FCC TEST REPORT

For

ActiveTrack

Model: AT11-11-11

Trade Name: Upstreem

Issued to

UPSTREEM S.A

Rue de Gosselies 13/9, Jumet, Belgium 6040

Issued by

Compliance Certification Services Inc. Wugu Lab
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Issued Date: 2019/12/04

Statements of Conformity
Determination of compliance is based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

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Revision History

Rev.		Issue Date		Revisions	Effect Page	Revised By
00		2019/12/04		Initial Issue	ALL	Edison Hu
01		2019/12/04		Change the wod notebook on page 20 to ActiveTrack	ALL	Edison Hu

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1 Certificate of Compliance (SAR Evaluation)

Applicant	UPSTREEM S.A Rue de Gosselies 13/9, Jumet, Belgium 6040
Manufacturer	MEC Taiwan Co. 4F. No.6-2, Dusing Rd., Hsinchu Science Park, Hsinchu, Taiwan.
Equipment Under Test:	ActiveTrack
Trade Name:	Upstreem
Model Name:	AT11-11-11
Date of Test:	Oct 31 ~ Nov 1 , 2019
Receive EUT Date:	July 8, 2019
Device Category:	PORTABLE DEVICES
Exposure Category:	GENERAL POPULATION/UNCONTROLLED EXPOSURE

Applicable Standards	
FCC	● IEEE 1528-2013 ● KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04 ● KDB 865664 D02 RF Exposure Reporting v01r02 ● KDB 447498 D01 General RF Exposure Guidance v06 ● KDB 941225 D01 3G SAR Procedures v03r01 ● KDB 248227 D01 802.11 Wi-Fi SAR v02r02
Limit	
1.6W/kg(1g) ; 4 W/kg (10g)	
Test Result	
Pass	

The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Approved by:

Kevin Tsai
Section Manager
Compliance Certification Services Inc.

Tested by:

Stella Chang
SAR Engineer
Compliance Certification Services Inc.

2 Description of Equipment Under Test

Product	ActiveTrack		
Trade Name	Upstreem		
Model Name	AT11-11-11		
Wireless Technology	Operating Mode	TX Freq Range (MHz)	Antenna Gain(dBi)
	GSM 850	824.2 ~ 848.8	-3.15
	GSM 1900	1850.2 ~ 1909.8	0.31
Modulation Technique	Operating Mode	TX Freq Range (MHz)	Antenna Gain(dBi)
	Bluetooth:GFSK for BLE-1Mbps	2402 ~ 2480	2
WWAN Antenna Specification	Brand name	taoglas	
	Parts Number	Main: FXP40.07.0085A	
	Type	PCB	
WLAN Antenna Specification	Brand name	Laird	
	Parts Number	Main: EQAE0004	
	Type	PCB	
Simulatious Transmission Configurations	GPRS + Bluetooth		
Rechargeable Li-polymer Battery–alternate	Band: Axiss Model: 513434 Rating: 3.7V/650mAh		

Remark:

1. The sample selected for test was prototype that representative to production product and was provided by manufacturer.
2. Voice call is not supported.

2.1 Summary of Highest SAR Values

Results for highest reported SAR values for each frequency band and mode are as below:

Technology/Band	Test configuration	Mode	Highest Reported 1g-SAR (W/kg)
GSM850	Front	GPRS (2 Tx slots)	0.146
GSM1900	Front	GPRS (2 Tx slots)	0.408
Technology/Band	Test configuration	Mode	Highest Reported 10g-SAR (W/kg)
GSM850	Edge 3	GPRS (2 Tx slots)	0.668
GSM1900	Edge 4	GPRS (2 Tx slots)	0.510

