



REPORT No.: SZ25120017S01

TEST REPORT

APPLICANT : Reliance Communications LLC

PRODUCT NAME : Orbic Trophy Plus 5G

MODEL NAME : R667L5U

BRAND NAME : Orbic

FCC ID : 2ABGH-R667L5U

STANDARD(S) : FCC 47 CFR Part 2 (2.1093)
IEEE 1528-2013

RECEIPT DATE : 2025-12-01

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Changed History		
Version	Date	Reason for Change
1.0	2025-12-09	First edition



1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during test as bellows:

<Highest Reported SAR Summary>

Frequency Band		Highest SAR Summary			
		Head (Gap 0mm)	Body-worn (Gap 10mm)	Hotspot (Gap 10mm)	Extremity (Gap 0mm)
		1g SAR (W/kg)			10g SAR (W/kg)
GSM	GSM850	0.342	1.108	1.108	N/A
	GSM1900	0.170	0.522	0.644	N/A
WCDMA	WCDMA II	0.297	0.555	0.807	N/A
	WCDMA IV	0.342	0.477	0.816	N/A
	WCDMA V	0.484	0.962	0.962	N/A
LTE	LTE Band 2	0.662	0.952	0.952	N/A
	LTE Band 5	0.344	0.878	0.878	N/A
	LTE Band 7	0.591	0.467	0.597	N/A
	LTE Band 12	0.241	0.272	0.381	N/A
	LTE Band 13	0.182	0.355	0.355	N/A
	LTE Band 48	0.760	0.635	1.100	N/A
	LTE Band 66/4	0.500	0.378	0.772	N/A
5G NR	n2 (NSA)	0.155	0.452	0.452	N/A
	n5 (NSA)	0.169	0.275	0.275	N/A
	n66 (NSA)	0.195	0.430	0.520	N/A
	n77 (NSA)	0.516	0.411	0.411	N/A
WLAN	2.4GHz WLAN	1.142	0.439	0.439	N/A
	5GHz WLAN	1.146	1.383	1.383	1.486
2.4GHz Band	Bluetooth	0.093	0.053	0.053	N/A

Highest Simultaneous Transmission SAR _{1g} (W/Kg):	1.593 W/kg	Limit (W/kg): 1.6
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Note:

1. This device is in compliance with Specific Absorption Rate (SAR) for general population or uncontrolled exposure limits (1.6 W/kg as averaged over any 1 gram of tissue; specified in FCC 47 CFR part 1 (1.1310) and ANSI/IEEE C95.1-1992), and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013 and FCC KDB publications.
2. For FDD-LTE Band 4 is full covered by FDD-LTE Band 66, therefore only FDD-LTE Band 66 was tested.



3. The declarations of EUT presented in the report are provided by applicant and/or manufacturer, and the test laboratory is not responsible for the accuracy of the information.

2. Technical Information

Note: Provide by applicant.

2.1. Applicant and Manufacturer Information

Applicant:	Reliance Communications LLC
Applicant Address:	555 Wireless Blvd. Hauppauge, NY 11788, USA
Manufacturer:	Unimaxcomm
Manufacturer Address:	35F,HBC HuiLong Center Building-II Minzhi Street,Longhua, Shenzhen, P.R. China 518110

2.2. Equipment under Test (EUT) Description

Product Name:	Orbic Trophy Plus 5G
EUT No.:	3#
Hardware Version:	V1.0
Software Version:	R667L5U_v1.1.2_BVZ
Frequency Bands:	GSM 850: 824 MHz ~ 849 MHz GSM 1900: 1850 MHz ~ 1910 MHz WCDMA Band II: 1850 MHz ~ 1910 MHz WCDMA Band IV: 1710 MHz ~ 1755 MHz WCDMA Band V: 824 MHz ~ 849 MHz LTE Band 2: 1850 MHz ~ 1910 MHz LTE Band 4: 1710 MHz ~ 1755 MHz LTE Band 5: 824 MHz ~ 849 MHz LTE Band 7: 2500 MHz ~ 2570 MHz LTE Band 12: 699 MHz ~ 716 MHz LTE Band 13: 777 MHz ~ 787 MHz LTE Band 48: 3550 MHz ~ 3700 MHz LTE Band 66: 1710 MHz ~ 1780 MHz 5G NR n2 (NSA): 1850 MHz ~ 1910 MHz 5G NR n5 (NSA): 824 MHz ~ 849 MHz 5G NR n66 (NSA): 1710 MHz ~ 1780 MHz 5G NR n77 (NSA): 3450 MHz ~ 3550 MHz; 3700 MHz ~ 3980 MHz WLAN 2.4GHz: 2412 MHz ~ 2462 MHz WLAN 5.2GHz: 5180 MHz ~ 5240 MHz



	WLAN 5.3GHz: 5260 MHz ~ 5320 MHz WLAN 5.5GHz: 5500 MHz ~ 5720 MHz WLAN 5.8GHz: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz NFC: 13.56 MHz	
Modulation Mode:	GSM/GPRS: GMSK EDGE: 8PSK WCDMA: QPSK, 16QAM LTE: QPSK, 16QAM, 64QAM 5G NR: DFT-s-OFDM/CP-OFDM, PI/2 BPSK QPSK, 16QAM, 64QAM, 256QAM 802.11b: DSSS 802.11a/g/n-HT20/HT40/ac-VHT20/40/80: OFDM BR+EDR: GFSK(1Mbps), $\pi/4$ -DQPSK(2Mbps), 8-DPSK(3Mbps) Bluetooth LE: GFSK (1Mbps, 2Mbps) NFC: ASK	
Multi-slot Class:	GPRS: Multi-slot Class 12 EDGE: Multi-slot Class 12	
Operation Class:	Class B	
Carrier Aggregation:	Uplink & Downlink	
VoLTE Mode:	Support	
VoWIFI Mode:	Support	
Hotspot Mode:	Support (5G WLAN only for B1 & B4)	
Antenna Type:	WWAN: PIFA Antenna WLAN: PIFA Antenna Bluetooth: PIFA Antenna NFC: Loop Antenna	
SIM Cards Description:	SIM 1	GSM+WCDMA +LTE+5G NR
	SIM 2	GSM+WCDMA +LTE+5G NR

Note:

1. This report was updated based on the original report SZ23040391S01, Model: R667L5U, only disabling mmW function, adding 256+8GB of memory, changing PCB board and external color and product name. Therefore, we need to conduct verification for low-frequency, medium-frequency and high-frequency ranges. Only the latest results were recorded in this report.
2. For more detailed description, please refer to specification or user manual supplied by the applicant and/or manufacturer.



2.3. Environment of Test Site/Conditions

Normal Temperature (NT):	18-25 °C
Relative Humidity:	30-75 %

During SAR test, EUT is in Traffic Mode (Channel Allocated) at Normal Voltage Condition. A communication link is set up with a System Simulator (SS) by air link, and a call is established.

The EUT shall use its internal transmitter. The antenna(s), battery and accessories shall be those specified by the Factory. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output. If a wireless link is used, the antenna connected to the output of the base station simulator shall be placed at least 50 cm away from the handset.

The signal transmitted by the simulator to the antenna feeding point shall be lower than the output power level of the handset by at least 35 dB.

3. Specific Absorption Rate (SAR)

3.1. Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational or controlled and general population or uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational or controlled exposure limits are Middle than the limits for general population or uncontrolled.

3.2. SAR Definition

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density. (ρ). The equation description is as below:

$$SAR = \frac{d}{dt} \left(\frac{dW}{dm} \right) = \frac{d}{dt} \left(\frac{dW}{\rho dv} \right)$$

SAR is expressed in units of Watts per kilogram (W/kg).

SAR measurement can be either related to the temperature elevation in tissue by,

$$SAR = C \left(\frac{\delta T}{\delta t} \right)$$

Where C is the specific head capacity, δT is the temperature rise and δt the exposure duration, or related to the electrical field in the tissue by

$$SAR = \frac{\sigma |E|^2}{\rho}$$

Where σ is the conductivity of the tissue, ρ is the mass density of the tissue and $|E|$ is the rmselectrical field strength.

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.



4. RF Exposure Limits

4.1. Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

Limits for General Population/Uncontrolled Exposure (W/kg)

Type Exposure	Uncontrolled Environment Limit
Spatial Peak SAR (1g cube tissue for head and trunk)	1.6 W/kg
Spatial Peak SAR (10g cube tissue for limbs)	4.0 W/kg
Spatial Peak SAR (1g cube tissue for whole body)	0.08 W/kg

Note:

1. Occupational/Uncontrolled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).
2. Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

4.2. Controlled Environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. The exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.



5. Applied Reference Documents

Leading reference documents for testing:

Identity	Document Title	Remark
FCC 47 CFR Part 2 (2.1093)	Radio Frequency Radiation Exposure Evaluation: Portable Devices	/
IEEE 1528-2013	IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques	/
KDB 447498 D01v06	General RF Exposure Guidance	/
KDB 248227 D01v02r02	SAR Measurement Procedures for 802.11 Transmitters	/
KDB 865664 D01v01r04	SAR Measurement 100 MHz to 6 GHz	/
KDB 865664 D02v01r02	RF Exposure Reporting	/
KDB 648474 D04v01r03	Handset SAR	/
KDB 941225 D01v03r01	3G SAR MEAUREMENT PROCEDURES	/
KDB 941225 D05v02r05	SAR Evaluation Consideration for LTE Devices	/
KDB 941225 D06v02r01	SAR Evaluation Procedures For Portable Devices With Wireless Router Capabilities	/
Note: Any additions, deviation, or exclusions from the method shall be noted in the "Remark".		

6. SAR Measurement System

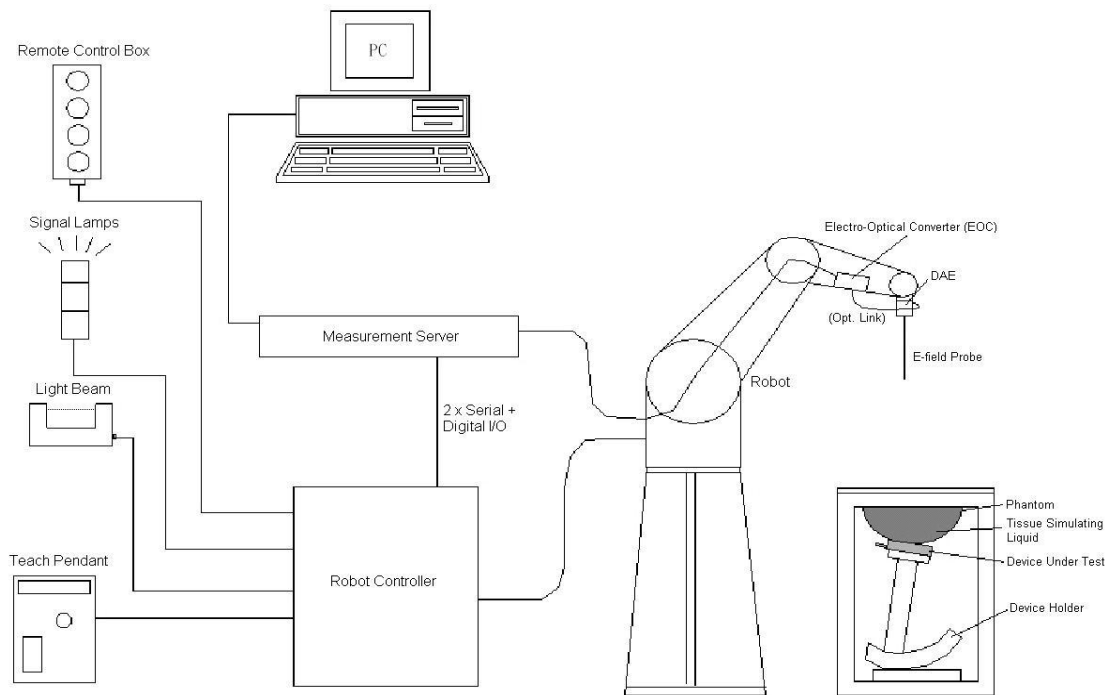


Fig 6.1 SPEAG DASY System Configurations

The DASY system for performance compliance tests is illustrated above graphically. This system consists of the following items:

- A standard high precision 6-axis robot with controller, a teach pendant and software.
- A data acquisition electronic (DAE) attached to the robot arm extension.
- A dosimetric probe equipped with an optical surface detector system.
- The electro-optical converter (ECO) performs the conversion between optical and electrical signals
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the accuracy of the probe positioning.
- A computer operating Windows XP.
- DASY software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom.
- A device holder.
- Tissue simulating liquid.
- Dipole for evaluating the proper functioning of the system.
- Some of the components are described in details in the following sub-sections.

6.1. E-Field Probe

The SAR measurement is conducted with the dosimetric probe (manufactured by SPEAG). The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. This probe has a built in optical surface detection system to prevent from collision with phantom.

➤ E-Field Probe Specification

<ES3DV3 Probe>

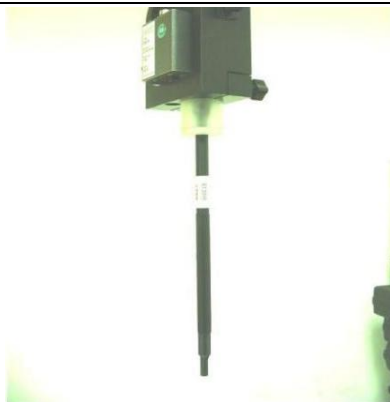
Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection system. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz to 3 GHz; Linearity: ± 0.2 dB	
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.4 dB in HSL (rotation normal to probe axis)	
Dynamic Range	5 μ W/g to 100 mW/g; Linearity: ± 0.2 dB	
Dimensions	Overall length: 330 mm (Tip: 16 mm) Tip diameter: 6.8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.7 mm	

Fig 6.2 Photo of ES3DV3

<EX3DV4 Probe>

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz to 6 GHz; Linearity: ± 0.2 dB	
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 μ W/g to 100 mW/g; Linearity: ± 0.2 dB	
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	

Fig 6.3 Photo of EX3DV4

➤ E-Field Probe Calibration

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than $\pm 10\%$. The spherical isotropy shall be evaluated and within ± 0.25 dB. The sensitivity parameters (NormX, NormY, and NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested. The calibration data can be referred to annex F of this report.

6.2. Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock. The input impedance of the DAE is 200M Ω ; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.



Fig 6.4 Photo of DAE

6.3. Robot

The SPEAG DASY system uses the high precision robots (DASY4: RX90BL; DASY5: TX90XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY4: CS7MB; DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

High precision (repeatability ± 0.035 mm)

High reliability (industrial design)

Jerk-free straight movements

Low ELF interference (the closed metallic construction shields against motor control fields)



Fig 6.5 Photo of DASY5

6.4. Measurement Server

The measurement server is based on a PC/104 CPU board with CPU (DASY4: 166 MHz, Intel Pentium; DASY5: 400 MHz, Intel Celeron), chip disk (DASY4: 32 MB; DASY5: 128 MB), RAM (DASY4: 64 MB, DASY5: 128 MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bits AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board. The measurement server performs all the real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operations.



Fig 6.6 Photo of Server for DASY5

6.5. Light Beam Unit

The light beam switch allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, such that the robot coordinates are valid for the probe tip.

The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.



