

RF Exposure report



The following samples were submitted and identified on behalf of the client as:

Product Name Type 2EG BLE Module
Brand Name Murata
Model No. Type2EG
Applicant Murata Electronics North America
2200 Lake Park Drive, Symrna GA 30080
Standards IEEE/ANSI C95.1-1992, IEEE 1528-2013
RSS102 Issue 5, IEC/IEEE 62209-1528:2020
FCC ID HSW2EG
IC 4492A-2EG
Date of EUT Receipt Sep. 21, 2022
Date of Test(s) Oct. 21, 2022
Date of Issue Nov. 15, 2022

In the configuration tested, the EUT complied with the standards specified above.

Remarks:

This report details the results of the testing carried out on one sample, the results contained in this test report do not relate to other samples of the same product. The manufacturer should ensure that all products in series production are in conformity with the product sample detailed in this report.

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Signed on behalf of SGS

Clerk / Kimmy Chiou	PM / Kiki Lin	Approved By / John Yeh

Date: Nov. 15, 2022

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Revision History

Report Number	Revision	Description	Issue Date	Revised By	Remark
TESA2208000291ES	00	Initial creation of document	Nov. 15, 2022	Kimmy Chiou	

Note:

1. The mark " * " is the revised version of the report due to comments submitted by the certification.

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1 GENERAL INFORMATION

1.1 Test Methodology

The SAR testing method and procedure for this device is in accordance with the following standards:

FCC:

IEEE/ANSI C95.1-1992

IEEE 1528-2013

KDB447498D04v01

KDB865664D01v01r04

KDB865664D02v01r02

ISED:

RSS102 Issue 5

IEC/IEEE 62209-1528:2020

KDB447498D01v06

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1.2 Description of EUT

Product Name	Type 2EG BLE Module	
Brand Name	Murata	
Model No.	Type2EG	
FCC ID	HSW2EG	
IC	4492A-2EG	
Duty Cycle	BLE	Please refer to section 20
Supported radios (TX Frequency Range, MHz)	BLE	2.4GHz (2400.0 – 2483.5 MHz)

1.3 Maximum value

5mm

Summary of Maximum SAR	
Mode	Highest SAR 1g Body (W/kg)
BLE	0.03

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2 MEASUREMENT SYSTEM

2.1 Test Facility

Laboratory	Test Site Address	Test Site Name	FCC Designation number	IC CAB identifier
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	1F, No. 8, Alley 15, Lane 120, Sec. 1, NeiHu Road, NeiHu District, Taipei City, 11493, Taiwan.	SAR 2	TW0029	TW3702
		SAR 6		
	No. 2, Keji 1st Rd., Guishan Township, Taoyuan County, 33383, Taiwan	SAR 1	TW0028	
		SAR 4		
	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan	SAR 3	TW0027	
		SAR 7		

Note: Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address.

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Block Diagram (DASY5)

The schematic diagram illustrates the control architecture for a robotic system. At the center is the **Measurement Server (DASY5)**, which interfaces with several components:

- Input/Output Devices:** A **Sheet out** printer, a **Remote Control Box**, and a **Signal lamp** are connected to the server.
- Robot Control:** The server connects to a **robot controller (CS8C)**, which in turn manages a **Servo Amplifier** and a **Servo Motor**.
- Computing and Vision:** A **PC** is linked to the server and the robot manipulator. The server also manages a **Robot Vision Computer (DASY5)** and a **Robot Vision Unit (DASY5)**.
- Sensors:** A **Light sensor** provides input to the server.

The **Robot Manipulator (DASY5)** is the primary actuator, connected to the server, the PC, and the vision system. It is also connected to a **Robot Vision Computer (DASY5)** and a **Robot Vision Unit (DASY5)**.

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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 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%.	

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PHANTOM (ELI)

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 (ELI)

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

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3 AR SYSTEM VERIFICATION

3.1 Tissue Simulating Liquid

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with homogeneous tissue simulating liquid. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15cm.

3.2 Tissue Simulant Liquid measurement

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 $\pm 5\%$ of the target values.

