FCC SAR Test Report

APPLICANT	:	Bullitt Group
EQUIPMENT	:	Messaging Device
BRAND NAME	:	Motorola
MODEL NAME	:	BM3A01
FCC ID	:	ZL5BM3A01
STANDARD	:	FCC 47 CFR Part 2 (2.1093)

We, Sporton International Inc. (Kunshan), would like to declare that the tested sample has been evaluated in accordance with the test procedures given in 47 CFR Part 2.1093 and FCC KDB and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of Sporton International Inc. (Kunshan), the test report shall not be reproduced except in full.

ACCREDITED
Cert #5145.02

Approved by: Si Zhang

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People's Republic of China

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Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA2N2305-01	Rev. 01	Initial issue of report.	Mar. 17, 2023

1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **Bullitt Group, Messaging Device, BM3A01,** are as follows.

Highest 1g SAR Summary			
Equipment Class	Frequency Band	Body (Separation 5mm)	Highest Simultaneous Transmission 1g SAR (W/kg)
Licensed	Band 23	1.36	1.45
	Band 255	**1.42**	
Date of Testing:		2023/2/28 ~ 2023/3/3	

Declaration of Conformity:
The test results with all measurement uncertainty excluded are presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the manufacturer takes all the responsibilities for the accuracy of product specification.

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg for Partial-Body 1g SAR) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013 and FCC KDB publications.

2. Administration Data

Sporton International Inc. (Kunshan) is accredited to ISO/IEC 17025:2017 by American Association for Laboratory Accreditation with Certificate Number 5145.02.

Testing Laboratory			
Test Firm	Sporton International Inc. (Kunshan)		
Test Site Location	No. 1098, Pengxi North Road, Kunshan Economic Development Zone Jiangsu Province 215300 People's Republic of China TEL : +86-512-57900158 FAX : +86-512-57900958		
Test Site No.	Sporton Site No.	FCC Designation No.	FCC Test Firm Registration No.
	SAR04-KS	CN1257	314309

Applicant	
Company Name	Bullitt Group
Address	One Valpy, Valpy Street, Reading, Berkshire, RG1 1AR, United Kingdom

Manufacturer	
Company Name	Bullitt Mobile Limited
Address	One Valpy, Valpy Street, Reading, Berkshire, RG1 1AR, United Kingdom

3. Guidance Applied

The Specific Absorption Rate (SAR) testing specification, method, and procedure for this device is in accordance with the following standards:

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2013
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB 865664 D02 SAR Reporting v01r02
- FCC KDB 447498 D01 General RF Exposure Guidance v06
- FCC KDB 616217 D04 SAR for laptop and tablets v01r02
- FCC KDB 941225 D05 SAR for LTE Devices v02r05

4. Equipment Under Test (EUT) Information

4.1 General Information

Product Feature & Specification	
Equipment Name	Messaging Device
Brand Name	Motorola
Model Name	BM3A01
FCC ID	ZL5BM3A01
SN Code	BM3A01123456789
Wireless Technology and Frequency Range	Band 23 : 2000 MHz ~ 2020 MHz Band 255 : 1626.6 MHz ~ 1660 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	MES: BPSK/QPSK Bluetooth LE
EUT Stage	Production Unit

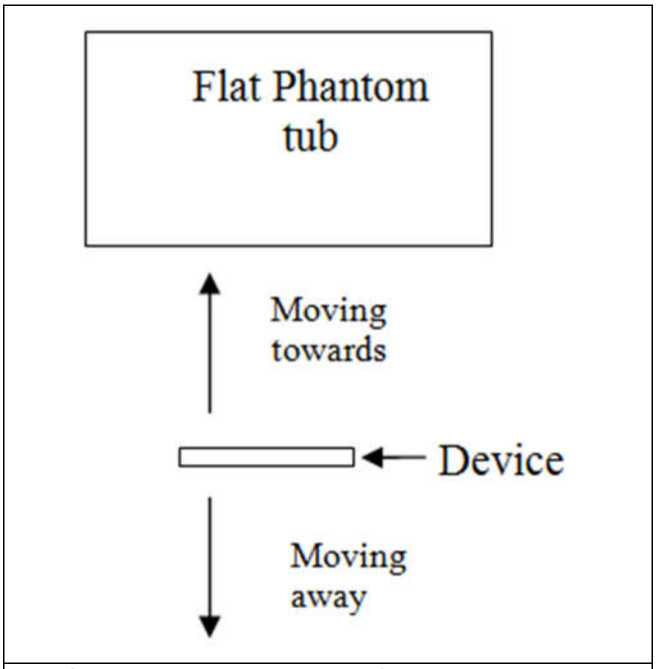
Remark:

1. The device was not support voice calling.
2. The device implements Proximity sensors trigger reduced power for the power management for SAR compliance at different exposure conditions (body). The device will invoke corresponding work scenarios power level, which are provided in the operational description. And the device will invoke corresponding work scenarios power level base on frequency bands/antennas, which can refer to power table at appendix E.
3. For Band 23/255 test, using FTM to perform SAR testing.
4. For Band 23/255 supports SCS 3.75 kHz and SCS 15 kHz, chose higher power which is SCS 15 kHz to perform SAR testing.
5. This device will be equipped with the Strap, the Strap are a metallic wristband and do not contain any electronic circuitry, so the Strap spot check the worst case of each band to satisfy SAR compliance.

5. Proximity Sensor Triggering Test

5.1 Proximity sensor triggering distances(Per KDB616217§6.2)

1. Proximity sensor triggering distance testing was performed according to the procedures outlined in KDB 616217 D04 section 6.2, and EUT moving further away from the flat phantom and EUT moving toward the flat phantom were both assessed.
2. Proximity sensor triggering distance testing was performed according and EUT moving further away from the flat phantom and EUT moving toward the flat phantom were both assessed and the tissue-equivalent medium for highest frequency (2000MHz) and lowest (1600MHz) frequency was used for proximity sensor triggering testing.
3. Capacitive proximity sensor placed coincident with antenna elements at the left end of the EUT are utilized to determine when the device comes in proximity of the user's body or finger or hand at the front or back side of the device. There is no need to do sensor coverage testing for the proximity sensor is designed to support sufficient detection range and sensitivity to cover regions of the sensors in all applicable directions since the proximity sensor entirely covers the antenna.
4. The sensors can use to detect the proximity of the user's body states at the front or back side of the device use a detection threshold distance. When front/back sides of body condition is detected reduced power will be active. The trigger distance shown in the sections below. The verification test and more details please refer to sensor operation description.
5. For verification of compliance of power reduction scheme, additional SAR testing with EUT transmitting at full RF power at a conservative trigger distance -1mm was performed.



Sensor detection test set-up, front and back sides

<P-Sensor>

Proximity Sensor Triggering Distance (mm)				
Position	Front		Back	
	Moving towards	Moving away	Moving towards	Moving away
Minimum	17	19	17	19

6. RF Exposure Limits

6.1 Uncontrolled Environment

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

6.2 Controlled Environment

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

Limits for Occupational/Controlled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	20.0