Fig. 6.7 Photo of Light Beam

6.6. Phantom

<SAM Twin Phantom>

Shell Thickness	2 ± 0.2 mm (sagging: <1%) Center ear point: 6 ± 0.2 mm
Filling Volume	Approx. 25 liters
Dimensions	Length: 1000 mm; Width: 500 mm; Height: adjustable feet
Measurement Areas	Left Head, Right Head, Flat Phantom



Fig. 6.8 Photo of SAM Phantom

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

6.7. Device Holder

<Device Holder for SAM Twin Phantom>

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5 mm distance, a positioning uncertainty of ± 0.5 mm would produce a SAR uncertainty of ± 20 %. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (EPR). Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity $\epsilon = 3$ and loss tangent $\delta = 0.02$. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

<Laptop Extension Kit>

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the mounting device in place of the phone positioned. The extension is fully compatible with the SAM Twin and ELI phantoms.



Fig 6.9 Device Holder

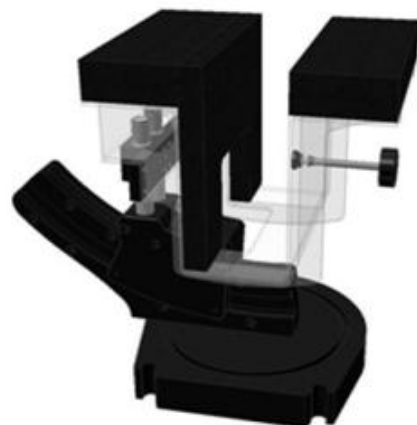


Fig 6.10 Laptop Extension Kit

6.8. Data Storage and Evaluation

➤ Data Storage

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files. The post-processing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type (e.g., [V/m], [A/m], [Mw/g]). Some of these units are not available in certain situations or give meaningless results, e.g., a SAR-output in a non-lose media, will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

➤ Data Evaluation

The DASY post-processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software.

Probe parameters:	- Sensitivity	$\text{Norm}_i, a_{i0}, a_{i1}, a_{i2}$
	- Conversion factor	ConvF_i
	- Diode compression point	dcpi
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the



exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power.

The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \times \frac{cf}{dcp_i}$$

With V_i = compensated signal of channel I, (I = x, y, z)
 U_i = input signal of channel I, (I = x, y, z)
 cf = crest factor of exciting field (DASY parameter)
 dcp_i = diode compression point (DASY parameter)

From the compensated input signals, the primary field data for each channel can be evaluated:

$$\text{E-field Probes: } E_i = \sqrt{\frac{V_i}{\text{Norm}_i \times \text{ConvF}}}$$

$$\text{H-field Probes: } H_i = \sqrt{V_i} \times \frac{a_{i0} + a_{i1} + a_{i2} f^2}{f}$$

With V_i = compensated signal of channel I, (I = x, y, z)
 Norm_i = sensor sensitivity of channel I, (I = x, y, z), $\text{Mv}/(\text{V/m})^2$ for E-field
 Probes ConvF = sensitivity enhancement in solution
 a_{ij} = sensor sensitivity factors for H-field probes
 f = carrier frequency [GHz]
 E_i = electric field strength of channel I in V/m
 H_i = magnetic field strength of channel I in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{\text{tot}} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$\text{SAR} = E_{\text{tot}}^2 \times \frac{\sigma}{\rho \times 1000}$$

with SAR = local specific absorption rate in mW/g

E_{tot} = total field strength in V/m

σ = conductivity in [mho/m] or [Siemens/m]

ρ = equivalent tissue density in g/cm^3

Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.



6.9. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial No./ SW Version	Calibration	
				Last Cal.	Due Date
SPEAG	900MHz System Validation Kit	D900V2	1d064	2024.10.21	2027.10.20
SPEAG	1800MHz System Validation Kit	D1800V2	2d158	2024.10.21	2027.10.20
SPEAG	5000MHz System Validation Kit	D5GHzV2	1176	2024.10.22	2027.10.21
SPEAG	DOSIMETRIC ASSESSMENT SYSTEM Software	DASY52	52.10.4.1527	NCR	NCR
SPEAG	Dosimetric E-Field Probe	EX3DV4	7608	2025.03.20	2026.03.19
SPEAG	Dosimetric E-Field Probe	ES3DV3	3295	2025.08.15	2026.08.14
SPEAG	Data Acquisition Electronics	DAE4	1643	2025.03.21	2026.03.20
SPEAG	SAM 1	QD000P40CD	1811	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
R&S	Network Emulator	CMW500	165755	2025.01.06	2026.01.05
Anritsu	Network Emulator	MT8820C	6201274521	2025.01.06	2026.01.05
Agilent	Network Analyzer	E5071B	MY42404762	2025.01.06	2026.01.05
SPEAG	Dielectric Assessment KIT	DAK-3.5	1279	2025.03.18	2026.03.17
mini-circuits	Amplifier	ZHL-42W+	608501717	NCR	NCR
mini-circuits	Amplifier	ZVE-8G+	754401735	NCR	NCR
Agilent	Signal Generator	N5182B	MY53050509	2025.09.02	2026.09.01
R&S	Power Sensor	NRP8S	103215	2025.01.06	2026.01.05
Agilent	Power Meter	E4416A	MY45102093	2025.09.02	2026.09.01
R&S	Power Sensor	NRP8S	103240	2025.01.06	2026.01.05
Anritsu	Power Meter	E4418B	GB43318055	2025.05.15	2026.05.14
Agilent	Dual Directional Coupler	778D	50422	NA	NA
MCL	Attenuation	351-218-010	N/A	NA	NA
R&S	Spectrum Analyzer	N9030A	MY54170556	2025.09.02	2026.09.01
KTJ	Thermo meter	TA298	N/A	2025.11.13	2026.11.12
SPEAG	Tissue Simulating Liquids	HBBL600-10000V6	24H		

Note:

1. The calibration certificate of DASY can be referred to annex F of this report.
2. The Insertion Loss calibration of Dual Directional Coupler and Attenuator were characterized via the network analyzer and compensated during system check.
3. The dielectric probe kit was calibrated via the network analyzer, with the specified procedure (calibrated in pure water) and calibration kit (standard) short circuit, before the dielectric



measurement. The specific procedure and calibration kit are provided by SPEAG.

4. In system check we need to monitor the level on the power meter, and adjust the power amplifier level to have precise power level to the dipole; the measured SAR will be normalized to 1 W input power according to the ratio of 1 W to the input power to the dipole. For system check, the calibration of the power amplifier is deemed not critically required for correct measurement; the power meter is critical and we do have calibration for it.
5. Attenuator insertion loss is calibrated by the network Analyzer, which the calibration is valid, before system check.
6. N.C.R means No Calibration Requirement.

7. Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 7.1. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 7.2. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in below table.

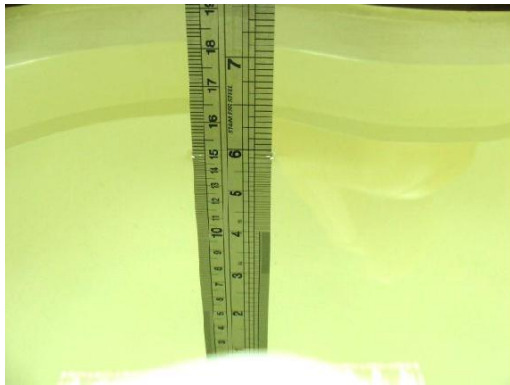


Fig 7.1 Photo of Liquid Height for Head SAR



Fig 7.2 Photo of Liquid Height for Body SAR

The following table gives the recipes for tissue simulating liquids

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (ϵ_r)
Head								
750	41.1	57.0	0.2	1.4	0.2	0	0.89	41.9
835	40.3	57.9	0.2	1.4	0.2	0	0.90	41.5
1800,1900,2000	55.2	0	0	0.3	0	44.5	1.40	40.0
2450	55.0	0	0	0	0	45.0	1.80	39.2
2600	54.8	0	0	0.1	0	45.1	1.96	39.0
Body								
750	51.7	47.2	0	0.9	0.1	0	0.96	55.5
835	50.8	48.2	0	0.9	0.1	0	0.97	55.2
1800,1900,2000	70.2	0	0	0.4	0	29.4	1.52	53.3
2450	68.6	0	0	0	0	31.4	1.95	52.7
2600	68.1	0	0	0.1	0	31.8	2.16	52.5

Simulating Liquid for 5GHz, Manufactured by SPEAG.

Ingredients	(% by weight)
Water	64~78%
Mineral oil	11~18%
Emulsifiers	9~15%
Additives and Salt	2~3%



Note: Please refer to the validation results for dielectric parameters of each frequency band. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using a SPEAG Dielectric Assessment KIT and an Agilent Network Analyzer.

Table 1: Dielectric Performance of Tissue Simulating Liquid

Frequency (MHz)	Tissue Type	Liquid Temp. (°C)	Conductivity (σ)	Conductivity Target (σ)	Delta (σ) (%)	Limit (%)	Date
900	HSL	22.1	0.942	0.97	-2.89	±5	2025.12.5
1800	HSL	22.1	1.427	1.40	1.93	±5	2025.12.5
5250	HSL	22.1	4.691	4.71	-0.40	±5	2025.12.5
Frequency (MHz)	Tissue Type	Liquid Temp. (°C)	Permittivity (ϵ_r)	Permittivity Target (ϵ_r)	Delta (ϵ_r) (%)	Limit (%)	Date
900	HSL	22.1	41.473	41.50	-0.07	±5	2025.12.5
1800	HSL	22.1	41.309	40.00	3.27	±5	2025.12.5
5250	HSL	22.1	35.614	35.95	-0.93	±5	2025.12.5

8. SAR System Verification

Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder.

8.1. Purpose of System Performance Check

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

8.2. System Setup

The output power on dipole port must be calibrated to 250 mW or 100 mW before dipole is connected. In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave which comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.



Fig 8.1 Photo of Dipole Setup

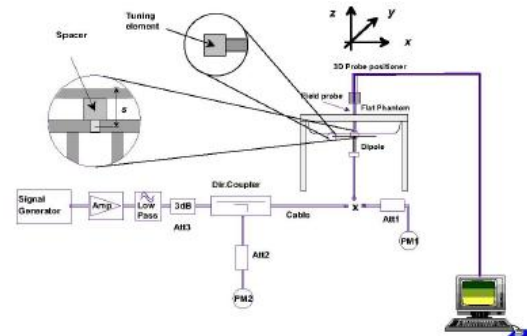


Fig 8.2 System Setup for System Evaluation



8.3. Validation Results

After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10%.

<Validation Setup>

Frequency (MHz)	Input Power (mW)	Dipole S/N	Probe S/N	DAE S/N
900	250	D900V2-1d064	3295	1643
1800	250	D1800V2-2d158	7608	1643
5250	100	D5GHzV2-1176-5250	7608	1643

<System Validation>

Frequency (MHz)	Tissue Type	Conductivity (σ)	Permittivity (ϵ_r)	CW Signal Validation		
				Sensitivity	Probe Linearity	Probe Isotropy
750	HSL	0.851	42.43	PASS	PASS	PASS
835	HSL	0.898	41.88	PASS	PASS	PASS
1750	HSL	1.386	39.91	PASS	PASS	PASS
1800	HSL	1.449	41.26	PASS	PASS	PASS
1900	HSL	1.435	39.65	PASS	PASS	PASS
2000	HSL	1.451	39.42	PASS	PASS	PASS
2300	HSL	1.764	38.99	PASS	PASS	PASS
2450	HSL	1.863	38.85	PASS	PASS	PASS
2600	HSL	1.973	38.58	PASS	PASS	PASS
3400	HSL	2.88	38.10	PASS	PASS	PASS
3500	HSL	2.91	37.90	PASS	PASS	PASS
3700	HSL	3.05	37.70	PASS	PASS	PASS
3900	HSL	3.15	37.50	PASS	PASS	PASS
4100	HSL	3.25	37.20	PASS	PASS	PASS
4200	HSL	3.34	37.00	PASS	PASS	PASS
4400	HSL	3.58	36.70	PASS	PASS	PASS
4600	HSL	3.70	36.60	PASS	PASS	PASS
4800	HSL	3.82	36.40	PASS	PASS	PASS
4900	HSL	3.96	36.20	PASS	PASS	PASS
5250	HSL	4.528	35.32	PASS	PASS	PASS
5600	HSL	4.905	34.89	PASS	PASS	PASS
5750	HSL	5.077	34.28	PASS	PASS	PASS



Frequency (MHz)	Tissue Type	Conductivity (σ)	Permittivity (ϵ_r)	Modulation Signal Validation		
				Mod. Type	Duty Factor	PAR
750	HSL	0.851	42.43	N/A	N/A	N/A
835	HSL	0.898	41.88	GMSK	PASS	N/A
1750	HSL	1.386	39.91	N/A	N/A	N/A
1800	HSL	1.449	41.26	N/A	N/A	N/A
1900	HSL	1.435	39.65	GMSK	PASS	N/A
2000	HSL	1.451	39.42	GMSK	PASS	N/A
2300	HSL	1.764	38.99	OFDM	PASS	PASS
2450	HSL	1.863	38.85	OFDM	PASS	PASS
2600	HSL	1.973	38.58	TDD	PASS	N/A
3400	HSL	2.88	38.10	OFDM	PASS	PASS
3500	HSL	2.91	37.90	OFDM	PASS	PASS
3700	HSL	3.05	37.70	OFDM	PASS	PASS
3900	HSL	3.15	37.50	OFDM	PASS	PASS
4100	HSL	3.25	37.20	OFDM	PASS	PASS
4200	HSL	3.34	37.00	OFDM	PASS	PASS
4400	HSL	3.58	36.70	OFDM	PASS	PASS
4600	HSL	3.70	36.60	OFDM	PASS	PASS
4800	HSL	3.82	36.40	OFDM	PASS	PASS
4900	HSL	3.96	36.20	OFDM	PASS	PASS
5250	HSL	4.528	35.32	OFDM	N/A	PASS
5600	HSL	4.905	34.89	OFDM	N/A	PASS
5750	HSL	5.077	34.28	OFDM	N/A	PASS



<Validation Results>

Date	Frequency (MHz)	Tissue Type	Measured 1g SAR (W/kg)	Targeted 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Deviation (%)
2025.12.5	900	HSL	2.87	11.20	11.48	2.50
2025.12.5	1800	HSL	9.56	39.20	38.24	-2.45
2025.12.5	5250	HSL	8.09	76.70	80.9	5.48

Date	Frequency (MHz)	Tissue Type	Measured 10g SAR (W/kg)	Targeted 10g SAR (W/kg)	Normalized 10g SAR (W/kg)	Deviation (%)
2025.12.5	900	HSL	1.72	7.19	6.88	-4.31
2025.12.5	1800	HSL	5.07	20.10	20.28	0.90
2025.12.5	5250	HSL	2.18	22.10	21.8	-1.36

Note: System checks the specific test data please see annex C.

9. EUT Testing Position

This EUT was tested in ten different positions. They are right cheek/right tilted/left cheek/left tilted for head, Front/Back/Left/Right/Top/Bottom of the EUT with phantom 10 mm gap, as illustrated below, please refer to annex B for the test setup photos.

9.1. Handset Reference Points

The vertical centre line passes through two points on the front side of the handset – the midpoint of the width w_t of the handset at the level of the acoustic output, and the midpoint of the width w_b of the bottom of the handset.

The horizontal line is perpendicular to the vertical centre line and passes the center of the acoustic output. The horizontal line is also tangential to the handset at point A.

