



TEST REPORT



Report No. : KES-SR250248
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KES Co., Ltd.

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1. Client

- Name : Dogtra Co., Ltd.
- Address : 35, Namdongdong-ro 33beon-gil, Namdong-gu, Incheon 21694 Rep. of KOREA

2. Sample Description

- Product item : GPS TRACKING & TRAINING
- FCC ID : SWN-PT21U
- Model name : PT21U
- Multiple Model Name : PATHFINDER2 MINI COMPASS, PATHFINDER2 COMPASS, COMPASS HANDHELD GPS CONNECTOR
- Manufacturer etc. : Dogtra Co., Ltd.

3. Date of test : 2025.11.28

4. Location of Test : ☒ Permanent Testing Lab ☐ On Site Testing

- Address : #3002, #3503, #3701, 40, Simin-daero365beon-gil, Dongan-gu, Anyang-si, Gyeonggi-do, 14057, Republic of Korea

5. Test method used : CFR §2.1093

6. Test result : PASS

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.

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Affirmation	Tested by	Technical Manager
	Name : Min-sup, Kim (Signature)	Name : Wi-han, Jeong (Signature)

2025 . 12. 11.

KES Co., Ltd.



REPORT REVISION HISTORY

Date	Test Report No.	Revision History
2025.12.11	KES-SR250248	Initial

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1. General Information

Applicant: Dogtra Co., Ltd.
Applicant address: 35, Namdongdong-ro 33beon-gil, Namdong-gu, Incheon 21694
Rep. of KOREA
Test site: KES Co., Ltd.
Test site address: #3002, #3503, #3701, 40, Simin-daero365beon-gil, Dongan-gu,
Anyang-si, Gyeonggi-do, 14057, Republic of Korea
Test Facility FCC Accreditation Designation No.: KR0100, Registration No.: 444148
FCC rule part(s): CFR §2.1093
FCC ID: SWN-PT21U
Test device serial No.: ☒ Production ☐ Pre-production ☐ Engineering

1.1. Highest SAR Summary

EUT Type	GPS TRACKING & TRAINING				
Brand Name(Applicant)	Dogtra Co., Ltd.				
Model Name	PT21U				
Multiple Model Name	PATHFINDER2 MINI COMPASS, PATHFINDER2 COMPASS, COMPASS HANDHELD GPS CONNECTOR				
Antenna Type	Helical Ant. (VHF MURS) PCB passive Ant.(Bluetooth LE)				
EUT Stage	Identical Prototype				
Equipment Class	Band & Mode	TX Frequency	1g Front of the face (W/Kg)	1g Body (W/Kg)	10g Hands (W/Kg)
TNB	VHF MURS	151.82 MHz ~ 154.60 MHz	0.55	0.31	N/A
Simultaneous SAR per 690783 D01v01r03			0.62	0.38	N/A

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE C95.1-1992 and has been tested in accordance with the measurement procedures specified in Section 6 of this report;

1.2. Device Overview

Band & Mode	Operating Modes	Tx Frequency
VHF MURS	Data	151.82 MHz ~ 154.60 MHz
Bluetooth LE	Data	2 402 MHz ~ 2 480 MHz

1.3. Power Reduction for SAR

There is no power reduction used for any band/mode implemented in the device for SAR purposes.



1.4. Nominal and Maximum Output Power Specifications

This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v06.

Maximum Output Power

Mode / Band		Modulated Average (dBm)
VHF MURS	Maximum	31.2
	Nominal	30.0
Bluetooth LE	Maximum	2.0
	Nominal	1.0

1.5. Simultaneous Transmission Capabilities

This device contains VHF MURS and Bluetooth that may operate simultaneously. Therefore simultaneous transmission analysis is required. Per FCC KDB 447498 D01v06 4.3.2, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤ 1.6 W/kg.

No.	Simultaneous Transmission Configurations	Head	Body
1	VHF MURS + Bluetooth LE	Yes	Yes

Simultaneous Transmission Analysis

Simultaneous Transmission SAR evaluation using simulations was performed in accordance with KDB 447498 D01r06.

Head Simultaneous Transmission Analysis			
Band / Mode	VHF MURS SAR	Bluetooth LE Estimated SAR	Σ 1 g SAR
	[W/kg]	[W/kg]	[W/kg]
Head Simultaneous SAR	0.549	0.067	0.616

Body Simultaneous Transmission Analysis			
Band / Mode	VHF MURS SAR	Bluetooth LE Estimated SAR	Σ 1 g SAR
	[W/kg]	[W/kg]	[W/kg]
Body Simultaneous SAR	0.309	0.067	0.376



1.6. DUT Antenna Locations

The DUT antenna locations are included in Appendix F.

1.7. Near Field Communications (NFC) Antenna

This DUT does not support NFC function.

1.8. Miscellaneous SAR Test Considerations

This DUT supports VHF MURS and Bluetooth LE (1 Mbps). The DUT is a portable push-to-talk (PTT) two-way radio, and the SAR is tested at 0mm for body-worn accessory and 2.5mm for the front of the face according to KDB publication 447498 D01v06.

Bluetooth LE is exempted in accordance with Section 4.3.1 of FCC KDB Publication 447498 D01v06.

Standalone SAR test exclusion considerations

Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Test Exclusion Threshold condition(s), listed below, is (are) satisfied. These test exclusion conditions are based on source-based time-averaged maximum conducted output power of the RF channel requiring evaluation, adjusted for tune-up tolerance, and the minimum test separation distance required for the exposure conditions. The minimum test separation distance defined in 4.1 f) is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander. To qualify for SAR test exclusion, the test separation distances applied must be fully explained and justified, typically in the SAR measurement or SAR analysis report, by the operating configurations and exposure conditions of the transmitter and applicable host platform requirements, according to the required published RF exposure KDB procedures. When no other RF exposure testing or reporting are required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for SAR test exclusion. When required, the device specific conditions described in the other published RF exposure KDB procedures must be satisfied before applying these SAR test exclusion provisions; for example, handheld PTT two-way radios, handsets, laptops and tablets, etc.

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f_{\text{(GHz)}}/x}] \text{ W/kg, for test separation distances } \leq 50 \text{ mm;}$$

where $x = 7.5$ for 1-g SAR and $x = 18.75$ for 10-g SAR.

Band / Mode	Frequency	Maximum Allowed Power	Separation Distance	Estimated 1g SAR
	[MHz]	[mW]	[mm]	[W/kg]
Bluetooth LE 1 Mbps	2 480	1.58	5	0.067



1.9. Guidance Applied

- IEEE 1528-2013
- FCC KDB Publication 447498 D01v06 (General RF Exposure Guidance)
- FCC KDB Publication 865664 D01v01r04 (SAR Measurement 100 MHz to 6 GHz)
- FCC KDB Publication 865664 D02v01r02 (RF Exposure Reporting)
- FCC KDB Publication 690783 D01v01r03 (SAR Listings on Grants)
- FCC KDB Publication 643646 D01 v01r03 (SAR Test for PTT Radios)
- October 2016 TCBC workshop Notes (DUT Holder perturbations)
- October 2016 TCBC workshop Notes (Bluetooth SAR Testing)
- April 2019 TCBC workshop Notes (Tissue Simulating Liquids (TSL))

1.10. Device Serial Numbers

Several samples with identical hardware were used to support SAR testing. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units. The serial numbers used for each test are indicated alongside the results in Section 9.

Band & Mode	Serial Number
VHF MURS	SAR1



2. Introduction

The FCC and Innovation, Science, and Economic Development Canada have adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996 and Health Canada Safety Code 6 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices.

