# A Test Lab Techno Corp.

Changan Lab : No. 140-1, Changan Street, Bade District, Taoyuan City 33465, Taiwan (R.O.C.)

Tel : 886-3-271-0188 / Fax : 886-3-271-0190

## SAR EVALUATION REPORT

| | | |
|---|---|---|
| Test Report No. | : | 1702FS11 |
| Applicant | : | Yepzon Oy |
| Applicant Address | : | Finlaysoninkuja 9, 33210 Tampere Finland |
| Product Type | : | GPS Tracker |
| Trade Name | : | YEPZON |
| Model Number | : | Yepzon Freedom |
| Date of Received | : | Nov. 21, 2016 |
| Test Period | : | Dec. 01, 2016 ~ Jan. 25, 2017 |
| Date of Issued | : | Feb. 09, 2017 |
| Test Environment | : | Ambient Temperature : 22 ±2 °C |
| | | Relative Humidity : 40 - 70 % |
| Standard | : | ANSI/IEEE C95.1-1992 / IEEE Std. 1528-2013 |
| | | KDB 865664 D01 v01r04 / KDB 865664 D02 v01r02 |
| | | KDB 447498 D01 v06 / KDB 248227 D01 v02r02 |
| | | KDB 941225 D01 v03r01 / KDB 941225 D07 v01r02 |
| Test Lab Location | : | Chang-an Lab |



1. The test operations have to be performed with cautious behavior, the test results are as attached.
2. The test results are under chamber environment of A Test Lab Techno Corp. A Test Lab Techno Corp. does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples.
3. The measurement report has to be written approval of A Test Lab Techno Corp. It may only be reproduced or published in full. This report shall not be reproduced except in full, without the written approval of A Test Lab Techno Corp. The test results in the report only apply to the tested sample.

Approved By : _(Bill Hu)_

Tested By : _(Mark Duan)_

# Contents

# 1. Summary of Maximum Reported SAR Value

| Equipment Class | Mode | Highest Reported | | | |
|---|---|---|---|---|---|
| | | Head SAR$_{1g}$ (W/kg) | Body-Worn SAR$_{1g}$ (W/kg) | Body-Worn stand alone SAR$_{1g}$ (W/kg) | Hotspot SAR$_{1g}$ (W/kg) |
| PCB | GPRS 850 | N/A | N/A | 0.43 | N/A |
| | GPRS 1900 | N/A | N/A | 0.04 | N/A |
| | WCDMA Band II | N/A | N/A | 0.11 | N/A |
| | WCDMA Band V | N/A | N/A | 0.23 | N/A |
| DTS | 2.4GHz WLAN | N/A | N/A | 0.21 | N/A |
| Highest Simultaneous Transmission SAR | | Head SAR$_{1g}$ (W/kg) | Body-Worn SAR$_{1g}$ (W/kg) | Body-Worn stand alone SAR$_{1g}$ (W/kg) | Hotspot SAR$_{1g}$ (W/kg) |
| PCB+DTS | | N/A | N/A | 0.64 | N/A |

NOTE: 1. The N/A is EUT not apply to the assessment of the exposure conditions.

2. The test procedures, as described in American National Standards, Institute ANSI/IEEE C95.1 were employed and they specify the maximum exposure limit of Head & Body is SAR$_{1g}$ 1.6 W/kg of tissue for portable devices being used within 20cm between user and EUT in the uncontrolled environment. A description of the product and operating configuration, detailed summary of the test results, methodology and procedures used in the equipment used are included within this test report.

## 2. Description of Equipment under Test (EUT)

| | |
|---|---|
| Applicant | Yepzon Oy<br>Finlaysoninkuja 9, 33210 Tampere Finland |
| Manufacture | VVDN Technologies Pvt. Ltd<br>B-22,Infocity Sector-34, Gurgaon-122001, Haryana,India |
| Product Type | GPS Tracker |
| Trade Name | YEPZON |
| Model Number | Yepzon Freedom |
| IMEI No. | 357042061218534 |
| FCC ID | 2AENAYPZN02 |

