**FCC 47 CFR § 2.1093**

**RF EVALUATION REPORT (Digitizer)**

**FOR**

**GSM/WCDMA/LTE/5G NR Tablet + BT/BLE, DTS/UNII a/b/g/n/ac/ax**

**MODEL NUMBER: SM-X518U**

**FCC ID: A3LSMX518U**

**REPORT NUMBER: 4790841154-S2V2**

**ISSUE DATE: 7/31/2023**

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**Testing Laboratory**

**TL-637**

**Revision History**

| Rev. | Date | Revisions | Revised By |
|---|---|---|---|
| V1 | 7/13/2023 | Initial Issue | -- |
| V2 | 7/31/2023 | Revised Sec.4.2 & Sec.6 in report. | Sunghoon Kim |
| | | | |
| | | | |

**Table of Contents**

# 1. Attestation of SAR Characterization

| | |
|---|---|
| Applicant Name | SAMSUNG ELECTRONICS CO.,LTD. |
| FCC ID | A3LSMX518U |
| Model Number | SM-X518U |
| Applicable Standards | FCC 47 CFR § 2.1093 |
| Exposure Category | Magnetic field strength limit (A/m) |
| General population / Uncontrolled exposure | 1.63 |
| RF Exposure Conditions | The Highest Magnetic field strength (A/m) |
| | 0.544 |
| Date Tested | 7/11/2023 |
| Test Results | Pass |

UL Korea, Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Korea, Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

**Note:** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Korea, Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Korea, Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by IAS, any agency of the Federal Government, or any agency of any government

| Approved & Released By: | Prepared By: |
|---|---|
|  |  |
| Justin Park<br>Operations Leader<br>UL Korea, Ltd. Suwon Laboratory | Sunghoon Kim<br>Senior Laboratory Engineer<br>UL Korea, Ltd. Suwon Laboratory |

# 2. Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093.

- 447498 D04 Interim General RF Exposure Guidance v01

In addition to the above, the following information was used:

- TCB workshop April, 2022; Part18 and Wireless Power Transfer Updates (Part I)
- DASY6 MODULE WPT system handbook (incl. SW module WPT 2.0)

# 3. Facilities and Accreditation

The test sites and measurement facilities used to collect data are located at

| Suwon |
|---|
| SAR 1 Room |

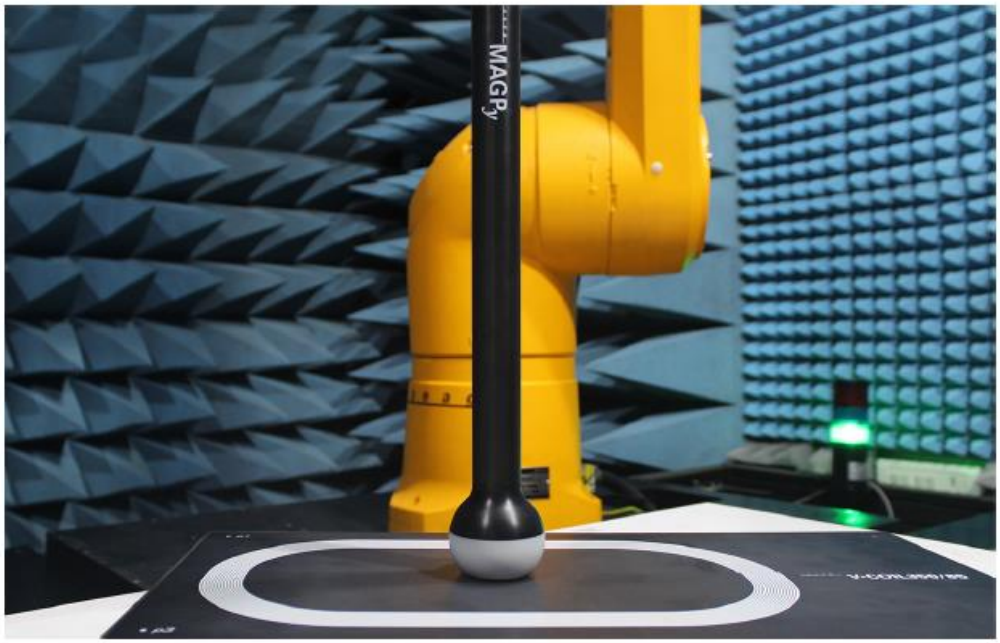
UL Korea, Ltd. is accredited by IAS, Laboratory Code TL-637.
The full scope of accreditation can be viewed at;

https://www.iasonline.org/wp-content/uploads/2017/05/TL-637-cert-New.pdf.

