Test Report

Verified code: 377761

Report No.: E20240725192701-6

Customer:	Lumi United Technology Co., Ltd
Address:	B1, Chongwen Park, Nanshan iPark, Liuxian Avenue, Taoyuan Residential District, Nanshan District, Shenzhen, China
Sample Name:	Voice Mate H1
Sample Model:	AT-R01E
Receive Sample Date:	Aug.05,2024
Test Date:	Aug.22,2024 ~ Aug.22,2024
Reference Document:	IEC/IEEE 62209-1528:2020 47 CFR FCC Part 2.1093 IEEE Std. C95.1-2019
Test Result:	Pass

Prepared by: Wen Wenwen   Reviewed by: Wu Haoting   Approved by: Xiao Liang

GRG METROLOGY & TEST GROUP CO., LTD.

Issued Date: 2024-09-06

GRG METROLOGY & TEST GROUP CO., LTD.
Address: No.163,Pingyun Road, West of Huangpu Avenue, Guangzhou, Guangdong, China
Tel：（+86）400-602-0999 FAX：（+86）020-38698685 Web：http://www.grgtest.com

Statement

1. The report is invalid without "special seal for inspection and testing"; some copies are invalid; The report is invalid if it is altered or missing; The report is invalid without the signature of the person who prepared, reviewed and approved it.

2. The sample information is provided by the client and responsible for its authenticity; The content of the report is only valid for the samples sent this time.

3. When there are reports in both Chinese and English, the Chinese version will prevail when the language problems are inconsistent.

4. If there is any objection concerning the report, please inform us within 15 days from the date of receiving the report.

5. This testing report is only for scientific research, teaching, internal quality control, etc.

——Blank space below this page——

TABLE OF CONTENTS

——Blank space below this page——

REPORT ISSUED HISTORY

Report Version	Report No.	Description	Compile Date
1.0	E20240725192701-6	Original Issue	2024-08-31

——Blank space below this page——

1. TEST RESULT SUMMARY

Body-worn					
Test mode	**Test Position**	**Gap (mm)**	**Highest Reported SAR_{1g} (W/Kg)**	**Limit(W/Kg)**	**Test Result**
Bluetooth LE	Front Face	0.00	0.225	1.6	PASS
Thread	Front Face	0.00	0.263		
Highest Simultaneous Transmission			0.488		

Note：
This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg for localized Head, Neck and Trunk 1g SAR, 4.0 W/Kg for localized Limbs 10g SAR) specified in FCC 47 CFR part 2 (2.1093) and IEEE C95.1-2019, and had been tested in accordance with the measurement methods and procedures specified in IEC/IEEE 1528-62209:2020.

——Blank space below this page——

2. GENERAL INFORMATION OF EUT

2.1 GENERAL INFORMATION

Applicant	Lumi United Technology Co., Ltd
Address	B1, Chongwen Park, Nanshan iPark, Liuxian Avenue, Taoyuan Residential District, Nanshan District, Shenzhen, China
Manufacturer	Lumi United Technology Co., Ltd
Address	B1, Chongwen Park, Nanshan iPark, Liuxian Avenue, Taoyuan Residential District, Nanshan District, Shenzhen, China

2.2 GENERAL DESCRIPTION

Product Name:	Voice Mate H1
Product Model:	AT-R01E
Trade Name:	Aqara
Additional Model:	AT-R01D
Model difference descriptions:	They have the same software and hardware constructions including circuit diagram, PCB layout and electrical parts, except Model name and packaging are different, as they would distribute in different regions to satisfy subdividing market demands.
Power Supply:	3.0V DC supplied by button cell
FCC ID:	2AKIT-ATR01
Device Type:	Portable device
HW Version:	V1.0
SW Version:	V1.0.0.1
Operation Frequency:	2405-2480 MHz(Thread) 2402-2480 MHz(BLE)
Device class:	Class B
Type of Modulation:	O-QPSK(Thread) GFSK(BLE)
Antenna Specification:	PIFA antenna
Antenna Gain:	1.0dBi gain (Max)；
Test Channels (low-mid-high):	11-18-26(Thread) 0-19-39(BLE)
Operating Mode:	Maximum continuous output
	Other Information
Power Supply:	DC 3V
Battery Specification:	CR2450 3.0V DC
Adapter Specification:	/
Sample submitting way:	■Provided by customer □Sampling
Note 1:	The EUT antenna gain is provided by the applicant. This report is made solely on the basis of such data and/or information. We accept no responsibility for the authenticity and completeness of the above data and information and the validity of the results

and/or conclusions.