| | Operate Bands | Operate Frequency (MHz) |
|---|---|---|
| RF Function | GPRS/EGPRS 850 | 824.2 - 848.8 |
| | GPRS/EGPRS 1900 | 1850.2 - 1909.8 |
| | WCDMA(RMC 12.2K) Band II | 1852.4 - 1907.6 |
| | WCDMA (RMC 12.2K) Band V | 826.4 - 846.6 |
| | IEEE 802.11b / 802.11g / 802.11n 2.4GHz 20MHz | 2412 - 2462 |
| | *GPRS Multi Class: 12 | |

| | |
|---|---|
| Antenna Type | 2G/3G: Armata 3G FPC Antenna<br>WLAN: Multilayer Chip Antenna |
| Battery Option | Standard |
| | Trade Name: Shenzhen Juheyuan Science & Technology Co., Ltd<br>Model: JHY342946G<br>Spec: DC 3.7V / 450mAh |
| Device Category | Portable Device |
| Application Type | Certification |

Note:The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

## 3. Introduction

The A Test Lab Techno Corp. has performed measurements of the maximum potential exposure to the user of **Yepzon Oy Trade Name : YEPZON   Model(s) : Yepzon Freedom**. The test procedures, as described in American National Standards, Institute C95.1-1999〔1〕were employed and they specify the maximum exposure limit of 1.6mW/g as averaged over any 1 gram of tissue for portable devices being used within 20cm between user and EUT in the uncontrolled environment. A description of the product and operating configuration, detailed summary of the test results, methodology and procedures used in the equipment used are included within this test report.

### 3.1   SAR Definition

Specific Absorption Rate (SAR) is defined as the time derivative (rate) of the incremental energy (dw) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density ($\rho$). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Figure 2).

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

Figure 2.    **SAR Mathematical Equation**

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

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

Where：

$\sigma$  =   conductivity of the tissue (S/m)
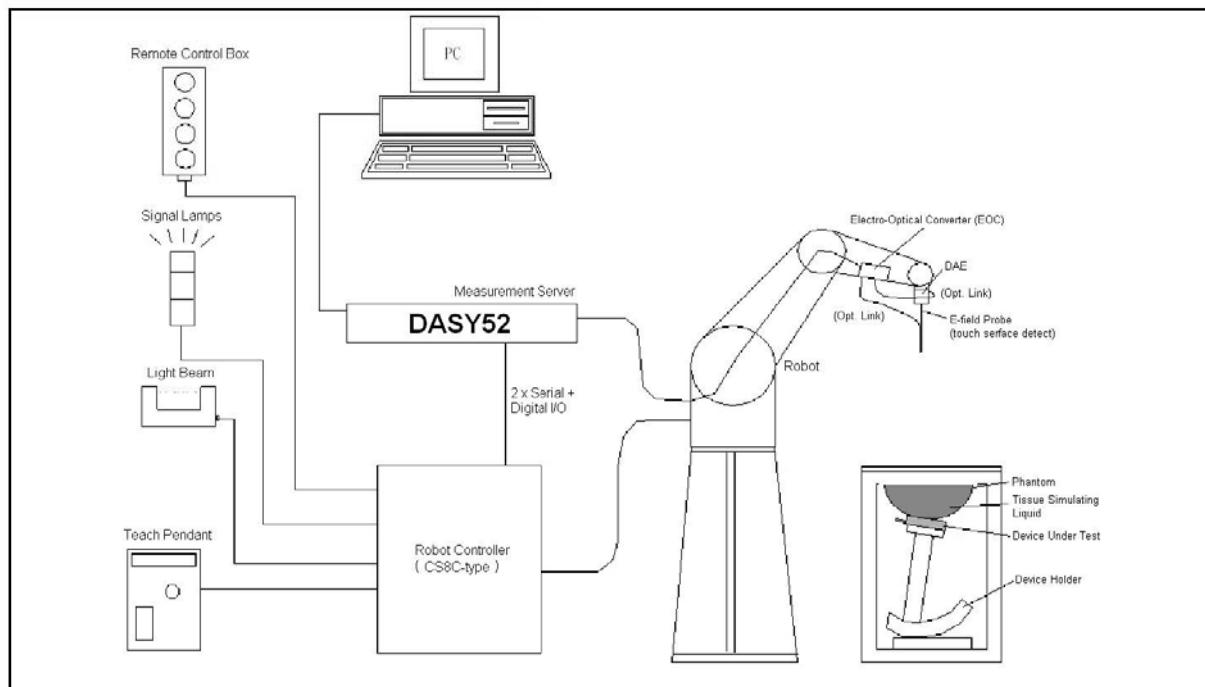
$\rho$  =   mass density of the tissue (kg/m3)

$E$  =   RMS electric field strength (V/m)

＊Note：

The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relations to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane〔2〕

## 4.    SAR Measurement Setup



The DASY52 system for performing compliance tests consists of the following items:

1.  A standard high precision 6-axis robot (Stäubli TX family) with controller, teach pendant and software.   An arm extension for accommodating the data acquisition electronics (DAE).