3.3 Measurement results of Tissue Simulant Liquid

Measured Frequency (MHz)	Liquid Temp. (°C)	Target Dielectric Constant, ϵ_r	Target Conductivity, σ (S/m)	Measured Dielectric Constant, ϵ_r	Measured Conductivity, σ (S/m)	% dev ϵ_r	% dev σ	Limit	Measurement Date
2402	22.3	39.282	1.757	40.274	1.826	2.52%	3.90%	$\pm 5\%$	Oct. 21, 2022
2450	22.3	39.200	1.800	40.211	1.868	2.58%	3.78%	$\pm 5\%$	Oct. 21, 2022

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3.4 The composition of the tissue simulating liquid:

Simulating Liquids for 600 MHz -10 GHz, Manufactured by SPEAG:

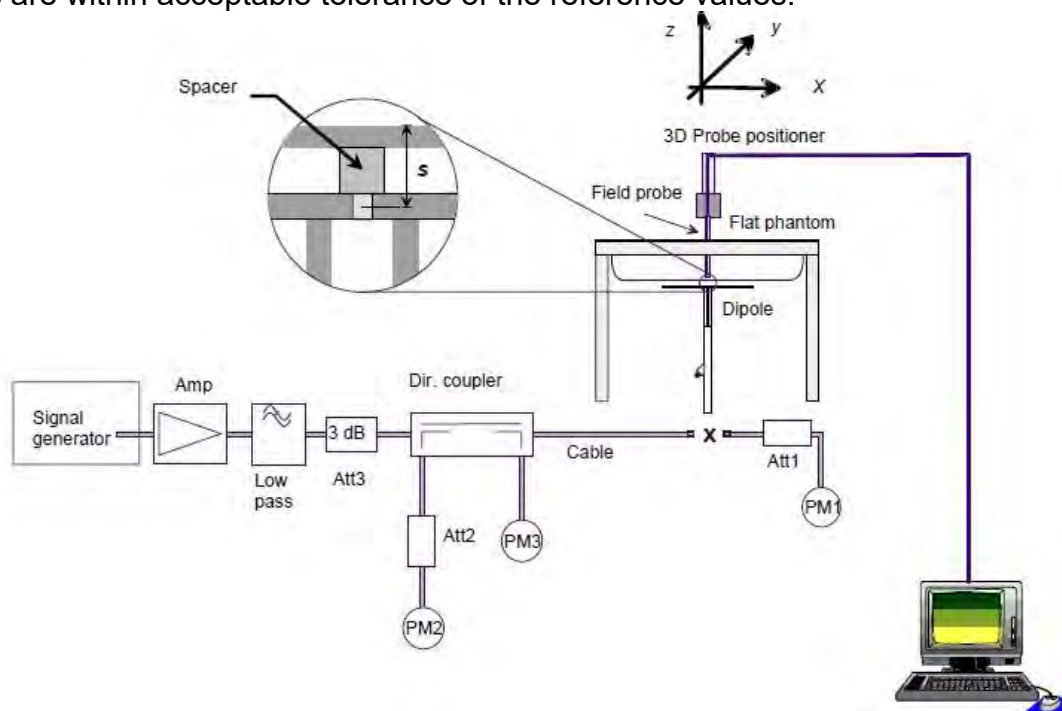
Broad-band head tissue simulating liquids	SPEAG Product	Frequency range (MHz)	Main Ingredients
	HBBL600-10000V6	600 - 10000	Water, Oil

3.5 System check

The microwave circuit arrangement for system check is sketched in below. The daily system accuracy verification occurs within the flat section of the SAM phantom and ELI phantom. A SAR measurement was performed to see if the measured SAR was within +/- 10% from the target SAR values.

The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed with SAR values normalized to 1W forward power delivered to the dipole.

During the tests, the liquid depth from the center of the flat phantom to the liquid top surface was 15 cm above 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.



The block diagram of system check

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3.6 System check results

Validation Kit	S/N	Frequency (MHz)	1W Target 1g-SAR (W/kg)	pin=250mW Measured 1g-SAR (W/kg)	Normalized to 1W 1g-SAR (W/kg)	Deviation (%)	Limit	Measurement Date
D2450V2	727	2450	52.8	12.8	51.2	-3.03	± 10%	Oct.21,2022

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4 TEST CONFIGURATIONS

4.1 Test Environment

Ambient Temperature: $22 \pm 2^{\circ}\text{C}$

Tissue Simulating Liquid: $22 \pm 2^{\circ}\text{C}$

4.2 Test Note

- **General:** Measurements are performed respectively on the lowest, middle and highest channels of the operating band(s).
- **General:** The EUT is set to maximum power level during all tests, and at the beginning of each test the battery is fully charged.
- **General:** During the SAR testing, the DASY system checks power drift by comparing the e-field strength of one specific location measured at the beginning with that measured at the end of the SAR testing.
- **General:** According to KDB865664D01v01r04, SAR measurement variability must be assessed for each frequency band. When the original highest measured SAR is $\geq 0.8\text{ W/kg}$, repeated that measurement once. 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 $\geq 1.45\text{ W/kg}$ ($\sim 10\%$ from the 1-g SAR limit).
- **General:** According to KDB 447498 D04v01 Appendix D RF Energy Coupling Enhancement Condition, transmitters with $\text{SAR} \leq 0.4\text{ W/kg}$ can be integrated in host platforms without further restrictions only if they also satisfy an additional condition referred to as test of the RF energy coupling enhancement.