3 Requirements for Compliance Testing Defined

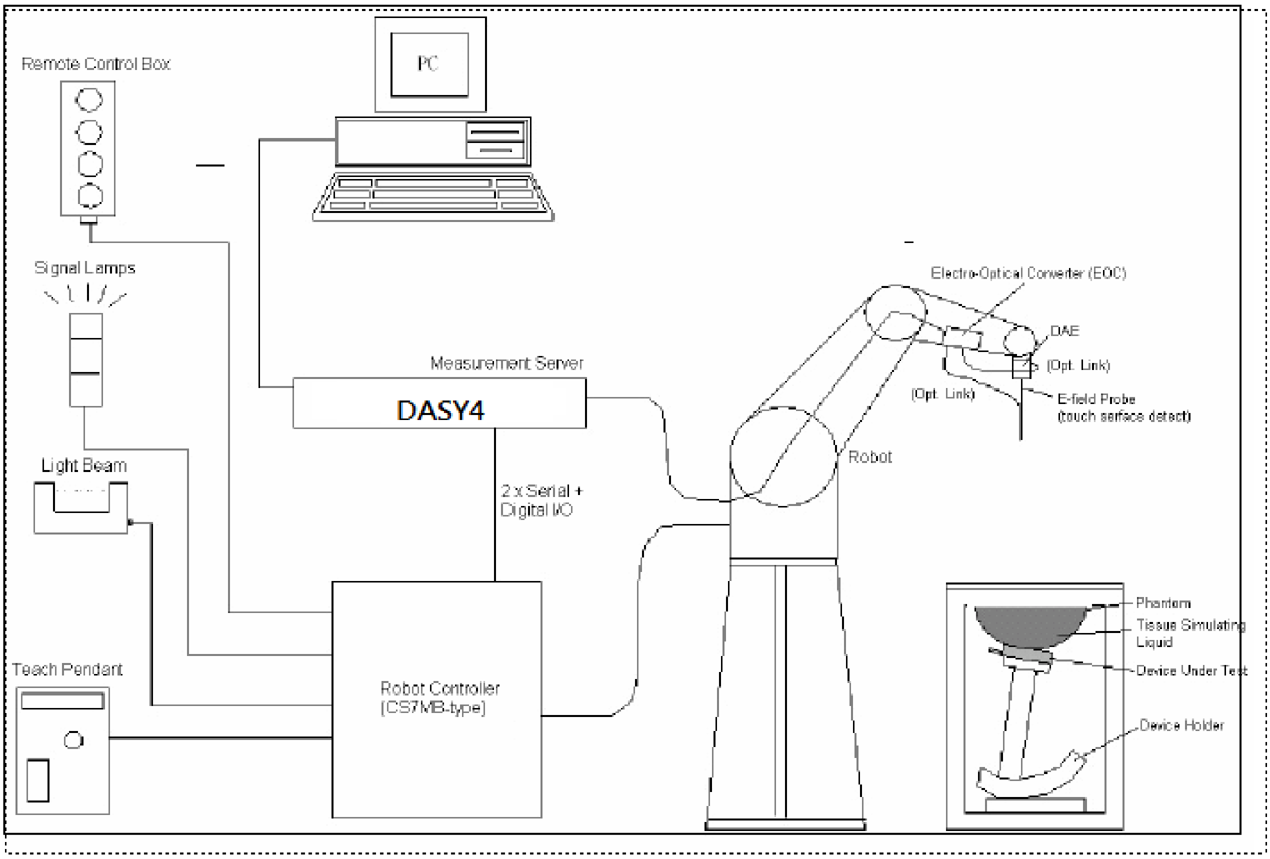
3.1 Requirements for Compliance Testing Defined by the FCC

The US Federal Communications Commission has released the report and order “Guidelines for Evaluating the Environmental Effects of RF Radiation", ET Docket No. 93-62 in August 1996 [1]. The order requires routine SAR evaluation prior to equipment authorization of portable transmitter devices, including portable telephones. For consumer products, the applicable limit is 1.6 W/kg for an uncontrolled environment and 8.0 mW/g for an occupational/controlled environment as recommended by the FCC 47 CFR §2.1093 and IEEE Std 1528-2013.

4 Dosimetric Assessment System

These measurements were performed with the automated near-field scanning system DASY4/DASY5 from Schmid & Partner Engineering AG (SPEAG). The system is based on a high precision robot (working range greater than 0.9 m) which positions the probes with a positional repeatability of better than ± 0.02 mm. Special E- and H-field probes have been developed for measurements close to material discontinuity, the sensors of which are directly loaded with a Schottky diode and connected via highly resistive lines to the data acquisition unit. The SAR measurements were conducted with the dosimetric probe EX3DV4-SN: 7466 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probe has been calibrated according to the procedure with accuracy of better than ±10%. The spherical isotropy was evaluated with the procedure and found to be better than ±0.25 dB. The phantom used was the SAM Twin Phantom as described in FCC supplement C, IEEE 1528 2013.

4.1 Measurement System Diagram



The DASY4/5 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (St¨aubli RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
- A 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 between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected 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.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows 7 or Windows XP.
- DASY4 software version: 4.7, Build 80.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Validation dipole kits allowing validating the proper functioning of the system.