The two lines intersect at point A. Note that for many handsets, point A coincides with the center of the acoustic output; however, the acoustic output may be located elsewhere on the horizontal line. Also note that the vertical centre line is not necessarily parallel to the front face of the handset, especially for clamshell handsets, handsets with flip covers, and other irregularly shaped handsets.



Fig. 9.1 Illustration for Cheek Position

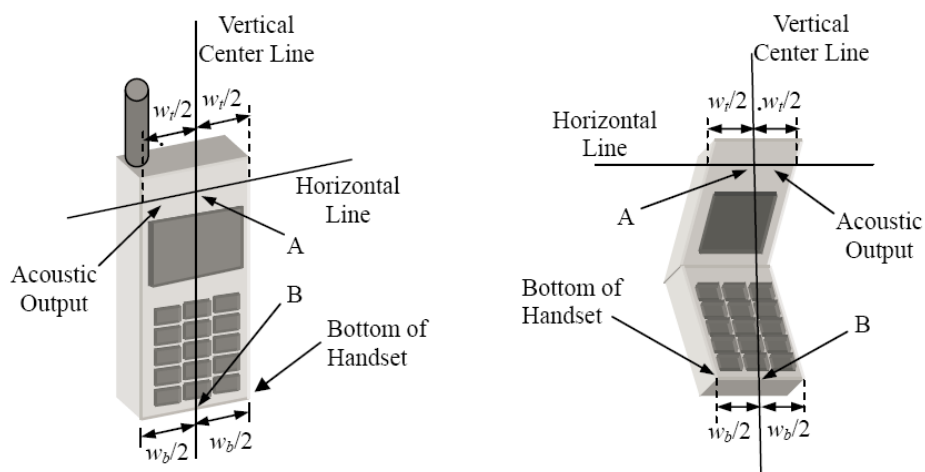


Fig. 9.2 Illustration for Handset Vertical and Horizontal Reference Lines

9.2. Positioning for Cheek / Touch

To position the device with the vertical center line of the body of the device and the horizontal line crossing the center piece in a plane parallel to the sagittal plane of the phantom. While maintaining the device in this plane, align the vertical center line with the reference plane containing the three ear and mouth reference point (M: Mouth, RE: Right Ear and LE: Left Ear) and align the center of the ear piece with the line RE-LE.

To move the device towards the phantom with the ear piece aligned with the line LE-RE until the phone touched the ear. While maintaining the device in the reference plane and maintaining the phone contact with the ear, move the bottom of the phone until any point on the front side is in contact with the cheek of the phantom or until contact with the ear is lost (see below figure)

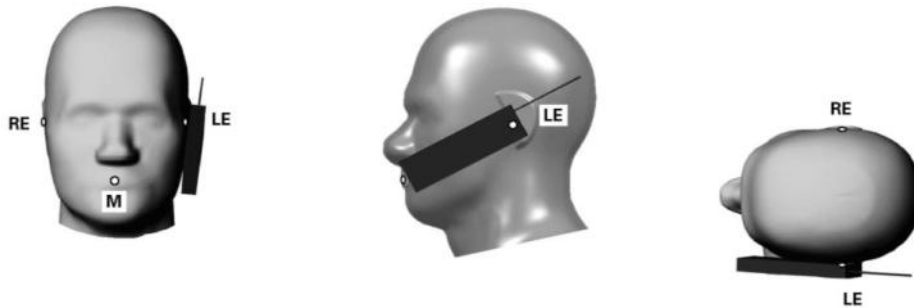


Fig 9.3 Illustration for Cheek Position

9.3. Positioning for Ear / 15° Tilt

To position the device in the “cheek” position described above.

While maintaining the device the reference plane described above and pivoting against the ear, moves it outward away from the mouth by an angle of 15 degrees or until contact with the ear is lost (see figure below).

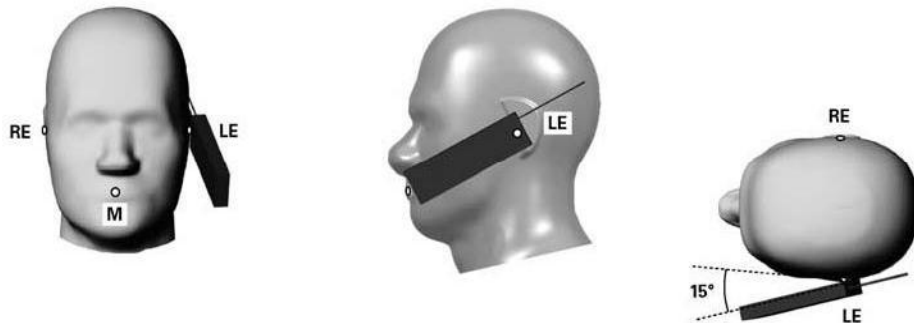


Fig 9.4 Illustration for Tilted Position

9.4. SAR Evaluation near the Mouth/Jaw Regions of the Phantom

Antennas located near the bottom of a phone may require SAR measurements around the mouth and jaw regions of the SAM head phantom. This typically applies to clam-shell style phones that are generally longer in the unfolded normal use positions or to certain older style long rectangular phones.

Under these circumstances, the following procedures apply, adopted from the FCC guidance on SAR handsets document FCC KDB Publication 648474 D04v01r03. The SAR required in these regions of SAM should be measured using a flat phantom. The phone should be positioned with a separation distance of 4 mm between the ear reference point (ERP) and the outer surface of the flat phantom shell. While maintaining this distance at the ERP location, the low (bottom) edge of the phone should be lowered from the phantom to establish the same separation distance between the peak SAR locations identified by the truncated partial SAR distribution measured with the SAM phantom. The distance from the peak SAR location to the phone is determined by the straight line passing perpendicularly through the phantom surface. When it is not feasible to maintain 4 mm separation at the ERP while also establishing the required separation at the peak SAR location, the top edge of the phone will be allowed to touch the phantom with a separation < 4 mm at the ERP. The phone should not be tilted to the left or right while placed in this inclined position to the flat phantom.

9.5. Body-worn Configurations

The body-worn configurations shall be tested with the supplied accessories (belt-clips, holsters, etc.) attached to the device in normal use configuration.

For body-worn and other configurations a flat phantom shall be used which is comprised of material with electrical properties similar to the corresponding tissues.

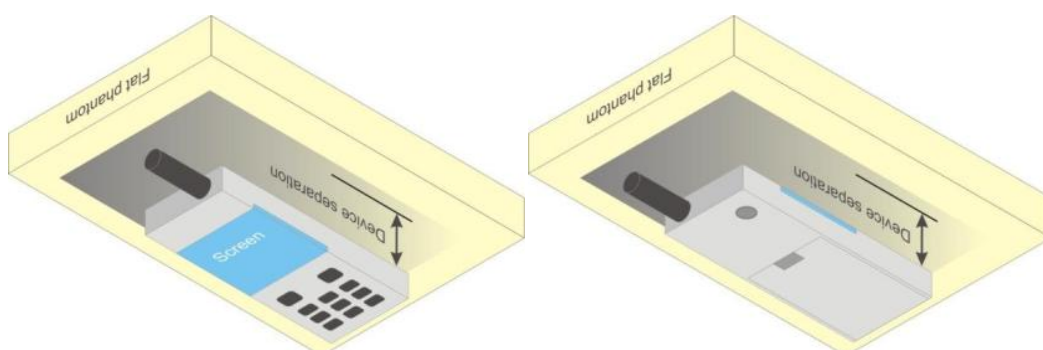


Fig 9.5 Illustration for Body Worn Position

9.6. Hotspot Mode Exposure Position Conditions

For handsets that support hotspot mode operations, with wireless router capabilities and various web browsing functions, the relevant hand and body exposure conditions are tested according to the hotspot SAR procedures in KDB 941225. A test separation distance of 10 mm is required between the phantom and all surfaces and edges with a transmitting antenna located within 25 mm from that surface or edge. When the form factor of a handset is smaller than 9 cm x 5 cm, a test separation distance of 5 mm (instead of 10 mm) is required for testing hotspot mode. When the separation distance required for body-worn accessory testing is larger than or equal to that tested for hotspot mode, in the same wireless mode and for the same surface of the phone, the hotspot mode SAR data may be used to support body-worn accessory SAR compliance for that particular configuration (surface).

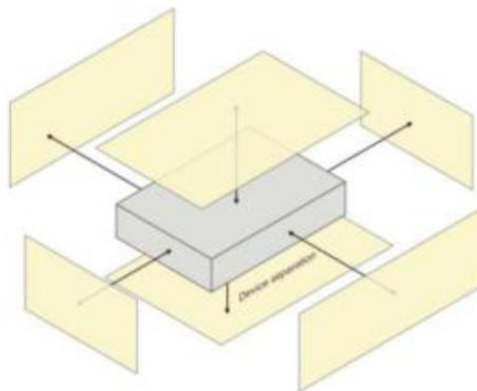


Fig 9.6 Illustration for Hotspot Position

10. Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

- (a) For WWAN power measurement, use base station simulator to configure EUT WWAN transmission in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.
- (b) Read the WWAN RF power level from the base station simulator.
- (c) For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power in each supported wireless interface and frequency band.
- (d) Connect EUT RF port through RF cable to the power meter, and measure WLAN/BT output power.

<SAR measurement>

- (a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.
- (b) Place the EUT in the positions as annex B demonstrates.
- (c) Set scan area, grid size and other setting on the DASY software.
- (d) Measure SAR results for the highest power channel on each testing position.
- (e) Find out the largest SAR result on these testing positions of each band.
- (f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg.

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

- (a) Power reference measurement.
- (b) Area scan.
- (c) Zoom scan.
- (d) Power drift measurement.

10.1. Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1 g and 10 g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1 g and 10 g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.



The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1 g and 10 g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

- (a) Extraction of the measured data (grid and values) from the Zoom Scan.
- (b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters).
- (c) Generation of a high-resolution mesh within the measured volume.
- (d) Interpolation of all measured values from the measurement grid to the high-resolution grid.
- (e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface.
- (f) Calculation of the averaged SAR within masses of 1 g and 10 g.

10.2. Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

10.3. Area Scan Procedures

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a 10 mm² step integral, with 1 mm interpolation used to locate the peak SAR area used for zoom scan assessments.

When an Area Scan has measured all reachable points, it computes the field maxima founding the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE 1528-2003.

10.4. Zoom Scan Procedures

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. A density of 1000 kg/m³ is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1 g cube is 10 mm, with the side



length of the 10 g cube 21.5 mm. The zoom scan integer steps can be user defined so as to reduce uncertainty, but normal practice for typical test applications utilize a physical step of 5 x 5 x 7 (8 mm x 8 mm x 5 mm) providing a volume of 32 mm in the X & Y axis, and 30 mm in the Z axis.

10.5. SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Sheppard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

10.6. Power Drift Monitoring

All SAR testing is under the DUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of DUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drift more than 5%, the SAR will be retested.

11. SAR Test Procedure

11.1. General Scan Requirements

Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std. 1528-2013.

			≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 mm $\pm$ 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2)$ mm $\pm$ 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			$30^{\circ} \pm 1^{\circ}$	$20^{\circ} \pm 1^{\circ}$
Maximum area scan spatial resolution: Δx_{Area} , Δy_{Area}			≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
			When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: Δx_{Zoom} , Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$ mm	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm
Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details.				
* When zoom scan is required and the <i>reported</i> SAR from the <i>area scan based 1-g SAR estimation</i> procedures of KDB Publication 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.				



11.2. Test Procedure

The Following steps are used for each test position

1. Establish a call with the maximum output power with a base station simulator. The connection between the mobile and the base station simulator is established via air interface.
2. Measurement of the local E-field value at a fixed location. This value serves as a reference value for calculating a possible power drift.
3. Measurement of the SAR distribution with a grid of 8 to 16 mm * 8 to 16 mm and a constant distance to the inner surface of the phantom. Since the sensors cannot directly measure at the inner phantom surface, the values between the sensors and the inner phantom surface are extrapolated. With these values the area of the maximum SAR is calculated by an interpolation scheme.
4. Around this point, a cube of 30 * 30 * 30 mm or 32 * 32 * 32 mm is assessed by measuring 5 or 8 * 5 or 8*4 or 5 mm. With these data, the peak spatial-average SAR value can be calculated.

11.3. Description of Interpolation/Extrapolation Scheme

The local SAR inside the phantom is measured using small dipole sensing elements inside a probe body. The probe tip must not be in contact with the phantom surface in order to minimize measurements errors, but the highest local SAR will occur at the surface of the phantom.

An extrapolation is using to determinate this highest local SAR values. The extrapolation is based on a fourth-order least-square polynomial fit of measured data. The local SAR value is then extrapolated from the liquid surface with a 1 mm step.

The measurements have to be performed over a limited time (due to the duration of the battery) so the step of measurement is high. It could vary between 5 and 8 mm. To obtain an accurate assessment of the maximum SAR averaged over 10 grams and 1 gram requires a very fine resolution in the three dimensionals scanned data array.

11.4. Wireless Router

Some battery-operated handsets have the capability to transmit and receive user through simultaneous transmission of WIFI simultaneously with a separate licensed transmitter. The FCC has provided guidance in FCC KDB Publication 941225 D06 v02r01 where SAR test considerations for handsets ($L \times W \geq 9 \text{ cm} \times 5 \text{ cm}$) are based on a composite test separation distance of 10 from the front, back and edges of the device containing transmitting antennas within 2.5 cm of their edges,



determined from general mixed use conditions for this type of devices. Since the hotspot SAR results may overlap with the body-worn accessory SAR requirements, the more conservative configurations can be considered, thus excluding some body-worn accessory SAR tests.

When the user enables the personal wireless router functions for the handset, actual operations include simultaneous transmission of both the WIFI transmitter and another licensed transmitter. Both transmitters often do not transmit at the same transmitting frequency and thus cannot be evaluated for SAR under actual use conditions due to the limitations of the SAR assessment probes. Therefore, SAR must be evaluated for each frequency transmission and mode separately and spatially summed with the WIFI transmitter according to FCC KDB Publication 447498 D01v06 publication procedures. The "Portable Hotspot" feature on the handset was NOT activated during SAR assessments, to ensure the SAR measurements were evaluated for a single transmission frequency RF signal at a time.

12. SAR Test Configuration

<GSM Mode>

A summary of these settings is illustrated below:

For GSM850 frequency band, the power control is set to 5 for GSM/GPRS mode (GSMK-CS1) and set to 8 for EDGE mode (MCS5); For GSM1900 frequency band, the power control is set to 0 for GSM/GPRS mode (GSMK-CS1) and set to 2 for EDGE mode (MCS5).

1. Per KDB 447498 D01v06, the maximum output power channel is used for SAR testing and for further SAR test reduction.
2. Per KDB 941225 D01v03r01, SAR test reduction for GSM / GPRS / EDGE modes is determined by the source-based time-averaged output power including tune-up tolerance. The mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested. Therefore, the GPRS (4Tx slots) for GSM850/GSM1900 is considered as the primary mode.
3. Other configurations of GSM / GPRS / EDGE are considered as secondary modes.

