1.7 System Components

EX3DV4 E-Field Probe

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Calibration	Basic Broad Band Calibration in air Conversion Factors (CF) for HSL 2450/5200/5300/5600/5800 MHz Additional CF for other liquids and frequencies upon request	
Frequency	10 MHz to > 6 GHz	
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 µW/g to > 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 µW/g)	
Dimensions	Tip diameter: 2.5 mm	
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.	

PHANTOM

Model	ELI	
Construction	The ELI phantom is used for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.	
Shell Thickness	2 ± 0.2 mm	
Filling Volume	Approx. 30 liters	
Dimensions	Major axis: 600 mm Minor axis: 400 mm	

DEVICE HOLDER

Construction	The device holder (Supporter) for Notebook is made by POM (polyoxymethylene resin) , which is non-metal and non-conductive. The height can be adjusted to fit varies kind of notebooks.	 Device Holder

1.8 SAR System Verification

The microwave circuit arrangement for system verification is sketched in Fig. b. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within +/- 10% from the target SAR values. These tests were done at 2450/5200/5300/5600/5800 MHz. The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed in the table 1 (SAR values are normalized to 1W forward power delivered to the dipole). During the tests, the liquid depth above the ear reference points was ≥ 15 cm ± 5 mm (frequency ≤ 3 GHz) or ≥ 10 cm ± 5 mm (frequency > 3 G Hz) in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.

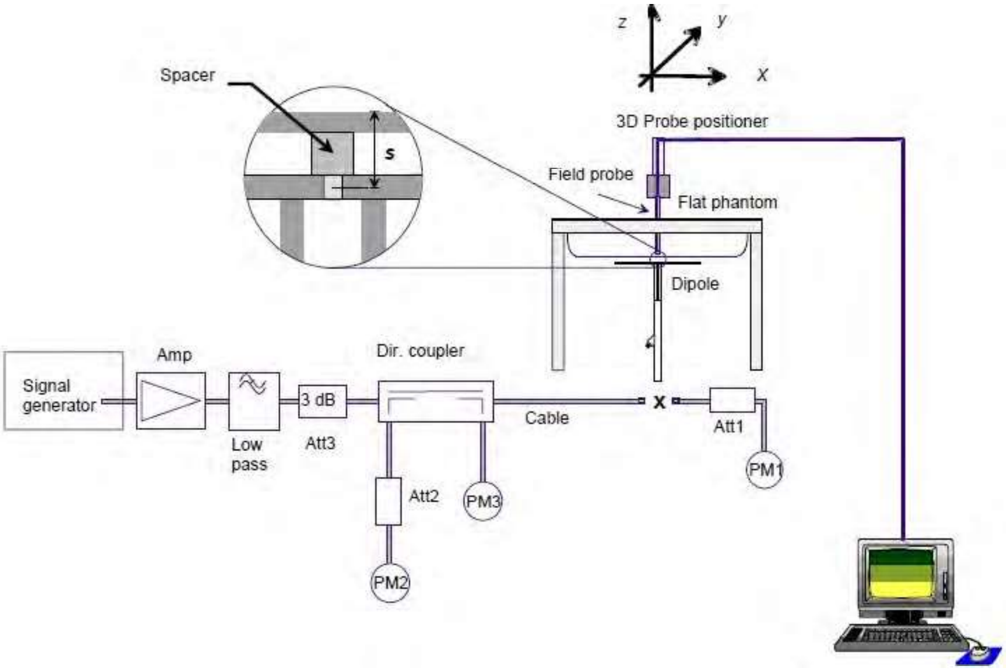


Fig. b The block diagram of system verification

Validation Kit	S/N	Frequency (MHz)		1W Target SAR-1g (mW/g)	pin=250mW Measured SAR-1g (mW/g)	Measured SAR-1g normalized to 1W (mW/g)	Deviation (%)	Measured Date
D2450V2	727	2450	Head	53.9	13.10	52.4	-2.78%	Oct. 27, 2021

Validation Kit	S/N	Frequency (MHz)		1W Target SAR-1g (mW/g)	Pin=100mW Measured SAR-1g (mW/g)	Measured SAR-1g normalized to 1W (mW/g)	Deviation (%)	Measured Date
D5GHzV2	1023	5200	Head	77.9	7.80	78	0.13%	Oct. 27, 2021
		5300	Head	80.4	7.94	79.4	-1.24%	Oct. 27, 2021
		5600	Head	83.9	8.34	83.4	-0.60%	Oct. 28, 2021
		5800	Head	80.9	7.85	78.5	-2.97%	Oct. 28, 2021

Table 1. Results of system validation

1.9 Tissue Simulant Fluid for the Frequency Band

The dielectric properties for this Head-simulant fluid were measured by using the SPEAG Dielectric Assessment Kit (DAKS-3.5)

All dielectric parameters of tissue simulates were measured within 24 hours of SAR measurements. The measured conductivity and permittivity are all within ± 5% of the target values.

The depth of the tissue simulant in the flat section of the phantom was ≥ 15 cm ± 5 mm (Frequency ≤3G) or ≥ 10 cm ± 5 mm (Frequency >3G) during all tests. (Fig. 2)

Tissue Type	Measurement Date	Measured Frequency (MHz)	Target Dielectric Constant, εr	Target Conductivity, σ (S/m)	Measured Dielectric Constant, εr	Measured Conductivity, σ (S/m)	% dev εr	% dev σ
Head	Oct. 27, 2021	2402	39.285	1.757	38.134	1.803	-2.93%	2.62%
		2417	39.259	1.771	38.105	1.816	-2.94%	2.54%
		2437	39.223	1.788	38.075	1.831	-2.93%	2.40%
		2441	39.216	1.792	38.072	1.834	-2.92%	2.34%
		2450	39.200	1.800	38.062	1.842	-2.90%	2.33%
		2457	39.191	1.808	38.053	1.847	-2.90%	2.16%
		2480	39.147	1.827	38.011	1.876	-2.90%	2.68%
		5190	35.997	4.645	35.589	4.576	-1.13%	-1.49%
		5200	35.986	4.655	35.561	4.589	-1.18%	-1.42%
		5210	35.974	4.665	35.538	4.603	-1.21%	-1.33%
		5230	35.951	4.686	35.512	4.641	-1.22%	-0.96%
		5270	35.906	4.727	35.428	4.697	-1.33%	-0.63%
		5300	35.871	4.758	35.323	4.739	-1.53%	-0.40%
		5310	35.860	4.768	35.301	4.757	-1.56%	-0.23%
	Oct. 28, 2021	5530	35.609	4.993	34.974	5.035	-1.78%	0.84%
		5600	35.529	5.065	34.777	5.131	-2.12%	1.30%
		5690	35.426	5.157	34.583	5.255	-2.38%	1.90%
		5755	35.351	5.224	34.512	5.341	-2.37%	2.24%
		5775	35.329	5.244	34.443	5.367	-2.51%	2.35%
		5795	35.306	5.265	34.379	5.401	-2.63%	2.58%
		5800	35.300	5.270	34.313	5.406	-2.80%	2.58%