4.2 System Components

DASY4/DASY5 Measurement Server	
	The DASY4/DASY5 measurement server is based on a PC/104 CPU board with a 166MHz low-power Pentium, 32MB chip disk and 64MB RAM. The necessary circuits for communication with either the DAE3 electronic box as well as the 16-bit AD-converter system for optical detection and digital I/O interface are contained on the DASY4/DASY5 I/O-board, which is directly connected to the PC/104 bus of the CPU board. The measurement server performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation.
	The PC-operating system cannot interfere with these time critical processes. All connections are supervised by a watchdog, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements. Furthermore, the measurement server is equipped with two expansion slots which are reserved for future applications. Please note that the expansion slots do not have a standardized pinout and therefore only the expansion cards provided by SPEAG can be inserted. Expansion cards from any other supplier could seriously damage the measurement server. Calibration: No calibration required.

Data Acquisition Electronics (DAE)	
	The data acquisition electronics (DAE4) consists of a highly sensitive electrometer grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock. The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of the DAE4 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

EX3DV4 Isotropic E-Field Probe for Dosimetric Measurements

Construction:	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration:	Basic Broad Band Calibration in air: 10-3000 MHz. Conversion Factors (CF) for HSL 900 and HSL 1800 CF-Calibration for other liquids and frequencies upon request.
Frequency:	10 MHz to > 6 GHz; Linearity: ± 0.2 dB (30 MHz to 3 GHz)
Directivity:	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in HSL (rotation normal to probe axis)
Dynamic Range:	10 µW/g to > 100 mW/g; Linearity: ± 0.2 dB (noise: typically < 1 µW/g)
Dimensions:	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Distance from probe tip to dipole centers: 1 mm
Application:	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.

SAM Phantom (V4.0)

Construction:	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 2013, CENELEC 50361 and IEC 62209. 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 manually teaching three points with the robot.
Shell Thickness:	2 ±0.2 mm
Filling Volume:	Approx. 25 liters
Dimensions:	Height: 810mm; Length: 1000mm; Width: 500mm

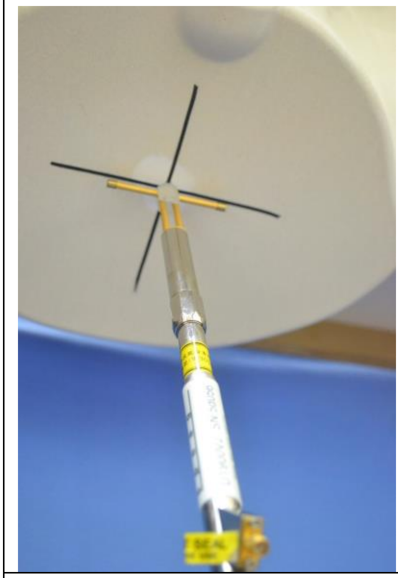
SAM Phantom (ELI4)

Construction:	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209 Part II and all known tissue simulating liquids. ELI4 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 supported by software version DASY4/DASY5 and higher and is compatible with all SPEAG dosimetric probes and dipoles
Shell Thickness:	2.0 ± 0.2 mm (sagging: <1%)
Filling Volume:	Approx. 25 liters
Dimensions:	Major ellipse axis: 600 mm
Minor axis:	400 mm 500mm

Device Holder for SAM Twin Phantom

Construction: In combination with the Twin SAM Phantom V4.0 or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, and flat phantom).

System Validation Kits for SAM Phantom (V4.0)



Construction: Symmetrical dipole with l/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

Frequency: 2450, 5300, 5600, 5800 MHz

Return loss: > 20 dB at specified validation position

Power capability: > 100 W (f < 1GHz); > 40 W (f > 1GHz)

Dimensions: D2450V2: dipole length: 51.5 mm; overall height: 290 mm
D5GHzV2: dipole length: 20.6 mm; overall height: 300 mm

System Validation Kits for ELI4 phantom

Construction: Symmetrical dipole with l/4 balun Enables measurement of feedpoint impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

Frequency: 2450, 5300, 5600, 5800 MHz

Return loss: > 20 dB at specified validation position

Power capability: > 100 W (f < 1GHz); > 40 W (f > 1GHz)

Dimensions: D2450V2: dipole length: 51.5 mm; overall height: 290 mm
D5GHzV2: dipole length: 20.6 mm; overall height: 300 mm

5 Evaluation Procedures

Data Evaluation

The DASY4/DASY5 post processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion factor	$ConvF_i$
	- Diode compression point	dcp_i
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

with	V_i	= Compensated signal of channel i	(i = x, y, z)
	U_i	= Input signal of channel i	(i = x, y, z)
	cf	= Crest factor of exciting field	(DASY parameter)
	dcp_i	= Diode compression point	(DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes:

$$E_i = \sqrt{\frac{V_i}{Norm_i \bullet ConvF}}$$

H-field probes:

$$H_i = \sqrt{Vi} \cdot \frac{a_{i10} + a_{i11} f + a_{i12} f^2}{f}$$

with	V_i	= Compensated signal of channel i	(i = x, y, z)
	$Norm_i$	= Sensor sensitivity of channel i	(i = x, y, z)

