RF Exposure Report

FCC ID	: 2AMK2-RM05CA
Equipment	: Marker Plus
Brand Name	: reMarkable
Model Name	: RM05C
Applicant	: reMarkable AS Fridtjof Nansens Vei 12 0369 Oslo Norway
Manufacture	: reMarkable AS Fridtjof Nansens Vei 12 0369 Oslo Norway
Standard	: FCC 47 CFR Part 2.1093

The product was received on Feb. 02, 2024 and testing was started from Mar. 26, 2024 and completed on Mar. 26, 2024. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample provide by manufacturer and the test data has been evaluated in accordance with the test procedures given in 47 CFR Part 2.1093 and has been pass the FCC requirement.

The results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. Laboratory, the test report shall not be reproduced except in full.

Approved by: Cona Huang / Deputy Manager

Sporton International Inc. Wensan Laboratory
No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan

Table of Contents

Revision History

REPORT NO.	VERSION	DESCRIPTION	ISSUED DATE
FA413019	Rev. 01	Initial issue of report	May 27, 2024

1. Description of Equipment Under Test (EUT)

Product Feature & Specification	
FCC ID	2AMK2-RM05CA
Equipment	Marker Plus
Brand Name	reMarkable
Model Name	RM05C
Frequency Range	110.1 KHz ~ 490KHz

2. RF Exposure Limit

<Limits for Maximum Permissible Exposure>

§ 1.1310 The criteria listed in table 1 shall be used to evaluate the environmental impact of human exposure to radio frequency(RF) radiation as specified in § 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of § 2.1093 of this chapter.

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

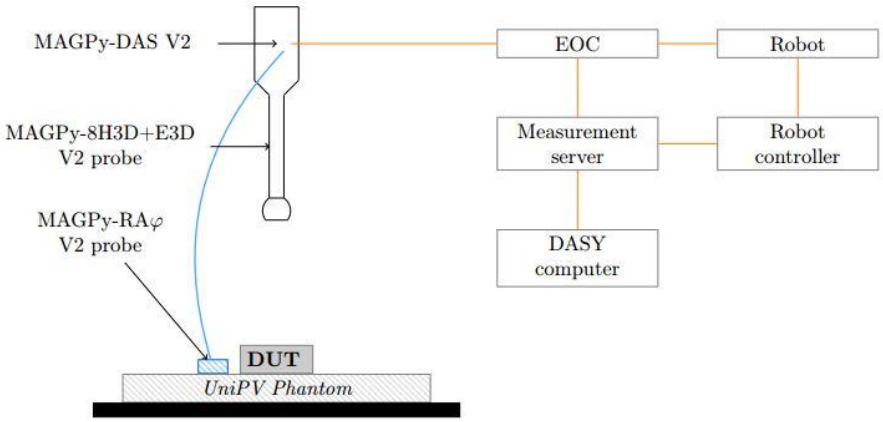
f = frequency in MHz

* = Plane-wave equivalent power density

(1) Occupational/controlled exposure limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when a person is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure. The phrase fully aware in the context of applying these exposure limits means that an exposed person has received written and/or verbal information fully explaining the potential for RF exposure resulting from his or her employment. With the exception of transient persons, this phrase also means that an exposed person has received appropriate training regarding work practices relating to controlling or mitigating his or her exposure. Such training is not required for transient persons, but they must receive written and/or verbal information and notification (for example, using signs) concerning their exposure potential and appropriate means available to mitigate their exposure. The phrase exercise control means that an exposed person is allowed to and knows how to reduce or avoid exposure by administrative or engineering controls and work practices, such as use of personal protective equipment or time averaging of exposure.

(2) General population/uncontrolled exposure limits apply in 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 fully aware of the potential for exposure or cannot exercise control over their exposure.

3. System Description and Setup



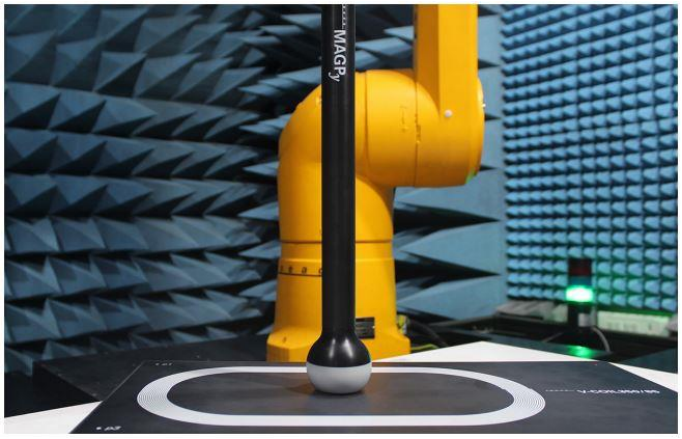
General Note:

