FCC SAR Test Report

FCC ID: Q95ER27

Report No.	:	BTL-FCC SAR-1-2012T154
Equipment	:	Insyde
Model Name	:	Insyde
Brand Name	:	Cardo Systems, LTD
Applicant	:	Cardo Systems, LTD
Address	:	101 E. Park Blvd., Suite 600, Plano TX, 75074, USA
Date of Receipt	:	December. 24, 2020
Date of Test	:	January. 13, 2021
Issued Date	:	February. 2, 2021

The above equipment has been tested and found in compliance with the requirement of the above standards by BTL Inc.

Prepared by :

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Testing Laboratory
0659

Approved by :

Peter Chen, Section Manager

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Declaration

BTL represents to the client that testing is done in accordance with standard procedures as applicable and that test instruments used has been calibrated with standards traceable to international standard(s) and/or national standard(s).

BTL's reports apply only to the specific samples tested under conditions. It is manufacture's responsibility to ensure that additional production units of this model are manufactured with the identical electrical and mechanical components. **BTL** shall have no liability for any declarations, inferences or generalizations drawn by the client or others from **BTL** issued reports.

The report must not be used by the client to claim product certification, approval, or endorsement by NIST, A2LA, or any agency of the U.S. Government.

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BTL's laboratory quality assurance procedures are in compliance with the **ISO/IEC 17025** requirements, and accredited by the conformity assessment authorities listed in this test report.

BTL is not responsible for the sampling stage, so the results only apply to the sample as received.

The information, data and test plan are provided by manufacturer which may affect the validity of results, so it is manufacturer's responsibility to ensure that the apparatus meets the essential requirements of applied standards and in all the possible configurations as representative of its intended use.

Limitation

For the use of the authority's logo is limited unless the Test Standard(s)/Scope(s)/Item(s) mentioned in this test report is (are) included in the conformity assessment authorities acceptance respective.

Please note that the measurement uncertainty is provided for informational purpose only and are not use in determining the Pass/Fail results.

REPORT ISSUED HISTORY

Report Version	Description	Issued Date
R00	Original Issue.	2021/1/25
R01	Revised antenna information. Revised exclusion calculations. Revised bluetooth names.	2021/2/2
R02	Revised battery information	2021/2/24

1. GENERAL INFORMATION

1.1. GENERAL DESCRIPTION OF EUT

<table>
<tr><td>Equipment</td><td colspan="2">Insyde</td></tr>
<tr><td>Brand Name</td><td colspan="2">Cardo Systems, LTD</td></tr>
<tr><td>Model Name</td><td colspan="2">Insyde</td></tr>
<tr><td>Battery Information</td><td colspan="2">Brand: Shenzhen EPT Battery Co., Ltd.
Model: 592653P 850mAh/3.7V BAT00007
Rating: 3.7V / 870mAh</td></tr>
<tr><td rowspan="2">Frequency Range</td><td>Bluetooth:</td><td>2402 MHz ~ 2480 MHz</td></tr>
<tr><td>Zigbee:</td><td>2405 MHz</td></tr>
<tr><td>Standard(s)</td><td colspan="2">KDB447498 D01 General RF Exposure Guidance v06
KDB248227 D01 802.11 Wi-Fi SAR v02r02
KDB865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
KDB865664 D02 SAR Reporting v01r02
ANSI Std C95.1:2019 Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.</td></tr>
</table>

The above equipment has been tested and found compliance with the requirement of the relative standards by BTL Inc.
The test data, data evaluation, and equipment configuration contained in our test report (Ref No. BTL-FCC-SAR-1-2012T154) were obtained utilizing the test procedures, test instruments, test sites that has been accredited by the Authority of TAF according to the ISO-17025 quality assessment standard and technical standard(s).

2. RF EMISSIONS MEASUREMENT

2.1. TEST FACILITY

The test facilities used to collect the test data in this report is **SAR Test room** at the location of No. 68-1, Ln. 169, Sec.2, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan.

2.2. MEASUREMENT UNCERTAINTY

Uncertainty Budget for Frequency range of 300 MHz to 3 GHz

Error Description	Uncertainty Value (± %)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)	Vi V_{eff}
Measurement System								
Probe Calibration	6.05	Normal	1	1	1	± 6.05 %	± 6.05 %	∞
Axial Isotropy	4.7	Rectangular	$\sqrt{3}$	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical Isotropy	9.6	Rectangular	$\sqrt{3}$	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary Effects	1	Rectangular	$\sqrt{3}$	1	1	± 0.6 %	± 0.6 %	∞
Linearity	4.7	Rectangular	$\sqrt{3}$	1	1	± 2.7 %	± 2.7 %	∞
Detection Limits	1	Rectangular	$\sqrt{3}$	1	1	± 0.6 %	± 0.6 %	∞
Modulation response	2.4	Rectangular	$\sqrt{3}$	1	1	±1.4 %	±1.4 %	∞
Readout Electronics	0.3	Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response Time	0.8	Rectangular	$\sqrt{3}$	1	1	± 0.5%	± 0.5 %	∞
Integration Time	2.6	Rectangular	$\sqrt{3}$	1	1	± 1.5 %	± 1.5 %	∞
RF Ambient – Noise	3	Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
RF Ambient– Reflections	3	Rectangula	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
Probe Positioner	0.4	Rectangular	$\sqrt{3}$	1	1	± 0.2 %	± 0.2 %	∞
Probe Positioning	2.9	Rectangular	$\sqrt{3}$	1	1	± 1.7 %	±1.7 %	∞
Max.SAR Evaluation	2	Rectangular	$\sqrt{3}$	1	1	± 1.15 %	± 1.15 %	∞
Test Sample Related								
Device Positioning	1.6 1.8	Normal	1	1	1	± 1.6 %	± 1.8 %	145
Device Holder	1.5 1.7	Normal	1	1	1	± 1.5 %	± 1.7 %	5
Power Drift	5.0	Rectangular	$\sqrt{3}$	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Setup								
Phantom Production Tolerances	6.1	Rectangular	$\sqrt{3}$	1	1	3.52	3.52	∞
SAR correction	1.9	Rectangular	$\sqrt{3}$	1	0.84	1.10	1.10	
Liquid Conductivity (mea.)	2.4	Rectangular	$\sqrt{3}$	0.78	0.71	1.08	1.08	∞
Liquid Permittivity (mea.)	2.4	Rectangular	$\sqrt{3}$	0.26	0.26	0.36	0.36	∞
Temp. unc. - Conductivity	3.4	Rectangular	$\sqrt{3}$	0.78	0.71	1.53	1.53	∞
Temp. unc. - Permittivity	0.4	Rectangular	$\sqrt{3}$	0.23	0.26	0.05	0.05	∞
Combined Standard Uncertainty (K = 1)						± 10.42 %	± 10.48 %	361
Expanded Uncertainty (K = 2)						**± 20.84 %**	**± 20.97 %**	

