
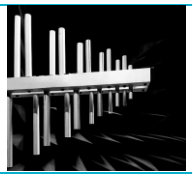
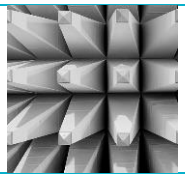

cetecom advanced

TEST REPORT

Test Report No.: 1-8053-24-01-04_TR2-R02

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-12047-01-00

Testing Laboratory

cetecom advanced GmbH
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Accredited Test Laboratory:
The testing laboratory (area of testing) is accredited according to DIN EN ISO/IEC 17025 (2018-03) by the Deutsche Akkreditierungsstelle GmbH (DAkkS)
The accreditation is valid for the scope of testing procedures as stated in the accreditation certificate with the registration number: D-PL-12047-01-00.

Applicant

EUCHNER GmbH + Co. KG
Kohlhammerstraße 16
70771 Leinfelden-Echterdingen/GERMANY

Phone: +49 711 7597-0

Contact: Tobias Lehmann
e-mail: tobias.lehmann@euchner.de
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Manufacturer

EUCHNER GmbH + Co. KG
Kohlhammerstraße 16
70771 Leinfelden-Echterdingen/GERMANY

Test Standard/s

RSS - 102 Issue 6	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)

For further applied test standards please refer to section 3 of this test report.

Test Item

Kind of test item:	Electronic-Key adapter
Device type:	Fixed device
Model name:	**CKS-A-LA1-SC-171792**
Serial number:	173914
FCC ID:	2AJ58-23
ISED Number:	22052-23
Hardware Version Identification No. (HVIN):	23
Product Marketing Name (PMN):	CKS-A-L Series
Firmware Version Identification Number (FVIN):	-/-
Host Marketing Name (HMN):	-/-
Hardware / Software status:	-/-
Frequency:	125 kHz RFID
Antenna:	Integrated antenna
Battery option:	7-16 V DC by external power supply
Accessories:	TAG
Test sample status:	identical prototype
Exposure category:	general population / uncontrolled environment

This test report is electronically signed and valid without handwritten signature. For verification of the electronic signatures, the public keys can be requested at the testing laboratory.

Test Report authorised:

cn=Alexander Hnatovskiy, o=cetecom advanced GmbH, ou=HNA-230601, email=alexander.hnatovskiy@cetecomadvanced.com, c=DE
2024.12.01 14:34:15 +01'00'

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2024.11.29 11:32:39 +01'00'

Marco Scigliano
Testing Manager
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1 Table of contents

2 General information

2.1 Notes and disclaimer

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This test report replaces the test report with the number 1-8053-24-01-04_TR1-R01 and dated 2024-07-20.

2.2 Application details

Date of receipt of order:	2024-06-04
Date of receipt of test item:	2024-08-05
Start of test:	2024-08-12
End of test:	2024-08-12

2.3 Statement of compliance

The EMF values found for the CKS-A-LA1-SC-171792 Electronic-Key adapter are below the maximum allowed levels according to the standards listed in section 3.

3 Test standard/s:

Test Standard	Version	Test Standard Description
RSS - 102 Issue 6	December 2023	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
RSS - 102 SPR-002 Issue 2	September 2016	Supplementary Procedure for Assessing Compliance with RSS-102 Nerve Stimulation Exposure Limits
Safety Code 6 (2015)	01.06.2015	Limits of Human Exposure to Radiofrequency Electromagnetic Energy in the Frequency Range from 3 kHz to 300 GHz
RSS-102.NS.MEAS Issue 1	15.12.2023	Measurement Procedure for Assessing Nerve Stimulation (NS) Compliance in Accordance with RSS-102
RSS-102.SAR.MEAS Issue 1 Amendment 1	15.12.2023	Measurement Procedure for Assessing Specific Absorption Rate (SAR) Compliance in Accordance with RSS-102
ISED - Notice 2024-DRS0005	17.05.2024	Updates on internal electric field strength (E-field) assessments using the DASY Module WPT (2.6+)
RSS - Gen Issue 5 incl. Amendment 1 & 2	February 2021	Spectrum Management and Telecommunications Radio Standards Specification - General Requirements for Compliance of Radio Apparatus
IEC PAS 63184	May 2021	Assessment methods of the human exposure to electric and magnetic fields from wireless power transfer systems – Models, instrumentation, measurement and numerical methods and procedures (frequency range of 1 kHz to 30 MHz)
IEC TR 62905	01.02.2018	IEC/TR 62905:2018(E) is a Technical Report. It describes general exposure assessment methods for wireless power transfer (WPT) at frequency up to 10 MHz considering thermal and stimulus effects. Exposure assessment procedures and experimental results are shown as examples such as electric vehicles (EVs) and mobile devices.

APPLICATION NOTE:
Testing WPT Devices with DASY8/6 Modules WPT and SAR for Compliance with ISED SPR-002 Issue 2 (Chapter 5 Test System and Procedures for Frequencies below 4 MHz, by SPEAG, R3, 05/24)

3.1 RF exposure limits

Reference levels for general public (uncontrolled environment) exposure to time-varying electric and magnetic fields

3.1.1 RSS 102 ISSUE 6 / Safety Code 6

According to RSS 102-ISSUE 06			
Frequency Range (MHz)	**Electric Field** (V/m rms)	**Magnetic Field** (A/m rms)	**Reference Period** (minutes)
0.003-10	**83**	**90**	**Instantaneous***
0.1-10	83	0.73/ f	6**
1.1-10	87/ $f^{0.5}$	0.73/ f	6**

Note: f is frequency in MHz.
* Based on nerve stimulation (NS).
** Based on specific absorption rate (SAR).

3.1.2 Nerve Stimulation limits according Safety Code 6 (basic restriction, pEind)

Limits for internal electric field strength are intended to prevent the occurrence of NS. At frequencies between 3 kHz and 10 MHz, basic restrictions for internal electric field strength in excitable tissues (Table 1) shall not be exceeded. For conditions where the determination of internal electric field strength is not possible or practical (e.g. by measurement or modelling), external unperturbed field strength assessment shall be carried out and the reference levels outlined in Section 2.2 of Safety Code 6 shall be respected.