Table 2. Dielectric Parameters of Tissue Simulant Fluid

The composition of the tissue simulating liquid:

Frequency (MHz)	Mode	Ingredient						Total amount
		DGMBE	Water	Salt	Preventol D-7	Cellulose	Sugar	
2450M	Head	550ml	450ml	—	—	—	—	1.0L(Kg)

Body Simulating Liquids for 5 GHz, Manufactured by SPEAG:

Ingredients	Water	Esters, Emulsifiers, Inhibitors	Sodium and Salt
(% by weight)	60-80	20-40	0-1.5

Table 3. Recipes for Tissue Simulating Liquid

1.10 Evaluation Procedures

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

1. The extraction of the measured data (grid and values) from the Zoom Scan.
2. The calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. The generation of a high-resolution mesh within the measured volume
4. The interpolation of all measured values from the measurement grid to the high-resolution grid
5. The extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. The calculation of the averaged SAR within masses of 1g and 10g.

The probe is calibrated at the center of the dipole sensors that is located 1 to 2.7mm away from the probe tip. During measurements, the probe stops shortly above the phantom surface, depending on the probe and the surface detecting system. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated. The angle between the probe axis and the surface normal line is less than 30 degree.

In the Area Scan, the gradient of the interpolation function is evaluated to find all the extreme of the SAR distribution. The uncertainty on the locations of the extreme is less than 1/20 of the grid size. Only local maximum within –2 dB of the global maximum are searched and passed for the Cube Scan measurement. In the Cube Scan, the interpolation function is used to extrapolate the Peak SAR from the lowest measurement points to the inner phantom surface (the extrapolation distance). The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5mm.

The maximum search is automatically performed after each area 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 area scanning 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. The 1g and 10g peak evaluations are only available for the predefined cube 7x7x7 scans. The routines are verified and optimized for the grid dimensions used in these cube measurements.

The measured volume of 30x30x30mm contains about 30g of tissue.

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 the last step, a 1g cube is placed numerically into the volume and its averaged SAR is calculated. This cube is the moved around until the highest averaged SAR is found. 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.

1.11 Probe Calibration Procedures

For the calibration of E-field probes in lossy liquids, an electric field with an accurately known field strength must be produced within the measured liquid. For standardization purposes it would be desirable if all measurements which are necessary to assess the correct field strength would be traceable to standardized measurement procedures. In the following two different calibration techniques are summarized:

1.11.1 Transfer Calibration with Temperature Probes

In lossy liquids the specific absorption rate (SAR) is related both to the electric field (E) and the temperature gradient ($\delta T / \delta t$) in the liquid.

$$SAR = C \frac{\delta T}{\delta t},$$

whereby σ is the conductivity, ρ the density and c the heat capacity of the liquid.

Hence, the electric field in lossy liquid can be measured indirectly by measuring the temperature gradient in the liquid. Non-disturbing temperature probes (optical probes or thermistor probes with resistive lines) with high spatial resolution (<1-2 mm) and fast reaction time (<1 s) are available and can be easily calibrated with high precision [1]. The setup and the exciting source have no influence on the calibration; only the relative positioning uncertainties of the standard temperature probe and the E-field probe to be calibrated must be considered. However, several problems limit the available accuracy of probe calibrations with temperature probes:

- The temperature gradient is not directly measurable but must be evaluated from temperature measurements at different time steps. Special precaution is necessary to avoid measurement errors caused by temperature gradients due to energy equalizing effects or convection currents in the liquid. Such effects cannot be completely avoided, as the measured field itself destroys the thermal equilibrium in the liquid. With a careful setup these errors can be kept small.
- The measured volume around the temperature probe is not well defined. It is difficult to calculate the energy transfer from a surrounding gradient temperature field into the probe. These effects must be considered, since temperature probes are calibrated in liquid with homogeneous temperatures. There is no traceable standard for temperature rise measurements.
- The calibration depends on the assessment of the specific density, the heat capacity and the conductivity of the medium. While the specific density and heat capacity can be measured accurately with standardized procedures (~ 2% for c; much better for ρ) , there is no standard for the measurement of the conductivity. Depending on the method and liquid, the error can well exceed ±5%.
- Temperature rise measurements are not very sensitive and therefore are often performed at a higher power level than the E-field measurements. The nonlinearities in the system (e.g., power measurements, different components, etc.) must be considered.

Considering these problems, the possible accuracy of the calibration of E-field probes with temperature gradient measurements in a carefully designed setup is about ±10% (RSS) [2]. Recently, a setup which is a combination of the waveguide techniques and the thermal measurements was presented in [3]. The estimated uncertainty of the setup is ±5% (RSS) when the same liquid is used for the calibration and for actual measurements and ±7-9% (RSS) when not, which is in good agreement with the estimates given in [2].

1.11.2 Calibration with Analytical Fields

In this method a technical setup is used in which the field can be calculated analytically from measurements of other physical magnitudes (e.g., input power). This corresponds to the standard field method for probe calibration in air; however, there is no standard defined for fields in lossy liquids.
When using calculated fields in lossy liquids for probe calibration, several points must be considered in the assessment of the uncertainty:

- The setup must enable accurate determination of the incident power.
- The accuracy of the calculated field strength will depend on the assessment of the dielectric parameters of the liquid.
- Due to the small wavelength in liquids with high permittivity, even small

setups might be above the resonant cutoff frequencies. The field distribution in the setup must be carefully checked for conformity with the theoretical field distribution.