2.3 BlUETOOTH AND ZIGBEE ANTENNA INFORMATION:

Ant.	Brand	Model	Type	Function	Frequency Range (MHz)	Gain (dBi)
Big	N/A	N/A	PCB	BR/EDR	2400-2500	0.10
				Zigbee		
Small	RALTRON	RCA-5220-A0-TR	PIFA	BR/EDR	2400-2500	2.66
				BLE		

2.4 THE MAXIMUM SAR 1G VALUES

Band	Mode	Highest Body Reported SAR-1g(W/kg)
FHSS	**BR_DH5**	**0.0544**

Note:

1) The device is in compliance with Specific Absorption Rate(SAR)for general population uncontrolled exposure limits according to the FCC rule §2.1093, the ANSI C95.1:2019/IEEE C95.1:2019, the NCRP Report Number 86 for uncontrolled environment and had been tested in accordance with the measurement methods and procedures specified in IEEE Std 1528-2013 .

2.5 LABORATORY ENVIRONMENT

Temperature	Min. = 18ºC, Max. = 25ºC
Relative humidity	Min. = 30%, Max. = 70%
Ground system resistance	< 0.5Ω
Ambient noise is checked and found very low and in compliance with requirement of standards. Reflection of surrounding objects is minimized and in compliance with requirement of standards.	

2.6 MAIN TEST INSTRUMENTS

Item	Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Interval
1	Data Acquisition Electronics	Speag	DAE4	1486	June. 04, 2020	1 Year
2	E-field Probe	Speag	EX3DV4	7369	May. 29, 2020	1 Year
3	System Validation Dipole	Speag	D2450V2	973	Sep. 21, 2018	3 Year
4	ELI4 Phantom	Speag	ELI4 Phantom V5.0	1240	N/A	N/A
5	ENA Network Analyzer	Agilent	E5071C	MY46524658	Apr. 07, 2020	1 Year
6	EXG Vector Signal Generator	Agilent	N5172B	MY53051229	Jun. 20, 2020	1 Year
7	Spectrum Analyzer	Keysight	N9010A	MY54200240	Jun. 11, 2020	1 Year
8	Power Meter	Anritsu	ML2495A	1128008	Jun. 11, 2020	1 Year
9	Power Sensor	Anritsu	MA2411B	1126001	Jun. 11, 2020	1 Year
10	Dielectric Probe Kit	Agilent	85070E	2593	N/A	N/A
11	Low pass filter	Mini-Circuits	SLP-2950+	M108294	N/A	N/A
12	Power Amplifier	Mini-Circuits	ZVE-2W-272+	N650001538	N/A	N/A
13	Power Amplifier	Mini-Circuits	ZVE-8G+	N628801631	N/A	N/A

Remark: “N/A” denotes no model name, serial No. or calibration specified.

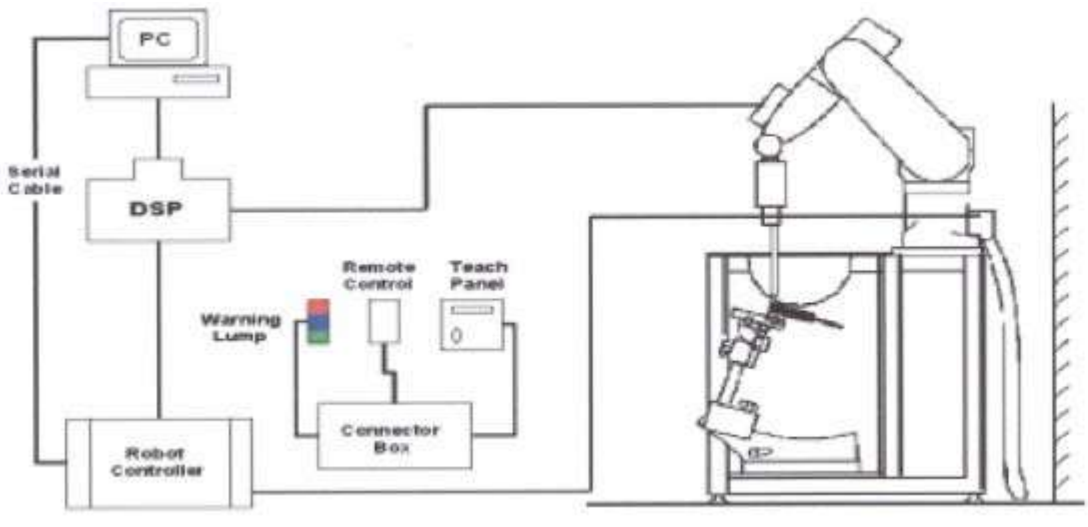
3. SAR MEASUREMENTS SYSTEM CONFIGURATION

3.1. SAR MEASUREMENT SET-UP

The DASY5 system for performing compliance tests consists of the following items:

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).
2. 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.
3. A data acquisition electronic (DAE) which performs the signal amplification, signal multiplexing, AD-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 EOC.
4. A unit to operate the optical surface detector which is connected to the EOC.
5. The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.
6. The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows.
7. DASY5 software and SEMCAD data evaluation software.
8. Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling the testing of left-hand and right-hand usage.
10. The device holder for handheld mobile phones.
11. Tissue simulating liquid mixed according to the given recipes.
12. System validation dipoles allowing to validate the proper functioning of the system.