Table 1. Internal Electric Field Strength Basic Restrictions (3 kHz - 10 MHz)	
Condition	**Internal Electric Field Strength (V/m) (in any excitable tissue)**
Controlled Environment	2.7 × 10-4*f*
Uncontrolled Environment	**1.35 × 10-4*f* ***
Frequency, *f*, is in Hz. Instantaneous, root mean square (RMS) values apply. In the case of RF fields with amplitude modulation, then RMS values during the maximum of the modulation envelope shall apply.	

*) For 125 kHz the Limit for uncontrolled environments calculates as shown below:
Limit: 1.35 × 10^(-4) × $f_{[kHz]}$ =135* $f_{[MHz]}$= 16.875 V/m

3.1.3 RSS 102 ISSUE 6 – SAR limits / Safety Code 6

The SAR is a measure of the rate at which electromagnetic energy is absorbed in the body. Basic restrictions for SAR are intended to prevent the occurrence of thermal effects from RF energy exposure on the body. At frequencies between 100 kHz and 6 GHz, the SAR limits (Table below) take precedence over field strength and power density reference levels and shall not be exceeded.

The SAR should be determined for situations where exposures occur at a distance of 0.2 m or less from the source. In all cases, the values in Table below shall not be exceeded. For conditions where SAR determination is impractical, external unperturbed field strength or power density measurements shall be carried out against the appropriate limits outlined in Section 2.2 of Safety code 6 shall be respected.

Specific Absorption Rate Limits (100 kHz - 6 GHz)		
Condition	SAR Basic Restriction (W/kg) **[2]**	
	Uncontrolled Environment General Population	Controlled Environment Occupational
The SAR averaged over the whole body mass. (pSAR)	**0.08**	0.40
The peak spatially-averaged SAR for the head, neck and trunk, averaged over any 1 g of tissue **[1]**	**1.60**	8.00
The peak spatially-averaged SAR in the limbs, averaged over any 10 g of tissue **[1]**	**4.00**	20.00

Table 1: RF exposure limits

The limit applied in this test report are shown in bold letters

[1] Defined as a tissue volume in the shape of a cube.

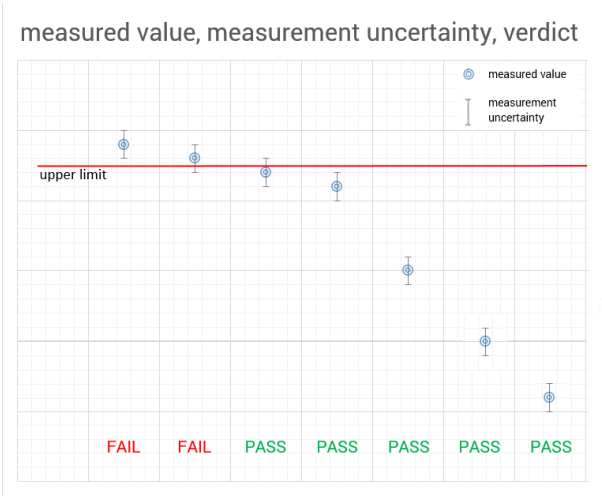
[2] Averaged over any 6 minute reference period.

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

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).

4 Reporting statements of conformity – decision rule

Only the measured values related to their corresponding limits will be used to decide whether the equipment under test meets the requirements of the test standards listed in chapter 3.
The measurement uncertainty is mentioned in this test report, see chapter 9, but is not taken into account - neither to the limits nor to the measurement results. Measurement results with a smaller margin to the corresponding limits than the measurement uncertainty have a potential risk of more than 5% that the decision might be wrong."



5 Summary of Measurement Results

☒	**No deviations from the technical specifications ascertained**
☐	Deviations from the technical specifications ascertained

Maximum SAR value (W/kg)		
	reported	**limit**
body worn 0 mm distance for 1g	**0.000**	**1.6**
extremity 0 mm distance for 10g	**0.000**	**4.0**
Maximum NS pE_{ind} value (V/m, rms)		
touch distance 0mm, instanteneous	**0.093**	**16.875**

The EUT full fills the requirements for Nerve Stimulation and SAR according RSS 102 ISSUE 06, RSS 102 - SPR-002 Issue 2 (BR). The measured values are below the limitations of Safety Code 6.

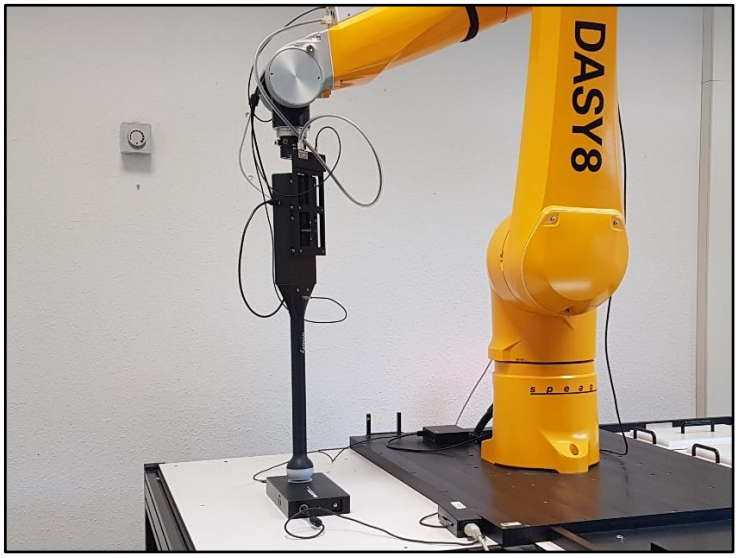
6 Test Environment

Ambient temperature:	20 – 24 °C
Relative humidity content:	40 – 50 %
Air pressure:	not relevant for this kind of testing
Power supply:	230 V / 50 Hz

7 Test Set-up

7.1 Measurement system

7.1.1 Measurement with MAGPy-H3D probe / DASY 8 WPT-System



The DASY8 WPT-System is a complete high precision robot-based evaluation platform for demonstrating compliance of wireless power transfer (WPT) devices according to IEC PAS 63184:2021(Chapter 8 "Measurement and numerical combination methods") and enables fully automated compliance testing. [1]

It is composed of the isotropic probe MAGPy-8H3D+E3D V2, the reference amplitude and phase probe (MAGPy-RAφ V2), and the data acquisition system (MAGPy-DAS V2) 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. The dedicated graphical user interface (GUI) fully automates the testing workflow.

