RF Exposure Procedures

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Overview

- Power Density Simulation Report Requirements
- Millimeter Wave RF Exposure Evaluation
- 5G New Radio (NR) Sub 6GHz
- Time-Averaging SAR (TAS)
- 802.11ax Transmitters
- Sensor Array Measurement Systems
- Dynamic Antenna Tuning
- Proximity Sensor PAG
- Tissue Simulating Liquids

Millimeter Wave RF Exposure Evaluation

- Recently seen the first grants for handsets utilizing 5G mmWave technology
- There are a few existing grants for mmWave mobile devices
- Combination of numerical simulation and measurements with Total Exposure Ratio Criteria to demonstrate compliance
- Slightly different approaches, but similar measurement methodologies

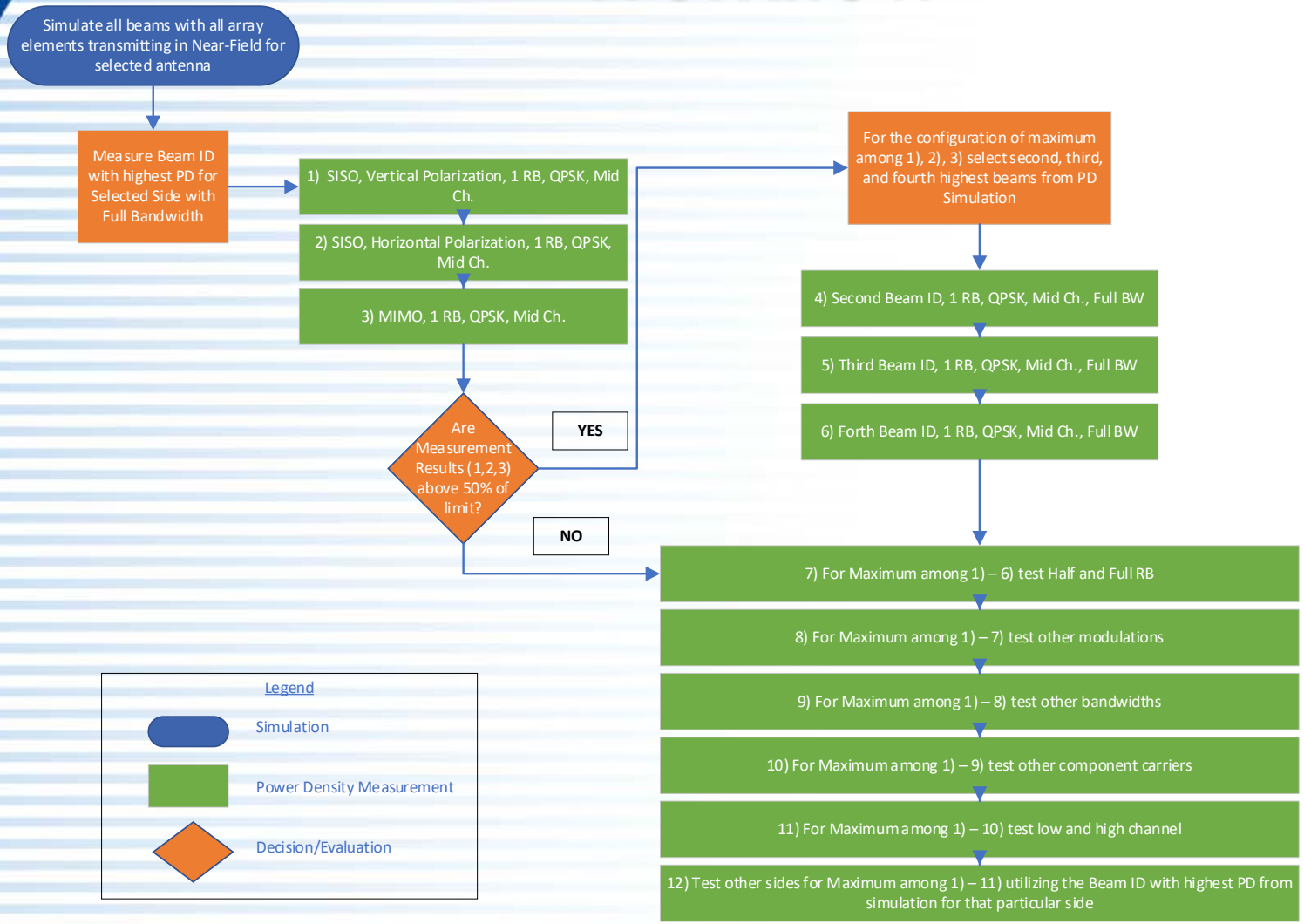
Power Density Simulation Report Requirements

- The following should be considered as minimum reporting requirements for documenting near field power density based on simulations for the purposes of reducing compliance measurement requirements.
  - FDTD or other numerical modeling algorithm implementation and validation
  - Transmitter model implementation and verification
  - Test device positioning
  - Steady state termination procedures
  - Power density in 4 cm^2 averaging area
  - Test results for determining worst case or justification for reduced measurement configurations

Recommended Millimeter Wave RF Exposure Test Procedure

- Simulate high power beam configurations for antenna arrays
  - For example, all array elements transmitting
- Use beam ID with highest PD as basis for measurement
- Begin by measuring PD with full bandwidth for different polarizations at 1 QPSK, 1 RB, Mid Ch.
- If result > 50% limit, repeat for 2nd, 3rd, and 4th highest beam
- Measure PD for other RB sizes, modulations, bandwidths, component carriers, channels, and device sides, based on max result from previous step
- PD scans need to be of sufficient size to fully capture hotspot
  - Fields at the measurement region boundary should be ~20-30 dB below the peaks