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

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

7. Specific Absorption Rate (SAR)

7.1 Introduction

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

7.2 SAR Definition

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

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

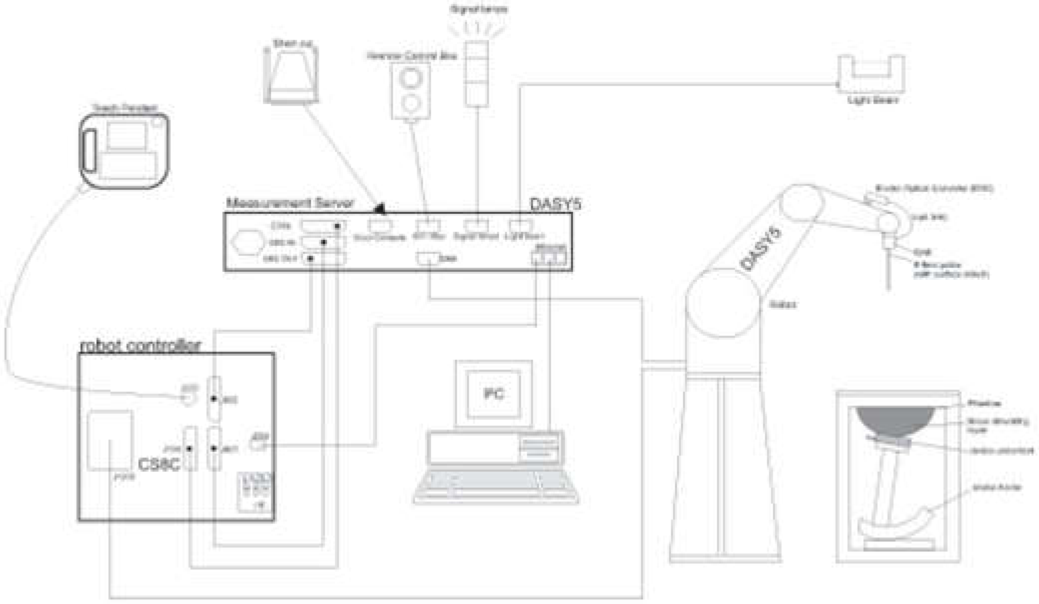
SAR is expressed in units of Watts per kilogram (W/kg)

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

8. System Description and Setup

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



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (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.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

8.1 E-Field Probe

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

<EX3DV4 Probe>

Construction	Symmetric design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz – >6 GHz Linearity: ±0.2 dB (30 MHz – 6 GHz)	
Directivity	±0.3 dB in TSL (rotation around probe axis) ±0.5 dB in TSL (rotation normal to probe axis)	
Dynamic Range	10 µW/g – >100 mW/g Linearity: ±0.2 dB (noise: typically <1 µW/g)	
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: 2.5 mm (body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	

8.2 Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

Photo of DAE

8.3 Phantom

<SAM Twin Phantom>

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

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

<ELI Phantom>

Shell Thickness	2 ± 0.2 mm (sagging: <1%)
Filling Volume	Approx. 30 liters
Dimensions	Major ellipse axis: 600 mm Minor axis: 400 mm

The ELI phantom is intended for compliance testing of handheld and body-mounted wireless devices or for evaluating transmitters operating at low frequencies. ELI is fully compatible with standard and all known tissue simulating liquids.

8.4 Device Holder

<Mounting Device for Hand-Held Transmitter>

In combination with the Twin SAM V5.0/V5.0c or ELI phantoms, the Mounting Device for Hand-Held Transmitters enables rotation of the mounted transmitter device to specified spherical coordinates. At the heads, the rotation axis is at the ear opening. Transmitter devices can be easily and accurately positioned according to IEC 62209-1, IEEE 1528, FCC, or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). And upgrade kit to Mounting Device to enable easy mounting of wider devices like big smart-phones, e-books, small tablets, etc. It holds devices with width up to 140 mm.

Mounting Device for Hand-Held Transmitters

Mounting Device Adaptor for Wide-Phones

<Mounting Device for Laptops and other Body-Worn Transmitters>

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

Mounting Device for Laptops

9. Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

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

<SAR measurement>

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

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

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

9.1 Spatial Peak SAR Evaluation

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

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

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

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

9.2 Power Reference Measurement

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

9.3 Area Scan

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB0 is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

<table>
<tr><td></td><td>≤ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td>Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td>Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3 – 4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
</table>

9.4 Zoom Scan

Zoom scans are used assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube shoes base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the zoom scan evaluates the averaged SAR for 1 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

<table>
<tr><td colspan="3"></td><td>$\leq$ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>$\leq$ 2 GHz: $\leq$ 8 mm
2 – 3 GHz: $\leq$ 5 mm*</td><td>3 – 4 GHz: $\leq$ 5 mm*
4 – 6 GHz: $\leq$ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>$\leq$ 5 mm</td><td>3 – 4 GHz: $\leq$ 4 mm
4 – 5 GHz: $\leq$ 3 mm
5 – 6 GHz: $\leq$ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>$\leq$ 4 mm</td><td>3 – 4 GHz: $\leq$ 3 mm
4 – 5 GHz: $\leq$ 2.5 mm
5 – 6 GHz: $\leq$ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>$\geq$ 30 mm</td><td>3 – 4 GHz: $\geq$ 28 mm
4 – 5 GHz: $\geq$ 25 mm
5 – 6 GHz: $\geq$ 22 mm</td></tr>
<tr><td colspan="5">Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
* When zoom scan is required and the <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is $\leq$ 1.4 W/kg, $\leq$ 8 mm, $\leq$ 7 mm and $\leq$ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

