RF Exposure Procedures

TCB Workshop

April 2018

Laboratory Division
Office of Engineering and Technology
Federal Communications Commission

Overview

- LTE DL CA SAR Test Exclusion Update
- WiGig/60 GHz RF Exposure Evaluation Update
- Other Updates

LTE DL CA

SAR Test Exclusion

Update

LTE Carrier Aggregation

- A summary of the interim guidance provided to test labs through KDB inquiries for LTE DL CA SAR test reduction according to power measurement considerations was presented in the October 2017 TCB Workshop
- Base on comments and suggestions received, further updates are considered to streamline the process
- There is no change to the LTE UL CA guidance provided in the October 2017 TCB Workshop

LTE DL CA Update

- Previous guidance considered inter-band and intra-band CA configurations separately
  - updated guidance does not consider these separately
  - in addition, the number of frequency bands used for the CC's also does not need consideration as required previously
- See example template on how to identify repeating CC combination subsets and any CC restrictions to update procedures presented in the October 2017 TCB Workshop

Example Template

Index	2CC	Restriction	Completely Covered by Measurement Superset	Index	3CC	Restriction	Completely Covered by Measurement Superset	Index	4CC	Restriction	Completely Covered by Measurement Superset	Index	5CC	Restriction	Completely Covered by Measurement Superset
2CC #1	CA_2C		3CC #7	3CC #1	CA_2A-2A-4A		4CC #1	4CC #1	CA_2A-2A-4A-4A		No	5CC #1	CA_2A-2A-46D	B46 SCC Only	No
2CC #2	CA_2A-2A		4CC #1	3CC #2	CA_2A-2A-5A		4CC #2	4CC #2	CA_2A-2A-4A-5A		No	5CC #2	CA_2A-5B-30A-66A		No
2CC #3	CA_2A-4A (2)		4CC #1	3CC #3	CA_2A-2A-12A		No	4CC #3	CA_2A-2A-4A-12A	B12 SCC Only	No	5CC #3	CA_2A-5B-66A-66A		No
2CC #4	CA_2A-5A		4CC #2	3CC #4	CA_2A-2A-13A		4CC #8	4CC #4	CA_2A-2A-5A-30A		No	5CC #4	CA_2A-46D-66A	B46 SCC Only	No
2CC #5	CA_2A-7A		4CC #16	3CC #5	CA_2A-2A-29A	B29 SCC Only	4CC #9	4CC #5	CA_2A-2A-5A-66A		No	5CC #5	CA_2A-46A-46C-66A	B46 SCC Only	No
2CC #6	CA_2A-12A (1)		3CC #3	3CC #6	CA_2A-2A-30A		4CC #9	4CC #6	CA_2A-2A-12A-30A	B12 SCC Only	No	5CC #6	CA_41C-41D		No
2CC #7	CA_2A-13A		4CC #31	3CC #7	CA_2C-66A		No	4CC #7	CA_2A-2A-12A-66A	B12 SCC Only	No	5CC #7	CA_46D-66A-66A	B46 SCC Only	No
2CC #8	CA_2A-14A		3CC #27	3CC #8	CA_2A-2A-66A		4CC #7	4CC #8	CA_2A-2A-13A-66A		No	5CC #8			
2CC #9	CA_2A-17A		No	3CC #9	CA_2A-2A-71A	B71 SCC Only	No	4CC #9	CA_2A-2A-29A-30A	B29 SCC Only	No	5CA_9			
2CC #10	CA_2A-29A (2)	B29 SCC Only	4CC #9	3CC #10	CA_2A-4A-4A		4CC #1	4CC #10	CA_2A-2A-66A-66A		No	5CA_10			
2CC #11	CA_2A-30A		4CC #9	3CC #11	CA_2A-4A-5A		4CC #2	4CC #11	CA_2A-4A-4A-5A		No	5CA_11			
2CC #12	CA_2A-46A	B46 SCC Only	5CC #5	3CC #12	CA_2A-4A-7A		4CC #16	4CC #12	CA_2A-4A-4A-12A	B12 SCC Only	No	5CA_12			
2CC #13	CA_2A-66A		5CC #2	3CC #13	CA_2A-4A-12A		No	4CC #13	CA_2A-4A-5B		No	5CA_13			
