following are necessary:
  - a) Intra-band and inter-band carrier aggregation requirements for both uplink and downlink, including Wi-Fi offloading using LTE-U, LAA or LWA related protocols:<sup>3</sup>
    - i) Support of contiguous and non-contiguous component carriers for intra-band aggregation.
    - ii) The frequency band combinations supported for inter-band carrier aggregation.
    - iii) The number of component carriers, including all combinations, supported for intra-band and inter-band carrier aggregation in the uplink and downlink.
    - iv) The channel bandwidth configurations applicable to each carrier aggregation configuration and the applicable carrier aggregation Bandwidth Classes; A ... F, etc.
    - v) Whether restrictions are applied to certain channel combinations.
    - vi) The RB combinations or certain variant protocols supported by the carrier aggregation configurations.
  - b) When carrier aggregation is limited to downlink only; *i.e.*, there is no uplink carrier aggregation, uplink maximum output power (single carrier) is measured for the supported combinations of downlink carrier aggregation:
    - i) According to the frequency bands and channel bandwidths allowed for the uplink and downlink configuration combinations.
    - ii) Uplink maximum output power is measured with downlink carrier aggregation active, only for the channel with highest measured maximum output power when downlink carrier aggregation is inactive, to confirm that when downlink carrier aggregation is active uplink maximum output power remains within the specified tune-up tolerance limits and not more

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<sup>2</sup> See KDB Publication 388624 D01 *Pre-Approval Guidance Procedure*, with respect to when the guidance provided in a specific KDB inquiry may be used for other products with identical implementation.

<sup>3</sup> These are on-going carrier aggregation related protocols intended to apply Wi-Fi offloading for LTE. LTE-Unlicensed (LTE-U) provides 5 GHz downlink aggregation of U-NII-1 and U-NII-3 bands. Licensed Assisted Access (LAA) is expected to be incorporated in 3GPP Rel. 13 to aggregate U-NII-1 and U-NII-2 bands. LTE-WLAN Radio Level Integration and Interworking Enhancement (LWA) is a 3GPP development for addressing IEEE 802.11 compatibility.

than ¼ dB higher than the maximum output power measured when downlink carrier aggregation inactive.<sup>4</sup>

- (a) The implemented CA configurations must be clearly identified along with the power measurement results; for example, CA\_(band #)(bandwidth class) ... for intra-band configurations and CA\_(band #)(bandwidth class)-(band #)(bandwidth class) ... for inter-band configurations, with respect to the number of carriers being aggregated. In some cases, multiple CA configurations are defined for different combinations of allowed channel bandwidth, which must be clearly identified to support the power measurement results. It should also be identified if all component carriers (CC) can be used as the primary and secondary carrier (PCC and SCC); therefore, uplink power measurements should be considered with the applicable combinations of PCC and SCC.
  - (b) The channel numbers and channel frequencies for both uplink and downlink must be clearly documented for the power measurement. The uplink channel is selected according to b) ii) above. The downlink channels selected to perform the uplink power measurement must satisfy 3GPP channel spacing (5.4.1A of 3GPP TS 36.521 or equivalent) and channel bandwidth (5.4.2A) requirements. The nominal channel spacing is determined by  $[BW_1 + BW_2 - 0.1 * |BW_1 - BW_2|] / 2$  MHz, where  $BW_1$  and  $BW_2$  are the channel bandwidths of the CC in a 2-CC aggregation configuration.
  - (c) The downlink PCC channel should be paired with the uplink channel according to normal configurations, as if there is no carrier aggregation. The downlink SCC should be adjacent to the PCC and remain within the downlink transmission band for contiguous intra-band CA. For non-contiguous intra-band CA, the SCC should be selected to provide maximum separation from the PCC and must remain fully within the downlink transmission band. For inter-band CA, the SCC should be near the middle of its transmission band.
  - (d) When it is unclear a KDB inquiry should be submitted to determine the downlink channel selection for the applicable CA configurations.
- iii) When the uplink maximum output power conditions in ii) are not satisfied, a KDB inquiry is required to determine if SAR evaluation for the uplink with downlink carrier aggregation active may be necessary.
  - iv) When SAR is not required for downlink only carrier aggregation and provided it is fully documented in the SAR report according to procedures in this KDB, a PAG is also not required.
- c) When uplink carrier aggregation applies, maximum output power and tune-up tolerance specified for each component carrier in each carrier aggregation configuration are required to determine the SAR test configurations.
    - i) When power reduction applies, the maximum output power specifications and measured results with and without carrier aggregation in the reduced power configurations are also necessary.
    - ii) When the maximum output power specified for production units, including tune-up tolerance, varies across channel bandwidth, modulation, RB allocation, channels etc., the conditions must be clearly identified in the KDB inquiry to address SAR testing concerns.