$\mu V/(V/m)^2$ for E0field Probes

$ConvF$	= Sensitivity enhancement in solution
aij	= Sensor sensitivity factors for H-field probes
f	= Carrier frequency (GHz)
Ei	= Electric field strength of channel i in V/m
Hi	= Magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with *SAR* = local specific absorption rate in W/kg
E_{tot} = total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm^3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

The power flow density is calculated assuming the excitation field as a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{377} \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

with P_{pwe} = Equivalent power density of a plane wave in mW/cm^2
E_{tot} = total electric field strength in V/m
H_{tot} = total magnetic field strength in A/m

6 SAR Measurement Procedures

6.1 Normal SAR Test Procedure

- **Power Reference Measurement**

The reference and drift jobs are useful jobs for monitoring the power drift of the device under test in the batch process. Both jobs measure the field at a specified reference position, at a selectable distance from the phantom surface. The reference position can be either the selected section's grid reference point or a user point in this section. The reference job projects the selected point onto the phantom surface, orients the probe perpendicularly to the surface, and approaches the surface using the selected detection method.

- **Area Scan**

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a finer measurement around the hot spot. The sophisticated interpolation routines implemented in DASY4/DASY5 software can find the maximum locations even in relatively coarse grids. The scan area is defined by an editable grid. This grid is anchored at the grid reference point of the selected section in the phantom. When the area scan's property sheet is brought-up, the grid resolution has to less than 15 mm by 15 mm at frequency ≤2GHz; the grid resolution has to less than 12mm by 12 mm at frequency between 2GHz to 4GHz; grid resolution has to less than 10 mm by 10 mm at frequency between 4GHz to 6GHz.

According to KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe abgle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

- **Zoom Scan**

Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default zoom scan measures points in accordance with the frequency can be divided into three parts. (1)The zoom scan volume was set to 5x5x7 points at frequency ≤ 2GHz. (2) The zoom scan volume was set to 7x7x7 points at frequency between 2GHz to 4GHz (3) The zoom scan volume was set to 7x7x12 points at frequency between 4GHz to 6GHz. The measures points within a cube whose base faces are centered around the maximum found in a preceding area scan job within the same procedure. If the preceding Area Scan job indicates more then one maximum, the number of Zoom Scans has to be enlarged accordingly.

According to KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04

<table>
<tr><th colspan="3"></th><th>≤ 3 GHz</th><th>> 3 GHz</th></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm</td><td>3 – 4 GHz: ≤ 5 mm
4 – 6 GHz: ≤ 4 mm</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">Uniform grid: $\Delta z_{Zoom}(n)$</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$:between 1st two points losest to phantom surface</td><td>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm
4 – 5 GHz: ≤ 2.5 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">≤ 1.5·$\Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Maximum zoom scan volume</td><td>x, y, z</td><td>≥ 30 mm</td><td colspan="2">3 – 4 GHz: ≥ 28 mm
4 – 5 GHz: ≥ 25 mm
5 – 6 GHz: ≥ 22 mm</td></tr>
</table>

- **Power Drift Measurement**

The drift job measures the field at the same location as the most recent reference job within the same procedure, and with the same settings. The drift measurement gives the field difference in dB from the reading conducted within the last reference measurement. Several drift measurements are possible for one reference measurement. This allows a user to monitor the power drift of the device under test within a batch process. In the properties of the Drift job, the user can specify a limit for the drift and have DASY4/DASY5 software stop the measurements if this limit is exceeded.

- **Z-Scan**

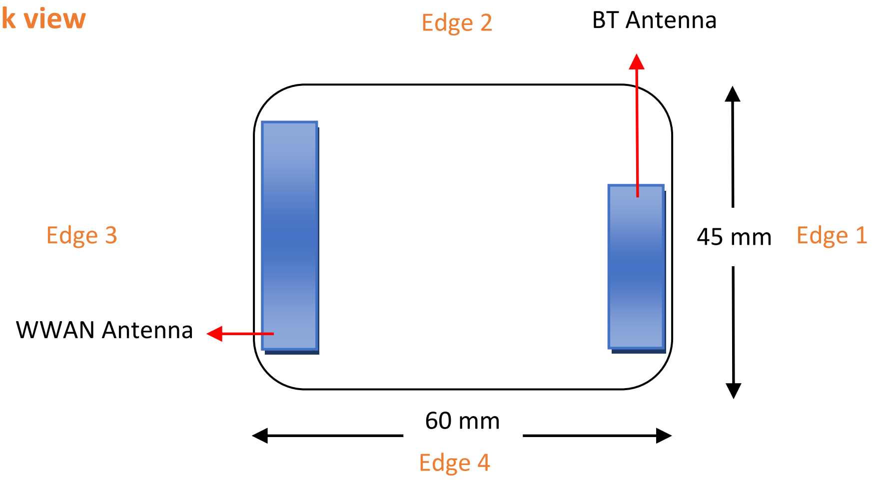
The Z Scan job measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. A user can anchor the grid to the current probe location. As with any other grids, the local Z-axis of the anchor location establishes the Z-axis of the grid.