This allows for Laboratory evaluation of WPT devices and any other local electromagnetic source not requiring magnetic (H-) field volume scans exceeding 2000 x 1000 x 1500 mm³ with a precision of ±2.0mm.

The H-field distributions can be analyzed directly, and the values are compared to the reference level, or they are converted into Maxwell field and used as excitations for determining the basic restriction quantities for further dosimetric analysis with the Magneto Quasi-Static (MQS) solver [2].

This specific solution is optimized for:

- Evaluation of E & H-field (3 kHz – 10 MHz)
- Demonstration of compliance (3 kHz and 4 MHz) according to IEC PAS 63184:2021 [3]

References:

[1] Assessment methods of the human exposure to electric and magnetic fields from wireless power transfer systems. Models, instrumentation, measurement and numerical methods and procedures (frequency range of 1 kHz to 30MHz), IEC PAS 63184:2021.

[2] The MQS conditions are violated above 4MHz and SPEAG recommends to use IEC/IEEE 62209-1528 for the frequency range above 4 MHz.

[3] Sim4Life, V7.2, ZMT Zurich MedTech AG, Zurich, Switzerland.

7.1.1.1 Workflow for Tier-4 Compliance Testing of IEC PAS 63184:2021

Compliance testing according to Tier-4 of IEC PAS 63184:2021 is the most accurate method ensuring no overestimation of the exposure. The workflow implemented in DASY8 Module WPT consists of the following steps:

1. probe alignment,
2. teaching of the DUT position,
3. 3D scan with automated grid optimization,
4. vector potential reconstruction (Sim4Life),
5. solving the MQS equation in the muscle half-space,
6. applying coverage factors (pre-determined by the IT'IS Foundation),
7. advanced evaluations in various posed Sim4Life ViP phantoms.

Additionally, the system performance is routinely verified using the standard verification sources as DUT's.

7.1.1.2 Compatibility with IEC PAS 63184:2021

DASY8 Module WPT is fully compliant with IEC PAS 63184:2021 and evaluates the reference values and basic restrictions according to:

- ICNIRP 2020
- ICNIRP 2010
- ICNIRP 1998
- IEEE 2019
- CFR 47 – Part 1, §1.1310
- FCC 2020
- FCC KDB 680106 D01
- FCC KDB 447498 D01
- HC Code 6
- ISED SPR-002 ISSUE 2

7.1.1.3 MAGPy-Probes

MAGPy-8H3D+E3D V2

The MAGPy-8H3D+E3D V2 probe consists of eight isotropic H-field subprobes and one isotropic E-field subprobe that are all integrated inside the probe head with a flat tip. Each isotropic H-field subprobe is comprised of three concentric orthogonal loop coil sensors. The isotropic E-field subprobe is composed of three orthogonal sensors (x and y sensors are dipoles, and the sensor measuring the z component is a monopole).

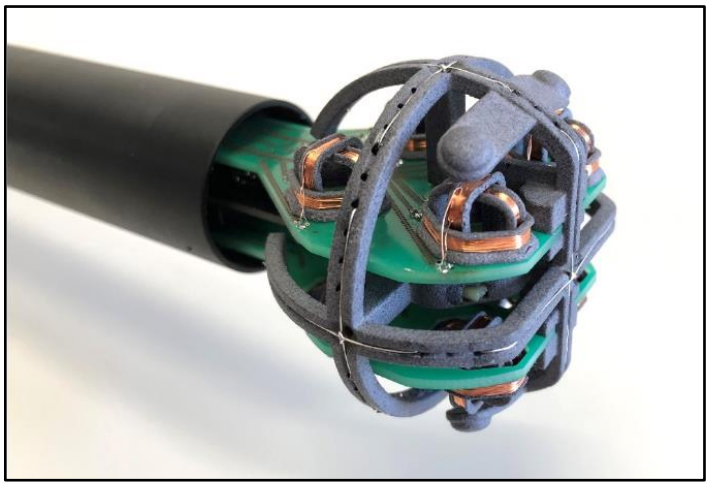
In total, the MAGPy-8H3D+E3D V2 probe contains 27 sensors that measure in the time domain. The specifications of the probe are provided in the table below.

The MAGPy-8H3D+E3D V2 probe measures the isotropic H-field and E-field, and is compatible withDASY8 Module WPT V2.2 and MAGPy V2.2.

Probe design	
Probe head diameter	60mm
H-field sub-probes	8 isotropic H-field sub-probes
	Concentric loops of 1 cm^2 arranged at the corners of a 22mm cube
E-field sub-probes	1 isotropic E-field sub-probe
	Orthogonal dipole/monopole (arm length: 53mm)
Temperature range	0–40 °C
Dimensions	110mm×635mm×35mm (MAGPy-8H3D+E3D V2 & MAGPy-DAS V2)
H-field measurement specifications	
Frequency range	3 kHz–10MHz
Dynamic range	0.1–3200A/m (0.12 µT–4 mT)
E-field measurement specifications	
Frequency range	3 kHz–10MHz
Dynamic range	0.08–2000V/m

The sensor offset, i.e., the distance from the outer surface (tip) of the probe to the center of the closest H-field sensors inside, is 7.5 mm. The distance to the virtual measuring point is 19 mm
(The center of the 8 sub-field probes)

The following picture shows The MAGPy-8H3D+E3D V2 probe with the probe-head cap removed, showing the eight isotropic H-field sub-probes and one isotropic E-field sub-probe:



MAGPy-RAφ V2

The MAGPy-RAφ V2 probe is a pick-up coil to serve as a phase and amplitude reference, composed of one loop with the specifications shown in following table.

It is connected to the MAGPy-8H3D+E3D V2 probe and should be placed near the DUT during the spatial scan to ensure a sufficient signal-to-noise ratio.