3.1.1. TEST SETUP LAYOUT

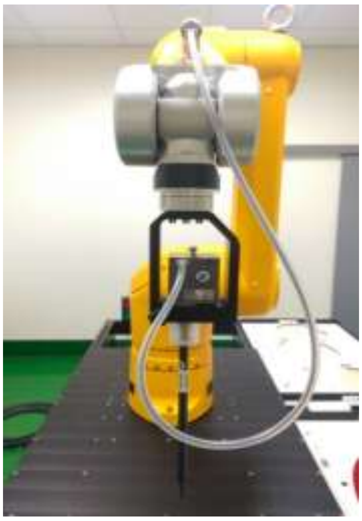


3.2. DASY5 E-FIELD PROBE SYSTEM

The SAR measurements were conducted with the dosimetric probe EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

3.2.1. EX3DV4 PROBE SPECIFICATION

Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available
Frequency	10 MHz to 6 GHz Linearity: ± 0.2 dB (30 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: ± 0.2dB
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Distance from probe tip to dipole centers: 1.0 mm



EX3DV4 E-field Probe

3.2.2. E-FIELD PROBE CALIBRATION

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than ±10%. The spherical isotropy was evaluated and found to be better than ± 0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1 GHz, and in a wave guide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$\mathbf{SAR} = \mathbf{C}\frac{\Delta T}{\Delta t}$$

Where: Δt = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

ΔT = Temperature increase due to RF exposure.

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

Where: σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m3).

3.2.3. OTHER TEST EQUIPMENT

3.2.3.1. DEVICE HOLDER FOR TRANSMITTERS

Construction: Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.) It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin SAM, ELI4 and SAM v6.0 Phantoms.
Material: POM, Acrylic glass, Foam

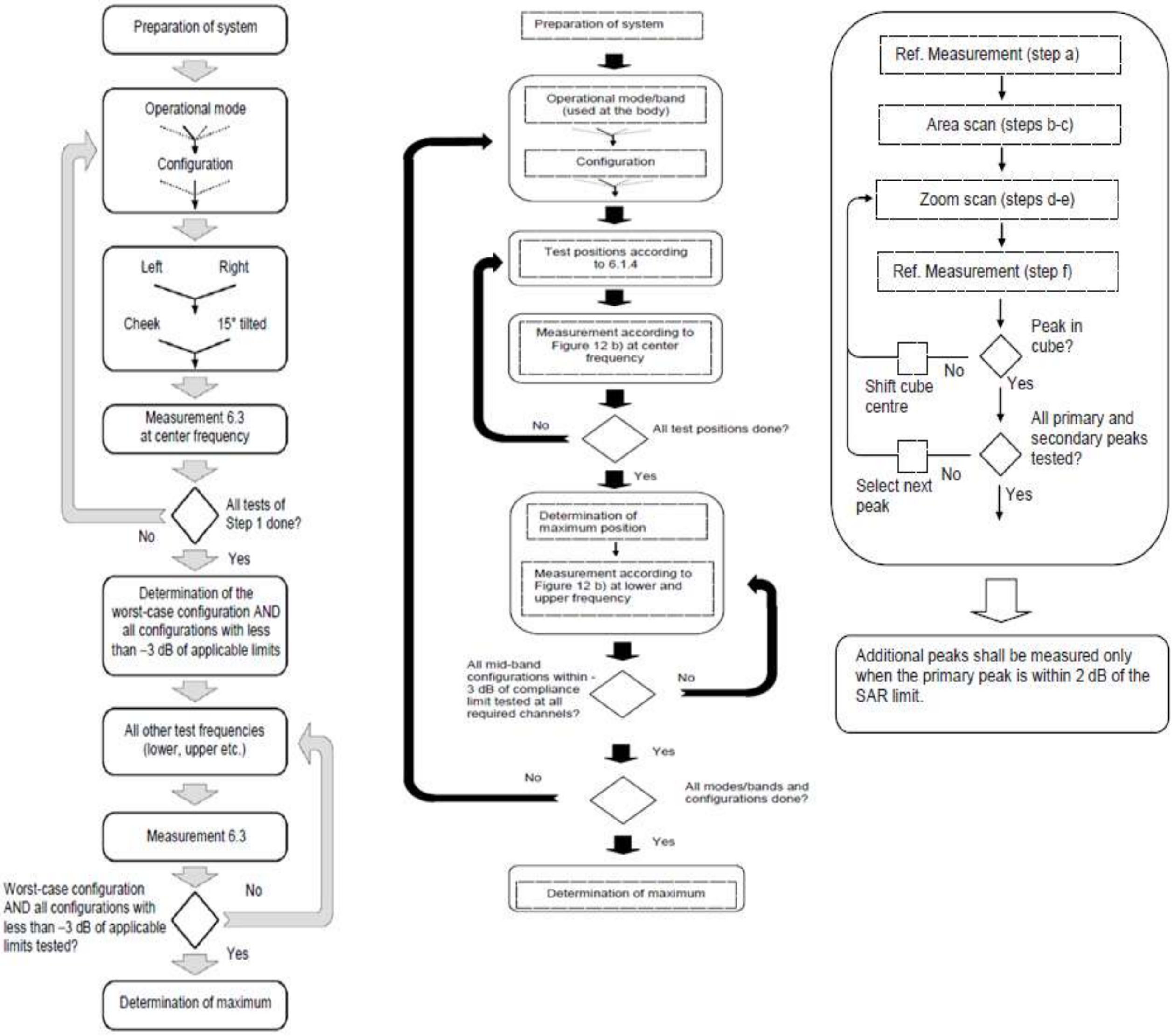
3.2.3.2 PHANTOM

Model	ELI4 Phantom	
Construction	Phantom 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±0.1 mm	
Filling Volume	Approx. 30 liters	
Dimensions	Length: 600 mm ; Width: 190mm Height: adjustable feet	
Aailable	Special	

Model	Twin SAM	
Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.	
Shell Thickness	2 ± 0.2 mm	
Filling Volume	Approx. 25 liters	
Dimensions	Length:1000mm; Width: 500mm Height: adjustable feet	
Aailable	Special	

3.2.4. SCANNING PROCEDURE

The SAR test against the head and body-worn phantom was carried out as follow:



After an area scan has been done at a fixed distance of 1.4mm from the surface of the phantom on the source side, a 3D scan is set up around the location of the maximum spot SAR. First, a point within the scan area is visited by the probe and a SAR reading taken at the start of testing. At the end of testing, the probe is returned to the same point and a second reading is taken. Comparison between these start and end readings enables the power drift during measurement to be assessed.