9.5 Volume Scan Procedures

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

9.6 Power Drift Monitoring

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

10. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	1640MHz System Validation Kit	D1640V2	347	2022/9/1	2023/8/31
SPEAG	2000MHz System Validation Kit	D2000V2	1083	2021/10/14	2024/10/13
SPEAG	Data Acquisition Electronics	DAE4	1664	2022/5/30	2023/5/29
SPEAG	Data Acquisition Electronics	DAE4	1437	2022/11/23	2023/11/22
SPEAG	Dosimetric E-Field Probe	EX3DV4	3819	2022/5/30	2023/5/29
SPEAG	Dosimetric E-Field Probe	EX3DV4	7576	2022/7/28	2023/7/27
SPEAG	SAM Twin Phantom	QD 000 P40 CD	1671	NCR	NCR
SPEAG	SAM Twin Phantom	QD 000 P40 CB	TP-1500	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
Agilent	Wireless Communication Test Set	E5515C	MY50267224	2022/7/7	2023/7/6
Keysight	Network Analyzer	E5071C	MY46523671	2022/10/17	2023/10/16
Speag	Dielectric Assessment KIT	DAK-3.5	1144	2022/8/15	2023/8/14
Agilent	Signal Generator	N5181A	MY50145381	2022/12/27	2023/12/26
Anritsu	Power Senor	MA2411B	1306099	2022/10/17	2023/10/16
Anritsu	Power Meter	ML2495A	1349001	2022/10/17	2023/10/16
Anritsu	Power Sensor	MA2411B	1542004	2022/12/27	2023/12/26
Anritsu	Power Meter	ML2495A	1339473	2022/12/27	2023/12/26
R&S	Power Sensor	NRP50S	101254	2022/4/7	2023/4/6
R&S	Power Sensor	NRP8S	109228	2022/4/7	2023/4/6
R&S	Spectrum Analyzer	FSP7	100818	2022/7/7	2023/7/6
R&S	CBT BLUETOOTH TESTER	CBT	100963	2022/12/27	2023/12/26
TES	Hygrometer	1310	200505600	2022/7/12	2023/7/11
Anymetre	Thermo-Hygrometer	JR593	2020062101	2022/7/12	2023/7/11
SPEAG	Device Holder	N/A	N/A	N/A	N/A
AR	Amplifier	5S1G4	0333096	Note 1	
Mini-Circuits	Amplifier	ZVE-3W-83+	599201528	Note 1	
Mini-Circuits	Amplifier	ZVA-183W-S+	726202215	Note 1	
ARRA	Power Divider	A3200-2	N/A	Note 1	
ET Industries	Dual Directional Coupler	C-058-10	N/A	Note 1	
Weinschel	Attenuator 1	3M-10	N/A	Note 1	
Weinschel	Attenuator 2	3M-20	N/A	Note 1	

Note:

1. Prior to system verification and validation, the path loss from the signal generator to the system check source and the power meter, which includes the amplifier, cable, attenuator and directional coupler, was measured by the network analyzer. The reading of the power meter was offset by the path loss difference between the path to the power meter and the path to the system check source to monitor the actual power level fed to the system check
2. Referring to KDB 865664 D01v01r04, the dipole calibration interval can be extended to 3 years with justification. The dipoles are also not physically damaged, or repaired during the interval.
3. The justification data of dipole can be found in appendix C. The return loss is < -20dB, within 20% of prior calibration, the impedance is within 5 ohm of prior calibration.

11. System Verification

11.1 Tissue Simulating Liquids

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 11.1.