Frequency range	3 kHz - 10 MHz
Dynamic range	0.1 – 3200 A/m (0.12 µT – 4 mT)
Loop coil size	50 × 50mm^2

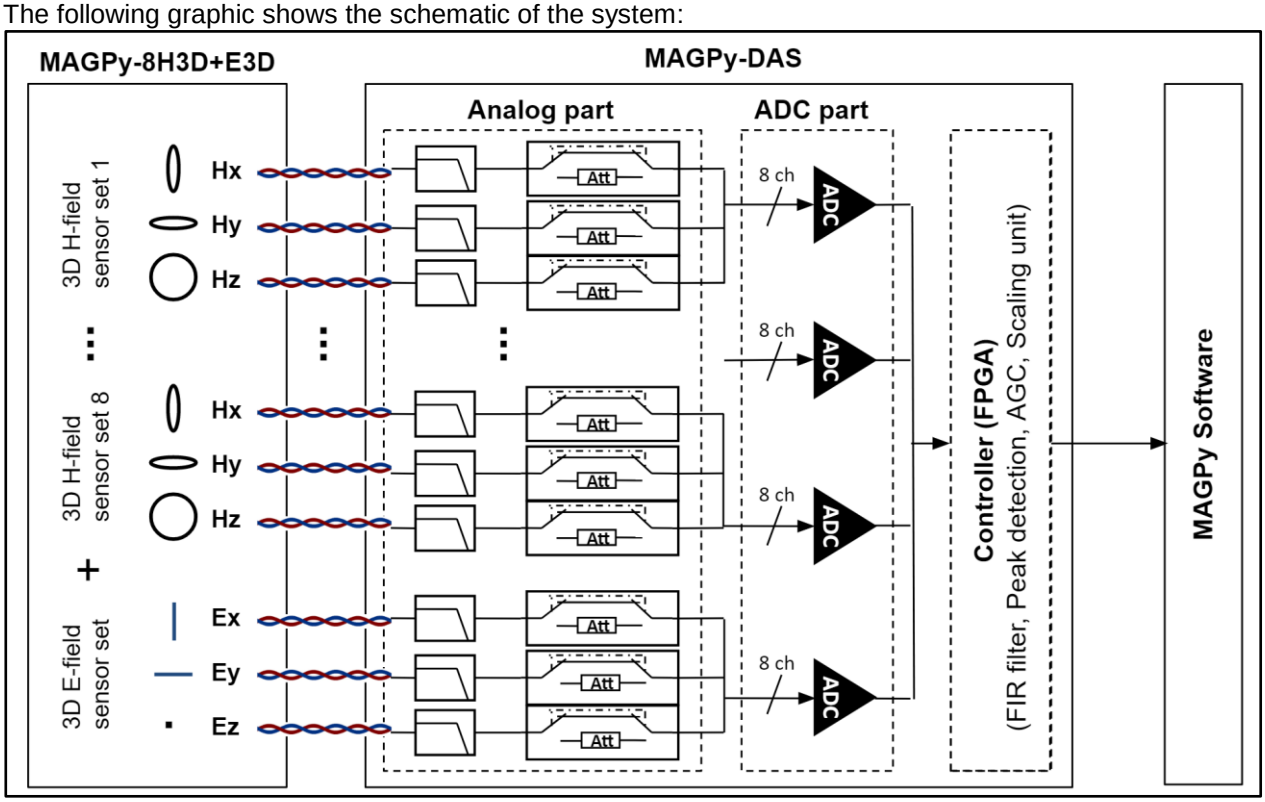
7.1.1.4 MAGPy-DAS: Data Acquisition System

Description of MAGPy-DAS V2

The MAGPy-DAS V2 is a speed-optimized unit that can process up to 27 input channels in real-time with a sampling rate of 25 MHz. The specifications of the MAGPy-DAS are:

- 27 x 14 Bit ADC Channels with 25 MSPs
- peak detection stage
- hardware supervising unit
- data transfer to backend
- 22 tap FIR filter

The following graphic shows the schematic of the system:



The measured analog signals from the MAGPy probes are firstly transferred to the analog input stage, which comprises filters, amplifiers, and attenuators. The analog signal is then transformed into a digital signal through the analog to digital converter (ADC) and treated in the field programmable gate arrays (FPGA) controller. The FPGA firmware consists of:

- FIR filter
- peak detection
- AGC (Automatic gain control unit)
- scaling unit

The controller communicates with the MAGPy software installed on the desktop or tablet PC across USB 2.0.

7.1.2 Uncertainties

The probe uncertainties stated by the manufacturer are considered to be the main relevant and dominant issues.

7.1.2.1 Typical uncertainty of Module WPT

DASY8 Uncertainty Budget for Peak H-field
according to IEC/IEEE 63184

Item	Error Description	Unc. Value (±dB)	Probab. Distr.	Div.	(c_i)	Std. Unc. (±dB)
Measurement system						
1	Amplitude calibration uncertainty	0.35	N	1	1	0.35
2	Probe anisotropy	0.6	R	$\sqrt{3}$	1	0.35
3	Probe dynamic linearity	0.2	R	$\sqrt{3}$	1	0.12
4	Probe frequency domain response	0.3	R	$\sqrt{3}$	1	0.17
5	Probe frequency linear interp. fit	0.15	R	$\sqrt{3}$	1	0.09
6	Gradient uncertainty	0.1	R	$\sqrt{3}$	1	0.06
7	Parasitic E-field sensitivity	0.1	R	$\sqrt{3}$	1	0.06
8	Detection limit	0.15	R	$\sqrt{3}$	1	0.09
9	Readout electronics	0	N	1	1	0
10	Probe positioning	0.19	N	1	1	0.19
11	Repeatability	0.1	N	1	1	0.10
12	Surface field reconstruction	0.3	N	1	1	0.3
Combined uncertainty ($k = 1$)						0.59
Expanded uncertainty ($k = 2$)						**1.33 (16.6%)**

Uncertainty budget for peak incident H-field measured with DASY8 Module WPT assessed according to IEC/IEEE 63184

DASY8 Uncertainty Budget for Incident E-field
according to IEC/IEEE 63184

Item	Error Description	Unc. Value (±dB)	Probab. Distr.	Div.	(c_i)	Std. Unc. (±dB)
Measurement system						
1	Amplitude calibration uncertainty	0.53	N	1	1	0.53
2	Probe anisotropy	0.8	R	$\sqrt{3}$	1	0.46
3	Probe dynamic linearity	1	R	$\sqrt{3}$	1	0.58
4	Probe frequency domain response	0.3	R	$\sqrt{3}$	1	0.17
5	Probe frequency linear interp. fit	0.15	R	$\sqrt{3}$	1	0.09
6	Parasitic H-field sensitivity	0.2	R	$\sqrt{3}$	1	0.12
7	Detection limit	0.15	R	$\sqrt{3}$	1	0.09
8	Readout electronics	0	N	1	1	0
9	Repeatability	0.1	N	1	1	0.10
Combined uncertainty ($k = 1$)						0.95
Expanded uncertainty ($k = 2$)						**1.89 (24.4%)**

Uncertainty budget for incident E-field measured with DASY8 Module WPT with linear gradients across the probe.