# 4. H-field Measurement System & Test Equipment

## 4.1. H-field Measurement System

DASYsystem Module WPT - MAGPy is optimized for evaluation of compliance for wireless power transfer (WPT) systems and any other sources operating in the 3kHz - 10MHz frequency range. Module WPT V2.0 is compatible with the DASY 6 systems and in addition has been extended for easy evaluations of pulsed sources.



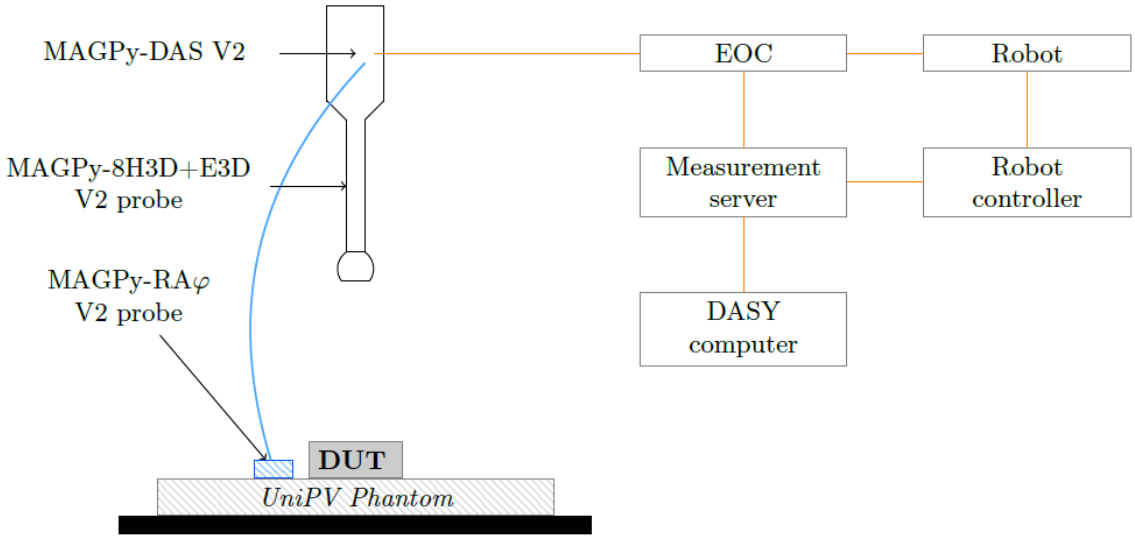




**Figure : Typical measurement setup with DASY system Module WPT-MAGPy**

**DASYsystem Module WPT – MAGPy's Specifications**

| | |
|---|---|
| System | DASY Module WPT is composed of the isotropic probe MAGPy-8H3D+E3D Version 2.0, the reference probe (MAGPy-RAφ), and the data acquisition system (MAGPy-DAS) mounted to the DASY8 robot via the emergency stop (MAGPy-ES). 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. At each probe location, eight isotropic H-field values are acquired in parallel. The dedicated graphical user interface (GUI) fully automates the testing workflow. |
| MAGPy-DAS | The MAGPy-DAS includes:<br>• 27x14 Bit ADC Channels with 25 MSPs<br>• Peak detection stage<br>• Hardware supervising unit<br>• Data transfer to the backend<br>• 22 tap FIR Filter |
| MAGPy-8H3D+E3D V2 | The MAGPy-H3D probe consists of eight isotropic H-field sensors and one isotropic E-field sensor:<br>Probe design:<br>• Probe length: 335 mm<br>• Probe tip diameter: 60 mm<br>• 8H3D: eight isotropic 1 cm3-H-field sensors, arranged at the corners of a 22 mm cube<br>• First isotropic H-field sensor plane: 7.5 mm from the tip<br>• E3D: one isotropic E-field sensor (dipole / monopole)<br>Sensor specifications:<br>• Frequency range: 3 kHz – 10 MHz<br>• H-field dynamic range: 0.1 A/m – 3200 A/m (0.12 µT – 4 mT)<br>• H-field extrapolation uncertainty: 0.6 dB ($k$ = 2)<br>• E-field dynamic range: 0.08 V/m – 2000 V/m |
| MAGPy-RAφV2 | The MAGPy-RAφ reference amplitude and phase probe includes:<br>• Frequency range: 3 kHz – 10 MHz<br>• Dynamic range: 0.1 A/m – 3200 A/m (0.12 µT – 4 mT)<br>• Loop coil area (sensor size): 18.9 cm2<br>• Size: 51 x 51 x 0.2 mm<br>• Sensor center: 25.5 x 25.5 mm |
| **Software** | Software components:<br>• DASY8 Module WPT application programming interface (API)<br>• MAGPy-DAS<br>• Sim4Life WPT (vector potential reconstruction, P-EM-QS solver)<br>• Graphic library , Report generator |

## 4.2. H-field measurement & extrapolation using MAGpy probe.

MAGPy probe can measured H-field strength at 7.83 mm distance from DUT's surface. And it is possible to Extrapolated the H-field strength of 0.5 mm using Sim4Life WPT software.

