SAR Compliance Test Report

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Statement of Compliance: BlackBerry RTS declares under its sole responsibility that the product to which this declaration relates, is in conformity with the appropriate RF exposure standards, recommendations and guidelines. It also declares that the product was tested in accordance with the appropriate measurement standards, guidelines and recommended practices.

Device Category: This BlackBerry® Smartphone is a portable device, designed to be used in direct contact with the user's head, hand and to be carried in approved accessories when carried on the user's body.

RF Exposure Environment: This device has been shown to be in compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in, FCC 47 CFR Part 2.1093, FCC 96-326, IEEE Std. C95.1-1992, Health Canada's Safety Code 6, as reproduced in RSS-102 issue 5-2015 and has been tested in accordance with the measurement procedures specified in latest FCC OET KDB Procedures, ANSI/IEEE Std. C95.3-2002, IEEE 1528-2013, and RSS 102-issue5-2015.

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RTS is accredited
according to
EN ISO/IEC 17025 by:

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Note 1: According to the hardware similarity document, BlackBerry model: RHT181LW and RHK211LW have identical Wi-Fi antennas, antenna match, conducted power, PCB and circuitry for the 2400 MHz – 2500 MHz and 5000 – 6000 MHz frequency bands. Therefore, model: RHK211LW was used for testing conducted power and SAR compliance on Bluetooth, and 802.11a/b/g/n/ac. The test results for these bands were reused for model RHT181LW.

Note 2: According to the hardware similarity document, BlackBerry model: RHT181LW and RHK211LW have the identical conducted power for GSM 850, WCDMA FDD V, and LTE band 5. Therefore, model: RHK211LW was used for testing conducted power on these bands and the results reused for model RHT181LW.

Note 3: According to the hardware similarity document, BlackBerry model: RHT181LW and RHM181LW have identical mid/high band antennas, antenna match, conducted power, PCB and circuitry for the 1700 MHz – 2300 MHz and 2500 MHz – 2600 MHz frequency bands. Therefore, model: RHM181LW was used for testing conducted power and SAR compliance on GSM 1900, UMTS bands II/IV, and LTE bands 2/4/7. The test results for these bands were reused for model RHT181LW.

Note 4: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. Information regarding the SAR test results and procedures for model: RHM181LW were taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

Note 5: All other modes/bands were tested using model: RHT181LW.

Revision History		
Rev. Number	**Date**	**Changes**
Initial	November 12, 2015	Initial
Rev 2	December 22, 2015	Added explanation regarding the body-worn, hotspot test conditions/configurations and single point SAR screening on page 6 and 8, Note: 5 and 6.

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1.0 OPERATING CONFIGURATIONS AND TEST CONDITIONS

1.1 Picture of Device

Please refer to Appendix E.

Figure 1.1-1 BlackBerry Smartphone

1.2 Antenna description

Type	Internal fixed antenna
Location	Please refer to Figure 1.9-1
Configuration	Internal fixed antenna

Table 1.2-1 Antenna description

1.3 Device description

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Device Model		RHT181LW (STV100-2)
FCC ID		L6ARHT180LW
Serial Number	**Radiated**	1161791688, 1161791942
	Conducted	1161792315
Hardware Rev		CER-62544-001- Rev1-x08-00/01
Software Build Number		AAC684, AAC698
Prototype or Production Unit		Production

Mode(s) of Operation	1-slot GSM 850 GSM 1900	2-slots EDGE/GPRS 850/1900	3-slots EDGE/GPRS 850/1900	4-slots EDGE/GPRS 850/1900
Target nominal maximum conducted RF output power (dBm)	32.5 29.5	30.5 28.5	29.0 26.0	27.5 25.5
Tolerance in power setting on centre channel (dB)	+2.0/-1.5	+2.0/-1.5	+2.0/-1.5	+2.0/-1.5
Duty cycle	1:8	2:8	3:8	4:8
Transmitting frequency range (MHz)	824.2 – 848.8 1850.2 – 1909.8	824.2 – 848.8 1850.2 – 1909.8	824.2 – 848.8 1850.2 – 1909.8	824.2 – 848.8 1850.2 – 1909.8
Mode(s) of Operation	802.11b	802.11g	802.11n	Bluetooth
Target nominal maximum conducted RF output power (dBm)	17.0	16.0	16.0	8.0
Tolerance in power setting on centre channel (dB)	±1.5	±1.5	±1.5	±1.0
Duty cycle	1:1	1:1	1:1	N/A
Transmitting frequency range (MHz)	2412-2462	2412-2462	2412-2462	2402-2483
Mode(s) of Operation	802.11 a/n/ac (U-NII-1)	802.11 a/n/ac (U-NII-2A)	802.11 a/n/ac (U-NII-2C)	802.11 a/n/ac (U-NII-3)
Target nominal maximum conducted RF output power (dBm)	15.5	15.5	15.5	15.5
Tolerance in power setting on centre channel (dB)	±1.5	±1.5	±1.5	±1.5
Duty cycle	1:1	1:1	1:1	1:1
Transmitting frequency range (MHz)	5180-5240	5260-5320	5520-5700	5745-5825
Mode(s) of Operation	HSPA^{+}/ WCDMA / UMTS FDD V (850)	HSPA^{+}/ WCDMA / UMTS FDD IV (1800)	HSPA^{+}/ WCDMA / UMTS FDD II (1900)	NFC
Target nominal maximum conducted RF	24.0	24.0	24.0	-----

output power (dBm)				
Tolerance in power setting on centre channel (dB)	±1.0	±1.0	±1.0	N/A
Duty cycle	1:1	1:1	1:1	N/A
Transmitting frequency range (MHz)	826.4 – 846.6	1712.4 – 1752.6	1852.4 – 1907.6	13.56
Mode(s) of Operation	CDMA2000/ 1xEvDO BC0 850	CDMA2000/ 1xEvDO BC1 1900		
Target nominal maximum conducted RF output power (dBm)	24.0	24.0		
Tolerance in power setting on centre channel (dB)	±1.0	±1.0		
Duty cycle	1:1	1:1		
Transmitting frequency range (MHz)	824.7 – 848.31	1851.25 – 1908.75		

Table 1.3-1 Test device characterization for U.S. wireless operating modes/bands

Note 1: SAR measurements on NFC haven't been conducted, since it is very low power and frequency magnetic field transceiver. SAR probes measure higher frequency/power electric field.

Note 2: Dynamic Antenna Tuning Technology has been implemented for LTE bands 5/13, WCDMA FDD band 5, GSM 850, and CDMA 850 BC0. Please refer to the associated separate report "Single Point SAR Screening for Antenna Tuning States" for the results of the additional testing done to address this functionality. All other frequency bands use fixed match/ open loop antenna tuning which is equivalent to the static tuning configurations used in traditional handsets that do not have any specific antenna tuning flexibility or additional hardware.

Note 3: Closed Loop Control is active for the applicable full SAR measurement configurations, which represent the highest SAR configuration as demonstrated by the single point SAR screening results.

Note 4: The BlackBerry model: RHT181LW also supports GSM/GPRS/EDGE 900/1800 MHz, and UMTS/HSPA$^+$ Bands I/VIII, and LTE bands 3/20 that are operational outside North America only, therefore no data is presented in this report for those bands.

Note 5: All body-worn SAR data tables were tested on each wireless mode that do not support hotspot mode at the maximum transmitting power. Please refer to Report Part 2 of 2, section 11.2, Page 36-96 for the test data.

Single point SAR screening scans were measured for body-worn configuration with 15 mm distance with the device front and back facing the flat phantom. Front/Back results in worst case SAR. This was agreed and approved by the FCC during our lab KDB inquiry.

Please refer to the associated separate report "Single Point SAR Screening for Antenna Tuning States" for the results of the additional testing done to address this functionality.

Note 6: Full/complete hotspot SAR measurements were conducted on the low bands on all 5 applicable sides of the device with 10 mm separation distance from the flat phantom. Please refer to Report Part 2 of 2, section 11.2, Page 36-96 for the test data.

Single point hotspot screening tests were performed on all 5 sides (front, back, left, right, bottom) for the low bands on this model.

Please refer to the associated separate report "Single Point SAR Screening for Antenna Tuning States" for the results of the additional testing done to address this functionality.

Device Model		RHT181LW (STV100-2)
FCC ID		L6ARHT180LW
Serial Number	**Radiated**	1161791688, 1161791942
	Conducted	1161792315
Hardware Rev		CER-62544-001- Rev1-x08-00/01
Software Build Number		AAC684, AAC698
Prototype or Production Unit		Production
Transmission channel bandwidth		Band 2: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz Band 4: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz, 15 MHz, 20 MHz Band 5: 1.4 MHz, 3 MHz, 5 MHz, 10 MHz Band 7: 5 MHz, 10 MHz, 15 MHz, 20 MHz Band 13: 5 MHz, 10 MHz

Transmission channel number and frequencies at highest bandwidth

	LTE band 2		LTE band 4		LTE band 5	
	f (MHz)	**Chan.**	**f (MHz)**	**Chan.**	**f (MHz)**	**Chan.**
L	1860.0	18700	1720.0	20050	829.0	20450
M	1880.0	18900	1732.5	20175	836.5	20525
H	1900.0	19100	1745.0	20300	844.0	20600

	LTE band 7		LTE band 13	
	f (MHz)	**Chan.**	**f (MHz)**	**Chan.**
L	2510.0	20850		
M	2535.0	21100	782.0	23230
H	2560.0	21350		

UE Category	Category 3		
Modulation supported in uplink	QPSK, 16QAM		
Description of LTE antenna	1 Tx/Rx Ant sharing with GSM/UMTS/CDMA, and 1 Rx ant		
LTE voice available/supported	Yes		
Hotspot with LTE+Wi-Fi	Yes		
Hotspot with LTE+Wi-Fi active with GSM/UMTS voice	No		
LTE MPR permanently built-in by design	Yes		
LTE A-MPR	Disabled during testing , by setting NV value to NV_01 on the CMW500		
Target nominal maximum conducted RF Output Power (dBm) +/- Tolerance in Power Setting on centre channel (dB)	Band 2: 23.0 ± 1.0 Band 4: 23.0 ± 1.0 Band 5: 23.0 ± 1.0	Band 7: 23.0 ± 1.0 Band 13: 23.0 ± 1.0	
Other non-LTE U.S. wireless operating modes/bands	GSM//WCDMA/HSPA$^+$/ CDMA/EvDO	GSM 850 MHz GSM 1900 MHz CDMA 850 MHz CDMA 1900 MHz	UMTS 850 MHz UMTS 1800 MHz UMTS 1900 MHz
	802.11 a/b/g/n/ac	2.45 GHz Wi-Fi 2.45 GHz BT 5.0 GHz Wi-Fi	

Table 1.3-2 Test device characterization for all North American wireless operating modes/bands

Note 1: As per 3GPP TS 36.521-1 V10.0.0 (2011-12):

"The channel numbers that designate carrier frequencies so close to the operating band edges that the carrier extends beyond the operating band edge shall not be used. This implies that the first 7, 15, 25, 50, 75 and 100 channel numbers at the lower operating band edge and the last 6, 14, 24, 49, 74 and 99 channel numbers at the upper operating band edge shall not be used for channel bandwidths of 1.4, 3, 5, 10, 15 and 20 MHz respectively."…5.4.4

Note 2: Dynamic Antenna Tuning Technology has been implemented for LTE bands 5/13, WCDMA FDD band 5, GSM 850, and CDMA 850 BC0. Please refer to the associated separate report "Single Point SAR Screening for Antenna Tuning States" for the results of the additional testing done to address this functionality. All other frequency bands use fixed match/ open loop antenna tuning which is equivalent to the static tuning configurations used in traditional handsets that do not have any specific antenna tuning flexibility or additional hardware.

Note 3: Closed Loop Control is active for the applicable full SAR measurement configurations, which represent the highest SAR configuration as demonstrated by the single point SAR screening results.

Note 4: LTE band 7 is not operational in the United States; however it is operational in Canada and remains in this report for filing to Industry Canada.

Note 5: All body-worn SAR data tables were tested on each wireless mode that do not support hotspot mode at the maximum transmitting power. Please refer to Report Part 2 of 2, section 11.2, Page 36-96 for the test data.

Single point SAR screening scans were measured for body-worn configuration with 15 mm distance with the device front and back facing the flat phantom. Front/Back results in worst case SAR. This was agreed and approved by the FCC during our lab KDB inquiry.

Please refer to the associated separate report "Single Point SAR Screening for Antenna Tuning States" for the results of the additional testing done to address this functionality.

Note 6: Full/complete hotspot SAR measurements were conducted on the low bands on all 5 applicable sides of the device with 10 mm separation distance from the flat phantom. Please refer to Report Part 2 of 2, section 11.2, Page 36-96 for the test data.

Single point hotspot screening tests were performed on all 5 sides (front, back, left, right, bottom) for the low bands on this model.

Please refer to the associated separate report "Single Point SAR Screening for Antenna Tuning States" for the results of the additional testing done to address this functionality.

Device Model		RHK211LW (STV100-1)
FCC ID		L6ARHK210LW
IC ID		2503A-RHK210LW
Serial Number	**Radiated**	Rev3-x06-01/02: 1161463503, 1161462755 Rev4-x06-01: 1161504665, 1161507560
	Conducted	Rev2-x06-00/01/02: 1161340110
Hardware Rev		CER-62541-001- Rev2-x06-00/01/02, Rev3-x06-01/02, Rev4-x06-01
Software Build Number		AAC056, AAC251, AAC273
Prototype or Production Unit		Production

Table 1.3-3 Test device characterization for GSM 850, UMTS band V, and LTE band 5 conducted power as well as Bluetooth and 802.11a/b/g/n/ac SAR testing on model RHK211LW

Note: Model RHK211LW was used to test conducted power on GSM 850, UMTS band V, LTE band 5, Bluetooth, and 802.11a/b/g/n/ac. Also, model RHK211LW was used to test SAR compliance on Bluetooth, and 802.11a/b/g/n/ac.

Test Item	
Kind of test item:	Blackberry Smartphone
Device type:	portable device
Model name:	**RHM181LW (STV100-4)**
S/N serial number:	1161466041 / 1161466952 / 1161466951 / 1161467034 / 1161509684 / 1161509633
FCC-ID:	L6ARHM180LW
IMEI-Number:	004402243072927 / 004402243072810 / 004402243072919 / 004402243072901 / 00440224308011010 / 004402243080037
Hardware status:	CER-62543-001 Rev 2-x06-01
Software status:	AAC273
Frequency:	see technical details
Antenna:	integrated antenna
Battery option:	integrated battery
Accessories:	holster
Test sample status:	identical prototype
Exposure category:	general population / uncontrolled environment

Table 1.3-4 Test device characterization for GSM 1900, UMTS bands II/IV, and LTE bands 2/4/7 on model RHM181LW

Note 1: Model RHM181LW was used to test conducted power and SAR compliance on GSM 1900, UMTS bands II/IV, and LTE bands 2/4/7.

Note 2: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

1.3.1 Highest reported 1 g avg. SAR values (W/Kg)

Configuration / Equipment Class	PCE	DSS	DTS	NII
Head	1.154	0.015	0.240	0.169
Body-Worn 15mm	0.951	0.009	0.112	0.379
Hotspot 10mm	1.165	0.025	0.053	0.180
Worst case simultaneous transmission across all configurations	1.482			

Table 1.3.1-1 Highest reported 1 g avg. SAR values (W/Kg)

1.4 Body worn accessories (holsters)

The device has been tested with the holster listed below and/or a 15mm manufacturer recommended separation distance. The holster has been designed with the intended device orientation being with the LCD facing the belt clip only. Proper positioning is vital for protection of the LCD display, and to help maximize the battery life of the device. The device can also be placed in the holster with the backside facing the belt clip. Body SAR measurements were carried out with the worst-case configuration front LCD side and backside towards the belt clip.

Number	Holster Type	Part Number	Separation distance (mm)
1	Body-worn Holster	HDW-61539-001	20

Table 1.4-1 Body worn holster

1.5 Headset

The device was tested with and without the following headset model numbers.

1)HDW-49299-00x
2)HDW-61938-00x

1.6 Battery

The device was tested with the following Lithium Ion Battery pack.

1)BAT-60122-003

1.7 Procedure used to establish test signal

- The device was put into test mode for SAR measurements by placing a call from a Rohde & Schwarz CMU 200 or CMW 500 Communications Test Instrument. The power control level was set to command the device to transmit at full power at the specified frequency. Other parameters include: Channel type = full rate, discontinuous transmission off, frequency hopping off. For LTE specific bandwidths, number of resource blocks, and resource block offsets were set. In addition, LTE A-MPR was disabled.
- Software Tool was used to set Wi-Fi to transmit at maximum power and duty cycle for each band, channel, and modulation.
- A Rohde & Schwarz CBT Bluetooth Tester was used to establish a connection with the DUT's Bluetooth radio.

1.8 Highlights of the KDB/FCC OET SAR Measurement Requirements

1.8.1 SAR Measurements 100 MHz to 6 GHz as per KDB 865664 D01 v01r03

- Repeat measurements when the measured SAR is ≥ 0.80 W/kg. If the measured SAR values are < 1.45 W/kg with ≤ 20% variation, only one repeated measurement was performed to reaffirm that the results are not expected to have substantial variations. An additional repeated measurement is required only if the measured results are within 10% of the SAR limit and vary by more than 20%, which are often related to device and measurement setup difficulties. Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.
- Maintained dielectric parameter uncertainty to ± 5.0% of the target values, (although it is very challenging to control/maintain both permittivity and conductivity for 5-6 GHz for all test channels within ± 5.0% of the target values, some conductivity values were measured slightly higher which resulted in more conservative SAR values.
- Liquid depth from SAM ERP or flat phantom was kept at 15 cm.
- Probe Requirement: Used SPEAG probe model ET3DV6/ES3DV3 for 2.45 GHz SAR testing specs are outlined below:

ET3DV6/ES3DV3	
Probe tip to sensor center	2.7 mm / 2.0 mm
Probe tip diameter is	6.8 mm / 4.0 mm
Probe calibration uncertainty	< 15 % for f = 2.45 GHz
Probe calibration range	± 100 MHz
EX3DV4	
Probe tip to sensor center	1.0 mm
Probe tip diameter is	2.5 mm
Probe calibration uncertainty	< 15 % for f = 2.45 to < 6.0 GHz
Probe calibration range	± 100 MHz

Table 1.8.1-1 Probe specification requirements

- Area scan resolution was maintained at 12mm (2-3 GHz), and 15mm (</= 2 GHz)
- System accuracy validation was conducted within ± 100 MHz of device mid-band frequency and results were within ± 10 % of the manufacturers target value for each band.
- Zoom scan: The following settings were used for the validation and measurement.

ET3DV6/ES3DV3	
Closest Measurement Point to Phantom	4.0 mm / 3.0 mm
Zoom Scan (x,y) Resolution	7.5 mm (≤2 GHz) or 5 mm (2-3 GHz)
Zoom Scan (z) Resolution	5.0 mm
Zoom Scan Volume	Minimum 30 x 30 x 30 mm[1]
EX3DV4	
Closest Measurement Point to Phantom	2.0 mm
Zoom Scan (x,y) Resolution	4.0 mm (5-6 GHz)
Zoom Scan (z) Resolution	2.0 mm (5-6 GHz)
Zoom Scan Volume	Minimum 24 x 24 x 22 mm[1]

Table 1.8.1-2 Zoom Scan requirement

Note: "Auto-extend zoom scan when maxima on boundary" is enabled, which can result in the zoom scan dimensions varying between 30x30x30 to 60x60x30 mm and 24x24x22 to 48x48x22 mm

1.8.2 802.11 a/b/g/n/ac SAR Measurement Procedures as per KDB 248227 D01 v02r01

Duty cycle

- Must scale *reported* SAR results up to 100% duty cycle.