DASY8 Uncertainty Budget for Peak 2×2×2 mm³ Cube-Average E_{ind} according to IEC/IEEE 63184						
Item	Error Description	Unc. Value (±dB)	Probab. Distr.	Div.	(c_i)	Std. Unc. (±dB)
Measurement system						
1	Amplitude calibration uncertainty	0.35	N	1	1	0.35
2	Probe anisotropy	0.6	R	$\sqrt{3}$	1	0.35
3	Probe dynamic linearity	0.2	R	$\sqrt{3}$	1	0.12
4	Probe frequency domain response	0.3	R	$\sqrt{3}$	1	0.17
5	Probe frequency linear interp. fit	0.15	R	$\sqrt{3}$	1	0.09
6	Spatial averaging	0.1	R	$\sqrt{3}$	1	0.06
7	Parasitic *E*-field sensitivity	0.1	R	$\sqrt{3}$	1	0.06
8	Detection limit	0.15	R	$\sqrt{3}$	1	0.09
9	Readout electronics	0	N	1	1	0
10	Probe positioning	0.19	N	1	1	0.19
11	Repeatability	0.1	N	1	1	0.1
12	Surface field reconstruction	0.3	N	1	1	0.3
Numerical simulations						
13	Grid resolution	0.18	R	$\sqrt{3}$	1	0.10
14	Tissue parameters	0	R	$\sqrt{3}$	1	0
15	Exposure position	0	R	$\sqrt{3}$	1	0
16	Source representation	0.24	N	1	1	0.24
17	Convergence and power budget	0	R	$\sqrt{3}$	1	0
18	Boundary conditions	0.1	R	$\sqrt{3}$	1	0.06
19	Phantom loading/backscattering	0.1	R	$\sqrt{3}$	1	0.06
Combined uncertainty ($k = 1$)						0.72
Expanded uncertainty ($k = 2$)						**1.44 (18.0%)**

Uncertainty budget for peak 2x2x2mm³ cube-average induced E-field measured with DASY8 Module WPT assessed according to IEC/IEEE 63184.

DASY8 Uncertainty Budget for Peak 5 mm Line-Average E_{ind} according to IEC/IEEE 63184						
Item	Error Description	Unc. Value (±dB)	Probab. Distr.	Div.	(c_i)	Std. Unc. (±dB)
Measurement system						
1	Amplitude calibration uncertainty	0.35	N	1	1	0.35
2	Probe anisotropy	0.6	R	$\sqrt{3}$	1	0.35
3	Probe dynamic linearity	0.2	R	$\sqrt{3}$	1	0.12
4	Probe frequency domain response	0.3	R	$\sqrt{3}$	1	0.17
5	Probe frequency linear interp. fit	0.15	R	$\sqrt{3}$	1	0.09
6	Spatial averaging	0.1	R	$\sqrt{3}$	1	0.06
7	Parasitic E-field sensitivity	0.1	R	$\sqrt{3}$	1	0.06
8	Detection limit	0.15	R	$\sqrt{3}$	1	0.09
9	Readout electronics	0	N	1	1	0
10	Probe positioning	0.19	N	1	1	0.19
11	Repeatability	0.1	N	1	1	0.1
12	Surface field reconstruction	0.3	N	1	1	0.3
Numerical simulations						
13	Grid resolution	0.25	R	$\sqrt{3}$	1	0.14
14	Tissue parameters	0	R	$\sqrt{3}$	1	0
15	Exposure position	0	R	$\sqrt{3}$	1	0
16	Source representation	0.27	N	1	1	0.27
17	Convergence and power budget	0	R	$\sqrt{3}$	1	0
18	Boundary conditions	0.1	R	$\sqrt{3}$	1	0.06
19	Phantom loading/backscattering	0.1	R	$\sqrt{3}$	1	0.06
Combined uncertainty ($k = 1$)						0.74
Expanded uncertainty ($k = 2$)						**1.48 (18.5%)**

Uncertainty budget for peak 5 mm line-average induced E-field measured with DASY8 Module WPT assessed according to IEC/IEEE 63184.

DASY8 Uncertainty Budget for Peak Local E_{ind}
according to IEC/IEEE 63184

Item	Error Description	Unc. Value (±dB)	Probab. Distr.	Div.	(c_i)	Std. Unc. (±dB)
Measurement system						
1	Amplitude calibration uncertainty	0.35	N	1	1	0.35
2	Probe anisotropy	0.6	R	$\sqrt{3}$	1	0.35
3	Probe dynamic linearity	0.2	R	$\sqrt{3}$	1	0.12
4	Probe frequency domain response	0.3	R	$\sqrt{3}$	1	0.17
5	Probe frequency linear interp. fit	0.15	R	$\sqrt{3}$	1	0.09
6	Spatial averaging	0.1	R	$\sqrt{3}$	1	0.06
7	Parasitic *E*-field sensitivity	0.1	R	$\sqrt{3}$	1	0.06
8	Detection limit	0.15	R	$\sqrt{3}$	1	0.09
9	Readout electronics	0	N	1	1	0
10	Probe positioning	0.19	N	1	1	0.19
11	Repeatability	0.1	N	1	1	0.1
12	Surface field reconstruction	0.3	N	1	1	0.3
Numerical simulations						
13	Grid resolution	0.09	R	$\sqrt{3}$	1	0.05
14	Tissue parameters	0	R	$\sqrt{3}$	1	0
15	Exposure position	0	R	$\sqrt{3}$	1	0
16	Source representation	0.27	N	1	1	0.27
17	Convergence and power budget	0	R	$\sqrt{3}$	1	0
18	Boundary conditions	0.1	R	$\sqrt{3}$	1	0.06
19	Phantom loading/backscattering	0.1	R	$\sqrt{3}$	1	0.06
Combined uncertainty ($k = 1$)						0.73
Expanded uncertainty ($k = 2$)						**1.45 (18.2%)**

Uncertainty budget for peak local (i.e., not spatial averaged) induced E-field measured with DASY8 Module WPT assessed according to IEC/IEEE 63184.