Timeslot consignations:

Remark:

1. The frame-averaged power is linearly reported the maximum burst averaged power over 8 time slots. The calculated methods are shown as below:
The duty cycle "x" of different time slots as below:
1 TX slot is 1/8, 2 TX slots is 2/8, 3 TX slots is 3/8 and 4 TX slots is 4/8
Based on the calculation formula:
Frame-averaged power = Burst averaged power + 10 log (x)
So,
Frame-averaged power (1 TX slot) = Burst averaged power (1 TX slot)– 9.03
Frame-averaged power (2 TX slots) = Burst averaged power (2 TX slots)– 6.02
Frame-averaged power (3 TX slots) = Burst averaged power (3 TX slots)– 4.26
Frame-averaged power (4 TX slots) = Burst averaged power (4 TX slots) – 3.01
2. CS1 coding scheme was used in GPRS conducted power measurements and SAR testing, MCS5 coding scheme was used in EGPRS conducted power measurements and SAR testing (if necessary).

No. of Slots:	Slot 1	Slot 2	Slot 3	Slot 4
Slot Consignation:	1Up 4Down	2Up 3Down	3Up 2Down	4Up 1Down
Duty Cycle:	1:8.3	1:4.15	1:2.77	1:2.08
Correct Factor:	-9.03dB	-6.02dB	-4.26dB	-3.01dB

<WCDMA Mode>

Summary of UMTS conducted power measurement:

1. The 3G SAR test reduction procedure is applied, when the maximum output power and tune-up tolerance specified for production units in a secondary mode is $\leq \frac{1}{4}$ dB higher than the primary mode, SAR measurement is not required for the secondary mode.
2. The following tests were conducted according to the test requirements outlines in 3GPP TS 34.121 specification.
3. The procedures in KDB 941225 D01v03r01 are applied for 3GPP Rel. 6 HSPA to configure the device in the required sub-test mode(s) to determine SAR test exclusion.
4. For HSPA+ devices supporting 16 QAM in the uplink, power measurements procedure is according to the configurations in Table C.11.1.4 of 3GPP TS 34.121-1.
5. Per KDB 941225 D01v03r01, RMC 12.2kbps setting is used to evaluate SAR. The maximum output power and tune-up tolerance specified for production units in HSDPA / HSUPA / DC-HSDPA / HSPA+ is $\leq \frac{1}{4}$ dB higher than RMC 12.2Kbps or when the highest reported SAR of the RMC12.2Kbps is scaled by the ratio of specified maximum output power and tune-up tolerance of HSDPA / HSUPA / DC-HSDPA / HSPA+ to RMC12.2Kbps and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for HSDPA / HSUPA / DC-HSDPA / HSPA+, and according to the following RF output power, the output power results of the secondary modes (HSDPA / HSUPA / DC-HSDPA / HSPA+) are less than $\frac{1}{4}$ dB higher than the primary modes; therefore, SAR measurement is not required for HSDPA / HSUPA / DC-HSDPA / HSPA+.
6. A fixed level power reduction is applied for WCDMA Band II when handset open Hotspot mode, the power reduction triggered.

HSDPA Setup Configuration

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	$\beta_{hs}^{(1)}$	CM (dB) ⁽²⁾
1	2/15	15/15	64	2/15	4/15	0.0
2	12/15 ⁽³⁾	15/15 ⁽³⁾	64	12/15 ⁽³⁾	24/15	1.0
3	15/15	8/15	64	15/8	30/15	1.5
4	15/15	4/15	64	15/4	30/15	1.5
Note 1: $\Delta_{ACK}, \Delta_{NACK}$ and $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$ Note 2: CM = 1 for $\beta_c/\beta_d = 12/15, \beta_{hs}/\beta_c = 24/15$. Note 3: For subtest 2 the β_c/β_d ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 11/15$ and $\beta_d = 15/15$.						

HSUPA Setup Configuration

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	$\beta_{hs}^{(1)}$	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM ⁽²⁾ (dB)	MPR (dB)	AG ⁽⁴⁾ Index	E-TFCI
1	11/15 ⁽³⁾	15/15 ⁽³⁾	64	11/15 ⁽³⁾	22/15	209/225	1039/225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	$\beta_{ed1}: 47/15$ $\beta_{ed2}: 47/15$	4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	2/15	56/75	4	1	3.0	2.0	17	71
5	15/15 ⁽⁴⁾	15/15 ⁽⁴⁾	64	15/15 ⁽⁴⁾	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1: Δ_{ACK} , Δ_{NACK} and $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$.

Note 2: CM = 1 for $\beta_c/\beta_d = 12/15$, $\beta_{hs}/\beta_c = 24/15$. For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.

Note 3: For subtest 1 the β_c/β_d ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 10/15$ and $\beta_d = 15/15$.

Note 4: For subtest 5 the β_c/β_d ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta_c = 14/15$ and $\beta_d = 15/15$.

Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g.

Note 6: β_{ed} cannot be set directly; it is set by Absolute Grant Value.

HSPA+ 3GPP release 7 (uplink category 7) 16QAM, Setup Configuration:

Table C.11.1.4: β values for transmitter characteristics tests with HS-DPCCH and E-DCH with 16QAM

Sub-test	β_c (Note 3)	β_d	β_{hs} (Note 1)	β_{ec}	β_{ed} (2xSF2) (Note 4)	β_{ed} (2xSF4) (Note 4)	CM (dB) (Note 2)	MPR (dB) (Note 2)	AG Index (Note 4)	E-TFCI (Note 5)	E-TFCI (boost)
1	1	0	30/15	30/15	$\beta_{ed1}: 30/15$ $\beta_{ed2}: 30/15$	$\beta_{ed3}: 24/15$ $\beta_{ed4}: 24/15$	3.5	2.5	14	105	105

Note 1: Δ_{ACK} , Δ_{NACK} and $\Delta_{CQI} = 30/15$ with $\beta_{hs} = 30/15 * \beta_c$.

Note 2: CM = 3.5 and the MPR is based on the relative CM difference, MPR = MAX(CM-1,0).

Note 3: DPDCH is not configured, therefore the β_c is set to 1 and $\beta_d = 0$ by default.

Note 4: β_{ed} can not be set directly; it is set by Absolute Grant Value.

Note 5: All the sub-tests require the UE to transmit 2SF2+2SF4 16QAM EDCH and they apply for UE using E-DPDCH category 7. E-DCH TTI is set to 2ms TTI and E-DCH table index = 2. To support these E-DCH configurations DPDCH is not allocated. The UE is signaled to use the extrapolation algorithm.

DC-HSDPA Setup Configuration

The following tests were completed according to procedures in section 7.3.13 of 3GPP TS34.108 v9.5.0. A summary of these settings are illustrated below:

Downlink Physical Channels are set as per 3GPP TS34.121-1 v9.0.0 E.5.

Table E.5.0: Levels for HSDPA connection setup

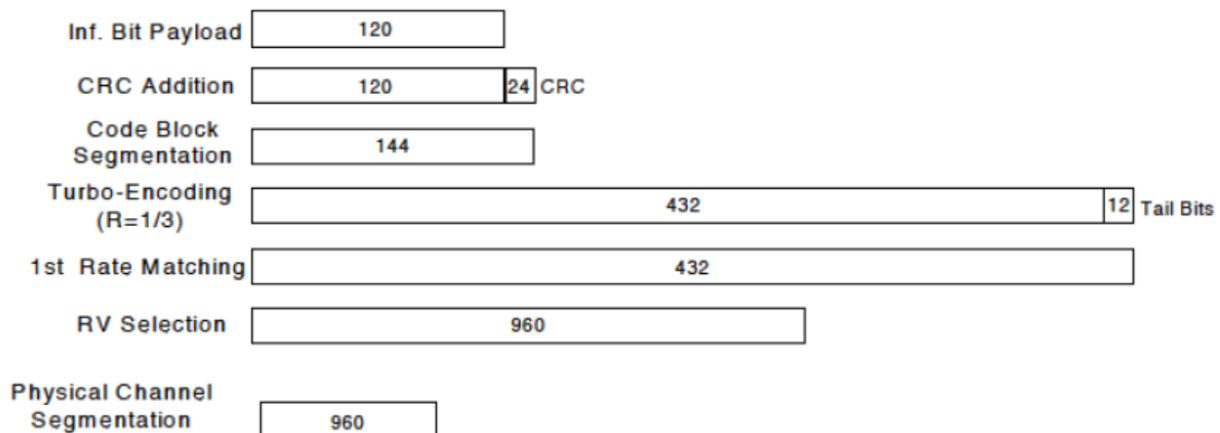
Parameter During Connection setup	Unit	Value
P-CPICH_Ec/Ior	dB	-10
P-CCPCH and SCH_Ec/Ior	dB	-12
PICH_Ec/Ior	dB	-15
HS-PDSCH	dB	off
HS-SCCH_1	dB	off
DPCH_Ec/Ior	dB	-5
OCNS_Ec/Ior	dB	-3.1

Call is set up as per 3GPP TS34.108 v9.5.0 sub clause 7.3.13

The configurations of the fixed reference channels for HSDPA RF tests are described in 3GPP TS 34.121, annex C for FDD and 3GPP TS 34.122.

Table C.8.1.12: Fixed Reference Channel H-Set 12

Parameter	Unit	Value
Nominal Avg. Inf. Bit Rate	kbps	60
Inter-TTI Distance	TTI's	1
Number of HARQ Processes	Processes	6
Information Bit Payload (N_{INF})	Bits	120
Number Code Blocks	Blocks	1
Binary Channel Bits Per TTI	Bits	960
Total Available SML's in UE	SML's	19200
Number of SML's per HARQ Proc.	SML's	3200
Coding Rate		0.15
Number of Physical Channel Codes	Codes	1
Modulation		QPSK
Note 1: The RMC is intended to be used for DC-HSDPA mode and both cells shall transmit with identical parameters as listed in the table. Note 2: Maximum number of transmission is limited to 1, i.e., retransmission is not allowed. The redundancy and constellation version 0 shall be used.		


Figure C.8.19: Coding rate for Fixed reference Channel H-Set 12 (QPSK)



<CDMA Mode>

1xEV-DO Rev. B

Call box setup procedure

1xEV-DO Release B

1> CMW 500 Signal Generator > 1xEV-DO Taskbar Enable

2> CMW 500 1xEV-DO Signaling Configuration Window >

3> 1xEV-DO Signaling On Window:

Under Access Network Control:

Band Class: BC0: US Cellular

RF Channel: 31

1xEV-DO Power: -70 dBm

4> 1xEV-DO Signaling Configuration Window

Under RF Frequency Band / Channel: Enter Ch. Frequency

- Under Carrier Configuration: RF Frequency
For Two Carriers: Low Channel (1013)

	<u>RF Channel</u>	<u>RF Channel Offset</u>
Carrier [0]	31	0
Carrier [1]	1013	982

- Under Carrier Configuration: RF Pilot
- | | <u>Carrier Sector</u> | <u>Active on AN</u> | <u>Assigned to AT</u> |
|-----------|-----------------------|---------------------|-----------------------|
| Pilot [0] | C0/S0 | ✓ | ✓ |
| | CA/S1 | ✓ | ✓ |

For Three Carriers: Low Channel (1013)

	<u>RF Channel</u>	<u>RF Channel Offset</u>
Carrier [0]	72	0
Carrier [1]	31	-41
Carrier [2]	1013	941

- Under Carrier Configuration: RF Pilot
- | | <u>Carrier Sector</u> | <u>Active on AN</u> | <u>Assigned to AT</u> |
|-----------|-----------------------|---------------------|-----------------------|
| Pilot [0] | C0/S0 | ✓ | ✓ |
| Pilot [1] | C1/S1 | ✓ | ✓ |
| Pilot [2] | C2/S2 | ✓ | ✓ |



<LTE Mode>

LTE Target MPR level

The device implements maximum power reduction per 3GPP 36.101 requirements where the MPR target is as below table. The MPR settings are implemented configured into firmware and cannot be disabled by the end user or LTE carrier network.

Modulation	Channel bandwidth / Transmission bandwidth configuration [RB]						MPR	3GPP
	1.4	3.0	5	10	15	20	Target	MPR
	MHz	MHz	MHz	MHz	MHz	MHz	(dB)	(dB)
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	1	≤ 1
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	1	≤ 1
64 QAM	> 5	> 4	> 8	> 12	> 16	> 18	2	≤ 2

Note: The measurement result showed some difference from the target MPR level, due to expected 0.5 dB measurement tolerance

LTE Bands

LTE Bands	Channel bandwidth / Transmission bandwidth configuration [RB]					
	1.4	3.0	5	10	15	20
	MHz	MHz	MHz	MHz	MHz	MHz
2	√	√	√	√	√	√
4	√	√	√	√	√	√
5	√	√	√	√	N/A	N/A
7	N/A	N/A	√	√	√	√
12	√	√	√	√	N/A	N/A
13	N/A	N/A	√	√	N/A	N/A
48	N/A	N/A	√	√	√	√
66	√	√	√	√	√	√

Note:

1. Per KDB 941225 D05v02r05, when a properly configured base station simulator is used for the SAR and power measurements, spectrum plots for each RB allocation and offset configuration is not required.
2. Per KDB 941225 D05v02r05, start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel.
3. Per KDB 941225 D05v02r05, 50% RB allocation for QPSK SAR testing follows 1RB QPSK allocation procedure.
4. Per KDB 941225 D05v02r05, for QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation



are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.

5. Per KDB 941225 D05v02r05, 16QAM/64QAM output power for each RB allocation configuration is $>$ not $\frac{1}{2}$ dB higher than the same configuration in QPSK and the reported SAR for the QPSK configuration is ≤ 1.45 W/kg; Per KDB941225 D05v02r05, 16QAM/64QAM SAR testing is not required.
6. Per KDB 941225 D05v02r05, smaller bandwidth output power for each RB allocation configuration is $>$ not $\frac{1}{2}$ Db higher than the same configuration in the largest supported bandwidth, and the reported SAR for the largest supported band width is ≤ 1.45 W/kg; Per KDB 941225 D05v02r05, smaller bandwidth SAR testing is not required.
7. For LTE B4 / B5 / B7 / B17 the maximum bandwidth does not support three non-overlapping channels, per KDB941225 D05v02r05, when a device supports overlapping channel assignment in a channel bandwidth configuration, the middle channel of the group of overlapping channels should be selected for testing.
8. LTE band 2 / 12 SAR test was covered by Band 25 / 17; according to April 2015 TCB workshop, SAR test for overlapping LTE bands can be reduced if
 - a. The maximum output power, including tolerance, for the smaller band is $\leq$ the larger band to qualify for the SAR test exclusion.
 - b. The channel bandwidth and other operating parameters for the smaller band are fully supported by the larger band.
9. According to 2017 TCB workshop, for 64 QAM and 16 QAM should be verified by checking the signal constellation with a call box to avoid incorrect maximum power levels due to MPR and other requirements associated with signal modulation, and the following figure is taken from the "Fundamental Measurement >> Modulation Analysis >> constellation" mode of the device connect to the CMW500 base station, therefore, the device 64QAM and 16QAM signal modulation are correct. Identify if Maximum Power Reduction (MPR) is optional or mandatory, i.e. built-in by design: only mandatory MPR may be considered during SAR testing, when the maximum output power is permanently limited by the MPR implemented within the UE; and only for the applicable RB (resource block) configurations specified in LTE standards: b) A-MPR (additional MPR) must be disabled.
10. Per KDB 447498 D01v06, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
 - a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
 - b. For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/ (duty cycle)"
 - c. For WWAN: Reported SAR (W/kg) = Measured SAR(W/kg) * Tune-up Scaling Factor
 - d. For WLAN/Bluetooth: Reported SAR (W/kg) = Measured SAR(W/kg) * Duty Cycle scaling factor * Tune-up scaling factor

- e. For TDD LTE SAR measurement, the duty cycle 1:1.59 (62.9 %) was used perform testing and considering the theoretical duty cycle of 63.3% for extended cyclic prefix in the uplink, and the theoretical duty cycle of 62.9% for normal cyclic prefix in uplink, a scaling factor of extended cyclic prefix $63.3\%/62.9\% = 1.006$ is applied to scale-up the measured SAR result. The Reported TDD LTE SAR = measured SAR (W/kg) * Tune-up Scaling Factor* scaling factor for extended cyclic prefix.
11. Per KDB 447498 D01v06, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is: ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
12. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥ 0.8 W/kg.
13. Per KDB 648474 D04v01r03, when the reported SAR for a body-worn accessory measured without a headset connected to the handset is ≤ 1.2 W/kg, SAR testing with a headset connected to the handset is not required.