Note 2: The EUT have two colors, the one is white, the other is black, they have the same software and hardware constructions including circuit diagram, PCB layout and electrical parts, except color is different. All tests were performed on the AT-R01E model.

2.3 LABORATORY ENVIRONMENT

Temperature	Min. = 18 ℃, Max. = 25 ℃
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.	

——Blank space below this page——

3. LABORATORY AND ACCREDITATIONS

3.1 LABORATORY

The tests and measurements refer to this report were performed by Shenzhen EMC Laboratory of GRG METROLOGY & TEST GROUP CO., LTD.

Add.:	No.1301 Guanguang Road Xinlan Community, Guanlan Street, Longhua District Shenzhen, 518110, People's Republic of China.
P.C.:	518000
Tel :	0755-61180008
Fax:	0755-61180008

3.2 ACCREDITATIONS

Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

USA	A2LA(Certificate #2861.01)

The measuring facility of laboratories has been authorized or registered by the following approval agencies.

Canada	ISED (Company Number: 24897，CAB identifier:CN0069)
USA	FCC (Registration Number: 759402，Designation Number:CN1198)

Copies of granted accreditation certificates are available for downloading from our web site, http://www.grgtest.com

——Blank space below this page——

4. TEST STANDARDS AND LIMITS

No.	Identity	Document Title
1	47 CFR FCC Part 2.1093	Radiofrequency radiation exposure evaluation: portable devices.
2	IEEE Std. C95.1-2019	IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz
3	IEC/IEEE 62209-1528: 2020	Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices Part 1528:Human models, instrumentation, and procedures(Frequency range of 4 MHz to 10 GHz)
Test relevant KDB procedures: KDB 447498 D04 v01 Interim General RF Exposure Guidance KDB 865664 D01 v01r04 SAR measurement 100 MHz to 6 GHz KDB 865664 D02 v01r02 RF Exposure Reporting		

Body region	Population/Uncontrolled Environments (W/kg)	Occupational/Controlled Environments (W/kg)
Whole body	0.08	0.4
Localized head, neck and trunk	1.6	8
Localized limbs	4	20

NOTE: **Whole Body SAR** is averaged over the entire body, **Localized head, neck and trunk SAR** is averaged over any 1 gram of tissue defined as a tissue volume in the shape of a cube. **Localized limbs SAR** is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

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

Occupational/Controlled Environments:
are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

5. SAR MEASUREMENTS SYSTEM

5.1 DEFINITION OF SPECIFIC ABSORPTION RATE (SAR)

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.

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:

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

SAR is expressed in units of Watts per kilogram (W/kg) SAR measurement can be related to the electrical field in the tissue by

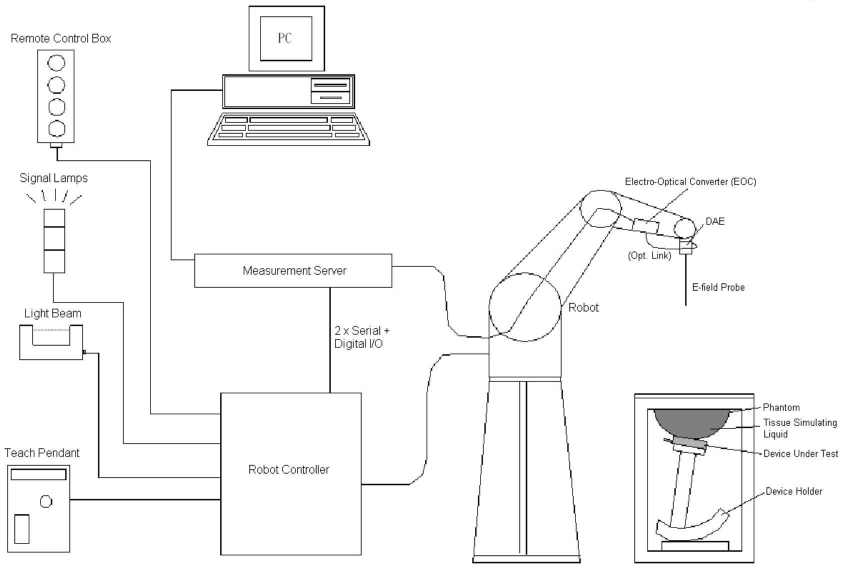
$$\mathrm{SAR} = \frac{\sigma E^2}{\rho}$$

Where: σ is the conductivity of the tissue;

ρ is the mass density of the tissue and E is the RMS electrical field strength.