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3KHz to 300 GHz and Health Canada RF Exposure Guidelines Safety Code 6. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields," Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

2.1. SAR definition

Specific Absorption Rate is defined as 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). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Equation 2-1)

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

Equation 2-1 SAR Mathematical Equation

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

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

Where: σ = conductivity of the tissue (S/m)

ρ = mass density of the tissue (kg/m³)

E = rms electrical field strength (V/m)

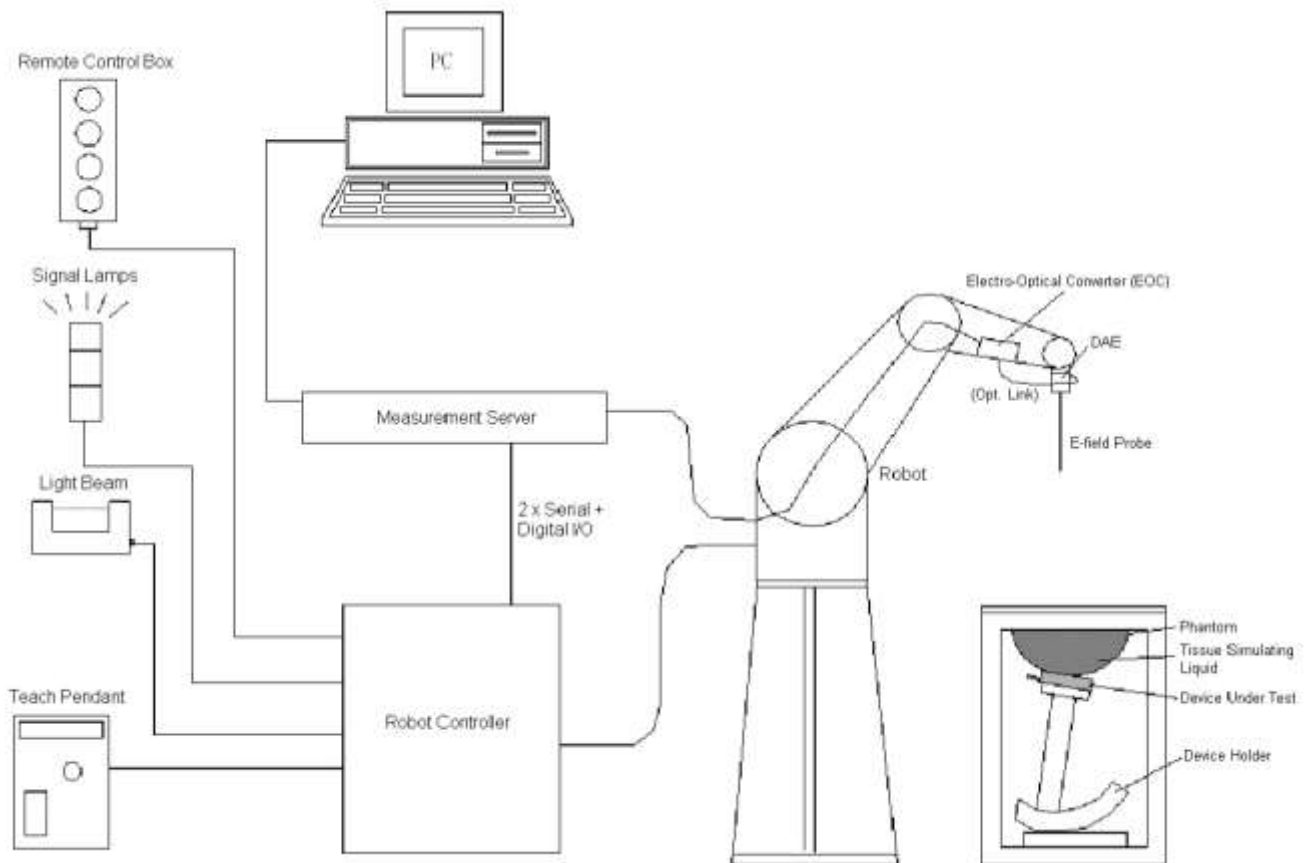
NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relation to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.



2.2. SAR Measurement Setup

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. 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, Win7 or Win10 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.





2.2.1. DASY Robot System

The DASY system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY6) 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)



Figure 2-1 DASY6 System

2.2.2. SAR 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.

Model	ES3DV3	
Construction	Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE).	
Frequency	10 MHz to 4 GHz Linearity: ± 0.2 dB	
Directivity	± 0.2 dB in TSL (rotation around probe axis) ± 0.3 dB in TSL (rotation normal to probe axis)	
Dynamic Range	5 μ W/g to 100 mW/g Linearity: ± 0.2 dB	
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from the probe tip to dipole centers: 2.0 mm	



2.2.3. Data Acquisition Electronics (DAE)

Model	DAE4	
Construction	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.	
Measurement Range	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)	
Input Offset Voltage	< 5μV (with auto zero)	
Input Bias Current	< 50 fA	
Dimensions	60 x 60 x 68 mm	

2.2.4. Phantoms

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

Model	ELI	
Construction	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.	
Material	Vinylester, glass fiber reinforced (VE-GF)	
Shell Thickness	2.0 ± 0.2 mm (bottom plate)	
Dimensions	Major axis: 600 mm Minor axis: 400 mm	
Filling Volume	approx. 30 liters	



2.2.5. Device Holders

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity $\epsilon = 3$ and loss tangent $\delta = 0.02$.

Model	Mounting Device	
Construction	In combination with the Twin SAM Phantom or ELI4, the Mounting Device enables the rotation of the mounted transmitter device in spherical coordinates. Rotation point is the ear opening point. Transmitter devices can be easily and accurately positioned according to IEC, IEEE, FCC or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat).	
Material	POM	

Model	Mounting Device for Laptops and other Body-Worn Transmitters	
Construction	In combination with the Twin SAM V5.0/V5.0c 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.	
Material	Polyoxymethylene (POM), PET-G, Foam	

2.2.6. Loop Antennas

Model	CLA- Serial	
Description	Confined Loop Antennas (CLA) are system validation antennas used to perform system checks with tissue simulating media at 6 – 220 MHz prior to specific absorption rate evaluations. The source is a resonant loop antenna integrated in a metallic structure to isolate the resonant structure from the environment.	
Frequency	150 MHz	
Return Loss	> 10 dB	
Power Capability	≤ 2 W continuous	
Diameter×height:	222 × 95 mm	



3. Dosimetric Assessment

The evaluation was performed using the following procedure compliant to FCC KDB Publication 865664 D01v01r04 and IEEE 1528-2013:

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01r04 (See Table 3-1) and IEC/IEEE 1528-2013.

2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.

3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01r04 (See Table 3-1) and IEEE 1528-2013. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the DASY manual online for more details):

- SAR values at the inner surface of the phantom are extrapolated from the measured values along the line away from the surface with spacing no greater than that in Table 3-1. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).
 - After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the “Not a knot” condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.
 - All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

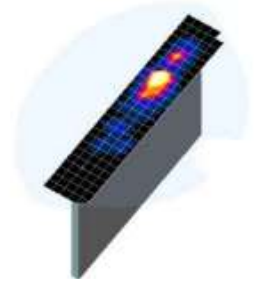


Figure 3-1 Sample

Table 3-1 Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r04*

Frequency	Maximum Area Scan Resolution (mm) ($\Delta x_{area}, \Delta y_{area}$)	Maximum Zoom Scan Resolution (mm) ($\Delta x_{zoom}, \Delta y_{zoom}$)	Maximum Zoom Scan Spatial Resolution (mm)			Minimum Zoom Scan Volume (mm) (x,y,z)
			Uniform Grid	Graded Grid		
				$\Delta z_{zoom}(n)$	$\Delta z_{zoom}(1)^*$	
≤ 2 GHz	≤ 15	≤ 8	≤ 5	≤ 4	$\leq 1.5^* \Delta z_{zoom}(n-1)$	≥ 30
2-3 GHz	≤ 12	≤ 5	≤ 5	≤ 4	$\leq 1.5^* \Delta z_{zoom}(n-1)$	≥ 30
3-4 GHz	≤ 12	≤ 5	≤ 4	≤ 3	$\leq 1.5^* \Delta z_{zoom}(n-1)$	≥ 28
4-5 GHz	≤ 10	≤ 4	≤ 3	≤ 2.5	$\leq 1.5^* \Delta z_{zoom}(n-1)$	≥ 25
5-6 GHz	≤ 10	≤ 4	≤ 2	≤ 2	$\leq 1.5^* \Delta z_{zoom}(n-1)$	≥ 22



4. TEST CONFIGURATION POSITIONS

4.1. Device Holder

This device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity $\epsilon = 3$ and loss tangent $\delta = 0.02$.

4.2. Positioning for Testing

Based on FCC guidance and expected exposure conditions, the device was positioned with the outside of the device touching the flat phantom and such that the location of maximum SAR was captured during SAR testing. The SAR test setup photograph is included in Appendix E.





5. RF Exposure Limits

In order for users to be aware of the head operating requirements for meeting RF exposure compliance, Operating instruction and cautions statements are included in the user's manual.

5.1. 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.

5.2. 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. This 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.

Table 5-1 SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6

Human Exposure Limits		
	Uncontrolled Environment General Population (W/kg) or (mW/g)	Controlled Environment Occupational (W/kg) or (mW/g)
Peak Spatial Average SAR Head	1.6	8.0
Whole Body SAR	0.08	0.4
Peak Spatial Average SAR Hands, Feet, Ankle, Wrists, etc.	4.0	20

1. The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2. The Spatial Average value of the SAR averaged over the whole body.
3. The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.



6. FCC Measurement Procedures

Power measurements for licensed transmitters are performed using a base station simulator under digital average power.

6.1. Measured and Reported SAR

Per FCC KDB Publication 447498 D01v06, when SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as *reported* SAR. The highest *reported* SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r03.