<WLAN 2.4GHz>

1. SAR is measured for 2.4 GHz 802.11b DSSS using either the fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:
- a. When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
 - b. When the reported SAR is > 0.8 W/kg, SAR is required for that position using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.
2. 2.4 GHz 802.11 g/n OFDM are additionally evaluated for SAR if the highest reported SAR for 802.11b, adjusted by the ratio of the OFDM to DSSS specified maximum output power, is > 1.2 W/kg. When SAR is required for OFDM modes in 2.4 GHz band, the Initial Test configuration Procedures should be followed.
3. For held-to-ear and hotspot operations, the initial test position procedures were applied. The test position with the highest extrapolated peak SAR will be used as the initial test position. When reported SAR for the initial test position is ≤ 0.4 W/kg, no additional testing for the remaining test positions was required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.
4. Justification for test configurations for WLAN per KDB Publication 248227 D02DR02-41929 for 2.4 GHz WI-FI single transmission chain operations, the highest measured maximum output

power channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4 GHz/802.11g/n) was not required due to the maximum allowed powers and the highest reported DSSS SAR.

5. A fixed level power reduction is applied for WiFi when handset operates "held to the body" condition or "held to the ear" condition, the power reduction triggered by audio receiver detection and call establish status.
6. Per KDB 248227 D01v02r02, In the 2.4 GHz band, separate SAR procedures are applied to DSSS and OFDM configurations to simplify DSSS test requirements. SAR is not required for the following 2.4 GHz OFDM conditions:
 - a. When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.
 - b. When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

<WLAN 5GHz>

A) U-NII-1 and U-NII-2A Bands

For devices that operate in only one of the U-NII-1 and U-NII-2A bands, the normally required SAR procedures for OFDM configurations are applied. For devices that operate in both U-NII bands using the same transmitter and antenna(s), SAR test reduction is determined according to the following:

1. When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition); otherwise, both bands are tested independently for SAR.
2. When different maximum output power is specified for the bands, begin SAR measurement in the band with higher specified maximum output power. The highest reported SAR for the tested configuration is adjusted by the ratio of lower to higher specified maximum output power for the two bands. When the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for the band with lower maximum output power in that test configuration; otherwise, both bands are tested independently for SAR.
3. The two U-NII bands may be aggregated to support a 160 MHz channel on channel number 50.
4. Without additional testing, the maximum output power for this is limited to the lower of the maximum output power certified for the two bands. When SAR measurement is required for at least one of the bands and the highest reported SAR adjusted by the ratio of specified maximum output power of aggregated to standalone band is > 1.2 W/kg, SAR is required for the 160 MHz channel. This procedure does not apply to an aggregated band with maximum output higher than the standalone band(s); the aggregated band must be tested independently for SAR. SAR is not required when the 160 MHz channel is operating at a reduced maximum power and also qualifies for SAR test exclusion.

**B) U-NII-2C and U-NII-3 Bands**

The frequency range covered by these bands is 380 MHz (5.47 – 5.85 GHz), which requires a minimum of at least two SAR probe calibration frequency points to support SAR measurements. when Terminal Doppler Weather Radar (TDWR) restriction applies, all channels that operate at 5.60 – 5.65 GHz must be included to apply the SAR test reduction and measurement procedures. When the same transmitter and antenna(s) are used for U-NII-2C band and U-NII-3 band or 5.8 GHz band of §15.247, the bands may be aggregated to enable additional channels with 20, 40 or 80 MHz bandwidth to span across the band gap, as illustrated in Appendix B. The maximum output power for the additional band gap channels is limited to the lower of those certified for the bands. Unless band gap channels are permanently disabled, they must be considered for SAR testing. The frequency range covered by these bands is 380 MHz (5.47 – 5.85 GHz), which requires a minimum of at least two SAR probe calibration frequency points to support SAR measurements. To maintain SAR measurement accuracy and to facilitate test reduction, the channels in U-NII-2C band above 5.65 GHz may be grouped with the 5.8 GHz channels in U-NII-3 or §15.247 band to enable two SAR probe calibration frequency points to cover the bands, including the band gap channels. When band gap channels are supported and the bands are not aggregated for SAR testing, band gap channels must be considered independently in each band according to the normally required OFDM SAR measurement and probe calibration frequency points requirements.

C) OFDM Transmission Mode SAR Test Configuration and Channel Selection Requirements

The initial test configuration for 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple configurations in a frequency band have the same specified maximum output power, the initial test configuration is determined according to the following steps applied sequentially.

1. The largest channel bandwidth configuration is selected among the multiple configurations with the same specified maximum output power.
2. If multiple configurations have the same specified maximum output power and largest channel bandwidth, the lowest order modulation among the largest channel bandwidth configurations is selected.
3. If multiple configurations have the same specified maximum output power, largest channel bandwidth and lowest order modulation, the lowest data rate configuration among these configurations is selected.
4. When multiple transmission modes (802.11a/g/n/ac) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, the lowest order 802.11 mode is selected; i.e., 802.11a is chosen over 802.11n then 802.11ac or 802.11g is

chosen over 802.11n. After an initial test configuration is determined, if multiple test channels have the same measured maximum output power, the channel chosen for SAR measurement is determined according to the following. These channel selection procedures apply to both the initial test configuration and subsequent test configuration(s), with respect to the default power measurement procedures or additional power measurements required for further SAR test reduction. The same procedures also apply to subsequent highest output power channel(s) selection.

5. The channel closest to mid-band frequency is selected for SAR measurement.
6. For channels with equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.

D) SAR Test Requirements for OFDM configurations

When SAR measurement is required for 802.11 a/n/ac OFDM configurations, each standalone and frequency aggregated band is considered separately for SAR test reduction. When the same transmitter and antenna(s) are used for U-NII-1 and U-NII-2A bands, additional SAR test reduction applies. When band gap channels between U-NII-2C band and 5.8 GHz U-NII-3 or §15.247 band are supported, the highest maximum output power transmission mode configuration and maximum output power channel across the bands must be used to determine SAR test reduction, according to the initial test configuration and subsequent test configuration requirements. In applying the initial test configuration and subsequent test configuration procedures, the 802.11 transmission configuration with the highest specified maximum output power and the channel within a test configuration with the highest measured maximum output power should be clearly distinguished to apply the procedures.

13. Conducted Power List

Remark: The output power of GSM/WCDMA/LTE/5G NR/WLAN/Bluetooth was recorded in annex E of the original report.

14. LTE Carrier Aggregation

➤ Carrier Aggregation Configuration

<Intra-band>

2CC Uplink Carrier Aggregation for Intra-band				
No.	Combination	MIMO	Restriction	Completely Covered by Measurement Superset
1	CA_5B	-	-	No
2	CA_48C	-	-	No
3	CA_66B	-	-	No
4	CA_66C	-	-	No

Note:

- According to the 3GPP 36.101 table 6.2.2A-1 specifics that the aggregation maximum allowed output power is equivalent to the signal carrier scenario for intra-band contiguous carrier aggregation scenarios. When the non-contiguous RB allocation is applied the MPR shell complies with the table 6.2.3A defined in 3GPP 36.101.
- According to the TCB Workshop publication, the output power of uplink CA would be measured with the wideband signal integration over the component carriers. And SAR measurement would be performed at the worst exposure condition of each band.
- Additional SAR measurement for LTE UL CA with other DL CA combinations are not required when the maximum output power of this configuration is not $> 1/4$ dB higher than the maximum output power for UL CA active.

<Inter-band>

2CC Uplink Carrier Aggregation for Inter-band				
No.	Combination	MIMO	Restriction	Completely Covered by Measurement Superset
1	CA_2A-4A	-	-	No
2	CA_2A-5A	-	-	No
3	CA_2A-13A	-	-	No
4	CA_2A-66A	-	-	No
5	CA_4A-5A	-	-	No

6	CA_4A-13A	-	-	No
7	CA_5A-66A	-	-	No
8	CA_13A-66A	-	-	No

Note:

According to October 2018 TCB Workshop publication, LTE uplink CA SAR assessment should follow:

- If the signal uplink 1-g SAR values for each band are both less than 0.8 W/kg and the algebraic summation of the 1-g SAR values are less than 1.45 W/kg no additional measurements need to be performed.
- If one or the signal uplink 1-g SAR values is greater than 0.8 W/kg, instead of algebraically summing the 1-g SAR values, sum up the SAR distributions, similar to the enlarged zoom scan (volume scan) procedures found in FCC KDB Publication 865664 D01. And PAG is required for this case.
- If the algebraic sum of the 1-g SAR values is > 1.45 W/kg additional measurements may have to be made. Submit a KDB inquiry for additional guidance. And PAG is required for this case.

➤ **Carrier Aggregation Configuration**

For the device supports bands and bandwidths and configurations are provided as follow table was according to 3GPP.

2CC Downlink Carrier Aggregation				
No.	Combination	DL 4x4 MIMO	Restriction	Completely Covered by Measurement Superset
1	CA_4A-13A	4A	-	No
2	CA_13A-66A	66A	-	3CC-22
3	CA_2A-13A	2A	-	3CC-10
4	CA_2A-2A	2A-2A	-	3CC-4
5	CA_2A-4A	2A, 4A	-	3CC-5
6	CA_2A-66A	2A, 66A	-	3CC-11
7	CA_2A-5A	2A	-	3CC-8
8	CA_4A-5A	4A	-	No
9	CA_5A-66A	66A	-	3CC-18
10	CA_4A-4A	4A-4A	-	3CC-15
11	CA_5B	-	-	3CC-21
12	CA_5A-5A	-	-	3CC-17
13	CA_66A-66A	66A-66A	-	3CC-26
14	CA_66B	66B	-	No
15	CA_66C	66C	-	No
16	CA_2A-48A	2A, 48A	-	3CC-27



17	CA_4A-48A	4A, 48A	-	No
18	CA_13A-48A	48A	-	3CC-30
19	CA_48A-66A	48A, 66A	-	3CC-34
20	CA_48C	48C	-	3CC-37
21	CA_5A-48A	48A	-	3CC-41

3CC Downlink Carrier Aggregation				
No.	Combination	DL 4x4 MIMO	Restriction	Completely Covered by Measurement Superset
1	CA_2A-2A-4A	2A, 4A	-	4CC-1
2	CA_2A-2A-5A	2A	-	4CC-3
3	CA_2A-2A-13A	2A	-	4CC-4
4	CA_2A-2A-66A	2A, 66A	-	4CC-5
5	CA_2A-4A-4A	2A, 4A	-	4CC-8
6	CA_2A-4A-5A	-	-	No
7	CA_2A-4A-13A	-	-	No
8	CA_2A-5A-66A	-	-	4CC-10
9	CA_2A-5B	2A	-	4CC-13
10	CA_2A-13A-66A	-	-	4CC-14
11	CA_2A-66A-66A	2A, 66A	-	4CC-24
12	CA_2A-66B	2A	-	No
13	CA_2A-66C	2A	-	No
14	CA_4A-5B	4A	-	No
15	CA_4A-4A-5A	4A	-	No
16	CA_4A-4A-13A	4A	-	No
17	CA_5A-5A-66A	66A	-	4CC-18
18	CA_5A-66A-66A	66A	-	No
19	CA_5A-66B	-	-	No
20	CA_5A-66C	-	-	No
21	CA_5B-66A	66A	-	4CC-21
22	CA_13A-66A-66A	66A	-	No
23	CA_13A-66B	-	-	No
24	CA_13A-66C	-	-	No
25	CA_66A-66C	66A	-	No
26	CA_66A-66A-66A	66A	-	No
27	CA_2A-48A-48A	-	-	No
28	CA_2A-48C	2A	-	4CC-32
29	CA_4A-48C	4A	-	No



30	CA_13A-48A-48A	-	-	No
31	CA_13A-48A-66A	-	-	No
32	CA_13A-48C	-	-	4CC-29
33	CA_48A-48A-66A	-	-	4CC-35
34	CA_48A-66A-66A	66A	-	No
35	CA_48A-66B	48A	-	No
36	CA_48A-66C	48A	-	No
37	CA_48C-66A	66A	-	No
38	CA_48D	-	-	4CC-42
39	CA_2A-13A-48A	-	-	No
40	CA_2A-5A-48A	-	-	No
41	CA_5A-48A-66A	-	-	No
42	CA_5A-48C	-	-	4CC-45

4CC Downlink Carrier Aggregation				
No.	Combination	DL 4x4 MIMO	Restriction	Completely Covered by Measurement Superset
1	CA_2A-2A-4A-4A	-	-	No
2	CA_2A-2A-4A-5A	-	-	No
3	CA_2A-2A-5A-66A	-	-	No
4	CA_2A-2A-13A-66A	-	-	No
5	CA_2A-2A-66A-66A	-	-	No
6	CA_2A-2A-66B	-	-	No
7	CA_2A-2A-66C	-	-	No
8	CA_2A-4A-4A-5A	-	-	No
9	CA_2A-4A-5B	-	-	No
10	CA_2A-5A-66A-66A	-	-	No
11	CA_2A-5A-66B	-	-	No
12	CA_2A-5A-66C	-	-	No
13	CA_2A-5B-66A	-	-	No
14	CA_2A-13A-66A-66A	-	-	No
15	CA_2A-13A-66B	-	-	No
16	CA_2A-13A-66C	-	-	No
17	CA_4A-4A-5B	-	-	No
18	CA_5A-5A-66A-66A	-	-	No
19	CA_5A-5A-66B	-	-	No
20	CA_5A-5A-66C	-	-	No
21	CA_5B-66A-66A	-	-	No

22	CA_5B-66B	-	-	No
23	CA_5B-66C	-	-	No
24	CA_2A-66A-66A-66A	-	-	No
25	CA_2A-13A-48C	-	-	No
26	CA_13A-48A-48C	-	-	No
27	CA_13A-48A-66B	-	-	No
28	CA_13A-48A-66C	-	-	No
29	CA_13A-48C-66A	-	-	No
30	CA_13A-48D	-	-	No
31	CA_2A-48A-48C	-	-	No
32	CA_2A-48C-66A	-	-	No
33	CA_2A-48D	-	-	No
34	CA_2A-5A-48C	-	-	No
35	CA_48A-48A-66A-66A	-	-	No
36	CA_48A-48A-66B	-	-	No
37	CA_48A-48A-66C	-	-	No
38	CA_48A-48C-66A	-	-	No
39	CA_48C-66A-66A	-	-	No
40	CA_48C-66B	-	-	No
41	CA_48C-66C	-	-	No
42	CA_48D-66A	-	-	No
43	CA_48E	-	-	No
44	CA_4A-48D	-	-	No
45	CA_5A-48C-66A	-	-	No
46	CA_5A-48D	-	-	No

➤ LTE Downlink Carrier Aggregation Conducted Power

1. According to KDB941225 D05A v01r02, Uplink maximum output power measurement with downlink carrier aggregation active should be measured, using the highest output channel measured without downlink carrier aggregation, to confirm that uplink maximum output power with downlink carrier aggregation active remains within the specified tune-up tolerance limits and not more than $\frac{1}{4}$ dB higher than the maximum output measured without downlink carrier aggregation active.
2. Uplink maximum output power with downlink carrier aggregation active does not show more than $\frac{1}{4}$ dB higher than the maximum output power without downlink carrier aggregation active, therefore SAR evaluation with downlink carrier aggregation active can be excluded.
3. For power measurement were control and acknowledge data is sent on uplink channels that operate identical to specifications when downlink carrier aggregation is inactive.