Above is the scanning procedure flow chart and table from the IEEE1528 standard.

This is the procedure for which all compliant testing should be carried out to ensure that all variations of the device position and transmission behavior are tested.

3.2.5. DATA STORAGE AND EVALUATION

3.2.5.1 DATA STORAGE

The DASY5 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension “DAE4”. The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

3.2.6. DATA EVALUATION BY SEMCAD

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

Probe parameters:	Sensitivity	Normi, a_{i0}, a_{i1}, a_{i2}
	Conversion factor	$ConvF_i$
	Diode compression point	Dcp_i
Device parameters:	Frequency	f
	Crest factor	cf
Media parameters:	Conductivity	
	Density	

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY5 components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

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

If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$Vi = Ui + Ui2 \cdot cf / dcpi$$

With	Vi = compensated signal of channel i	(i = x, y, z)
	Ui = input signal of channel i	(i = x, y, z)
	cf = crest factor of exciting field	(DASY parameter)
	dcpi = diode compression point	(DASY parameter)

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

E-field probes: Ei = (Vi / Normi · ConvF)1/2

H-field probes: Hi = (Vi)1/2 · (ai0 + ai1 f + ai2f2) / f

With V_i = compensated signal of channel i (i = x, y, z)

Normi = sensor sensitivity of channel i (i = x, y, z) [mV/(V/m)^2] for E-field Probes

ConvF = sensitivity enhancement in solution

aij = sensor sensitivity factors for H-field probes

f = carrier frequency [GHz]

Ei = electric field strength of channel i in V/m

Hi = magnetic field strength of channel i in A/m

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

Etot = (EX2+ EY2+ EZ2)1/2

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

SAR = (Etot) 2 · σ / (ρ· 1000)

With SAR = local specific absorption rate in mW/g

Etot = total field strength in V/m

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

= equivalent tissue density in g/cm3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid. The power flow density is calculated assuming the excitation field to be a free space field.

Ppwe = Etot2 / 3770 or Ppwe = Htot2 · 37.7

With Ppwe = equivalent power density of a plane wave in mW/cm

Etot = total field strength in V/m

Htot = total magnetic field strength in A/m

4. TISSUE-EQUIVALENT LIQUID

4.1. TISSUE-EQUIVALENT LIQUID INGREDIENTS

The liquid is consisted of water, salt and Glycol, Sugar, Preventol and Cellulose. The liquid has previously been proven to be suited for worst-case. The measured conductivity and relative permittivity should be within ±5% of the target values. The below table shows the detail solution. It’s satisfying the latest tissue dielectric parameters requirements proposed by the IEC 62209.

Composition of the Tissue Equivalent Matter

Tissue Type	Bactericide	DGBE	HEC	NaCl	Sucrose	Triton X-100	Water	Diethylene Glycol Mono-hexylether
Head 2450	-	45.0	-	0.1	-	-	54.9	-

4.2. TISSUE-EQUIVALENT LIQUID PROPERTIES

Dielectric Performance of Tissue Simulating Liquid

Tissue Verification									
Date	Tissue Type	Frequency (MHz)	Conductivity (σ)	Permittivity (εr)	Targeted Conductivity (σ)	Targeted Permittivity (εr)	Deviation Conductivity (σ) (%)	Deviation Permittivity (εr) (%)	Limit (%) ±5
2021/1/13	Head	2402	1.81	38.40	1.76	39.29	3.19	-2.26	±5
2021/1/13	Head	2441	1.86	38.26	1.79	39.21	3.85	-2.44	±5
2021/1/13	Head	2450	1.87	38.23	1.80	39.20	4.00	-2.48	±5
2021/1/13	Head	2480	1.90	38.15	1.83	39.16	3.88	-2.57	±5

Note:
1)The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.
2)KDB 865664 was ensured to be applied for probe calibration frequencies greater than or equal to 50MHz of the EUT frequencies.
3)The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies. The SAR test plots may slightly differ from the table above since the DASY rounds to three significant digits.
4) According to FCC TCB workshop April, 2019 RF Exposure Procedures Update(Effective February 19,2019, FCC has permitted the use of single head-tissue simulating liquid specified in IEEE 62209-1- for all SAR tests.