——Blank space below this page——

5.2 SAR SYSTEM



DASY System Configurations

The DASY system for performance compliance tests is illustrated above graphically. This system consists of the following items:

- A standard high precision 6-axis robot with controller, a teach pendant and software
- A data acquisition electronic (DAE) attached to the robot arm extension
- A dosimetric probe equipped with an optical surface detector system
- The electro-optical converter (EOC) performs the conversion between optical and electrical signals
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the accuracy of the probe positioning
- A computer operating Windows XP
- DASY software
- Remove control with teach pendant and additional circuitry for robot safety such as warming lamps, etc.
- The SAM twin phantom
- A device holder
- Tissue simulating liquid
- Dipole for evaluating the proper functioning of the system

Components are described in details in the following sub-sections.

5.3 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.

- **E-Field Probe Specification**

<ES3DV3 Probe>

Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	 **Photo of ES3DV3**
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	

- **E-Field Probe Calibration**

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than ± 10%. The spherical isotropy shall be evaluated and within ± 0.25dB. The sensitivity parameters (NormX, NormY, and NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested. The calibration data can be referred to appendix C of this report.

——Blank space below this page——

5.4 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 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80dB.

Photo of DAE

——Blank space below this page——

5.5 ROBOT

The SPEAG DASY system uses the high precision robots (DASY5: TX60XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

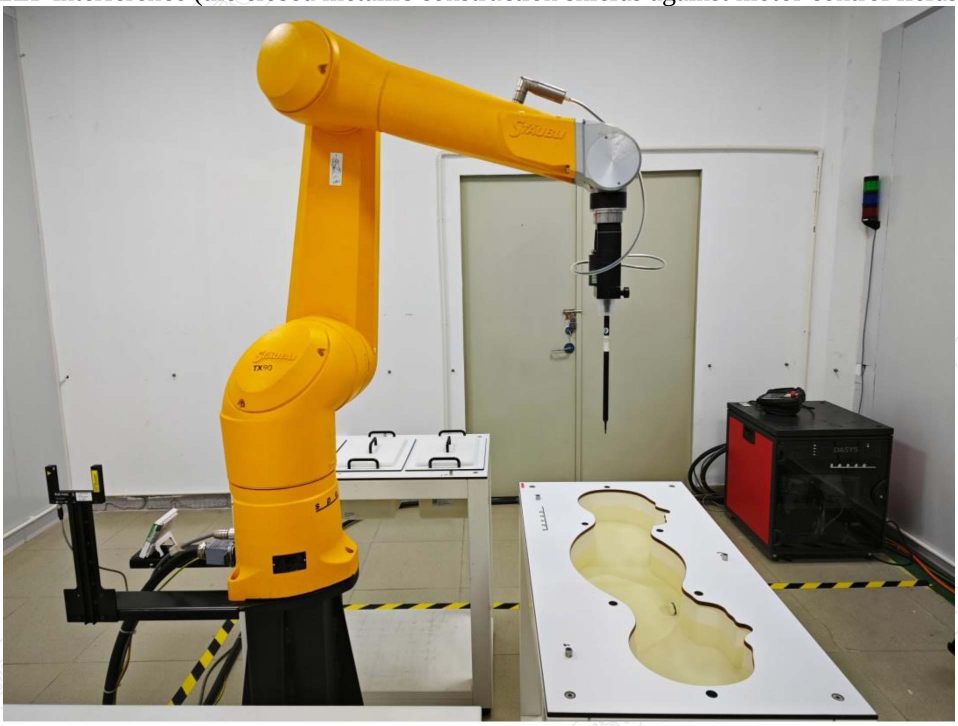


Photo of DASY5

5.6 MEASUREMENT SERVER

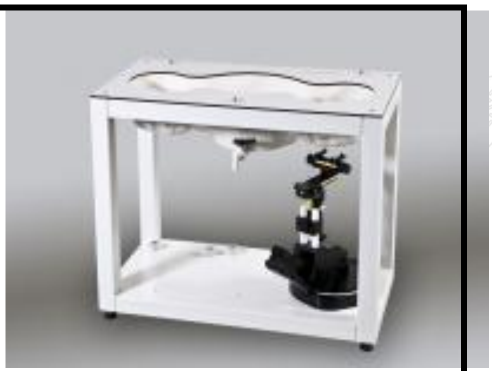
The measurement server is based on a PC/104 CPU board with CPU (DASY5: 400 MHz, Intel Celeron), chip disk (DASY5: 128 MB), RAM (DASY5: 128 MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all the real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operations.

