



# **RF Exposure Procedures Update**

**FCC / OET  
Laboratory Division**

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**TCB Workshop**



# Overview

- Interim and evolving SAR test considerations
  - LTE devices, occupational PTT radios, personal wireless routers (hot spots), UMPC mini-tablets, sleeves & cradles (host-carriers)
    - dynamic and fixed power reduction, proximity sensing
    - simultaneous transmission SAR volume scans
- Test setup issues
  - power reduction by sensing
  - external antennas for devices used in portable exposure conditions
  - making SAR measurements with proper phantom configurations
- KDB procedures and miscellaneous updates
  - low duty factor devices, e-Readers
  - KDB 447498 dongles, KDB 616217 Supplement
  - SAR probe and dipole calibration issues
  - KDB & PBA issues relating to non-standard test procedures
  - information needed in KDB & PBA inquiries to expedite responses
  - WiMax, HSPA<sup>+</sup> and other clarifications
  - SAR standards status



# **Interim SAR Test Considerations for LTE**



# LTE SAR Test Concerns

- Interim LTE test considerations are based on recent test inquiries on
  - issues relating to channel bandwidth, resource block (RB) allocation, simultaneous voice & data transmission, power reduction mechanisms etc
  - the need to address design and test concerns of early generation products
  - the need to have sufficient flexibility to target certain on-going concerns
- Procedures may be simplified in subsequent revisions
  - after issues relating to early generation products have subsided
  - when designs and implementations mature
  - when simultaneous transmission SAR procedures can be improved
- Interim procedures need sufficient flexibility to manage the test combinations required with respect to
  - multiple channel bandwidths, varying RB allocations and signal modulation
  - certain power and design issues observed in early implementations
  - certain on-going simultaneous transmission SAR measurement difficulties



# Interim LTE SAR Procedures

- Included procedures for testing USB dongles & handsets
  - in stand-alone SAR configurations
  - in simultaneous transmission SAR conditions, with
    - fixed and dynamic power reduction configurations
    - for voice & data mode combinations in different wireless modes
- Identified test combinations for small, medium and full RB allocations to address certain on-going concerns in some early implementations
  - for the applicable channel bandwidth & signal modulation configurations
- Test reduction is applied progressively according to the SAR measured for certain core configurations
  - while ensuring potential issues are not overlooked
- A KDB inquiry is recommended after stand-alone SAR testing
  - to seek further test reduction for the more complex simultaneous transmission & dynamic power reduction configurations of an individual product



# Voice/Data Power Reduction

- LTE handsets with multiple transmitters allowing simultaneous voice & data transmissions through single or separate antennas are coming
- Some implementations may require the maximum output power in data modes to be reduced during voice calls to meet SAR requirements, where power reduction can be
  - applied at different fixed levels or adjusted dynamically
  - for selected operating modes and frequency bands
- SAR measurement difficulties are expected to vary with individual product design and test setup flexibility
  - SAR for different frequency bands must be measured independently
  - simultaneous transmission with dynamic power reduction cannot be tested in normal operating modes when different frequency bands are involved
  - simultaneous transmission SAR test requirements can be dependent on transmitter power levels, antenna proximity, device form factor and SAR distributions etc
  - non-standard test setup requires PBA to confirm results are acceptable



# Simultaneous SAR Measurements

- Simultaneous transmission SAR measurement implementations can be optimized differently in different SAR systems
  - detailed implementation requirements are not described in SAR standards
  - certain implementation & optimization may need further documentation and validation to support routine use
  - availability of detailed documentation may vary from system to system
- Simultaneous transmission SAR measurements are typically quite time-consuming
  - test labs should consult with SAR system manufacturers about the simultaneous SAR measurement capabilities of individual systems
  - any ad hoc or non-standard considerations, adaptations should be confirmed through KDB inquiries to ensure test setups are acceptable
- Simultaneous transmission SAR measurements should follow the general requirements outlined in KDB 648474 and KDB 616217 to qualify for TCB PBA approval
  - otherwise, FCC filing may be required