5. SYSTEM CHECK

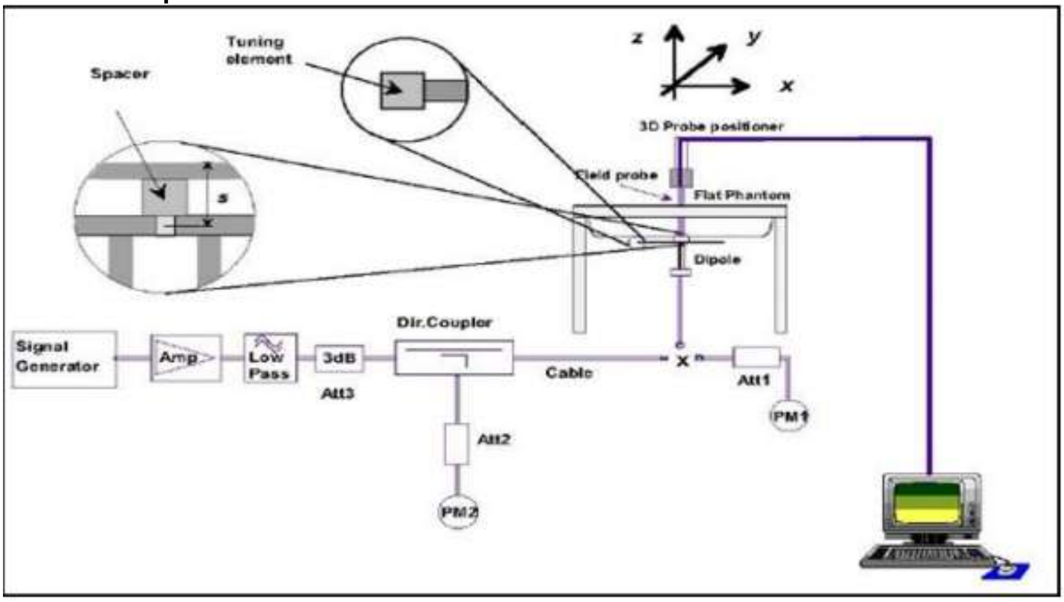
5.1. DESCRIPTION OF SYSTEM CHECK

The manufacturer calibrates the probes annually. Dielectric parameters of the tissue simulants were measured every day using the dielectric probe kit and the network analyzer. A system check measurement was made following the determination of the dielectric parameters of the simulant, using the dipole validation kit. A power level of 250 mW(below 3GHz) or 100mW(3-6GHz), which was placed under the flat section of the twin SAM phantom. The system check results (dielectric parameters and SAR values) are given in the 6.2.

System check results have to be equal or near the values determined during dipole calibration with the relevant liquids and test system (±10 %).

System check is performed regularly on all frequency bands where tests are performed with the DASY5 system.

System Check Set-up



5.2. DESCRIPTION OF SYSTEM CHECK

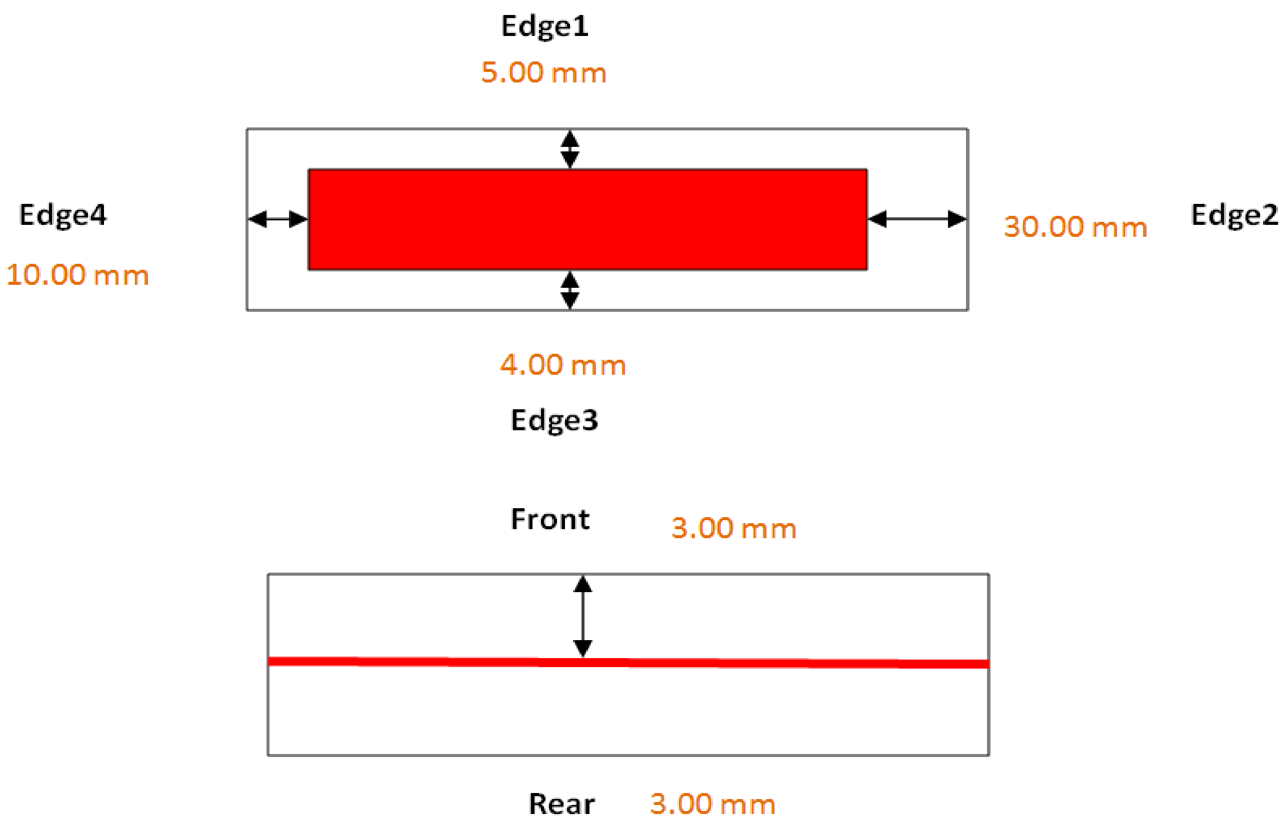
System Check in Tissue Simulating Liquid

The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE P1528 (described above). The following table shows system check results for all frequency bands and tissue liquids used during the tests.