References

1. N. Kuster, Q. Balzano, and J.C. Lin, Eds., *Mobile Communications Safety*, Chapman & Hall, London, 1997.
2. K. Meier, M. Burkhardt, T. Schmid, and N. Kuster, \Broadband calibration of E-field probes in lossy media", *IEEE Transactions on Microwave Theory and Techniques*, vol. 44, no. 10, pp. 1954{1962, Oct. 1996.
3. K. Jokela, P. Hyysalo, and L. Puranen, \Calibration of specific absorption rate (SAR) probes in waveguide at 900 MHz", *IEEE Transactions on Instrumentation and Measurements*, vol. 47, no. 2, pp. 432{438, Apr. 1998.

1.12 Test Standards and Limits

According to FCC 47CFR §2.1093(d) The limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (''SAR'') in Section 4.2 of ''IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz,'' ANSI/IEEE C95.1, By the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in ''Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields,'' NCRP Report No. 86, Section 17.4.5. Copyright NCRP, 1986, Bethesda, Maryland 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards. The criteria to be used are specified in paragraphs (d)(1) and (d)(2) of this section and shall apply for portable devices transmitting in the frequency range from 100 kHz to 6 GHz. Portable devices that transmit at frequencies above 6 GHz are to be evaluated in terms of the MPE limits specified in § 1.1310 of this chapter. Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 GHz should be made at a minimum distance of 5 cm from the radiating source.

(1) Limits for Occupational/Controlled exposure: 0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over an 10 grams of tissue (defined as a tissue volume in the shape of a cube).

(2) Occupational/Controlled limits apply when persons are exposed as a consequence of their employment provided these persons are fully aware of and exercise control over their exposure. Awareness of exposure can be accomplished by use of warning labels or by specific training or education through appropriate means, such as an RF safety program in a work environment.

(3) Limits for General Population/Uncontrolled exposure: 0.08 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). General Population/Uncontrolled limits apply when the general public may be exposed, or when persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or do not

exercise control over their exposure. Warning labels placed on consumer devices such as cellular telephones will not be sufficient reason to allow these devices to be evaluated subject to limits for occupational/controlled exposure in paragraph (d)(1) of this section. (Table 4.)

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
Spatial Peak SAR (Brain)	1.60 W/kg	8.00 W/kg
Spatial Average SAR (Whole Body)	0.08 W/kg	0.40 W/kg
Spatial Peak SAR (Hands/Feet/Ankle/Wrist)	4.00 W/kg	20.00 W/kg

Table 4. RF exposure limits

Notes:

1. Uncontrolled environments are defined as locations where there is potential exposure of individuals who have no knowledge or control of their potential exposure.
2. Controlled environments are defined as locations where there is potential exposure of individuals who have knowledge of their potential exposure and can exercise control over their exposure.

2. Summary of Results

2.1 Decision rules

Reported measurement data comply with IEEE 1528-2013:
Determining compliance shall be based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

2.2 Summary of Results

Antenna	Mode	Position	Distance (mm)	CH	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power (dBm)	Duty cycle scaling	Power scaling	Averaged SAR over 1g (W/kg)		Plot page
										Measured	Reported	
Tx1	WLAN 802.11b	Bottom Surface	0	2	2417	20.50	19.48	1.04	126.47%	0.609	0.799	-
		Bottom Surface	0	6	2437	20.50	19.40	1.04	128.82%	0.617	0.824	-
		Bottom Surface	0	10	2457	20.50	19.49	1.04	126.18%	0.638	0.835	43
	WLAN 802.11n(40M) 5.2G	Bottom Surface	0	38	5190	16.00	14.93	1.04	127.94%	0.846	1.128	-
		Bottom Surface	0	46	5230	16.00	14.90	1.04	128.82%	0.872	1.171	44
		Bottom Surface*	0	46	5230	16.00	14.90	1.04	128.82%	0.867	1.164	-
	WLAN 802.11ac(80M) 5.2G	Bottom Surface	0	42	5210	16.00	14.97	1.05	126.77%	0.851	1.136	45
		Bottom Surface*	0	42	5210	16.00	14.97	1.05	126.77%	0.847	1.131	-
	WLAN 802.11n(40M) 5.3G	Bottom Surface	0	54	5270	16.00	14.91	1.04	128.53%	0.774	1.037	46
		Bottom Surface	0	62	5310	16.00	14.95	1.04	127.35%	0.730	0.969	-
	WLAN 802.11ac(80M) 5.6G	Bottom Surface	0	106	5530	15.00	13.98	1.05	126.47%	0.697	0.928	-
		Bottom Surface	0	138	5690	15.00	13.95	1.05	127.35%	0.831	1.114	47
		Bottom Surface*	0	138	5690	15.00	13.95	1.05	127.35%	0.827	1.109	-
	WLAN 802.11ac(40M) 5.8G	Bottom Surface	0	151	5755	16.50	15.57	1.04	123.88%	0.910	1.175	48
		Bottom Surface	0	159	5795	16.50	15.44	1.04	127.64%	0.871	1.157	-
		Bottom Surface*	0	151	5755	16.50	15.57	1.04	123.88%	0.905	1.168	-
	WLAN 802.11ac(80M) 5.8G	Bottom Surface	0	155	5775	16.50	15.49	1.05	126.18%	0.863	1.147	49
		Bottom Surface*	0	155	5775	16.50	15.49	1.05	126.18%	0.858	1.140	-
Tx2	WLAN 802.11b	Bottom Surface	0	2	2417	21.00	19.92	1.04	128.23%	0.458	0.609	-
		Bottom Surface	0	6	2437	21.00	19.95	1.04	127.35%	0.463	0.611	-
		Bottom Surface	0	10	2457	21.00	19.98	1.04	126.47%	0.475	0.623	50
	Bluetooth(GFSK)	Bottom Surface	0	78	2480	10.50	9.95	1.41	113.50%	0.032	0.051	51
	WLAN 802.11n(40M) 5.2G	Bottom Surface	0	38	5190	16.50	15.46	1.04	127.06%	0.632	0.837	-
		Bottom Surface	0	46	5230	16.50	15.48	1.04	126.47%	0.658	0.867	52
	WLAN 802.11ac(80M) 5.2G	Bottom Surface	0	42	5210	16.50	15.49	1.05	126.18%	0.648	0.861	53
	WLAN 802.11n(40M) 5.3G	Bottom Surface	0	54	5270	16.50	15.48	1.04	126.47%	0.622	0.820	-
		Bottom Surface	0	62	5310	16.50	15.49	1.04	126.18%	0.630	0.828	54
	WLAN 802.11ac(80M) 5.6G	Bottom Surface	0	106	5530	16.50	15.46	1.05	127.06%	0.664	0.888	-
		Bottom Surface	0	138	5690	16.50	15.49	1.05	126.18%	0.704	0.935	55
	WLAN 802.11n(40M) 5.8G	Bottom Surface	0	151	5755	17.50	16.48	1.04	126.47%	0.807	1.064	-
		Bottom Surface	0	159	5795	17.50	16.44	1.04	127.64%	0.840	1.117	56
		Bottom Surface*	0	159	5795	17.50	16.44	1.04	127.64%	0.835	1.111	-