Typical steps to consider for SAR testing

Note: for 802.11b DSSS testing just use step 2, 3, and 5

1. Identify the maximum output power specified at each antenna port of production units for the applicable OFDM configurations
    a. An initial test configuration is selected for each antenna port based on the highest declared output power and according to channel bandwidth, modulation and data rate combinations in each frequency band or aggregated band.
        i. See section "*Choosing an OFDM transmission mode and test channel*" for more info.
2. Apply the "*default power measurement procedures*" to measure maximum output power for each standalone and aggregated frequency band.
    a. When band gap channels between U-NII-2C band and U-NII-3 band or §15.247 5.8 GHz band are used, apply the following to determine high, middle and low channels for power measurement and SAR test reduction.
        i. channels in U-NII-2C band below 5.65 GHz are considered as one band
        ii. channels above 5.65 GHz, together with channels in U-NII-3 band or §15.247 5.8 GHz band, are considered as a separate band
    b. The maximum output power of band gap channels is limited to the lowest maximum output power certified for the adjacent bands.
    c. The measured maximum output power results are used to reduce the number of channels that need testing.
3. Apply *initial test configuration* procedures to each frequency band or aggregated band.
    a. For next to the ear, UMPC mini-tablet or hotspot mode exposure configurations with multiple test positions, the *initial test position* procedure is applied using the *initial test configuration* to reduce the number of test positions.
    b. Apply the *2.45 GHz and 5.0 GHz test reduction* as necessary
4. *Subsequent test configuration* procedures are applied to determine if the remaining OFDM transmission mode configurations may need testing.
    a. All channels in a smaller channel bandwidth configuration that overlap with a larger channel bandwidth in the initial test configuration need consideration.
    b. Additional test reduction may be applied according to the highest reported SAR of the initial test configuration or previous subsequent test configuration(s).
5. Apply simultaneous transmission SAR test exclusion and, when required, perform SAR measurement.
    a. If SAR testing has not been done on a particular position due to *initial test position* reductions then for simultaneous transmission exemption you apply the highest *reported* SAR value for that configuration (Head, body, HS).

Default power measurement procedures

- OFDM (a/g/n/ac): Identify the highest declared power (target + tolerance) on 802.11a/g/n/ac for each frequency band and channel bandwidth applicable.
  - For each frequency band power is measured using the transmission mode configuration (802.11 mode, channel bandwidth, modulation, and data rate) yielding the highest declared power (target + tolerance).
    - When the same declared power applies to multiple transmission modes then measure power on the highest channel bandwidth configuration with the lowest order modulation and data rate.
    - When the same declared power applies to multiple 802.11 modes with the same channel bandwidth and modulation then measure power on all these configurations.
- DSSS (b): Test on channels 1, 6, 11 using the highest bandwidth and lowest order modulation and date rate.
- You want to test on the low, mid, and high channels of a frequency band.
  - If there is not an absolute middle channel due to an even number of channels in the band, you must test on two mid channels.
  - Data rates are not expected to affect conducted power in any major way.

Initial Test Configuration

- An initial test configuration is determined according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each frequency band and aggregated band for SAR measurement using the highest measured maximum output power channel.
  - Use the criteria found in "*choosing an OFDM transmission mode and test channel*"
  - *Reported* SAR > 0.8 W/kg – Test the channel with the 2nd/3rd/4th etc. highest measured output power until the *reported* SAR ≤ 1.2 W/kg or all channels are tested

Choosing a OFDM transmission mode and test channel

- You want to test on the 802.11 OFDM configuration with the highest declared power (Target + Tune-up Tolerance) for that frequency band
  - When the same declared power is specified for multiple transmission modes within a frequency band then test with the highest channel bandwidth, lowest order modulation and lowest data rate.
  - When the same declared power applies to multiple 802.11 modes the use the same channel bandwidth, modulation, and data rate then test using the lowest order 802.11 mode.
    - The order goes 802.11a, g, n, ac
- Test on the channel with the highest measured output power.
  - If multiple channels have the same measured power then select the channel closest to the mid-band frequency.

- If multiple channels have the same measured power and are the same distance from the mid-band frequency (i.e. two mid channels or high and low channels) the higher frequency channel is tested.

Initial Test Position

- You find the initial test position for Head and MHS by using Area scans on all the test positions.
  - The test position with the highest SAR becomes the initial test position for that configuration.
  - You will have one for Head and one for MHS and you must do it for 2.4GHz and 5.0GHz.
  - Rank all the positions from highest SAR to lowest. When additional test positions are required to be tested you test the next worst case.
- **Additional test positions required?** Check the *reported* SAR of the initial test position
  - *Reported* SAR ≤ 0.4 W/kg – No further SAR testing required
  - *Reported* SAR > 0.4 W/kg – Test the test position that resulted in the 2nd/3rd/4th etc. highest SAR (from the Area scans) until the *reported* SAR ≤ 0.8 W/kg or all the test positions are tested.
- **Additional channels required?** Check the *reported* SAR of each test position
  - *Reported* SAR > 0.8 W/kg – Test the channel with the 2nd/3rd/4th etc. highest measured output power until the *reported* SAR ≤ 1.2 W/kg or all channels are tested.

Subsequent Test Configuration

- SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each frequency band, in each exposure condition, according to the declared power.
- Not tested if the highest *reported* SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration declared power and the adjusted SAR ≤ 1.2 W/kg.
  - Initial mode $SAR_{reported}$ x(Subsequent mode $_{Declared\ power,\ mW}$ /Initial mode $_{Declared\ power,\ mW}$) ≤ 1.2W/kg
  - This is checked with each 802.11 mode separately.
  - If some of the other 802.11 modes have the same power apply the same criteria used to find the initial test configuration.
- When the subsequent test configuration is found, test like we did before
  - Test using the highest measured output channel
  - Test using the initial test position
  - *Reported* SAR > 1.2 W/kg – Test the channel with the 2nd/3rd/4th etc. highest measured output power until the *reported* SAR ≤ 1.2 W/kg or all channels are tested.
    - Slightly different then the rules for the initial test configuration

2.4 GHz test reduction

- Split into 802.11b DSSS and 802.11g/n OFDM
- 802.11b DSSS SAR Testing
  - Tested on the highest measured maximum output power channel
  - *Reported* SAR > 0.8 W/kg, the 2nd highest conducted power channel is tested

    - If any *reported* SAR > 1.2 W/kg, then all channels must be tested
- 802.11g/n OFDM SAR Testing
    - Not tested if the highest *reported* SAR for 802.11b DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR ≤ 1.2 W/kg
        - $SAR_{reported} \times (OFDM_{Declared\ power,\ mW} / DSSS_{Declared\ power,\ mW}) \leq 1.2$ W/kg

5.0 GHz test reduction

- U-NII-1 (low band) and U-NII-2A (mid band) have additional SAR reduction when both are used on the same transmitter
    - When the same maximum output power is specified for both bands
        - Test on U-NII-2A and if the highest *reported* SAR ≤ 1.2 W/kg, U-NII-1 isn't required for that exposure condition.
    - When different maximum output power is specified for the bands
        - Test on the band with the higher specified power.
        - If the highest *reported* SAR (of an exposure condition) is adjusted by the ratio of lower to higher specified power and the adjusted SAR ≤ 1.2 W/kg, testing on the lower power band isn't required for that exposure condition.
        - $SAR_{reported} \times (Lower\ P\ Band_{declared\ power,\ mW} / Higher\ P\ Band_{declared\ power,\ mW})$

Mode		GHz	Channel
802.11a UNII	U-NII-1	5.18	36
		5.20	40
		5.22	44
		5.24	48
	U-NII-2A	5.26	52
		5.28	56
		5.30	60
		5.32	64
	U-NII-2C	5.500	100
		5.520	104
		5.540	108
		5.560	112
		5.580	116
		5.600	120
		5.620	124
		5.640	128
		5.660	132
		5.680	136
		5.700	140
	U-NII-3	5.745	149
		5.765	153
		5.785	157
		5.805	161
		5.825	165

1.8.3 3G SAR Measurement Procedures as per KDB 941225 D01 v03r00

In the following procedures, the mode tested for SAR is referred to as the primary mode. The equivalent modes considered for SAR test reduction are denoted as secondary modes. Both primary and secondary modes must be in the same frequency band. When the maximum output power and tune-up tolerance specified for production units in a secondary mode is ≤ ¼ dB higher than the primary mode or when the highest *reported* SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode. This is referred to as the 3G SAR test reduction procedure in the following SAR test guidance, where the primary mode is identified in the applicable wireless mode test procedures and the secondary mode is wireless mode being considered for SAR test reduction by that procedure. When the 3G SAR test reduction procedure is not satisfied, it is identified as "otherwise" in the applicable procedures; SAR measurement is required for the secondary mode.

For example, when the *reported* SAR of a primary mode is 1.4 W/kg and the maximum output power specified for the primary and secondary modes are 250 mW and 200 mW, the scaled SAR would be 1.4 x (200/250) = 1.12 W/kg; therefore, SAR is not required for the secondary mode.

1.8.3.1 GSM, GPRS, EDGE and DTM

The following procedures may be considered for each frequency band to determine SAR test reduction for devices operating in GSM/GPRS/EDGE modes to demonstrate RF exposure compliance. GSM voice mode transmits with 1 time slot. GPRS and EDGE may transmit up to 4 time slots in the 8 time-slot frame according to the multi slot class implemented in a device. For Class A devices with Dual Transfer Mode (DTM) capability that support simultaneously transmission using both circuit switched (CS) and packet switched (PS) connections, the aggregate time slots must be considered in the applicable exposure conditions to determine SAR compliance. Unless it is clearly explained in the SAR report that DTM is not feasible or does not apply to a device, DTM SAR results are expected for Class A GSM/(E)GPRS devices to demonstrate SAR compliance. When enhanced EDGE mode with additional time slots or higher order modulations (QAM) applies, until procedures are available, a KDB inquiry is necessary to determine the configurations required for SAR testing. The SAR test reduction procedures for GSM/(E)GPRS devices may be considered in conjunction with the applicable SAR test reduction provisions in KDB Publication 447498. Regardless of whether DTM applies to a GSM/(E)GPRS device, operating parameters such as device Class, (E)GPRS multi slot class, DTM multi slot class and the maximum time-slot burst averaged conducted output power must be clearly identified in the SAR report to support the test configurations and measurement results. A summary of the specific procedures and test configurations applied to the SAR measurements must be clearly described in the SAR report to support the test results.

Dual Transfer Mode (DTM)

Class A GSM/(E)GPRS devices operate in DTM can transmit simultaneously using both circuit switched (CS) and packet switched (PS) connections defined by the DTM multi slot classes (see 3GPP TS 43.055 and TS 45.001). Mobile stations operating in DTM configurations are required to have one allocated CS time-slot for voice and additional PS slots for packet data. The total number of downlink and uplink time slots is defined by the DTM multi slot class. DTM devices may operate according to earlier GSM requirements using two transceivers or the more recent 3GPP requirements using a single transceiver to transmit CS and PS data in consecutive time-slots within the same GSM frame. Furthermore, additional DTM multi slot classes and enhanced DTM configurations have also been considered in recent and on-going revisions of the 3GPP/GSM requirements, which may require further considerations for SAR testing.

For Class A devices, the SAR evaluation must take into account the maximum CS and PS time slots defined by the DTM multi slot class for the device, with respect to head body-worn accessory and other near body operating configurations and exposure conditions. SAR may be evaluated for DTM with the device operating in DTM using one CS plus the number of PS time-slots that result in the highest source-based time-averaged maximum output or by summing the single time-slot CS and highest maximum output multi slot PS SAR.38 A communication test set with DTM support is necessary to configure the test device for SAR measurement in DTM mode. Alternatively, the single slot CS GSM/GMSK voice mode SAR for each applicable exposure condition can be added respectively to the PS (E)GPRS multi slot data-mode SAR to demonstrate SAR compliance for DTM.

General Reporting Requirements

The following information is required in the SAR report to identify the required test configurations for supporting the results.

1) Device class - A, B or C
2) Identify the GPRS/EDGE multi slot class, including the maximum number of downlink, uplink and total time slots per frame
3) For Class A devices with DTM capability, identify the DTM multi slot class and include the maximum number of downlink, uplink and total time slots per frame for DTM operations; i.e. CS and PS time-slots
4) The maximum output power specified for production units, including tune-up tolerance, within the time-slot burst for each operating mode – GMSK/8-PSK in CS/GSM and PS/(E)GPRS configurations
5) Descriptions of the test device and communication test set configurations used in the DTM SAR measurements or procedures applied to sum DTM SAR for the required operating configurations and exposure conditions, with respect to maximum measured time-slot burst averaged conducted output power and maximum number of time slots defined by the DTM multi slot class for the device.

SAR Test Reduction

SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data 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. GSM voice and GPRS data use GMSK, which is a constant amplitude modulation with minimal peak to average power difference within the time-slot burst. For EDGE, GMSK is used for MCS 1 – MCS 4 and 8-PSK is used for MCS 5 – MCS 9; where 8-PSK has an inherently higher peak-to-average power ratio. The GMSK and 8-PSK EDGE configurations are considered separately for SAR compliance. The GMSK EDGE configurations are grouped with GPRS and considered with respect to time-averaged maximum output power to determine compliance. The 3G SAR test reduction procedure is applied to 8-PSK EDGE with GMSK GPRS/EDGE as the primary mode.

Additional Information

- The device supports EGPRS/GPRS Multi-slot Class 12, DTM/GPRS Multi-slot Class11 and DTM/EGPRS Multi-slot Class10.
- CMU200 base station simulator with DTM software option CMU-K44 was used to set device in DTM (CS+PD) mode for testing. However, device could not be connected in DTM 4-slots uplink.
- For each slot addition in multi-slot modes (DTM, GPRS, EDGE), there is software power reduction of ≈ 3/1/2 dB per slot respectively for GSM 850 and 2/2.5/0.5 dB per slot respectively for GSM 1900.
- For head configurations, 1 slot CS, 2/3-slots (PD) and DTM (CS+PD) were evaluated.
- For body SAR configurations, 1 slot CS, 2/3/4-slots GPRS (PD) mode were tested.
- In EDGE/GPRS mode, GMSK Modulation was used using CS1-CS4 or MCSI-MCS4.
- 8-PSK modulation or MCS5-MCS9 code scheme were avoided since maximum burst avg . power was measured lower on those modulation schemes.
- As per IEEE 1528 -2013 "both GSM and GPRS use GMSK, which is a constant amplitude modulation; therefore, the maximum time-averaged output power with respect to the maximum number of time slots used in each mode can be used to determine the most conservative mode for SAR testing. Similarly, EGPRS (which uses GMSK and 8PSK) can be included with GSM and GPRS in this determination of the most conservative mode for SAR testing due to its innate similarities to GSM and GPRS."

1.8.3.2 UMTS/WCDMA, HSPA, HSPA+, and DC-HSDPA

WCDMA Handsets

The following procedures are applicable to 3GPP Release 99, Release 5 and Release 6 UMTS/WCDMA handsets. The default test configuration is to measure SAR with an established radio link between the handset and a communication test set using a 12.2 kbps RMC (reference measurement channel) configured in Test Loop Mode 1. SAR is selectively confirmed for other physical channel configurations (DPCCH & DPDCHn), HSDPA and HSPA (HSUPA/HSDPA) modes according to output power, exposure conditions and device operating capabilities. Uplink and downlink are both configured with the same RMC and required AMR. SAR for Release 5 HSDPA and Release 6 HSPA are measured respectively using the applicable FRC (fixed reference channel) and E-DCH reference channel configurations. Maximum output power is verified by applying the applicable versions of 3GPP TS 34.121. SAR must be measured according to these maximum output conditions and requirements in KDB Publication 447498. When Maximum Power Reduction (MPR) applies, the implementations must be clearly identified in the SAR report to support test results according to Cubic Metric (CM) and, as appropriate, Enhanced MPR (E-MPR) requirements.

Output Power Verification

Maximum output power is verified on the high, middle and low channels according to procedures described in section 5.2 of 3GPP TS 34.121, using the appropriate RMC or AMR with TPC (transmit power control) set to all "1's" for WCDMA/HSDPA or by applying the required inner loop power control procedures to maintain maximum output power while HSUPA is active. Results for all applicable physical channel configurations (DPCCH, DPDCHn and spreading codes, HSDPA, HSPA) are requied in the SAR report. All configurations that are not supported by the handset or cannot be measured due to technical or equipment limitations must be clearly identified

Head SAR Measurements

SAR for next to the ear head exposure is measured using a 12.2 kbps RMC with TPC bits configured to all "1's". The 3G SAR test reduction procedure is applied to AMR configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for 12.2 kbps AMR in 3.4 kbps SRB (signaling radio bearer) using the highest *reported* SAR configuration in 12.2 kbps RMC for head exposure.

Body SAR Measurements
SAR for body-worn accessory configurations is measured using a 12.2 kbps RMC with TPC bits configured to all "1's". The 3G SAR test reduction procedure is applied to other spreading codes and multiple DPDCHn configurations supported by the handset with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured using an applicable RMC configuration with the corresponding spreading code or DPDCHn, for the highest *reported* body-worn accessory exposure SAR configuration in 12.2 kbps RMC. When more than 2 DPDCHn are supported by the handset, it may be necessary to configure additional DPDCHn using FTM (Factory Test Mode) or other chipset based test approaches with parameters similar to those used in 384 kbps and 768 kbps RMC.

Handsets with Release 5 HSDPA
The 3G SAR test reduction procedure is applied to HSDPA body-worn accessory configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSDPA using the *HSDPA body SAR* procedures in the "Release 5 HSDPA Data Devices" section of this document, for the highest *reported* SAR body-worn accessory exposure configuration in 12.2 kbps RMC. Handsets with both HSDPA and HSUPA are tested according to Release 6 HSPA test procedures.

Handsets with Release 6 HSPA (HSDPA/HSUPA)
The 3G SAR test reduction procedure is applied to HSPA (HSUPA/HSDPA with RMC) body-worn accessory configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSPA using the *HSPA body SAR* procedures in the "Release 6 HSPA Data Devices" section of this document, for the highest *reported* body-worn accessory exposure SAR configuration in 12.2 kbps RMC. When VOIP is applicable for next to the ear head exposure in HSPA, the 3G SAR test reduction procedure is applied to HSPA with 12.2 kbps RMC as the primary mode; otherwise, the same HSPA configuration used for body-worn accessory measurements is tested for next to the ear head exposure.

Release 5 HSDPA Data Devices
The following procedures are applicable to HSDPA data devices operating under 3GPP Release 5. SAR is required for devices in body-worn accessory and other body exposure conditions, including handsets and data modems operating in various electronic devices. HSDPA operates in conjunction with WCDMA and requires an active DPCCH. The default test configuration is to measure SAR in WCDMA with HSDPA remain inactive, to establish a radio link between the test device and a communication test set using a 12.2 kbps RMC configured in Test Loop Mode 1. SAR for HSDPA is selectively measured using the highest *reported* SAR configuration in WCDMA, with an FRC in H-set 1 and a 12.2 kbps RMC. SAR is selectively confirmed for other physical channel configurations (DPCCH & DPDCHn) according to exposure conditions, device operating capabilities and maximum output power specified for production units, including tune-up tolerance by applying the 3G SAR test reduction procedures. Maximum output power is verified according to the applicable versions of 3GPP TS 34.121. SAR must be measured based on these maximum output conditions and requirements in KDB Publication 447498, with respect to the UE Categories, and explained in the SAR report. When Maximum Power Reduction (MPR) applies, the implementations must be clearly identified in the SAR report to support test results according to Cubic Metric (CM) and, as appropriate, Enhanced MPR (E-MPR) requirements.

Output Power Verification
Maximum output power is verified on the high, middle and low channels according to Release 5 procedures described in section 5.2 of 3GPP TS 34.121, using an FRC with H-set 1 and a 12.2 kbps RMC with TPC set to all "1's". When HSDPA is active, output power is measured according to requirements for HS-DPCCH Sub-test 1 - 4. Results for all applicable physical channel configurations (DPCCH, DPDCHn and spreading codes, HS-DPCCH etc.), with and without HSDPA active, are required in the SAR report. All configurations that are not supported by the test device or cannot be measured due to technical or equipment limitations must be clearly identified.

SAR Measurement
When voice transmission in next to the ear head exposure conditions is applicable to a WCDMA/HSDPA data device, head SAR is measured according to the 'Head SAR' procedures in the 'WCDMA Handsets' section of this document. SAR for body exposure configurations is measured according to the 'Body-Worn Accessory SAR' procedures in the 'WCDMA Handsets' section. The 3G SAR test reduction procedure is applied to *HSDPA body SAR* with 12.2 kbps RMC as the primary mode. Body SAR for HSDPA is measured using an FRC with H-Set 1 in Sub-test 1 and a 12.2 kbps RMC configured in Test Loop Mode 1, for the highest *reported* SAR configuration in 12.2 kbps RMC without HSDPA.

HSDPA is configured according to the applicable UE category of a test device. The number of HS-DSCH/HS-PDSCHs, HARQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the H-set. To maintain a consistent test configuration and stable transmission conditions, QPSK is used in the H-set for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 4 ms and a CQI repetition factor of 2 to maintain a constant rate of active CQI slots. DPCCH and DPDCH gain factors(β c, β d), and HS-DPCCH power offset parameters (ΔACK, ΔNACK, ΔCQI) are set according to values indicated in Table 1. The CQI value is determined by the UE category, transport block size, number of HS-PDSCHs and modulation used in the H-set.

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{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: 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 $\beta_c/\beta_d = 12/15$, $\beta_{hs}/\beta_c = 24/15$.
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 $\beta_d = 15/15$.

