cDASY6 SAR Measurements

APPLICATION NOTE

5G NR NSA Mode below 6 GHz (Version 0.8)

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cDASY6 SAR measurements for 5G NR NSA Mode below 6 GHz (Version 0.8)

1 History Note of Version 0.8

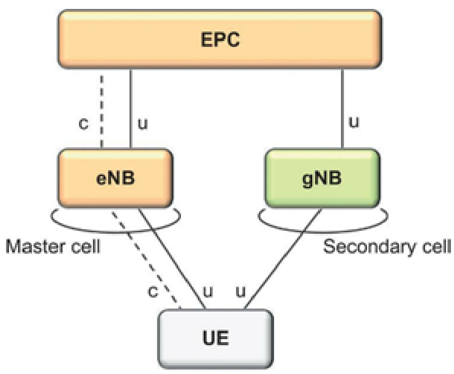
SPEAG is committed to provide guidance for testing of 5G NR (New Radio) from the very early on. Version 0.8 is the first edition of this application note that has been prepared, according to the guidance SPEAG received from the FCC, to provide DASY user with measurement recommendations. This application note will be updated when call box support for 5G NR becomes avalable or when additional input is available from the FCC or other regulatory authorities.

2 Introduction

The initial launch of 5G NR in 2019 is expected to be mostly based on operations in the Non-Standalone (NSA) mode. 5G NR NSA require LTE as an anchor to support NR signaling and control and NR is mainly used for high speed user data transmission. While 3GPP specifications for 5G NR have recently been finalized, certain additional implementation details will be considered in subsequent 3GPP releases. As 5G products are getting ready for launch, SPEAG is providing SAR test labs and device manufacturers the SAR measurement recommendations it has received from the FCC. Until further update is available, the purpose of this application note is to provide interim guidance for cDASY6 system users to perform SAR measurements for products operating in the 5G NR NSA mode

3 NSA Background

As an interim step for 5G NR deployments, 3GPP has specified the non-standalone configurations, using Dual Connectivity (DC) between the UE and both an NR base station (gNB - 5G) and LTE base station (eNB- 4G). The EPC core network is connected to the eNB. All control-plane (c) functions are handled by LTE, and NR is used only for data in the user-plane (u). 5G is activated only when higher data rates are needed.



The initial deployment of NR is expected to be mainly in TDD mode to optimize throughput. 3GPP Rel. 15 has no limitation for uplink/downlink transmission duty cycle, although some deployments may limit the TDD DL:UL transmission ratio to lower values (e.g., 25-30%). The transmission duty factor required to perform SAR measurements should be determined according to the operating characteristics and capabilities of the individual products. Provided a device is able to support 100% duty factor in the uplink, all SAR measurements should be performed at 100% duty factor. In special cases where the DUT hardware does not support 100% duty cycle, testing at the maximum possible duty cycle is required. 3GPP Rel. 15 has specified that CP-OFDM and DFT-S-OFDM are the OFDM waveforms supported by 5G NR. Besides maximum output power, signal modulations for the sub-carriers, aggregated channel bandwidth, resource block (RB) configurations and maximum power reduction (MPR) etc. can influence the PAPR (peak to average power ratio) of NR signals, which would need consideration to determine the applicable wireless modes required for SAR measurement.

4 SAR Test Considerations

4.1 5G NR Test Mode Support

Until call box support is available, 5G product manufacturers would need to provide NR test mode support for SAR measurements. The wireless transmission configurations used in test modes should be equivalent to those required for compliance testing by regulatory authorities; for example, channel bandwidth, sub-carrier spacing, RB allocation configurations etc. Whether the DL:UL configurations for TDD is static or dynamic, the highest transmission duty factor will need consideration according to product capabilities to determine the appropriate test configurations.