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4.3 Test position

Module SAR test position (5mm)

The device was tested for all surfaces with test separation distance 5mm.

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4.4 FCC Test limit

§ 2.1093(d)(1)

Applications for equipment authorization of portable RF sources subject to routine environmental evaluation must contain a statement confirming compliance with the limits specified in § 1.1310 as part of their application. Technical information showing the basis for this statement must be submitted to the Commission upon request. The SAR limits specified in § 1.1310(a) through (c) of this chapter shall be used for evaluation of portable devices transmitting in the frequency range from 100 kHz to 6 GHz. Portable devices that transmit at frequencies above 6 GHz shall be evaluated in terms of the MPE limits specified in Table 1 to § 1.1310(e)(1). A minimum separation distance applicable to the operating configurations and exposure conditions of the device shall be used for the evaluation. In general, maximum time-averaged power levels must be used for evaluation. All unlicensed personal communications service (PCS) devices and unlicensed NII devices shall be subject to the limits for general population/uncontrolled exposure.

Radiofrequency radiation exposure limits.

§ 1.1310(a)

Specific absorption rate (SAR) shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in § 1.1307(b) within the frequency range of 100 kHz to 6 GHz (inclusive).

§ 1.1310(b)

The SAR limits for occupational/controlled exposure are 0.4 W/kg, as averaged over the whole body, and a peak spatial-average SAR of 8 W/kg, averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the parts of the human body treated as extremities, such as hands, wrists, feet, ankles, and pinnae, where the peak spatial-average SAR limit for occupational/controlled exposure is 20 W/kg, averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). Exposure may be averaged over a time period not to exceed 6 minutes to determine compliance with occupational/controlled SAR limits.

§ 1.1310(c)

The SAR limits for general population/uncontrolled exposure are 0.08 W/kg, as averaged over the whole body, and a peak spatial-average SAR of 1.6 W/kg, averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the parts of the human body treated as extremities, such as hands, wrists, feet, ankles, and pinnae, where the peak spatial-average SAR limit is 4 W/kg, averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). Exposure may be averaged over a time period not to exceed 30 minutes to determine compliance with general population/uncontrolled SAR limits.

Note to paragraphs (a) through (c):

SAR is a measure of the rate of energy absorption due to exposure to RF electromagnetic energy. These SAR limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized 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 Std C95.1-1992, copyright 1992 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 Radiofrequency Electromagnetic Fields," NCRP Report No. 86, Section 17.4.5, copyright 1986 by NCRP, Bethesda, Maryland 20814. Limits for whole body SAR and peak spatial-average SAR are based

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on recommendations made in both of these documents. The MPE limits in Table 1 are based generally on criteria published by the NCRP in "Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," NCRP Report No. 86, Sections 17.4.1, 17.4.1.1, 17.4.2 and 17.4.3, copyright 1986 by NCRP, Bethesda, Maryland 20814. In the frequency range from 100 MHz to 1500 MHz, these MPE exposure limits for field strength and power density are also generally based on criteria recommended by the ANSI in [Section 4.1](#) of "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz," ANSI/IEEE Std C95.1-1992, copyright 1992 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017.

Portable devices that transmit at frequencies above 6 GHz shall be evaluated in terms of the MPE limits specified in Table 1 to [§ 1.1310\(e\)\(1\)](#).

According to ANSI/IEEE C95.1-1992, the criteria listed in the following Table shall be used to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in §1.1310.

Peak Spatially Averaged Power Density was evaluated over a circular area of 4cm² per interim FCC Guidance for near-field power density evaluations per October 2018 TCB Workshop notes

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Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*(100)	≤6
3.0-30	1842/f	4.89/f	*(900/f ²)	<6
30-300	61.4	0.163	1.0	<6
300-1,500			f/300	<6
1,500-100,000			5	<6
(ii) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	<30
1.34-30	824/f	2.19/f	*(180/f ²)	<30
30-300	27.5	0.073	0.2	<30
300-1,500			f/1500	<30
1,500-100,000			1.0	<30

f = frequency in MHz. * = Plane-wave equivalent power density.

Table 1 to § 1.1310(e)(1) - Limits for Maximum Permissible Exposure (MPE)

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4.5 ISED Test limit

For SAR limit, refer to the following table 3 from RSS 102.