Fig 11.1 Photo of Liquid Height for Body SAR

11.2 Tissue Verification

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (εr)
For Head								
1640	54.3	0	0	0.4	0	45.3	1.31	40.2
2000	55.2	0	0	0.3	0	44.5	1.40	40.0

<Tissue Dielectric Parameter Check Results>

Frequency (MHz)	Tissue Type	Liquid Temp. (℃)	Conductivity (σ)	Permittivity (ε_r)	Conductivity Target (σ)	Permittivity Target (ε_r)	Delta (σ) (%)	Delta (ε_r) (%)	Limit (%)	Date
1640	Head	22.5	1.281	38.598	1.31	40.20	-2.21	-3.99	±5	2023/2/28
1640	Head	22.2	1.343	41.918	1.31	40.20	2.52	4.27	±5	2023/3/2
2000	Head	22.4	1.463	39.187	1.40	40.00	4.50	-2.03	±5	2023/3/1
2000	Head	22.5	1.391	38.715	1.40	40.00	-0.64	-3.21	±5	2023/3/3

11.3 System Performance Check Results

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

<1g SAR>

Date	Frequency (MHz)	Tissue Type	Input Power (mW)	Dipole S/N	Probe S/N	DAE S/N	Measured 1g SAR (W/kg)	Targeted 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Deviation (%)
2023/2/28	1640	Head	250	347	7576	1664	7.970	34.600	31.88	-7.86
2023/3/2	1640	Head	250	347	7576	1664	8.370	34.600	33.48	-3.24
2023/3/1	2000	Head	250	1083	3819	1437	10.400	40.900	41.6	1.71
2023/3/3	2000	Head	250	1083	3819	1437	10.500	40.900	42	2.69

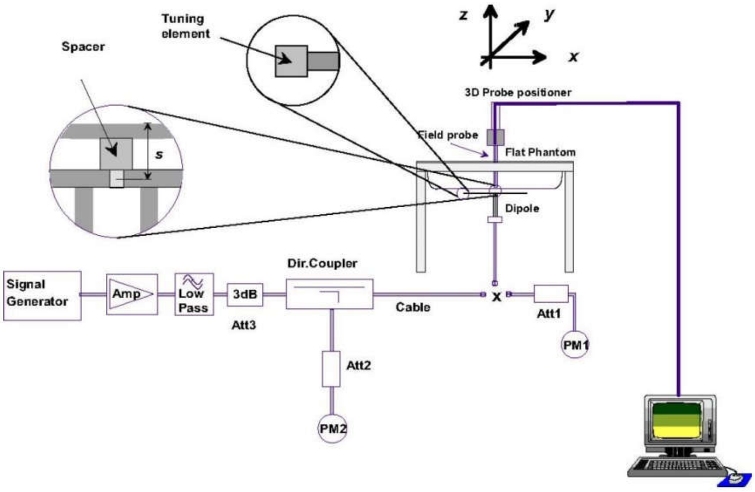


Fig 11.3.1System Performance Check Setup

Fig 11.3.2 Setup Photo

12. RF Exposure Positions

12.1 SAR Testing for Body

Per FCC KDB Publication 447498 D01 v06 where SAR test considerations are based on a composite test separation distance of 5 mm from the front, back and edges of the device containing transmitting antennas within 2.5cm of their edges.

13. Conducted RF Output Power (Unit: dBm)

The detailed conducted power table can refer to Appendix E.

14. Bluetooth Exclusions Applied

Mode Band	Max Average power(dBm)
	LE
2.4GHz Bluetooth	-1.0

Note:

1. Per KDB 447498 D01v06, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:
   [(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)] ·[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR
   - f(GHz) is the RF channel transmit frequency in GHz
   - Power and distance are rounded to the nearest mW and mm before calculation
   - The result is rounded to one decimal place for comparison

Bluetooth Max Power (dBm)	Separation Distance (mm)	Frequency (GHz)	exclusion thresholds
-1.0	< 5	2.48	0.3

Note:
Per KDB 447498 D01v06, when the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion. The test exclusion threshold is 0.3 which is <= 3, SAR testing is not required.

15. Antenna Location

The detailed antenna location information can refer to SAR Test Setup Photos.