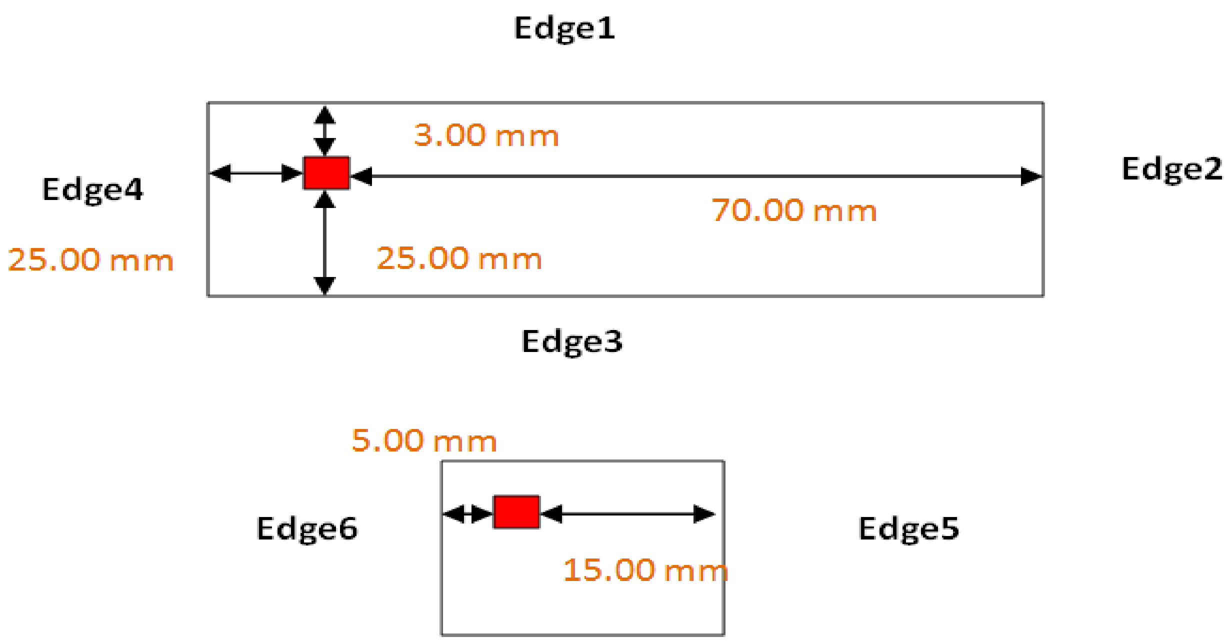
Date	System Dipole			Parameters	Target [W/kg]	Measured [W/kg]	Deviation [%]	Limited [%]
	Type	Serial No.	Liquid					
2021/1/13	D2450V2	973	Head	1g SAR	51.9	54.0	4.05	± 10

6. OPERATIONAL CONDITIONS DURING TEST

6.1. TEST POSITION ANTENNA LOCATION



Big Ant		
Antenna	Position	Distance (mm)
Big	Edge1	5.00
Big	Edge2	30.00
Big	Edge3	4.00
Big	Edge4	10.00
Big	Front	3.00
Big	Rear	3.00



Small Ant		
Antenna	Position	Distance (mm)
Small	Edge1	3.00
Small	Edge2	70.00
Small	Edge3	25.00
Small	Edge4	25.00
Small	Edge5	15.00
Small	Edge6	5.00

6.2. TEST CONFIGURATION

6.2.1.BODY TEST CONFIGURATION

The SAR Exclusion Threshold in KDB 447498 D01can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an EUT edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned adjacent the phantom and the edge containing the antenna positioned perpendicular to the phantom.

SAR test reduction and exclusion guidance

(1)The SAR exclusion threshold for distances<50mm is defined by the following equation:

$$\frac{\text{(max. power of channel, including tune-up tolerance, mW)}}{\text{(min. test separation distance, mm)}} \cdot \sqrt{\text{Frequency (GHz)}} \leq 3.0$$

The test exclusions are applicable only when the minimum test separation distance is ≤50mm and for transmission frequencies between 100MHz and 6GHz. When the minimum test separation distance is<5mm, a distance of 5mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

(2)The SAR exclusion threshold for distances>50mm is defined by the following equation, as illustrated in KDB 447498 D01 Appendix B:

a) at 100 MHz to1500 MHz

$$\text{[Power allowed at numeric Threshold at 50 mm in step 1) + (test separation distance - 50 mm)} \cdot \text{(f}_{\text{(MHz)}}\text{/150)] mW}$$

b) at >1500MHz and ≤6GHz

$$\text{[Power allowed at numeric Threshold at 50 mm in step 1) + (test separation distance - 50 mm)} \cdot \text{10] mW}$$

6.3 SAR EXCLUSION CALCULATIONS FOR WI-FI ANTENNA < 50MM FROM THE USER

According to KDB 447498 D01 v06 in section 4.3.1, if the calculated threshold value is > 3 then SAR testing is required.

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)	Calculated Threshold Value
			dBm	mW	Rear	Rear
Big	BR_DH5	2441	17.50	56.00	3.00	**17.50**
	Zigbee	2405	-0.74	1.00	3.00	**0.31**

Note:
1. The use way of the product is only Rear close to head,so we just assess Rear side.

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)			Calculated Threshold Value		
			dBm	mW	Edge1	Edge5	Edge6	Edge1	Edge5	Edge6
Small	BLE	2480	2.00	2.00	3.00	15.00	5.00	**0.63**	**0.21**	**0.63**

Note:
1. The use way of the product are Edge1,Edge5 and Edge6 close to body,so we assess Edge1,Edge5 and Edge6.

6.4 SAR EXCLUSION CALCULATIONS FOR WI-FI ANTENNA > 50MM FROM THE USER

According to KDB 447498 D01 v06, if the calculated Power threshold is less than the output power then SAR testing is required.

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)	Calculated Threshold Value
			dBm	mW	Rear	Rear
Big	BR_DH5	2441	17.50	56.00	3.00	**<50mm**
	Zigbee	2405	-0.74	1.00	3.00	**<50mm**

Note:
1. The use way of the product is only Rear close to head,so we just assess Rear side.

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)			Calculated Threshold Value		
			dBm	mW	Edge1	Edge5	Edge6	Edge1	Edge5	Edg6
Small	BLE	2480	2.00	2.00	3.00	15.00	5.00	**<50mm**	**<50mm**	**<50mm**

Note:
1. The use way of the product are Edge1,Edge5 and Edge6 close to body,so we assess Edge1,Edge5 and Edge6.