7 Measurement Uncertainty

According to KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz section 2.8.2, SAR measurement uncertainty analysis is required in SAR reports only when the highest measured SAR in a frequency band is ≥ 1.5 W/kg for 1-g SAR, the equivalent ratio (1.5/1.6) should be applied to extremity and occupational exposure conditions,the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval.

8 Antenna Location

Back view



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9 Summary of SAR Test Exclusion Configurations

9.1 Standalone SAR Test Exclusion Calculations

Since the device is a ActiveTrack whose antenna is already determined to not meet the minimum antenna to user separation distance for modular SAR, therefore testing is required by default.

9.1.1 SAR Exclusion Calculations for Wi-Fi Antenna < 50mm from the User

According to KDB 447498 v06 in section 4.3.1, if the calculated **threshold value is > 3** then SAR testing is required.

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)					Calculated Threshold Value				
			dBm	mW	Back	Edge 1	Edge 2	Edge 3	Edge 4	Back	Edge 1	Edge 2	Edge 3	Edge 4
WWAN	GSM850	848.8	32.0	1585	11.33	51	7.48	5	7.48	128.88	>50mm	195.22	292.05	195.22
WWAN	GSM1900	1909.8	30.0	1000	11.33	51	7.48	5	7.48	121.97	>50mm	184.75	276.39	184.75
Wi-Fi	BLE	2480	-1.0	0.79	11.33	5	7.48	50.59	7.48	0.11	0.25	0.17	>50mm	0.17

9.1.2 SAR Exclusion Calculations for Wi-Fi Antenna > 50mm from the User

According to KDB 447498 v06, if the calculated Power threshold is less than the output power then SAR testing is required.

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)					Calculated Threshold Value				
			dBm	mW	Back	Edge 1	Edge 2	Edge 3	Edge 4	Back	Edge 1	Edge 2	Edge 3	Edge 4
WWAN	GSM850	848.8	32.0	1585	11.33	51	7.48	5	7.48	<50mm	172.81	<50mm	<50mm	<50mm
WWAN	GSM1900	1909.8	30.0	1000	11.33	51	7.48	5	7.48	<50mm	118.54	<50mm	<50mm	<50mm
Wi-Fi	BLE	2480	-1.0	0.79	11.33	5	7.48	50.59	7.48	<50mm	<50mm	<50mm	101.15	<50mm

9.1.3 SAR Required Test Configuration
For WWAN and Bluetooth

Test Configurations	Back	Edge1	Edge2	Edge3	Edge4
GSM850	Yes	Yes	Yes	Yes	Yes
GSM1900	Yes	Yes	Yes	Yes	Yes
Bluetooth	No	No	No	No	No

Note(s):

1. Yes = SAR is required.
2. No = SAR is not required.

10 Exposure Limit

(A). Limits for Occupational/Controlled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	2.0

(B). Limits for General Population/Uncontrolled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

NOTE: **Whole-Body SAR** is averaged over the entire body, **partial-body SAR** is averaged over any 1 gram of tissue defined as a tissue volume in the shape of a cube. **SAR for hands, wrists, feet and ankles** is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

Population/Uncontrolled Environments:

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

Occupational/Controlled Environments:

are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

NOTE
GENERAL POPULATION/UNCONTROLLED EXPOSURE
PARTIAL BODY LIMIT
1.6 W/kg

11 Tissue Dielectric Properties

11.1 Test Liquid Confirmation

Simulating Liquids Parameter Check

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectric parameters are within the tolerances of the specified target values

The relative permittivity and conductivity of the tissue material should be within ± 5% of the values given in the table below 5% may not be easily achieved at certain frequencies.