Note:

$$\text{Scaling} = \frac{\text{reported SAR}}{\text{measured SAR}} = \frac{\text{P2(mW)}}{\text{P1(mW)}} = 10^{\left(\frac{\text{P2}-\text{P1}}{10}\right)(\text{dBm})}$$

Reported SAR = measured SAR * (scaling)

Where P2 is maximum specified power, P1 is measured conducted power

2.3 Reporting statements of conformity

The conformity statement in this report is based solely on the test results, measurement uncertainty is excluded.

3. Simultaneous Transmission Analysis

Simultaneous Transmission Scenarios:

Simultaneous Transmit Configurations	Body
2.4G TX1+2.4G TX2	Yes
5G TX1+5G TX2	Yes
5G TX1+BT	Yes
5G TX1+5G TX2+BT	Yes

Note:
1. For 2.4/5GHz WLAN Main and Aux antennas, the maximum output power of each antenna during simultaneous transmission is the same with (or less than) that used in standalone transmission, and we used the sum of 1-g SAR provision in KDB447498D01 to exclude the simultaneous transmitted SAR measurement.

3.1 Estimated SAR calculation

According to KDB447498 D01v06 – When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

$$\text{Estimated SAR} = \frac{\text{Max. tune up power (mW)}}{\text{Min. test separation distance(mm)}} \times \frac{\sqrt{\text{f(GHz)}}}{7.5}$$

If the minimum test separation distance is < 5mm, a distance of 5mm is used for estimated SAR calculation. When the test separation distance is >50mm, the 0.4W/kg is used for SAR-1g.

3.2 SPLSR evaluation and analysis

Per KDB447498D01, when the sum of SAR is larger than the limit, SAR test exclusion is determined by the SAR sum to peak location separation ratio(SPLSR).

The simultaneous transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SAR to peak location separation ratio to qualify for test exclusion.

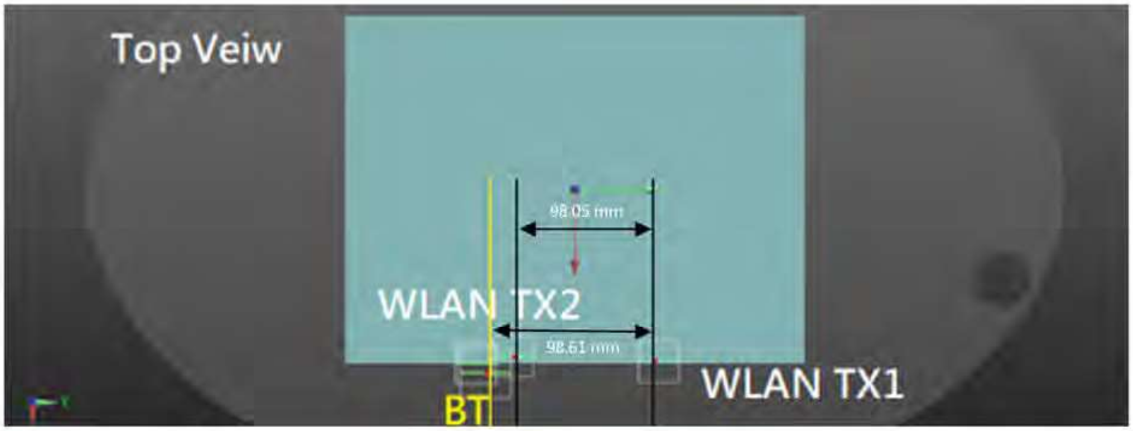
The ratio is determined by **(SAR1 + SAR2)^1.5/Ri**, rounded to two decimal digits, and must be **≤ 0.04** for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion.

SAR1 and SAR2 are the highest reported or estimated SAR for each antenna in the pair, and Ri is the separation distance between the peak SAR locations for the antenna pair in mm.

When standalone test exclusion applies, SAR is estimated; the peak location is assumed to be at the feed-point or geometric center of the antenna.

		Reported SAR					Scenario 1	Scenario 2	Scenario 3	Scenario 4	
Exposure Position		1	2	3	4	5	1+2 Summed 1g SAR (W/kg)	3+4 Summed 1g SAR (W/kg)	3+5 Summed 1g SAR (W/kg)	3+4+5 Summed 1g SAR (W/kg)	SPLSR
		2.4GHz WLAN TX1_Main_ChainB	2.4GHz WLAN TX2_Aux_ChainA	5GHz WLAN TX1_Main_ChainB	5GHz WLAN TX2_Aux_ChainA	Bluetooth TX2_Aux_ChainA					
		1g SAR (W/kg)	1g SAR (W/kg)	1g SAR (W/kg)	1g SAR (W/kg)	Estimated 1g SAR (W/kg)					
Bottom Surface	0	0.835	0.623	1.175	1.117	0.051	**1.458**	**2.292**	**1.220**	**2.337**	**Analysis as below**