# **Interim SAR Test Reduction Considerations for PTT Radios**



# Occupational PTT Radios

- Occupational PTT radios intended for law enforcement, fire & rescue or other public safety operations often have a large number of optional accessories, such as
  - antennas for covering overlapping bands or subsets of frequency bands
  - multiple battery options to accommodate different body-worn accessories and extended use conditions
  - various body-worn and audio accessory combinations for specific use requirements
  - large number of accessories can result in thousands of test combinations
- SAR test reduction considerations are necessary to streamline test requirements for equipment certification; for example,
  - SAR must be measured for certain core configurations
  - similarities in the design, operating and exposure characteristics of certain accessories may allow the number of tests to be reduced progressively based on measured SAR levels to demonstrate compliance



# PTT SAR Considerations

- SAR test procedures based on general test experience and assumptions are inadequate for addressing large combinations of accessories used for some PTT radios
- By applying the interim procedures in draft KDB 643646 to test products for equipment certification can ease existing test concerns while allowing manufacturers, test labs and the FCC to identify issues and make improvements
- The interim test reduction procedures included guidance for testing SAR in front of the face & for body-worn conditions for different
  - antenna and battery options
  - body-worn and audio accessory combinations
- Suggestions for reporting formats are also included to allow the applicable test configurations and results to be documented consistently to facilitate review and approval
  - these templates may require further adjustment with respect to the accessories available for an individual product



# Interim PTT SAR Procedures

- The general test reduction concepts require SAR to be tested on the highest output power channels for each antenna in each operating frequency band using certain defined default configurations
  - test reduction may be applied to the other required test channels (see KDB 447498 (6)(c)) based on the SAR of the default configurations
  - other battery options are tested with respect to the SAR measured for the highest SAR condition in the default configurations
- body-worn accessories should be tested without audio accessories
  - except when only a single audio accessory is required for testing
  - to establish the baseline to further streamline the test reduction requirements for audio accessories
- Audio accessory testing includes
  - those with integral antennas, such as shoulder-worn microphones
    - these must be test independently because of the separate antenna
  - those without any radiating element are typically passive
    - these may qualify for more test reduction



# **Interim SAR Considerations for Personal Wireless Routers (hot spots)**



# Personal Wireless Routers

- Battery operated personal wireless routers (hot spots) enable multiple Wi-Fi connections to share a 3G connection; may be implemented as
  - a stand-alone device
  - an integral part of another device, such as a handset
  - partially incorporated in a unit that requires external transmitter support
- These devices have small form factor and are typically operated by users in portable exposure conditions, where the
  - operating configurations & exposure conditions may vary among devices
- Use of manual instructions to restrict these devices to operate in mobile exposure conditions is problematic and unenforceable
  - prohibiting portable use is difficult and impractical for such small devices
- SAR test considerations can be based on composite use conditions
  - a composite test separation distance according to general mixed use conditions may be applied for this type of devices
  - the test distances should be appropriate for the form factor of a device and based on conservative exposure conditions according to user expectations



# Interim Router SAR Procedures

- For stand-alone wireless routers with length  $\geq 3.5''$  and width  $\geq 2''$ 
  - test SAR at 1 cm from the top & bottom surfaces and also from side edges with a transmitting antenna  $\leq 2.5$  cm from an edge
  - if applicable, apply the simultaneous transmission SAR exclusion procedures in KDB 648474 or perform simultaneous transmission SAR
- For wireless routers incorporated in portable devices, e.g. handsets
  - apply stand-alone wireless router test conditions, including simultaneous transmission SAR requirements, for wireless routing functions
  - the SAR results may overlap with some of the body-worn accessory SAR requirements; therefore, test only the more conservative configurations
- For stand-alone units requiring an external or peripheral transmitter to provide wireless routing; e.g. a USB dongle transmitter
  - evaluate stand-alone SAR for the base unit and assume the external transmitter has 1.6 W/kg
  - assume the peak SAR location is 1 cm from the USB connector and apply the simultaneous transmission SAR exclusion procedures in KDB 648474