Table 1.8.2.2-1: Sub-test settings for HSDPA

Release 6 HSPA Data Devices
The following procedures are applicable to HSPA (HSUPA/HSDPA) data devices operating under 3GPP Release 6.29 SAR is required for devices in body-worn accessory and other body exposure conditions, including handsets and data modems operating in various electronic devices. HSUPA operates in conjunction with WCDMA and HSDPA. SAR is initially measured in WCDMA test configurations with HSPA remain inactive. The default test configuration is to establish a radio link between the test device and a communication test set to configure a 12.2 kbps RMC in Test Loop Mode 1. SAR for HSPA is selectively measured with HS-DPCCH, E-DPCCH and E-DPDCH, all enabled, along with a 12.2 kbps RMC using the highest *reported* SAR configuration in WCDMA with 12.2 kbps RMC only.
An FRC is configured according to HS-DPCCH Sub-test 1 using H-set 1 and QPSK.31 HSPA is configured according to E-DCH Sub-test 5 requirements. SAR for other HSPA sub-test configurations is confirmed selectively according to exposure conditions, E-DCH UE Category and maximum output power of production units, including tune-up tolerance by applying the 3G SAR test reduction procedure. Maximum output power is verified according to procedures in applicable versions of 3GPP TS 34.121. SAR must be measured based on these maximum output conditions and requirements in KDB Publication 447498, with respect to the UE Categories for HS-DPCCH and HSPA, and explained in the SAR report. When Maximum Power Reduction (MPR) applies, the implementations must be clearly identified in the SAR report to support test results according to Cubic Metric (CM) and, as appropriate, Enhanced MPR (E-MPR) requirements.

Output Power Verification

Maximum output power is verified on the high, middle and low channels according to Release 6 procedures in section 5.2 of 3GPP TS 34.121, using the appropriate RMC, FRC and E-DCH configurations. When E-DCH is not active, TPC is set to all "1's"; otherwise, inner loop power control with power control algorithm 2 is required to maintain E-TFCI requirements. When HSPA is active output power for the applicable HSPA modes should be measured for E-DCH Sub-test 1 - 5. Results for all applicable physical channel configurations (DPCCH, DPDCH and spreading codes, HS-DPCCH, E-DPCCH, E-DPDCHk) are required in the SAR report. All configurations that are not supported by the test device or cannot be measured due to technical or equipment limitations must be clearly identified.

SAR Measurement

When voice transmission in next to the ear head exposure conditions is applicable to a WCDMA/HSPA data device, head SAR is measured according to the 'Head SAR Measurements' procedures in the 'WCDMA Handsets' section of this document. SAR for body exposure configurations is measured according to the 'Body-Worn Accessory SAR' procedures in the 'WCDMA Handsets' section. The 3G SAR test reduction procedure is applied to *HSPA body SAR* with 12.2 kbps RMC as the primary mode. Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 and power control algorithm 2, according to the highest *reported* body SAR configuration in 12.2 kbps RMC without HSPA. When VOIP applies to head exposure, the 3G SAR test reduction procedure is applied with 12.2 kbps RMC as the primary mode; otherwise, the same HSPA configuration used for body SAR measurements are applied to head exposure testing.

Due to inner loop power control requirements in HSPA, a communication test set is required for output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and E-DCH configurations for HSPA are configured according to the β values indicated in Table 2 and other applicable procedures described in the 'WCDMA Handset' and 'Release 5 HSDPA Data Devices' sections of this document.

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{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	β_{ed1}: 47/15 β_{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 β_c/β_d =12/15, β_{hs}/β_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 β_c = 10/15 and β_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 β_c = 14/15 and β_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.

Table 1.8.2.2-2: Sub-test for HUSPA

HSPA, HSPA+ and DC-HSDPA SAR Guidance

SAR test exclusion may apply to 3GPP Rel. 6 HSPA, Rel. 7 HSPA+ and Rel. 8 DC-HSDPA. When SAR measurement is required for HSPA, HSPA+ or DC-HSDPA, a KDB inquiry is required to confirm that the wireless mode configurations in the test setup have remained stable throughout the SAR measurements. Without prior KDB confirmation to determine the SAR results are acceptable, a PBA is required for TCB approval.

SAR test exclusion for HSPA, HSPA+ and DC-HSDPA is determined according to the following:

1. The HSPA procedures are applied to configure 3GPP Rel. 6 HSPA devices in the required sub-test mode(s) to determine SAR test exclusion.
2. SAR is required for Rel. 7 HSPA+ when SAR is required for Rel. 6 HSPA; otherwise, the 3G SAR test reduction procedure is applied to (uplink) HSPA+ with 12.2 kbps RMC as the primary mode. Power is measured for HSPA+ that supports uplink 16 QAM according to configurations in Table C.11.1.4 of 3GPP TS 34.121-1 to determine SAR test reduction.
3. SAR is required for Rel. 8 DC-HSDPA when SAR is required for Rel. 5 HSDPA; otherwise, the 3G SAR test reduction procedure is applied to DC-HSDPA with 12.2 kbps RMC as the primary mode. Power is measured for DC-HSDPA according to the H-Set 12, FRC configuration in Table C.8.1.12 of 3GPP TS 34.121-1 to determine SAR test reduction. A primary and a secondary serving HS-DSCH Cell are required to perform the power measurement and for the results to be acceptable.
4. Regardless of whether a PBA is required, the following information must be verified and included in the SAR report for devices supporting HSPA, HSPA+ or DC-HSDPA:
    a. The output power measurement results and applicable release version(s) of 3GPP TS 34.121
        i. Power measurement difficulties due to test equipment setup or availability must be resolved between the grantee and its test lab.
    b. The power measurement results are in agreement with the individual device implementation and specifications. When Enhanced MPR (E-MPR) applies, the normal MPR targets may be modified according to the Cubic Metric (CM) measured by the device, which must be taken into consideration.
    c. The UE category, operating parameters, such as the β and Δ values used to configure the device for testing, power setback procedures described in 3GGPP TS 34.121 for the power measurements, and HSPA/HSPA+ channel conditions (active and stable) for the entire duration of the measurement according to the required E-TFCI and AG index values.
5. When SAR measurement is required, the test configurations, procedures and power measurement results must be clearly described to confirm that the required test parameters are used, including E-TFCI and AG index stability and output power conditions.

1.8.4 LTE SAR Evaluation Procedures as per KDB 941225 D05 v02r03

Largest channel bandwidth standalone SAR test requirements

QPSK with 1 RB allocation

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 among RB offsets at the upper edge, middle and lower edge of each *required test channel*. When the *reported* SAR is ≤ 0.8 W/kg, testing of the remaining RB offset configurations and *required test channels* is not required for 1 RB allocation; otherwise, SAR is required for the remaining *required test channels* and only for the RB offset configuration with the highest output power for that channel.8 When the *reported* SAR of a *required test channel* is > 1.45 W/kg, SAR is required for all three RB offset configurations for that *required test channel*.

QPSK with 50% RB allocation

The same procedures required for 1 RB allocation are applied to measure the SAR for QPSK with 50% RB allocation

QPSK with 100% RB allocation

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.

Higher order modulations

For each modulation besides QPSK; e.g., 16-QAM, 64-QAM, apply all the above the QPSK to determine the QAM configurations that may need SAR measurement. For each configuration identified as required for testing, SAR is required only when the highest maximum output power for the configuration in the higher order modulation is > ½ dB higher than the same configuration in QPSK or when the *reported* SAR for the QPSK configuration is > 1.45 W/kg.

Other channel bandwidth standalone SAR test requirements

For the other channel bandwidths used by the device in a frequency band, apply all the procedures required for the largest channel bandwidth in section 1.0 to determine the channels and RB configurations that need SAR testing and only measure SAR when the highest maximum output power of a configuration requiring testing in the smaller channel bandwidth is > ½ dB higher than the equivalent channel configurations in the largest channel bandwidth configuration or the *reported* SAR of a configuration for the largest channel bandwidth is > 1.45 W/kg. The equivalent channel configuration for the RB allocation, RB offset and modulation etc. is determined for the smaller channel bandwidth according to the same number of RB allocated in the largest channel bandwidth. For example, 50 RB in 10 MHz channel bandwidth does not apply to 5 MHz channel bandwidth; therefore, this cannot be tested in the smaller channel bandwidth. However, 50% RB allocation in 10 MHz channel bandwidth is equivalent to 100% RB allocation in 5 MHz channel bandwidth; therefore, these are the equivalent configurations to be compared to determine the specific channel and configuration in the smaller channel bandwidth that need SAR testing.

Additional information

• MPR has been implemented permanently by the manufacturer as per 3GPP TS36.101
• A-MPR was disabled for all SAR measurements.
• LTE Head SAR was evaluated to cover third-party VoIP applications at full power.
• According to "3GPP TS 36.521-1 V10.0.0 (2011-12)":
  •"The channel numbers that designate carrier frequencies so close to the operating band edges that the carrier extends beyond the operating band edge shall not be used. This implies that the first 7, 15, 25, 50, 75 and 100 channel numbers at the lower operating band edge and the last 6, 14, 24, 49, 74 and 99 channel numbers at the upper operating band edge shall not be used for channel bandwidths of 1.4, 3, 5, 10, 15 and 20 MHz respectively."…

1.8.5 SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities as per KDB 941225 D06 v02r00

Standalone personal wireless routers and handsets with hotspot mode capabilities must address hand-held and other near-body exposure conditions to show SAR compliance. The following procedures are applicable when the overall device length and width are ≥ 9 cm x 5 cm respectively. A test separation of 10 mm is required. SAR must be measured for all sides and surfaces with a transmitting antenna located within 25 mm from that surface or edge, for the data modes, wireless technologies and frequency bands supporting hotspot mode. The standalone SAR results in each device test orientation must be analyzed for the applicable hotspot mode simultaneous transmission configurations to determine SAR test exclusion and volume scan requirements.

1.8.6 Procedure for Fast SAR Scan as per KDB 447498 D01 v05r02

Fast SAR or area scan based 1-g SAR estimation can be used instead of full SAR measurements as long as the following conditions are fulfilled:

- For dipole validation the 1g SAR for the area and zoom scan must be with ±3%
- 1g Measured SAR ≤ 1.2 W/kg
- The difference between the zoom and area scan 1g SAR ≤ 0.1 W/kg
- A zoom scan is required on the worst case for each configuration of a frequency band.
    - For head configuration: A zoom scan is required for **each** position with 1g SAR ≥ 0.8 and 1 additional zoom scan to cover all the remaining positions. The scan is done on the worst case for the position(s)
- Polynomial fit algorithm is utilized. Set in DASY by double clicking the area scan procedure
- Area scan is measure at a distance ≤ 4 mm from the phantom surface
- A zoom scan is not required for any other purpose
    - For simultaneous transmission the coordinates for the maxima can be found using the area scan
- DASY must not show any error, warning, or alert messages during the scan.
    - Example: noise in measurement, peak to close to the scan boundary. Peaks are too sharp, etc.
- The frequency band being tested is ≤ 3 GHz

1.8.7 Procedure for Fast SAR Testing as per IEEE 1528 - 2013

Overview of the steps from the Spreadsheet/wizard provided by Industry Canada

STEP A: **FAST SAR** scans done on all necessary configurations and positions.

STEP B: **FULL SAR** scan done on the maximum SAR for each band. (1 Full Scan per band).

STEP C-1: Select the band with the overall highest **FULL SAR.**

STEP C-2: Perform additional **FULL SAR** measurements on all **FAST SAR** scans ≥ **Threshold 1**.

$$Threshold\ 1 = SAR_{maxFAST\ for\ a\ band} \times 0.76557 (< 3GHz), \quad SAR_{maxFAST\ for\ a\ band} \times 0.71921 (> 5GHz)$$

> **Note 1:** This threshold changes with each band as it is dependent on the highest **FAST SAR** for THAT band. Use the equation based on the frequency of the band being examined.
>
> **Note 2:** these values are based on the uncertainty found in the uncertainty budget and will change if they do. Refer below to the derivation of this equation.

STEP D: Just reports the highest **FULL SAR** measurement of each band.

STEP E: Perform STEP C-2 on any band whose maximum **FULL SAR** measurement ≥ **Threshold 2**.

$$Threshold\ 2 = SAR_{highest\ overall\ FULL\ SAR\ for\ all\ bands} \times 0.68388 (< 3GHz)$$

$$Threshold\ 2 = SAR_{highest\ overall\ FULL\ SAR\ for\ all\ bands} \times 0.63880 (> 5GHz)$$

> **Note 1:** This threshold is the SAME for ALL BANDS as it is dependent on the overall highest **FULL SAR** out of all the bands. Therefore, you will use (< 3 GHz) or (>5 GHz) depending on where the overall highest **FULL SAR** is located.
>
> **Note2:** these values are based on the uncertainty found in the uncertainty budget and will change if they do. Refer below to the derivation of this equation.

STEP F: Do any omitted FAST SAR scans from STEP A. Basically wants you to fill in any blanks you left in STEP A.

Threshold 1 (SAR $_{i,\,j,\,fast}$ equation) derived for our lab:

$$SAR_{i,j,fast} \geq SAR_{i,max,fast} \times \left[B_{i,fast} - \sqrt{(B_{i,fast})^2 - 1}\right]$$

$SAR_{i,j,fast}$ = Any **FAST SAR** scan done on the band being examined

$SAR_{i,max,fast}$ = The maximum **FAST SAR** of the band being examined

$$B_{i,fast} = \frac{1}{1 - \left[1.64\left(U_{i,fast}\right)\right]^2}$$

$U_{i,fast}$ = **11.35 %** for < 3 GHz, $U_{i,fast}$ = **13.9 %** for > 5 GHz

Note: Uncertainty found in the uncertainty budget ÷ 2 ($U_{i,fast}$ is in K=1, budget is in k=2). So, 22.7%/2, and 27.8%/2 = 11.35 and 13.9. Input them in <u>decimal</u> form, so 0.1135 and 0.1390.

$$B_{i,fast} = 1.03589\ (< 3\ GHz)\,, \qquad B_{i,fast} = 1.05481\ (> 5\ GHz)$$

$$\left[B_{i,fast} - \sqrt{(B_{i,fast})^2 - 1}\right] = 0.76557\ (< 3\ GHz),$$
$$\left[B_{i,fast} - \sqrt{(B_{i,fast})^2 - 1}\right] = 0.71921 (> 5\ GHz)$$

$$SAR_{i,j,fast} \geq SAR_{i,max,fast} \times 0.76557 (< 3GHz), \quad SAR_{i,j,fast} \geq SAR_{i,max,fast} \times 0.71921 (> 5GHz)$$

In words: Threshold 1 is the maximum **FAST SAR** measurement for that band multiplied by 0.76557 or 0.71921. Any **FAST SAR** measurement in the same band equal or above this threshold must have a **FULL SAR** measurement done.

Note: This threshold changes with each band as it is dependent on the highest **FAST SAR** for THAT band.

Threshold 2 ($SAR_{i, j, full}$ equation) derived for our lab:

$$SAR_{i,max,full} \geq SAR_{highest,full} \times \left[B_i - \sqrt{(B_i)^2 - 1}\right]$$

$SAR_{i,max,full}$ = The maximum **FULL SAR** of the band being examined

$SAR_{highest,full}$ = The overall highest **FULL SAR** out of all the bands

$$B_i = \frac{1}{1 - \left[1.64 \times \sqrt{(U_{i,fast})^2 + (U_{i,full})^2}\right]^2}$$

	$U_{i,fast}$	$U_{i,full}$
< 3 GHz	11.35 %	11.15 %
> 5 GHz	13.90 %	12.30 %

Note: Uncertainty found in the uncertainty budget ÷ 2 ($U_{i,fast}$ is in K=1, budget is in k=2). So, 22.7%/2, and 22.3%/2 = 11.35 and 11.15. Input them in <u>decimal</u> form, so 0.1135 and 0.1115

$$B_i = 1.07306 (< 3\ GHz), \qquad B_i = 1.10212 (> 5\ GHz)$$

$$\left[B_i - \sqrt{(B_i)^2 - 1}\right] = 0.68388 (< 3\ GHz), \qquad \left[B_i - \sqrt{(B_i)^2 - 1}\right] = 0.63880 (> 5\ GHz)$$

$$SAR_{i,max,full} \geq SAR_{highest,full} \times 0.68388 (< 3GHz)$$

$$SAR_{i,max,full} \geq SAR_{highest,full} \times 0.63880 (> 5GHz)$$

In words: Threshold 2 is the overall highest **FULL SAR** out of all bands multiplied by 0.68388 or 0.63880. When the maximum **FULL SAR** of a band is equal or above **Threshold 2** then you must apply **Threshold 1** to the band and perform the additional FULL SAR scans.

Note: This threshold is the <u>SAME for ALL BANDS</u> as it is dependent on the overall highest **FULL SAR** out of all the bands. Therefore, you will use (< 3 GHz) or (>5 GHz) depending on where the overall highest **FULL SAR** is located.

Glossary

N = a frequency band + Modulations. I.e. GSM 850, UMTS V, CDMA 850

i = all the N bands/all supported frequency bands. i^{th} band refers to a specific supported band.

j = all test configurations performed on a band. Refers to all the **FAST SAR** or **FULL SAR** scans performed on a band.

$U_{i,\ fast}$ = Uncertainty of **FAST SAR** when k = 1. (In the uncertainty budget k = 2 so you ÷ 2).

$U_{i,\ full}$ = Uncertainty of **FULL SAR** when k = 1. (In the uncertainty budget k = 2 so you ÷ 2).

$$B_{i,fast} = \frac{1}{1 - \left[1.64\left(U_{i,fast}\right)\right]^2}$$

$$B_i = \frac{1}{1 - \left[1.64 \times \sqrt{\left(U_{i,fast}\right)^2 + \left(U_{i,full}\right)^2}\right]^2}$$

$SAR_{i,\ max,\ fast}$ = The max **FAST SAR** for each band

$SAR_{i,\ j,\ fast}$ = Each individual **FAST SAR** scan performed

$SAR_{i,\ max,\ full}$ = The max **FULL SAR** for each band

$SAR_{max,\ full}$ = $Max(SAR_{i,max,full})$: the overall highest **FULL SAR** from the max **FULL SAR** of each band

$SAR_{i,\ j,\ full}$ = Each individual **FULL SAR** scan performed

$SAR_{highest,\ full}$ = $Max(SAR_{i,j,full})$: the overall highest **FULL SAR** from ALL the **FULL SAR** scans done.

$SAR_{i,j,fast} \geq SAR_{i,max,fast} \times \left[B_{i,fast} - \sqrt{\left(B_{i,fast}\right)^2 - 1}\right]$ (Determines THE additional **FULL SAR** scans to be done)

$SAR_{i,max,full} \geq SAR_{highest,full} \times \left[B_i - \sqrt{(B_i)^2 - 1}\right]$ (Determines IF additional **FULL SAR** scans need to be done)

1.8.8 LTE Rel. 10 carrier aggregation as per KDB 941225 D05A v01r01

When carrier aggregation is limited to downlink only; *i.e.,* there is no uplink carrier aggregation, uplink maximum output power (single carrier) is measured for the supported combinations of downlink carrier aggregation:

I) According to the frequency bands and channel bandwidths allowed for the uplink and downlink configuration combinations.

II) Uplink maximum output power is measured with downlink carrier aggregation active, using the channel with highest measured maximum output power when downlink carrier aggregation is inactive, 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 ¼ dB higher than the maximum output power measured when downlink carrier aggregation inactive.2

III) When the uplink maximum output power conditions in ii) are not satisfied, a KDB inquiry is required to determine if SAR evaluation for the uplink with downlink carrier aggregation active may be necessary.

Please refer to section 11.4 of the report for the conducted power data.

1.8.9 CDMA 2000 1x as per KDB 941225 D01 v03

The following procedures apply to CDMA 2000 Release 0 and Release A single carrier (1x RTT) handsets operating with Mobile Protocol Revision 6 or 7 (MOB_P_REV 6 or 7)4. The default test configuration is to measure SAR in RC3 with an established radio link between the handset and a communication test set. SAR in RC1 is selectively confirmed according to the 3G SAR test reduction procedure with RC3 as the primary mode. The forward and reverse links are configured with the same RC for SAR measurement. Maximum output power is verified by applying the procedures defined in 3GPP2 C.S0011 and TIA-98-E. SAR must be measured according to these maximum output conditions and requirements in KDB Publication 447498.

Output Power Verification

Maximum output power is verified on the high, middle and low channels according to procedures in section 4.4.5.2 of 3GPP2 C.S0011/TIA-98-E. Results for at least steps 3, 4 and 10 of the power measurement procedures are required in the SAR report. Steps 3 and 4 are measured using Loopback Service Option SO55 with power control bits in “All Up” condition. TDSO/SO32 may be used instead of SO55 for step 4. Step 10 is measured using TDSO/SO32 with power control bits in the “Bits Hold” condition (i.e. alternative Up/Down Bits). All power measurements defined in C.S0011/TIA-98-E that are inapplicable to the handset or cannot be measured due to technical or equipment limitations must be clearly identified in the test report.

