

# SAR Test Report

Report No. : SFBGDG-WTW-P24010524

Applicant : CIPHERLAB CO., LTD

Address : 12F, 333 Dunhua S. Rd., Sec.2 Taipei, Taiwan 106

Product : UHF RFID reader

FCC ID : Q3N-RUHF

Brand : CIPHERLAB

Model No. : RS36-UHF, RK26-UHF, RS38-UHF (refer to item 2 for more details)

FCC Rule Part : CFR §2.1093

Standards : IEEE Std 1528:2013, KDB 865664 D01 v01r04, KDB 865664 D02 v01r02,  
KDB 447498 D01 v06, KDB 616217 D04 v01r02

Sample Received Date : Jan. 24, 2024

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Test Location : No. 19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City, Taiwan

FCC Accredited No. : TW0003

**CERTIFICATION:** The above equipment have been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch—Lin Kou Laboratories**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by TAF or any government agencies.

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Appendix A. SAR Plots of System Verification

Appendix B. SAR Plots of SAR Measurement

## Release Control Record

Report No.	Reason for Change	Date Issued
SFBDGD-WTW-P24010524	Initial release	May 10, 2024

## SAR Test Report

### 1. Summary of Maximum SAR Value

Equipment Class	Mode	Highest SAR <sub>1g</sub> Body Tested at 0 mm (W/kg)	Highest SAR <sub>10g</sub> Extremity Tested at 30 mm (W/kg)
DSS	RFID	0.50	0.16

**Note:**

1. The SAR criteria (**Head & Body: SAR-1g 1.6 W/kg**, and **Extremity: SAR-10g 4.0 W/kg**) for general population/uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992.

**References Guidance:** IEEE C95.1:1992

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### 2. Description of Equipment Under Test

EUT Type	UHF RFID reader
FCC ID	Q3N-RUHF
Brand Name	CIPHERLAB
Model Name	RS36-UHF, RK26-UHF, RS38-UHF
Tx Frequency Bands (Unit: MHz)	RFID : 902.75-927.25
Uplink Modulations	RFID : FHSS(PR-ASK)
Antenna Type	PIFA Antenna
EUT Stage	Engineering Sample

#### Note:

1. All models are listed as below.

Brand	Model	Difference
CIPHERLAB	RS36-UHF (Main)	With RS36(Mobile Computer), Battery (Brand : CIPHERLAB/Model : BA-0154A0)
	RK26-UHF (Series)	With RK26(Mobile Computer), Battery (Brand : CIPHERLAB/Model : BA-0124A0)
	RS38-UHF (Series)	With RS38(Mobile Computer), Battery (Brand : CIPHERLAB/Model : BA-0174A5)

2. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

#### List of Accessory:

Battery	Brand Name	CIPHERLAB
	Model Name	BA-0133A0
	Power Rating	3.6Vdc, 3000mAh, 10.8Wh
	Type	Li-ion

### **3. SAR Measurement System**

#### **3.1 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:

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

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

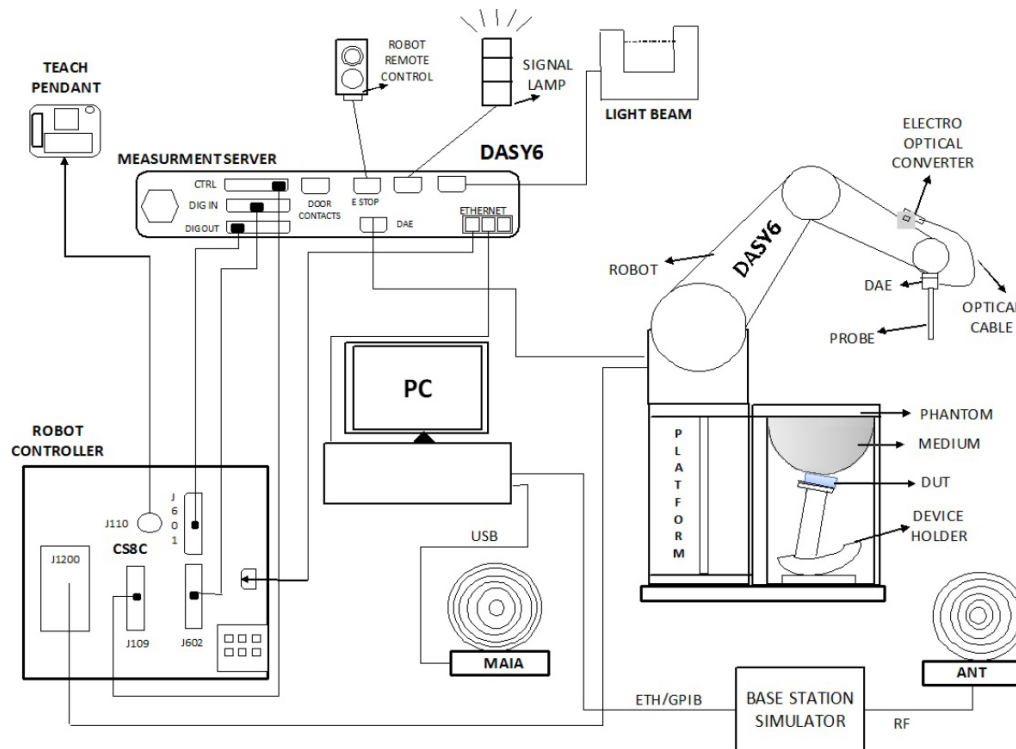
SAR measurement can be related to the electrical field in the tissue by

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

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

#### **3.2 SPEAG DASY6 System**

DASY6 system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY6 software defined. The DASY6 software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC.