DASY8 Uncertainty Budget for Peak 1 cm² Area-Average J_{ind} according to IEC/IEEE 63184

Item	Error Description	Unc. Value (±dB)	Probab. Distr.	Div.	(c_i)	Std. Unc. (±dB)
Measurement system						
1	Amplitude calibration uncertainty	0.35	N	1	1	0.35
2	Probe anisotropy	0.6	R	$\sqrt{3}$	1	0.35
3	Probe dynamic linearity	0.2	R	$\sqrt{3}$	1	0.12
4	Probe frequency domain response	0.3	R	$\sqrt{3}$	1	0.17
5	Probe frequency linear interp. fit	0.15	R	$\sqrt{3}$	1	0.09
6	Spatial averaging	0.1	R	$\sqrt{3}$	1	0.06
7	Parasitic E-field sensitivity	0.1	R	$\sqrt{3}$	1	0.06
8	Detection limit	0.15	R	$\sqrt{3}$	1	0.09
9	Readout electronics	0	N	1	1	0
10	Probe positioning	0.19	N	1	1	0.19
11	Repeatability	0.1	N	1	1	0.1
12	Surface field reconstruction	0.3	N	1	1	0.3
Numerical simulations						
13	Grid resolution	0.12	R	$\sqrt{3}$	1	0.07
14	Tissue parameters	0	R	$\sqrt{3}$	1	0
15	Exposure position	0	R	$\sqrt{3}$	1	0
16	Source representation	0.1	N	1	1	0.1
17	Convergence and power budget	0	R	$\sqrt{3}$	1	0
18	Boundary conditions	0.1	R	$\sqrt{3}$	1	0.06
19	Phantom loading/backscattering	0.1	R	$\sqrt{3}$	1	0.06
Combined uncertainty ($k = 1$)						0.68
Expanded uncertainty ($k = 2$)						**1.36 (17.0%)**

Uncertainty budget for peak 1 cm² area-average induced current density measured with DASY8 Module WPT assessed according to IEC/IEEE 63184.

DASY8 Uncertainty Budget for psSAR1 g
according to IEC/IEEE 63184

Item	Error Description	Unc. Value (±dB)	Probab. Distr.	Div.	(c_i)	Std. Unc. (±dB)
Measurement system						
1	Amplitude calibration uncertainty	0.35	N	1	1	0.35
2	Probe anisotropy	0.6	R	$\sqrt{3}$	1	0.35
3	Probe dynamic linearity	0.2	R	$\sqrt{3}$	1	0.12
4	Probe frequency domain response	0.3	R	$\sqrt{3}$	1	0.17
5	Probe frequency linear interp. fit	0.15	R	$\sqrt{3}$	1	0.09
6	Spatial averaging	0.1	R	$\sqrt{3}$	1	0.06
7	Parasitic E-field sensitivity	0.1	R	$\sqrt{3}$	1	0.06
8	Detection limit	0.15	R	$\sqrt{3}$	1	0.09
9	Readout electronics	0	N	1	1	0
10	Probe positioning	0.19	N	1	1	0.19
11	Repeatability	0.1	N	1	1	0.1
12	Surface field reconstruction	0.2	N	1	1	0.2
Numerical simulations						
13	Grid resolution	0.02	R	$\sqrt{3}$	1	0.01
14	Tissue parameters	0	R	$\sqrt{3}$	1	0
15	Exposure position	0	R	$\sqrt{3}$	1	0
16	Source representation	0.09	N	1	1	0.09
17	Convergence and power budget	0	R	$\sqrt{3}$	1	0
18	Boundary conditions	0.1	R	$\sqrt{3}$	1	0.06
19	Phantom loading/backscattering	0.1	R	$\sqrt{3}$	1	0.06
Combined uncertainty ($k = 1$)						0.63
Expanded uncertainty ($k = 2$)						**1.27 (33.9%)**

Uncertainty budget for peak 1 gram mass-average induced SAR measured with DASY8 Module WPT assessed according to IEC/IEEE 63184.

DASY8 Uncertainty Budget for psSAR10 g according to IEC/IEEE 63184						
Item	Error Description	Unc. Value (±dB)	Probab. Distr.	Div.	(c_i)	Std. Unc. (±dB)
Measurement system						
1	Amplitude calibration uncertainty	0.35	N	1	1	0.35
2	Probe anisotropy	0.6	R	$\sqrt{3}$	1	0.35
3	Probe dynamic linearity	0.2	R	$\sqrt{3}$	1	0.12
4	Probe frequency domain response	0.3	R	$\sqrt{3}$	1	0.17
5	Probe frequency linear interp. fit	0.15	R	$\sqrt{3}$	1	0.09
6	Spatial averaging	0.1	R	$\sqrt{3}$	1	0.06
7	Parasitic E-field sensitivity	0.1	R	$\sqrt{3}$	1	0.06
8	Detection limit	0.15	R	$\sqrt{3}$	1	0.09
9	Readout electronics	0	N	1	1	0
10	Probe positioning	0.19	N	1	1	0.19
11	Repeatability	0.1	N	1	1	0.1
12	Surface field reconstruction	0.2	N	1	1	0.2
Numerical simulations						
13	Grid resolution	0	R	$\sqrt{3}$	1	0
14	Tissue parameters	0	R	$\sqrt{3}$	1	0
15	Exposure position	0	R	$\sqrt{3}$	1	0
16	Source representation	0.04	N	1	1	0.04
17	Convergence and power budget	0	R	$\sqrt{3}$	1	0
18	Boundary conditions	0.1	R	$\sqrt{3}$	1	0.06
19	Phantom loading/backscattering	0.1	R	$\sqrt{3}$	1	0.06
Combined uncertainty ($k = 1$)						0.63
Expanded uncertainty ($k = 2$)						**1.25 (33.4%)**

Uncertainty budget for peak 10 gram mass-average induced SAR measured with DASY8 Module WPT assessed according to IEC/IEEE 63184.