Per KDB Publication 447498 D01v06, testing of other required channels within the operating mode of a frequency band is not required when the reported 1g or 10g SAR for the mid-band or highest output power channel is:

- ≤ 0.8 W/kg or 2.0 W/kg, for 1g or 10g respectively, when the transmission band is ≤ 100 MHz
- ≤ 0.6 W/kg or 1.5 W/kg, for 1g or 10g respectively, when the transmission band is between 100 MHz and 200 MHz
- ≤ 0.4 W/kg or 1.0 W/kg, for 1g or 10g respectively, when the transmission band is ≥ 200 MHz

6.2. Procedures Used to Establish RF signal for SAR

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The reported SAR is scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit. Establishing connections in this manner ensure a consistent means for testing SAR and are recommended for evaluating SAR. Devices under test are evaluated prior to testing, with a fully charged battery and were configured to operate at maximum output power. In order to verify that the device is tested throughout the SAR test at maximum output power, the SAR measurement system measures a "point SAR" at an arbitrary reference point at the start and end of the 1 gram SAR evaluation, to assess for any power drifts during the evaluation. If the power drift deviates by more than 5%, the SAR test and drift measurements are repeated.

As required by §§ 2.1091(d)(2) and 2.1093(d)(5), RF exposure compliance must be determined at the maximum average power level according to source-based time-averaging requirements to determine compliance for general population exposure conditions. Unless it is specified differently in the published RF exposure KDB procedures, these requirements also apply to test reduction and test exclusion considerations. Time-averaged maximum conducted output power applies to SAR and, as required by § 2.1091(c), time-averaged effective radiated power applies to MPE. When an antenna port is not available on the device to support conducted power measurement, such as for FRS (Part 95) devices and certain Part 15 transmitters with built-in integral antennas, the maximum output power and tolerance allowed for production units should be used to determine RF exposure test exclusion and compliance.

6.3. Handheld push-to-talk (PTT) two-way radios

When a body-worn accessory is not supplied with the PTT radio, a test separation distance ≤ 10 mm, applicable to the device form factor, must be applied to determine body-worn accessory SAR test exclusion. A test separation distance of 25 mm must be applied for in-front-of the face SAR test exclusion and SAR measurements. When body-worn accessory SAR testing is required, the body-worn accessory requirements in 4.2.2 should be applied.



7. RF Conducted Power

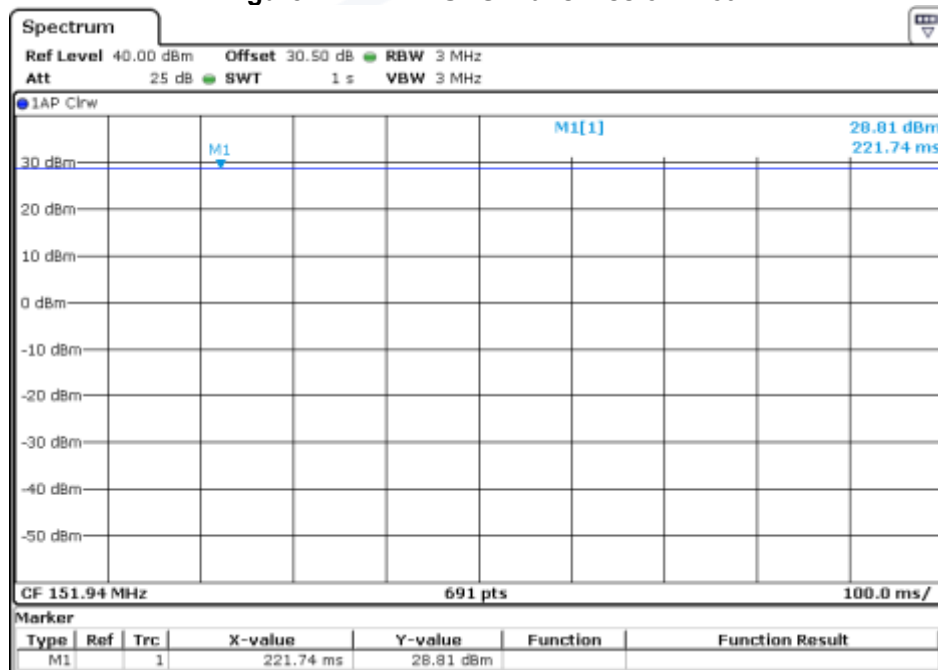
7.1. VHF MURS Conducted Power

Table 7-1 VHF MURS Conducted Power

Mode	CH.	Freq. [MHz]	Conducted Power [dBm]	
			[dBm]	[mW]
VHF	F1	151.82	30.95	1244.51
	F2	151.88	30.96	1247.38
	F3	151.94	30.99	1256.03
	F4	154.57	30.38	1091.44
	F5	154.60	30.40	1096.48

Note: The bolded channel at which the conducted Power was measured at the highest was recorded.

Figure 7-1 VHF MURS Transmission Plot



Equation 7-1 VHF MURS Duty Cycle Calculation

Duty Cycle of this device is 100 %

Duty Cycle[%] = (Pulse / Period) X 100 = (1.000 / 1.000) X 100 = 100 %



7.2. Bluetooth Conducted Power

Table 7-2 Bluetooth Conducted Power

Mode	Data Rate	CH.	Freq. [MHz]	Conducted Power [dBm]	
				[dBm]	[mW]
Bluetooth	LE 1Mbps	0	2402	0.62	1.15
		19	2442	1.02	1.26
		39	2480	1.06	1.28

Note: The bolded channel at which the conducted Power was measured at the highest was recorded.





8. Tissue & System Verification

8.1. Tissue Verification

Table 8-1 Measured Tissue Properties

Tissue Type	Measured Frequency (MHz)	Tissue Temp (°C)	Measured Conductivity (σ)	Measured Permittivity (ϵ_r)	Target Conductivity (σ)	Target Permittivity (ϵ_r)	Conductivity Deviation (%)	Permittivity Deviation (%)	Test Date
HSL2450	150.00	21.9	0.759	51.404	0.76	52.3	-0.13	-1.71	2025.11.28
	151.82		0.766	50.587	0.76	52.3	0.69	-3.19	
	151.88		0.766	50.587	0.76	52.3	0.69	-3.19	
	151.94		0.766	50.587	0.76	52.3	0.69	-3.19	
	154.57		0.771	49.817	0.76	52.1	1.06	-4.41	
	154.60		0.771	49.817	0.76	52.1	1.06	-4.41	

Tissue Verification Notes:

1. The above measured tissue parameters were used in the DASY software. The DASY software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per KDB Publication 865664
2. D01v01r04 and IEEE 1528-2013 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.
3. Per April 2019 TCBC Workshop Notes, effective February 19, 2019, FCC has permitted the use of single head-tissue simulating liquid specified in IEC 62209-1 for all SAR tests.



8.2. System Verification

Prior to SAR assessment, the system is verified to $\pm 10\%$ of the SAR measurement on the reference dipole at the time of calibration by the calibration facility.

Table 8-2 System Verification Results – 1 g

SAR System #	Test Date	Tissue Frequency (MHz)	Amb. Temp (°C)	Liquid Temp (°C)	Input Power (mW)	CLA SN	Probe SN	1W Target SAR-1 g (W/kg)	Measured SAR-1 g (W/kg)	Normalized to 1W SAR-1 g (W/kg)	Deviation (%)
1	2025.11.28	150	22.8	21.9	1 000	4014	3315	3.70	3.83	3.83	3.51

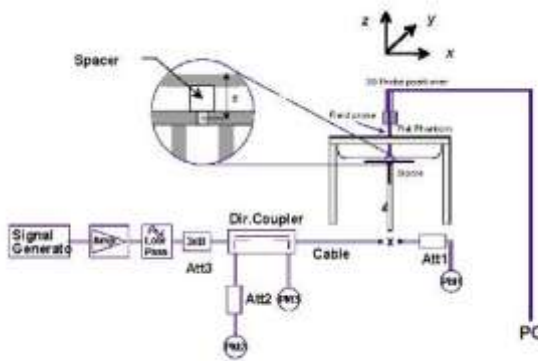


Figure 8-1 System Verification Setup Diagram

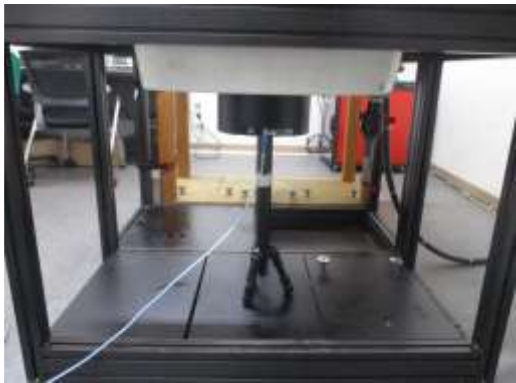


Figure 8-2 System Verification Setup Photo



9. SAR Data Summary

9.1. Standalone Head SAR Data

Table 9-1 VHF MURS Front of the face SAR

Plot No.	Device Serial Number	Frequency		Mode	Test Position	Separation Distance (cm)	Maximum Allowed Power [dBm]	Measured Conducted Power [dBm]	Scaling Factor (Duty Cycle)	Scaling Factor (Power)	Power Drift [dB]	Measured SAR 1 g (W/kg)	Reported SAR 1 g (W/kg)
		MHz	Ch.										
1	SAR1	151.94	F3	VHF MURS	Front of the face	2.5	31.2	30.99	1.000	1.050	-0.08	0.523	0.549
	SAR1	151.82	F1	VHF MURS	Front of the face	2.5	31.2	30.95	1.000	1.059	-0.05	0.499	0.528
	SAR1	151.88	F2	VHF MURS	Front of the face	2.5	31.2	30.96	1.000	1.057	-0.07	0.441	0.466
	SAR1	154.57	F4	VHF MURS	Front of the face	2.5	31.2	30.38	1.000	1.208	-0.03	0.281	0.339
	SAR1	154.60	F5	VHF MURS	Front of the face	2.5	31.2	30.40	1.000	1.202	-0.03	0.304	0.365
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population								Front of the face 1.6 W/kg (mW/g) Averaged over 1 gram					