16. SAR Test Results

General Note:

1. Per KDB 447498 D01v06, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
   a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
   b. For SAR testing of Band 23/255 signal with 86% duty cycle (Declared by Manufacturer), the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle) *86%".
   c. For Band 23/255: Reported SAR(W/kg)= Measured SAR(W/kg)* Duty Cycle scaling factor * Tune-up scaling factor
2. Per KDB 447498 D01v06, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the *reported* 1-g or 10-g SAR for the mid-band or highest output power channel is:
   - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
   - ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
   - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required when the measured SAR is ≥ 0.8W/kg.
4. The device implements Proximity sensors trigger reduced power for the power management for SAR compliance at different exposure conditions (body). The device will invoke corresponding work scenarios power level, which are provided in the operational description. And the device will invoke corresponding work scenarios power level base on frequency bands/antennas, which can refer to power table at appendix E.
5. For distance SAR and non-distance SAR always chose higher SAR to do co-located analysis.
6. Although the distance 1gSAR is greater than 0.8 W/kg at body exposure conditions, the distance SAR verified the worst of the non-distance SAR and less than non-distance SAR, so there is no need to be tested other channels.
7. For Band 23/255 supports SCS 3.75 kHz and SCS 15 kHz, chose higher power which is SCS 15 kHz to perform SAR testing.