# **Interim SAR Test for UMPC Mini-Tablets**



# UMPC Mini-Tablets

- These are mini tablets with overall dimensions smaller than a small size netbook with 8” diagonal display
  - form factor allows them to fit in the palm of a hand, but not restricted to hand use
  - the smaller size may not balance well on the lap
  - keypad & display allow user interaction at close proximity
- A composite test separation distance of 5 mm should be applied to test all sides and edges of the device with an antenna closer than 2.5 cm from the surface or edge
  - this also accounts for hand exposure; therefore, hand SAR testing is not necessary
- Simultaneous transmission SAR exclusion may be applied according to KDB 648474
- A KDB inquiry is recommended to ensure the device is qualified as a UMPC mini-tablet to avoid improper test configurations that may lead to delays during equipment approval
  - PBA may not be required for TCB approval if is confirmed in a KDB inquiry and all test issues have been fully addressed
- A PBA is required for TCB approval when proximity sensing is applied to reduce maximum output power in any of the operating modes



# **Interim SAR Considerations for Host-Carriers (Sleeves & Cradles)**



# Sleeves and Cradles

- These are portable host-carriers for devices such as cellphones or other small electronic devices
- The combination typically operate in conjunction with each other to enhance the functional capabilities of the host
- The host-carrier typically communicates with the host through Wi-Fi and may have a wired connection to the host to extend its battery capacity
- The host-carrier may provide voice, data or video support to the host using additional wireless technologies not available on the host
- The host-carrier may not have its own user interface and has to depend on the display and keypad on the host for user input/output
- The host and host-carrier transmitters may operate independently and also in conjunction with each other, including simultaneous transmission
- The host-carrier may be designed to work with a specific host or allow different hosts from the same or different manufacturers to be used
- Head, body or hand exposure conditions may apply for the combination
- There could also be other functions that might not have been identified yet



# Testing Sleeve & Host

- If the host-carrier can operate independently, with or without the host attached, these conditions must be test independently
- If the host can operate independently in the carrier, the host must be tested independently in the host-carrier
  - Wi-Fi typically require test firmware in the host for testing
- If the host & host-carrier can operate in conjunction with each other, including simultaneous transmission, these operating configurations must be tested
- In some cases, test reduction may be considered on a case-by-case basis according to the antenna locations, certain host/carrier limitations or low SAR conditions based on previous test results for a host
- All simultaneous transmission conditions for host and host-carrier independent operations and in conjunction with each other must either qualify for simultaneous transmission SAR exclusion (KDB 648474) or perform volume scan SAR measurements
- Hand-held & body exposure conditions for UMPC mini-tablet may apply
- Due to the complexity of the test configurations, a test lab KDB inquiry is recommended to confirm test setup. PBA is required for TCB approval.



# Test Setup Issues



# Power Reduction by Sensing

- Proximity and other similar sensors may be incorporated in devices to reduce the maximum output power in selected operating modes to satisfy SAR compliance
- Test results, typically based on power measurements at varying device to phantom distances, must be included in KDB inquiries to demonstrate the reliability and consistency of the distance range the sensor can be activated and deactivated to obtain SAR test guidance for these devices
- Additional considerations are necessary to ensure a device is operating in the reduced or maximum output power conditions when it is put in the required test configuration and the sensor is properly triggered
- The test setup must be fully described in the final SAR report and supported by the sensor activation, deactivation and distance results
- Details of the sensing design, implementation and operating characteristics may be included in the technical descriptions exhibit and properly referenced in the SAR report for equipment certification
  - the SAR report must include sufficient high level descriptions to support the test setup and results