4. Selected highest measured power when downlink carrier aggregation is inactive for conducted power comparison with downlink carrier aggregation is active, to confirm that when downlink carrier aggregation is active uplink maximum output power remains within the specified tune-up tolerance limits and not more than $\frac{1}{4}$ dB higher than the maximum output power measured when downlink carrier aggregation inactive.
5. For non-contiguous intra-band CA, the SCC selected to provide maximum separation from the PCC and must remain fully within the downlink transmission band.
6. For Intra-band, contiguous CA, the downlink channels selected to perform the uplink power measurement must satisfy
7. 3GPP channel spacing (5.4.1A of 3GPP TS 36.521 or equivalent) and channel bandwidth (5.4.2A) requirements.

$$\text{Nominal channel spacing} = \left\lceil \frac{BW_{\text{Channel}(1)} + BW_{\text{Channel}(2)} - 0.1|BW_{\text{Channel}(1)} - BW_{\text{Channel}(2)}|}{0.6} \right\rceil 0.3 \text{ [MHz]}$$

8. The output power of CA Uplink & downlink was recorded in annex E of the original report.

15. 5G NR EN-DC Consideration

➤ General Guidance

1. It is operated at EN-DC (NSA) for 5G NR implementation according to the character of the device. SAR measurement should be performed separately for the limitations of the probe calculation factors.
2. When the EN-DC is active the output power of the LTE anchors is equal or less than the standalone carrier, therefore the LTE output power and SAR were estimated based on the standalone carrier to performed sim-TX analysis with 5G NR, WLAN and Bluetooth.
3. According to October 2020 TCB Workshop publication, EN-DC SAR assessment should follow:
 - a. If the signal uplink 1-g SAR values for each band are both less than 0.8 W/kg and the algebraic summation of the 1-g SAR values are less than 1.45 W/kg no additional measurements need to be performed.
 - b. If one or the signal uplink 1-g SAR values is greater than 0.8 W/kg, instead of algebraically summing the 1-g SAR values, sum up the SAR distributions, similar to the enlarged zoom scan (volume scan) procedures found in FCC KDB Publication 865664 D01. And PAG is required for this case.
 - c. If the algebraic sum of the 1-g SAR values is > 1.45 W/kg additional measurements may have to be made. Submit a KDB inquiry for additional guidance and PAG is required for this case.
 - d. When the algebraic sum of the 1-g SAR values is > 1.6 W/kg, SPLSR analysis procedure should be applied.

➤ 5G NR Anchor Combination

5G-NR	EN-DC Combination	LTE Uplink	5G-NR Uplink	SCS (kHz)	Maximum Bandwidth (MHz)
FDD	DC_2A-66A_n5A	2A/66A	n5A	15	20
FDD	DC_13A_n66A	13A	n66A	15	30
FDD	DC_2A-13A_n66A	2A/13A	n66A	15	30
FDD	DC_13A-66A_n66A	13A	n66A	15	30
FDD	DC_5A_n2A	5A	n2A	15	20
FDD	DC_2A_n5A	2A	n5A	15	20
FDD	DC_66A_n5A	66A	n5A	15	20
FDD	DC_2A_n66A	2A	n66A	15	30
FDD	DC_5A_n66A	5A	n66A	15	30
FDD	DC_2A-5A_n2A	5A	n2A	15	20
FDD	DC_5A-66A_n2A	5A/66A	n2A	15	20
FDD	DC_2A-2A_n5A	2A	n5A	15	20
FDD	DC_66A-66A_n5A	66A	n5A	15	20



FDD	DC_2A-5A_n66A	2A/5A	n66A	15	30
FDD	DC_2A-66A_n66A	2A	n66A	15	30
FDD	DC_5A-66A_n66A	5A	n66A	15	30
FDD	DC_2A-2A_n66A	2A	n66A	15	30
FDD	DC_66A_n2A	66A	n2A	15	20
FDD	DC_2A-66A_n2A	66A	n2A	15	20
FDD	DC_13A_n2A	13A	n2A	15	20
FDD	DC_48A_n5A	48A	n5A	15	20
FDD	DC_13A-66A_n2A	13A/66A	n2A	15	20
FDD	DC_2A-48A_n5A	2A	n5A	15	20
FDD	DC_2A-48A_n66A	2A	n66A	15	30
FDD	DC_48A-66A_n5A	66A	n5A	15	20
FDD	DC_13A-48A_n66A	13A	n66A	15	30
FDD	DC_13A-48A_n2A	13A	n2A	15	20
FDD	DC_2A-13A_n2A	13A	n2A	15	20
TDD	DC_2A_n77A	2A	n77A	30	100
TDD	DC_5A_n77A	5A	n77A	30	100
TDD	DC_13A_n77A	13A	n77A	30	100
TDD	DC_66A_n77A	66A	n77A	30	100
TDD	DC_66A-66A_n77A	66A	n77A	30	100
TDD	DC_2A-2A_n77A	2A	n77A	30	100
FDD	DC_66A-66A_n2A	66A	n2A	15	20

➤ **Maximum Power for EN-DC (head)**

EN-DC Configuration	LTE Signal Carrier				5G NR		
	Band	BW (MHz)	Maximum Power(dBm)		Band	BW (MHz)	Maximum Power(dBm)
			Standalone	EN-DC Active			EN-DC Active
DC_5A_n2A	5	10	24.8	24.8	n2	20	20
DC_13A_n2A	13	10	24.8	24.8	n2	20	20
DC_66A_n2A	66	20	/	19.8	n2	20	20
DC_2A_n5A	2	20	/	19.8	n5	20	20
DC_48A_n5A	48	20	/	19.3	n5	20	20
DC_66A_n5A	66	20	/	19.8	n5	20	20
DC_2A_n66A	2	20	/	19.8	n66	30	20
DC_5A_n66A	5	10	24.8	24.8	n66	30	20
DC_13A_n66A	13	10	24.8	24.8	n66	30	20



DC_2A_n77A	2	20	/	19.8	n77	100	18
DC_5A_n77A	5	10	24.8	24.8	n77	100	18
DC_13A_n77A	13	10	24.8	24.8	n77	100	18
DC_66A_n77A	66	20	/	19.8	n77	100	18

➤ **Maximum Power for EN-DC (body)**

EN-DC Configuration	LTE Signal Carrier				5G NR		
	Band	BW (MHz)	Maximum Power(dBm)		Band	BW (MHz)	Maximum Power(dBm)
			Standalone	EN-DC Active			EN-DC Active
DC_5A_n2A	5	10	24.8	23.8	n2	20	20
DC_13A_n2A	13	10	24.8	23.8	n2	20	20
DC_66A_n2A	66	20	/	19.8	n2	20	20
DC_2A_n5A	2	20	/	19.8	n5	20	20
DC_48A_n5A	48	20	/	21.3	n5	20	20
DC_66A_n5A	66	20	/	19.8	n5	20	20
DC_2A_n66A	2	20	/	19.8	n66	30	20
DC_5A_n66A	5	10	24.8	23.8	n66	30	20
DC_13A_n66A	13	10	24.8	23.8	n66	30	20
DC_2A_n77A	2	20	/	19.8	n77	100	20
DC_5A_n77A	5	10	24.8	23.8	n77	100	20
DC_13A_n77A	13	10	24.8	23.8	n77	100	20
DC_66A_n77A	66	20	/	19.8	n77	100	20



16. Hotspot Mode Evaluation Procedure

➤ EUT Antenna Location

The location of antenna was recorded in annex B

ANT 1:

TRX: GSM 850, WCDMA Band V, LTE Band 5/12/13, 5G NR n5 (NSA)

PRX MIMO: LTE Band 2/4/7/66, 5G NR n2/66

ANT 2: PRX: LTE Band 48, 5G NR n77

ANT3: TRX: GSM 1900, WCDMA Band II/IV, LTE Band 2/4/7/66, 5G NR n2/66 (NSA)

DRX2: LTE Band 48, 5G NR n77

ANT4: TRX0: LTE Band 48, 5G NR n77(NSA)

ANT5: DRX: GSM 850/1900, WCDMA Band II/IV/V, LTE Band 2/4/5/7/12/13/66, 5G NR n2/5/66

ANT 7: ENDC TX: LTE Band 2/66

DRX: LTE Band 2/4/7/66, 5G NR n2/66 (NSA)

ANT 8: TX/RX: WLAN 2.4GHz/5GHz CH0, Bluetooth

RX: GPS

ANT9: TX/RX: WLAN 2.4GHz/5GHz CH1

ANT 10: TRX1(for ENDC): LTE Band 48, 5G NR n77(NSA)

NFC

➤ EUT Antenna Distance

Antenna Location	Front	Back	Left	Right	Top	Bottom
ANT 1	<5mm	<5mm	>25mm	<5mm	>25mm	<5mm
ANT 3	<5mm	<5mm	<5mm	>25mm	>25mm	<5mm
ANT 4	<5mm	<5mm	<5mm	>25mm	<25mm	>25mm
ANT 7	<5mm	<5mm	<5mm	>25mm	>25mm	>25mm
ANT 8	<5mm	<5mm	>25mm	<5mm	<5mm	>25mm
ANT 9	<5mm	<5mm	>25mm	<25mm	>25mm	>25mm



ANT 10	<5mm	<5mm	>25mm	<25mm	<5mm	>25mm
--------	------	------	-------	-------	------	-------

➤ **Hotspot Evaluation**

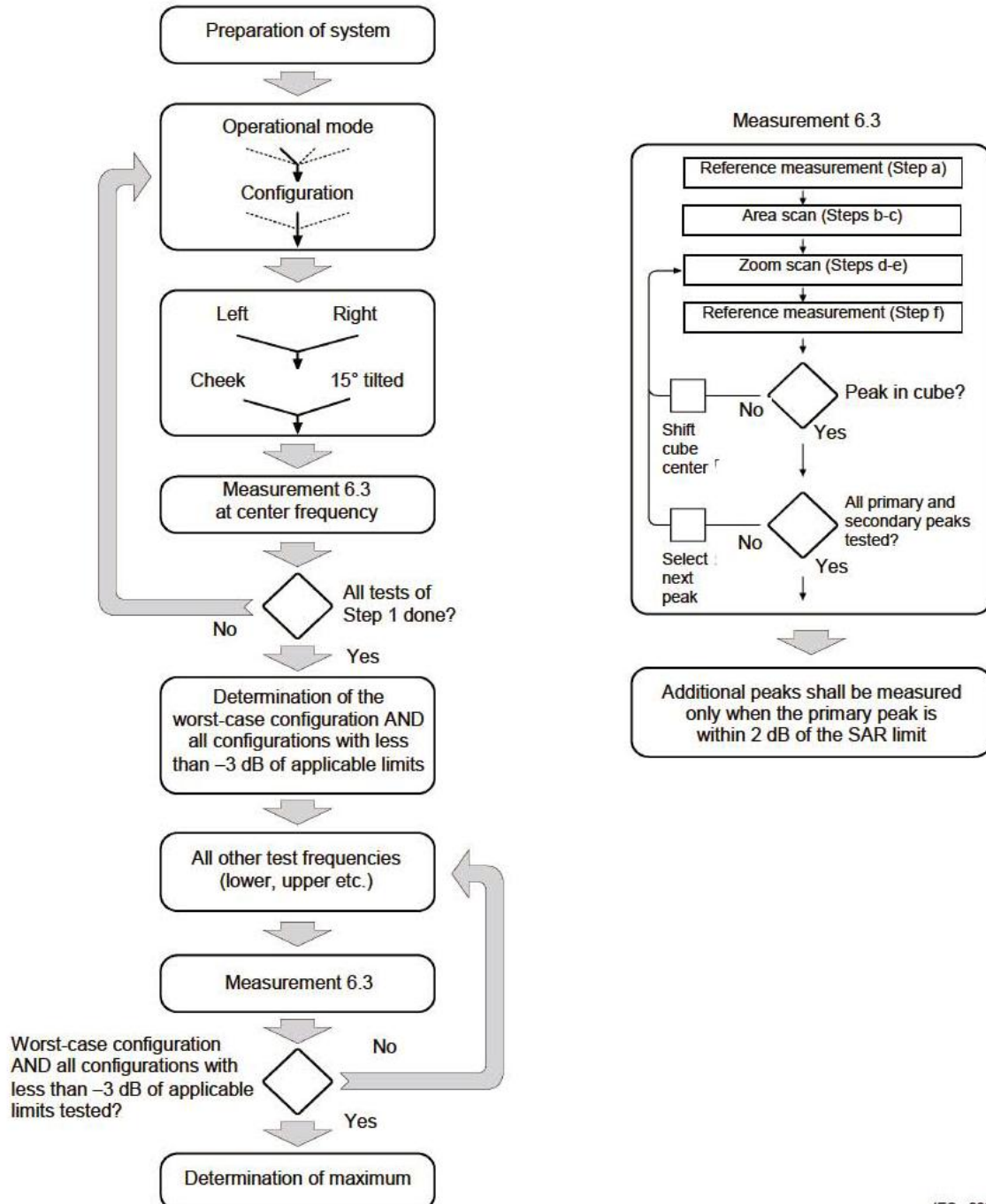
Assessment	Hotspot Side for SAR Test Distance: 10mm					
Antennas	Front	Back	Left	Right	Top	Bottom
ANT 1	Yes	Yes	No	Yes	No	Yes
ANT 3	Yes	Yes	Yes	No	No	Yes
ANT 4	Yes	Yes	Yes	No	Yes	No
ANT 7	Yes	Yes	Yes	No	No	No
ANT 8	Yes	Yes	No	Yes	Yes	No
ANT 9	Yes	Yes	No	Yes	No	No
ANT 10	Yes	Yes	No	Yes	Yes	No

Note :

1. The SAR evaluation procedures for Portable Devices with Wireless Router function is according to KDB 941225 D06 Hotspot SAR v02r01.
2. Head/Body-worn/Hotspot mode SAR assessments are required.
3. Referring to KDB 941225 D06, when the overall device length and width are $\geq 9\text{cm} \times 5\text{cm}$, the test distance is 10 mm. SAR must be measured for all sides and surfaces with a transmitting antenna located within 25mm from that surface or edge.
4. For WWAN bands, all of surface or edges would be tested except the bottom side of ANT 1/3 and top side of ANT 4/7/10 in this report.
5. For WLAN bands, all of surface or edges would be tested except the bottom side in this report.