7.1.3 Definition of test position and distances

In absence of an equipment specific regulation with given test distances, all not further noted test positions were measured in “touched” mode, the probe radome touching the DUT at the defined test position.
Due to the mechanical concept of the used probe a distance between DUT surface and electrical centre of the probe antennas remains.

Probe type	Maximum distance (cm)	
	Magnetic Field	Electrical Field
MAGPy-8H3D+E3D V2	0.85 (Sub @ lowest plane)	5.0

7.1.3.1 System Check and Validation

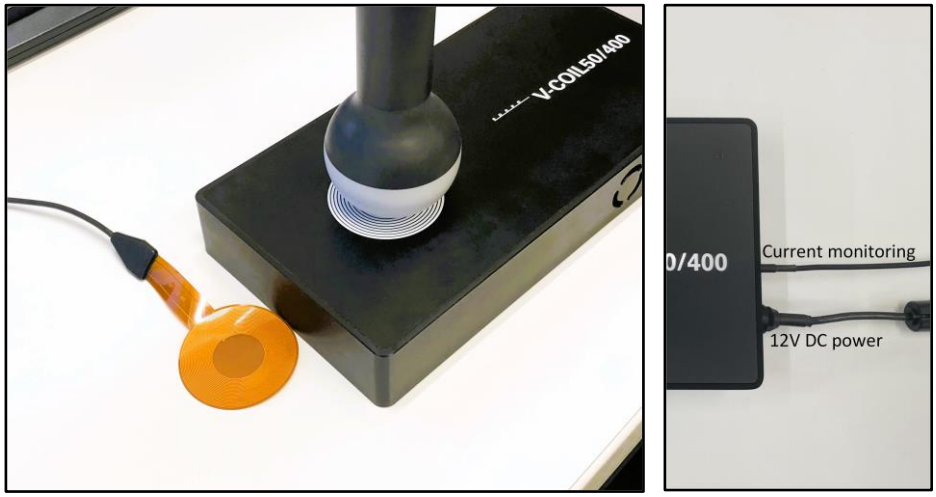
Overview

Verification and Validation (V&V) sources are designed as well-defined sources with target values to verify that the system works within its specification. A system check is typically performed prior to any compliance evaluation.

For the DASY8 Module WPT, a set of four system validation sources (3 kHz, 85 kHz, 400 kHz and 6.78 MHz) are available. These sources consist of series resonant spiral coils, fed with an integrated current source. The current source consists of an oscillator and an amplifier at the appropriate frequency.

A monitoring port in the form of a SMB connector is available on the device to monitor the current through the coil. The port offers the voltage across a 1 Ohm resistor connected in series with the coil, therefore the current I corresponds to the measured voltage $V_{testport}$ ($I = V_{testport}$). The voltage on the port can thus be monitored with an oscilloscope and this should be equal to the current through the coil.

Target values ($H_{inc;max}$, $E_{ind;max}$, $J_{ind;max}$) for each source have been determined for several distances through simulations using the MQS solver in Sim4Life. The details of the evaluation are available at Application Notes, for each source.



The picture above shows a 400 kHz system check and validation device, with the power cable and the current monitoring cable connected.

Specifications

The specifications of the sources are as follows:

Item	V-Coil500/3	V-Coil350/85	V-Coil50/400	V-Coil25/6780
Frequency (kHz)	3	85	400	6780
Coil Dimension (mm)	500 x 500	350 x 200	50 x 50	25 x 25
No. of Turns	11	13	11	10
Current Source	I500/3	I350/85	I50/400	I25/6780
Current Monitor Port	SMB	SMB	SMB	SMB
Device Dimensions (mm)	500 x 500 x 35	250 x 500 x 35	125 x 250 x 35	125 x 250 x 35

7.2 Test results

7.2.1 System Check 400kHz source

WPT 2.6 - measurement - 12/08/2024		Peak Eind (V/m, rms)		Peak Jind (A/m², rms)	psSAR (mW/kg)	
Spacing (mm)	Peak Hinc (A/m, rms)	Cube avg.	Line avg.	Surface avg.	1g avg.	10g avg.
0	288	4.57	4.69	2.88	8.18	4.04

target values		Peak Eind (V/m, rms)		Peak Jind (A/m², rms)	psSAR (mW/kg)	
Spacing (mm)	Peak Hinc (A/m, rms)	Cube avg.	Line avg.	Surface avg.	1g avg.	10g avg.
0	280	4.42	4.53	2.79	7.67	3.79

Comparison (in dB)		Peak Eind (V/m, rms)		Peak Jind (A/m², rms)	psSAR (mW/kg)	
Spacing (mm)	Peak Hinc (A/m, rms)	Cube avg.	Line avg.	Surface avg.	1g avg.	10g avg.
0	0.24	0.29	0.30	0.28	0.56	0.55

7.2.2 cDASY8 Module WPT Measurement Report (new version)

Device under test

- Model / Manufacturer: Euchner
- Serial number: 173914
- Dimensions: 50 x 50 x 50 mm
- Measurement scenario: centre of EUT at worst case side touch (top)

Hardware setup

- DASY version DASY8 Module WPT 2.6.0.5002
- Software version: 2.0.61, backend: 2.2.22
- Probe model, serial no. and configuration date:
  MAGPy-8H3D+E3Dv2, WP000009, *2023/11/02*

Scan setup

- Center location: X: -12.00 mm, Y: -3.00 mm, Z: 165.00 mm
- Dimensions: X: 124.7 mm, Y: 124.7 mm, Z: 37.0 mm
- Resolution: X: 7.33 mm, Y: 7.33 mm, Z: 7.33 mm
- Completed on: 2024/08/12 12:53:46