# External Antennas

- External antennas used with devices approved for portable exposure conditions (also discussed in the April 2010 TCB workshop)
  - must have practical mechanisms to ensure a minimum separation distance ( $> 20$  cm) is available in the installation to qualify specific antenna(s) for use in mobile exposure conditions; otherwise,
  - SAR evaluation may be necessary, with respect to the operating configurations and exposure conditions of the antenna use conditions to show compliance
- It is unacceptable and unenforceable to require users to maintain a minimum separation to satisfy RF exposure compliance
  - instructions are often overlooked or ignored
- Applying the maximum antenna gains allowed to comply with MPE at different frequencies is problematic
  - the detailed antenna characteristics of an antenna may not be available for a user to determine if an antenna meets RF exposure requirements according to specific antenna gain requirements at all applicable frequencies
  - exposure from devices used in portable exposure conditions is highly dependent on use configurations; therefore, specific antenna(s) must be identified and supplied with a device to determine RF exposure evaluation and compliance requirements



# Phantom Test Positions

- Devices that are not intended for use next to the ear have been incorrectly tested according to handset/head exposure procedures
  - such test results are inappropriate for demonstrating compliance; therefore, unacceptable for equipment certification
  - for example, wrist watch transmitters designed to be worn on the wrist should be tested for next to the mouth and wrist use conditions
- For devices that do not conform to the surface of a flat phantom, a KDB inquiry is necessary to determine appropriate phantom and device test positioning alternatives for SAR testing
  - for example, some wrist watches or tracking devices cannot be positioned flat against the phantom due to varying curvatures
- When non-standard test procedures are applied, a PBA is required for TCB approval
  - if the test variations are straight forward, certain exceptions for PBA may be considered during lab KDB inquiries



# **KDB Procedures & Miscellaneous Updates**



# Low Duty Factor Devices

- The SAR exclusion procedures for e-Readers are only applicable to simple e-Readers
  - these are devices that use a specific type of black & white display technology to optimize the information displayed on the device and transmitted over the air
  - these procedures do not apply to other types of e-Readers or other devices containing e-Reader functions
  - do not identify these other devices as e-Readers in inquiries and SAR reports, which will likely introduce issues and cause delays
- SAR exclusion for certain low transmission duty factor devices, such as location-based navigators or location tracking devices, must submit a KDB inquiry with the necessary analysis to determine if a device qualifies for SAR test reduction or exclusion
- An analysis report is required in place of the typical SAR report to justify the duty factor and SAR exclusion
  - the same duty factor determined according to the SAR test exclusion considerations may be applied when SAR tests are required
  - PBA requirements may be waived after issues and concerns have been fully addressed and confirmed in a lab KDB inquiry



# KDB 616217 Supplement

- There has been at least one recent certification that applied the supplemental procedures in KDB 616217 to address
  - conservative SAR testing requirements
  - modular approval issues
  - simultaneous transmission SAR issues
  - OEM integration, implementation requirements
  - grantee/OEM coordination and responsibility
- Many of the other certifications are still using the earlier KDB 616217 procedures for laptop displays only
  - these older procedures have generated numerous unnecessary Class II permissive changes and various OEM integration and grantee responsibility issues
  - further revision to phase out the earlier KDB 616217 procedures is expected
  - manufacturers and test labs should start applying the new supplemental procedures to avoid last minute problems and delays
- In applying KDB 616217 supplement, a test lab or TCB KDB inquiry is recommended to ensure the test configurations, procedures, results and all necessary OEM requirements and instructions have been applied correctly to avoid delays during equipment approval