Table 9-2 VHF MURS Body SAR

Plot No.	Device Serial Number	Frequency		Mode	Test Position	Separation Distance (cm)	Maximum Allowed Power [dBm]	Measured Conducted Power [dBm]	Scaling Factor (Duty Cycle)	Scaling Factor (Power)	Power Drift [dB]	Measured SAR 1 g (W/kg)	Reported SAR 1 g (W/kg)
		MHz	Ch.										
6	SAR1	151.94	F3	VHF MURS	Rear Side	0	31.2	30.99	1.000	1.050	-0.06	0.294	0.309
	SAR1	151.82	F1	VHF MURS	Rear Side	0	31.2	30.95	1.000	1.059	-0.01	0.267	0.283
	SAR1	151.88	F2	VHF MURS	Rear Side	0	31.2	30.96	1.000	1.057	0.01	0.282	0.298
	SAR1	154.57	F4	VHF MURS	Rear Side	0	31.2	30.38	1.000	1.208	0.09	0.202	0.244
	SAR1	154.60	F5	VHF MURS	Rear Side	0	31.2	30.40	1.000	1.202	-0.04	0.215	0.258
ANSI / IEEE C95.1 1992 – SAFETY LIMIT Spatial Peak Uncontrolled Exposure / General Population								Body 1.6 W/kg (mW/g) Averaged over 1 gram					

9.2. SAR Test Notes

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2013, and FCC KDB Publication 447498 D01v06.
2. Batteries are fully charged at the beginning of the SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
5. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v06.
6. The SAR is tested at 0mm for body-worn accessory and 2.5mm for the front of the face according to KDB publication 447498 D01v06.



10. SAR Measurement Uncertainty

Table 10-1 Uncertainty of SAR equipment for measurement Head 0.15 GHz to 3 GHz

<i>A</i>	<i>b</i>	<i>c</i>		<i>d</i>	<i>e=f(d, k)</i>	<i>f</i>	<i>g</i>	<i>h=c x f/e</i>	<i>l=c x g/e</i>	<i>C_i x U_i</i>		<i>k</i>
source of uncertainty	Ref.	Unc. ± %		Prob Dist.	Div.	C _i (1 g)	C _i (10 g)	Uncertainty ± %, (1 g)	Uncertainty ± %, (10 g)	contribution 1g	contribution 10g	V _i
Measurement system errors												
Probe calibration	8.4.1.1	6.65		N	2.000	1	1	3.325	3.325	3.33	3.33	∞
Probe calibration drift	8.4.1.2	1.0		N	1.000	1	1	1.00	1.00	1.00	1.00	∞
Probe linearity and detection limit	8.4.1.3	4.7		R	1.732	1	1	2.71	2.71	2.71	2.71	∞
Broadband signal	8.4.1.4	3.0		N	2.000	1	1	1.50	1.50	1.50	1.50	∞
Probe isotropy	8.4.1.5	7.6		R	1.732	1	1	4.39	4.39	4.39	4.39	∞
Other probe and data acquisition errors	8.4.1.6	0.3		N	1.000	1	1	0.30	0.30	0.30	0.30	∞
RF ambient and noise	8.4.1.7	1.8		N	1.000	1	1	1.80	1.80	1.80	1.80	∞
Probe positioning errors	8.4.1.8	0.25		N	1.000	0.67	0.67	0.17	0.17	0.11	0.11	-
Data processing errors	8.4.1.9	0.3		N	1.000	1	1	0.30	0.30	0.30	0.30	∞
Phantom and device (DUT or validation antenna) errors												
Measurement of phantom conductivity(σ)	8.4.2.1	1.90		N	1.000	0.78	0.71	1.48	1.35	1.16	0.96	∞
Temperature effects (medium)	8.4.2.2	2.00	2.17	R	1.732	0.23	0.78	0.27	0.90	0.06	0.70	∞
Shell permittivity	8.4.2.3	14.0		R	1.732	0.5	0.5	4.04	4.04	2.02	2.02	∞
Distance between the radiating element of the DUT and the phantom medium	8.4.2.4	2.0		N	1.000	2	2	4.00	4.00	8.00	8.00	∞
Repeatability of positioning the DUT or source against the phantom	8.4.2.5	1.0	0.9	N	1.000	1	1	1.00	0.90	1.00	0.90	88
Device holder effects	8.4.2.6	1.8	1.1	N	1.000	1	1	1.80	1.10	1.80	1.10	-
Effect of operating mode on probe sensitivity DUT	8.4.2.7	2.4		R	1.732	1	1	1.39	1.39	1.39	1.39	∞
Time-average SAR	8.4.2.8	0.0		R	1.732	1	1	0.00	0.00	0.00	0.00	∞
Variation in SAR due to drift in output of DUT data	8.4.2.9	5.0		N	1.732	1	1	2.89	2.89	2.89	2.89	-
Corrections to the SAR result (if applied)												
Phantom deviation from target (ϵ, σ)	8.4.3.1	1.9		N	1.000	1	0.84	1.90	1.60	1.90	1.34	-
SAR scaling	8.4.3.2	0.0		R	1.732	1	1	0.00	0.00	0.00	0.00	-
Combined standard uncertainty, $u(\Delta\text{SAR})$				RSS				9.90	9.80			V_{eff}
Expanded uncertainty, U				$k = 2$				19.80	19.60			
(95 % confidence interval)												

**11. Equipment List**

Equipment	Manufacturer	Model	Serial No.	Cal. Date	Next Cal. Date	Cal. Interval
SAR Chamber#1	Dymstec	N/A	N/A	N/A	N/A	N/A
Thermo-Hygrostat	HANKUK MOONTERS	HK-030-AU1	1506231	N/A	N/A	N/A
Staubli Robot Unit	Staubli	TX60L	F15/5Y7QA1/A/01	N/A	N/A	N/A
Electro Optical Converter	SPEAG	EOC60	1096	N/A	N/A	N/A
2mm Oval Phantom V6.0	SPEAG	QD OVA 003 AA	2036	N/A	N/A	N/A
Device Holder	SPEAG	Laptop Holder	SM LH1 001 CD	N/A	N/A	N/A
Data Acquisition Electronics	SPEAG	DAE4	1699	2025-01-21	2026-01-21	1 Year
E-Field Probe	SPEAG	ES3DV3	3315	2025-03-14	2026-03-14	1 Year
CLA Antenna	SPEAG	CLA150	4014	2025-02-19	2027-02-19	2 Years
RF Signal Generator	ANRITSU	68369B	992113	2025-08-13	2026-08-13	1 Year
RF POWER AMPLIFIER	L2 Microwave	BPA01T10W2-H	SH-01-0001	2025-05-21	2026-05-21	1 Year
DUAL DIRECTIONAL COUPLER	HP	778D-012	16468	2025-06-09	2026-06-09	1 Year
EPM Series Power Meter	HP	E4419B	GB40202055	2025-01-10	2026-01-10	1 Year
E-Series AVG Power Sensor	Agilent	E9300H	MY41495967	2025-01-10	2026-01-10	1 Year
E-Series AVG Power Sensor	Agilent	E9300H	US39215405	2025-01-10	2026-01-10	1 Year
POWER METER	ANRITSU	ML2495A	1438001	2025-01-10	2026-01-10	1 Year
Pulse Power Sensor	ANRITSU	MA2411B	1339205	2025-01-10	2026-01-10	1 Year
Attenuator	HP	8491B	22234	2025-01-10	2026-01-10	1 Year
Attenuator	Agilent	8491B	51229	2025-06-09	2026-06-09	1 Year
Low Pass Filter	MINI-CIRCUITS	VLF-320+	32433	2025-04-18	2026-04-18	1 Year
DIELECTRIC ASSESSMENT KIT	SPEAG	DAK-12	1026	2025-04-22	2026-04-22	1 Year
Network Analyzer	HP	8720C	3124A01008	2025-06-09	2026-06-09	1 Year
DIGITAL THERMOMETER	DAEKWANG	811CE	NONE	2025-06-12	2026-06-12	1 Year
DIGITAL THERMOMETER	NONE	TP101	191105	2025-01-16	2026-01-16	1 Year
Spectrum Analyzer	R&S	FSVA3030	101127	2025-04-03	2026-04-03	1 Year

Note:

1. CBT (Calibration Before Testing). Prior to testing, the measurement paths containing a cable, amplifier, attenuator, coupler or filter were connected to a calibrated source (i.e. a signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to the system verification and output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements.
2. All equipment was used solely within its calibration period.