**Fig-3.1 SPEAG DASY6 System Setup**

## 3.2.1 Robot

The DASY6 systems use the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version of CS8c from Stäubli is used. The Stäubli robot series have many features that are important for our application:

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




**Fig-3.2 SPEAG DASY6 System**


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### 3.2.2 Probes


The SAR measurement is conducted with the dosimetric probe. 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.

<b>Model</b>	EX3DV4	
<b>Construction</b>	Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE).	
<b>Frequency</b>	4 MHz to 10 GHz Linearity: $\pm 0.2$ dB	
<b>Directivity</b>	$\pm 0.1$ dB in TSL (rotation around probe axis) $\pm 0.3$ dB in TSL (rotation normal to probe axis)	
<b>Dynamic Range</b>	10 $\mu$ W/g to 100 mW/g Linearity: $\pm 0.2$ dB (noise: typically $< 1$ $\mu$ W/g)	
<b>Dimensions</b>	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	

### 3.2.3 Data Acquisition Electronics (DAE)

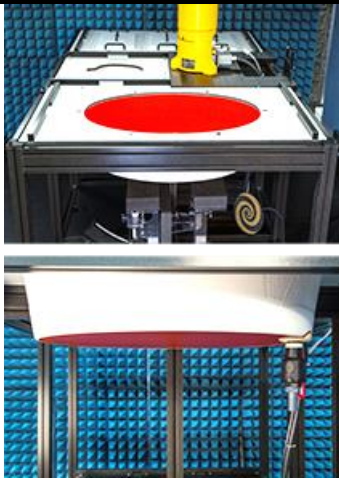
<b>Model</b>	DAE3, DAE4	
<b>Construction</b>	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.	
<b>Measurement Range</b>	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)	
<b>Input Offset Voltage</b>	$< 5\mu$ V (with auto zero)	
<b>Input Bias Current</b>	$< 50$ fA	
<b>Dimensions</b>	60 x 60 x 68 mm	

### 3.2.4 Phantoms


<b>Model</b>	SAM-Twin Phantom	
<b>Construction</b>	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE Std 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body-mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.	
<b>Material</b>	Vinylester, fiberglass reinforced (VE-GF)	
<b>Shell Thickness</b>	2 $\pm$ 0.2 mm (6 $\pm$ 0.2 mm at ear point)	
<b>Dimensions</b>	Length: 1000 mm Width: 500 mm Height: adjustable feet	
<b>Filling Volume</b>	approx. 25 liters	





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<b>Model</b>	ELI	
<b>Construction</b>	The ELI phantom is used for compliance testing of handheld and body-mounted wireless devices. 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.	
<b>Material</b>	Vinylester, fiberglass reinforced (VE-GF)	
<b>Shell Thickness</b>	2.0 ± 0.2 mm (bottom plate)	
<b>Dimensions</b>	Major axis: 600 mm Minor axis: 400 mm	
<b>Filling Volume</b>	approx. 30 liters	


### 3.2.5 Device Holder

<b>Model</b>	MD4HHTV5 - Mounting Device for Hand-Held Transmitters	
<b>Construction</b>	In combination with the Twin SAM 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).	
<b>Material</b>	Polyoxymethylene (POM)	


<b>Model</b>	MDA4WTV5 - Mounting Device Adaptor for Ultra Wide Transmitters	
<b>Construction</b>	An 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.	
<b>Material</b>	Polyoxymethylene (POM)	

<b>Model</b>	MDA4SPV6 - Mounting Device Adaptor for Smart Phones	
<b>Construction</b>	The solid low-density MDA4SPV6 adaptor assuring no impact on the DUT radiation performance and is conform with any DUT design and shape.	
<b>Material</b>	ROHACELL	


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<b>Model</b>	MD4LAPV5 - Mounting Device for Laptops and other Body-Worn Transmitters	
<b>Construction</b>	In combination with the Twin SAM or ELI phantoms, the Mounting Device (Body-Worn) enables testing of transmitter devices according to IEC 62209-2 specifications. The device holder can be locked for positioning at a flat phantom section.	
<b>Material</b>	Polyoxymethylene (POM), PET-G, Foam	

### 3.2.6 System Validation Dipoles

<b>Model</b>	D-Serial	
<b>Construction</b>	Symmetrical dipole with 1/4 balun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions.	
<b>Frequency</b>	750 MHz to 5800 MHz	
<b>Return Loss</b>	> 20 dB	
<b>Power Capability</b>	> 100 W ( $f < 1\text{GHz}$ ), > 40 W ( $f > 1\text{GHz}$ )	