2CC #14	CA_2A-71A	B71 SCC Only	3CC #17	3CC #14	CA_2A-4A-13A		No	4CC #14	CA_2A-4A-5A-30A		No	5CA_14			
2CC #15	CA_4A-4A		4CC #1	3CC #15	CA_2A-4A-29A	B29 SCC Only	4CC #20	4CC #15	CA_2A-4A-7C		No	5CA_15			
2CC #16	CA_4A-5A (1)		4CC #2	3CC #16	CA_2A-4A-30A		4CC #19	4CC #16	CA_2A-4A-7A-7A		No	5CA_16			
2CC #17	CA_4A-7A (1)		4CC #16	3CC #17	CA_2A-4A-71A	B71 SCC Only	No	4CC #17	CA_2A-4A-7A-12A	B12 SCC Only	No	5CA_17			
2CC #18	CA_4A-12A (2)		4CC #3	3CC #18	CA_2A-5B		4CC #13	4CC #18	CA_2A-4A-12B	B12 SCC Only	No	5CA_18			
2CC #19	CA_4A-13A		3CC #14	3CC #19	CA_2A-5A-30A		4CC #23	4CC #19	CA_2A-4A-12A-30A	B12 SCC Only	No	5CA_19			
2CC #20	CA_4A-17A	B17 SCC Only	No	3CC #20	CA_2A-5A-66A		4CC #23	4CC #20	CA_2A-4A-29A-30A	B29 SCC Only	No	5CA_20			
2CC #21	CA_4A-29A (2)	B29 SCC Only	4CC #20	3CC #21	CA_2A-7A-7A		4CC #16	4CC #21	CA_2A-5B-30A		5CC #2	5CA_21			
2CC #22	CA_4A-30A		4CC #19	3CC #22	CA_2A-7A-12A		No	4CC #22	CA_2A-5B-66A		5CC #3	5CA_22			
2CC #23	CA_4A-46A	B46 SCC Only	4CC #42	3CC #23	CA_2A-12B		No	4CC #23	CA_2A-5A-30A-66A		No	5CA_23			
2CC #24	CA_4A-71A	B71 SCC Only	3CC #43	3CC #24	CA_2A-12A-30A		No	4CC #24	CA_2A-5A-66B		No	5CA_24			
2CC #25	CA_5B		5CC #2	3CC #25	CA_2A-12A-66A		No	4CC #25	CA_2A-5A-66C		No	5CA_25			
2CC #26	CA_5A-25A		No	3CC #26	CA_2A-13A-66A		4CC #31	4CC #26	CA_2A-5A-66A-66A		No	5CA_26			
2CC #27	CA_5A-30A		4CC #23	3CC #27	CA_2A-14A-30A		No	4CC #27	CA_2A-12A-30A-66A	B12 SCC Only	No	5CA_27			
2CC #28	CA_5A-66A		4CC #23	3CC #28	CA_2A-29A-30A	B29 SCC Only	4CC #9	4CC #28	CA_2A-12A-66A-66A	B12 SCC Only	No	5CA_28			
2CC #29	CA_7A-7A (1)		4CC #16	3CC #29	CA_2A-30A-66A		4CC #23	4CC #29	CA_2A-13A-66B		No	5CA_29			
2CC #30	CA_7A-12A		3CC #22	3CC #30	CA_2A-46C	B46 SCC Only	5CC #5	4CC #30	CA_2A-13A-66C		No	5CA_30			
2CC #31	CA_7A-46A (1)	B46 SCC Only	No	3CC #31	CA_2A-46A-46A	B46 SCC Only	4CC #34	4CC #31	CA_2A-13A-66A-66A		No	5CA_31			
2CC #32	CA_12B		3CC #23	3CC #32	CA_2A-46A-66A	B46 SCC Only	4CC #34	4CC #32	CA_2A-46D	B46 SCC Only	5CC #1	5CA_32			
2CC #33	CA_12A-25A		No	3CC #33	CA_2A-66B		4CC #24	4CC #33	CA_2A-46A-46C	B46 SCC Only	5CC #5	5CA_33			
2CC #34	CA_12A-30A		4CC #4	3CC #34	CA_2A-66C		4CC #25	4CC #34	CA_2A-46A-46A-66A	B46 SCC Only	No	5CA_34			
2CC #35	CA_12A-66A (1)		3CC #25	3CC #35	CA_2A-66A-66A		4CC #26	4CC #35	CA_2A-46C-66A	B46 SCC Only	5CC #5	5CA_35			
2CC #36	CA_13A-46A	B46 SCC Only	No	3CC #36	CA_2A-66A-71A	B71 SCC Only	No	4CC #36	CA_4A-4A-5B		No	5CA_36			
2CC #37	CA_13A-66A		4CC #8	3CC #37	CA_4A-4A-5A		4CC #37	4CC #37	CA_4A-4A-5A-30A		No	5CA_37			
2CC #38	CA_14A-30A		3CC #27	3CC #38	CA_4A-4A-7A (1)		No	4CC #38	CA_4A-4A-12A-30A	B12 SCC Only	No	5CA_38			
2CC #39	CA_14A-66A		3CC #66	3CC #39	CA_4A-4A-12A		4CC #38	4CC #39	CA_4A-4A-29A-30A	B29 SCC Only	No	5CA_39			
2CC #40	CA_25A-25A (1)		4CC #49	3CC #40	CA_4A-4A-13A		No	4CC #40	CA_4A-5B-30A		No	5CA_40			