Head SAR Measurements

SAR for next to the ear head exposure is measured in RC3 with the handset configured to transmit at full rate in SO55. The 3G SAR test reduction procedure is applied to RC1 with RC3 as the primary mode; otherwise, SAR is required for the channel with maximum measured output in RC1 using the head exposure configuration that results in the highest *reported* SAR in RC3.

Body SAR Measurements

Body-worn accessory SAR is measured in RC3 with the handset configured in TDSO/SO32 to transmit at full rate on FCH only with all other code channels disabled. The body-worn accessory procedures in KDB Publication 447498 are applied. The 3G SAR test reduction procedure is applied to the multiple code channel configuration (FCH+SCHn), with FCH only as the primary mode. Otherwise, SAR is required for

multiple code channel configuration (FCH + SCHn), with FCH at full rate and SCH0 enabled at 9600 bps, using the highest *reported* SAR configuration for FCH only. When multiple code channels are enabled, the transmitter output can shift by more than 0.5 dB and may lead to higher SAR drifts and SCH dropouts.
The 3G SAR test reduction procedure is applied to body-worn accessory SAR in RC1 with RC3 as the primary mode. Otherwise, SAR is required for RC1, with SO55 and full rate, using the highest *reported* SAR configuration for body-worn accessory exposure in RC3.

Handsets with built-in Ev-Do
For handsets with Ev-Do capabilities, the 3G SAR test reduction procedure is applied to Ev-Do Rev. 0 with 1x RTT RC3 as the primary mode to determine body-worn accessory test requirements. Otherwise, body-worn accessory SAR is required for Rev. 0, at 153.6 kbps, using the highest *reported* SAR configuration for body-worn accessory exposure in RC3.
The 3G SAR test reduction procedure is applied separately to Rev. A and Rev. B, with Rev. 0 as the primary mode to determine body-worn accessory SAR test requirements. When SAR is not required for Rev. 0, the 3G SAR test reduction is applied with 1x RTT RC3 as the primary mode. Otherwise, SAR is required for Rev. A or Rev. B, with a Reverse Data Channel payload size of 4096 bits and a Termination Target of 16 slots defined for Subtype 2 and 3 Physical Layer configurations, using the highest *reported* SAR configuration for body-worn accessory exposure in Rev. 0 or RC3, as appropriate.
A Forward Traffic Channel data rate corresponding to the 2-slot version of 307.2 kbps with ACK Channel transmitting in all slots is configured in the downlink for Rev. 0, Rev. A and Rev. B.

1x-Advanced
Maximum output power is verified for 1x-Advanced by applying the 1x RTT power measurement procedures using SO75, with RC 8 in the uplink and RC11 in the downlink. Smart blanking must be disabled. The test device is configured with Forward Power Control Mode = 000 and Reverse Power Control = 400 bps; that is, 400 kHz for both uplink and downlink power control. The power measurement results must be included in the SAR report to satisfy power requirements in KDB Publication 447498 and to qualify for SAR test exclusion or to support the SAR test setup and results.
The 3G SAR test reduction procedure is applied to 1x-Advanced with 1x RTT RC3 as the primary mode. When SAR measurement is required, the 1x-Advanced power measurement configurations are used. The 1x Advanced SAR procedures are applied separately to head, body-worn accessory and other exposure conditions.

1.9 General SAR Test Reduction and Exclusion procedure as per KDB 447498 D01 V05r02 and SAR Handsets Multi transmitters and Ant procedure as per KDB 648474 D04 v01r02

Standalone SAR test exclusion guidance:

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances*

$$\left(\frac{\text{max. power of channel, including tune} - \text{up tolerance}\ (mW)}{\text{min. test separation distance}\ (mm)} \times \sqrt{f_{(GHz)}}\right) \leq 3.0$$, For 1g SAR

Where:

- $f_{(GHz)}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation[17]
- If *distance* is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion
- The result is rounded to one decimal place for comparison

SAR test reduction considerations:

Testing of other required channels within the operating mode of a frequency band is not required when the *reported* 1-g for the mid-band or highest output power is:

- ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz

Note: Highest output channel is only tested if the maximum output power variation across the required test channels is > ½ dB

Simultaneous Transmission SAR Test exclusion considerations:

When the sum of 1-g of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit, SAR test exclusion applies to that simultaneous transmission configuration. When the sum is greater than the SAR limit, the SAR to peak location separation ratio procedures described below may be applied to determine if simultaneous transmission SAR test exclusion applies. The ratio is determined by:

$$\left([SAR1 + SAR2]^{\frac{1.5}{R_i}}\right) \leq 0.04$$

Where:

- Ri = the separation distance between the peak SAR locations for the antenna pair (mm)

Simultaneous Transmission SAR required:

Antenna pairs with SAR to antenna separation ratio > 0.04; test is only required for the configuration that results in the highest SAR in standalone configuration for each wireless mode and exposure condition.

1.10 Wi-Fi and Hotspot Mode Power Reductions

Static/fixed power reduction scheme on the following modes/bands have been implemented when Hotspot Mode is enabled or active to comply with body SAR with 10 mm test separation from flat phantom on standalone transmitter and multi-band simultaneous transmission conditions:

- GSM850 3-slot ≈ 2.0 dB
- GSM850 4-slot ≈ 2.0 dB
- GSM1900 2-slot ≈ 1.5 dB
- GSM1900 3-slot ≈ 1.0 dB
- GSM1900 4-slot ≈ 2.0 dB
- WCDMA FDD II ≈ 3.0 dB
- WCDMA FDD IV ≈ 3.5 dB
- LTE band 2 ≈ 3.0 dB
- LTE band 4 ≈ 3.0 dB
- LTE band 7 ≈ 3.5 dB
- WLAN 2.4GHz ≈ 7.0 dB
- WLAN 5 GHz ≈ 6.0 dB
- CDMA 1900 BC1 ≈ 3.0 dB

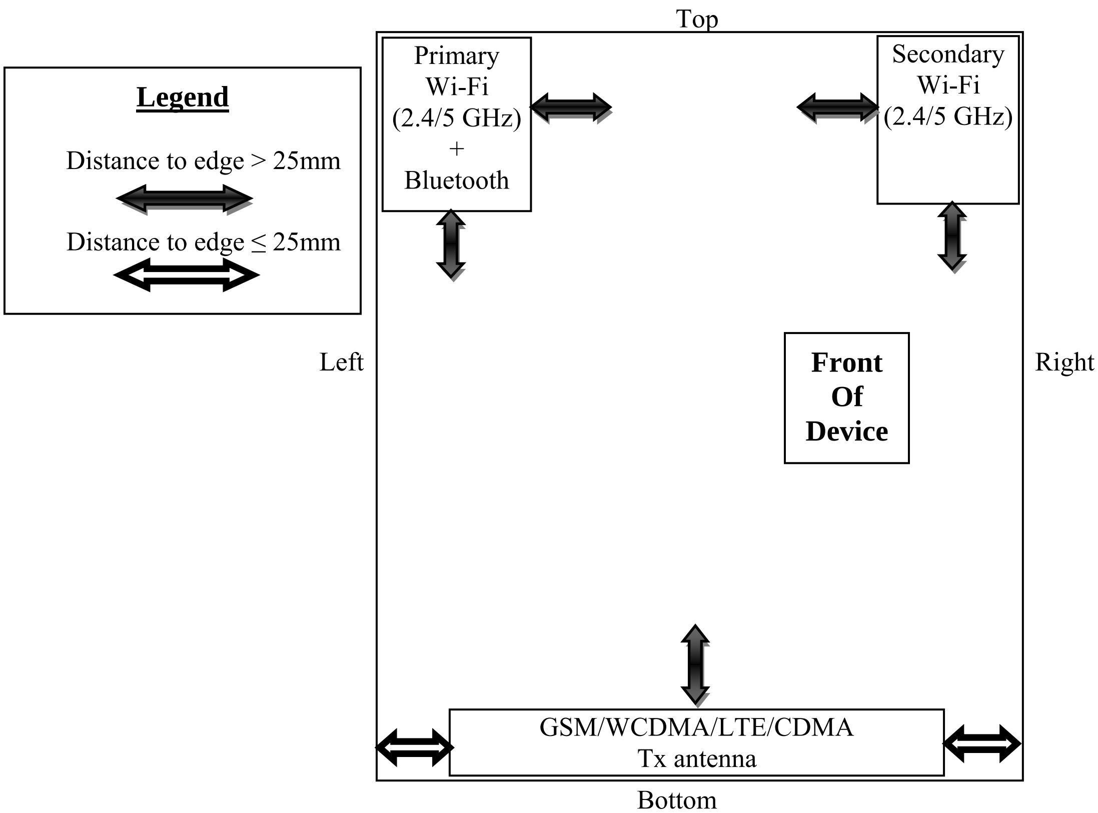

Figure 1.8.4-1 Identification of all sides for SAR Testing

Note: According to FCC guidance, Hotspot SAR testing is not required on any edge that is more than 2.5cm from the transmitting antenna.

Hotspot Sides for SAR Testing						
Mode	**Front**	**Back**	**Top**	**Bottom**	**Left**	**Right**
GPRS 850/1900, WCDMA/HSPA II/IV/V, LTE band 2/4/5/7/12/17/30, CDMA/EvDO 850 BC0/1900 BC1	Yes	Yes	No	Yes	Yes	Yes
Bluetooth 2.4GHz, Primary 802.11 b/g/n & 802.11a/n/ac	Yes	Yes	Yes	No	Yes	No
Secondary 802.11 b/g/n & 802.11a/n/ac	Yes	Yes	Yes	No	No	Yes

Table 1.8.4-1 Identification of all sides for SAR Testing

2.0 DESCRIPTION OF THE TEST EQUIPMENT

2.1 SAR measurement system

SAR measurements were performed using a Dosimetric Assessment System (DASY52), an automated SAR measurement system manufactured by Schmid & Partner Engineering AG (SPEAG), of Zurich, Switzerland.

The DASY 52 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller and software.
- An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A DAE module that performs the signal amplification, signal multiplexing, A/D conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the Electro-optical coupler (EOC).
- A unit to operate the optical surface detector that is connected to the EOC.
- The EOC performs the conversion from an optical signal into the digital electric signal of the DAE. The EOC is connected to the PC plug-in card.
- The functions of the PC plug-in card based on a DSP are to perform the time critical tasks such as signal filtering, surveillance of the robot operation fast movement interrupts.
- A computer operating Windows.
- DASY52 software version 52.8.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM Twin Phantom enabling testing left-hand and right-hand usage.
- The device holder for mobile phones.
- Tissue simulating liquid mixed according to the given recipes (see section 6.1).
- System validation dipoles allowing for the validation of proper functioning of the system.

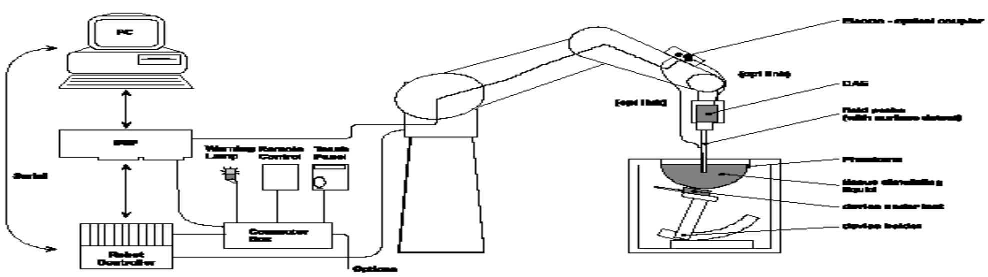

Figure 2.1-1 System Description

2.1.1 Equipment List

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date (MM/DD/YY)
SCHMID & Partner Engineering AG	E-field probe	ET3DV6	1643	3/13/2016
SCHMID & Partner Engineering AG	Data Acquisition Electronics (DAE4)	DAE4	881	01/13/2016
SCHMID & Partner Engineering AG	Dipole Validation Kit	D750V3	1021	03/11/2017
SCHMID & Partner Engineering AG	Dipole Validation Kit	D835V2	446	03/11/2017
SCHMID & Partner Engineering AG	Dipole Validation Kit	D1900V2	545	03/12/2017
Agilent Technologies	Signal generator	8648C	4037U03155	10/06/2017
Amplifier Research	Amplifier	5S1G4M3	300986	CNR
Amplifier Research	Coupler	DC7144	300993	CNR
Agilent Technologies	Network analyzer	8753ES	US39174857	10/06/2016
Agilent Technologies	Power meter	N1911A	MY45100905	06/09/2017
Agilent Technologies	Power sensor	N1921A	SG45240281	02/04/2016
CPI Wireless Solutions	Amplifier	VZC-6961K4	SK4310E5	CNR
Rohde & Schwarz	Wideband Base Station Simulator	CMW 500	136298	11/28/2016
Rohde & Schwarz	Wideband Base Station Simulator	CMW 500	115595	11/19/2016
Rohde & Schwarz	Base Station Simulator	CMU 200	109747	11/27/2015
Weinschel Corp	20dB Attenuator	33-20-34	BMO697	CNR

Table 2.1.1-1 Equipment list for model RHT181LW testing

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date (MM/DD/YY)
SCHMID & Partner Engineering AG	E-field probe	EX3DV4	3592	11/10/2015
SCHMID & Partner Engineering AG	E-field probe	ES3DV3	3225	2/25/2016
SCHMID & Partner Engineering AG	Data Acquisition Electronics (DAE4)	DAE4	881	01/13/2016
SCHMID & Partner Engineering AG	Dipole Validation Kit	D2450V2	791	09/10/2015*
SCHMID & Partner Engineering AG	Dipole Validation Kit	D2450V2	747	11/14/2015
SCHMID & Partner Engineering AG	Dipole Validation Kit	D5000V2	1033	11/08/2015
Agilent Technologies	Signal generator	8648C	4037U03155	09/25/2015
Agilent Technologies	Power meter	E4419B	GB40202821	09/25/2015
Agilent Technologies	Power sensor	8481A	MY41095233	10/06/2015
Agilent Technologies	Power sensor	8481A	MY41095417	10/06/2015
Amplifier Research	Amplifier	5S1G4M3	300986	CNR
Amplifier Research	Coupler	DC7144	300993	CNR
Agilent Technologies	Network analyzer	8753ES	US39174857	10/24/2015
Agilent Technologies	Power meter	N1911A	MY45100905	06/09/2017
Agilent Technologies	Power sensor	N1921A	SG45240281	02/04/2016
Rohde & Schwarz	Signal generator	SMA 100	102106	11/28/2015
CPI Wireless Solutions	Amplifier	VZC-6961K4	SK4310E5	CNR
Rohde & Schwarz	Wideband Base Station Simulator	CMW 500	136298	11/28/2016
Rohde & Schwarz	Wideband Base Station Simulator	CMW 500	115595	11/19/2016
Rohde & Schwarz	Base Station Simulator	CMU 200	109747	11/27/2015
Rohde & Schwarz	Bluetooth Tester	CBT	100370	11/25/2015
Weinschel Corp	20dB Attenuator	33-20-34	BMO697	CNR

Table 2.1.1-2 Equipment list for model RHK211LW testing

Note 1: "*" equipment was sent for calibration before due date

Note 2: Testing on model RHK211LW was done on July 15 to September 21, 2015

Equipment	Type	Manufacturer	Serial No.	Last Calibration	Frequency (months)
Dosimetric E-Field Probe	ET3DV6	Schmid & Partner Engineering AG	1554	May 19, 2015	12
Dosimetric E-Field Probe	ES3DV3	Schmid & Partner Engineering AG	3320	February 25, 2015	12
Dosimetric E-Field Probe	ES3DV3	Schmid & Partner Engineering AG	3326	August 18, 2014	12
Dosimetric E-Field Probe	ES3DV3	Schmid & Partner Engineering AG	3326	August 12, 2015	12
Dosimetric E-Field Probe	EX3DV4	Schmid & Partner Engineering AG	3944	August 19, 2014	12
Dosimetric E-Field Probe	EX3DV4	Schmid & Partner Engineering AG	3944	August 14, 2015	12
1750 MHz System Validation Dipole	D1750V2	Schmid & Partner Engineering AG	1093	May 13, 2015	24
1900 MHz System Validation Dipole	D1900V2	Schmid & Partner Engineering AG	5d009	May 13, 2015	24
2600 MHz System Validation Dipole	D2600V2	Schmid & Partner Engineering AG	1040	August 15, 2013	24
Data acquisition electronics	DAE3V1	Schmid & Partner Engineering AG	413	January 15, 2015	12
Data acquisition electronics	DAE3V1	Schmid & Partner Engineering AG	477	May 22, 2015	12
Data acquisition electronics	DAE4	Schmid & Partner Engineering AG	1387	August 12, 2014	12
Data acquisition electronics	DAE4	Schmid & Partner Engineering AG	1387	August 12, 2015	12
Software	DASY52 52.8.7	Schmid & Partner Engineering AG	---	N/A	--
Triple Modular Flat Phantom V5.1	QD 000 P51 C	Schmid & Partner Engineering AG	1154	N/A	--
SAM Twin Phantom V5.0	QD 000 P40 C	Schmid & Partner Engineering AG	1813	N/A	--
Universal Radio Communication Tester	CMU 200	Rohde & Schwarz	106826	February 11, 2015	24
Universal Radio Communication Tester	CMW500	Rohde & Schwarz	102375	January 28, 2015	24
Network Analyser 300 kHz to 6 GHz	8753ES	Hewlett Packard)*	US39174436	January 29, 2015	24
Dielectric Probe Kit	85070C	Hewlett Packard	US99360146	N/A	12
Signal Generator	8671B	Hewlett Packard	2823A00656	January 29, 2015	24
Amplifier	25S1G4 (25 Watt)	Amplifier Reasearch	20452	N/A	--
Power Meter	NRP	Rohde & Schwarz	101367	January 21, 2015	24
Power Meter Sensor	NRP Z22	Rohde & Schwarz	100227	January 21, 2015	12
Power Meter Sensor	NRP Z22	Rohde & Schwarz	100234	January 21, 2015	12
Directional Coupler	778D	Hewlett Packard	19171	January 21, 2015	12

Table 2.1.1-3 Equipment list for model RHM181LW testing

Note 1: Testing on model RHM181LW was done on July 29 to September 15, 2015
Note 2: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

2.2 Description of the test setup

Before SAR measurements are conducted, the device and the DASY equipment are setup as follows:

2.2.1 Device and base station simulator setup

- Power up the device.
- Turn on the base station simulator and set the radio channel and power to the appropriate values.
- Connect an antenna to the RF IN/OUT of the communication test set and place it close to the device.

2.2.2 DASY setup

- Turn the computer on and log on to Windows.
- Start the DASY software by clicking on the icon located on the Windows desktop.
- Mount the DAE unit and the probe. Turn on the DAE unit.
- Turn the Robot Controller on by turning the main power switch to the horizontal position
- Align the probe by clicking the 'Align probe in light beam' button.
- Open a file and configure the proper parameters - probe, medium, communications system etc.
- Establish a connection between the Device and the communications test instrument. Place the Device on the stand and adjust it under the phantom.
- Start SAR measurements.

3.0 ELECTRIC FIELD PROBE CALIBRATION

3.1 Probe Specifications

SAR measurements were conducted using the dosimetric probes ES3DV3/ET3DV6 and EX3DV4, designed by Schmid & Partner Engineering AG for the measurement of SAR. The probe is constructed using the thin film technique, with printed resistive lines on ceramic substrates. It has a symmetrical design with triangular core, built-in optical fibre for the surface detection system and built-in shielding against static discharge. The probe is sensitive to E-fields and thus incorporates three small dipoles arranged so that the overall response is close to isotropic. The table below summarizes the technical data for the probe.