17. Block Diagram of the Tests to be Performed

17.1. Head



IEC 228/05

17.2. Body

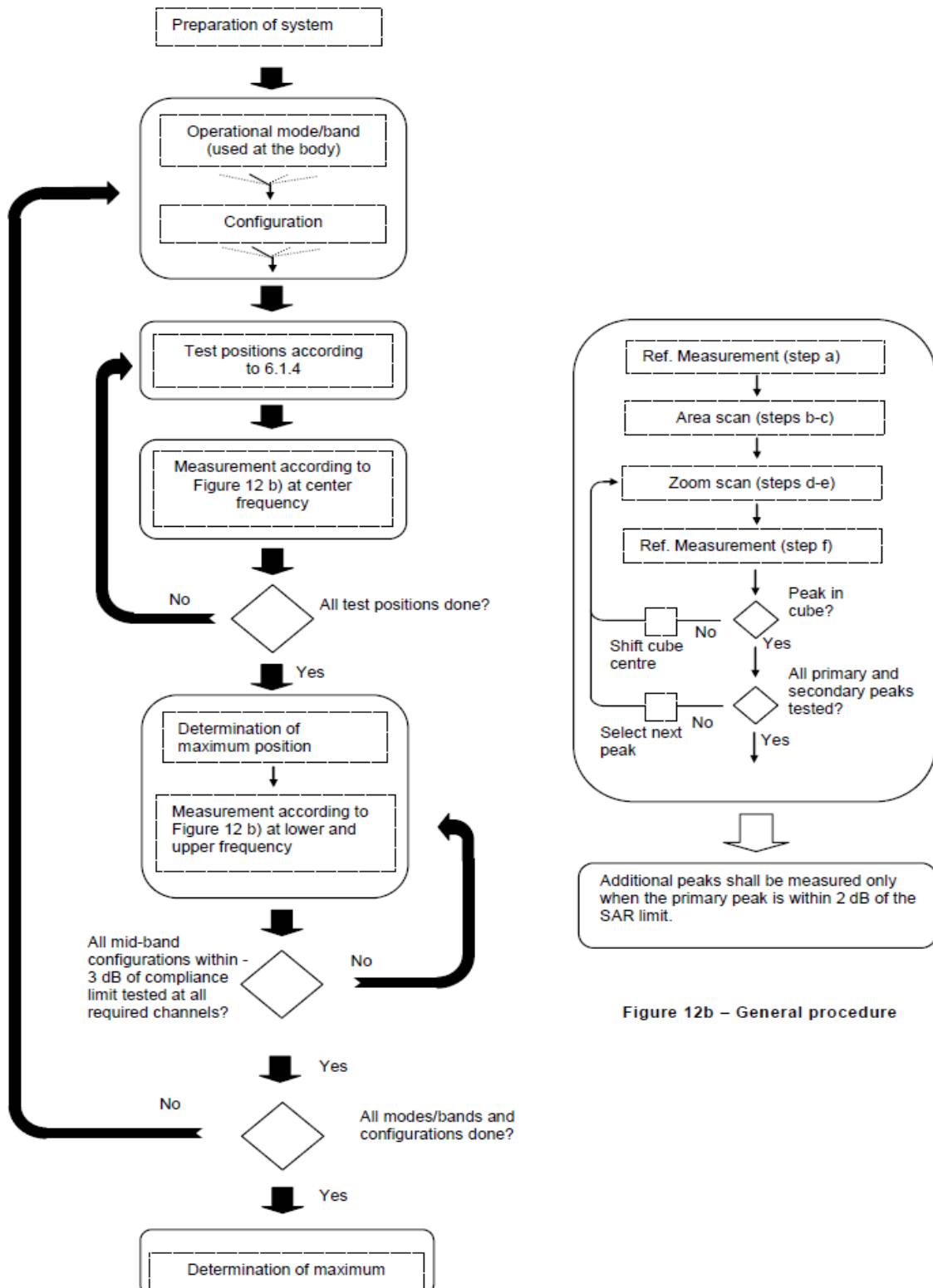


Figure 12b – General procedure

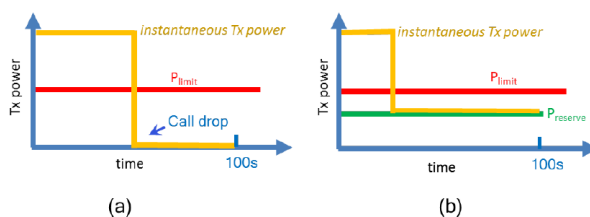
18. Smart Transmit Algorithm

FCC SAR limit is defined based on time average RF exposure. Qualcomm® Smart Transmit algorithm developed by Qualcomm, when running in a wireless device, will ensure the wireless device is in compliance with IN limit of SAR averaged over a defined time window, denoted as SAR_time_window, at all times. The Smart Transmit algorithm will not only ensure the wireless device to comply with RF exposure requirement, but also will improve the user experience and network performance.

For a given wireless device, once the SAR of the wireless device is characterized at a transmit power level via SAR measurement, SAR at a different power level for the characterized configuration(s) can be scaled by the change in the corresponding power level. Therefore, for a characterized device, SAR compliance can be achieved through transmit power control and management.

The basic concept of the Smart Transmit algorithm by Qualcomm is that if time-averaged transmit power approaches the P_{limit} , then the modem needs to limit instantaneous transmit power to make sure that the time-averaged transmit power does not exceed the P_{limit} in any SAR_time_window (i.e., the time-averaged SAR complies with the CE SAR limit in any SAR_time_window). The wireless device can instantaneously transmit at high transmit powers and exceed the P_{limit} for a short duration before limiting the power to maintain the time-averaged transmit power under the P_{limit} .

The Smart Transmit algorithm can be configured to manage the instantaneous transmit power (Tx power) to keep the time-averaged power to not exceed P_{limit} . To avoid dropping the radio link, Smart Transmit algorithm starts the power limiting enforcement earlier in time to back off the Tx power to a reserve level (denoted as Preserve) so that wireless device can maintain the radio link at a minimum reserve power level for as long as needed and at the same time ensure that the time-averaged Tx power over any SAR_time_window is less than P_{limit} at all times (see Figure 1-1(b)). At all times, Smart Transmit meets the below equation:



$$time\ avg.\ Tx\ power = \frac{1}{T} \int_t^{t+T} inst.\ Tx\ power(t) dt \leq P_{limit}$$

Figure 1-1 Smart Transmit Operation: (a) Transmit at high power when needed and permitted; (b) Transmit with reserve power to support continuous transmission at a minimum power level (Preserve)



where, *time avg. Tx power* is the power averaged between t and $t+T$ time period; T is *SAR_time_window*; *inst. Tx power (t)* is the instantaneous transmit power at t time instant; P_{limit} is the predefined time averaged power limit.

19. Proximity Sensor Considerations

19.1. Proximity Sensor Triggering Distances

➤ P-sensor Triggering Distance Testing

The EUT should be moved further away from and toward the flat phantom that fill with the tissue simulating liquid to determine the proximity sensor triggering distances. Conducted power is monitored qualitatively to identify the general triggering characteristics and recorded quantitatively, versus spacing, as required by the procedures.

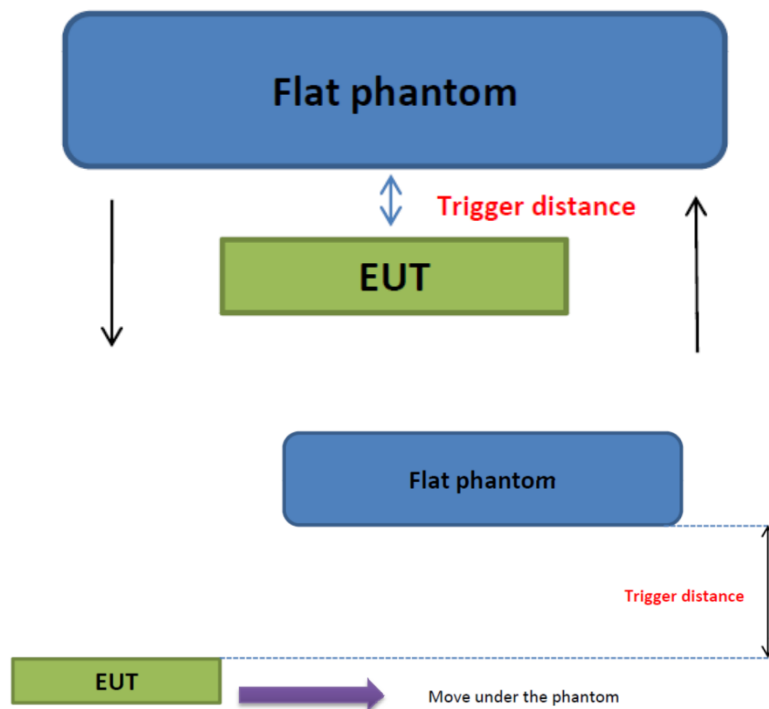


Fig.19.1 Illustration for proximity sensor trigger

➤ P-sensor Triggering Distance

Proximity Sensor Triggering Distance (mm)						
Exposure Position	Front Side	Back Side	Left Side	Right Side	Top Side	Bottom Side
Minimum	10	15	15	15	15	15



19.2. Proximity Sensor Coverage

Proximity sensors are not normally designed to cover the entire back surface or edges of a mobile phone. The sensing regions are usually limited to areas near the sensor element. If a sensor is spatially offset from the antenna(s), it is necessary to verify sensor triggering for conditions where the antenna is next to the user but the sensor is laterally further away to ensure sensor coverage is sufficient for reducing the power to maintain compliance. For P-sensor coverage testing, the device is moved and “along the direction of maximum antenna and sensor offset”. Illustrating in the internal photo exhibit, although the sensor spatially offset, there is no trigger condition where the antenna is next to the user, the sensor is laterally further away, therefore proximity sensor coverage testing is not required. This procedure is not required since the antenna, sensor and peak SAR location is overlapped with the sensor.

20. Test Results List

20.1. Test Guidance

1. Per KDB 447498 D01v06, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
 - a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
 - b. For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1 / (duty cycle)".
 - c. For WWAN: Reported SAR (W/kg) = Measured SAR (W/kg) * Tune-up Scaling Factor.
 - d. For WLAN/Bluetooth: Reported SAR (W/kg) = Measured SAR (W/kg) * Duty Cycle scaling factor * Tune-up scaling factor.
2. Per KDB 447498 D01v06, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the *reported* 1-g or 10-g SAR for the mid-band or highest output power channel is:
 - a. ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
 - b. ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
 - c. ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥ 0.8 W/kg.
4. Per KDB 648474 D04v01r03, when the reported SAR for a body-worn accessory measured without a headset connected to the handset is ≤ 1.2 W/kg, SAR testing with a headset connected to the handset is not required.
5. Per KDB 648474 D04v01r03, for smart phones with a display diagonal dimension > 15.0 cm or an overall diagonal dimension > 16.0 cm, when hotspot mode applies, 10-g extremity SAR is required only for the surfaces and edges with hotspot mode 1-g reported SAR > 1.2 W/kg, however, when power reduction applies to hotspot mode the measured SAR must be scaled to the maximum output power, including tolerance, allowed for tablet modes to compare with the 1.2 W/kg SAR test reduction threshold.
6. Per KDB 248227 D01v02r02, a Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement. The test frequencies established using test mode must correspond to the actual channel frequencies required for operations in the U.S. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. In addition, a periodic

transmission duty factor is required for current generation SAR systems to measure SAR correctly. Unless it is permitted by specific KDB procedures or continuous transmission is specifically restricted by the device, the reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit. When a device is not capable of sustaining continuous transmission or the output can become nonlinear, and it is limited by hardware design and unable to transmit at higher than 85% duty factor, a periodic duty factor within 15% of the maximum duty factor the device is capable of transmitting should be used. The reported SAR must be scaled to the maximum transmission duty factor to determine compliance. Descriptions of the procedures applied to establish the specific duty factor used for SAR testing are required in SAR reports to support the test results.

7. For CA UL SAR measurement, the worst condition of standalone transmission would be tested.
8. The LTE Band 2/66 in antenna 7 is TX only when ENDC is in use and do not support independent transmission.
9. The LTE Band 48 in antenna 10 is TX only when ENDC is in use and do not support independent transmission.
10. 5G NR is TX only in the ENDC state and does not support independent transmission.
11. The 5G NR (NSA) SAR measurement procedure should be followed the TCB workshop publication in October 2020:
 - a. If the signal uplink 1-g SAR values for each band are both less than 0.8 W/kg and the algebraic summation of the 1-g SAR values are less than 1.45 W/kg no additional measurements need to be performed.
 - b. If one or the signal uplink 1-g SAR values is greater than 0.8 W/kg, instead of algebraically summing the 1-g SAR values, sum up the SAR distributions, similar to the enlarged zoom scan (volume scan) procedures found in FCC KDB Publication 865664 D01. And PAG is required for this case.
 - c. If the algebraic sum of the 1-g SAR values is > 1.45 W/kg additional measurements may have to be made. Submit a KDB inquiry for additional guidance and PAG is required for this case.
 - d. When the algebraic sum of the 1-g SAR values is > 1.6 W/kg, SPLSR analysis procedure should be applied.
12. The maximum power of NFC is less than 1mW per the manual information, therefore it is not required for RF exposure.
13. The mechanism conditions of SAR head and body to achieve full power and reduced power conversion are as follows:

DSI	Body/Head	Power	Condition
0	/	full Power	SAR sensor OFF, WLAN OFF;
1	Body	single band	receiver OFF, SAR sensor ON, WLAN OFF;
2	Body	WLAN simultaneously	receiver OFF, SAR sensor ON,



			WLAN ON;
3	body/head	BT simultaneously	BT ON, WWAN ON;
4	Head	single band	receiver ON, WLAN OFF;
5	Head	WLAN simultaneously	receiver ON, WLAN ON;

SET	Body/Head	Power	Condition
0	/	full Power	SAR sensor CS2 OFF, WWAN OFF;
1	Body	single band	receiver OFF, SAR sensor ON; WWAN OFF;
2	Body	WWAN simultaneously	receiver OFF, SAR sensor ON, WWAN ON;
3	Head	single band	receiver ON, WWAN OFF;
4	Head	WWAN simultaneously	receiver ON, WWAN ON;

14. The Power level condition applied should be follow:

Transmission Condition	Wireless System	Antenna	Head	Body
Standalone	GSM850	ANT 1	Full Power	Full Power
	GSM1900	ANT 3	Full Power	Full Power
	WCDMA II	ANT 3	Full Power	Full Power
	WCDMA IV	ANT 3	Full Power	Full Power
	WCDMA V	ANT 1	Full Power	Full Power
	LTE Band 2	ANT 3	Full Power	Full Power
	LTE Band 5	ANT 1	Full Power	Full Power
	LTE Band 7	ANT 3	Full Power	Reduced Power Level 2
	LTE Band 12	ANT 1	Full Power	Full Power
	LTE Band 13	ANT 1	Full Power	Full Power
	LTE Band 48	ANT 4	Reduced Power Level 1	Full Power
	LTE Band 66	ANT 3	Full Power	Full Power
	2.4GHz WLAN	ANT 8	Full Power	Full Power
		ANT 9	Full Power	Full Power
	5GHz WLAN	ANT 8	Full Power	Full Power
		ANT 9	Full Power	Full Power
	Bluetooth	ANT 8	Full Power	Full Power