Table 3: SAR Limits for Devices Used by the General Public (Uncontrolled Environment)

Body Region	Average SAR (W/kg)	Averaging Time (minutes) ²⁰	Mass Average (g)
Whole Body	0.08	6	Whole Body
Localized Head, Neck and Trunk	1.6	6	1
Localized Limbs	4	6	10

For localized exposures to radiofrequency EMF in the 6 GHz to 300 GHz frequency range, Health Canada's recommendations are as follows:

Table 1: Basic restrictions for local electromagnetic field exposure above 6 GHz up to 300 GHz

Exposure scenario	Exposure duration (t)	Local absorbed energy density [kJ/m ²]	Local absorbed power density [W/m ²]
Controlled Environment	0 sec < t < 360 sec	36 [0.05+0.95(t/360) ^{0.5}]	n/a
	t ≥ 6 min	n/a	100
Uncontrolled Environment	0 sec < t < 360 sec	7.2 [0.05+0.95(t/360) ^{0.5}]	n/a
	t ≥ 6 min	n/a	20

Notes:

- "n/a" signifies "not applicable" and does not need to be taken into account when determining compliance.
- "t" is time in seconds, and restrictions must be satisfied for all values of t between >0 s and <360 s, regardless of the temporal characteristics of the exposure itself.
- Local absorbed power density exposures are to be averaged over 6 min.
- Local absorbed power density is to be averaged over a square 4-cm² surface area of the body. Above 30 GHz, an additional constraint is imposed, such that the spatial peak exposure is restricted to two times that of the 4-cm² restriction.
- Local absorbed energy density is to be averaged over a square 4-cm² surface area of the body. Above 30 GHz, an additional constraint is imposed, such that the spatial peak exposure is restricted to 72[0.025+0.975(t/360)^{0.5}] kJ/m² for controlled environment and 14.4[0.025+0.975(t/360)^{0.5}] kJ/m² for uncontrolled environment exposure.
- Exposure from any pulse, group of pulses, or subgroup of pulses in a train, as well as from the summation of exposures (including non-pulsed EMFs), delivered in t s, where t is the sum of all periods in which there is non-zero exposure, must not exceed these levels.

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5 MAXIMUM OUTPUT POWER

5.1 BLE

Mode	Channel	Frequency (MHz)	GFSK	
			Max. Rated Avg.Power + Max. Tolerance (dBm)	Average Output Power (dBm)
BLE_1M	CH 00	2402	6.5	6.02
	CH 20	2442		5.99
	CH 39	2480		6.01
Mode	Channel	Frequency (MHz)	GFSK	
			Max. Rated Avg.Power + Max. Tolerance (dBm)	Average Output Power (dBm)
BLE_2M	CH 00	2402	6.5	6.03
	CH 20	2442		6.00
	CH 39	2480		6.04

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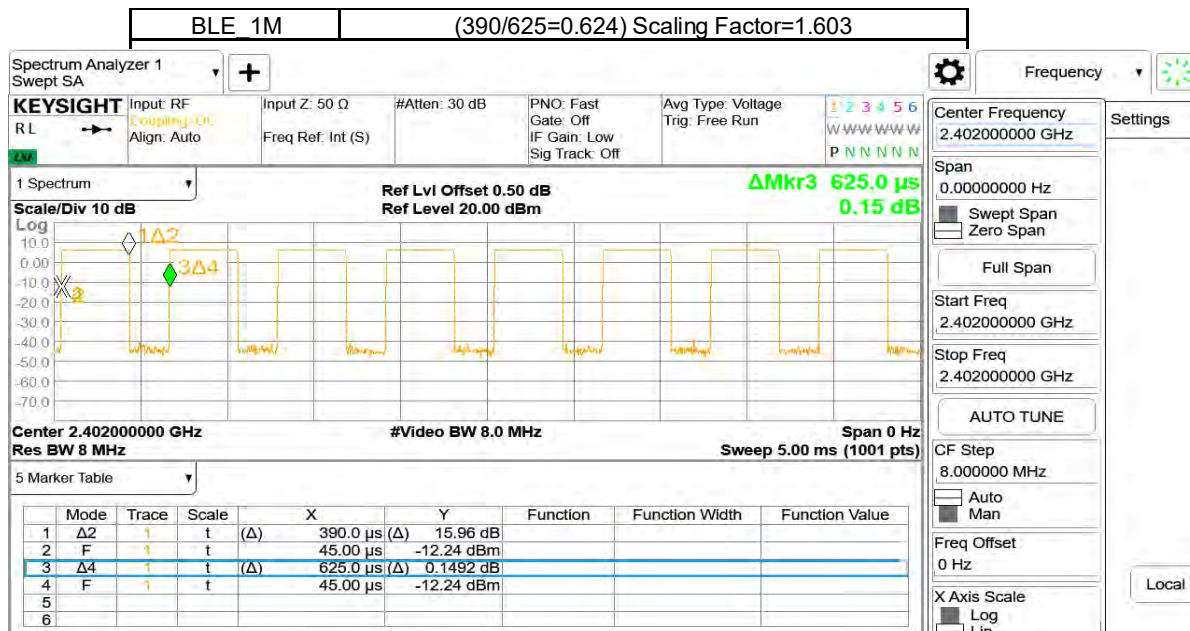
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7 SUMMARY OF RESULTS