Property	Data
Frequency range	30 MHz – 3 GHz
Linearity	±0.1 dB
Directivity (rotation around probe axis)	≤ ±0.2 dB
Directivity (rotation normal to probe axis)	±0.4 dB
Dynamic Range	5 mW/kg – 100 W/kg
Probe positioning repeatability	±0.2 mm
Spatial resolution	< 0.125 mm ^{3}
Probe model EX3DV4 for 2.4 – 6 GHz	
Probe tip to sensor center	1.0 mm
Probe tip diameter is	2.5 mm
Probe calibration uncertainty	< 15 % for f = 2.45 to < 6.0 GHz
Probe calibration range	± 100 MHz

Table 3.1-1 Probe specifications

3.2 Probe calibration and measurement uncertainty

The probe had been calibrated with accuracy better than ±12% (<2600 MHz) and 13.1% (5000 MHz). The sensitivity parameters (NormX, NormY, and NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe were tested. The probe calibration parameters are shown on Appendix D and below:

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	41.9	0.89	6.69	6.69	6.69	0.32	3.00	± 12.0 %
900	41.5	0.97	6.09	6.09	6.09	0.33	3.00	± 12.0 %
1810	40.0	1.40	5.18	5.18	5.18	0.80	2.02	± 12.0 %
1950	40.0	1.40	4.93	4.93	4.93	0.80	2.06	± 12.0 %
2450	39.2	1.80	4.58	4.58	4.58	0.80	1.62	± 12.0 %

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	55.5	0.96	6.29	6.29	6.29	0.36	2.49	± 12.0 %
900	55.0	1.05	6.00	6.00	6.00	0.33	3.00	± 12.0 %
1810	53.3	1.52	4.50	4.50	4.50	0.80	2.60	± 12.0 %
1950	53.3	1.52	4.56	4.56	4.56	0.80	2.23	± 12.0 %
2450	52.7	1.95	3.93	3.93	3.93	0.70	1.60	± 12.0 %

Table 3.2-1 Probe ET3DV6 SN: 1643 (Cal issued: 03/13/2015) used to test model RHT181LW

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	41.9	0.89	6.50	6.50	6.50	0.61	1.31	± 12.0 %
900	41.5	0.97	6.22	6.22	6.22	0.30	1.84	± 12.0 %
1810	40.0	1.40	5.26	5.26	5.26	0.50	1.46	± 12.0 %
1950	40.0	1.40	5.01	5.01	5.01	0.80	1.11	± 12.0 %
2300	39.5	1.67	4.77	4.77	4.77	0.75	1.25	± 12.0 %
2450	39.2	1.80	4.60	4.60	4.60	0.57	1.49	± 12.0 %
2600	39.0	1.96	4.40	4.40	4.40	0.72	1.30	± 12.0 %

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	55.5	0.96	6.19	6.19	6.19	0.80	1.23	± 12.0 %
900	55.0	1.05	6.07	6.07	6.07	0.53	1.41	± 12.0 %
1810	53.3	1.52	4.89	4.89	4.89	0.63	1.46	± 12.0 %
1950	53.3	1.52	4.86	4.86	4.86	0.44	1.86	± 12.0 %
2300	52.9	1.81	4.48	4.48	4.48	0.80	1.29	± 12.0 %
2450	52.7	1.95	4.34	4.34	4.34	0.72	1.14	± 12.0 %
2600	52.5	2.16	4.06	4.06	4.06	0.80	1.08	± 12.0 %

Table 3.2-2 Probe ES3DV3 SN: 3225 (Cal issued: 02/25/2015) used to test model RHK211LW

[C] Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
2600	39.0	1.96	6.80	6.80	6.80	0.36	0.93	± 12.0 %
5250	35.9	4.71	4.63	4.63	4.63	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.20	4.20	4.20	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.34	4.34	4.34	0.40	1.80	± 13.1 %

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
2600	52.5	2.16	6.84	6.84	6.84	0.78	0.62	± 12.0 %
5250	48.9	5.36	4.06	4.06	4.06	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.78	3.78	3.78	0.45	1.90	± 13.1 %
5750	48.3	5.94	3.81	3.81	3.81	0.50	1.90	± 13.1 %

Table 3.2-3 Probe EX3DV4 SN: 3592 (Cal issued: 11/10/2014) used to test model RHK211LW

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	41.9	0.89	7.09	7.09	7.09	0.23	3.00	± 12.0 %
835	41.5	0.90	6.86	6.86	6.86	0.24	3.00	± 12.0 %
900	41.5	0.97	6.54	6.54	6.54	0.28	3.00	± 12.0 %
1750	40.1	1.37	5.37	5.37	5.37	0.49	2.53	± 12.0 %
1900	40.0	1.40	5.12	5.12	5.12	0.68	2.19	± 12.0 %
2450	39.2	1.80	4.30	4.30	4.30	0.80	1.68	± 12.0 %

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	55.5	0.96	6.77	6.77	6.77	0.25	3.00	± 12.0 %
835	55.2	0.97	6.65	6.65	6.65	0.29	3.00	± 12.0 %
900	55.0	1.05	6.29	6.29	6.29	0.27	3.00	± 12.0 %
1750	53.4	1.49	4.81	4.81	4.81	0.75	2.58	± 12.0 %
1900	53.3	1.52	4.58	4.58	4.58	0.80	2.39	± 12.0 %
2450	52.7	1.95	3.92	3.92	3.92	0.78	1.37	± 12.0 %

Table 3.2-4 Probe ET3DV6 SN: 1554 (Cal issued: 05/19/2015) used to test model RHM181LW

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
450	43.5	0.87	6.75	6.75	6.75	0.22	2.55	± 13.3 %
750	41.9	0.89	6.32	6.32	6.32	0.26	2.16	± 12.0 %
835	41.5	0.90	6.14	6.14	6.14	0.29	2.01	± 12.0 %
900	41.5	0.97	6.04	6.04	6.04	0.45	1.55	± 12.0 %
1450	40.5	1.20	5.52	5.52	5.52	0.46	1.56	± 12.0 %
1640	40.3	1.29	5.25	5.25	5.25	0.64	1.25	± 12.0 %
1750	40.1	1.37	5.19	5.19	5.19	0.80	1.19	± 12.0 %
1900	40.0	1.40	5.04	5.04	5.04	0.45	1.61	± 12.0 %
2450	39.2	1.80	4.51	4.51	4.51	0.71	1.35	± 12.0 %

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
450	56.7	0.94	7.00	7.00	7.00	0.15	1.80	± 13.3 %
750	55.5	0.96	6.09	6.09	6.09	0.31	1.96	± 12.0 %
835	55.2	0.97	6.11	6.11	6.11	0.80	1.20	± 12.0 %
900	55.0	1.05	5.95	5.95	5.95	0.71	1.31	± 12.0 %
1450	54.0	1.30	5.29	5.29	5.29	0.46	1.87	± 12.0 %
1640	53.8	1.40	5.14	5.14	5.14	0.80	1.28	± 12.0 %
1750	53.4	1.49	4.73	4.73	4.73	0.80	1.25	± 12.0 %
1900	53.3	1.52	4.54	4.54	4.54	0.71	1.38	± 12.0 %
2150	53.1	1.66	4.46	4.46	4.46	0.72	1.26	± 12.0 %
2450	52.7	1.95	4.16	4.16	4.16	0.80	1.02	± 12.0 %

Table 3.2-5 Probe ES3DV3 SN: 3320 (Cal issued: 02/25/2015) used to test model RHM181LW

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	41.9	0.89	6.54	6.54	6.54	0.56	1.34	± 12.0 %
835	41.5	0.90	6.32	6.32	6.32	0.34	1.84	± 12.0 %
900	41.5	0.97	6.20	6.20	6.20	0.49	1.46	± 12.0 %
1750	40.1	1.37	5.26	5.26	5.26	0.69	1.27	± 12.0 %
1900	40.0	1.40	5.10	5.10	5.10	0.80	1.24	± 12.0 %
2450	39.2	1.80	4.55	4.55	4.55	0.79	1.30	± 12.0 %

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	55.5	0.96	6.22	6.22	6.22	0.80	1.16	± 12.0 %
835	55.2	0.97	6.26	6.26	6.26	0.40	1.45	± 12.0 %
900	55.0	1.05	6.06	6.06	6.06	0.80	1.13	± 12.0 %
1750	53.4	1.49	4.88	4.88	4.88	0.80	1.23	± 12.0 %
1900	53.3	1.52	4.66	4.66	4.66	0.47	1.66	± 12.0 %
2450	52.7	1.95	4.28	4.28	4.28	0.80	1.10	± 12.0 %

Table 3.2-6 Probe ES3DV3 SN: 3326 (Cal issued: 08/18/2014) used to test model RHM181LW

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3326

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
750	41.9	0.89	6.41	6.41	6.41	0.58	1.34	± 12.0 %
835	41.5	0.90	6.18	6.18	6.18	0.22	2.53	± 12.0 %
900	41.5	0.97	6.10	6.10	6.10	0.57	1.39	± 12.0 %
1750	40.1	1.37	5.18	5.18	5.18	0.59	1.30	± 12.0 %
1900	40.0	1.40	5.00	5.00	5.00	0.74	1.20	± 12.0 %
2450	39.2	1.80	4.42	4.42	4.42	0.77	1.29	± 12.0 %

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
750	55.5	0.96	6.33	6.33	6.33	0.80	1.15	± 12.0 %
835	55.2	0.97	6.24	6.24	6.24	0.35	1.87	± 12.0 %
900	55.0	1.05	6.18	6.18	6.18	0.63	1.36	± 12.0 %
1750	53.4	1.49	4.85	4.85	4.85	0.55	1.50	± 12.0 %
1900	53.3	1.52	4.67	4.67	4.67	0.74	1.31	± 12.0 %
2450	52.7	1.95	4.27	4.27	4.27	0.80	1.09	± 12.0 %

Table 3.2-7 Probe ES3DV3 SN: 3326 (Cal issued: 08/12/2015) used to test model RHM181LW

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	41.9	0.89	10.41	10.41	10.41	0.49	0.79	± 12.0 %
835	41.5	0.90	9.95	9.95	9.95	0.28	1.06	± 12.0 %
900	41.5	0.97	9.79	9.79	9.79	0.78	0.60	± 12.0 %
1750	40.1	1.37	8.42	8.42	8.42	0.76	0.58	± 12.0 %
1900	40.0	1.40	8.24	8.24	8.24	0.45	0.71	± 12.0 %
2450	39.2	1.80	7.52	7.52	7.52	0.49	0.69	± 12.0 %
2600	39.0	1.96	7.33	7.33	7.33	0.41	0.82	± 12.0 %
3500	37.9	2.91	7.24	7.24	7.24	0.52	0.83	± 13.1 %
5200	36.0	4.66	5.28	5.28	5.28	0.35	1.80	± 13.1 %
5300	35.9	4.76	5.08	5.08	5.08	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.87	4.87	4.87	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.76	4.76	4.76	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.76	4.76	4.76	0.40	1.80	± 13.1 %

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
750	55.5	0.96	9.92	9.92	9.92	0.48	0.77	± 12.0 %
835	55.2	0.97	9.82	9.82	9.82	0.38	0.89	± 12.0 %
900	55.0	1.05	9.54	9.54	9.54	0.60	0.71	± 12.0 %
1750	53.4	1.49	8.09	8.09	8.09	0.49	0.76	± 12.0 %
1900	53.3	1.52	7.85	7.85	7.85	0.34	0.95	± 12.0 %
2450	52.7	1.95	7.43	7.43	7.43	0.75	0.59	± 12.0 %
2600	52.5	2.16	7.26	7.26	7.26	0.80	0.50	± 12.0 %
3500	51.3	3.31	6.72	6.72	6.72	0.32	1.30	± 13.1 %
5200	49.0	5.30	4.56	4.56	4.56	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.40	4.40	4.40	0.40	1.90	± 13.1 %
5500	48.6	5.65	4.15	4.15	4.15	0.45	1.90	± 13.1 %
5600	48.5	5.77	4.06	4.06	4.06	0.45	1.90	± 13.1 %
5800	48.2	6.00	4.02	4.02	4.02	0.50	1.90	± 13.1 %

Table 3.2-8 Probe EX3DV4 SN: 3944 (Cal issued: 08/19/2014) used to test model RHM181LW

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
750	41.9	0.89	10.22	10.22	10.22	0.24	1.33	± 12.0 %
835	41.5	0.90	9.96	9.96	9.96	0.22	1.40	± 12.0 %
900	41.5	0.97	9.74	9.74	9.74	0.22	1.38	± 12.0 %
1750	40.1	1.37	8.42	8.42	8.42	0.33	0.89	± 12.0 %
1900	40.0	1.40	8.19	8.19	8.19	0.37	0.80	± 12.0 %
2450	39.2	1.80	7.28	7.28	7.28	0.38	0.80	± 12.0 %
2600	39.0	1.96	7.15	7.15	7.15	0.30	0.95	± 12.0 %
3500	37.9	2.91	7.12	7.12	7.12	0.48	0.89	± 13.1 %
5200	36.0	4.66	5.36	5.36	5.36	0.35	1.80	± 13.1 %
5300	35.9	4.76	5.08	5.08	5.08	0.40	1.80	± 13.1 %
5500	35.6	4.96	4.92	4.92	4.92	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.80	4.80	4.80	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.77	4.77	4.77	0.40	1.80	± 13.1 %

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
750	55.5	0.96	9.98	9.98	9.98	0.28	1.18	± 12.0 %
835	55.2	0.97	9.91	9.91	9.91	0.36	0.94	± 12.0 %
900	55.0	1.05	9.72	9.72	9.72	0.49	0.81	± 12.0 %
1750	53.4	1.49	8.13	8.13	8.13	0.45	0.80	± 12.0 %
1900	53.3	1.52	7.91	7.91	7.91	0.46	0.80	± 12.0 %
2450	52.7	1.95	7.53	7.53	7.53	0.33	0.90	± 12.0 %
2600	52.5	2.16	7.37	7.37	7.37	0.30	0.95	± 12.0 %
3500	51.3	3.31	6.81	6.81	6.81	0.31	1.33	± 13.1 %
5200	49.0	5.30	4.68	4.68	4.68	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.48	4.48	4.48	0.40	1.90	± 13.1 %
5500	48.6	5.65	4.16	4.16	4.16	0.50	1.90	± 13.1 %
5600	48.5	5.77	4.02	4.02	4.02	0.50	1.90	± 13.1 %
5800	48.2	6.00	4.11	4.11	4.11	0.50	1.90	± 13.1 %

Table 3.2-9 Probe EX3DV4 SN: 3944 (Cal issued: 08/14/2015) used to test model RHM181LW

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

4.0 SAR MEASUREMENT SYSTEM VERIFICATION

Prior to conducting SAR measurements, the system was validated using the dipole validation kit and the flat section of the SAM phantom. A power level of 1.0W was applied to the dipole antenna. The verification results are in the table below with a comparison to reference values. Printouts are shown in Appendix A. All the measured parameters are within the allowed tolerances.

At above 1.5 – 2 GHz, dipoles maintain good return loss of -15 dB to -20 dB, therefore SAR measurements are limited to approximately +/- 100 MHz of the probe/dipole calibration frequency.

4.1 System accuracy verification for head adjacent use

Dipole Validation For RHT181LW											
			Measured			Area & Zoom Dev. (%)	Target		Deviation (%)		Date Measured
							Zoom Scan				
Freq. (MHz)	Dipole Serial	Probe Serial	Scan Type	SAR 1g	SAR 10g		1g	10g	1g	10g	MM/DD/YY
750	1021	1643	Area	8.29	5.56	1.22					10/20/15
			Zoom	8.19	5.42		8.28	5.42	-1.09	0.00	
835	446	1643	Area	9.35	6.20	0.00					10/07/15
			Zoom	9.35	6.21		9.28	6.06	0.75	2.48	
835	446	1643	Area	9.65	6.42	0.52					10/13/15
			Zoom	9.60	6.40		9.28	6.06	3.45	5.61	
835	446	1643	Area	9.41	6.24	0.64					10/19/15
			Zoom	9.35	6.22		9.28	6.06	0.75	2.64	
835	446	1643	Area	9.60	6.39	0.52					10/22/15
			Zoom	9.55	6.37		9.28	6.06	2.91	5.12	
1900	545	1643	Area	37.5	19.7	1.90					10/26/15
			Zoom	36.8	19.8		39.6	20.8	-7.07	-4.81	

Table 4.1-1 System accuracy (validation for head adjacent use) used for testing model RHT181LW

Dipole Validation For RHK211LW											
			Measured			Area & Zoom Dev. (%)	Target		Deviation (%)		Date Measured
							Zoom Scan				
Freq. (MHz)	Dipole Serial	Probe Serial	Scan Type	SAR 1g	SAR 10g		1g	10g	1g	10g	MM/DD/YY
2450	747	3225	Area	55.1	25.9	1.47					09/04/15
			Zoom	54.3	25.6		52.8	24.6	2.84	4.07	
2450	747	3225	Area	55.9	26.0	2.01					09/15/15
			Zoom	54.8	25.8		52.8	24.6	3.79	4.88	
5200	1033	3592	Area	81.6	22.8	-4.56					09/09/15
			Zoom	85.5	24.7		79.4	22.6	7.68	9.29	
5200	1033	3592	Area	78.4	22.0	-6.56					09/14/15
			Zoom	83.9	24.3		79.4	22.6	5.67	7.52	
5500	1033	3592	Area	85.8	23.7	-5.19					09/09/15
			Zoom	90.5	25.9		84.4	23.9	7.23	8.37	
5500	1033	3592	Area	85.6	23.9	-4.89					09/14/15
			Zoom	90.0	26.1		84.4	23.9	6.64	9.21	
5800	1033	3592	Area	82.7	23.0	-3.61					09/09/15
			Zoom	85.8	24.6		79.4	22.6	8.06	8.85	
5800	1033	3592	Area	83.0	22.8	-1.31					09/14/15
			Zoom	84.1	24.2		79.4	22.6	5.92	7.08	

Table 4.1-2 System accuracy (validation for head adjacent use) used for testing model RHK211LW

System performence check (1000 mW)									
System validation Kit	Probe	Frequency	Target SAR_{1g} /mW/g (+/- 10%)	Target SAR_{10g} /mW/g (+/- 10%)	Measured SAR_{1g} / mW/g	SAR_{1g} dev.	Measured SAR_{10g} / mW/g	SAR_{10g} dev.	Measured date
D1750V2 S/N: 1093	ES3DV3 S/N: 3326	1750 MHz head	37.20	19.90	35.40	-4.8%	19.00	-4.5%	2015-07-31
D1750V2 S/N: 1093	ES3DV3 S/N: 3320	1750 MHz head	37.20	19.90	36.00	-3.2%	19.30	-3.0%	2015-08-04
D1750V2 S/N: 1093	ES3DV3 S/N: 3326	1750 MHz body	37.50	20.30	37.70	0.5%	20.10	-1.0%	2015-07-29
D1750V2 S/N: 1093	ET3DV6 S/N: 1554	1750 MHz body	37.50	20.30	35.80	-4.5%	20.00	-1.5%	2015-08-17
D1750V2 S/N: 1093	ET3DV6 S/N: 1554	1750 MHz body	37.50	20.30	35.80	-4.5%	20.00	-1.5%	2015-08-18
D1750V2 S/N: 1093	ET3DV6 S/N: 1554	1750 MHz body	37.50	20.30	34.60	-7.7%	19.30	-4.9%	2015-08-19
D1900V2 S/N: 5d009	ES3DV3 S/N: 3320	1900 MHz head	41.10	21.40	39.50	-3.9%	20.80	-2.8%	2015-07-29
D1900V2 S/N: 5d009	ES3DV3 S/N: 3320	1900 MHz head	41.10	21.40	39.20	-4.6%	20.70	-3.3%	2015-07-30
D1900V2 S/N: 5d009	ES3DV3 S/N: 3320	1900 MHz body	40.50	21.50	41.30	2.0%	22.10	2.8%	2015-08-14
D1900V2 S/N: 5d009	ES3DV3 S/N: 3320	1900 MHz body	40.50	21.50	41.20	1.7%	21.90	1.9%	2015-08-17
D1900V2 S/N: 5d009	ES3DV3 S/N: 3320	1900 MHz body	40.50	21.50	42.10	4.0%	22.30	3.7%	2015-08-18
D1900V2 S/N: 5d009	ES3DV3 S/N: 3320	1900 MHz body	40.50	21.50	42.50	4.9%	22.60	5.1%	2015-08-19
D1900V2 S/N: 5d009	EX3DV4 S/N: 3944	1900 MHz body	40.50	21.50	38.60	-4.7%	20.60	-4.2%	2015-08-29
D2600V2 S/N: 1040	EX3DV4 S/N: 3944	2600 MHz head	58.00	26.10	55.80	-3.8%	24.70	-5.4%	2015-08-04
D2600V2 S/N: 1040	EX3DV4 S/N: 3944	2600 MHz head	56.90	25.90	59.80	5.1%	27.10	4.6%	2015-09-01
D2600V2 S/N: 1040	EX3DV4 S/N: 3944	2600 MHz body	56.80	25.90	54.80	-3.5%	24.30	-6.2%	2015-09-03
D2600V2 S/N: 1040	EX3DV4 S/N: 3944	2600 MHz body	56.80	25.90	56.80	0.0%	25.30	-2.3%	2015-09-04
D2600V2 S/N: 1040	EX3DV4 S/N: 3944	2600 MHz body	56.80	25.90	56.70	-0.2%	25.70	-0.8%	2015-09-05

Table 4.1-3 System accuracy (validation for head adjacent use) used for testing model RHM181LW

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

5.0 PHANTOM DESCRIPTION

The SAM Twin Phantom, manufactured by SPEAG, was used during the SAR measurements. The phantom is made of a fibreglass shell integrated with a wooden table.