Millimeter Wave Testing Workflow



Millimeter Wave Additional Considerations

- A sufficiently large measurement region and proper measurement spatial resolution are required to maintain field reconstruction accuracy
  - Fields at the measurement region boundary should be ~20-30 dB below the peaks
- "Reported" PD is not directly applicable but uncertainty must be taken into account for final results

5G New Radio (NR) Sub 6GHz

- Existing FCC KDB Guidance should be applied in relevant situations.
- Test Equipment and call boxes are not readily available
  - Factory Test Mode should be used for testing in interim
  - A KDB Inquiry should be submitted if there are limitations to FTM that do not allow for required testing
- Simultaneous Transmission Scenarios should be evaluated independently

Time Averaging SAR

- Addressed extensively in previous TCB Workshops
- Verification of algorithm is key
  - Need to see multiple test cases: startup, steady state, call drop and reconnect
- Looking for "Moving Average" for all test cases
- Averaging time window depends on frequency
- Total exposure ratio: $\frac{SAR}{SAR\ Limit} + \frac{PD}{PD\ Limit} < 1$

802.11ax SAR Testing

- General principles of FCC KDB Publication 248227 D01 can be applied to determine the SAR Initial Test Configurations and test reduction
- In applying the test guidance, the IEEE 802.11 mode with the maximum output power (out of all modes) should be considered for testing
- For modes with the same maximum output power, the guidance from section 5.3.2 a) of FCC KDB Publication 248227 D01 should be applied, with 802.11ax being considered as the highest 802.11 mode for the appropriate frequency bands

802.11ax SAR Testing (Cont.)

- When SAR testing for 802.11ax is required:
  - If the maximum output power is highest for OFDMA scenarios, choose the tone size with the maximum number of tones and the highest maximum output power
  - Otherwise, consider the fully allocated channel for SAR testing.
  - When SAR testing is required on RU sizes less than the fully allocated channel, use the RU number closest to the middle of the channel, choosing the higher RU number when two RUs are equidistant to the middle of the channel
- Maximum output powers for each RU size should be measured

Sensor Array Measurement Considerations

- Guidance from previous FCC presentations at TCB Workshop is still applicable
  - Allowed for pre-scan test reduction measurements for 2G/3G technology
  - Final tests to demonstrate compliance should be done on a traditional SAR measurement system
- Still evaluating for pre-scan measurements for 4G and Wi-Fi technologies
- Awaiting additional information from IEC 62209-3 standards committee
- Draft KDB Publication in development

Dynamic Antenna Tuning

- SAR is measured according to required procedures with dynamic tuner active allowing device to automatically tune.
- Auto-tune state determined by device during normal SAR measurement verified and listed alongside the reported SAR results.

Dynamic Antenna Tuning

- Additional single point SAR measurements to verify other tuner configurations result in equivalent or lower SAR value
  - total number tuner states divided evenly among each supported band / air interface and exposure condition combination
  - tuner state is established remotely so that the device is not moved for the entire series of single point SAR measurements for the tuner states in each combination
  - single point measurements performed at the peak SAR location of the highest measured SAR configuration for each combination. SAR probe remains stationary throughout the entire series of single point measurements for each combination
  - if any single point SAR measurement result is > 1.2 W/kg for a band/exposure condition combination set, all supported tuner states are evaluated with single point SAR measurements for the combination.

Dynamic Antenna Tuning

- Applicable only to implementations where tuning hardware is separate from the antenna and does not influence antenna performance (other than impedance matching).
- Future update to KDB Publication 648474 D04 Handset SAR
- PAG is required however TCBs/grantees may use PAG Re-use procedures
  - Notification KDB inquiry should include operational description of dynamic antenna tuning implementation and approved test procedure
  - Only applicable if prior implementation remains the same in new application

Power Reduction Pre-Approval Guidance

- Use of proximity sensors in both mobile and portable devices for the purpose of power reduction has become widespread and commonplace
- These sensors have been implemented in a wide array of device form factors and sizes
- Procedures for determining proximity sensor triggering distance, coverage, and tilt angle are outlined in section 6 of FCC KDB Publication 616217 D04

Power Reduction Pre-Approval Guidance (Cont.)

- May utilize various sensing mechanisms, including capacitive, thermal, Hall effect (magnetic), among others
- Due to the well established data and uniformity in implementation the following power reduction mechanisms do not require PAG:
  - Power Reduction based on Capacitive Proximity Sensors
  - Power reduction based on audio routing to the earpiece of the device
  - Power Reduction based on user-enabled hotspot mode via software

Proximity Sensor Pre-Approval Guidance (Cont.)

- Due to the high variability in implementation the following proximity sensor types will still require a PAG:
  - Thermal (Infrared)
  - Motion
  - Hall Effect/Magnetic
  - Other mechanisms not listed in previous slide

Tissue Simulating Liquids (TSL)

- Effective February 19, 2019, FCC has permitted the use of single head-tissue simulating liquid specified in IEC 62209-1 for all SAR tests
- Mix and Match of traditional FCC SAR TSLs and IEC 62209-1 TSL in a single application is not permitted
- TSL can be changed in a Permissive Change. If SAR increases and original SAR > 1.2 W/kg, additional SAR measurements will be required
- IEC 62209-1 TSL is an alternative, not mandatory at this time
- If FCC parameters are used, ±5% tolerance. If IEC parameters, ±10%

Questions?

Thank You!