7.1 Decision rules

Reported measurement data comply with Test Methodology in section 1.1.

Determining compliance shall be based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

7.2 Summary of SAR Results

5mm

Mode	Antenna	Position	Distance (mm)	Channel	Freq. (MHz)	Max. Rated Avg. Power + Max. Tolerance (dBm)	Measured Avg. Power (dBm)	Duty cycle scaling	Power scaling	Averaged SAR over 1g (W/kg)		ID
										Measured	Reported	
BLE_1M	Ant1	Front Surface	5	0	2402	6.50	6.02	1.60	111.69%	0.014	0.025	001
BLE_1M	Ant1	Back Surface	5	0	2402	6.50	6.02	1.60	111.69%	0.009	0.016	-
BLE_1M	Ant1	Top Edge	5	0	2402	6.50	6.02	1.60	111.69%	0.001	0.002	-
BLE_1M	Ant1	Bottom Edge	5	0	2402	6.50	6.02	1.60	111.69%	0.006	0.011	-
BLE_1M	Ant1	Left Edge	5	0	2402	6.50	6.02	1.60	111.69%	0.001	0.002	-
BLE_1M	Ant1	Right Edge	5	0	2402	6.50	6.02	1.60	111.69%	0.002	0.004	-

Note:

Reported SAR = measured SAR * Power scaling * Duty cycle scaling

7.3 RF Energy Coupling Enhancement Condition

Worst-case test configuration	Mode	Device-to-phantom distance (mm)		Reported Peak SAR (W/kg)	Percent Change	The ratio of the highest SAR to 5mm single point SAR
Front Surface	BLE	Initial	0	0.0108	-----	52.2%
		1	5	0.00516	-52.2%	-----
Back Surface	BLE	Initial	0	0.0311	-----	84.6%
		1	5	0.00479	-84.6%	-----
Top Edge	BLE	Initial	0	0.00385	-----	96.4%
		1	5	0.000137	-96.4%	-----
Bottom Edge	BLE	Initial	0	0.00831	-----	74.2%
		1	5	0.00214	-74.2%	-----
Left Edge	BLE	Initial	0	0.0156	-----	93.7%
		1	5	0.000981	-93.7%	-----
Right Edge	BLE	Initial	0	0.000345	-----	85.5%
		1	5	0.00005	-85.5%	-----

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7.4 Reporting statements of conformity

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

7.5 Conclusion

The device is compliant because all the standalone results are less than their corresponding criteria.

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8 INSTRUMENTS LIST

Equipment List					
Manufacturer	Device	Type	Serial number	Date of last calibration	Date of next calibration
SPEAG	Data acquisition Electronics	DAE4	1665	Feb/28/2022	Feb/27/2023
SPEAG	Dosimetric E-Field Probe	EX3DV4	7642	Mar/02/2022	Mar/01/2023
SPEAG	System Validation Dipole	D2450V2	727	Apr/25/2022	Apr/24/2023
SPEAG	Dielectric Assessment Kit	DAKS-3.5	1053	Feb/28/2022	Feb/27/2023
R&S	MXG Analog Signal Generator	SMB100A03	182012	Jun/13/2022	Jun/12/2023
Agilent	Dual-directional coupler	772D	MY46151258	Oct/03/2022	Oct/02/2023
Agilent	Dual-directional coupler	778D	MY46151242	Aug/30/2022	Aug/29/2023
EMCI	Amplifier	ZVE-8G	980190	Calibration not required	Calibration not required
R&S	Power Sensor	NRP18S	101973	Jan/22/2022	Jan/21/2023
R&S	Power Sensor	NRP18S	101358	Jan/22/2022	Jan/21/2023
R&S	Power Meter	NRX	102034	Dec/28/2021	Dec/27/2022
SPEAG	Software	DASY 52 V52.10.4.152 7	N/A	Calibration not required	Calibration not required
SPEAG	Phantom	SAM	N/A	Calibration not required	Calibration not required
LKM	Digital thermometer	DTM3000	EC14010603	Sep/27/2022	Sep/26/2023
TECPEL	Digital thermometer	DTM-303A	TP190085	Jan/14/2022	Jan/13/2023