The SAM Twin Phantom is a fibreglass shell phantom with 2 mm shell thickness. It has three measurement areas:

Left side head
Right side head
Flat phantom

The phantom table dimensions are: 100x50x85 cm (LxWxH). The table is intended for use with freestanding robots.

The bottom shelf contains three pair of bolts for locking the device holder in place. The device holder positions are adjusted to the standard measurement positions in the three sections. Only one device holder is necessary if two phantoms are used (e.g., for different solutions).

A white cover is provided to top the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. Free space scans of devices on the cover are possible; however the optical surface detector does not work properly at the cover surface. Place a sheet of white paper on the cover when using optical surface detection.

Liquid depth of ≥ 15 cm is maintained in the phantom for all the measurements.

Figure 5.0-1 SAM Twin Phantom

6.0 TISSUE DIELECTRIC PROPERTIES

6.1 Composition of tissue simulant

The composition of the brain and muscle simulating liquids are shown in the table below.

INGREDIENT	MIXTURE 800-900MHz		MIXTURE 1800-1900MHz		MIXTURE 2450 MHz		MIXTURE 5 – 6 GHz	
	Brain %	Muscle %	Brain %	Muscle %	Brain %	Muscle %	Brain %	Muscle %
Water	40.29	65.45	55.24	69.91	55.0	68.75	64	64-78
Sugar	57.90	34.31	0	0	0	0	0	0
Salt	1.38	0.62	0.31	0.13	0	0	0	0
HEC	0.24	0	0	0	0	0	0	0
Bactericide	0.18	0.10	0	0	0	0	0	0
DGBE	0	0	44.45	29.96	40.0	31.25	0	0
Triton X-100	0	0	0	0	5.0	0	0	0
Additives and Salt	0	0	0	0	0	0	3	2-3
Emulsifiers	0	0	0	0	0	0	15	9-15
Mineral Oil	0	0	0	0	0	0	18	11-18

Table 6.1-1 Tissue simulant recipe

6.1.1 Equipment

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date (MM/DD/YY)
Pyrex, England	Graduated Cylinder	N/A	N/A	N/A
Pyrex, USA	Beaker	N/A	N/A	N/A
Acculab	Weight Scale	V1-1200	018WB2003	N/A
IKA Works Inc.	Hot Plate	RC Basic	3.107433	N/A
Dell	PC using GPIB card	GX110	347	N/A
Agilent Technologies	Dielectric probe kit	HP 85070C	US9936135	CNR
Agilent Technologies	Network Analyzer	8753ES	US39174857	10/06/2016
Control Company	Digital Thermometer	15-077-21	51129471	07/01/2016

Table 6.1.1-1 Tissue simulant preparation equipment for model RHT181LW

Manufacturer	Test Equipment	Model Number	Serial Number	Cal. Due Date (MM/DD/YY)
Pyrex, England	Graduated Cylinder	N/A	N/A	N/A
Pyrex, USA	Beaker	N/A	N/A	N/A
Acculab	Weight Scale	V1-1200	018WB2003	N/A
IKA Works Inc.	Hot Plate	RC Basic	3.107433	N/A
Dell	PC using GPIB card	GX110	347	N/A
Agilent Technologies	Dielectric probe kit	HP 85070C	US9936135	CNR
Agilent Technologies	Network Analyzer	8753ES	US39174857	10/24/2015
Control Company	Digital Thermometer	23609-234	21352860	09/22/2015

Table 6.1.1-2 Tissue simulant preparation equipment for model RHK211LW

6.1.2 Preparation procedure

800-900 MHz liquids

- Fill the container with **water**. Begin heating and stirring.
- Add the **Cellulose,** the **preservative substance** and the **salt**. After several hours, the liquid will become more transparent again. The container must be covered to prevent evaporation.
- Add **Sugar**. Stir it well until the sugar is sufficiently dissolved.
- Keep the liquid hot but below the boiling point for at least an hour. The container must be covered to prevent evaporation.
- Remove the container from, and turn the hotplate off and allow the liquid to cool off to room temperature prior to performing dielectric measurements.

1800-2450 MHz liquid

- Fill the container with water and place it on hotplate. Begin heating and stirring.
- Add the salt, Glycol/Triton X-100. The container must be covered to prevent evaporation.
- Keep the liquid hot enough to dissolve sugar for at least an hour. The container must be covered to prevent evaporation.
- Remove the container from, and turn the hotplate off and allow the liquid to cool off to room temperature prior to performing dielectric measurements.

6.2 Electrical parameters of the tissue simulating liquid

The tissue dielectric parameters shall be measured before a batch can be used for SAR measurements to ensure that the simulated tissue was properly made and will simulate the desired human characteristic. Limits and measured electrical parameters are shown in the table below.
Recommended limits are adopted from IEEE P1528-2003:
" Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", DASY manual and from FCC Tissue Dielectric Properties web page at http://www.fcc.gov/fcc-bin/dielec.sh

Dielectric Parameters For Head Liquid For Model RHT181LW

Liquid HSL	Freq. (MHz)	Measured HSL			Target HSL		Deviation (%)		Date Measured
		ε'r	ε''r	σ (S/m)	ε'r	σ (S/m)	ε'r	σ (S/m)	MM/DD/YY
750	685	43.93	22.67	0.86	42.3	0.89	3.86	-2.92	10/20/2015
	700	43.57	22.21	0.86	42.1	0.89	3.48	-2.84	
	715	43.25	22.05	0.88	42.1	0.89	2.73	-1.45	
	750	42.88	22.41	0.94	41.9	0.89	2.34	5.07	
	790	42.66	22.25	0.98	41.7	0.90	2.30	8.65	
835	815	41.92	19.05	0.86	41.6	0.90	0.77	-4.05	10/7/2015
	820	41.91	19.05	0.87	41.6	0.90	0.74	-3.45	
	835	41.73	19.07	0.89	41.5	0.90	0.56	-1.56	
	850	41.53	19.05	0.90	41.5	0.92	0.07	-2.10	
	865	41.30	19.03	0.92	41.5	0.93	-0.49	-1.51	
835	815	40.78	19.35	0.88	41.6	0.90	-1.97	-2.52	10/13/2015
	820	40.67	19.35	0.88	41.6	0.90	-2.24	-1.92	
	835	40.45	19.30	0.90	41.5	0.90	-2.53	-0.39	
	850	40.24	19.12	0.90	41.5	0.92	-3.04	-1.73	
	865	40.06	19.06	0.92	41.5	0.93	-3.47	-1.38	
835	815	41.26	19.12	0.87	41.6	0.90	-0.82	-3.68	10/19/2015

	820	41.18	19.09	0.87	41.6	0.90	-1.01	-3.24	
	835	41.00	18.97	0.88	41.5	0.90	-1.20	-2.09	
	850	40.77	18.96	0.90	41.5	0.92	-1.76	-2.55	
	865	40.52	19.03	0.92	41.5	0.93	-2.36	-1.53	
835	815	41.12	19.03	0.86	41.6	0.90	-1.15	-4.13	10/22/2015
	820	41.18	19.15	0.87	41.6	0.90	-1.01	-2.94	
	835	41.18	19.29	0.90	41.5	0.90	-0.77	-0.44	
	850	41.05	19.12	0.90	41.5	0.92	-1.08	-1.73	
	865	40.64	18.89	0.91	41.5	0.93	-2.07	-2.26	
1900	1850	38.66	12.94	1.33	40.0	1.40	-3.35	-4.87	10/26/2015
	1900	38.51	13.18	1.39	40.0	1.40	-3.73	-0.49	
	1915	38.55	13.24	1.41	40.0	1.40	-3.63	0.75	
	1950	38.35	13.23	1.44	40.0	1.40	-4.13	2.51	
	1980	38.11	13.22	1.46	40.0	1.40	-4.73	4.01	

Table 6.2-1 Electrical parameters of head tissue simulating liquid used for testing model RHT181LW

Dielectric Parameters For Muscle Liquid For Model RHT181LW									
Liquid MSL	Freq. (MHz)	Measured MSL			Target MSL		Deviation (%)		Date Measured
		Ɛ'r	Ɛ''r	σ (S/m)	Ɛ'r	σ (S/m)	Ɛ'r	σ (S/m)	MM/DD/YY
750	685	55.72	23.60	0.90	55.8	0.96	-0.14	-6.32	10/20/2015
	700	55.18	23.11	0.90	55.7	0.96	-0.94	-6.25	
	715	54.81	22.91	0.91	55.7	0.96	-1.59	-5.07	
	750	54.85	23.58	0.98	55.5	0.96	-1.17	2.50	
	790	54.88	23.20	1.02	55.4	0.97	-0.94	5.10	
835	815	53.44	20.95	0.95	55.3	0.97	-3.37	-2.07	10/7/2015
	820	53.39	20.93	0.95	55.3	0.97	-3.46	-1.57	
	835	53.20	20.91	0.97	55.2	0.97	-3.62	0.13	
	850	53.03	20.88	0.99	55.2	0.99	-3.93	-0.25	
	865								
835	815	54.34	21.66	0.98	55.3	0.97	-1.74	1.24	10/13/2015
	820	53.97	21.49	0.98	55.3	0.97	-2.41	1.06	
	835	53.17	21.35	0.99	55.2	0.97	-3.68	2.24	
	850	53.13	21.57	1.02	55.2	0.99	-3.75	3.03	
	865								
835	815	54.70	21.03	0.95	55.3	0.97	-1.08	-1.70	10/22/2015
	820	54.77	21.13	0.96	55.3	0.97	-0.96	-0.63	
	835	54.81	21.26	0.99	55.2	0.97	-0.71	1.81	
	850	54.69	21.02	0.99	55.2	0.99	-0.92	0.40	
	865								
1900	1850	50.79	14.97	1.54	53.3	1.52	-4.71	1.36	10/26/2015
	1900	50.82	14.91	1.58	53.3	1.52	-4.65	3.68	
	1915	50.78	14.91	1.59	53.3	1.52	-4.73	4.50	
	1950								
	1980								

Table 6.2-2 Electrical parameters of muscle tissue simulating liquid used for testing model RHT181LW

Dielectric Parameters For Head Liquid For RHK211LW									
Liquid HSL	Freq. (MHz)	Measured HSL			Target HSL		Deviation (%)		Date Measured
		Ɛ'r	Ɛ''r	σ (S/m)	Ɛ'r	σ (S/m)	Ɛ'r	σ (S/m)	MM/DD/YY
2450	2400	37.61	13.28	1.77	39.3	1.76	-4.30	0.74	9/4/2015
	2425	37.53	13.34	1.80	39.2	1.78	-4.26	1.10	
	2450	37.43	13.41	1.83	39.2	1.80	-4.52	1.54	
	2480	37.31	13.49	1.86	39.2	1.83	-4.82	1.70	
2450	2400	38.06	13.23	1.77	39.3	1.76	-3.16	0.38	9/15/2015
	2425	37.94	13.29	1.79	39.2	1.78	-3.22	0.72	
	2450	37.92	13.37	1.82	39.2	1.80	-3.28	1.20	
	2480	37.77	13.42	1.85	39.2	1.83	-3.65	1.21	
5200	5180	34.39	16.29	4.70	36.0	4.63	-4.47	1.41	9/9/2015
	5200	34.35	16.30	4.71	36.0	4.66	-4.59	1.17	
	5240	34.25	16.35	4.77	35.9	4.70	-4.61	1.39	
	5280	34.18	16.36	4.81	35.9	4.74	-4.79	1.41	
	5320	34.11	16.40	4.85	35.8	4.78	-4.73	1.54	
5200	5180	34.77	16.33	4.71	36.0	4.63	-3.42	1.64	9/14/2015
	5200	34.71	16.35	4.73	36.0	4.66	-3.58	1.50	
	5240	34.65	16.39	4.78	35.9	4.70	-3.48	1.66	
	5280	34.56	16.43	4.83	35.9	4.74	-3.73	1.82	
	5320	34.50	16.47	4.87	35.8	4.78	-3.63	1.98	
5500	5500	34.14	16.64	5.09	35.6	4.96	-4.10	2.65	9/9/2015
	5580	33.92	16.67	5.17	35.6	5.04	-4.72	2.67	
	5640	33.87	16.74	5.25	35.5	5.11	-4.59	2.79	
	5720	33.64	16.76	5.33	35.4	5.19	-4.97	2.76	
5500	5500	34.21	16.62	5.09	35.6	4.96	-3.90	2.53	9/14/2015
	5580	34.06	16.69	5.18	35.6	5.04	-4.33	2.80	
	5640	33.98	16.72	5.25	35.5	5.11	-4.28	2.66	
	5720	33.82	16.81	5.35	35.4	5.19	-4.46	3.07	
5800	5745	33.85	16.91	5.40	35.4	5.21	-4.38	3.73	9/9/2015
	5775	33.79	16.94	5.44	35.3	5.24	-4.28	3.86	
	5800	33.72	16.94	5.47	35.3	5.27	-4.48	3.72	
	5825	33.65	16.97	5.50	35.3	5.30	-4.67	3.76	
5800	5745	33.76	16.80	5.37	35.4	5.21	-4.63	3.06	9/14/2015
	5775	33.70	16.84	5.41	35.3	5.24	-4.53	3.25	
	5800	33.66	16.87	5.44	35.3	5.27	-4.65	3.29	
	5825	33.63	16.88	5.47	35.3	5.30	-4.73	3.21	

Table 6.2-3 Electrical parameters of head tissue simulating liquid used for testing model RHK211LW

Dielectric Parameters For Muscle Liquid For RHK211LW									
Liquid MSL	Freq. (MHz)	Measured MSL			Target MSL		Deviation (%)		Date Measured
		Ɛ'ᵣ	Ɛ''ᵣ	σ (S/m)	Ɛ'ᵣ	σ (S/m)	Ɛ'ᵣ	σ (S/m)	MM/DD/YY
2450	2400	50.77	14.61	1.95	52.8	1.90	-3.84	2.67	9/4/2015
	2425	50.67	14.71	1.98	52.7	1.93	-3.85	2.82	
	2450	50.59	14.82	2.02	52.7	1.95	-4.00	3.59	
	2480	50.47	14.92	2.06	52.7	1.99	-4.23	3.44	
2450	2400	50.52	14.66	1.96	52.8	1.90	-4.33	3.05	9/15/2015
	2425	50.40	14.70	1.98	52.7	1.93	-4.36	2.76	
	2450	50.40	14.81	2.02	52.7	1.95	-4.37	3.50	
	2480	50.24	14.88	2.05	52.7	1.99	-4.66	3.16	
5200	5180	46.86	19.21	5.54	49.0	5.28	-4.37	4.84	9/9/2015
	5200	46.81	19.22	5.56	49.0	5.30	-4.47	4.91	
	5240	46.72	19.23	5.61	49.0	5.35	-4.65	4.78	
	5280	46.62	19.26	5.66	48.9	5.39	-4.66	4.96	
	5320	46.52	19.30	5.71	48.9	5.44	-4.87	4.99	
5500	5500	46.68	19.15	5.86	48.6	5.65	-3.95	3.71	9/9/2015
	5580	46.65	19.25	5.98	48.5	5.74	-3.81	4.11	
	5640	46.60	19.31	6.06	48.4	5.81	-3.72	4.28	
	5720	46.42	19.36	6.16	48.3	5.91	-3.89	4.24	
5800	5745	46.41	19.39	6.20	48.3	5.94	-3.91	4.33	9/9/2015
	5775	46.38	19.43	6.24	48.2	5.97	-3.78	4.56	
	5800	46.32	19.43	6.27	48.2	6.00	-3.90	4.49	
	5825	46.24	19.45	6.30	48.2	6.03	-4.07	4.52	

Table 6.2-4 Electrical parameters of muscle tissue simulating liquid for testing model RHK211LW

Liquid HSL	Freq. (MHz)	Target head tissue		Measurement head tissue					Measurement date
		Permittivity	Conductivity (S/m)	Permittivity	Dev. %	Conductivity ε"	Conductivity (S/m)	Dev. %	
1750	1712	40.13	1.35	39.1	-2.7%	13.81	1.32	-2.6%	2015-07-31
	1720	40.11	1.35	39.0	-2.8%	13.82	1.32	-2.4%	
	1732	40.10	1.36	38.9	-2.9%	13.81	1.33	-2.3%	
	1745	40.08	1.37	38.9	-2.9%	13.84	1.34	-1.8%	
	1750	40.07	1.37	38.9	-3.0%	13.85	1.35	-1.7%	
	1752	40.07	1.37	38.9	-3.0%	13.84	1.35	-1.7%	
1900	1850	40.00	1.40	40.1	0.2%	12.94	1.33	-4.9%	2015-07-29
	1852	40.00	1.40	40.1	0.2%	12.94	1.33	-4.8%	
	1860	40.00	1.40	40.0	0.1%	12.96	1.34	-4.2%	
	1880	40.00	1.40	40.0	-0.1%	13.00	1.36	-2.9%	
	1900	40.00	1.40	39.9	-0.2%	13.05	1.38	-1.5%	
	1908	40.00	1.40	39.9	-0.3%	13.06	1.39	-1.0%	
	1910	40.00	1.40	39.9	-0.3%	13.04	1.39	-1.0%	
2600	2510	39.12	1.87	38.2	-2.5%	12.88	1.80	-3.6%	2015-08-04
	2535	39.09	1.89	38.0	-2.7%	12.96	1.83	-3.4%	
	2560	39.06	1.92	38.0	-2.7%	13.03	1.86	-3.4%	
	2600	39.01	1.96	37.8	-3.0%	13.13	1.90	-3.3%	
2600	2510	39.12	1.87	38.8	-0.9%	13.30	1.86	-0.5%	2015-09-01
	2535	39.09	1.89	38.7	-1.0%	13.35	1.88	-0.5%	
	2560	39.06	1.92	38.6	-1.3%	13.31	1.90	-1.3%	
	2568	39.05	1.93	38.6	-1.2%	13.36	1.91	-1.1%	
	2593	39.02	1.96	38.5	-1.4%	13.54	1.95	-0.2%	
	2600	39.01	1.96	38.4	-1.5%	13.55	1.96	-0.2%	
	2637	38.96	2.00	38.3	-1.6%	13.58	1.99	-0.6%	
	2680	38.91	2.05	38.2	-1.8%	13.66	2.04	-0.7%	

Table 6.2-5 Electrical parameters of muscle tissue simulating liquid for testing model RHM181LW

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

Liquid MSL	Freq. (MHz)	Target head tissue		Measurement body tissue					Measurement date
		Permittivity	Conductivity (S/m)	Permittivity	Dev. %	Conductivity ε"	Conductivity (S/m)	Dev. %	
1750	1712	53.53	1.46	52.1	-2.7%	15.91	1.52	3.5%	2015-07-29
	1720	53.51	1.47	52.1	-2.7%	15.91	1.52	3.6%	
	1732	53.48	1.48	52.0	-2.7%	15.90	1.53	3.7%	
	1745	53.44	1.49	52.0	-2.7%	15.89	1.54	3.8%	
	1750	53.43	1.49	52.0	-2.7%	15.91	1.55	4.1%	
	1752	53.43	1.49	52.0	-2.7%	15.89	1.55	4.0%	
1750	1712	53.53	1.46	52.3	-2.3%	15.86	1.51	3.1%	2015-08-17
	1720	53.51	1.47	52.2	-2.4%	15.84	1.52	3.1%	
	1732	53.48	1.48	52.2	-2.4%	15.81	1.52	3.1%	
	1745	53.44	1.49	52.2	-2.4%	15.81	1.53	3.3%	
	1747	53.44	1.49	52.2	-2.4%	15.81	1.54	3.4%	
	1750	53.43	1.49	52.2	-2.4%	15.82	1.54	3.5%	
	1752	53.43	1.49	52.2	-2.4%	15.82	1.54	3.5%	
1900	1850	53.30	1.52	53.8	1.0%	14.32	1.47	-3.1%	2015-08-14
	1852	53.30	1.52	53.8	0.9%	14.33	1.48	-2.9%	
	1860	53.30	1.52	53.8	0.9%	14.34	1.48	-2.4%	
	1880	53.30	1.52	53.7	0.8%	14.37	1.50	-1.1%	
	1900	53.30	1.52	53.7	0.7%	14.40	1.52	0.1%	
	1908	53.30	1.52	53.7	0.7%	14.40	1.53	0.5%	
	1910	53.30	1.52	53.7	0.7%	14.40	1.53	0.7%	
1900	1850	53.30	1.52	52.7	-1.1%	14.08	1.45	-4.7%	2015-08-29
	1852	53.30	1.52	52.7	-1.1%	14.10	1.45	-4.4%	
	1860	53.30	1.52	52.7	-1.1%	14.10	1.46	-4.0%	
	1880	53.30	1.52	52.7	-1.2%	14.06	1.47	-3.3%	
	1900	53.30	1.52	52.7	-1.1%	14.18	1.50	-1.4%	
	1908	53.30	1.52	52.7	-1.2%	14.22	1.51	-0.7%	
	1910	53.30	1.52	52.6	-1.2%	14.22	1.51	-0.6%	
2600	2510	52.62	2.04	51.3	-2.5%	15.11	2.11	3.7%	2015-09-03
	2535	52.59	2.07	51.3	-2.5%	15.21	2.14	3.6%	
	2560	52.56	2.11	51.1	-2.8%	15.13	2.15	2.3%	
	2568	52.55	2.12	51.1	-2.8%	15.11	2.16	1.9%	
	2593	52.52	2.15	51.1	-2.8%	15.22	2.20	2.0%	
	2600	52.51	2.16	51.0	-2.9%	15.27	2.21	2.1%	
	2637	52.46	2.22	50.9	-3.0%	15.45	2.27	2.3%	
	2680	52.41	2.28	50.8	-3.1%	15.40	2.30	0.9%	