12. Conclusion

The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of the FCC and Innovation, Science, and Economic Development Canada, with respect to all parameters subject to this test. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables.





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Appendix A. SAR Plots for System Verification

The plots for system verification with largest deviation for each SAR system combination are shown as follows.





Test Laboratory: KES Co., Ltd.

Date: 2025-11-28

System Verification for 150 MHz**DUT: CLA-150 - SN: 4014**

Communication System: System Verification; Frequency: 150 MHz; Duty Cycle: 1:1

Medium: HSL150 Medium parameters used: $f = 150$ MHz; $\sigma = 0.759$ S/m; $\epsilon_r = 51.404$; $\rho = 1000$ kg/m³

Ambient Temperature 22.8 °C; Liquid Temperature 21.9 °C

DASY5 Configuration:

- Probe: ES3DV3 - SN3315; ConvF(7.09, 6.87, 7.15) @ 150 MHz; Calibrated: 2025-03-14
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1699; Calibrated: 2025-01-21
- Phantom: ELI v6.0; Type: QDOVA003AA; Serial: TP:2036
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Pin=1 W/Area Scan (161x161x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 4.46 W/kg

Pin=1 W/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 68.96 V/m; Power Drift = -0.03 dB

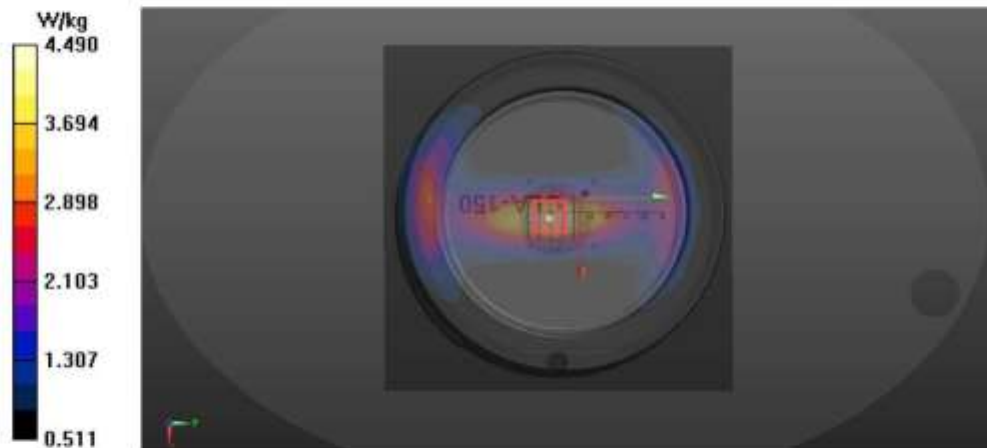
Peak SAR (extrapolated) = 6.56 W/kg

SAR(1 g) = 3.83 W/kg; SAR(10 g) = 2.51 W/kg

Smallest distance from peaks to all points 3 dB below = 18.7 mm

Ratio of SAR at M2 to SAR at M1 = 62.9%

Maximum value of SAR (measured) = 4.49 W/kg





Appendix B. SAR Plots for SAR Measurement

The plots for SAR measurement are shown as follows.





Test Laboratory: KES Co., Ltd.

Date: 2025-11-28

P01_150 MHz Band_VHF MURS_Front of the face_2.5 cm_F3**DUT: PT21U**

Communication System: VHF; Frequency: 151.94 MHz; Duty Cycle: 1:1

Medium: HSL150 Medium parameters used: $f = 152 \text{ MHz}$; $\sigma = 0.766 \text{ S/m}$; $\epsilon_r = 50.587$; $\rho = 1000 \text{ kg/m}^3$

Ambient Temperature 22.8 °C; Liquid Temperature 21.9 °C

DASY5 Configuration:

- Probe: ES3DV3 - SN3315; ConvF(7.09, 6.87, 7.15) @ 151.94 MHz; Calibrated: 2025-03-14
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1699; Calibrated: 2025-01-21
- Phantom: ELI v6.0; Type: QDOVA003AA; Serial: TP:2036
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

- Area Scan (61x201x1): Interpolated grid: $dx=1.500 \text{ mm}$, $dy=1.500 \text{ mm}$

Maximum value of SAR (interpolated) = 0.599 W/kg

- Zoom Scan (5x5x7)/Cube 0: Measurement grid: $dx=8\text{mm}$, $dy=8\text{mm}$, $dz=5\text{mm}$

Reference Value = 27.73 V/m; Power Drift = -0.08 dB

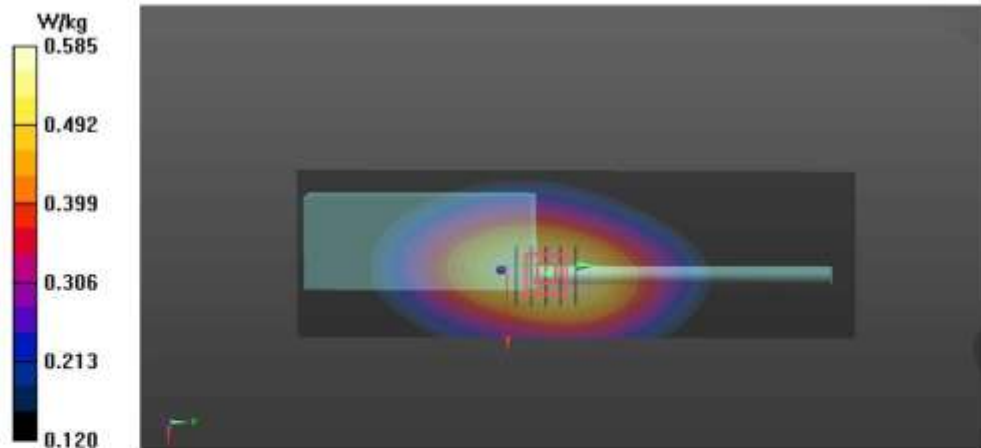
Peak SAR (extrapolated) = 0.779 W/kg

SAR(1 g) = 0.523 W/kg; SAR(10 g) = 0.393 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 71.2%

Maximum value of SAR (measured) = 0.585 W/kg





Test Laboratory: KES Co., Ltd.

Date: 2025-11-28

P06_150 MHz Band_VHF MURS_Rear Side_0 cm_F3**DUT: PT21U**

Communication System: VHF; Frequency: 151.94 MHz; Duty Cycle: 1:1

Medium: HSL150 Medium parameters used: $f = 152$ MHz; $\sigma = 0.766$ S/m; $\epsilon_r = 50.587$; $\rho = 1000$ kg/m³

Ambient Temperature 22.8 °C; Liquid Temperature 21.9 °C

DASY5 Configuration:

- Probe: ES3DV3 - SN3315; ConvF(7.09, 6.87, 7.15) @ 151.94 MHz; Calibrated: 2025-03-14
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1699; Calibrated: 2025-01-21
- Phantom: ELI v6.0; Type: QDOVA003AA; Serial: TP:2036
- Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

- Area Scan (61x201x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.370 W/kg

- Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 21.44 V/m; Power Drift = -0.06 dB

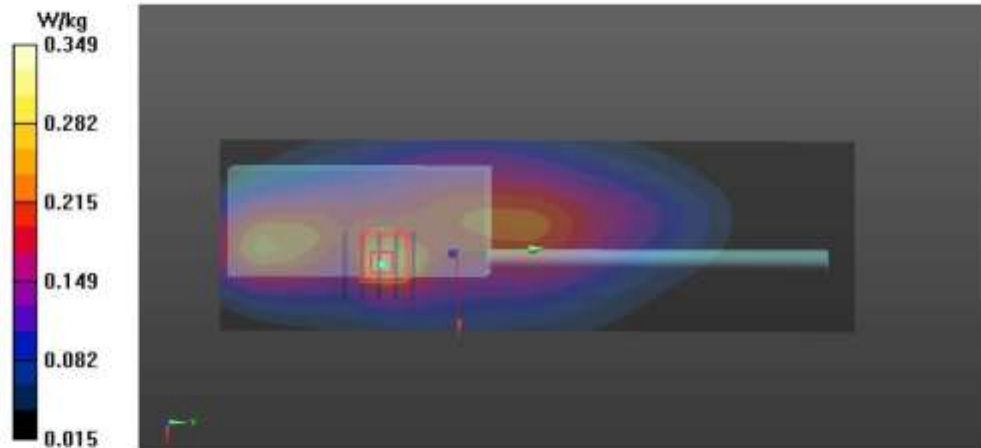
Peak SAR (extrapolated) = 0.673 W/kg

SAR(1 g) = 0.294 W/kg; SAR(10 g) = 0.182 W/kg

Smallest distance from peaks to all points 3 dB below = 15.8 mm

Ratio of SAR at M2 to SAR at M1 = 52.3%

Maximum value of SAR (measured) = 0.349 W/kg





Appendix C. Probe & Dipole Antenna Calibration Certificates

The SPEAG calibration certificates are shown as follows.