Photo of Server for DASY5

5.7 PHANTOM

<SAM Twin Phantom>

Shell Thickness	2 ±0.2 mm; Center ear point: 6 ±0.2 mm	 **Photo of SAM Phantom**
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.

——Blank space below this page——

5.8 DEVICE HOLDER

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5 mm distance, a positioning uncertainty of ±0.5mm would produce a SAR uncertainty of ± 20%. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (ERP).Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity ε = 3 and loss tangent δ = 0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

Device Holder

5.9 DATA STORAGE AND EVALUATION

- **Data Storage**

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files. The post-processing 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 erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

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

- **Data Evaluation**

The DASY post-processing software (SEMCAD) 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	$Norm_i$, 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	σ
	- Density	ρ

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 DASY components. In the direct measuring mode of the multi-meter 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：

$$\mathbf{V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}}$$

with V_i= compensated signal of channel i, (i = x, y, z)
U_i = input signal of channel i, (i = x, y, z)
cf = crest factor of exciting field (DASY parameter)
dcp_i = diode compression point (DASY parameter)

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

E-field Probes：$\mathbf{E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}}$

H-field Probes:
$$H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1} f + a_{i2} f^2}{f}$$

with V_i = compensated signal of channel i,(i = x, y, z)
$Norm_i$= sensor sensitivity of channel i, (i = x, y, z), µV/(V/m)^2 for E-field Probes
ConvF= sensitivity enhancement in solution
a_{ij}= sensor sensitivity factors for H-field probes
f = carrier frequency [GHz]
E_i= electric field strength of channel i in V/m
H_i= magnetic field strength of channel i in A/m

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

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

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

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with SAR = local specific absorption rate in mW/g
E_{tot}= total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm^3

Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.

——Blank space below this page——

6. TEST EQUIPMENT LIST

Name of Equipment	Manufacturer	Model	Serial Number	Calibration Due
System Validation Dipole	SPEAG	D2450V2	933	2027-03-13
EX3DVx SAR Probe	SPEAG	SP EX3 004 CC	7716	2025-05-12
DAE4 Data Acquisition Electronics	SPEAG	DAE4	1718	2025-05-10
ENA Series Network Analyzer	Keysight	E5071C	MY46901661	2024-09-04
DAK	SPEAG	DAK-3.5	/	N/A
SAM Twin Phantom	SPEAG	QD 000 P40 CD	1745	N/A
Power Meter	Agilent	E4419B	MY40330214	2024-10-12
Power Sensor	Agilent	E9304A	MY51470045	2024-10-13
Power Meter	Anritsu	ML2495A	1204003	2025-01-11
Power Sensor	Anritsu	MA2411B	1126150	2025-01-11
Signal generator	Keysight	N5173B	MY59100374	2024-09-19

Remark:

1. "N/A" denotes no model name, serial No. or calibration specified.
2. *Thesetestequipmentshavebeenrecalibratedbetweenthetestperiods.Allthesetestequipments were within the valid period when the tests were performed.
3. Per KDB865664 D01 requirements for dipole calibration, the test laboratory has adopted three-year extended calibration interval. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.
   a) There is no physical damage on the dipole;
   b) System check with specific dipole is within 10% of calibrated value;
   c) The most recent return-loss result , measured at least annually, deviates by no more than 20% from the previous measurement;
   d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.

7. SYSTEM VERIFICATION PROCEDURE

7.1 TISSUE VERIFICATION

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 head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 6.1. 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 as followed:

Photo of Liquid Height

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (εr)
For Head								
2450	55.0	0	0	0	0	45.0	1.80	39.2

The following table shows the measuring results for simulating liquid.

Tissue Type	Measured Frequency (MHz)	Target Value (±10%)		Measured Value		Tissue temperature (℃)	Measured Date
		εr	σ(S/m)	εr	σ(S/m)		
2450 HSL	2450	39.20 (35.28~43.12)	1.80 (1.62~1.98)	38.464	1.776	21.3	2024-08-22

Note:

1) The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 ℃ 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 significantdigits.