- Only yellow highlighted cells need power measurement
- Above is a partial list, truncated at the end of the table

WiGig/60 GHz

RF Exposure Evaluation

mm-Wave Standards Development

- IEC TC106 AHG10 completed a Technical Report (IEC TR 63170) on mm-wave power density measurement considerations
  - approved and awaiting final publication
- There have been some concerns regarding the applicability of power density definitions used in localized near-field exposure conditions
  - this is being addressed in the on-going IS development
  - in the IEEE/IEC dual logo project, IEEE P1528.5; JWG12
- Discrepancies in the interpretation of power density definitions among test labs and also between measurements and simulations have also been observed
  - due to varying interpretations of evaluation plane and/or Poynting vector considerations
  - results show noticeable differences in both values and distributions

Regulatory Collaborations

- FCC and ISED collaborated in January 2018 to review measurement concerns relating to localized near-field power density measurements
  - using commercially available system validation & system check sources
- Measurements are supported for horizontal planar surfaces only
  - with mm-wave probe in vertical orientation
- Basic performance of the mm-wave probe seems satisfactory
  - test setup can be demanding for test lab unfamiliar with the procedures
  - additional improvements to the measurement setup and procedures can be expected from the system manufacturer later this year
  - support for field reconstruction along curved or contoured surfaces to determine power density on non-planar surfaces may be underway

Power Density Assessment

- Combinations of assessment alternatives were identified in the October 2017 TCB Workshop
  - using numerical simulation to identify subsets of worst case transmission and exposure conditions
  - measurements may be performed for the subset of worst case conditions
  - certain exposure mitigation mechanisms that are built-in as an integral part of device operations may be considered to reduce exposure potential and simplify evaluation considerations
- It has been suggested that measurement techniques may soon be able to identify worst case transmission and exposure conditions for certain device implementations
- Procedures to reduce measurement time through fast scanning techniques may already be under consideration
- Applicable near-field power density definitions may need review

System Validation & System Check

- It is recommended that the system validation and system check results of defined sources (in IEC TR) be submitted through a KDB inquiry to confirm test lab readiness before preforming (first) evaluation for equipment approval
- Depending on the test setup and test device complexity, KDB inquiries are recommended to resolve any testing concerns before actual measurement on how to
  - identify the measurement and exposure planes with respect to device configuration and exposure conditions
  - address any signal coherence and exposure enhancement issues
  - apply combinations of numerical simulation, measurement and mitigation techniques to show compliance
  - present results and information in the test reports to demonstrate compliance

Spatial Averaging Requirements

- Until further notice, a spatial averaging area of 1 cm^2 is required to determine power density compliance in any 1 cm^2 area
- Either a circular or square averaging area may be accepted
- Somewhat larger averaging areas; e.g., ≤ 4 cm^2, if appropriate, may be considered according to on-going and further research efforts
- Questions concerning frequency dependency and conservativeness of spatial averaging criteria may also need consideration
- There also appear to be on-going considerations within the IEEE and ICNIRP regarding relevant parameters to consider for localized near-field exposure with respect to incident and absorbed power density, which could influence spatial averaging considerations

Reporting Considerations

- Depending on the power density assessment methodologies used
  - test reports for measurements, simulations, certain pre-screening tests or exposure mitigation verification results are necessary to support compliance
  - these generally require standalone, separate reports
- The general reporting requirements in KDB 865664 D02 are applicable
  - rationale and justifications must be clearly identified to support the purpose of each assessment and associated test setup, including operating parameters
  - system validation is required and system check results must be included in the test report, including reference source calibration results and distribution plots
- When using numerical simulation to support test reduction or pre-screening
  - validity of the simulation, antenna and device models must be fully justified
- When using numerical simulation as the primary means to show compliance
  - KDB 865664 D02 and KDB 447498 requirements for numerical simulation apply
  - validation of the numerical tools and models, modeling details, accuracy of results and appropriate uncertainty considerations are necessary