16.1 Body SAR

Plot No.	Band	SCS	Modulation	RB Size	RB offset	Test Position	Gap (mm)	Power Reduction	Ch.	Freq. (MHz)	Accessory	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)
	Band 255	15KHz	QPSK	1	1	Front	5mm	Reduced	261674	1643.3	-	18.02	19.50	1.406	86	1.000	0.16	0.980	1.378
01	Band 255	15KHz	QPSK	1	1	Back	5mm	Reduced	261674	1643.3	-	18.02	19.50	1.406	86	1.000	-0.09	1.010	**1.420**
	Band 255	15KHz	QPSK	1	1	Back	5mm	Reduced	261674	1643.3	Strap	18.02	19.50	1.406	86	1.000	0.08	0.967	1.360
	Band 255	15KHz	QPSK	1	1	Left Side	5mm	Full	261674	1643.3	-	22.57	24.00	1.390	86	1.000	0.01	0.324	0.450
	Band 255	15KHz	QPSK	1	1	Right Side	5mm	Full	261674	1643.3	-	22.57	24.00	1.390	86	1.000	0.03	0.087	0.121
	Band 255	15KHz	QPSK	1	1	Top Side	5mm	Full	261674	1643.3	-	22.57	24.00	1.390	86	1.000	-0.15	0.563	0.783
	Band 255	15KHz	QPSK	1	1	Bottom Side	5mm	Full	261674	1643.3	-	22.57	24.00	1.390	86	1.000	0.1	0.647	0.899
	Band 255	15KHz	QPSK	1	1	Bottom Side	5mm	Full	261505	1626.7	-	22.41	24.00	1.442	86	1.000	0.04	0.619	0.893
	Band 255	15KHz	QPSK	1	1	Bottom Side	5mm	Full	261843	1659.9	-	22.49	24.00	1.416	86	1.000	-0.17	0.461	0.653
	Band 255	15KHz	QPSK	1	1	Front	5mm	Reduced	261505	1626.7	-	17.88	19.50	1.452	86	1.000	-0.14	0.930	1.350
	Band 255	15KHz	QPSK	1	1	Front	5mm	Reduced	261843	1659.9	-	17.74	19.50	1.500	86	1.000	-0.04	0.822	1.233
	Band 255	15KHz	QPSK	1	1	Back	5mm	Reduced	261505	1626.7	-	17.88	19.50	1.452	86	1.000	0.06	0.940	1.365
	Band 255	15KHz	QPSK	1	1	Back	5mm	Reduced	261843	1659.9	-	17.74	19.50	1.500	86	1.000	-0.04	0.833	1.249
	Band 255	15KHz	QPSK	1	1	Front	16mm	Full	261674	1643.3	-	22.57	24.00	1.390	86	1.000	-0.06	1.000	1.390
	Band 255	15KHz	QPSK	1	1	Front	16mm	Full	261505	1626.7	-	22.41	24.00	1.442	86	1.000	0.07	0.946	1.364
	Band 255	15KHz	QPSK	1	1	Front	16mm	Full	261843	1659.9	-	22.49	24.00	1.416	86	1.000	0.01	0.876	1.240
	Band 255	15KHz	QPSK	1	1	Back	16mm	Full	261674	1643.3	-	22.57	24.00	1.390	86	1.000	0.07	0.995	1.383
	Band 23	15KHz	QPSK	1	1	Front	5mm	Reduced	25600	2010	-	18.11	19.50	1.377	86	1.000	-0.05	0.904	1.245
02	Band 23	15KHz	QPSK	1	1	Back	5mm	Reduced	25600	2010	-	18.11	19.50	1.377	86	1.000	0.08	0.985	**1.357**
	Band 23	15KHz	QPSK	1	1	Back	5mm	Reduced	25600	2010	Strap	18.11	19.50	1.377	86	1.000	0.01	0.931	1.282
	Band 23	15KHz	QPSK	1	1	Left Side	5mm	Full	25600	2010	-	22.68	24.00	1.355	86	1.000	-0.1	0.431	0.584
	Band 23	15KHz	QPSK	1	1	Right Side	5mm	Full	25600	2010	-	22.68	24.00	1.355	86	1.000	-0.09	0.082	0.112
	Band 23	15KHz	QPSK	1	1	Top Side	5mm	Full	25600	2010	-	22.68	24.00	1.355	86	1.000	0.11	0.524	0.710
	Band 23	15KHz	QPSK	1	1	Bottom Side	5mm	Full	25600	2010	-	22.68	24.00	1.355	86	1.000	0.1	0.546	0.740
	Band 23	15KHz	QPSK	1	1	Front	5mm	Reduced	25501	2000.1	-	18.02	19.50	1.406	86	1.000	0.08	0.845	1.188
	Band 23	15KHz	QPSK	1	1	Front	5mm	Reduced	25699	2019.9	-	18.01	19.50	1.409	86	1.000	0.01	0.846	1.192
	Band 23	15KHz	QPSK	1	1	Back	5mm	Reduced	25501	2000.1	-	18.02	19.50	1.406	86	1.000	-0.09	0.916	1.288
	Band 23	15KHz	QPSK	1	1	Back	5mm	Reduced	25699	2019.9	-	18.01	19.50	1.409	86	1.000	0.11	0.943	1.329
	Band 23	15KHz	QPSK	1	1	Front	16mm	Full	25600	2010	-	22.68	24.00	1.355	86	1.000	0.16	0.979	1.327
	Band 23	15KHz	QPSK	1	1	Front	16mm	Full	25501	2000.1	-	22.55	24.00	1.396	86	1.000	0.06	0.935	1.306
	Band 23	15KHz	QPSK	1	1	Front	16mm	Full	25699	2019.9	-	22.45	24.00	1.429	86	1.000	0.07	0.921	1.316
	Band 23	15KHz	QPSK	1	1	Back	16mm	Full	25600	2010	-	22.68	24.00	1.355	86	1.000	-0.13	0.946	1.282

16.2 Repeated SAR Measurement

<1g>

No.	Band	SCS	Modulation	RB Size	RB offset	Test Position	Gap (mm)	Power Reduction	Ch.	Freq. (MHz)	Accessory	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 1g SAR (W/kg)	Ratio	Reported 1g SAR (W/kg)
1st	Band 255	15KHz	QPSK	1	1	Back	5mm	Reduced	261674	1643.3	-	18.02	19.50	1.406	86	1.000	-0.09	1.010	1	1.420
2st	Band 255	15KHz	QPSK	1	1	Back	5mm	Reduced	261674	1643.3	-	18.02	19.50	1.406	86	1.000	0.11	0.976	1.127	1.372
1st	Band 23	15KHz	QPSK	1	1	Back	5mm	Reduced	25600	2010	-	18.11	19.50	1.377	86	1.000	0.08	0.985	1	1.357
2st	Band 23	15KHz	QPSK	1	1	Back	5mm	Reduced	25600	2010	-	18.11	19.50	1.377	86	1.000	0.01	0.967	1.019	1.332

General Note:

1. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg.
2. Per KDB 865664 D01v01r04, if the ratio among the repeated measurement is ≤ 1.2 and the measured SAR <1.45W/kg, only one repeated measurement is required.
3. The ratio is the difference in percentage between original and repeated *measured SAR*.
4. All measurement SAR result is scaled-up to account for tune-up tolerance and is compliant.