**Calibration Laboratory of
Schmid & Partner
Engineering AG**

Zeughausstrasse 43, 8004 Zurich, Switzerland



S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
S Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA
Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client **KES**
Gyeonggi-do, Republic of Korea

Certificate No. **ES-3315_Mar25****CALIBRATION CERTIFICATE**Object **ES3DV3 - SN:3315**Calibration procedure(s) **QA CAL-01.v10, QA CAL-12.v10, QA CAL-23.v6, QA CAL-25.v8
Calibration procedure for dosimetric E-field probes**Calibration date **March 14, 2025**

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3) °C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Calibration Date (Certificate No.)	Sched. Cal.
Power Sensor R&S NRP-33T	SN: 100967	28-Mar-24 (No. 217-04038)	Mar-25
Short [S6019i] + Attenuator [S6020i]	SN: L1119	26-Mar-24 (No. 217-04048)	Mar-25
OCP DAK-12	SN: 1016	24-Sept-24 (No. OCP-DAK12-1016_Sep24)	Sep-25
OCP DAK-3.5	SN: 1249	23-Sept-24 (No. OCP-DAK3.5-1249_Sep24)	Sep-25
Reference Probe EX3DV4	SN: 7349	10-Jan-25 (No. EX3-7349_Jan25)	Jan-26
DAE4	SN: 1301	07-Nov-24 (No. DAE4-1301_Nov24)	Nov-25

Secondary Standards	ID	Check Date (in house)	Sched. Check
ACAP 2020 Calibration Box	SN: L1404	30-Sept-24 (No. Report_ACAP2020E-Cave_20240930s)	Sep-25

	Name	Function	Signature
Calibrated by	Aldonia Georgiadou	Laboratory Technician	
Approved by	Sven Köhn	Technical Manager	
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
Issued: March 14, 2025			

Certificate No: ES-3315_Mar25

Page 1 of 9

**Calibration Laboratory of
Schmid & Partner
Engineering AG**

Zeughausstrasse 43, 8004 Zurich, Switzerland



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Glossary

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\theta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices – Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}: Assessed for E-field polarization $\theta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z} = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal. DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical Isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).



ES3DV3 - SN:3315

March 14, 2025

Parameters of Probe: ES3DV3 - SN:3315**Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k = 2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	1.10	1.14	1.18	$\pm 10.1\%$
DCP (mV) ^B	104.6	103.5	103.6	$\pm 4.7\%$

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Max dev.	Max Unc ^E k = 2
0	CW	X	0.00	0.00	1.00	0.00	134.0	$\pm 1.4\%$	$\pm 4.7\%$
		Y	0.00	0.00	1.00		141.0		
		Z	0.00	0.00	1.00		138.7		

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

^A The uncertainties of Norm X,Y,Z do not affect the E^2 -field uncertainty inside TSL (see Page 5)

^B Linearization parameter uncertainty for maximum specified field strength.

^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.



ES3DV3 - SN:3315

March 14, 2025

Parameters of Probe: ES3DV3 - SN:3315**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle	17.1°
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm



ES3DV3 - SN:3315

March 14, 2025

Parameters of Probe: ES3DV3 - SN:3315**Calibration Parameter Determined in HSL**

f (MHz) ^C	Relative Permittivity ^F	Conductivity ^F (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unc ^H (k = 2)
150	52.3	0.76	7.09	6.87	7.15	0.00	2.00	±13.3%
300	45.3	0.87	7.36	7.36	7.36	0.14	1.00	±13.3%

^C Frequency validity above 300 MHz of ±100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ±50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ±10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4–9 MHz, and ConvF assessed at 13 MHz is 9–19 MHz. Above 5 GHz frequency validity can be extended to ±110 MHz.

^F The probes are calibrated using tissue simulating liquids (TSL) that deviate for ϵ and σ by less than ±5% from the target values (typically better than ±3%) and are valid for TSL with deviations of up to ±10% if SAR correction is applied.

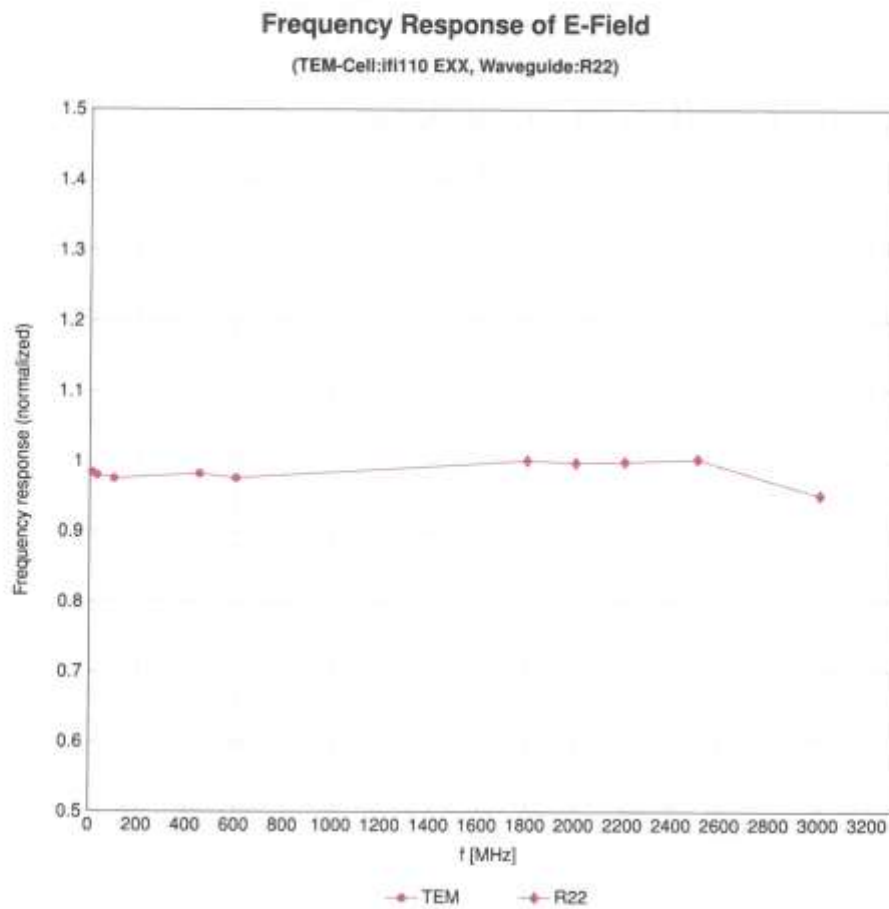
^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ±1% for frequencies below 3 GHz and below ±2% for frequencies between 3–6 GHz at any distance larger than half the probe tip diameter from the boundary.

^H The stated uncertainty is the total calibration uncertainty (k = 2) of Norm-ConvF. This is equivalent to the uncertainty component with the symbol CF in Table 9 of IEC/IEEE 62209-1528:2020.