7.2 SYSTEM CHECK PROCEDURE

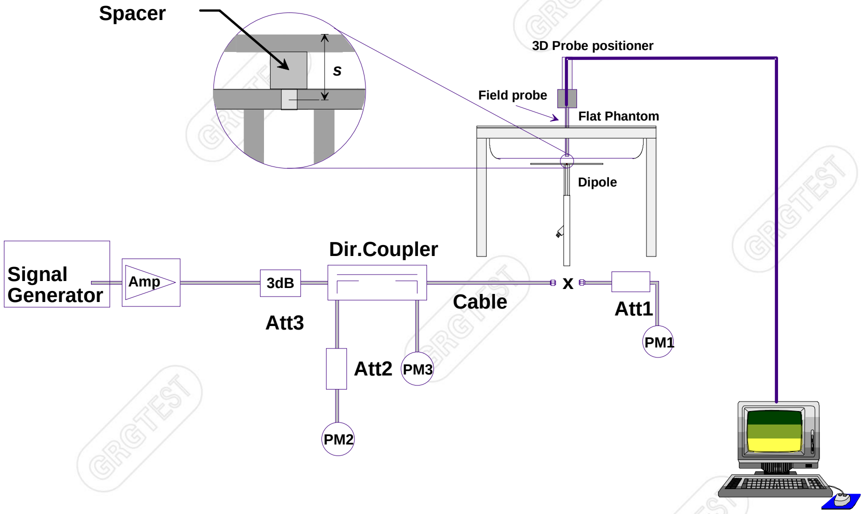
Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder.

- **Purpose of System Performance check**

  The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

- **System Setup**

  In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



System Setup for System Evaluation

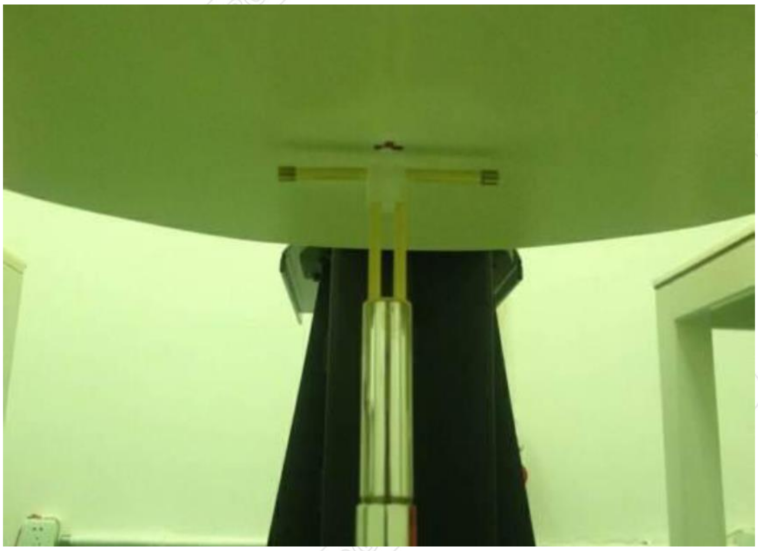


Photo of Dipole Setup

- **Validation Results**

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

Dipole	Tissue Type	Target Value(W/Kg) (±10%) (Normalized to 1W)		Measured Value (W/Kg)(1W)		Tissue temperature (℃)	Measured Date
		1g	10g	1g	10g		
D2450V2	2450 HSL	52.80 （47.52~58.08）	24.50 (22.05~26.95)	48.0	22.16	21.3	2024-08-22

Target and Measurement SAR after Normalized

——**Blank space below this page**——

8. SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

8.1 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 imit).
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 Chapter 12.