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9 UNCERTAINTY BUDGET

Measurement Uncertainty evaluation template for DUT SAR test (0.3-3G)

A	c	D	e		f	g	$h=c * f / e$	$i=c * g / e$	k
Source of Uncertainty	Tolerance/ Uncertainty	Probability Distributio	Div	Div Value	ci (1g)	ci (10g)	Standard uncertainty	Standard uncertainty	vi, or Veff
Measurement system									
Probe calibration	6.00%	N	1	1	1	1	6.00%	6.00%	∞
Isotropy , Axial	3.50%	R	$\sqrt{3}$	1.732	1	1	2.02%	2.02%	∞
Isotropy, Hemispherical	9.60%	R	$\sqrt{3}$	1.732	1	1	5.54%	5.54%	∞
Modulation Response	2.40%	R	$\sqrt{3}$	1.732	1	1	1.40%	1.40%	∞
Boundary Effect	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Linearity	4.70%	R	$\sqrt{3}$	1.732	1	1	2.71%	2.71%	∞
Detection Limits	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Readout Electronics	0.30%	N	1	1	1	1	0.30%	0.30%	∞
Response time	0.80%	R	$\sqrt{3}$	1.732	1	1	0.46%	0.46%	∞
Integration Time	2.60%	R	$\sqrt{3}$	1.732	1	1	1.50%	1.50%	∞
Measurement drift (class A evaluation)	1.75%	R	$\sqrt{3}$	1.732	1	1	1.01%	1.01%	∞
RF ambient condition - noise	3.00%	R	$\sqrt{3}$	1.732	1	1	1.73%	1.73%	∞
RF ambient conditions - reflections	3.00%	R	$\sqrt{3}$	1.732	1	1	1.73%	1.73%	∞
Probe positioner Mechanical restrictions	0.40%	R	$\sqrt{3}$	1.732	1	1	0.23%	0.23%	∞
Probe Positioning with respect to phantom shell	2.90%	R	$\sqrt{3}$	1.732	1	1	1.67%	1.67%	∞
Post-processing	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Max SAR Eval	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Test Sample related									
Test sample positioning	2.90%	N	1	1	1	1	2.90%	2.90%	M-1
Device Holder Uncertainty	3.60%	N	1	1	1	1	3.60%	3.60%	M-1
Drift of output power	5.00%	R	$\sqrt{3}$	1.732	1	1	2.89%	2.89%	∞
Phantom and Setup									
Phantom Uncertainty	4.00%	R	$\sqrt{3}$	1.732	1	1	2.31%	2.31%	∞
Liquid permittivity (mea.)	2.58%	N	1	1	0.64	0.43	1.65%	1.11%	M
Liquid Conductivity (mea.)	3.90%	N	1	1	0.6	0.49	2.34%	1.91%	M
Combined standard uncertainty		RSS					11.77%	11.62%	
Expant uncertainty (95% confidence interval), K=2							23.54%	23.24%	

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10 SAR MEASUREMENT RESULTS

Date: 2022/10/21

ID: 001

Report No. : TESA2208000291ES

BLE_1M_Body_Front Surface_CH 0_5mm_Ant1

Communication System: Bluetooth Low Engery; Frequency: 2402 MHz;Duty Cycle: 1:1.603

Medium parameters used: $f = 2402$ MHz; $\sigma = 1.826$ S/m; $\epsilon_r = 40.274$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient temperature: 22.5°C; Liquid temperature: 22.3°C

DASY5 Configuration:

- Probe: EX3DV4 - SN7642; ConvF(8.12, 8.12, 8.12); Calibrated: 2022/03/02
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1665; Calibrated: 2022/02/28
- Phantom: SAM
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (61x111x1): Interpolated grid: dx=12 mm, dy=12 mm

Maximum value of SAR (interpolated) = 0.0320 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 1.391 V/m; Power Drift = -0.11 dB