Transmission Condition	Wireless System	Antenna	Head	Body
CA & ENDC & Simultaneous	GSM850	ANT 1	Full Power	Reduced Power Level 4
	GSM1900	ANT 3	Full Power	Full Power
	WCDMA II	ANT 3	Full Power	Full Power
	WCDMA IV	ANT 3	Full Power	Full Power
	WCDMA V	ANT 1	Full Power	Reduced Power Level 4
	LTE Band 2	ANT 3	Full Power	Full Power
		ANT 7	Reduced Power Level 3	Reduced Power Level 4
	LTE Band 5	ANT 1	Full Power	Reduced Power Level 4
	LTE Band 7	ANT 3	Full Power	Reduced Power Level 2
	LTE Band 12	ANT 1	Full Power	Full Power
	LTE Band 13	ANT 1	Full Power	Full Power
	LTE Band 48	ANT 4	Reduced Power Level 1	Reduced Power Level 4
		ANT 10	Reduced Power Level 3	Reduced Power Level 4
	LTE Band 66	ANT 3	Full Power	Full Power
		ANT 7	Reduced Power Level 3	Reduced Power Level 4
	n2 (NSA)	ANT 3	Reduced Power Level 3	Reduced Power Level 4
	n5 (NSA)	ANT 1	Reduced Power Level 3	Reduced Power Level 4
	n66 (NSA)	ANT 3	Reduced Power Level 3	Reduced Power Level 4
	n77 (NSA)	ANT 10	Reduced Power Level 3	Reduced Power Level 4
	2.4GHz WLAN	ANT 8	Reduced Power Level 3	Full Power
		ANT 9	Reduced Power Level 3	Full Power
	5GHz WLAN	ANT 8	Reduced Power Level 3	Reduced Power Level 4
		ANT 9	Reduced Power Level 3	Reduced Power Level 4
	Bluetooth	ANT 8	Full Power	Full Power



20.2. Validation Data

Plot No.	Band/Mode	Test Position	CH.	Ave. Power (dBm)	Tune-up Limit (dBm)	Tune-up Scaling Factor	Meas. SAR _{1g} (W/kg)	Reported SAR _{1g} (W/kg)
Full Power (ANT 1)								
OR.	GSM850/4 TX slots	Back Side	189	26.05	27.00	1.245	0.890	1.108
1#	GSM850/4 TX slots	Back Side (256+8GB)	189	26.05	27.00	1.245	0.718	0.894
	GSM850/4 TX slots	Back Side (128+6GB)	189	26.05	27.00	1.245	0.667	0.830
Reduced Power Level 4 for ENDC (ANT 7)								
OR.	LTE Band 2/1RB#0 20M	Back Side	18900	18.89	19.80	1.233	0.558	0.688
2#	LTE Band 2/1RB#0 20M	Back Side (256+8GB)	18900	18.89	19.80	1.233	0.704	0.868
	LTE Band 2/1RB#0 20M	Back Side (128+6GB)	18900	18.89	19.80	1.233	0.638	0.787
Full Power (ANT 8)								
OR.	WLAN 5.2GHz/802.11a	Back Side	44	17.53	18.50	1.250	0.935	1.187
	WLAN 5.2GHz/802.11a	Back Side (256+8GB)	44	17.53	18.50	1.250	0.885	1.123
3#	WLAN 5.2GHz/802.11a	Back Side (128+6GB)	44	17.53	18.50	1.250	1.090	1.383

Note: The 5.2G WLAN reported 1g SAR (W/kg) should be scaled with the duty cycle scaling factor 1.015.



21. Simultaneous Transmission Evaluation

21.1. Simultaneous Transmission Consideration

No.	Simultaneous Transmission Consideration	Head	Body-Worn	Hotspot
1	WWAN+WLAN 2.4GHz SISO/MIMO	Yes	Yes	Yes
2	WWAN+WLAN 5.2GHz/5.8GHz SISO/MIMO	Yes	Yes	Yes
3	WWAN+WLAN 5.3GHz/5.5GHz SISO/MIMO	Yes	Yes	No
4	WWAN+Bluetooth	Yes	Yes	Yes

Note:

1. When the user enables the personal wireless router functions for the handset, actual operations include simultaneous transmission of the WWAN and WLAN transmitters. The "Portable Hotspot" feature on the handset was NOT activated, to ensure the SAR measurements were evaluated for a single transmission frequency RF signal.
2. The hotspot SAR result may overlap with the body-worn accessory SAR requirements, per KDB 941225 D06, the more conservative configurations can be considered, thus excluding some unnecessary body-worn accessory SAR tests.
3. Simultaneous Transmission SAR evaluation is not required for BT and WLAN 2.4GHz, because the software mechanism have been incorporated to guarantee that the WLAN 2.4GHz and Bluetooth transmitters would not simultaneously operate.
4. Per KDB 447498D01v06, simultaneous transmission SAR evaluation procedures is as followed:
Step 1: If sum of 1 g SAR < 1.6 W/kg, Simultaneous SAR measurement is not required.
Step 2: If sum of 1 g SAR > 1.6 W/kg, ratio of SAR to peak separation distance for pair of transmitters calculated.
Step 3: If the ratio of SAR to peak separation distance is ≤ 0.04 , Simultaneous SAR measurement is not required.
Step 4: If the ratio of SAR to peak separation distance is > 0.04 , Simultaneous SAR measurement is required and simultaneous transmission SAR value is calculated.
(The ratio is determined by: $(SAR_1 + SAR_2) ^{1.5} / R_i \leq 0.04$,
 R_i is the separation distance between the peak SAR locations for the antenna pair in mm.
5. The co-location of WWAN+WLAN 2.4GHz/5GHz SISO would not be recorded since it is less than the combination of WWAN+WLAN 2.4GHz/5GHz MIMO.



21.2. Simultaneous Transmission Analysis

The EUT supports simultaneous transmission of multiple radios. RF exposure compliance in simultaneous transmission scenarios is evaluated in this section.

It must be noted here that Qualcomm Smart Transmit time-averaging algorithm was applied to only WWAN, where the time-averaged power level is controlled so that RF exposure is $\leq$ SAR_design_target for sub-6 WWAN. Since there is total design-related uncertainty arising from TxAGC and device-to-device variation, the worst-case RF exposure should be determined by accounting for this uncertainty in the corresponding design target, thus, with 1dB of device uncertainty for sub-6 WWAN. Therefore, the worst-case RF exposure for this EUT is:

Worst-case Time-averaged RF Exposure for WWAN

Title	WWAN Wireless System
	Sub-6G
Maximum time-averaged power level	P_{limit}
Maximum time-averaged exposure	SAR_design_target=0.8W/kg (1g SAR)
Maximum Design-related uncertainty	1.0 dB
Worst-case time-averaged RF exposure	Reported SAR =1.0W/kg (1g)

Note:

The highest SAR value obtained from UL FCC SAR Test Report. For scenarios where $(P_{\text{limit}} + 1.0\text{dB uncertainty}) \geq P_{\text{max}}$ (maximum RF tune-up output power), time-averaged SAR exposure from Smart Transmit enabled EUT (at P_{limit}) cannot exceed reported SAR corresponding to P_{max} .

RF exposure compliance with WWAN+WLAN simultaneous transmission scenarios is demonstrated for various radio configurations using below equation:

$$\text{Total norm. RF exposure} = \text{norm. RF exposure from Smart Transmit enabled WWAN (norm. SAR from 4G} + \text{norm. SAR from 5G sub-6G)} + \text{norm. SAR from WLAN} \leq 1.0 \text{ normalized limit (1)}$$

Smart Transmit algorithm in WWAN adds directly the time-averaged RF exposure from 4G and time-averaged RF exposure from 5G sub-6G, i.e.,

$$\text{norm. RF exposure from Smart Transmit enabled WWAN: (normalized SAR exposure from 4G)} + \text{(normalized PD exposure from 5G sub-6G)} \leq 1.0 \text{ normalized limit (2)}$$



In other words, Smart Transmit algorithm controls the total RF exposure from both 4G radio and 5G sub-6G NR to not exceed CE limit. Smart transmit algorithm assumes hotspots are collocated (i.e., ignoring spatial distribution of hotspots) and directly adds normalized RF exposures from 4G and from 5G sub-6G, i.e.,

If $A = \text{max normalized time-averaged SAR exposure from 4G}$,
 $B = \text{max normalized time-averaged SAR exposure from 5G sub-6G}$,

Then, equation (2) can be re-written as below because Smart Transmit assumes 4G hotspots are collocated with 5G sub-6G hotspot:

Smart Transmit enabled WWAN: $x(t) * A + (1-x(t)) * B \leq 1.0$ normalized limit (3)

Here, " $x(t)*A$ " represents percentage of normalized time-averaged RF exposure from 4G, and $x(t)$ ranges between $[0,1]$; " $(1-x(t))*B$ " is remaining percentage of RF exposure contribution from 5G sub-6G. Smart Transmit controls 'x' in real time such that the sum of these exposures never exceeds 1.0 normalized limit.

Note that mathematically:

$$(t) * A + (1-(t))*B \leq \max(A,B) \leq 1.0 \text{ normalized limit for } x(t) \in [0,1] \quad (4)$$

Therefore, if below equations (5a) and (5b) are proven:

$$A + \text{norm.SAR from WLAN} \leq 1.0 \text{ norm.limit (5a)},$$

$$B + \text{norm.SAR from WLAN} \leq 1.0 \text{ norm.limit (5b)},$$

Then, based on equation (4), below condition is also proved:

$$[(t) * A + (1-(t))*B] + \text{norm.SAR from WLAN} \leq 1.0 \text{ norm.limit (5c)}$$

Which is the same as equation (1), to demonstrate compliance for simultaneous transmission.

Additionally, it should be noted that in the absence of 5G sub-6G, Smart Transmit limits the maximum RF exposure contributed from 4G to 100% normalized exposure (i.e., $x=1.0$ in equation 3). Therefore:

Smart Transmit enabled WWAN: $A = \text{max (normalized SAR exposure from 4G)} \leq 1.0$ normalized limit (6a)

Smart Transmit enabled WWAN: $B = \text{max (normalized SAR exposure from 5G sub-6G)} \leq 1.0$ normalized limit (6b)



The compliance for simultaneous transmission scenarios of WWAN (4G/5G sub-6G) radio enabled with Smart Transmit and WLAN without Smart Transmit is re-evaluated for all transmission scenarios supported by this EUT.

As described in equation (7), simultaneous transmission analysis for WWAN + WLAN is performed in two parts:

4G WWAN + WLAN (i.e., Eq. (7a) with compliance demonstration in the main report

5G sub-6G WWAN + WLAN (i.e., Eq. (7b) with compliance demonstration in the main report

By combining above a. and b., the CE requirement expressed in Eq. (1), re-written below, is met:

Step 1: Total Exposure Ratio (TER) = LTE + WLAN + BT < 1

Step 2: Total Exposure Ratio (TER) = 5G NR + WLAN + BT < 1

21.3. Simultaneous Transmission Exposure Evaluation

Note: This report documents only the validation data, and only evaluates the simultaneous transmission results where the verified data is greater than the original data. The remaining simultaneous transmission data still refer to the original report.

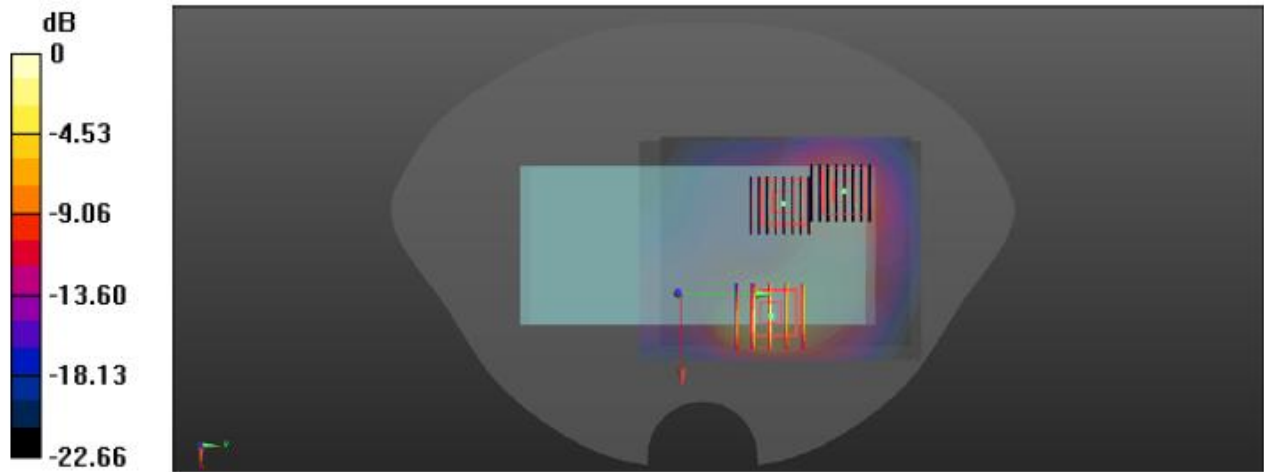
21.4. SPLSR Assessment and Analysis

➤ General Guidance

1. Per KDB 447498, When standalone SAR is measured, the peak location is determined by the x, y, z coordinates of the extrapolated and interpolated results reported by the zoom scan measurement, or area scan measurement when area scan based 1-g SAR estimation is applicable.
2. When standalone SAR is measured for both antennas in the pair, the peak location separation distance is computed by the square root of $[(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2]$, where (x_1, y_1, z_1) and (x_2, y_2, z_2) are the coordinates in the area scans or extrapolated peak SAR locations in the zoom scans, as appropriate.
3. The ratio is determined by $(SAR_1 + SAR_2)^{1.5}/R_i$, rounded to two decimal digits, and must be ≤ 0.04 for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion.
4. In this report, the minimum distance between the spatially separated antenna and the closest antenna of the co-located antenna pair to be conservative value for the calculation of SPLSR per TCB WS publication in Apr. 2022.

➤ SPLSR Analysis Results

Band	Position	SAR (W/kg)	Gap	SAR peak location (cm)			3D distance (mm)	Summed SAR (W/kg)	SPLSR Results	Simultaneous SAR
			(cm)	X	Y	Z				
LTE Band 2	Back Side	0.952	10	0.0075	0.022	-0.207	248.1	1.86	0.01	Not required
5G WIFI		0.486	10	-0.046	0.04	-0.207				
5G WIFI		0.419	10	-0.052	0.069	-0.207				



22. Uncertainty Assessment

According to KDB 865664 D01 SAR measurement 100 MHz to 6GHz, when the highest measured 1-g SAR is less than 1.5 W/kg and 10-g extremity SAR less than 3.75 W/kg, the expanded SAR measurement uncertainty must be less than 30% with a confidence interval of k=2. When these conditions are met, extensive SAR measurement uncertainty analysis described in IEEE 1528-2013 is not required in the SAR report and submitted for equipment approval. For this device, both the 1-g SAR is less than 1.5 W/kg. Therefore the measurement uncertainty table is not required in this report.



Annex A General Information

1. Identification of the Responsible Testing Laboratory

Laboratory Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Laboratory Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, Guangdong Province, P. R. China
Telephone:	+86 755 36698555
Facsimile:	+86 755 36698525

2. Identification of the Responsible Testing Location

Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Address:	FL.3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, Guangdong Province, P. R. China

3. Facilities and Accreditations

The FCC designation number is CN1192, the test firm registration number is 226174.

Note:

The main report is end here and the other annex (B,C,D,E,F) will be submitted separately.

***** END OF MAIN REPORT *****