Scenario 5: 3+4+5									
Position	Conditions	SAR Value (W/kg)	Coordinates (cm)			ΣSAR (W/kg)	Peak Location Separation Distance (mm)	SPLSR	Simultaneous Transmission SAR Test
			x	y	z				
Bottom Surface	5GHz WLAN TX1_Main_ChainB	1.175	103.20	57.40	-0.20	-	-	-	-
	5GHz WLAN TX2_Aux_ChainA+BT	1.162	100.20	-40.60	0.76	2.337	98.05	0.036	SPLSR ≤ 0.04, Not required



4. Instruments List

Manufacturer	Device	Type	Serial number	Date of last calibration	Date of next calibration
SPEAG	Dosimetric E-Field Probe	EX3DV4	7466	Jan.29,2021	Jan.28,2022
SPEAG	System Validation Dipole	D2450V2	727	Apr.14,2021	Apr.13,2022
		D5GHzV2	1023	Jan.26,2021	Jan.25,2022
SPEAG	Data acquisition Electronics	DAE4	1665	Mar.01,2021	Feb.28,2022
SPEAG	Software	DASY52 4.7.80	N/A	Calibration not required	Calibration not required
SPEAG	Phantom	ELI	N/A	Calibration not required	Calibration not required
SPEAG	Dielectric Assessment Kit	DAKS-3.5	1053	Feb.17,2021	Feb.16,2022
Agilent	Dual-directional coupler	772D	MY46151242	Aug.16.2021	Aug.15.2022
		778D	MY48220468	Aug.16.2021	Aug.15.2022
Agilent	Signal Generator	N5181A	MY50141235	May.30,2021	May.29,2022
Agilent	Power Meter	E4417A	MY51410006	Mar.23,2021	Mar.22,2022
Agilent	Power Sensor	E9301H	MY51470001	Mar.23,2021	Mar.22,2022
			MY51470002	Mar.23,2021	Mar.22,2022
TECPEL	Digital thermometer	DTM-303A	TP130074	Apr.26,2021	Apr.25,2022

5. Measurements

Date: 2021/10/27

Report No. :E5/2021/A0015

WLAN 802.11b, Body, Bottom Surface, CH 10, 0mm, TX1

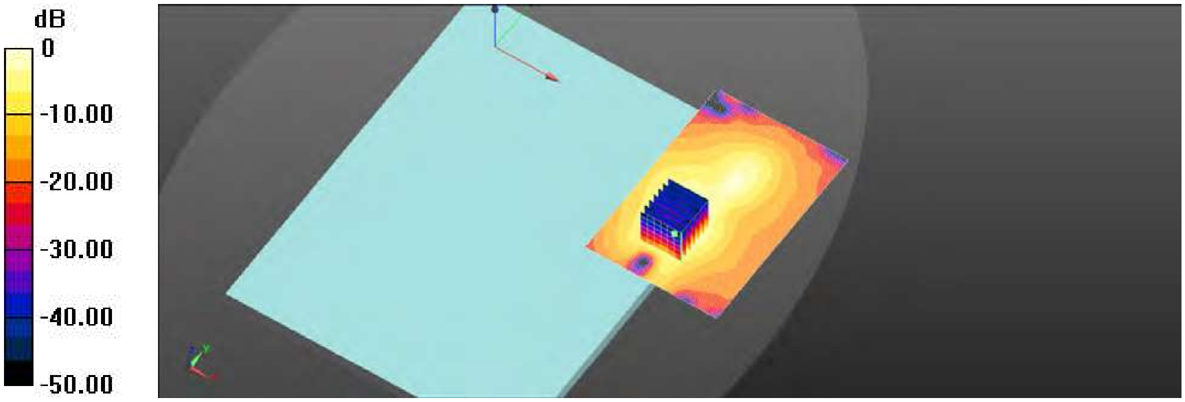
Communication System: WLAN 2.45G; Frequency: 2457 MHz; Duty cycle= 1:1.037
Medium parameters used: f = 2457 MHz; σ = 1.847 S/m; ε_r = 38.053; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 22.1°C; Liquid temperature: 22.4°C

DASY5 Configuration:

- Probe: EX3DV4 - SN7466; ConvF(8.08, 8.08, 8.08) @ 2457 MHz; Calibrated: 2021/1/29
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1665; Calibrated: 2021/3/1
- Phantom: ELI
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (81x121x1): Interpolated grid: dx=12 mm, dy=12 mm
Maximum value of SAR (interpolated) = 1.00 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.642 V/m; Power Drift = 0.12 dB
Peak SAR (extrapolated) = 1.49 W/kg
SAR(1 g) = 0.638 W/kg; SAR(10 g) = 0.287 W/kg
Smallest distance from peaks to all points 3 dB below = 10.3 mm
Ratio of SAR at M2 to SAR at M1 = 43.4%
Maximum value of SAR (measured) = 1.04 W/kg



0 dB = 1.00 W/kg = 0.01 dBW/kg

Date: 2021/10/27

Report No. : E5/2021/A0015

WLAN 802.11n(40M) 5.2G, Body, Bottom Surface, CH 46, 0mm, TX1

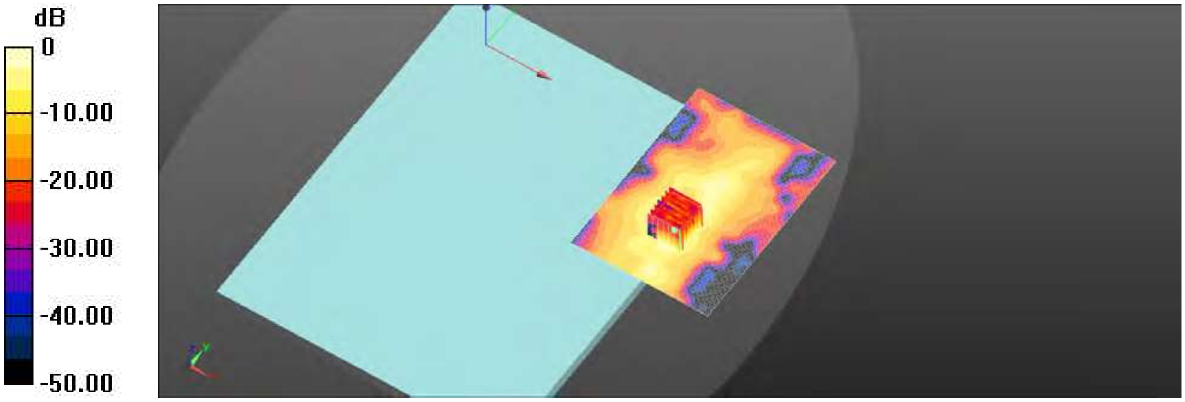
Communication System: WLAN 5G; Frequency: 5230 MHz; Duty cycle= 1:1.042
Medium parameters used: f = 5230 MHz; σ = 4.641 S/m; ε_r = 35.512; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 22.0°C; Liquid temperature: 22.2°C