# KDB 447498 USB Dongles

- The PBA requirement for 1.2 W/kg SAR threshold described in section 2 of KDB 447498 applies to products tested according to the procedures in that section of the KDB only
  - do not mix this with other SAR test reduction or exclusion thresholds described in other KDB procedures
- There have been some new USB dongle designs that may require additional confirmation in order to apply the typical swivel dongle procedures in KDB 447498; for example,
  - dongles with mechanical stops or switching mechanisms to restrict transmission in specific USB connector positions
  - dongles using sensing mechanisms to reduce maximum output power in selected operating modes or positions
  - dongles with form factors different than the traditional memory stick
  - dongles with unusual rotational or swivel flexibilities and construction
  - dongle-like devices that may not be qualified to use the dongle procedures



# SAR Probe Calibration

- Devices intended for TCB approval must be tested with SAR probes calibrated according to procedures in IEEE Standard 1528-2003 and Supplement C 01-01
- SAR measurements using probes calibrated with other procedures do not qualify for TCB approval and must be considered on a case-by-case basis through KDB inquiries to be acceptable for equipment certification filed at the FCC
- There have been several situations where signal specific or modulation specific SAR probe calibrations are applied and have resulted in problems and delays
- Signal and/or modulation specific SAR probe calibrations have not been considered in on-going drafts and revisions of SAR measurement standards
  - additional details, comparison and validation results are necessary for case-by-case considerations to determine if individual circumstances are acceptable



# Dipole Calibration

- It has been discussed multiple times during previous TCB workshops that SAR systems require a calibrated dipole for system validation and routine verification
- A dipole calibrated with an SAR system that require the dipole to validate the system is unacceptable
- There have been a few cases where test labs and TCBs are not following the dipole calibration requirements in KDB 450824
  - a dipole calibrated with respect to KDB 450824 is required to verify SAR system accuracy and support the test results
  - dipoles calibrated outside the frequency range of the test device also need additional consideration with respect to KDB 450824
- In order to qualify for the extended dipole calibration interval, the annual measurements identified in KDB 450824 must be included in the SAR report
  - the original dipole calibration date instead of a projected 3 year extended calibration due date should be identified in the SAR report



# Non-Standard Procedures

- When non-standard test procedures are used to test a device, KDB 388624 requires a PBA for TCB approval
- A test lab KDB inquiry is generally necessary to verify if certain non-standard test setup and/or device configurations are acceptable for demonstrating compliance
- There have been a few circumstances where test labs and TCBs have made incorrect interpretations and assumptions and resulted in problems and delays
- Some of these include
  - devices with LTE, power sensing and power reduction issues
  - UMPC mini-tablets and battery operated personal wireless routers
  - non-standard SAR probe calibration and dipole calibration requirements
  - adjustments to certain simultaneous transmission SAR measurement requirements
  - arbitrary test reduction considerations
  - deviations from the published KDB test procedures
  - applying incorrect interpretations or procedures to determine PBA requirements
- Certain MIMO configurations – 3 x 3 or more may need KDB inquiry to address certain test setup issues



# KDB/PBA Documentation

- When submitting a KDB/PBA inquiry
  - include the necessary information to seek timely responses
    - transmitter types, technologies, maximum output power, device form factor and dimensions, antenna types and locations with photo illustrations, technical details of design and operating issues, operating configurations and exposure conditions etc
    - FCC IDs are required to associate the guidance or procedures provided in specific KDB inquiries with subsequent equipment certification approvals
  - a copy of the KDB inquiry should be provided to the TCB during equipment approval to avoid confusion and unnecessary delays
- PBA process requires a TCB to submit a PBA inquiry to seek authorization to approve such filings
  - a test lab KDB inquiry is not mandatory for the PBA, but recommended if there are testing concerns
- Any supporting information, rationale, justification, KDB publications and other test setup descriptions must be included in appropriate sections of the SAR report to facilitate review and approval
  - information included in other filing exhibits used to justify SAR test results; for example, technical description, must be clearly identified and referenced in relevant sections of the SAR report