ES3DV3 - SN:3315

March 14, 2025



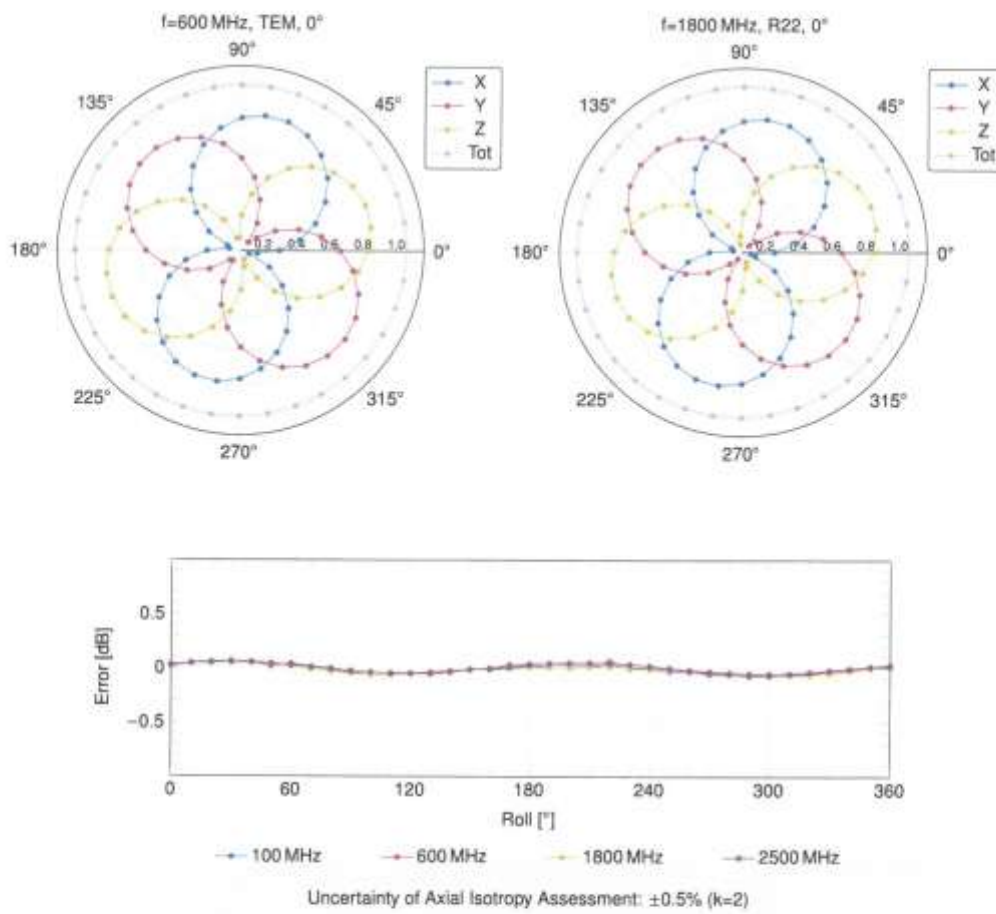
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)



ES3DV3 · SN:3315

March 14, 2025

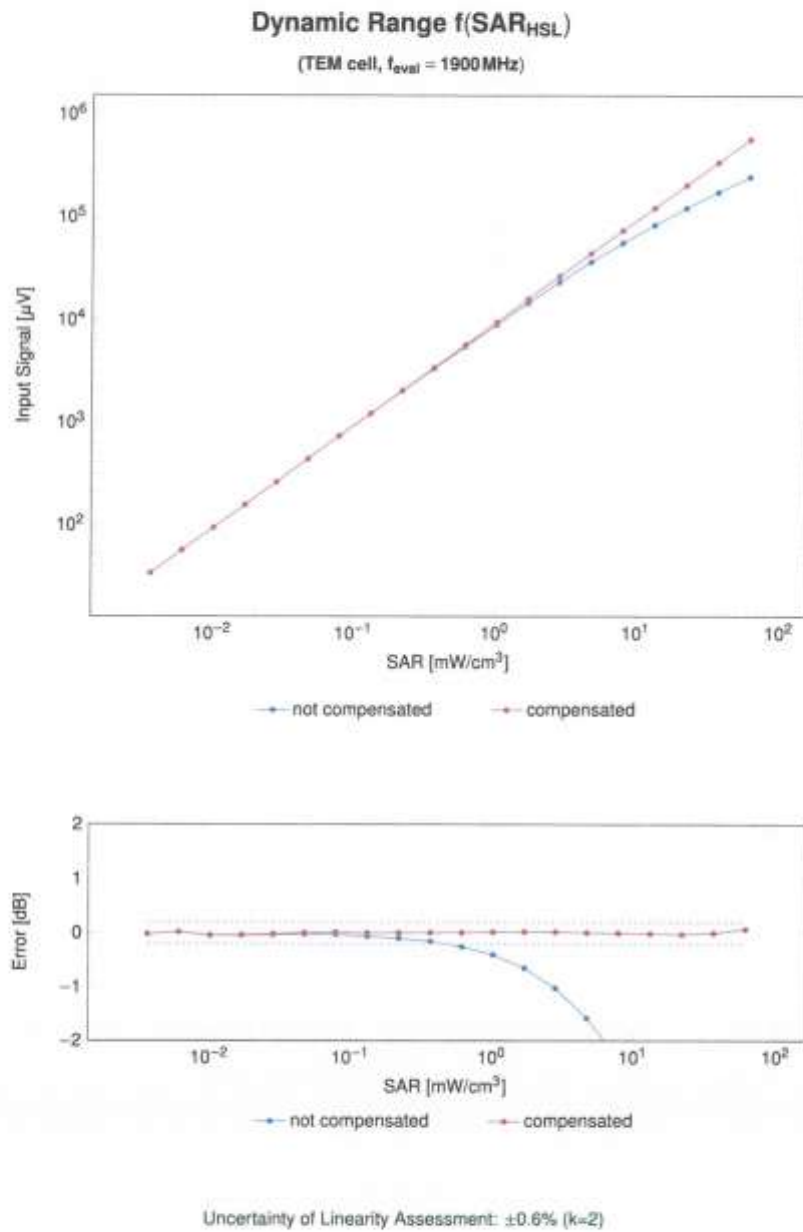
Receiving Pattern (ϕ), $\theta = 0^\circ$





ES3DV3 - SN:3315

March 14, 2025

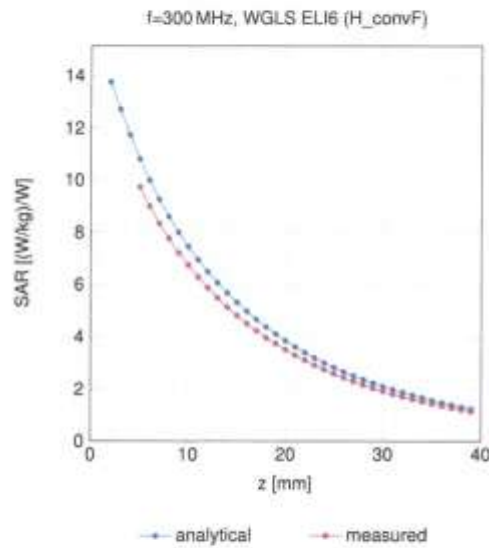




ES3DV3 - SN:3315

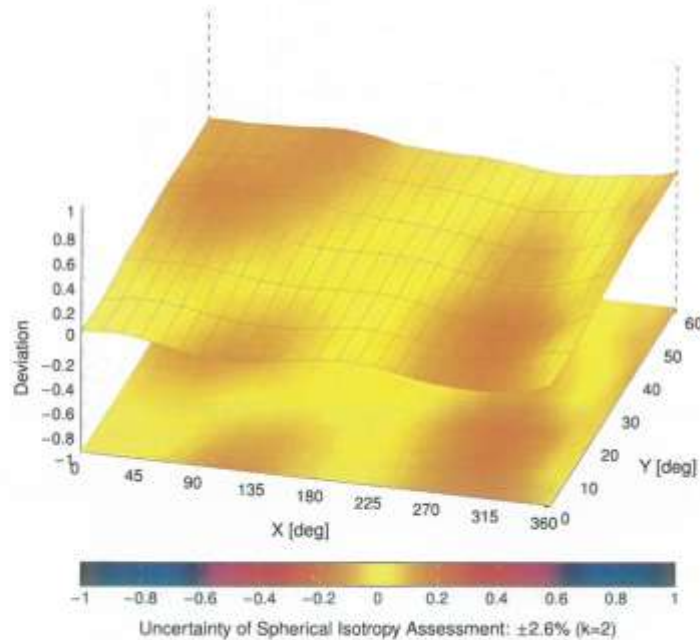
March 14, 2025

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), f = 900 MHz



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Accreditation No.: SCS 0108

Client: HCT

Gyeonggi-do, Republic of Korea

Certificate No. CLA150-4014_Aug25

CALIBRATION CERTIFICATE

Object: CLA150 - SN: 4014

Calibration procedure(s): QA CAL-15.v11
Calibration Procedure for SAR Validation Sources below 700 MHz

Calibration date: August 13, 2025

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.All calibrations have been conducted in the closed laboratory facility: environment temperature $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP2	SN: 104778	26-Mar-25 (No. 217-04289)	Mar-26
Power sensor NRP-Z91	SN: 103245	26-Mar-25 (No. 217-04289)	Mar-26
Reference 20 dB Attenuator	SN: CC2552 (20x)	26-Mar-25 (No. 217-04284)	Mar-26
3.5mm mismatch combination	SN: L1152	24-Mar-25 (No. 217-04293)	Mar-26
Reference Probe EX3DV4	SN: 2677	06-Jan-25 (No. EX3-3677_Jan25)	Jan-26
DAE4	SN: 854	18-Oct-24 (No. DAE4-854_Oct24)	Oct-25

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter NRP2	SN: 107193	08-Nov-21 (in house check Jun-24)	In house check: Jun-26
Power sensor NRP-Z91	SN: 100822	15-Dec-09 (in house check Jun-24)	In house check: Jun-26
Power sensor NRP-Z91	SN: 100416	01-Jan-04 (in house check Jun-24)	In house check: Jun-26
RF generator HP 8648C	SN: US3642U01700	04-Aug-09 (in house check Jun-24)	In house check: Jun-26
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Sep-24)	In house check: Sep-26

Calibrated by: Name: Claudio Leubler Function: Laboratory Technician

Approved by: Sven Kuhn Technical Manager

Signature

Issued: August 14, 2025

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Certificate No: CLA150-4014_Aug25

Page 1 of 6

결	담당자	확인자
재	김리훈	
특위/영	DL 7/13/25	6/1/25
일	2025-06-26	2025-06-26



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Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

- IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- DASY System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The source is mounted in a touch configuration below the center marking of the flat phantom.
- Return Loss:** This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor $k=2$, which for a normal distribution corresponds to a coverage probability of approximately 95%.