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in IEEE 1528 2013 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in IEEE 1528 2013 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations and extrapolated according to the head parameters specified in IEEE 1528 2013

Target Frequency (MHz)	Head		Body	
	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5000	36.2	4.45	49.3	5.07
5100	36.1	4.55	49.1	5.18
5200	36.0	4.66	49.0	5.30
5300	35.9	4.76	48.9	5.42
5400	35.8	4.86	48.7	5.53
5500	35.6	4.96	48.6	5.65
5600	35.5	5.07	48.5	5.77
5700	35.4	5.17	48.3	5.88
5800	35.3	5.27	48.2	6.00

11.2 Typical Composition of Ingredients for Liquid Tissue Phantoms

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

alt: 99^{+}% Pure Sodium Chloride
Sugar: 98^{+}% Pure Sucrose
Water: De-ionized, 16 $M\Omega^{+}$ resistivity
HEC: Hydroxy thyl Cellulose
DGBE: 99^{+}% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]
Triton X-100 (ultra-pure): Polyethylene glycol mono [4-(1, 1, 3, 3-tetramethylbutyl)phenyl]ether

Simulating Liquids for 5 GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	78
Mineral oil	11
Emulsifiers	9
Additives and Salt	2

11.3 Simulating Liquids Parameter Check Results

Tissue Type	Measurement Date	Measured Frequency (MHz)	Target Dielectric Constant, εr	Target Conductivity, σ (S/m)	Measured Dielectric Constant, εr	Measured Conductivity, σ (S/m)	% dev εr	% dev σ
Head	2019/10/31	824.20	41.556	0.899	42.812	0.875	3.02%	-2.69%
		835.00	41.500	0.900	42.671	0.884	2.82%	-1.78%
	2019/11/1	1880.00	40.000	1.400	38.910	1.451	-2.73%	3.64%
		1900.00	40.000	1.400	38.853	1.463	-2.87%	4.50%

12 System Performance Check

The system performance check is performed prior to any usage of the system in order to guarantee reproducible results. The system performance check verifies that the system operates within its specifications. The system performance check results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

System Performance Check Measurement Conditions

- The measurements were performed in the flat section of the SAM twin phantom filled with Head simulating liquid of the following parameters.
- The DASY4/DASY5 system with an E-field probe EX3DV4 SN: 7466 was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 15 mm (below 1 GHz) and 10 mm (above 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 10mm was aligned with the dipole.
- Special 7x7x7 fine cube was chosen for cube integration (dx=dy= 5 mm, dz= 5 mm).
- Distance between probe sensors and phantom surface was set to 3.0 mm.
- The dipole input power (forward power) was 250 mW±3%.
- The results are normalized to 1 W input power.

Reference SAR Values for System Performance Check

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

System Dipole	Serial No.	Cal. Date	Freq. (MHz)	Target SAR Values (W/kg)		
				1g/10g	Head	Body
D835V2	4d063	2019/08/23	835	1g	2.42	N/A
				10g	1.57	N/A
D1900V2	5d173	2019/08/23	1900	1g	9.92	N/A
				10g	5.22	N/A

12.1 System Performance Check Results

Date	System Dipole			Parameters	Target	Measured	Deviation[%]	Limited[%]
	Type	Serial No.	Liquid					
2019/10/31	D835V2	4d063	Head	1g SAR:	2.42	2.47	2.07	± 10
				10g SAR:	1.57	1.62	3.18	± 10
2019/11/01	D1900V2	5d173	Head	1g SAR:	9.92	9.96	0.40	± 10
				10g SAR:	5.22	5.28	1.15	± 10

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13 RF Output Power Measurement

GSM Output Power

1) According to KDB941225 D01 Section 5.3 , SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested.

2) According to KDB 447498 D01 Section 4.1 , 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

13.1 GSM(850 & 1900 Band)

Band	Slot	Channel No.	Frequency (MHz)	Average power(dBm)	Tune up power(dBm)	Frame Avg Pwr	SAR Test (Yes/No)	Note
GPRS 850	1	128	824.2	31.9	32.0	22.9	No	
		189	836.4	31.8	32.0	22.8		
		251	848.8	31.3	32.0	22.3		
GPRS 850	2	128	824.2	31.8	32.0	25.8	Yes	1
		189	836.4	31.6	32.0	25.6		
		251	848.8	31.3	32.0	25.2		
GPRS 1900	1	512	1850.2	29.5	30.0	20.5	No	
		661	1880	29.7	30.0	20.7		
		810	1909.8	29.4	30.0	20.4		
GPRS 1900	2	512	1850.2	29.4	30.0	23.4	Yes	1
		661	1880	29.6	30.0	23.6		
		810	1909.8	29.2	30.0	23.2		

Note(s):

1) Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:
a) ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
b) ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
c) ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