4.2 Independent exposure testing for 4G LTE / 5G NR

Due to the operating flexibility introduced by 5G NR and certain specific requirements described above for NSA, independent exposure testing of LTE and NR is necessary to overcome SAR measurement difficulties and to simplify testing considerations. By keeping the 4G LTE and 5G NR SAR measurements separate, the independently evaluated SAR can be scaled according to the operating parameters specific for each wireless technology to accommodate the diverse flexibility supported by 5G NR; for example, simultaneous transmission of different technologies (NR, LTE, Wi-Fi and Bluetooth). When different transmission duty factors or maximum output power may be applicable to a NR configuration (signal modulation, channel bandwidth and RB allocations in a frequency band), the SAR results may be scaled according to output power and transmission duty factor.

4.3 Probe calibration

5G NR SAR testing will require special SMC probe calibration at the NR frequency bands; for example, 3.5 / 4.5 GHz band. The SPEAG calibration process for SAR probes is currently being refined to include 5G NR. Calibrations for NR bands will be available for CP-OFDM and DFT-S-OFDM by middle of Q2, 2019. Until, these new calibrations are available, cDASY6 users may apply existing LTE UIDs with the best match for the NR test signal (frequency band, channel bandwidth, number of RBs, duplexing type, etc.) to perform SAR measurements.

4.4 Combination of SAR values for 4G LTE / 5G NR technologies

For the initial NR NSA deployment, 4G and 5G are at different frequency bands; therefore, the signals are uncorrelated. The SAR distributions can be combined according to the methods described in IEC 62209-2 (2010) Clause 6.3.2, i.e.

1. summation of peak spatial-averaged 1g/10g SAR values to determine an upper bound SAR value
2. selection of highest assessed maximum SAR values according to spatially separated SAR maxima that do not effect each other by more than 5 %.
3. calculation of multi-band SAR from existing area and zoom scans
4. volumetric scanning.

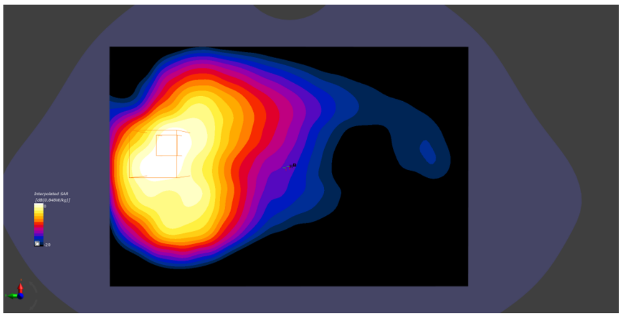
Methods 1) and 2) are already available in cDASY6. Methods 3) and 4) are currently available in DASY52 and will be incorporated in cDASY6 by early Q3 2019..

5 Measurement Example

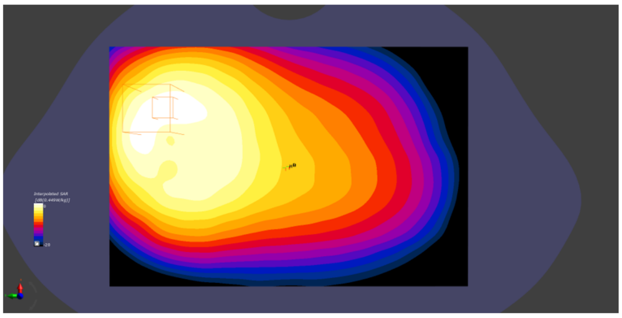
5.1 Method 1

The SAR values for a device supporting 5G NR NSA / LTE were measured for the band combination DC_3_n28.

- LTE carrier on band 3 (1710-1785 MHz UL)
- 5G NR carrier on band n28 (703-748 MHz UL)



LTE Band 3 : 1g = 0.917 W/Kg, 10g = 0.458 W/Kg



5G NR Band n_28 : 1g = 0.423 W/Kg, 10g = 0.226 W/Kg

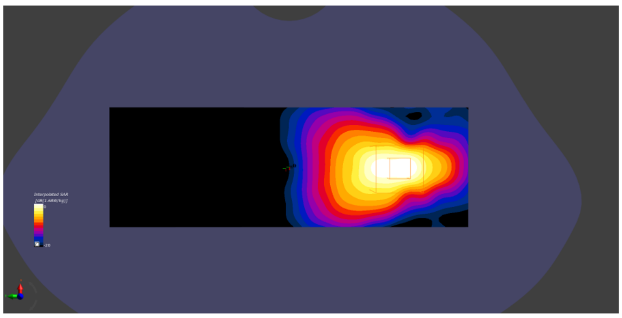
The combined 1g / 10g SAR (1.34 / 0.684 W/Kg) are less than the limits (1.6 / 2.0 W/Kg), Method 1 is applicable.