So we can use this function for MAGPy probe to measure H-field strength radiating of digitizer's coil and check the 0.5 mm H-field strength. In order to additionally verify the H-field strength Extrapolated method, we progress to test using Reference source(V-coil50/400) as follows and compared Measured H-field strength and Extrapolated H-field strength at 7.83 mm separation distance from reference source.

(Test A is Measured H-field at 7.83 mm & Extrapolated H-field at 0.5 mm.

Test B is Measured H-field at 14.83 mm & Extrapolated H-field at 7.83 mm.

| Test distance | Test A | Test B | Deviation(%) | Plot |
|---|---|---|---|---|
| Measured H-field (A/m) | **123.48 (at 7.83mm)** | 71.88 (at 14.33mm) | -0.4 | 1 |
| Extrapolated H-field (A/m) | 224.0 (at 0.5mm) | **123.0 (at 7.83mm)** | | 2 |

Depending on the test results, the deviation between Measured H-field at 7.83 mm and Extrapolated H-field at 7.83 mm is -0.4 %. Therefore, DUT measurement proceeds using the function of that extrapolation method. (The Plots refer to App_C.)

## 4.3. Test Equipment

| Name of Equipment | Manufacturer | Type/Model | Serial No. | Cal Date | Cal. Due Date |
|---|---|---|---|---|---|
| Probe | SPEAG | MAGPy-8H3D+E3D | 3054 | 1-9-2023 | 1-9-2024 |
| | SPEAG | MAGPy-DAS | 3054 | 1-9-2023 | 1-9-2024 |
| System verification Source | SPEAG | V-Coil50/400 | 1014 | 10-6-2022 | 10-6-2023 |

# 5. Measurement Uncertainty

**Measurement uncertainty of H-field (3 kHz to 10 MHz)**
**(According to IEC/IEEE 63184)**

| Error Description | Unc. Value (± dB) | Prob. Distr. | Div. | *ci* | Std. Unc. (± dB) |
|---|---|---|---|---|---|
| **Probe uncertainty** | | | | | |
| Amplitude calibration uncertainty | 0.47 | Normal | 1 | 1 | 0.47 |
| Probe anisotropy | 0.50 | Rectangular | 1.732 | 1 | 0.29 |
| Probe dynamic linearity | 0.15 | Rectangular | 1.732 | 1 | 0.09 |
| Probe frequency domain response | 0.25 | Rectangular | 1.732 | 1 | 0.14 |
| Gradient uncertainty | 0.10 | Rectangular | 1.732 | 1 | 0.06 |
| Parasitic E-field sensitivuty | 0.10 | Rectangular | 1.732 | 1 | 0.06 |
| Detection limit | 0.15 | Rectangular | 1.732 | 1 | 0.09 |
| Readout electronics | 0.00 | Normal | 1 | 1 | 0.00 |
| Probe positioning | 0.19 | Normal | 1 | 1 | 0.19 |
| Repeatability | 0.10 | Normal | 1 | 1 | 0.10 |
| Combined Standard Uncertainty (k = 1) | | | | | 0.63 |
| Expanded Uncertainty U, Coverage Factor = 2, > 95 % Confidence = | | | | | **1.24** |