13.2 Bluetooth

Band	Channel No.	Frequency (MHz)	Average power(dBm)	Tune up power(dBm)	SAR Test (Yes/No)	Note
BLE	Low	2402	-1.42	-1	No	1
	Middle	2441	-1.29	-1		
	High	2480	-3.27	-3		

Note(s):

1. Per exclusion calculations in Section 9, SAR testing for Bluetooth is not required.

14 SAR Measurements Results

GSM:

Test Mode	Band	Mode	Dist. (mm)	Test Position	Ch#	Freq. (MHz)	Power (dBm)		Area Scan 1g SAR (W/kg)	Zoom Scan 1g SAR (W/kg)	Reported SAR 1g (W/kg)	Area Scan 10g SAR (W/kg)	Zoom Scan 10g SAR (W/kg)	Reported 10g SAR (W/kg)	Note	Plot No.
							Tune up limit	Meas.								
FCC	GSM850	GPRS (2 Tx slots)	10	Front	128	824.2	32.00	31.80	0.150	0.139	0.146	0.100	0.094	0.098		1
			0	Back	128	824.2	32.00	31.80	0.217	0.197	0.206	0.143	0.135	0.141		
			0	Edge 1	128	824.2	32.00	31.80	0.077	0.103	0.108	0.044	0.042	0.044		
			0	Edge 2	128	824.2	32.00	31.80	0.159	0.147	0.154	0.100	0.090	0.095		
			0	Edge 3	128	824.2	32.00	31.80	1.350	1.810	1.895	0.650	0.638	0.668		2
			0	Edge 4	128	824.2	32.00	31.80	0.272	0.283	0.296	0.170	0.157	0.164		
FCC	GSM1900	GPRS (2 Tx slots)	10	Front	661	1880	30.00	29.60	0.367	0.372	0.408	0.216	0.235	0.258		3
			0	Back	661	1880	30.00	29.60	0.525	0.511	0.560	0.282	0.313	0.343		
			0	Edge 1	661	1880	30.00	29.60	0.038	0.040	0.044	0.022	0.026	0.029		
			0	Edge 2	661	1880	30.00	29.60	0.396	0.375	0.411	0.212	0.213	0.234		
			0	Edge 3	661	1880	30.00	29.60	0.507	0.321	0.352	0.234	0.158	0.173		
			0	Edge 4	661	1880	30.00	29.60	0.938	0.987	1.082	0.422	0.465	0.510		4

Note(s):

According to 447498 D01 Section 6.2 , The neck region of the SAM Phantom was chosen for wrist worn (Back) extremity SAR test.

For front (screen side) We test at 10 mm away from the flat phantom.

15 Simultaneous Transmission SAR Analysis

KDB 447498 D01 General RF Exposure Guidance v06, introduces a new formula for calculating the SAR to Peak Location Ratio (SPLSR) between pairs of simultaneously transmitting antennas:

$SPLSR = (SAR_1 + SAR_2)^{1.5} / R_i$

Where:

SAR_1 is the highest Reported or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition

SAR_2 is the highest Reported or estimated SAR for the second of a pair of simultaneous transmitting antennas, in the same test operating mode and exposure condition as the first

R_i is the separation distance between the pair of simultaneous transmitting antennas. When the SAR is measured, for both antennas in the pair, it is determined by the actual x, y and z coordinates in the 1-g SAR for each SAR peak location, based on the extrapolated and interpolated result in the zoom scan measurement, using the formula of $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$

A new threshold of 0.04 is also introduced in the KDB. Thus, in order for a pair of simultaneous transmitting antennas with the sum of 1-g SAR > 1.6 W/kg to qualify for exemption from Simultaneous Transmission SAR measurements, it has to satisfy the condition of:

$(SAR_1 + SAR_2)^{1.5} / R_i \leq 0.04$

15.1 Estimated SAR for Simultaneous Transmission SAR Analysis

Considerations for SAR estimation

1. When standalone SAR test exclusion applies, standalone SAR must also be estimated to determine simultaneous transmission SAR test exclusion.
2. Dedicated Host Approach criteria for SAR test exclusion is likewise applied to SAR estimation, with certain distinctions between test exclusion and SAR estimation:
   - When the separation distance from the antenna to an adjacent edge is ≤ 5 mm, a distance of 5 mm is applied for SAR estimation; this is the same between test exclusion and SAR estimation calculations.
   - When the separation distance from the antenna to an adjacent edge is > 5 mm but ≤ 50 mm, the actual antenna-to-edge separation distance is applied for SAR estimation.
   - When the minimum test separation distance is > 50 mm, the estimated SAR value is 0.4 W/kg

15.1.1 Estimated SAR for Bluetooth

According to section 9, the Bluetooth must be estimated according to following to determine simultaneous transmission SAR test exclusion:

- *(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[*$\sqrt{f_{(GHz)}}$*/x]* W/kg for test separation distances ≤ 50 mm; where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.
- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm.