DASY5 Configuration:

- Probe: EX3DV4 - SN7466; ConvF(5.6, 5.6, 5.6) @ 5230 MHz; Calibrated: 2021/1/29
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1665; Calibrated: 2021/3/1
- Phantom: ELI
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (101x141x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 1.30 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 4.654 V/m; Power Drift = 0.18 dB
Peak SAR (extrapolated) = 3.74 W/kg
SAR(1 g) = 0.872 W/kg; SAR(10 g) = 0.258 W/kg
Smallest distance from peaks to all points 3 dB below = 10.8 mm
Ratio of SAR at M2 to SAR at M1 = 56.6%
Maximum value of SAR (measured) = 1.64 W/kg



0 dB = 1.64 W/kg = 2.15 dBW/kg

Date: 2021/10/27

Report No. : E5/2021/A0015

WLAN 802.11ac(80M) 5.2G, Body, Bottom Surface, CH 42, 0mm, TX1

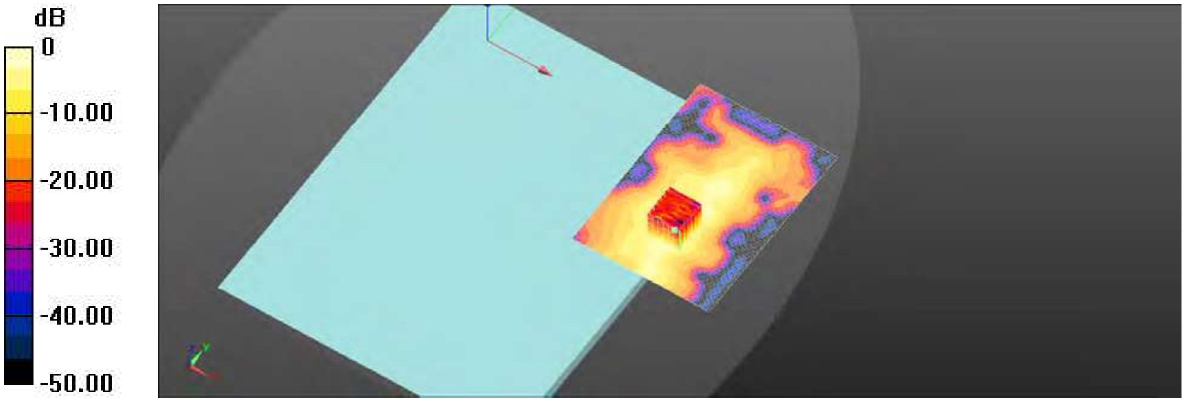
Communication System: WLAN 5G; Frequency: 5210 MHz; Duty cycle= 1:1.053
Medium parameters used: f = 5210 MHz; $\sigma = 4.603$ S/m; $\varepsilon_r = 35.538$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Ambient temperature: 22.0°C; Liquid temperature: 22.2°C

DASY5 Configuration:

- Probe: EX3DV4 - SN7466; ConvF(5.6, 5.6, 5.6) @ 5210 MHz; Calibrated: 2021/1/29
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1665; Calibrated: 2021/3/1
- Phantom: ELI
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (101x141x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 1.62 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 3.227 V/m; Power Drift = 0.11 dB
Peak SAR (extrapolated) = 3.26 W/kg
SAR(1 g) = 0.851 W/kg; SAR(10 g) = 0.270 W/kg
Smallest distance from peaks to all points 3 dB below = 6.8 mm
Ratio of SAR at M2 to SAR at M1 = 56.5%
Maximum value of SAR (measured) = 1.71 W/kg



0 dB = 1.71 W/kg = 2.33 dBW/kg

Date: 2021/10/27

Report No. :E5/2021/A0015

WLAN 802.11n(40M) 5.3G, Body, Bottom Surface, CH 54, 0mm, TX1

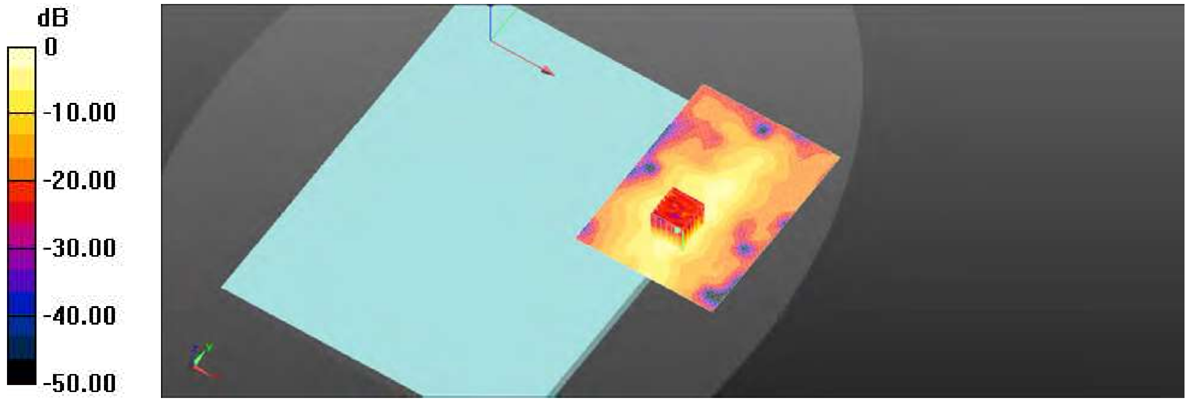
Communication System: WLAN 5G; Frequency: 5270 MHz; Duty cycle= 1:1.042
Medium parameters used: f = 5270 MHz; σ = 4.697 S/m; ε_r = 35.428; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.8°C; Liquid temperature: 22.1°C