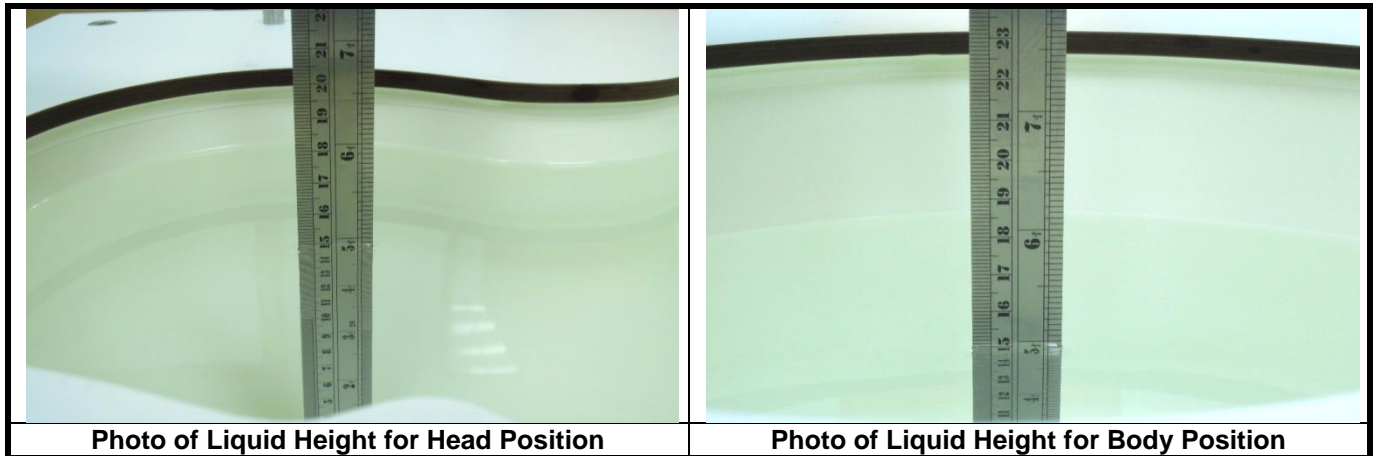
### 3.2.7 Power Source

<b>Model</b>	Powersource1	
<b>Signal Type</b>	Continuous Wave	
<b>Operating Frequencies</b>	600 MHz to 5850 MHz	
<b>Output Power</b>	-5.0 dBm to +17.0 dBm	
<b>Power Supply</b>	5V DC, via USB jack	
<b>Power Consumption</b>	<3 W	
<b>Applications</b>	System performance check and validation with a CW signal.	

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### 3.2.8 Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. 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. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 10 % are listed in Table-3.1.



**Table-3.1 Targets of Tissue Simulating Liquid**

Frequency (MHz)	Target Permittivity	Range of $\pm 10\%$	Target Conductivity	Range of $\pm 10\%$
450	43.5	39.2 ~ 47.9	0.87	0.78 ~ 0.96
750	41.9	37.7 ~ 46.1	0.89	0.80 ~ 0.98
835	41.5	37.4 ~ 45.7	0.90	0.81 ~ 0.99
900	41.5	37.4 ~ 45.7	0.97	0.87 ~ 1.07
1450	40.5	36.5 ~ 44.6	1.20	1.08 ~ 1.32
1500	40.4	36.4 ~ 44.4	1.23	1.11 ~ 1.35
1640	40.2	36.2 ~ 44.2	1.31	1.18 ~ 1.44
1750	40.1	36.1 ~ 44.1	1.37	1.23 ~ 1.51
1800	40.0	36.0 ~ 44.0	1.40	1.26 ~ 1.54
1900	40.0	36.0 ~ 44.0	1.40	1.26 ~ 1.54
2000	40.0	36.0 ~ 44.0	1.40	1.26 ~ 1.54
2100	39.8	35.8 ~ 43.8	1.49	1.34 ~ 1.64
2300	39.5	35.6 ~ 43.5	1.67	1.50 ~ 1.84
2450	39.2	35.3 ~ 43.1	1.80	1.62 ~ 1.98
2600	39.0	35.1 ~ 42.9	1.96	1.76 ~ 2.16
3000	38.5	34.7 ~ 42.4	2.40	2.16 ~ 2.64
3500	37.9	34.1 ~ 41.7	2.91	2.62 ~ 3.20
4000	37.4	33.7 ~ 41.1	3.43	3.09 ~ 3.77
4500	36.8	33.1 ~ 40.5	3.94	3.55 ~ 4.33
5000	36.2	32.6 ~ 39.8	4.45	4.01 ~ 4.90
5200	36.0	32.4 ~ 39.6	4.66	4.19 ~ 5.13
5400	35.8	32.2 ~ 39.4	4.86	4.37 ~ 5.35
5600	35.5	32.0 ~ 39.1	5.07	4.56 ~ 5.58
5800	35.3	31.8 ~ 38.8	5.27	4.74 ~ 5.80
6000	35.1	31.6 ~ 38.6	5.48	4.93 ~ 6.03
6500	34.5	31.1 ~ 38.0	6.07	5.46 ~ 6.68

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The dielectric properties of the tissue simulating liquids are defined in IEC 62209-1 and IEC 62209-2. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using a dielectric assessment kit and a network analyzer.