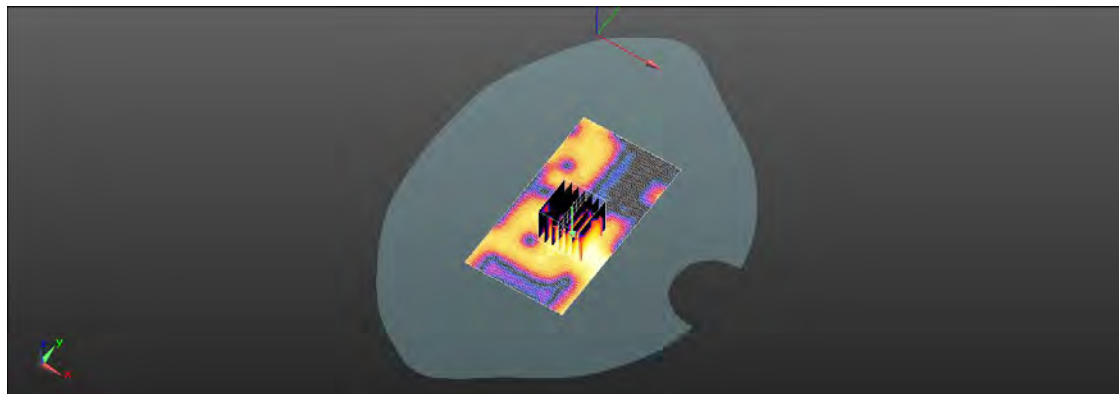
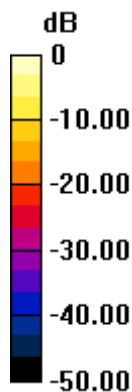
Peak SAR (extrapolated) = 0.0320 W/kg

SAR(1 g) = 0.014 W/kg; SAR(10 g) = 0.0052 W/kg

Smallest distance from peaks to all points 3 dB below: Larger than measurement grid

Ratio of SAR at M2 to SAR at M1 = 49.5%

Maximum value of SAR (measured) = 0.0237 W/kg



0 dB = 0.0237 W/kg = -16.24 dBW/kg

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11 SAR SYSTEM CHECK RESULTS

Date: 2022/10/21

Report No. : TESA2208000291ES

Dipole 2450 MHz_SN:727

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.868$ S/m; $\epsilon_r = 40.211$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient temperature: 22.5°C; Liquid temperature: 22.3°C

DASY5 Configuration:

- Probe: EX3DV4 - SN7642; ConvF(8.12, 8.12, 8.12); Calibrated: 2022/03/02
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1665; Calibrated: 2022/02/28
- Phantom: SAM
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (71x111x1): Interpolated grid: dx=12 mm, dy=12 mm

Maximum value of SAR (interpolated) = 20.4 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 103.1 V/m; Power Drift = 0.02 dB

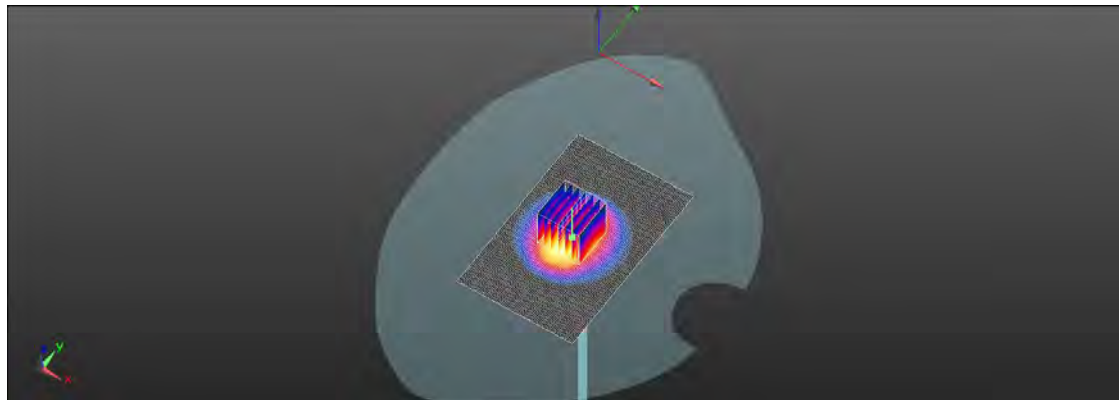
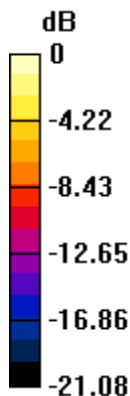
Peak SAR (extrapolated) = 25.9 W/kg

SAR(1 g) = 12.8 W/kg; SAR(10 g) = 6.03 W/kg

Smallest distance from peaks to all points 3 dB below = 9.2 mm

Ratio of SAR at M2 to SAR at M1 = 50.2%

Maximum value of SAR (measured) = 19.5 W/kg



0 dB = 19.5 W/kg = 12.89 dBW/kg

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12 FCC RF EXPOSURE TEST EXEMPTION FOR MOBILE CONDITIONS

12.1 Antenna information

Antenna Type	Supplier	Antenna Part No.	Freq. (MHz)	Peak Antenna Gain (dBi)
Monopole	TAOGLAS	GW26.0152	2.4GHz	1.80

Note: Antenna information is provided by the applicant.