Table 6.2-6 Electrical parameters of muscle tissue simulating liquid for testing model RHM181LW

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

6.2.2 Test Configuration

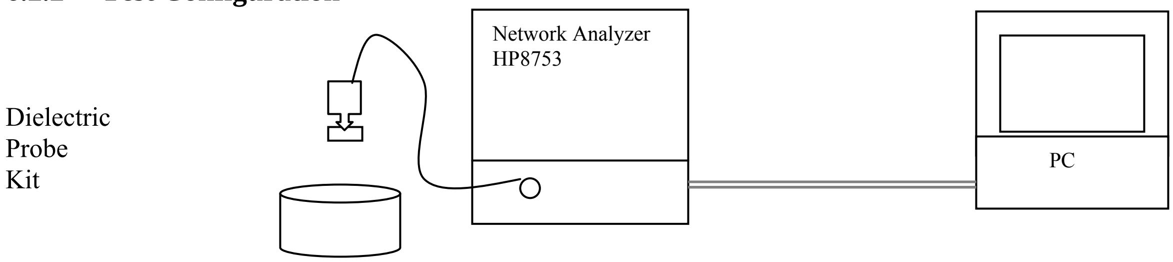

Figure 6.2.2-1 Test configuration

6.2.3 Procedure

1. Turn NWA on and allow at least 30 minutes for warm up.
2. Mount dielectric probe kit so that interconnecting cable to NWA will not be moved during measurements or calibration.
3. Pour de-ionized water and measure water temperature (±1°).
4. Set water temperature in HP-Software (Calibration Setup).
5. Perform calibration.
6. Relative permittivity $\varepsilon r = \varepsilon'$ and conductivity can be calculated from ε'' ($\sigma = \omega\, \varepsilon_0\, \varepsilon''$)
7. Measure liquid shortly after calibration.
8. Stir the liquid to be measured. Take a sample (~50ml) with a syringe from the center of the liquid container.
9. Pour the liquid into a small glass flask. Hold the syringe at the bottom of the flask to avoid air bubbles.
10. Put the dielectric probe in the glass flask. Check that there are no air bubbles in front of the opening in the dielectric probe kit.
11. Perform measurements.
12. Adjust medium parameters in DASY software for the frequencies necessary for the measurements (‘Setup Config’, select medium (e.g. Head 835 MHz) and press ‘Option’-button.
13. Select the current medium for the frequency of the validation (e.g. Setup Medium Brain 835 MHz).

7.0 SAR SAFETY LIMITS

Standards/Guideline	Localized SAR Limit (W/kg) General public (uncontrolled)	Localized SAR Limits (W/kg) Workers (controlled)
ICNIRP Standard	2.0 (10g)	10.0 (10g)
IEEE C95.1 Standard	1.6 (1g)	8.0 (1g)

Table 7.0-1 SAR safety limits for Controlled / Uncontrolled environment

Human Exposure	Localized SAR Limits (W/kg) 10g, ICNIRP Standard	Localized SAR Limits (W/kg) 1g, IEEE C95.1 Standard
Spatial Average (averaged over the whole body)	0.08	0.08
Spatial Peak (averaged over any X g of tissue)	2.00	1.60
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.00	4.00 (10g)

Table 7.0-2 SAR safety limits

Uncontrolled Environments are defined as locations where there is exposure of individuals who have no knowledge or control of their exposure.

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).

8.0 DEVICE POSITIONING

8.1 Device holder for SAM Twin Phantom

The Device was positioned for all test configurations using the DASY5 holder. The device holder facilitates the rotation of the mounted transmitter in spherical coordinates whereby the rotation point is the ear opening. The devices can be easily, accurately and with repeatability positioned according to FCC and CENELEC specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

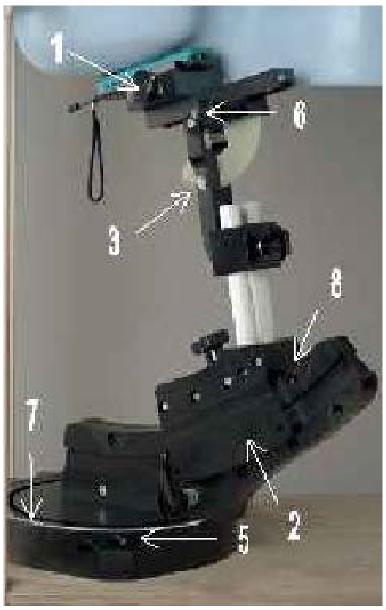

Figure 8.1-1 Device Holder

1. Put the phone in the clamp mechanism (1) and hold it straight while tightening. (Curved phones or phones with asymmetrical ear pieces should be positioned so that the earpiece is in the symmetry plane of the clamp).
2. Adjust the sliding carriage (2) to 90°. Then adjust the phone holder angle (3) until the reference line of the phone is horizontal (parallel to the flat phantom bottom). The phone reference line is defined as the front tangential line between the earpiece and the center of the device bottom (or the center of the flip hinge). For devices with parallel front and backsides, the phone holder angle (3) is 0°.
3. Place the device holder at the desired phantom section and move it securely against the positioning pins (4). The screw in front of the turning plate can be applied for correct positioning (5). (Do not tighten it too strongly).
4. Shift the phone clamp (6) so that the earpiece is exactly below the ear marking of the phantom. The phone is now correctly positioned in the holder for all standard phantom measurements, even after changing the phantom or phantom section.
5. Adjust the device position angles to the desired measurement position.
6. After fixing the device angles, move the phone fixture up until the phone touches the ear marking. (The point of contact depends on the design of the device and the positioning angle).

8.2 Description of the test positioning

8.2.1 Test Positions of Device Relative to Head

The handset was tested in two test positions against the head phantom, the "cheek" position and the "tilted" position, on both left and right sides of the phantom.

The handset was tested in the above positions according to IEEE 1528- 2003 "Recommended Practice for Determining the Spatial-Peak Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques".

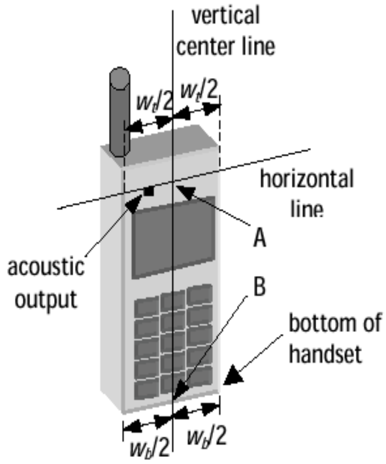

Figure 8.2.1-1 Handset vertical and horizontal reference lines – fixed case

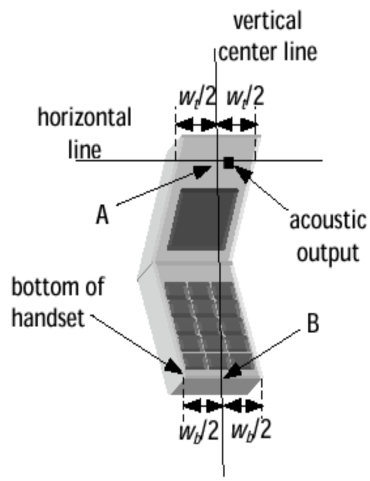

Figure 8.2.1-2 Handset vertical and horizontal reference lines – "clam-shell"

Definition of the "cheek" position

1) Ready the handset for talk operation, if necessary. For example, for handsets with a cover piece, open the cover.
2) Define two imaginary lines on the handset: the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset: the midpoint of the width *wt* of the handset at the level of the acoustic output (point A on Figures 8.2.1-1 and 8.2.1-2), and the midpoint of the width *wb* of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Figure 8.2.1-1). 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 centerline is not necessarily parallel to the front face of the handset (see Figure 8.2.1-2), especially for clamshell handsets, handsets with flip pieces, and other irregularly shaped handsets.
3) Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Figure 8.2.1-3), such that the plane defined by the vertical center line and the horizontal center line is in a plane approximately parallel to the sagittal plane of the phantom.
4) Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the ear.
5) While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is the plane normal to MB ("*mouth-back*") - NF ("*neck-front*") including the line MB (reference plane).
6) Rotate the phone around the vertical centerline until the phone (horizontal line) is symmetrical with respect to the line NF.
7) While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, rotate the handset about the line NF until any point on the handset is in contact with a phantom point below the ear (cheek).

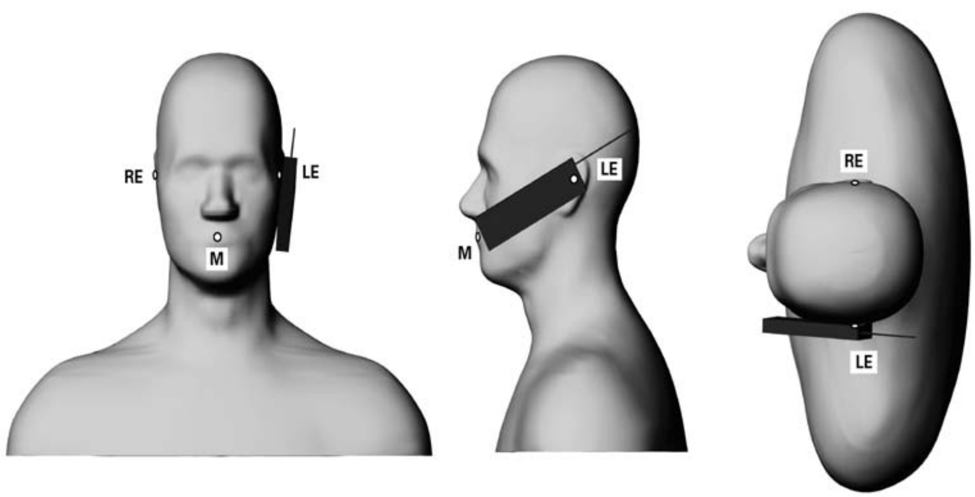

Figure 8.2.1-3 Phone position 1, "cheek" or "touch" position. The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

Definition of the "Tilted" Position

1) Repeat steps 1 to 7 from above.
2) While maintaining the device in the reference plane (described above) and pivoting against the ear, move the device outward away from the mouth by an angle of 15 degrees, or until the antenna touches the phantom**.**

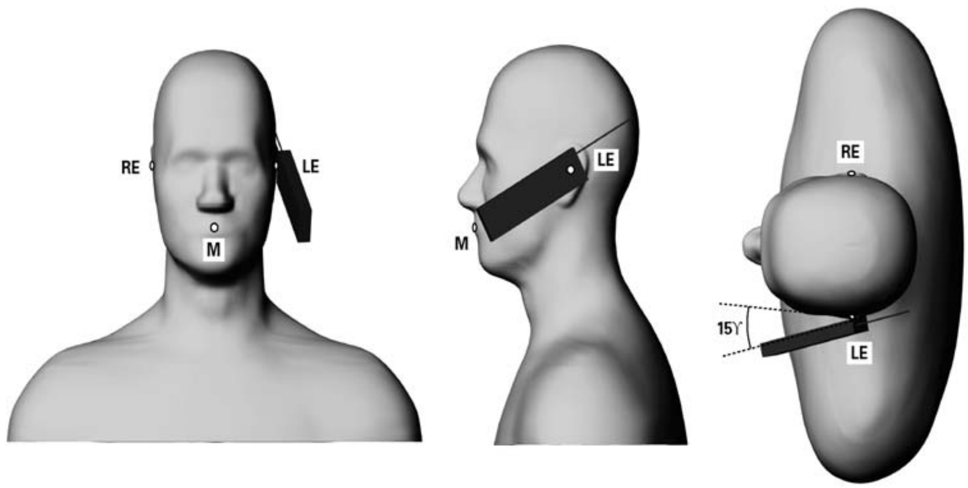

Figure 8.2.1-4 Phone position 2, "tilted position." The reference points for the right ear (RE), left ear (LE) and mouth (M), which define the reference plane for phone positioning, are indicated. The shoulders are shown for illustration purposes only.

8.2.2 Body-worn Configuration

Body-worn configurations, as shown in appendix E, have been tested with the device for RF exposure compliance. The device was tested with a holster and/or a minimum separation distance. The device was tested with 15 mm BLACKBERRY recommended separation distance to allow typical after-market holster to be used. For holster testing the holster case and the belt clip was placed against the flat section of the phantom. A headset was then connected to the device to simulate hands-free operation in a body worn holster configuration. BLACKBERRY body-worn holsters with belt-clip have been designed to maintain ~ 19-20 mm separation distance from body.

8.2.3 Limb/Hand Configuration

BlackBerry device is not a limb-worn device and hasn't been tested for such a configuration.

As per Clause 6.1.4.9 in the IEC/EN 62209-2 standard:

"Additional studies remain needed for devising a representative method for evaluating SAR in the hand of hand-held devices. Future versions of this standard are intended to contain a test method based on scientific data and rationale. Annex J presents the currently available test procedure."

Clause J.2 of the IEC/EN 62209-2 states that testing for compliance for the exposure of the hand is not applicable for devices that are intended to being hand-held to enable use at the ear (see EN 62209-1) or worn on the body when transmitting.

In addition, BlackBerry device is not intended to be held in hand at a distance of larger than 200 mm from the head and body during normal use.

9.0 HIGH LEVEL EVALUATION

9.1 Maximum search

The maximum search is automatically performed after each coarse scan measurement. It is based on splines in two or three dimensions. The procedure can find the maximum for most SAR distributions even with relatively large grid spacing. After the coarse scan measurement, the probe is automatically moved to a position at the interpolated maximum. The following scan can directly use this position for reference, e.g., for a finer resolution grid or the cube evaluations.

9.2 Extrapolation

The extrapolation can be used in z-axis scans with automatic surface detection. The SAR values can be extrapolated to the inner phantom surface. The extrapolation distance is the sum of the probe sensor offset, the surface detection distance and the grid offset. The extrapolation is based on fourth order polynomial functions. The extrapolation is only available for SAR values.

9.3 Boundary correction

The correction of the probe boundary effect in the vicinity of the phantom surface is done in the standard (worst case) evaluation; the boundary effect is reduced by different weights for the lowest measured points in the extrapolation routine. The result is a slight overestimation of the extrapolated SAR values (2% to 8%) depending on the SAR distribution and gradient. The advanced evaluation makes a full compensation of the boundary effect before doing the extrapolation. This is only possible for probes with specifications on the boundary effect.

9.4 Peak search for 1g and 10g cube averaged SAR

The 1g and 10g peak evaluations are done using a minimum predefined cube of 5x5x7 (≤2 GHz) / 7x7x7 (2-3 GHz) / 7x7x12 (5-6 GHz) scan. The cube's (x,y) parameters will extend if the maxima is found to be outside the zoom scan boundary to ensure the absolute peak value is recorded. The routines are verified and optimized for the grid dimensions used in these cube measurements. The measured volume of 30x30x30mm (<3 GHz) / 24x24x22mm (5-6 GHz) with 7.5mm (≤2 GHz) / 5mm (2-3 GHz) / 4mm (5-6 GHz) resolution in (x,y) and 5mm (<3 GHz) / 2mm (5-6 GHz) resolution in z axis amounts to 175 (≤2 GHz) / 343 (2-3 GHz) / 588 (5-6 GHz) measurement points. The first procedure is an extrapolation (incl. Boundary correction) to get the points between the lowest measured plane and the surface. The next step uses 3D interpolation to get all points within the measured volume in a 1mm grid. In the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is then moved around until the highest averaged SAR is found. This last procedure is repeated for a 10 g cube. If the highest SAR is found at the edge of the measured volume, the system will issue a warning: higher SAR values might be found outside of the measured volume. In that case the cube measurement can be repeated, using the new interpolated maximum as the center.

10.0 MEASUREMENT UNCERTAINTY

DASY5 Uncertainty Budget
(0.3 - 3 GHz range)

Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	±6.0 %	N	1	1	1	±6.0 %	±6.0 %	∞
Axial Isotropy	±4.7 %	R	$\sqrt{3}$	0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	$\sqrt{3}$	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Linearity	±4.7 %	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Modulation Response^{m}	±2.4 %	R	$\sqrt{3}$	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %	∞
Response Time	±0.8 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %	∞
Integration Time	±2.6 %	R	$\sqrt{3}$	1	1	±1.5 %	±1.5 %	∞
RF Ambient Noise	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
RF Ambient Reflections	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.4 %	R	$\sqrt{3}$	1	1	±0.2 %	±0.2 %	∞
Probe Positioning	±2.9 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Max. SAR Eval.	±2.0 %	R	$\sqrt{3}$	1	1	±1.2 %	±1.2 %	∞
Test Sample Related								
Device Positioning	±2.9 %	N	1	1	1	±2.9 %	±2.9 %	145
Device Holder	±3.6 %	N	1	1	1	±3.6 %	±3.6 %	5
Power Drift	±5.0 %	R	$\sqrt{3}$	1	1	±2.9 %	±2.9 %	∞
Power Scaling^{p}	±0 %	R	$\sqrt{3}$	1	1	±0.0 %	±0.0 %	∞
Phantom and Setup								
Phantom Uncertainty	±6.1 %	R	$\sqrt{3}$	1	1	±3.5 %	±3.5 %	∞
SAR correction	±1.9 %	R	$\sqrt{3}$	1	0.84	±1.1 %	±0.9 %	∞
Liquid Conductivity (mea.)^{DAK}	±2.5 %	R	$\sqrt{3}$	0.78	0.71	±1.1 %	±1.0 %	∞
Liquid Permittivity (mea.)^{DAK}	±2.5 %	R	$\sqrt{3}$	0.26	0.26	±0.3 %	±0.4 %	∞
Temp. unc. - Conductivity^{BB}	±3.4 %	R	$\sqrt{3}$	0.78	0.71	±1.5 %	±1.4 %	∞
Temp. unc. - Permittivity^{BB}	±0.4 %	R	$\sqrt{3}$	0.23	0.26	±0.1 %	±0.1 %	∞
Combined Std. Uncertainty						±11.2 %	±11.1 %	361
Expanded STD Uncertainty						**±22.3 %**	**±22.2 %**	

Table 10.0-1 Worst-Case uncertainty budget for DASY5 assessed according to IEEE P1528-2013.
Source: Schmid & Partner Engineering AG.
For BlackBerry RTS lab

[1] The budget is valid for the frequency range 300MHz - 3 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerably smaller.