Since the range of  $\pm 10\%$  of the required target values is used to measure relative permittivity and conductivity, the SAR correction procedure is applied to correct measured SAR for the deviations in permittivity and conductivity. Only positive correction has been used to scale up the measured SAR, and SAR result would not be corrected if the correction  $\Delta$  SAR has a negative sign.

The following table gives the recipes for tissue simulating liquids.

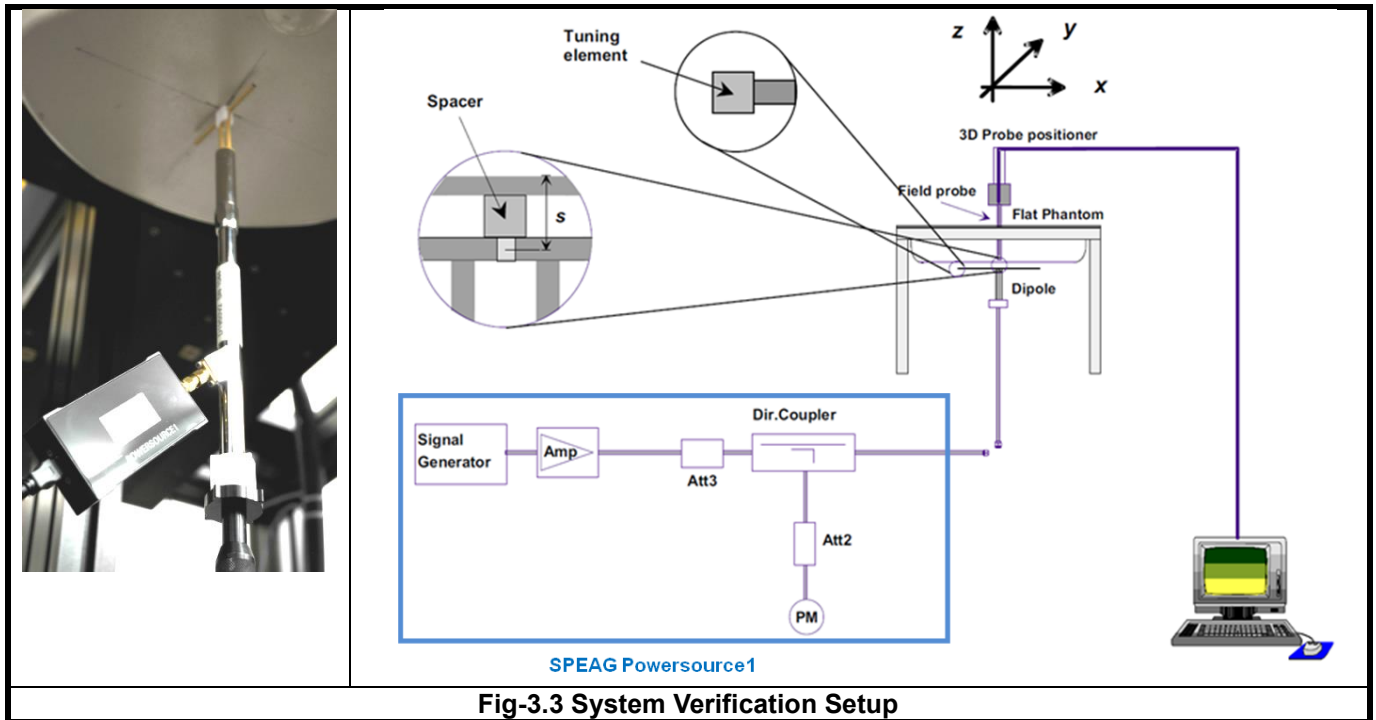
**Table-3.2 Recipes of Tissue Simulating Liquid**

Tissue Type	Bactericide	DGBE	HEC	NaCl	Sucrose	Triton X-100	Water	Diethylene Glycol Mono-hexylether	Oxidized Mineral Oil
H750	0.2	-	0.2	1.5	56.0	-	42.1	-	-
H835	0.2	-	0.2	1.5	57.0	-	41.1	-	-
H900	0.2	-	0.2	1.4	58.0	-	40.2	-	-
H1450	-	43.3	-	0.6	-	-	56.1	-	-
H1640	-	45.8	-	0.5	-	-	53.7	-	-
H1750	-	47.0	-	0.4	-	-	52.6	-	-
H1800	-	44.5	-	0.3	-	-	55.2	-	-
H1900	-	44.5	-	0.2	-	-	55.3	-	-
H2000	-	44.5	-	0.1	-	-	55.4	-	-
H2300	-	44.9	-	0.1	-	-	55.0	-	-
H2450	-	45.0	-	0.1	-	-	54.9	-	-
H2600	-	45.1	-	0.1	-	-	54.8	-	-
H3500	-	8.0	-	0.2	-	20.0	71.8	-	-
H5G	-	-	-	-	-	17.2	65.5	17.3	-
H6G	-	-	-	-	-	-	56.0	-	44.0

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### 3.3 SAR System Verification

The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.