8.2 MEASUREMENT UNCERTAINTY

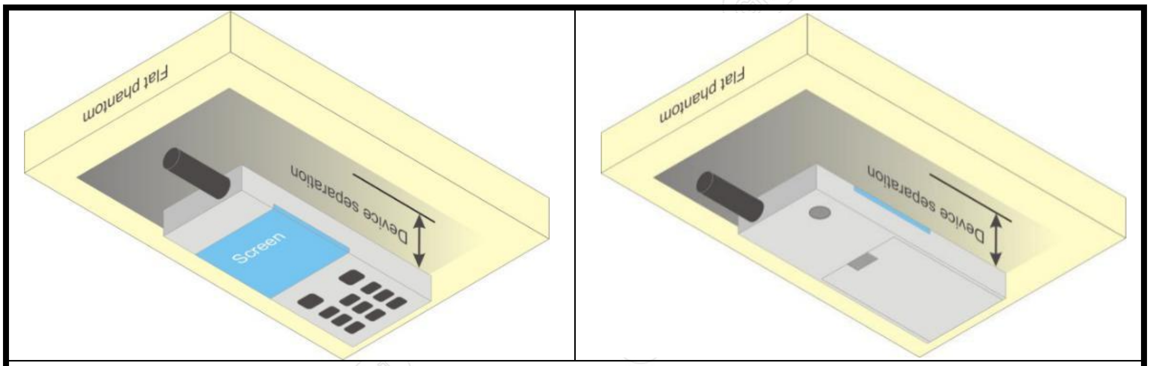
Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in ICE/IEEE 62209-1528 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

9. EUT TESTING POSITION

9.1 BODY WORN POSITION

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration. Per KDB 648474 D04, body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB 447498 D04 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for body-worn accessory, measured without a headset connected to the handset is < 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a handset attached to the handset.

Accessories for body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are test with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-chip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.



Body Worn Position

10. MEASUREMENT PROCEDURES

The measurement procedures are as follows:

(a) Use base station simulator (if applicable) or engineering software to transmit RF power continuously (continuous Tx) in the middle channel.
(b) Keep EUT to radiate maximum output power or 100% duty factor (if applicable)
(c) Measure output power through RF cable and power meter.
(d) Place the EUT in the positions as setup photos demonstrates.
(e) Set scan area, grid size and other setting on the DASY software.
(f) Measure SAR transmitting at the middle channel for all applicable exposure positions.
(g) Identify the exposure position and device configuration resulting the highest SAR
(h) Measure SAR at the lowest and highest channels at the worst exposure position and device configuration if applicable.

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

10.1 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

10.2 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.

10.3 AREA SCAN PROCEDURES

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 IEC/IEEE 62209-1528 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 D01 SAR measurement 100 MHz to 6 GHz.

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	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.	

——Blank space below this page——

10.4 ZOOM SCAN PROCEDURES

Zoom scans are used assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10gram 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 D01 SAR measurement 100 MHz to 6 GHz.

<table>
<tr><th colspan="3"></th><th>≤ 3 GHz</th><th>> 3 GHz</th></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 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>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 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>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm
4 – 5 GHz: ≤ 2.5 mm
5 – 6 GHz: ≤ 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>≥ 30 mm</td><td>3 – 4 GHz: ≥ 28 mm
4 – 5 GHz: ≥ 25 mm
5 – 6 GHz: ≥ 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 reported SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 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>

10.5 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 post-processor can combine and subsequently superpose these measurement data to calculating the multi-band SAR.

.

10.6 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 drift more than ±0.2dB, the SAR will be retested.

——Blank space below this page——

11. CONDUCTED POWER

< Thread Conducted Average Power Ant1>

Mode	Channel	Frequency (MHz)	Conducted Average Power (dBm)	Tune-up Limit (dBm)
Thread	CH 11	2405	8.34	8.50
	CH 18	2440	8.22	
	CH 26	2480	8.16	

< BLE Conducted Average Power Ant1>

Mode	Channel	Frequency (MHz)	Conducted Average Power (dBm)	Tune-up Limit (dBm)
BLE 1M	CH 0	2402	7.61	8.00
	CH 19	2440	7.45	
	CH 39	2480	7.32	
BLE 2M	CH 0	2402	7.60	8.00
	CH 19	2440	7.45	
	CH 39	2480	7.32	

Note:

1. Per KDB 447498 D04Chapter 2.1.3, A more comprehensive exemption, considering a variable power threshold that depends on both the separation distance and power, is provided in Formula (B.1). This exemption is applicable to the frequency range between 300 MHz and 6 GHz, with test separation distances between 0.5 cm and 40 cm, and for all RF sources in fixed, mobile, and portable device exposure conditions.
2. Accordingly, a RF source is considered an RF exempt device if its available maximum time-averaged (matched conducted) power or its effective radiated power (ERP), whichever is greater, are below a specified threshold.

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

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

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).
The example values shown in Table B.2 are for illustration only.