# 6. DUT Informations

The manufacturer implemented the Factory Test Mode (FTM) mode (Pen tip detection) at 562.5 kHz that forcedly operates one coil among the X-Y axis coils of Digitizer built into the DUT, we tested this FTM mode.

The FTM mode has 98.4% signal. However, Actual coil's Tx operation is about 20%.

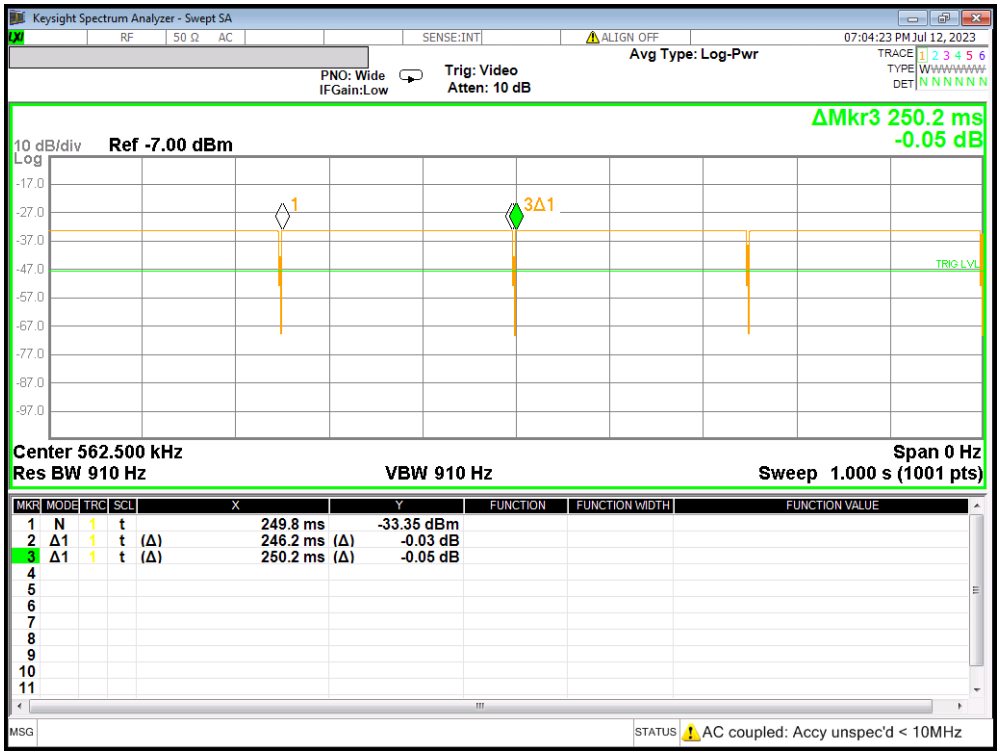
So The duty factor was compensated for the FTM mode measurement result.

Detail of Digitizer's duty operation was mentioned in Operational description.