**Fig-3.3 System Verification Setup**

The SPEAG Powersource1 is a portable and very stable RF source providing a continuous wave (CW) signal. It is designed for conducting SAR system checks and SAR system validation of DASY and is compatible with IEC 62209-1, IEC 62209-2 and IEEE Std 1528 standards. The Powersource1 has been calibrated by SPEAG's ISO/IEC 17025-accredited calibration center. When using Powersource1, the setup can be simplified, as shown in Fig-3.3. The signal purity is warranted by design. Since the Powersource1 is calibrated, no additional equipment is needed and the Powersource1 can directly be connected to the SMA connector of the dipole without a cable as all separate components (signal generator, amplifier, coupler and power meter) are built into the unit.

The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The Powersource1 is adjusted for the desired forward power of 17 dBm at the dipole connector and the RF output power would be turned on. After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.

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### 3.4 SAR Measurement Procedure

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

- Power reference measurement
- Area scan
- Zoom scan
- Power drift measurement

The SAR measurement procedures for each of test conditions are as follows:

- Make EUT to transmit maximum output power
- Measure conducted output power through RF cable
- Place the EUT in the specific position of phantom
- Perform SAR testing steps on the DASY system
- Record the SAR value

#### 3.4.1 Area Scan and Zoom Scan Procedure

First area scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an area scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, zoom scan is required. The zoom scan is performed around the highest E-field value to determine the averaged SAR-distribution.

Measure the local SAR at a test point at 1.4 mm of the inner surface of the phantom recommended by SEPAG. The area scan (two-dimensional SAR distribution) is performed cover at least an area larger than the projection of the EUT or antenna. The measurement resolution and spatial resolution for interpolation shall be chosen to allow identification of the local peak locations to within one-half of the linear dimension of the corresponding side of the zoom scan volume. Following table provides the measurement parameters required for the area scan.

Parameter	$f \leq 3 \text{ GHz}$	$3 \text{ GHz} < f \leq 6 \text{ GHz}$
Maximum distance from closest measurement point to phantom surface	$5 \pm 1$	$\delta \ln(2)/2 \pm 0.5$
Maximum probe angle from probe axis to phantom surface normal at the measurement location	$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
Maximum area scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$	$\leq 2 \text{ GHz: } \leq 15 \text{ mm}$ $2 - 3 \text{ GHz: } \leq 12 \text{ mm}$	$3 - 4 \text{ GHz: } \leq 12 \text{ mm}$ $4 - 6 \text{ GHz: } \leq 10 \text{ mm}$

From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that will not be within the zoom scan of other peaks. Additional peaks shall be measured only when the primary peak is within 2 dB of the SAR compliance limit (e.g. 1 W/kg for 1.6 W/kg, 1 g limit; or 1.26 W/kg for 2 W/kg, 10 g limit).

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The zoom scan (three-dimensional SAR distribution) is performed at the local maxima locations identified in previous area scan procedure. The zoom scan volume must be larger than the required minimum dimensions. When graded grids are used, which only applies in the direction normal to the phantom surface, the initial grid separation closest to the phantom surface and subsequent graded grid increment ratios must satisfy the required protocols. The 1-g SAR averaging volume must be fully contained within the zoom scan measurement volume boundaries; otherwise, the measurement must be repeated by shifting or expanding the zoom scan volume. The similar requirements also apply to 10-g SAR measurements. Following table provides the measurement parameters required for the zoom scan.

Parameter		$f \leq 3$ GHz	$3 \text{ GHz} < f \leq 6$ GHz
Maximum zoom scan spatial resolution: $\Delta x_{\text{zoom}}, \Delta y_{\text{zoom}}$		$\leq 2$ GHz: $\leq 8$ mm 2 – 3 GHz: $\leq 5$ mm	3 – 4 GHz: $\leq 5$ mm 4 – 6 GHz: $\leq 4$ mm
Maximum zoom scan spatial resolution, normal to phantom surface	<i>uniform grid:</i> $\Delta z_{\text{zoom}}(n)$	$\leq 5$ mm	3 – 4 GHz: $\leq 4$ mm 4 – 5 GHz: $\leq 3$ mm 5 – 6 GHz: $\leq 2$ mm
	<i>graded grids:</i> $\Delta z_{\text{zoom}}(1)$	$\leq 4$ mm	3 – 4 GHz: $\leq 3.0$ mm 4 – 5 GHz: $\leq 2.5$ mm 5 – 6 GHz: $\leq 2.0$ mm
	$\Delta z_{\text{zoom}}(n>1)$	$\leq 1.5 \cdot \Delta z_{\text{zoom}}(n-1)$ mm	
Minimum zoom scan volume (x, y, z)		$\geq 30$ mm	3 – 4 GHz: $\geq 28$ mm 4 – 5 GHz: $\geq 25$ mm 5 – 6 GHz: $\geq 22$ mm

Per IEC 62209-2 AMD1, the successively higher resolution zoom scan is required if the zoom scan measured as defined above complies with both of the following criteria, or if the peak spatial-average SAR is below 0.1 W/kg, no additional measurements are needed:

- (1) The smallest horizontal distance from the local SAR peaks to all points 3 dB below the SAR peak shall be larger than the horizontal grid steps in both x and y directions ( $\Delta x, \Delta y$ ). This shall be checked for the measured zoom scan plane conformal to the phantom at the distance  $z_{M1}$ .
- (2) The ratio of the SAR at the second measured point (M2) to the SAR at the closest measured point (M1) at the x-y location of the measured maximum SAR value shall be at least 30 %.