# WiMax & HSPA+ Status

- WiMax PBA issues are improving; however, there are still problems with test labs not properly applying the WiMax procedures in KDB 615223
- There are also problems with WiMax PBAs that are not thoroughly review by some TCBs
- The current version of WiMax procedures is based on early-on products and implementations, more recent information needs to be considered to simplify and streamline these procedures before removing WiMax from the PBA list
- Recent KDB and PBA inquiries have shown very little activities on HSPA+
  - HSPA+ will remain on PBA list until further trends can be established



# WiMax Procedures Update

## ● April 2010 TCB workshop:

- for each channel bandwidth, if QPSK SAR is  $< 0.8$  W/kg and (QPSK) maximum power  $> 16$ QAM, test highest output channel for 16QAM

## ● Further relaxation:

- for each channel bandwidth, if the 16QAM maximum output power is  $\leq \frac{1}{4}$  dB higher than QPSK and
  - QPSK SAR is  $< 0.8$  W/kg, 16QAM SAR is not needed
  - QPSK SAR is between 0.8 and 1.2 W/kg, test 16QAM using the highest SAR channel in QPSK
  - QPSK SAR is  $> 1.2$  W/kg, test 16QAM using the highest SAR channel in QPSK; and if the 16QAM SAR is  $> 1.2$ , test all channels in 16QAM
- each USB dongle orientation that require SAR testing must be treated independently to apply the test reduction relaxation
  - this also applies to other test reduction procedures for USB dongles



# Handset Test Channels

## ● Original April 2010 slide

- when maximum output variation across channels is  $< \frac{1}{2}$  dB
  - either maximum output or middle channels may be used to determine test reduction for each mode in a cellphone; otherwise,
  - use the maximum output channel to determine test reduction for all other product and technology configurations, including cellphones

## ● Clarification

- when maximum output variation across channels is  $< \frac{1}{2}$  dB
  - either maximum output or middle channels may be used to determine test reduction for each mode in a cellphone; otherwise,
- when maximum output variation across channels is  $\geq \frac{1}{2}$  dB
  - use the maximum output channel to determine test reduction for all other product and technology configurations, including cellphones



# KDB 447498

- KDB 447498 may not fully apply to evolving products
  - when unclear, a KDB inquiry is recommended
- These may relate to emerging form factors for UMPC mini-tablets, host-carriers (sleeves & cradles), certain on-going test reduction considerations (PTT, proximity sensing, power reduction etc.), hand SAR thresholds for emerging products, certain simultaneous transmission conditions etc.
- KDB 447498 (4)(c)(iii): Contact FCC to determine if
  - Original: (1) Hand SAR is required for hand-held and hand-operated devices with output power  $> 1000 \cdot [f_{(\text{GHz})}]^{-0.5}$  mW that are designed with the hand operating closer than 5 cm from the antenna during normal use.
  - Interim revision: (1) Hand SAR is required for hand-held and hand-operated devices that are designed to operate with the hand at (a)  $\leq 2.5$  cm from the antenna during normal use or (b)  $\leq 5.0$  and  $> 2.5$  cm when the maximum output power is  $> 1000 \cdot [f_{(\text{GHz})}]^{-0.5}$  mW.
- KDB 447498 will be updated to take into consideration some of these more recent products, form factors, operating configurations and exposure conditions etc. when related issues are maturing



# SAR Standards

- IEEE 1528 and IEC 62209-1 revisions
  - balloting are planned for both drafts near the end of 2010 or early 2011
  - both documents may not have the necessary procedures to establish device test configurations for specific technologies
    - there have been discussions about plans to review & address SAR measurement issues for current generation digital technologies in recent IEC 62209 and TC-106 plenary meetings
  - certain generalized considerations described in both documents may need additional detailed procedures for implementation, including but not limited to fast SAR methods, simultaneous transmission SAR, certain test reduction considerations etc
- After these standards are formally published, additional considerations will be necessary to determine implementation issues for each individual method or consideration before test guidance can be provided through KDB publications for test labs and TCBs to apply these for equipment certification