**Duty Factor Measured Results**

| Mode | T on (ms) | Period (ms) | Measured Duty Cycle | Actual maximum Duty Cycle | Duty Factor (Measured Duty/ Actual Duty) |
|---|---|---|---|---|---|
| FTM | 246.200 | 250.200 | 98.40% | 20.00% | 0.20 |

**Duty Cycle plots**




# 7. RF Exposure Conditions (Test Configurations)

| RF Exposure Conditions | Mode (Scanning) | Separation distance of DUT's surface-to-Probe's element | Test Position |
|---|---|---|---|
| Standalone | FTM mode | 7.83 mm | Front |

**Notes:**

1. Digitizer is generally not expected to be used in head & body-worn exposure conditions. It is considered in the Hand exposure condition because it is mainly used by holding it in the hand. And Digitizer's coils operates to radiated to display of DUT. So other surface or edges are not considered.
2. Test distance 7.83 mm means that distance between DUT's surface to Probe's element. In fact, DUT's surface to Probe's tip are almost touched(0.5mm gap).

# 8. System verification


A set of four system verification sources (3kHz, 85kHz, 400kHz and 6.78 MHz) are available. According to the manufacturer's guide, the system verification was performed in the nearest frequency band with DUT's operate frequency. And The deviation of measured values from the target values of calibration report should be less than the expanded uncertainty (1.24 dB).

**Reference Target SAR Values**

The reference SAR values can be obtained from the calibration certificate of system validation dipoles.

| Verification Source | Serial No. | Cal. Date | Cal.due date | Target Magnetic field strength (A/m) | |
|---|---|---|---|---|---|
| | | | | Measured at 7mm | Extrapolated at 2mm |
| V-coil50/400 | 1014 | 10-6-2022 | 10-6-2023 | 158.56 | 245.00 |

**System verification Results**

**SAR 1 Room**

| Date Tested | System Source | | Measured at 7mm Results (A/m) | | Delta (±dB) | Extrapolated at 2mm Results | | Delta (±dB) | Plot No. |
|---|---|---|---|---|---|---|---|---|---|
| | Type | Serial # | Test results | Target | | Test results | Target | | |
| 7-11-2023 | V-coil50/400 | 1014 | 123.48 | 158.56 | -1.09 | 203.00 | 245.00 | -0.82 | 1 |

**Notes:**

The deviation of measured values from the target values of calibration report should be less than the expanded uncertainty (1.24 dB).

# 9. Test results

| Test mode | Test positon | duty factor | Magnetic field strength results (A/m) | | | | Plot No. |
|---|---|---|---|---|---|---|---|
| | | | Measured Result at 7.83 mm | Extrapolated Result at 0.5 mm | Measured Result X (duty factor) at 7.83 mm | Extrapolated Result X (duty factor) at 0.5 mm | |
| FTM mode | Front | 0.20 | 1.170 | 2.680 | 0.238 | 0.544 | 1 |

**Additional test Guidance**

| Test mode | Test positon/ Test distance | Magnetic field strength results (A/m) | | Deviation (%) | Plot No. |
|---|---|---|---|---|---|
| | | Measured Result at 7.83 mm | Extrapolated Result at 7.83 mm | | |
| FTM mode | Front / 7.83 mm | 1.170 | | -16.3 | 1 |
| FTM mode | Front / 14.83 mm | | 0.979 | | 2 |

**Notes:**

1. For Extrapolated Results at 0.5mm, The result are estimated based on the measured Magnetic field strength at 7.83 mm.
2. The duty factor was compensated for the FTM mode measurement result.
3. For Additional test Guidance, It was confirmed that the deviation between Measured H-field and Estimated H-field was within 30% at 7.83 test distance according to 2022.April TCB workshop note (Part.18 and Wireless Power Transfer Updates)

# 10. TER analysis results

This device is tablet device. SAR test is not required for front side (display) according to KDB 616217 D04 SAR for laptop and tablets v01r02. So TER analysis is not require with other transmitters.

# Appendixes

**Refer to separated files for the following appendixes.**

**4790841154-S2 FCC Report Digitizer evaluation _App A_Test setup photos**

**4790841154-S2 FCC Report Digitizer evaluation _App B_Highest Magnetic field strength Test Plots**

**4790841154-S2 FCC Report Digitizer evaluation _App C_System verification Plots**

**4790841154-S2 FCC Report Digitizer evaluation _App D_Probe Cal. Certificates**

**4790841154-S2 FCC Report Digitizer evaluation _App E_Verification Source Cal. Certificates**

**END OF REPORT**