If one or both of the above criteria are not met, the zoom scan measurement shall be repeated using a finer resolution. New horizontal and vertical grid steps shall be determined from the measured SAR distribution so that the above criteria are met. Compliance with the above two criteria shall be demonstrated for the new measured zoom scan.

### 3.4.2 Volume Scan Procedure

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.



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### 3.4.3 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 5%, the SAR will be retested.

### 3.4.4 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 from 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

### 3.4.5 SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Shepard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1 g and 10 g cubes, the extrapolation distance should not be larger than 5 mm.

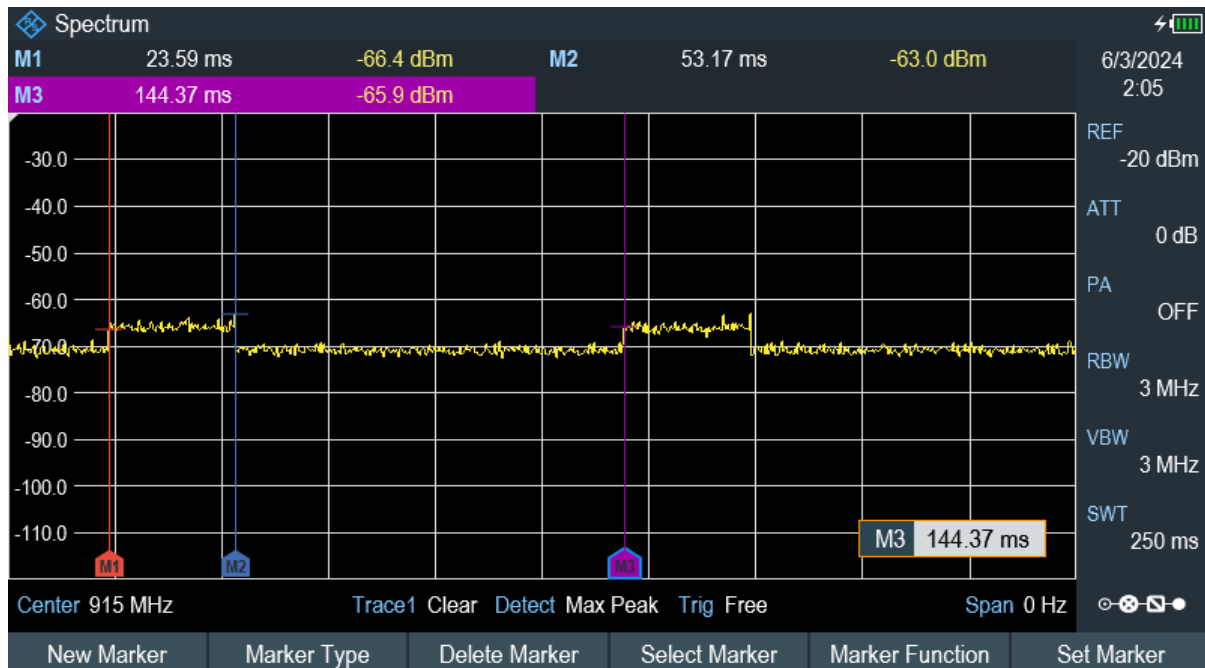


## 4. SAR Measurement Evaluation

### 4.1 EUT Configuration and Setting

#### <Considerations Related to NFC(RFID) for Setup and Testing>

Generally, various vendor-specific external test software and chipset-based internal test modes are commonly used for SAR measurements. These chipset-based test mode utilities are often hardware and manufacturer dependent and often include significant flexibility to reconfigure or reprogram the device. NFC (RFID) devices must be configured for the highest duty cycle. Additionally, current generation SAR systems require periodic transmission of duty cycle to correctly measure SAR. The reported SAR must be scaled to 100% transmission duty cycle to determine compliance with the maximum trim tolerance limit.



Time-domain plot for RFID transmission signal

The duty factor of RFID signal has been calculated as following.

$$\text{Duty Factor} = \text{Pulse Width} / \text{Total Period} = (53.17 - 23.59) / (144.37 - 23.59) = 24.49 \%$$

### 4.2 EUT Testing Position

#### 4.2.1 Body Exposure Conditions

This device was tested on the Body exposure conditions. Body SAR was tested on the Front Face, Left Side, Right Side with 0 cm separation distance.

#### 4.2.2 Extremity Exposure Conditions

This device was tested on the Extremity exposure conditions. Extremity SAR was tested on the Front Face with 3 cm separation distance.

## SAR Test Report

### 4.3 Tissue Verification

The measuring results for tissue simulating liquid are shown as below.