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<sup>4</sup> When the specified maximum output power and tune-up tolerance are the same for the different channel bandwidth, RB and modulation configurations, maximum output power for the uplink with downlink carrier aggregation active may be measured using the highest maximum output power configuration for uplink with downlink carrier aggregation inactive measured among the channel bandwidth, modulation and RB combinations in each frequency band.

- d) A clear description of the test equipment and setup is required to support the power and SAR measurement results.
  - e) Any other restrictions or limitations associated with the carrier aggregation implementation must be clearly identified.
- 4) When enhanced SC-FDMA is supported for uplink transmissions, details of the implementation, limitations and restrictions are necessary to determine SAR measurement requirements, including:
    - a) Decoupling of control and data transmissions to enable simultaneous transmission of PUCCH and PUSCH.
    - b) Non-contiguous data transmission with clustered SC-FDMA to enable non-contiguous subcarriers in PUSCH transmissions.
    - c) Issues relating to dynamic switching among the SC-FDMA schemes also need consideration to determine SAR test configurations.
    - d) When a partially allocated PUSCH, a cluster of partially allocated PUSCH or a fully allocated PUSCH is transmitted simultaneously either with or without PUCCH, peak to average power ratio of the signal can increase substantially above Rel. 8 implementations. The SAR testing concerns for these need additional consideration.
  - 5) When multiple transmit antennas are used to support uplink MIMO or other transmit diversity configurations, details of the implementation and operation for such features are necessary to determine SAR measurement concerns. These are currently considered on a case-by-case basis for all emerging Rel. 10 LTE products until sufficient information and testing expertise can be established to prepare guidance.
  - 6) UE category and descriptions of the category requirements for supporting carrier aggregation, uplink MIMO and other UE configurations should be clearly described in the KDB inquiry and SAR report.
  - 7) While it is highly unexpected and until more can be learned, if it is suspected that the hardware or firmware associated with any LTE Rel. 10 features may introduce SAR influences for a product; for example, certain network enhancement features such as CoMP, HetNet, Relay, SON, cross carrier scheduling, eICIC, enhanced downlink MIMO, MBMS, M2M/D2D support etc., the potential of SAR concerns and any hardware, firmware or other limitations or restrictions applied to alleviate such concerns must be explained in the KDB inquiry and equipment certification filing (Technical Description exhibit).
  - 8) Detailed descriptions of SVLTE or similar support in any carrier aggregation configurations to identify other SAR measurement concerns.
  - 9) Description of the device and other transmitters/antennas contained within it to identify various standalone and/or simultaneous transmission SAR testing concerns.

## Change Notice

**08/12/2014:** 941225 D05A LTE Rel.10 KDB Inquiry Sheet v01r01 replaces 941225 D05A LTE Rel.10 KDB Inquiry Sheet v01. Updated document to exclude network related enhancements and certain downlink only carrier aggregation from Rel. 10 LTE PBA requirement.

**10/23/2015:** 941225 D05A LTE Rel.10 KDB Inquiry Sheet v01r02 replaces 941225 D05A LTE Rel.10 KDB Inquiry Sheet v01r01. Updated document to clarify the downlink carrier aggregation channel selection conditions for uplink power measurement, changed PBA to PAG and included minor clarifications for LTE-U, LAA and LWA. Heading numbering added.