1. DASY8 Module WPT is a special solution for high precision evaluations in the laboratory. The precision is achieved by combining the MAGPy system with the DASY robotics system and Sim4Life simulation platform. It is the fist and only fully automated system for demonstrating compliance of WPT devices.
2. The setup figure shows a typical setup for the measurements with DASY8 Module WPT. The MAGPy-8H3D+E3D V2 probe with MAGPy-DAS V2 is mounted on a TX-90 or TX2-90 robot allowing to scan volumes as large as 2000 × 1000 × 1500 mm with a precision of ±0.2 mm. In any distance the H-fild distributions can be analyzed directly and the values are compared to the reference level, or they are converted into Maxwell fild and used as excitations for determining the basic restriction quantities for further dosimetric analysis with the Magneto Quasi-Static (MQS) solver. This specifi solution is optimized for evaluation of H-field sources (3kHz–10MHz) and demonstration of compliance (3KHz–4 MHz)
3. Sicne the DASY8 Module WPT system alternatively, curve-tting techniques may be used to estimate the field value(s) at dsep based on measurements taken at larger distances . The test equipment permits the estimation of fields at 0mm separation distance based on measurements near the surface; Maxwell total field reconstruction is employed.
4. The DASY8 Module WPT with MAGPy-8H3D+E3D V2 Probe is capable of measuring the H-fild in frequency and time-domain in the frequency band from 3 kHz to 10 MHz, covering a dynamic range from 0.1 to >3100 A/m.
5. The DASY8 Module WPT provides the relation between an externally applied H-field to each of the three sensors and the corresponding ADC reading over the frequency range from 3 kHz to 10 MHz. The frequency-dependent adjustment factors are used to determine the incident measured H-fild from an ADC reading. For the frequency range from 1 to 10 MHz, the adjustment factors are applied with fiite impulse response (FIR) fiters directly inside the MAGPy-8H3D+E3D V2 in time-domain and frequencies <1 MHz in the frequency domain in the PC-based post-processing software.
6. In summary, this system of DASY8 Module WPT with MAGPy-8H3D+E3D V2 Probe fully meets the probe requirements of RSS-102.NS.MEAS

Probe Spec

The MAGPy-8H3D+E3D V2 probe consists of eight isotropic H-field sensors and one isotropic E-field sensor:
Probe design:
- Probe length: 335 mm
- Probe tip diameter: 60 mm
- 8H3D: eight isotropic 1 cm3-H-field sensors, arranged at the corners of a 22 mm cube
- First isotropic H-field sensor plane: 7.5 mm from the tip
- E3D: one isotropic E-field sensor (dipole / monopole)

Sensor specifications:
- Frequency range: 3 kHz – 10 MHz
- H-field dynamic range: 0.1 A/m – 3200 A/m (0.12 µT – 4 mT)
- H-field extrapolation uncertainty: 0.6 dB (k = 2)
- E-field dynamic range: 0.08 V/m – 2000 V/m



- **Compliance Evaluation**

DASY8 Module WPT SW version V2.2 offers compliance evaluation with respect to:

• **Reference levels** on the basis of the incident *H*- and *E*-fields measured from the volume scan

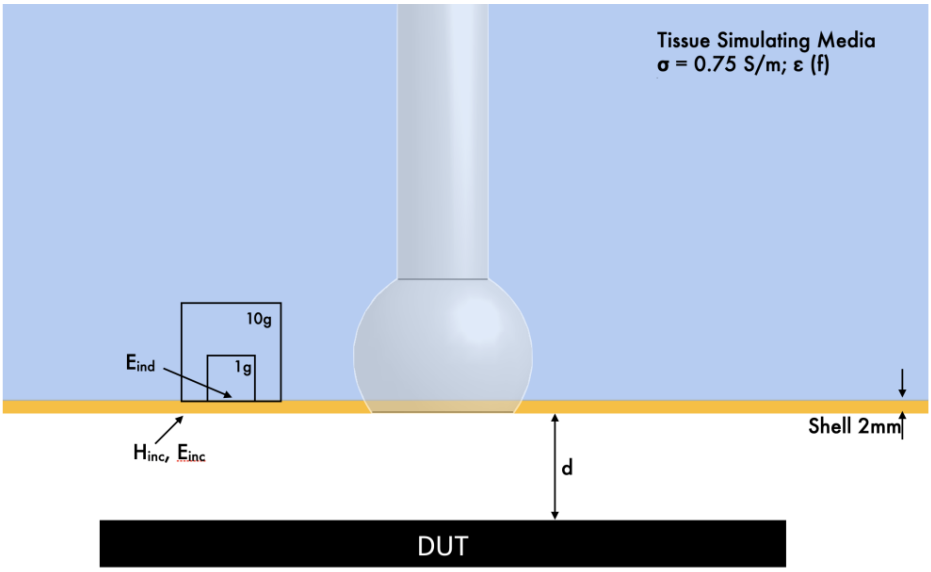
• **Basic restrictions** on the basis of the peak induced *E*-field, peak induced current density, and **peak spatial-average SAR** calculated from the Sim4Life simulation.