Other Updates

Wireless Power Transfer at Distance

- A few vendors have inquired about WPT at distance
  - for operations in Part 15 or Part 18
  - using varying approaches & implementations
- The design, implementation, operating and exposure conditions for these require case-by-case consideration
  - for user and bystander exposures, in accordance with applicable mitigation techniques
  - exposure needs consideration in regions surrounding and also between the transmitters and receivers to demonstrate compliance
- A few products have received equipment approval
  - according to Part 15 or Part 18 requirements

Dynamic Time-Averaging of SAR

- A few vendors and interested parties have inquired about regulatory requirements for specific time-averaging implementations
- The approaches and implementations used can vary significantly
  - the algorithms may use different control parameters
    - combinations of transmission duration, time interval, duty factor and power level etc. may be adjusted in a dynamic manner
  - the implementations may apply different time-averaging criteria
    - for example, continuous compliance in any 20 ms durations vs. averaging over a 100 sec window
  - SAR testing and algorithm verification considerations may vary with conservativeness of the implementation
- When competing implementations exist in devices with multiple transmitters, additional testing concerns may need consideration
  - for example, simultaneous transmission SAR compliance

Movement Detection

- Movement detection has been used to trigger power reduction
  - according to specific chipset based implementations, in conjunction with proximity sensing using specific parameter settings
  - according to proprietary implementations, e.g., using accelerometers and in conjunction with other hardware and analysis to detect movement
- Sensitivity & conditions of movement detection need validation
  - triggering variations due to proximity from different object types
  - reliability of the movement detection to trigger power reduction for applicable exposure conditions; e.g., on body vs. at a small distance
- Fail safe considerations
- A KDB inquiry is recommended to determine the applicable test configurations and procedures necessary for validating the implementation to ensure SAR results are acceptable
- A PAG is required under already existing requirements

Expedited Area Scans

- Expedited area scans may be used to reduce measurement time
  - when full mechanical probe detection is performed in an initial area scan to precisely determine the probe trajectories and measurement point locations
  - subsequent area scans can avoid most of the probe detections required to determine measurement point locations where
    - the same measurement grid resolution and configurations (shape, size and location) are used
    - for the same test device in the same test position
    - without moving the test device from its position in the initial area scan
- This may overlap with a few other SAR scan implementations
  - for example, fast scans, ultra-fast scans, mother scans etc.
  - for the interim, only those that meet above criteria would qualify as “expedited area scans”
  - guidance for other similar or related scans will be considered separately

Tissue Dielectric Parameters

- IEC TC106, MT1 has administered multiple studies since 2009 to confirm SAR conservativeness for the SAM phantom
  - phase I and II – SAR simulations using dipoles and generic transmitters
  - phase III – thermal (temperature rise) simulations of selected SAR cases
- Thermal analyses were applied to SAR simulations that may not show a sufficient level of conservativeness
- Initial thermal analyses included FCC body tissue parameters for 1-g SAR and IEC tissue parameters for 10-g SAR; missing 1-g SAR for IEC tissue parameters
  - additional analyses have been added recently (end of March 2018) to include 1-g SAR for IEC tissue parameters
- Upon review of all results and supporting information in on-going Unified Draft under IEEE/IEC JWG 13 with no further concerns we can consider
  - replacing existing FCC head and body parameters with IEC tissue parameters
  - the conservativeness of IEC dielectric parameters in the newly extended frequency range of 4 – 150 MHz also need consideration

Dipole Calibration

- A couple of inquiries were received about 6 months ago regarding
  - the feasibility of a test lab using its SAR measurement system to calibrate system validation and system check dipoles for other test labs
  - this would avoid issues relating to using its SAR system to calibrate dipoles used by the same system
  - possibility for FCC to accept certain national accreditation to support such effort
- Some of the related concerns may include
  - how to ensure the same calibration protocols and quality assurance requirements used by the SAR system and dipole manufacturers are applied by a test lab
  - issues relating to repairs and subsequent re-calibration
  - assurance of reliable calibrations and adherence to required protocols
- The possibility to initiate this through relevant test lab accreditation process is under consideration, in conjunction with
  - protocols required for accreditors and test labs
  - procedures required for TCB review
  - implementation and logistic concerns