5.2 Method 2

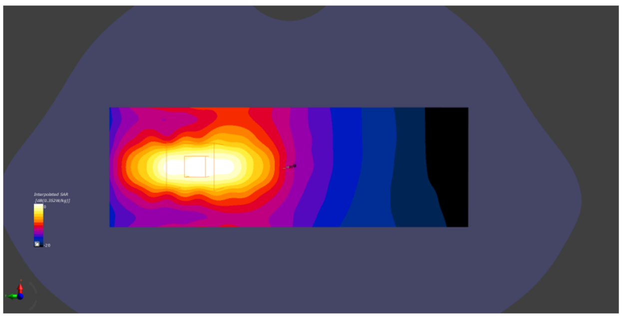
The SAR values of a device supporting 5G NR NSA / LTE were measured for the band combination DC_3_n28.

- LTE carrier on band 3 (1710-1785 MHz UL)
- 5G NR carrier on band n28 (703-748 MHz UL)

Measurements were made separately for each band, using the highest bandwidth (20 MHz) and lowest order modulation (QPSK) with 100% RB and the results are shown in the extract below:



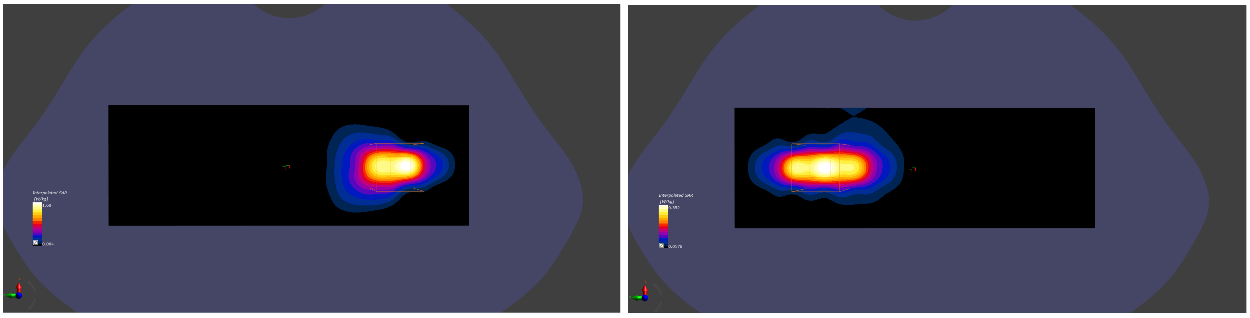
LTE Band 3 : 1g = 1.41 W/Kg, 10g = 0.640 W/Kg



5G NR Band n_28 : 1g = 0.299 W/Kg, 10g = 0.134 W/Kg

The combined 1g SAR (1.709 W/Kg) is greater than the limits (1.6 W/Kg). Method 1 may be applied to 10g SAR, but not for 1g SAR. The area scan patterns in the figure however indicate that the overlap between

the area scans could be analyzed further.
Accordingly, the individual area scans are visualized in the linear scale, with the lower scale value set to 5% of the peak value where the two area scans show little or no overlap; therefore, Method 2 is applicable for both 1g and 10g SAR. The SAR value can be taken as the maximum of the two; 1.41 W/Kg for 1g and 0.640 W/Kg for 10g.



6 Conclusion

The 5G NR NSA mode will co-exist with 4G LTE in the initial deployments in 2019. Exposure compliance testing in this mode will require independent SAR testing for LTE and 5G, followed by applying the SAR combining methods detailed in the IEC / IEEE SAR measurement standards. Until call box support is available, manufacturer support for NR test modes is needed to configure the device according to 5G NR transmission requirements for exposure testing. Probe calibration for 5G NR and SAR combining methods will be fully supported in cDASY6 by early Q3 2019.