DASY5 Configuration:

- Probe: EX3DV4 - SN7466; ConvF(5.5, 5.5, 5.5) @ 5270 MHz; Calibrated: 2021/1/29
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1665; Calibrated: 2021/3/1
- Phantom: ELI
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (101x141x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 1.48 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 2.428 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 3.02 W/kg
SAR(1 g) = 0.774 W/kg; SAR(10 g) = 0.246 W/kg
Smallest distance from peaks to all points 3 dB below = 6.6 mm
Ratio of SAR at M2 to SAR at M1 = 55.9%
Maximum value of SAR (measured) = 1.57 W/kg



0 dB = 1.57 W/kg = 1.96 dBW/kg

Date: 2021/10/28

Report No. :E5/2021/A0015

WLAN 802.11ac(80M) 5.6G, Body, Bottom Surface, CH 138, 0mm, TX1

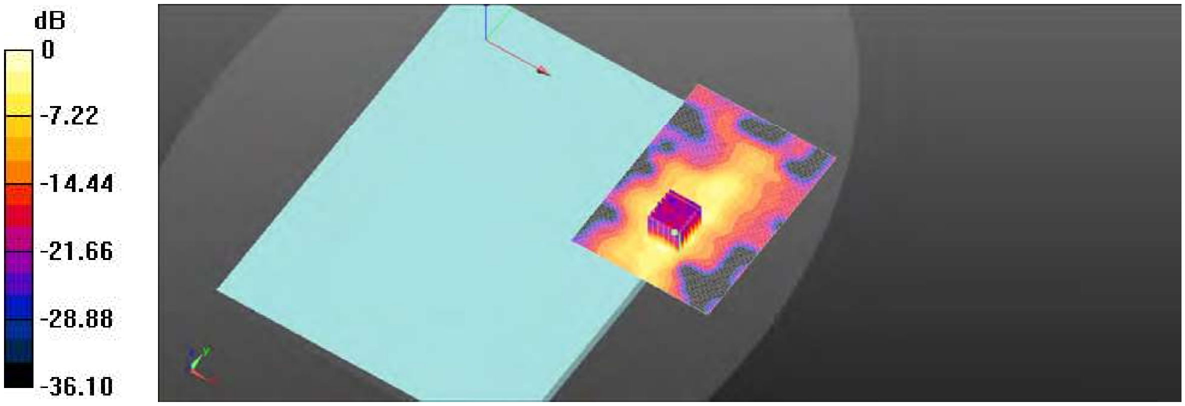
Communication System: WLAN 5G; Frequency: 5690 MHz; Duty cycle= 1:1.053
Medium parameters used: f = 5690 MHz; σ = 5.255 S/m; ε_r = 34.583; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.6°C; Liquid temperature: 21.9°C

DASY5 Configuration:

- Probe: EX3DV4 - SN7466; ConvF(5.04, 5.04, 5.04) @ 5690 MHz; Calibrated: 2021/1/29
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1665; Calibrated: 2021/3/1
- Phantom: ELI
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (101x141x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 1.68 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 3.414 V/m; Power Drift = 0.16 dB
Peak SAR (extrapolated) = 3.42 W/kg
SAR(1 g) = 0.831 W/kg; SAR(10 g) = 0.262 W/kg
Smallest distance from peaks to all points 3 dB below = 8 mm
Ratio of SAR at M2 to SAR at M1 = 53.3%
Maximum value of SAR (measured) = 1.62 W/kg



0 dB = 1.62 W/kg = 2.10 dBW/kg

Date: 2021/10/28

Report No. : E5/2021/A0015

WLAN 802.11ac(40M) 5.8G, Body, Bottom Surface, CH 151, 0mm, TX1

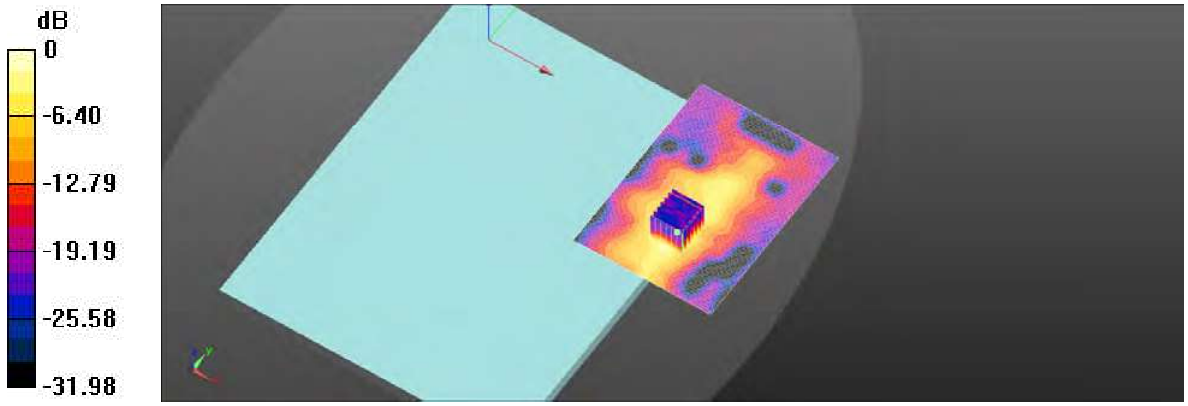
Communication System: WLAN 5G; Frequency: 5755 MHz; Duty cycle= 1:1.042
Medium parameters used: f = 5755 MHz; $\sigma = 5.341$ S/m; $\varepsilon_r = 34.512$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.5°C; Liquid temperature: 21.7°C

DASY5 Configuration:

- Probe: EX3DV4 - SN7466; ConvF(5.02, 5.02, 5.02) @ 5755 MHz; Calibrated: 2021/1/29
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1665; Calibrated: 2021/3/1
- Phantom: ELI
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (101x141x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 1.81 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 3.242 V/m; Power Drift = 0.13 dB
Peak SAR (extrapolated) = 3.74 W/kg
SAR(1 g) = 0.910 W/kg; SAR(10 g) = 0.295 W/kg
Smallest distance from peaks to all points 3 dB below = 8 mm
Ratio of SAR at M2 to SAR at M1 = 52.9%
Maximum value of SAR (measured) = 1.76 W/kg