12.2 Single RF Source

As per §1.1307(b)(3)(i),

- (A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);
- (B) Or the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold P_{th} (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by:

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases}$$

Where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases}$$

d = the separation distance (cm);

Note: when 10-g extremity SAR applies, SAR test exemption may be considered by applying a factor of 2.5 to the SAR-based exemption thresholds.

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- (C) Or using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

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Table 1 to § 1.1307(b)(3)(i)(C) –

Single RF Sources Subject to Routine Environmental Evaluation

RF Source frequency (MHz)			Minimum Distance			Threshold ERP (W)
fL		fH	$\lambda L / 2\pi$		$\lambda H / 2\pi$	
0.3	-	1.34	159m	-	35.6m	1920 R ²
1.34	-	30	35.6m	-	1.6m	3450 R ² /f ²
30	-	300	1.6m	-	159mm	3.83 R ²
300	-	1500	159mm	-	31.8mm	0.0128 R ² f
1500	-	100000	31.8mm	-	0.5mm	19.2R ²

R= minimum separation distance in meter

f = frequency in MHz

SAR-based thresholds are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum time-averaged power or maximum time-averaged ERP, whichever is greater.

The SAR-based exemption formula of § 1.1307(b)(3)(i)(B), repeated here as Formula (B.2), applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power or effective radiated power (ERP), whichever is greater, of less than or equal to the threshold P_{th} (mW).

$$P_{th} \text{ (mW)} = ERP_{20 \text{ cm}} \text{ (mW)} = \begin{cases} 2040f & 0.3 \text{ GHz} \leq f < 1.5 \text{ GHz} \\ 3060 & 1.5 \text{ GHz} \leq f \leq 6 \text{ GHz} \end{cases} \quad (\text{B. 1})$$

$$P_{th} \text{ (mW)} = \begin{cases} ERP_{20 \text{ cm}} (d/20 \text{ cm})^x & d \leq 20 \text{ cm} \\ ERP_{20 \text{ cm}} & 20 \text{ cm} < d \leq 40 \text{ cm} \end{cases} \quad (\text{B. 2})$$

where

$$x = -\log_{10} \left(\frac{60}{ERP_{20 \text{ cm}} \sqrt{f}} \right)$$

and f is in GHz, d is the separation distance (cm), and ERP_{20cm} is per Formula (B.1).

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12.3 Test exemption result:

Mode	Frequency (MHz)	Max. tune-up power (dBm)	Peak gain (dBi)	ERP (dBm)	ERP (W)	Permissible Minimum separation distance ($\lambda/2\pi$) (m)	R = actual Minimum separation distance(m)	ERP _{th} (W)	ERP/ERP _{th}
BLE	2478	6.5	1.8	6.15	0.004	0.0193	0.200	0.768	0.005

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13 ISD RF EXPOSURE TEST EXEMPTION FOR MOBILE CONDITIONS

13.1 Antenna information

Antenna Type	Supplier	Antenna Part No.	Freq. (MHz)	Peak Antenna Gain (dBi)
Monopole	TAOGLAS	GW26.0152	2.4GHz	1.80

Note: Antenna information is provided by the applicant.

13.2 Standard Applicable

According to RSS-102 issue 5 §2.5.2 RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

below 20 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);

at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $22.48/f^{0.5}W$ (adjusted for tune-up tolerance), where f is in MHz;

at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);

at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834} W$ (adjusted for tune-up tolerance), where f is in MHz;

This is a Mobile device, at which separation distance between the user and the device's antenna is 20cm. Therefore, section 2.5.2 shall be complied with.

13.3 Maximum Permissible Exposure (MPE) Exemption

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Operation Mode	Evaluation Frequency (MHz)	Max. output Power include Tolerance (dBm)	Antenna Gain (dBi)	Max. EIRP (W)	Limit (W)	Max. EIRP / Limit	Pass / Fail
BLE	2478.00	6.5	1.80	0.01	2.734	0.004	Pass

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14 APPENDIXES

Refer to separated files for the following appendixes.

14.1 SAR_Appendix A Photographs

14.2 SAR_Appendix B DAE & Probe Cal. Certificate

14.3 SAR_Appendix C Phantom Description & Dipole Cal. Certificate

- End of report -

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