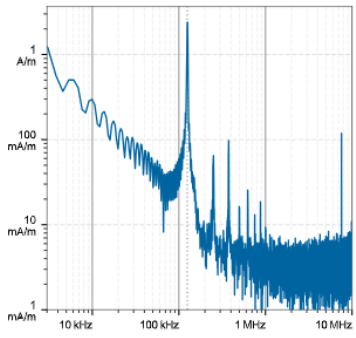
Measurement results

- Maximum H-field$_{[RMS]}$: 1.62 A/m
  X: 489.04 mA/m, Y: 330.25 mA/m, Z: 1.51 A/m
- Maximum H-Field location relative to DUT: X: 3.67 mm, Y: -3.67 mm, Z: 8.50 mm
- Maximum E-field$_{[RMS]}$: 31.09 V/m
  X: 502.10 mV/m, Y: 270.40 mV/m, Z: 31.08 V/m
- Maximum E-field location relative to DUT: X: 0.00 mm, Y: 7.33 mm, Z: 0.00 mm
- Distance to -20.0 dB boundary: 36.67 mm
- Offset relative to DUT: X: 0.00 mm, Y: 0.00 mm, Z: 1.00 mm

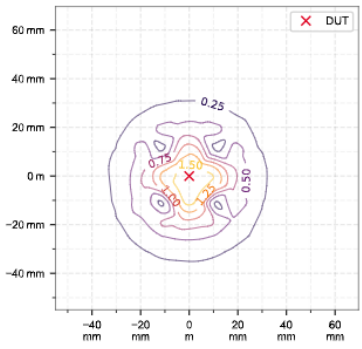
H-field magnitude at maximum, H-field magnitude at lowest plane, Post-processing setup

- Sim4Life version: 8.0.1.15446
- Sim4Life solver: Low Frequency Magneto Quasi Static
- Conductivity: 0.750 S/m
- Tissue density: 1000 kg/m³
- Frequency: 125.00 kHz
- Resolution: X: 1.00 mm, Y: 1.00 mm, Z: 1.00 mm
- Simulation date: 2024/08/12 13:38:07

H-field magnitude [RMS] at maximum location



H-field magnitude [RMS] at lowest plane



7.2.3 Incident fields and induced quantities in the anatomical model

f = 125 kHz, σ = 0.750 S/m, tissue density = 1,000 kg/m³

			Peak E_{ind} (V/m, rms)		Peak J_{ind} (A/m², rms)	psSAR (mW/kg, rms)		H-field extent
Distance (mm)	Peak H_{inc} (A/m, rms)	Peak E_{inc} (V/m, rms)	Cube avg.	Line avg.	Surface avg.	**LIMIT: 1600** 1g avg.	**Limit: 4000** 10g avg.	-20 dB radius (mm)
0.0	3.61	31.1	0.012	0.012	0.007	0.000	0.000	34.0
2.0	3.12	29.1	0.010	0.010	0.006	0.000	0.000	34.7
5.0	2.40	23.2	0.008	0.008	0.005	0.000	0.000	36.3

7.2.4 Standard compliance evaluation Safety Code 6

with multi-frequency enhancement, total field evaluation, coverage factor on, absolute

Distance (mm)	pH_{inc} (RL) (A/m, rms)	pE_{inc} (RL) (V/m, rms)	**pE_{ind} (BR) (V/m, rms)**	pSAR (BR) (mW/kg, rms)
0.0	3.61	31.1	0.093	0.000
2.0	3.12	29.1	0.081	0.000
5.0	2.40	23.2	0.064	0.000

Limitations:

Peak (RLs)

pE_{inc} 83 V/m, rms

pH_{inc} 90 A/m, rms

Peak (BRs)

pE_{ind} 16.875 V/m, rms*
**) calculated in chapter 3.2*

pSAR 0.08 W/kg, rms
80.0 mW/kg, rms

NOTE: Detailed test results are shown in the additional document: 1-8053-24-01-04_TR2-A102-R01.

7.3 Final verdict according RSS 102 – SPR 002 Issue 2

The EUT full fills the requirements for Nerve Stimulation and SAR according RSS 102 ISSUE 06, RSS 102 - SPR-002 Issue 2 (BR). The measured values are below the limitations of Safety Code 6.

8 Test equipment and ancillaries used for tests

To simplify the identification of the test equipment and/or ancillaries which were used, the reporting of the relevant test cases only refer to the test item number as specified in the table below.

Equipment	Type	Manufacturer	Serial No.	Last Calibration	Frequency (months)
E / H Field Probe	MAGPy-8H3D+E3D V2	Schmid & Partner Engineering AG	3079	Oct 24, 2023	12
MAGPy FPGA Board	WP	Schmid & Partner Engineering AG	000009	Oct 24, 2023	12
Data Acquisition System	MAGPy-DAS V2	Schmid & Partner Engineering AG	1023	Oct 24, 2023	12
Pick up coil for phase and amplitude reference	MAGPy-RAφ V2	Schmid & Partner Engineering AG	7635	Oct 24, 2023	12
400 kHz Reference source	V-Coil50/400	Schmid & Partner Engineering AG	1021	Nov 02, 2023	12
DASY8 Module WPT (2.6) software	SW – Version 2.6.0.5002	Schmid & Partner Engineering AG	---	N/A	--
Notebook Jupyter v2.6.07	SW – Version 2.0.61, backend: 2.2.22	Schmid & Partner Engineering AG	---	N/A	--
Sim4Life V Simulation Software (+Plug In)	SW – Version 8.0.1.15446	Schmid & Partner Engineering AG / ZMT Zurich MedTech AG	---	N/A	--

9 Observations

No observations exceeding those reported with the single test cases have been made.

Annex A: Photo documentation

Photo documentation is described in the additional document: **1-8053-24-01-04_TR1-A101-R01**

Annex B: Detailed test results from system WPT

Detailed test results from WPT System are in the additional document: **1-8053-24-01-04_TR1-A201-R01**

Annex C: Calibration parameters

WPT System calibration data are in the additional document: **1-8053-24-01-04_TR1-A301-R01**

Annex D: Technical brief cover sheet on human RF exposure

Technical brief cover sheet on human RF exposure (Annex A for ISED) is in the additional document:
1-8053-24-01-04_TR2-A401-R02 _RSS-102_Annex A

Annex E: Document History

Version	Applied Changes	Date of Release
-R01	Initial Release	2024-07-20
-R02	Changed PMN on page1.	2024-11-29

Annex F: Further Information

Glossary

BW	-	Bandwidth
DUT	-	Device under Test
EUT	-	Equipment under Test
HW	-	Hardware
N/A	-	not applicable
SAR	-	Specific Absorption Rate
S/N	-	Serial Number
SW	-	Software