Plot No.	Frequency (MHz)	Liquid Temp. (°C)	Measured Conductivity ( $\sigma$ )	Measured Permittivity ( $\epsilon_r$ )	Target Conductivity ( $\sigma$ )	Target Permittivity ( $\epsilon_r$ )	Conductivity Deviation (%)	Permittivity Deviation (%)	Test Date
S01	835	21.6	0.944	41.1	0.9	41.5	4.89	-0.96	Mar. 05, 2024

Plot No.	Frequency (MHz)	Liquid Temp. (°C)	Measured Conductivity ( $\sigma$ )	Measured Permittivity ( $\epsilon_r$ )	Target Conductivity ( $\sigma$ )	Target Permittivity ( $\epsilon_r$ )	Conductivity Deviation (%)	Permittivity Deviation (%)	Test Date
S02	835	21.6	0.944	41.1	0.9	41.5	4.89	-0.96	Mar. 05, 2024

#### Note:

The dielectric properties of the tissue simulating liquid have been measured within 24 hours before the SAR testing and within  $\pm 10\%$  of the target values. Liquid temperature during the SAR testing has kept within  $\pm 2^\circ\text{C}$ .

### 4.4 System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01. The validation status in tabulated summary is as below.

Test Date	Probe S/N	Calibration Point		Measured Conductivity ( $\sigma$ )	Measured Permittivity ( $\epsilon_r$ )	Validation for CW			Validation for Modulation		
						Sensitivity Range	Probe Linearity	Probe Isotropy	Modulation Type	Duty Factor	PAR
Mar. 05, 2024	7554	Body	835	0.944	41.1	Pass	Pass	Pass	FHSS (PR-ASK)	N/A	N/A

### 4.5 System Verification

The measuring result for system verification is tabulated as below.

Test Date	Mode	Frequency (MHz)	1W Target SAR-1g (W/kg)	Measured SAR-1g (W/kg)	Normalized to 1W SAR-1g (W/kg)	Deviation (%)	Dipole S/N	Probe S/N	DAE S/N	Output Power (dBm)
Mar. 05, 2024	Body	835	9.72	0.53	10.57	8.80	4d121	7554	1431	17

Test Date	Mode	Frequency (MHz)	1W Target SAR-10g (W/kg)	Measured SAR-10g (W/kg)	Normalized to 1W SAR-10g (W/kg)	Deviation (%)	Dipole S/N	Probe S/N	DAE S/N	Output Power (dBm)
Mar. 05, 2024	Body	835	6.32	0.346	6.90	9.23	4d121	7554	1431	17

## SAR Test Report

### 4.6 Maximum Output Power

#### 4.6.1 Maximum Target Conducted Power

The maximum conducted average power (Unit: dBm) including tune-up tolerance is shown as below.

RFID Tune-up Power (Not include Duty cycle)			
Mode	Channel	Frequency	Ant 0 Max Tune-up
RFID	0	902.75	24.5
	25	914.75	25.0
	49	927.25	25.0

RFID Time-Avg. Tune-up Power (Include Duty cycle)			
Mode	Channel	Frequency	Ant 0 Max Tune-up
RFID	0	902.75	18.5
	25	914.75	19.0
	49	927.25	19.0

#### 4.6.2 Measured Conducted Power Result

The measuring conducted power (Unit: dBm) are shown as below.

RFID Conducted Power (Not Include Duty Cycle)			
Mode	Channel	Frequency	SISO Ant 0 Avg. Power
RFID	0	902.75	24.07
	25	915.25	24.69
	49	927.25	24.30

RFID Time-Avg. Conducted Power (Include Duty Cycle)			
Mode	Channel	Frequency	SISO Ant 0 Avg. Power
RFID	0	902.75	17.96
	25	915.25	18.58
	49	927.25	18.19

## SAR Test Report

### 4.7 SAR Testing Results

#### 4.7.1 SAR Test Reduction Considerations

##### <KDB 447498 D01, General RF Exposure Guidance>

Testing of other required channels within the operating mode of a frequency band is not required when the reported SAR for the mid-band or highest output power channel is:

- (1)  $\leq 0.8 \text{ W/kg}$  or  $2.0 \text{ W/kg}$ , for 1-g or 10-g respectively, when the transmission band is  $\leq 100 \text{ MHz}$
- (2)  $\leq 0.6 \text{ W/kg}$  or  $1.5 \text{ W/kg}$ , for 1-g or 10-g respectively, when the transmission band is between  $100 \text{ MHz}$  and  $200 \text{ MHz}$
- (3)  $\leq 0.4 \text{ W/kg}$  or  $1.0 \text{ W/kg}$ , for 1-g or 10-g respectively, when the transmission band is  $\geq 200 \text{ MHz}$

When SAR is not measured at the maximum power level allowed for production units, the measured SAR will be scaled to the maximum tune-up tolerance limit to determine compliance. The scaling factor for the tune-up power is defined as maximum tune-up limit (mW) / measured conducted power (mW). The reported SAR would be calculated by measured SAR x tune-up power scaling factor.

The SAR has been measured with highest transmission duty factor supported by the test mode tools for WLAN and/or Bluetooth. When the transmission duty factor could not achieve 100%, the reported SAR will be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up power. The scaling factor for the duty factor is defined as 100% / transmission duty cycle (%). The reported SAR would be calculated by measured SAR x tune-up power scaling factor x duty cycle scaling factor.