0 dB = 1.76 W/kg = 2.46 dBW/kg

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.
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台灣檢驗科技股份有限公司 t (886-2) 2299-3279 f (886-2) 2298-0488 www.sgs.com.tw
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Date: 2021/10/28

Report No. : E5/2021/A0015

WLAN 802.11ac(80M) 5.8G, Body, Bottom Surface, CH 155, 0mm, TX1

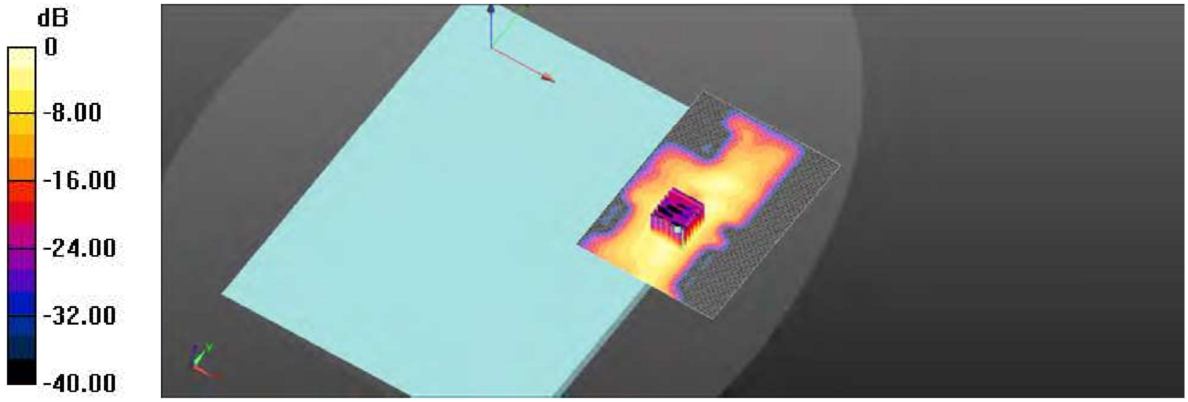
Communication System: WLAN 5G; Frequency: 5775 MHz; Duty cycle= 1:1.053
Medium parameters used: f = 5775 MHz; σ = 5.367 S/m; ε_r = 34.443; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 21.5°C; Liquid temperature: 21.7°C

DASY5 Configuration:

- Probe: EX3DV4 - SN7466; ConvF(5.02, 5.02, 5.02) @ 5775 MHz; Calibrated: 2021/1/29
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1665; Calibrated: 2021/3/1
- Phantom: ELI
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (101x141x1): Interpolated grid: dx=10 mm, dy=10 mm
Maximum value of SAR (interpolated) = 1.67 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 3.554 V/m; Power Drift = 0.16 dB
Peak SAR (extrapolated) = 3.65 W/kg
SAR(1 g) = 0.863 W/kg; SAR(10 g) = 0.271 W/kg
Smallest distance from peaks to all points 3 dB below = 7.6 mm
Ratio of SAR at M2 to SAR at M1 = 51.3%
Maximum value of SAR (measured) = 1.75 W/kg



0 dB = 1.75 W/kg = 2.43 dBW/kg

Date: 2021/10/27

Report No. :E5/2021/A0015

WLAN 802.11b, Body, Bottom Surface, CH 10, 0mm, TX2

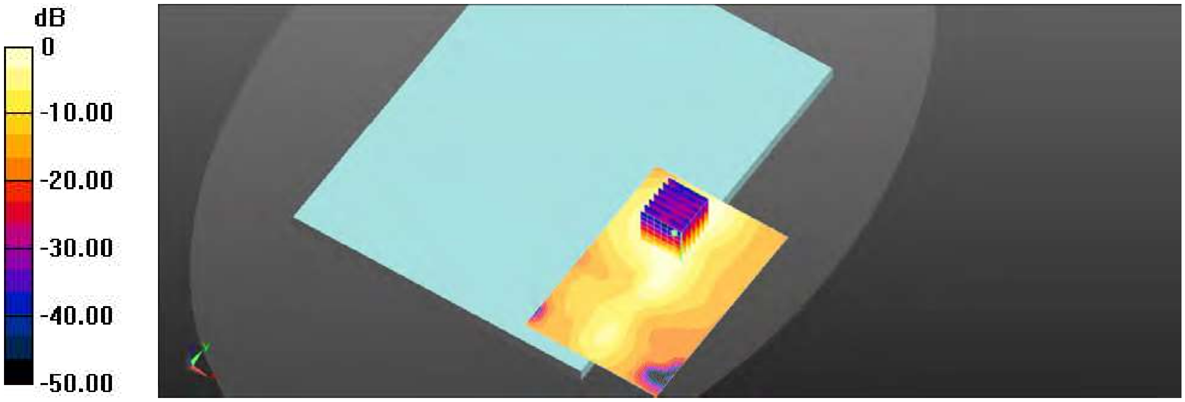
Communication System: WLAN 2.45G; Frequency: 2457 MHz; Duty cycle= 1:1.037
Medium parameters used: f = 2457 MHz; σ = 1.847 S/m; ε_r = 38.053; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient temperature: 22.1°C; Liquid temperature: 22.4°C

DASY5 Configuration:

- Probe: EX3DV4 - SN7466; ConvF(8.08, 8.08, 8.08) @ 2457 MHz; Calibrated: 2021/1/29
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1665; Calibrated: 2021/3/1
- Phantom: ELI
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (81x121x1): Interpolated grid: dx=12 mm, dy=12 mm
Maximum value of SAR (interpolated) = 0.662 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.289 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 0.904 W/kg
SAR(1 g) = 0.475 W/kg; SAR(10 g) = 0.239 W/kg
Smallest distance from peaks to all points 3 dB below = 9 mm
Ratio of SAR at M2 to SAR at M1 = 55.2%
Maximum value of SAR (measured) = 0.683 W/kg



0 dB = 0.662 W/kg = -1.79 dBW/kg