**Measurement Conditions**

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	ELI4 Flat Phantom	Shell thickness: 2 ± 0.2 mm
EUT Positioning	Touch Position	
Zoom Scan Resolution	$dx, dy = 4.0$ mm, $dz = 1.4$ mm	Graded Ratio = 1.4 (Z direction)
Frequency	150 MHz ± 1 MHz	

HSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal HSL parameters	22.0 °C	52.3	0.76 mho/m
Measured HSL parameters	(22.0 ± 0.2) °C	50.3 ± 6 %	0.77 mho/m ± 6 %
HSL temperature change during test	< 0.5 °C	-----	-----

SAR result with HSL

SAR averaged over 1 cm ³ (1 g) of HSL	Condition	
SAR measured	1 W input power	3.77 W/kg
SAR for nominal HSL parameters	normalized to 1W	3.70 W/kg ± 18.4 % (k=2)
SAR averaged over 10 cm ³ (10 g) of HSL	condition	
SAR measured	1 W input power	2.53 W/kg
SAR for nominal HSL parameters	normalized to 1W	2.49 W/kg ± 18.0 % (k=2)



Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with HSL

Impedance, transformed to feed point	$46.8 \Omega + 4.5 j\Omega$
Return Loss	-24.7 dB

Additional EUT Data

Manufactured by	SPEAG
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**DASY5 Validation Report for HSL**

Date: 13.08.2025

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4014

Communication System: UID 0 - CW; Frequency: 150 MHz

Medium parameters used: $f = 150$ MHz; $\sigma = 0.77$ S/m; $\epsilon_r = 50.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(12.23, 12.23, 12.23) @ 150 MHz; Calibrated: 06/01/2025
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 18/10/2024
- Phantom: ELI v6.0; Type: QDOVA003AA; Serial: TP:2034
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan,**dist=1.4mm (8x10x8)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 80.80 V/m; Power Drift = -0.05 dB

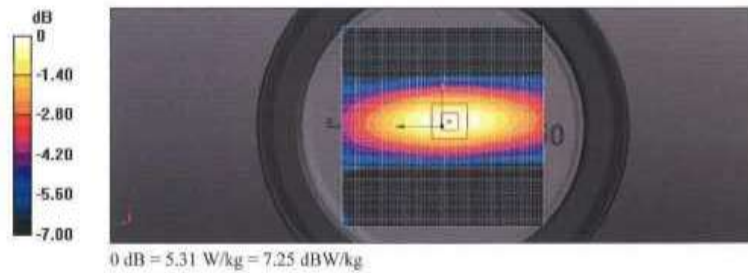
Peak SAR (extrapolated) = 7.06 W/kg

SAR(1 g) = 3.77 W/kg; SAR(10 g) = 2.53 W/kg

Smallest distance from peaks to all points 3 dB below: Larger than measurement grid (> 14 mm)

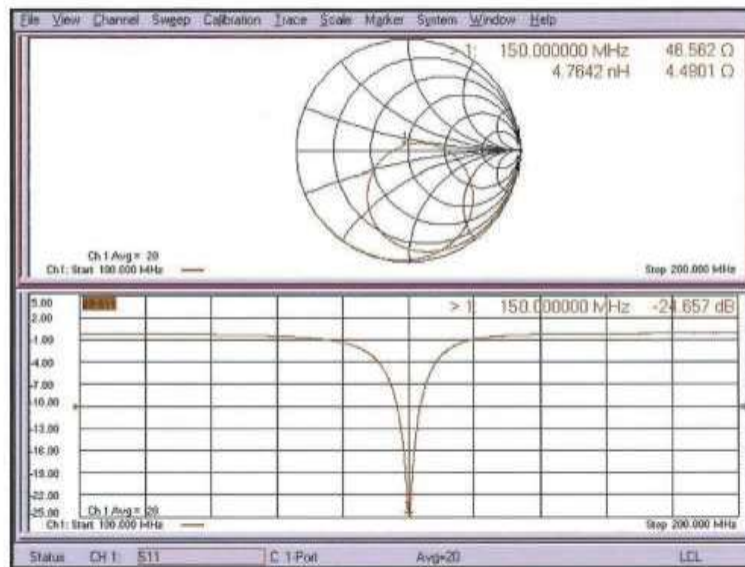
Ratio of SAR at M2 to SAR at M1 = 80.9%

Maximum value of SAR (measured) = 5.31 W/kg





Impedance Measurement Plot for HSL





Appendix D. SAR Tissue Specifications

Measurement Procedure for Tissue verification:

- 1) The network analyzer and probe system was configured and calibrated.
- 2) The probe was immersed in the tissue. The tissue was placed in a nonmetallic container. Trapped air bubbles beneath the flange were minimized by placing the probe at a slight angle.
- 3) The complex admittance with respect to the probe aperture was measured.
- 4) The complex relative permittivity ϵ' can be calculated from the below equation (Pournaropoulos and Misra):

$$Y = \frac{j2\omega\epsilon_r\epsilon_0}{[\ln(b/a)]^2} \int_a^b \int_a^b \int_0^\pi \cos\phi' \frac{\exp[-j\omega'(\mu_0\epsilon_r\epsilon_0)^{1/2}r]}{r} d\phi' d\rho' d\rho$$

where Y is the admittance of the probe in contact with the sample, the primed and unprimed coordinates refer to source and observation points, respectively, $r^2 = \rho^2 + \rho'^2 - 2\rho\rho'\cos\phi'$, ω is the angular frequency, and $j = \sqrt{-1}$.

Table D-1 Composition of the Tissue Equivalent Matter - Head

Frequency (MHz)	150
Tissue	Head
Ingredients (% by weight)	
Bactericide	-
Mineral Oil	-
Emulsifiers	-
NaCl	1.57
Tween 20	43.31
Water	55.12

Table D-2 Recommended Tissue Dielectric Parameters (IEC/IEEE 62209-1528)

Frequency (MHz)	Relative permittivity (ϵ_r)	Conductivity (σ) (S/m)
300	45.3	0.87
450	43.5	0.87
750	41.9	0.89
835	41.5	0.90
900	41.5	0.97
1450	40.5	1.20
1500	40.4	1.23
1640	40.2	1.31
1750	40.1	1.37
1800	40.0	1.40
1900	40.0	1.40
2000	40.0	1.40
2100	39.8	1.49
2300	39.5	1.67
2450	39.2	1.80
2600	39.0	1.96
3000	38.5	2.40
3500	37.9	2.91
4000	37.4	3.43
4500	36.8	3.94
5000	36.2	4.45
5200	36.0	4.66
5400	35.8	4.86
5600	35.5	5.07
5800	35.3	5.27
6000	35.1	5.48

NOTE—For convenience, permittivity and conductivity values at some frequencies that are not part of the original data from Drossos et al. [B60] or the extension to 5800 MHz are provided (i.e., the values shown in italics). These values were linearly interpolated between the values in this table that are immediately above and below these values, except the values at 6000 MHz that were linearly extrapolated from the values at 3000 MHz and 5800 MHz.



Appendix E. SAR System Validation

Per FCC KDB Publication 865664 D02v01r02, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue- equivalent media for system validation, according to the procedures outlined in FCC KDB Publication 865664 D01v01r04 and IEEE 1528-2013. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

Table E-1 SAR System Validation Summary

SAR System #	Freq. [MHz]	Date	Probe SN	Probe Type	Cond.	Perm.	CW Validation			Mod. Validation		
					(σ)	(ϵ_r)	Sensitivity	Probe Linearity	Probe Isotropy	Mod. Type	Duty Factor	PAR
1	150	2025-10-23	3315	ES3DV3	0.750	51.329	PASS	PASS	PASS	GFSK	PASS	PASS

NOTE: While the probes have been calibrated for both CW and modulated signals, all measurements were performed using communication systems calibrated for CW signals only. Modulations in the table above represent test configurations for which the measurement system has been validated per FCC KDB Publication 865664 D01v01r04 for scenarios when CW probe calibrations are used with other signal types. SAR systems were validated for modulated signals with a periodic duty cycle, such as GMSK, or with a high peak to average ratio (> 5 dB), such as OFDM according to FCC KDB Publication 865664 D01v01r04.