Table B.2—Example Power Thresholds (mW)

Frequency (MHz)	Distance (mm)									
	5	10	15	20	25	30	35	40	45	50
300	39	65	88	110	129	148	166	184	201	217
450	22	44	67	89	112	135	158	180	203	226
835	9	25	44	66	90	116	145	175	207	240
1900	3	12	26	44	66	92	122	157	195	236
2450	3	10	22	38	59	83	111	143	179	219
3600	2	8	18	32	49	71	96	125	158	195
5800	1	6	14	25	40	58	80	106	136	169

Faction	Separation Distance (mm)	Frequency (MHz)	Max Tune-up Limit (dBm)	Max Tune-up Limit (mW)	Exclusion thresholds (mW)
Thread	5	2405	8.50	7.08	3
BLE	5	2402	8.00	6.31	3

3. Per KDB 447498 D04Chapter 4.2.2, 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 > 3, so SAR test is required.

——Blank space below this page——

12. EUT ANTENNA LOCATION

Note: The EUT is a circle with a diameter of 41mm, surface and transmission antenna is less than 25mm, so it all face needs to be tested.

——Blank space below this page——

13. SAR TEST RESULTS SUMMARY

General Note:

1. Per KDB 447498 D04v01, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.

   Scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.

   Reported SAR(W/kg)= Measured SAR(W/kg) Scaling Factor*
2. Per KDB 447498 D04v01, for each exposure position, if the highest output channel reported SAR≤0.8W/kg, other channels SAR testing are not necessary
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.

Band	Mode	Test Position	Gap (mm)	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR_{1g} (W/kg)	Reported SAR_{1g} (W/kg)	Plot No.
Thread	O-QPSK	Front Face	0	2405	8.34	8.50	1.04	0.06	0.227	0.236	
		Rear Face	0	2405	8.34	8.50	1.04	0.15	0.073	0.075	
		Top Face	0	2405	8.34	8.50	1.04	0.10	0.057	0.059	
		Bottom Face	0	2405	8.34	8.50	1.04	0.03	0.037	0.038	
		Left Face	0	2405	8.34	8.50	1.04	0.14	0.068	0.071	
		Right Face	0	2405	8.34	8.50	1.04	0.10	0.018	0.019	
		Front Face	0	2440	8.22	8.50	1.07	0.07	0.240	0.256	
		Front Face	0	2480	8.16	8.50	1.08	0.04	0.243	**0.263**	1#

Band	Mode	Test Position	Gap (mm)	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR_{1g} (W/kg)	Reported SAR_{1g} (W/kg)	Plot No.
BLE	GFSK	Front Face	0	2405	7.61	8.00	1.09	0.10	0.177	0.194	
		Rear Face	0	2405	7.61	8.00	1.09	0.15	0.057	0.063	
		Top Face	0	2405	7.61	8.00	1.09	0.05	0.046	0.050	
		Bottom Face	0	2405	7.61	8.00	1.09	0.07	0.015	0.016	
		Left Face	0	2405	7.61	8.00	1.09	0.16	0.053	0.058	
		Right Face	0	2405	7.61	8.00	1.09	0.16	0.013	0.015	
		Front Face	0	2440	7.45	8.00	1.14	0.00	0.180	0.204	
		Front Face	0	2480	7.32	8.00	1.17	0.08	0.192	**0.225**	2#

14. SIMULTANEOUS TRANSMISSION ANALYSIS

Application Simultaneous Transmission information:

Position	Simultaneous state
Body	Thread + BLE

Simultaneous Mode	Position	Thread 1-g SAR (W/kg)	BLE 1-g SAR (W/kg)	1-g Sum SAR (W/kg)
Thread + BLE	Front Face	0.263	0.225	0.488
	Rear Face	0.075	0.063	0.138
	Top Face	0.059	0.050	0.109
	Bottom Face	0.038	0.016	0.054
	Left Face	0.071	0.058	0.129
	Right Face	0.019	0.015	0.034

——Blank space below this page——

APPENDIX A. SYSTEM CHECKING SCANS

Please refer to the attached document E20240725192701 System Check scans.

APPENDIX B. MEASUREMENT SCANS

Please refer to the attached document E20240725192701 Measurement scans.

APPENDIX C. RELEVANT PAGES FROM PROBE CALIBRATION REPORT(S)

Please refer to the attached document E20240725192701 Calibration reports.

APPENDIX D: PHOTOGRAPH OF SET UP

Please refer to the attached document E20240725192701-test setup photo-FCC+IC.

APPENDIX E: PHOTOGRAPH OF THE EUT

Please refer to the attached document E20240725192701-EUT Photo.

----------- End of Report -----------