17. Simultaneous Transmission Analysis

NO.	Simultaneous Transmission Configurations	Messaging Device
		Body
1.	Band 23/255 + Bluetooth	Yes

General Note:

1. According to the EUT characteristic, Band 23/255 and Bluetooth can transmit simultaneously.
2. The reported SAR summation is calculated based on the same configuration and test position.
3. Per KDB 447498 D01v06, simultaneous transmission SAR is compliant if,
   i) 1g Scalar SAR summation < 1.6W/kg and 10g Scalar SAR summation < 4.0W/kg.
   ii) SPLSR = (SAR1 + SAR2)^1.5 / (min. separation distance, mm), and the peak separation distance is determined from the square root of [(x1-x2)2 + (y1-y2)2 + (z1-z2)2], where (x1, y1, z1) and (x2, y2, z2) are the coordinates of the extrapolated peak SAR locations in the zoom scan.
   iii) If SPLSR ≤ 0.04 for 1g SAR and SPLSR≤ 0.10 for 10g SAR , simultaneously transmission SAR measurement is not necessary.
   iv) Simultaneously transmission SAR measurement, and the reported multi-band 1g SAR < 1.6W/kg and 10g SAR < 4.0W/kg.
4. Bluetooth SAR is estimated per KDB 447498 D01v06 based on the formula below:
   i) (*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)]·[√f(GHz)/*x*] W/kg for *test separation distances* ≤ 50 mm; where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.
   ii) When the minimum separation distance is < 5mm, the distance is used 5mm to determine SAR test exclusion.
   iii) 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm.
   iv) BLE estimated SAR is conservatively determined by 5mm separation, for all applicable exposure positions.

BLE Max Power	Exposure Position	Body (1g SAR)
	Test separation	5 mm
-1.0 dBm	Estimated SAR (W/kg)	0.033 W/kg

17.1 Body Exposure Conditions

Band	Exposure Position	1	2	1+2
		WWAN	Bluetooth	Summed
		1g SAR (W/kg)	1g SAR Estimated SAR (W/kg)	1g SAR (W/kg)
Band 255	Front	1.390	0.033	1.42
	Back	1.420	0.033	**1.45**
	Left side	0.450	0.033	0.48
	Right side	0.121	0.033	0.15
	Top side	0.783	0.033	0.82
	Bottom side	0.899	0.033	0.93
Band 23	Front	1.327	0.033	1.36
	Back	1.357	0.033	1.39
	Left side	0.584	0.033	0.62
	Right side	0.112	0.033	0.15
	Top side	0.710	0.033	0.74
	Bottom side	0.740	0.033	0.77

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18. Uncertainty Assessment

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

19. References

[1] FCC 47 CFR Part 2 “Frequency Allocations and Radio Treaty Matters; General Rules and Regulations”

[2] ANSI/IEEE Std. C95.1-1992, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”, September 1992

[3] IEEE Std. 1528-2013, “IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques”, Sep 2013

[4] SPEAG DASY System Handbook

[5] FCC KDB 865664 D01 v01r04, "SAR Measurement Requirements for 100 MHz to 6 GHz", Aug 2015.

[6] FCC KDB 865664 D02 v01r02, “RF Exposure Compliance Reporting and Documentation Considerations” Oct 2015.

[7] FCC KDB 447498 D01 v06, “Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies”, Oct 2015

[8] FCC KDB 616217 D04 v01r02, “SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers”, Oct 2015

[9] FCC KDB 941225 D05 v02r05, “SAR Evaluation Considerations for LTE Devices”, Dec 2015

------THE END------