Since SPEAG release a DASY8 Module WPT system (*SW Module WPT V2.2*) for E and H-Field measurement, and also the system support Sim4Life plug-in includes the components to import the 3D H-fild scan data (Hx, Hy, Hz values in the measurement volume) to the Sim4Life simulation platform. And a magneto quasi-static (MQS) simulation is automatically setup to solve for a lossy halfspace Phantom setup. The lossy half-space has muscle tissue dielectric properties (σ = 0.75 S/m, ρ = 1000 kg/m3,), The induced electric (E-) fields and **specific absorption rate (SAR)** are assessed with Sim4Life's Quasi-Static EM Solver (P-EM-QS) using only the measured data.

The post-processing engine determines the maximum induced E-field, current density, and SAR values in a homogeneous half-space of muscle tissue equivalent media (half-space muscle phantom) positioned at the compliance distance. In general, the compliance distance corresponds to the closest point (with respect to the exposure source) the human body (e.g., a part of the hand) can reach during the operation of the source.

The relative dielectric constant, conductivity, and mass density of the homogeneous phantom used in the simulations were 55, 0.75 S/m, and 1000 kg/m3 respectively, which correspond to the phantom.

- **Simulation Results**



The distance used in the test raw data for simulation and compliance evaluation results is defined as the spacing between the top surface of the DUT and the bottom surface of the fictive phantom shell (with a thickness of 2 mm). In this case, the evaluation is made at distance d. Typically d = 0, i.e., at the DUT surface. The evaluation locations of the incident fields (i.e., Hinc and Einc) as well as the induced fields (e.g., Eind, psSAR1g, and psSAR10g) are also illustrated.

4. Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	Near-field Electric and Megnetic Field Sensor System	MAGPy-8H3D+E3D	3059	Apr. 12, 2023	Apr. 11, 2024
SPEAG	Near-field Electric and Megnetic Field Sensor System	MAGPy-DAS	3064	Apr. 12, 2023	Apr. 11, 2024
SPEAG	Calibration Procedure for MAGPy Validation Source	V-Coil350/85	1023	May. 16, 2023	May. 15, 2024
SPEAG	Calibration Procedure for MAGPy Validation Source	V-Coil50/400	1018	May. 13, 2023	May. 12, 2024

5. System Validiation

SPEAG developed the evaluation system DASY8 Module WPT for small-to-large size wireless power transfer (WPT) devices that combines subsystems of DASY8, MAGPy, and Sim4Life. The IT'IS Foundation was mandated to develop the system check and validation sources for WPT evaluations.
Below table shows the target value and measured value after normalized to 1A and comparing to the Target value provided by SPEAG calibration, the verification data should be within its specification of 1.24dB.

Test Date	Calibrated Parameters (kHz)	Distance of the Virtual Phantom from the Surface (mm)	Raw Measurements				
			Peak H-field (A/m)	Peak H-field (A/m)	Induced peak current density 1cm^2 area avg.(A/m^2)	Induced peak E-field (V/m)	
						cube avg.	line avg.
2024/3/26	85	2	Target	183	1.08	3.24	3.27
			Raw Measurement	175	1.05	3.14	3.17
			Scaled to 1A current				
			Peak H-field (A/m)	Peak H-field (A/m)	Induced peak current density 1cm^2 area avg.(A/m^2)	Induced peak E-field (V/m)	
						cube avg.	line avg.
			Target	232.29	1.37	4.11	4.15
			Raw Measurement	222.14	1.33	3.99	4.02
			Deviation (dB)				
				Peak H-field (A/m)	Induced peak current density 1cm^2 area avg.(A/m^2)	Induced peak E-field (V/m)	
						cube avg.	line avg.
				-0.19	-0.12	-0.14	-0.13