Relative DASY5 Uncertainty Budget for Fast SAR Tests
(0.3 - 3 GHz range)

Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	±6.0 %	N	1	0	0			
Axial Isotropy	±4.7 %	R	$\sqrt{3}$	0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	$\sqrt{3}$	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Linearity	±4.7 %	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Modulation Response	±2.4 %	R	$\sqrt{3}$	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	±0.3 %	N	1	0	0			
Response Time	±0.8 %	R	$\sqrt{3}$	0	0			
Integration Time	±2.6 %	R	$\sqrt{3}$	1	1	±1.5 %	±1.5 %	∞
RF Ambient Noise	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
RF Ambient Reflections	±3.0 %	R	$\sqrt{3}$	0	0			
Probe Positioner	±0.4 %	R	$\sqrt{3}$	1	1	±0.2 %	±0.2 %	∞
Probe Positioning	±2.9 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Spatial x-y-Resolution	±10.0 %	R	$\sqrt{3}$	1	1	±5.8 %	±5.8 %	∞
Fast SAR z-Approximation	±7.0 %	R	$\sqrt{3}$	1	1	±4.0 %	±4.0 %	∞
Test Sample Related								
Device Positioning	±2.9 %	N	1	1	1	±2.9 %	±2.9 %	145
Device Holder	±3.6 %	N	1	1	1	±3.6 %	±3.6 %	5
Power Drift	±5.0 %	R	$\sqrt{3}$	1	1	±2.9 %	±2.9 %	∞
Power Scaling	±0 %	R	$\sqrt{3}$	0	0			
Phantom and Setup								
Phantom Uncertainty	±6.1 %	R	$\sqrt{3}$	1	1	±3.5 %	±3.5 %	∞
SAR correction	±1.9 %	R	$\sqrt{3}$	0	0			
Liquid Conductivity (mea.)	±2.5 %	R	$\sqrt{3}$	0	0			
Liquid Permittivity (mea.)	±2.5 %	R	$\sqrt{3}$	0	0			
Temp. unc. - Conductivity	±3.4 %	R	$\sqrt{3}$	0	0			
Temp. unc. - Permittivity	±0.4 %	R	$\sqrt{3}$	0	0			
Combined Std. Uncertainty						±11.4 %	±11.4 %	748
Expanded STD Uncertainty						**±22.7 %**	**±22.7 %**	

Table 10.0-2 Worst-Case uncertainty budget for DASY5 assessed according to IEEE P1528-2013
Source: Schmid & Partner Engineering AG.
For BlackBerry RTS lab

DASY5 Uncertainty Budget
(3 - 6 GHz range)

Error Description	Uncert. value	Prob. Dist.	Div.	(c_i) 1g	(c_i) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	±6.55 %	N	1	1	1	±6.55 %	±6.55 %	∞
Axial Isotropy	±4.7 %	R	$\sqrt{3}$	0.7	0.7	±1.9 %	±1.9 %	∞
Hemispherical Isotropy	±9.6 %	R	$\sqrt{3}$	0.7	0.7	±3.9 %	±3.9 %	∞
Boundary Effects	±2.0 %	R	$\sqrt{3}$	1	1	±1.2 %	±1.2 %	∞
Linearity	±4.7 %	R	$\sqrt{3}$	1	1	±2.7 %	±2.7 %	∞
System Detection Limits	±1.0 %	R	$\sqrt{3}$	1	1	±0.6 %	±0.6 %	∞
Modulation Response^{m}	±2.4 %	R	$\sqrt{3}$	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	±0.3 %	N	1	1	1	±0.3 %	±0.3 %	∞
Response Time	±0.8 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %	∞
Integration Time	±2.6 %	R	$\sqrt{3}$	1	1	±1.5 %	±1.5 %	∞
RF Ambient Noise	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
RF Ambient Reflections	±3.0 %	R	$\sqrt{3}$	1	1	±1.7 %	±1.7 %	∞
Probe Positioner	±0.8 %	R	$\sqrt{3}$	1	1	±0.5 %	±0.5 %	∞
Probe Positioning	±6.7 %	R	$\sqrt{3}$	1	1	±3.9 %	±3.9 %	∞
Max. SAR Eval.	±4.0 %	R	$\sqrt{3}$	1	1	±2.3 %	±2.3 %	∞
Test Sample Related								
Device Positioning	±2.9 %	N	1	1	1	±2.9 %	±2.9 %	145
Device Holder	±3.6 %	N	1	1	1	±3.6 %	±3.6 %	5
Power Drift	±5.0 %	R	$\sqrt{3}$	1	1	±2.9 %	±2.9 %	∞
Power Scaling^{p}	±0 %	R	$\sqrt{3}$	1	1	±0.0 %	±0.0 %	∞
Phantom and Setup								
Phantom Uncertainty	±6.6 %	R	$\sqrt{3}$	1	1	±3.8 %	±3.8 %	∞
SAR correction	±1.9 %	R	$\sqrt{3}$	1	0.84	±1.1 %	±0.9 %	∞
Liquid Conductivity (mea.)^{DAK}	±2.5 %	R	$\sqrt{3}$	0.78	0.71	±1.1 %	±1.0 %	∞
Liquid Permittivity (mea.)^{DAK}	±2.5 %	R	$\sqrt{3}$	0.26	0.26	±0.3 %	±0.4 %	∞
Temp. unc. - Conductivity^{BB}	±3.4 %	R	$\sqrt{3}$	0.78	0.71	±1.5 %	±1.4 %	∞
Temp. unc. - Permittivity^{BB}	±0.4 %	R	$\sqrt{3}$	0.23	0.26	±0.1 %	±0.1 %	∞
Combined Std. Uncertainty						±12.3 %	±12.2 %	748
Expanded STD Uncertainty						**±24.6 %**	**±24.5 %**	

Table 10.0-3 Worst-Case uncertainty budget for DASY52 assessed according to IEEE P1528-2013.
Source: Schmid & Partner Engineering AG.
For BlackBerry RTS lab

DASY5 Uncertainty Budget **According to IEEE 1528/2003 and IEC 62209-1 for the 300 MHz - 3 GHz range**								
Source of uncertainty	Uncertainty Value ± %	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	Standard Uncertainty ± %, (1g)	Standard Uncertainty ± %, (10g)	v_i^2 or v_{eff}
Measurement System								
Probe calibration	± 6.0 %	Normal	1	1	1	± 6.0 %	± 6.0 %	∞
Axial isotropy	± 4.7 %	Rectangular	√3	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical isotropy	± 9.6 %	Rectangular	√3	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary effects	± 1.0 %	Rectangular	√3	1	1	± 0.6 %	± 0.6 %	∞
Probe linearity	± 4.7 %	Rectangular	√3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√3	1	1	± 0.6 %	± 0.6 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.8 %	Rectangular	√3	1	1	± 0.5 %	± 0.5 %	∞
Integration time	± 2.6 %	Rectangular	√3	1	1	± 1.5 %	± 1.5 %	∞
RF ambient noise	± 3.0 %	Rectangular	√3	1	1	± 1.7 %	± 1.7 %	∞
RF ambient reflections	± 3.0 %	Rectangular	√3	1	1	± 1.7 %	± 1.7 %	∞
Probe positioner	± 0.4 %	Rectangular	√3	1	1	± 0.2 %	± 0.2 %	∞
Probe positioning	± 2.9 %	Rectangular	√3	1	1	± 1.7 %	± 1.7 %	∞
Max.SAR evaluation	± 1.0 %	Rectangular	√3	1	1	± 0.6 %	± 0.6 %	∞
Test Sample Related								
Device positioning	± 2.9 %	Normal	1	1	1	± 2.9 %	± 2.9 %	145
Device holder uncertainty	± 3.6 %	Normal	1	1	1	± 3.6 %	± 3.6 %	5
Power drift	± 5.0 %	Rectangular	√3	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Set-up								
Phantom uncertainty	± 4.0 %	Rectangular	√3	1	1	± 2.3 %	± 2.3 %	∞
Liquid conductivity (target)	± 5.0 %	Rectangular	√3	0.64	0.43	± 1.8 %	± 1.2 %	∞
Liquid conductivity (meas.)	± 5.0 %	Rectangular	√3	0.64	0.43	± 1.8 %	± 1.2 %	∞
Liquid permittivity (target)	± 5.0 %	Rectangular	√3	0.6	0.49	± 1.7 %	± 1.4 %	∞
Liquid permittivity (meas.)	± 5.0 %	Rectangular	√3	0.6	0.49	± 1.7 %	± 1.4 %	∞
Combined Std.						± 11.1 %	± 10.8 %	387
Expanded Std.						**± 22.1 %**	**± 21.6 %**	

Table 9: Measurement uncertainties
Worst-Case uncertainty budget for DASY5 assessed according to IEEE 1528/2003.
The budget is valid for 2G and 3G communication signals and frequency range 300MHz - 3 GHz.
For these conditions it represents a worst-case analysis. For specifc tests and configurations, the uncertainty could be considerable smaller.

Table 10.0-4 Worst-Case uncertainty budget for DASY5 for CETECOM lab

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

Relative DASY5 Uncertainty Budget for SAR Tests

According to IEEE 1528/2013 and IEC62209/2011 for the 0.3 - 3GHz range

Error Description	certainty Valu ± %	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	Standard Uncertainty ± %, (1g)	Standard Uncertainty ± %, (10g)	v_i^2 or v_{eff}
Measurement System								
Probe calibration	± 6.0 %	Normal	1	1	1	± 6.0 %	± 6.0 %	∞
Axial isotropy	± 4.7 %	Rectangular	√3	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical isotropy	± 9.6 %	Rectangular	√3	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary effects	± 1.0 %	Rectangular	√3	1	1	± 0.6 %	± 0.6 %	∞
Probe linearity	± 4.7 %	Rectangular	√3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√3	1	1	± 0.6 %	± 0.6 %	∞
Modulation Response	± 2.4 %	Rectangular	√3	1	1	± 1.4 %	± 1.4 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.8 %	Rectangular	√3	1	1	± 0.5 %	± 0.5 %	∞
Integration time	± 2.6 %	Rectangular	√3	1	1	± 1.5 %	± 1.5 %	∞
RF ambient noise	± 3.0 %	Rectangular	√3	1	1	± 1.7 %	± 1.7 %	∞
RF ambient reflections	± 3.0 %	Rectangular	√3	1	1	± 1.7 %	± 1.7 %	∞
Probe positioner	± 0.4 %	Rectangular	√3	1	1	± 0.2 %	± 0.2 %	∞
Probe positioning	± 2.9 %	Rectangular	√3	1	1	± 1.7 %	± 1.7 %	∞
Max. SAR evaluation	± 2.0 %	Rectangular	√3	1	1	± 1.2 %	± 1.2 %	∞
Test Sample Related								
Device positioning	± 2.9 %	Normal	1	1	1	± 2.9 %	± 2.9 %	145
Device holder uncertainty	± 3.6 %	Normal	1	1	1	± 3.6 %	± 3.6 %	5
Power drift	± 5.0 %	Rectangular	√3	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Set-up								
Phantom uncertainty	± 6.1 %	Rectangular	√3	1	1	± 3.5 %	± 3.5 %	∞
SAR correction	± 1.9 %	Rectangular	√3	1	0.84	± 1.1 %	± 0.9 %	∞
Liquid conductivity (meas.)	± 5.0 %	Rectangular	√3	0.78	0.71	± 2.3 %	± 2.0 %	∞
Liquid permittivity (meas.)	± 5.0 %	Rectangular	√3	0.26	0.26	± 0.8 %	± 0.8 %	∞
Temp. Unc. - Conductivity	± 3.4 %	Rectangular	√3	0.78	0.71	± 1.5 %	± 1.4 %	∞
Temp. Unc. - Permittivity	± 0.4 %	Rectangular	√3	0.23	0.26	± 0.1 %	± 0.1 %	∞
Combined Uncertainty						± 11.3 %	± 11.3 %	330
Expanded Std. Uncertainty						**± 22.7 %**	**± 22.5 %**	

Table 10: Measurement uncertainties
Worst-Case uncertainty budget for DASY5 assessed according to IEEE 1528/2013
and IEC 62209-1/2011 standards. The budget is valid for the frequency range 300MHz -3 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller.

Table 10.0-5 Worst-Case uncertainty budget for DASY5 for CETECOM lab

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

DASY5 Uncertainty Budget

According to IEC 62209-2/2010 for the 300 MHz - 6 GHz range

Source of uncertainty	Uncertainty Value	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	Standard Uncertainty ± %, (1g)	Standard Uncertainty ± %, (10g)	v_i^2 or v_{eff}
Measurement System								
Probe calibration	± 6.6 %	Normal	1	1	1	± 6.6 %	± 6.6 %	∞
Axial isotropy	± 4.7 %	Rectangular	√ 3	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical isotropy	± 9.6 %	Rectangular	√ 3	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary effects	± 2.0 %	Rectangular	√ 3	1	1	± 1.2 %	± 1.2 %	∞
Probe linearity	± 4.7 %	Rectangular	√ 3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√ 3	1	1	± 0.6 %	± 0.6 %	∞
Modulation Response	± 2.4 %	Rectangular	√ 3	1	1	± 1.4 %	± 1.4 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.8 %	Rectangular	√ 3	1	1	± 0.5 %	± 0.5 %	∞
Integration time	± 2.6 %	Rectangular	√ 3	1	1	± 1.5 %	± 1.5 %	∞
RF ambient noise	± 3.0 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
RF ambient reflections	± 3.0 %	Rectangular	√ 3	1	1	± 1.7 %	± 1.7 %	∞
Probe positioner	± 0.8 %	Rectangular	√ 3	1	1	± 0.5 %	± 0.5 %	∞
Probe positioning	± 6.7 %	Rectangular	√ 3	1	1	± 3.9 %	± 3.9 %	∞
Post-processing	± 4.0 %	Rectangular	√ 3	1	1	± 2.3 %	± 2.3 %	∞
Test Sample Related								
Device positioning	± 2.9 %	Normal	1	1	1	± 2.9 %	± 2.9 %	145
Device holder uncertainty	± 3.6 %	Normal	1	1	1	± 3.6 %	± 3.6 %	5
Power drift	± 5.0 %	Rectangular	√ 3	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Set-up								
Phantom uncertainty	± 7.9 %	Rectangular	√ 3	1	1	± 4.6 %	± 4.6 %	∞
SAR correction	± 1.9 %	Rectangular	√ 3	1	0.84	± 1.1 %	± 0.9 %	∞
Liquid conductivity (meas.)	± 5.0 %	Rectangular	√ 3	0.78	0.71	± 2.3 %	± 2.0 %	∞
Liquid permittivity (meas.)	± 5.0 %	Rectangular	√ 3	0.26	0.26	± 0.8 %	± 0.8 %	∞
Temp. Unc. - Conductivity	± 3.4 %	Rectangular	√ 3	0.78	0.71	± 1.5 %	± 1.4 %	∞
Temp. Unc. - Permittivity	± 0.4 %	Rectangular	√ 3	0.23	0.26	± 0.1 %	± 0.1 %	∞
Combined Uncertainty						± 12.7 %	± 12.6 %	330
Expanded Std. Uncertainty						**± 25.4 %**	**± 25.3 %**	

Table 11: Measurement uncertainties.
Worst-Case uncertainty budget for DASY5 assessed according to according to IEC 62209-2/2010 standard. The budget is valid for the frequency range 300MHz - 6 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller.

Table 10.0-6 Worst-Case uncertainty budget for DASY5 for CETECOM lab

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

Relative DASY5 Uncertainty Budget for SAR Tests								
According to IEEE 1528/2003 and IEC 62209-1 for the 3 - 6 GHz range								
Error Description	Uncertainty Value	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	Standard Uncertainty ± %, (1g)	Standard Uncertainty ± %, (10g)	v_i^2 or v_{eff}
Measurement System								
Probe calibration	± 6.6 %	Normal	1	1	1	± 6.6 %	± 6.6 %	∞
Axial isotropy	± 4.7 %	Rectangular	√3	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical isotropy	± 9.6 %	Rectangular	√3	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary effects	± 2.0 %	Rectangular	√3	1	1	± 1.2 %	± 1.2 %	∞
Probe linearity	± 4.7 %	Rectangular	√3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√3	1	1	± 0.6 %	± 0.6 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.8 %	Rectangular	√3	1	1	± 0.5 %	± 0.5 %	∞
Integration time	± 2.6 %	Rectangular	√3	1	1	± 1.5 %	± 1.5 %	∞
RF ambient noise	± 3.0 %	Rectangular	√3	1	1	± 1.7 %	± 1.7 %	∞
RF ambient reflections	± 3.0 %	Rectangular	√3	1	1	± 1.7 %	± 1.7 %	∞
Probe positioner	± 0.8 %	Rectangular	√3	1	1	± 0.5 %	± 0.5 %	∞
Probe positioning	± 6.7 %	Rectangular	√3	1	1	± 3.9 %	± 3.9 %	∞
Max. SAR evaluation	± 4.0 %	Rectangular	√3	1	1	± 2.3 %	± 2.3 %	∞
Test Sample Related								
Device positioning	± 2.9 %	Normal	1	1	1	± 2.9 %	± 2.9 %	145
Device holder uncertainty	± 3.6 %	Normal	1	1	1	± 3.6 %	± 3.6 %	5
Power drift	± 5.0 %	Rectangular	√3	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Set-up								
Phantom uncertainty	± 4.0 %	Rectangular	√3	1	1	± 2.3 %	± 2.3 %	∞
Liquid conductivity (target)	± 5.0 %	Rectangular	√3	0.64	0.43	± 1.8 %	± 1.2 %	∞
Liquid conductivity (meas.)	± 5.0 %	Rectangular	√3	0.64	0.43	± 1.8 %	± 1.2 %	∞
Liquid permittivity (target)	± 5.0 %	Rectangular	√3	0.6	0.49	± 1.7 %	± 1.4 %	∞
Liquid permittivity (meas.)	± 5.0 %	Rectangular	√3	0.6	0.49	± 1.7 %	± 1.4 %	∞
Combined Uncertainty						± 12.1 %	± 11.9 %	330
Expanded Std. Uncertainty						**± 24.3 %**	**± 23.8 %**	

Table 12: Measurement uncertainties
Worst-Case uncertainty budget for DASY5 valid for 3G communication signals and frequency range 3 - 6 GHz. Probe calibration error reflects uncertainty of the EX3D probe. For specific tests and configurations, the uncertainty could be considerable smaller.

Table 10.0-7 Worst-Case uncertainty budget for DASY5 for CETECOM lab

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A

Relative DASY5 Uncertainty Budget for SAR Tests								
According to IEEE 1528/2013 and IEC62209-1/2011 (3-6GHz range)								
Error Description	Uncertainty Value	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	Standard Uncertainty ± %, (1g)	Standard Uncertainty ± %, (10g)	v_i^2 or v_{eff}
Measurement System								
Probe calibration	± 6.6 %	Normal	1	1	1	± 6.6 %	± 6.6 %	∞
Axial isotropy	± 4.7 %	Rectangular	√3	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical isotropy	± 9.6 %	Rectangular	√3	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary effects	± 2.0 %	Rectangular	√3	1	1	± 1.2 %	± 1.2 %	∞
Probe linearity	± 4.7 %	Rectangular	√3	1	1	± 2.7 %	± 2.7 %	∞
System detection limits	± 1.0 %	Rectangular	√3	1	1	± 0.6 %	± 0.6 %	∞
Modulation Response	± 2.4 %	Rectangular	√3	1	1	± 1.4 %	± 1.4 %	∞
Readout electronics	± 0.3 %	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response time	± 0.8 %	Rectangular	√3	1	1	± 0.5 %	± 0.5 %	∞
Integration time	± 2.6 %	Rectangular	√3	1	1	± 1.5 %	± 1.5 %	∞
RF ambient noise	± 3.0 %	Rectangular	√3	1	1	± 1.7 %	± 1.7 %	∞
RF ambient reflections	± 3.0 %	Rectangular	√3	1	1	± 1.7 %	± 1.7 %	∞
Probe positioner	± 0.8 %	Rectangular	√3	1	1	± 0.5 %	± 0.5 %	∞
Probe positioning	± 6.7 %	Rectangular	√3	1	1	± 3.9 %	± 3.9 %	∞
Max. SAR evaluation	± 4.0 %	Rectangular	√3	1	1	± 2.3 %	± 2.3 %	∞
Test Sample Related								
Device positioning	± 2.9 %	Normal	1	1	1	± 2.9 %	± 2.9 %	145
Device holder uncertainty	± 3.6 %	Normal	1	1	1	± 3.6 %	± 3.6 %	5
Power drift	± 5.0 %	Rectangular	√3	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Set-up								
Phantom uncertainty	± 6.6 %	Rectangular	√3	1	1	± 3.8 %	± 3.8 %	∞
SAR correction	± 1.9 %	Rectangular	√3	1	0.84	± 1.1 %	± 0.9 %	∞
Liquid conductivity (meas.)	± 5.0 %	Rectangular	√3	0.78	0.71	± 2.3 %	± 2.0 %	∞
Liquid permittivity (meas.)	± 5.0 %	Rectangular	√3	0.26	0.26	± 0.8 %	± 0.8 %	∞
Temp. Unc. - Conductivity	± 3.4 %	Rectangular	√3	0.78	0.71	± 1.5 %	± 1.4 %	∞
Temp. Unc. - Permittivity	± 0.4 %	Rectangular	√3	0.23	0.26	± 0.1 %	± 0.1 %	∞
Combined Uncertainty						± 12.4 %	± 12.4 %	330
Expanded Std. Uncertainty						**± 24.9 %**	**± 24.8 %**	

Table 13: Measurement uncertainties
Worst-Case uncertainty budget for DASY5 assessed according to IEEE 1528/2013
and IEC 62209-1/2011 standards. The budget is valid for the frequency range 3GHz -6GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller.

Table 10.0-8 Worst-Case uncertainty budget for DASY5 for CETECOM lab

Note: Model RHM181LW was tested using the external lab CETECOM ICT Services GmbH. This information was taken from the CETECOM SAR test report for model RHM181LW, report number 1-0042/15-01-15-A