#### 4.7.2 SAR Results for Body Exposure Condition (Test Separation Distance is 0 mm)

Plot No.	Band	Test Position	Ch.	Sample	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Duty Cycle(%)	Time-Avg. Measured Conducted Power (dBm)	Duty Cycle	Crest Factor	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR-1g (W/kg)	Scaled SAR-1g (W/kg)
	RFID	Front Face	25	RS36-UHF	25.00	24.69	24.49	18.58	100.00	1.00	19.00	18.58	1.10	0.01	0.101	0.11
	RFID	Left Side	25	RS36-UHF	25.00	24.69	24.49	18.58	100.00	1.00	19.00	18.58	1.10	0.04	0.367	0.40
1	RFID	Right Side	25	RS36-UHF	25.00	24.69	24.49	18.58	100.00	1.00	19.00	18.58	1.10	0.09	0.459	0.50
	RFID	Right Side	0	RS36-UHF	24.50	24.07	24.49	17.96	100.00	1.00	18.50	17.96	1.13	-0.15	0.372	0.42
	RFID	Right Side	49	RS36-UHF	25.00	24.30	24.49	18.19	100.00	1.00	19.00	18.19	1.21	-0.13	0.382	0.46
	RFID	Right Side	25	RK26-UHF	25.00	24.69	24.49	18.58	100.00	1.00	19.00	18.58	1.10	0.07	0.432	0.48
	RFID	Right Side	25	RS38-UHF	25.00	24.69	24.49	18.58	100.00	1.00	19.00	18.58	1.10	0.17	0.366	0.40

#### 4.7.3 SAR Results for Extremity Exposure Condition (Test Separation Distance is 30 mm)

Plot No.	Band	Test Position	Ch.	Sample	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Duty Cycle(%)	Time-Avg. Measured Conducted Power (dBm)	Duty Cycle	Crest Factor	Max. Tune-up Power (dBm)	Measured Conducted Power (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR-10g (W/kg)	Scaled SAR-10g (W/kg)
2	RFID	Front Face	25	RS36-UHF	25.00	24.69	24.49	18.58	100.00	1.00	19.00	18.58	1.10	0.15	0.141	0.16
	RFID	Front Face	0	RS36-UHF	24.50	24.07	24.49	17.96	100.00	1.00	18.50	17.96	1.13	0.18	0.101	0.11
	RFID	Front Face	49	RS36-UHF	25.00	24.30	24.49	18.19	100.00	1.00	19.00	18.19	1.21	-0.09	0.107	0.13
	RFID	Front Face	25	RK26-UHF	25.00	24.69	24.49	18.58	100.00	1.00	19.00	18.58	1.10	-0.11	0.126	0.14
	RFID	Front Face	25	RS38-UHF	25.00	24.69	24.49	18.58	100.00	1.00	19.00	18.58	1.10	0.02	0.107	0.12

## SAR Test Report

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### 4.7.4 SAR Measurement Variability

According to KDB 865664 D01, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are  $\leq 1.45$  W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is  $\leq 1.10$ , the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These 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.

Since all the measured SAR are less than 0.8 W/kg, the repeated measurement is not required.

### 4.7.5 Simultaneous Multi-band Transmission Evaluation

There is no simultaneous transmission configuration in this device.

**Test Engineer :** Rhys Liu

## SAR Test Report

### 5. Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
System Validation Dipole	SPEAG	D835V2	4d121	Aug. 21, 2023	1 Year
Dosimetric E-Field Probe	SPEAG	EX3DV4	7554	Sep. 19, 2023	1 Year
Data Acquisition Electronics	SPEAG	DAE4	1431	Aug. 24, 2023	1 Year
Universal Wireless Test Set	Anritsu	MT8870A	6262411397	Dec. 04, 2023	1 Year
Thermometer	YFE	YF-160A	150601219	Apr. 28, 2023	1 Year
Dielectric Assessment Kit	SPEAG	DAKS-3.5	1092	May. 23, 2023	1 Year
Dielectric Assessment Kit	SPEAG	DAKS_VNA R140	0010917	May. 22, 2023	1 Year
Powersource1	SPEAG	SE_UMS_160 BA	1052	Jul. 13, 2023	1 Year

## **6. Measurement Uncertainty**

According to KDB 865664 D01, SAR measurement uncertainty analysis is required in SAR reports only when the highest measured SAR in a frequency band is  $\geq 1.5$  W/kg for 1-g SAR, and  $\geq 3.75$  W/kg for 10-g SAR. The procedures described in IEEE Std 1528-2013 should be applied. The expanded SAR measurement uncertainty must be  $\leq 30\%$ , for a confidence interval of  $k = 2$ . When the highest measured SAR within a frequency band is  $< 1.5$  W/kg for 1-g and  $< 3.75$  W/kg for 10-g, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. Hence, the measurement uncertainty analysis is not required in this SAR report because the test result met the condition.

## SAR Test Report

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### 7. Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

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The road map of all our labs can be found in our web site also.

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