For Zigbee:

1. The device incorporate Zigbee based DSSS radio that was modified to proprietary protocol.
2. The device transmits packets based on 560uSec.
3. After Each packet transmit, device set to receiving mode for a duration of 16.1mSec before next packet transmit.
4. Per these conditions, for 100mSec time frame device transmit 6 pulses. This is the Max device Transmission Duty Cycle:
   a. Tx time=0.56uSec
   b. Rx time=16.6mSec
   c. DC %= (0.56*6)/100= 3.36% DC.
5. The Device Max Duty cycle cannot be modified by user. It is a part of the device FW that is not available to any user apart from Cardo Development

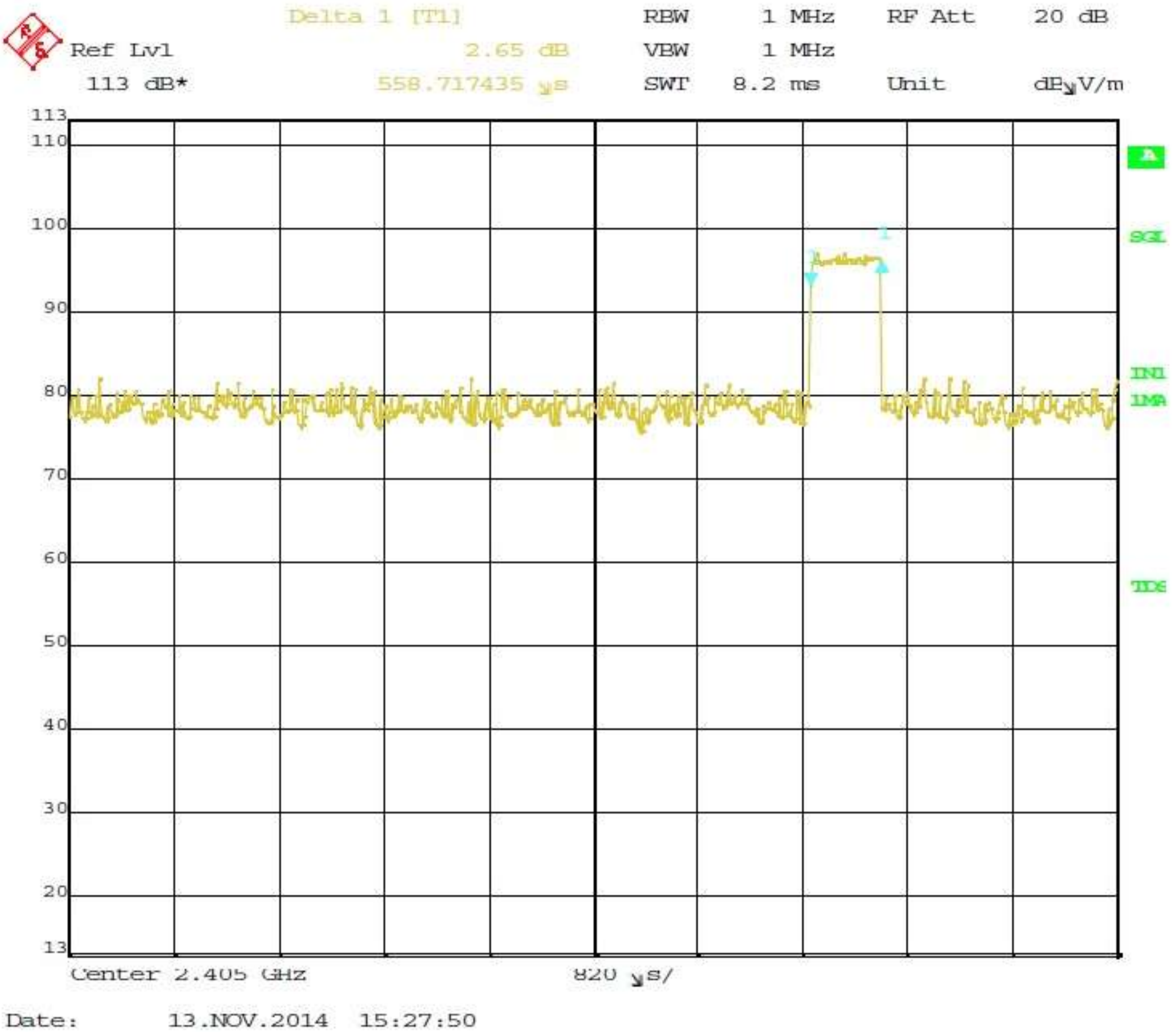


Figure 33. Burst Duration

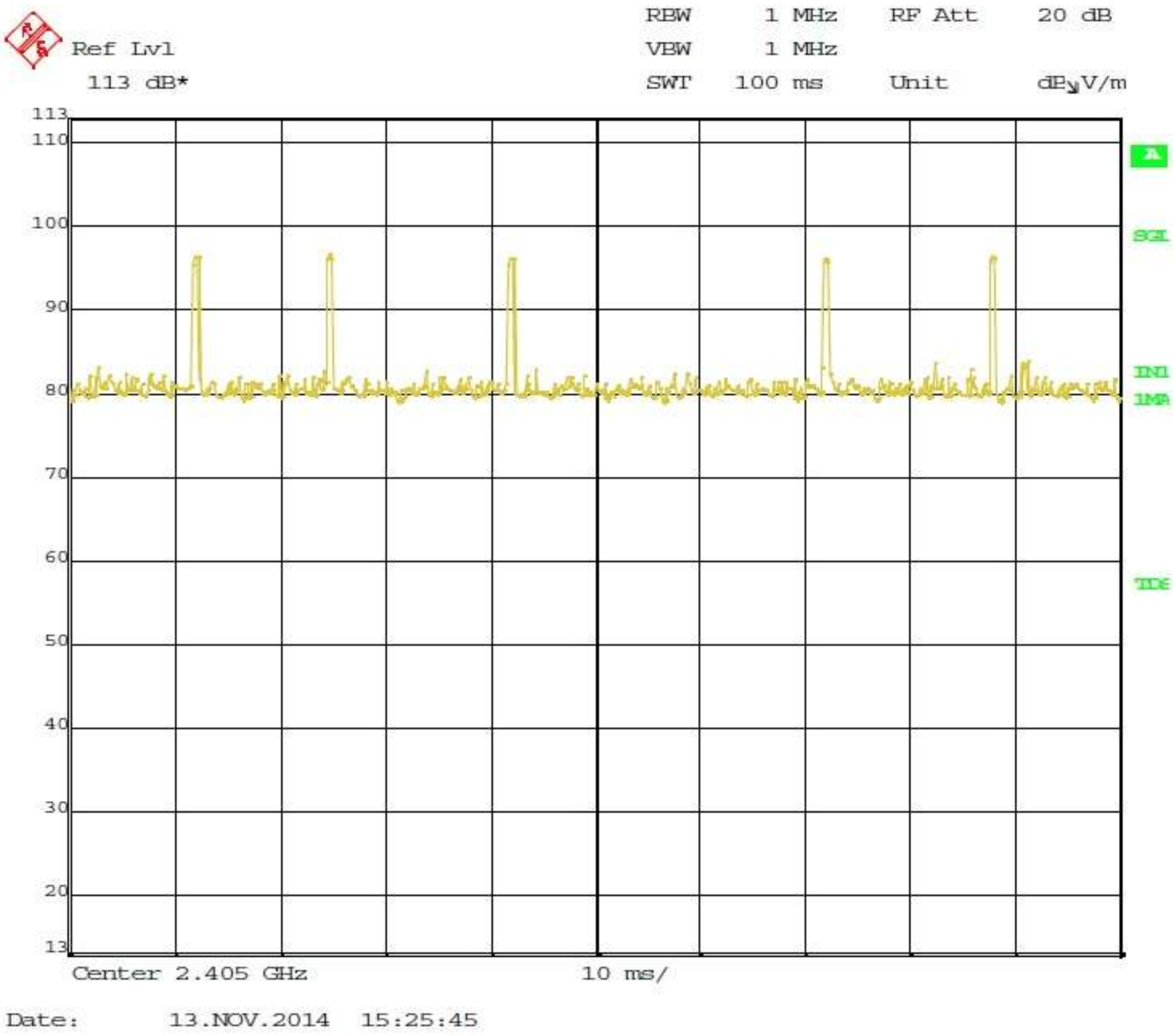


Figure 34. Number of Bursts in 100msec

Antenna	Mode	Frequency (MHz)	Max. output Power(dBm)	Duty Cycle(%)	Max. Average Output Power(dBm)	Max. Average Output Power(mW)
Big	Zigbee	2405	14.00	3.36	-0.74	1.00

7. SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

7.1. SAR MEASUREMENT VARIABILITY

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) 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.

The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.

The detailed repeated measurement results are shown in Section 8.2.

8. CONDUCTED POWER RESULTS

8.1. CONDUCTED POWER MEASUREMENT RESULTS OF BLUETOOTH AND ZIGBEE

Big Ant

Band	Mode	Channel	Frequency (MHz)	Max Power (dBm)	AVG Power (dBm)
BR	DH5	0	2402	16.50	16.37
		39	2441	17.50	17.36
		78	2480	17.50	17.16
EDR	2DH5	0	2402	13.50	13.23
		39	2441	14.50	14.41
		78	2480	14.50	14.14
	3DH5	0	2402	14.00	13.82
		39	2441	15.00	14.99
		78	2480	15.00	14.81

Small Ant

Band	Mode	Channel	Frequency (MHz)	Max Power (dBm)	AVG Power (dBm)
BR	DH5	0	2402	1.00	Not Require
		39	2441	1.00	
		78	2480	1.50	
EDR	2DH5	0	2402	1.00	Not Require
		39	2441	1.00	
		78	2480	1.00	
	3DH5	0	2402	1.00	Not Require