Test Date	Calibrated Parameters (kHz)	Distance of the Virtual Phantom from the Surface (mm)	Raw Measurements				
			Peak H-field (A/m)	Peak H-field (A/m)	Induced peak current density 1cm^2 area avg.(A/m^2)	Induced peak E-field (V/m)	
						cube avg.	line avg.
2024/3/26	400	2	Target	243	1.35	4.53	4.64
			Raw Measurement	241	1.21	4.01	4.11
			Scaled to 1A current				
			Peak H-field (A/m)	Peak H-field (A/m)	Induced peak current density 1cm^2 area avg.(A/m^2)	Induced peak E-field (V/m)	
						cube avg.	line avg.
			Target	311.22	1.73	5.80	5.94
			Raw Measurement	308.66	1.55	5.14	5.26
			Deviation (dB)				
				Peak H-field (A/m)	Induced peak current density 1cm^2 area avg.(A/m^2)	Induced peak E-field (V/m)	
						cube avg.	line avg.
				-0.04	-0.48	-0.53	-0.53

6. RF Exposure Results

General Note:

1. The device is a universal stylus initiative and used on any support touch pad device.
2. Consider the device was used on hand during normal usage, the device evaluation at 0cm around the device.
3. The stylus support battery option, for RF exposure was assessment with < 15% battery state, equal 50% and > 85% battery state will verify worst configuration found from 15% state.

6.1. Maximum Permissible Exposure Evaluation

Electric field Strength Result

Plot No.	Position	Test Distance (mm)	Client Battery State	Measured Einc (V/m)	Einc Limit (V/m)	Result
	Front	0	< 15%	2.14	614	Pass
	Back	0	< 15%	0.894	614	Pass
	Left Side	0	< 15%	1.05	614	Pass
	Right Side	0	< 15%	0.955	614	Pass
	Top	0	< 15%	0.699	614	Pass
1	Tip	0	< 15%	3.26	614	Pass
	Front	0	= 50%	1.93	614	Pass
	Tip	0	= 85%	2.01	614	Pass

Magnetic field Strength Result

Plot No.	Position	Test Distance (mm)	Client Battery State	Measured Hinc (A/m)	Hinc Limit (A/m)	Result
	Front	0	< 15%	0.273	1.63	Pass
	Back	0	< 15%	0.244	1.63	Pass
	Left Side	0	< 15%	0.234	1.63	Pass
	Right Side	0	< 15%	0.261	1.63	Pass
	Top	0	< 15%	0.267	1.63	Pass
	Tip	0	< 15%	0.182	1.63	Pass
2	Front	0	= 50%	0.326	1.63	Pass
	Tip	0	= 85%	0.218	1.63	Pass

Conclusion:

The field strength limit refers to Part 1.1310 and the test result of exposure evaluation is less than the a applicable MPE limit.

7. Uncertainty

Uncertainty Budget for Peak Incident H-field					
Error Description	Uncertainty Value (±dB)	Probability	Divisor	(Ci)	Standard Uncertainty (dB)
Measurement System					
Amplitude calibration uncertainty	0.35	N	1	1	0.35
Probe anisotropy	0.60	R	1.732	1	0.35
Probe dynamic linearity	0.20	R	1.732	1	0.12
Probe frequency domain response	0.30	R	1.732	1	0.17
Probe frequency linear interp. fit	0.15	R	1.732	1	0.09
Spatial averaging	0.10	R	1.732	1	0.06
Parasitic E-field sensitivity	0.10	R	1.732	1	0.06
Detection limit	0.15	R	1.732	1	0.09
Readout electronics	0.0	N	1	1	0.0
Probe positioning	0.19	N	1	1	0.19
Repeatability	0.10	N	1	1	0.10
Surface fild reconstruction	0.30	N	1	1	0.30
Combined uncertainty (k = 1)					0.67 dB
Expanded uncertainty (k = 2)					1.33 dB

Uncertainty Budget for Peak Incident E-field					
Error Description	Uncertainty Value (±dB)	Probability	Divisor	(Ci)	Standard Uncertainty (dB)
Measurement System					
Amplitude calibration uncertainty	0.53	N	1	1	0.53
Probe anisotropy	0.80	R	1.732	1	0.46
Probe dynamic linearity	1.00	R	1.732	1	0.58
Probe frequency domain response	0.30	R	1.732	1	0.17
Probe frequency linear interp. fit	0.15	R	1.732	1	0.09
Parasitic H-fild sensitivity	0.20	R	1.732	1	0.12
Detection limit	0.15	R	1.732	1	0.09
Readout electronics	0	N	1	1	0
Repeatability	0.10	N	1	1	0.10
Combined uncertainty (k = 1)					0.95 dB
Expanded uncertainty (k = 2)					1.89 dB