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)	Estimated 1-g SAR (W/Kg)
			dBm	mW		
Bluetooth	2.4GHz	2441	-1.0	0.79	5.0	0.033

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)	Estimated 10-g SAR (W/Kg)
			dBm	mW		
Bluetooth	2.4GHz	2441	-1.0	0.79	5.0	0.013

15.2 Simultaneous Transmission Analysis

15.2.1 Sum of the SAR for WWAN + BT

Per KDB 447498 D01 section 4.3.2, the simultaneous transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SAR to peak location separation ratio to qualify for test exclusion.

GSM850 + BT

Test Position	Simulataneous Transmission Scenario		1+2 Summed 1g SAR(W/kg)	SPLSR (Yes/No)
	1	2		
	GSM850	Bluetooth		
Front	0.146	0.033	0.179	NO
Test Position	Simulataneous Transmission Scenario		1+2 Summed 10g SAR(W/kg)	SPLSR (Yes/No)
	1	2		
	GSM850	Bluetooth		
Back	0.141	0.013	0.154	NO
Edge 1	0.044	0.013	0.057	NO
Edge 2	0.095	0.013	0.108	NO
Edge 3	0.668	0.013	0.681	NO
Edge 4	0.164	0.013	0.177	NO

Note(s):
As the Sum of the 1g SAR is less than 1.6W/Kg, so SPLSR is not required.
As the Sum of the 10g SAR is less than 4.0W/Kg, so SPLSR is not required.

GSM1900 + BT

Test Position	Simulataneous Transmission Scenario		1+2 Summed 1g SAR(W/kg)	SPLSR (Yes/No)
	1	2		
	GSM1900	Bluetooth		
Front	0.408	0.033	0.441	NO
Test Position	Simulataneous Transmission Scenario		1+2 Summed 10g SAR(W/kg)	SPLSR (Yes/No)
	1	2		
	GSM1900	Bluetooth		
Back	0.343	0.013	0.356	NO
Edge 1	0.029	0.013	0.042	NO
Edge 2	0.234	0.013	0.247	NO
Edge 3	0.173	0.013	0.186	NO
Edge 4	0.510	0.013	0.523	NO

Note(s):
As the Sum of the 1g SAR is less than 1.6W/Kg, so SPLSR is not required.
As the Sum of the 10g SAR is less than 4.0W/Kg, so SPLSR is not required.

16 Equipment List & Calibration Status

Name of Equipment	Manufacturer	Type/Model	Serial Number	Calibration Cycle(year)	Calibration Due
Radio Communication Analyzer	Anritsu	MT8820C	6201061049	1	2019/12/26
S-Parameter Network Analyzer	Agilent	E5071C	MY46107530	1	2020/2/22
Dielectric parameter probes	SPEAG	DAKS-3.5	1053	1	2020/1/28
Power Meter	Agilent	E4417A	MY51410006	1	2020/02/18
Power Sensor	Agilent	E9301H	MY51470001	1	2020/02/18
Data Acquisition Electronics (DAE)	SPEAG	DAE4	856	1	2020/04/23
Dosimetric E-Field Probe	SPEAG	EX3DV4	7466	1	2020/02/03
835 MHz System Validation Dipole	SPEAG	D835V2	4d063	1	2020/08/22
1900 MHz System Validation Dipole	SPEAG	D1900V2	5d173	1	2020/04/22
Robot	Staubli	RX90L	F02/5T69A1/A/01	N/A	N/A
Amplifier	Mini-Circuit	ZVE-8G	665500309	N/A	N/A
Amplifier	Mini-Circuit	ZHL-1724HLN	D072602#2	N/A	N/A
Thermometer	Changzhou Xinwang	PT1	EC14011603	1	2020/7/30

17 Facilities

All measurement facilities used to collect the measurement data are located at

☐ No. 81-1, Lane 210, Bade Rd. 2, Luchu Hsiang, Taoyuan Hsien, Taiwan, R.O.C.

☒ No.11, Wugong 6th Rd., Wugu Dist., New Taipei City 24891, Taiwan. (R.O.C.)

☐ No. 199, Chunghsen Road, Hsintien City, Taipei Hsien, Taiwan, R.O.C.

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19 Attachments

Exhibit	Content
1	System Performance Check Plots
2	SAR Test Data Plots
3	SAR Equipment calibration report
4	T190219D06-SF PHOTOs

END OF REPORT