		39	2441	1.00	
		78	2480	1.00	
BLE		0	2402	1.00	Not Require
		19	2440	1.00	
		39	2480	2.00	

1. As per FCC OET KDB 447498 D01, conducted output power and SAR testing are not required for DH5,2DH5,3DH5 and BLE channels when the Max power is under 10 dBm and the separation distance is 5mm.

8.2. CONDUCTED POWER MEASUREMENT RESULTS ZIGBEE

Big Ant

Channel	Frequency (MHz)	Max Power (dBm)	AVG Power (dBm)
0	2405	13.00	12.58

8.3. SAR TEST PROCEDURE

General Notes:

1. Per KDB447498 D01, all measurement SAR results are scaled to the maximum tune-up tolerance limit to demonstrate compliant.

2. Per KDB447498 D01, testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:≤0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is≤100 MHz. When the maximum output power variation across the required test channels is > ½ dB, instead of the middle channel, the highest output power channel must be used.

3. Per KDB865664 D01,for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg; if the deviation among the repeated measurement is ≤20%,and the measured SAR <1.45W/kg, only one repeated measurement is required.

9. SAR TEST RESULTS

9.1. HEAD SAR TEST RESULTS

SAR test results of Bluetooth

Mode	Channel	Test Position	Ant	Max une-up (dBm)	AVG Power (dBm)	Area Scan	SAR 1g	Reported SAR 1g
BR_DH5	39	Left Cheek	Big	17.50	17.36	0.0242	0.0200	0.0207
	39	Right Cheek	Big	17.50	17.36	0.0569	0.0527	**0.0544**

10. TEST LAYOUT

Specific Absorption Rate Test Layout

Liquid depth in the flat Phantom (≥15cm depth)

HSL(2450MHz)

Appendix A. SAR Plots of System Verification

(Pls See BTL-FCC SAR-1-2012T154_Appendix A.)

Appendix B. SAR Plots of SAR Measurement

(Pls See BTL-FCC SAR-1-2012T154_Appendix B.)

Appendix C. Calibration Certificate

(Pls See BTL-FCC SAR-1-2012T154_Appendix C.)

Appendix D. Photographs of the Test Set-Up

(Pls See BTL-FCC SAR-1-2012T154_Appendix D.)

End of Test Report