2.  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.

3.  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.

4.  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.

5.  A probe alignment unit which improves the (absolute) accuracy of the probe positioning.

6.  A computer operating Windows 2000 or Windows XP.

7.  DASY52 software.

8.  Remote controls with teach pendant and additional circuitry for robot safety such as warning lamps, etc.

9.  The SAM twin phantom enabling testing left-hand and right-hand usage.

10. The device holder for handheld mobile phones.

11. Tissue simulating liquid mixed according to the given recipes.

12. Validation dipole kits allowing validating the proper functioning of the system.

## 4.1 DASY E-Field Probe System

The SAR measurements were conducted with the dosimetric probe (manufactured by SPEAG), designed in the classical triangular configuration 〔3〕 and optimized for dosimetric evaluation. The probes is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped when reaching the maximum.

### 4.1.1 E-Field Probe Specification

| | |
|---|---|
| Construction | Symmetrical design with triangular core |
| | Built-in shielding against static charges |
| | PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |
| Calibration | ISO/IEC 17025 calibration service available |
| Frequency | 10 MHz to > 6 GHz |
| | Linearity: ± 0.2 dB (30 MHz to 6 GHz) |
| Directivity | ±0.3 dB in brain tissue (rotation around probe axis) |
| | ±0.5 dB in brain tissue (rotation normal probe axis) |
| Dimensions | Overall length: 337 mm (Tip: 20 mm) |
| | Tip diameter: 2.5 mm (Body: 12 mm) |
| | Typical distance from probe tip to dipole centers: 1 mm |
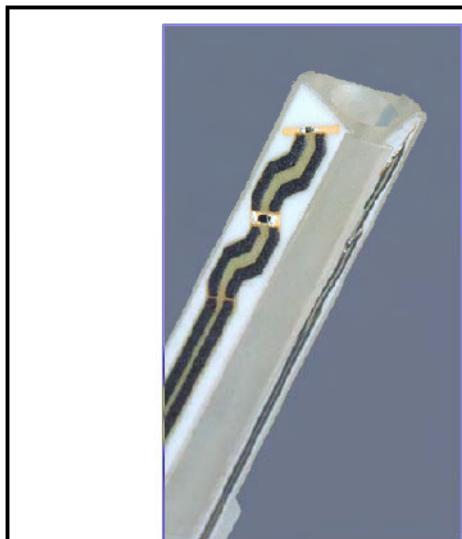


Figure 3.    E-field Probe



Figure 4.    Probe setup on robot

### 4.1.2 E-Field Probe Calibration process

Dosimetric Assessment Procedure
Each E-Probe/Probe Amplifier combination has unique calibration parameters. A TEM cell calibration procedure is conducted to determine the proper amplifier settings to enter in the probe parameters. The amplifier settings are determined for a given frequency by subjecting the probe to a known E-field density (1 mW/cm$^2$) using an RF Signal generator, TEM cell, and RF Power Meter.

Free Space Assessment
The free space E-field from amplified probe outputs is determined in a test chamber. This calibration can be performed in a TEM cell if the frequency is below 1 GHz and in a waveguide or other methodologies above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/cm$^2$.

Temperature Assessment
E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated head tissue. The E-field in the medium correlates with the temperature rise in the dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$SAR = C\frac{\Delta T}{\Delta t}$$

Where :
$\Delta t$ = Exposure time (30 seconds),
C = Heat capacity of tissue (head or body),
$\Delta T$ = Temperature increase due to RF exposure.

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

Where :
$\sigma$ = Simulated tissue conductivity,
$\rho$ = Tissue density (kg/m$^3$).

## 4.2    Data Acquisition Electronic (DAE) System

Model：                     DAE3, DAE4
Construction：              Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY4/5 embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.
Measurement Range：         -100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)
Input Offset Voltage：      < 5µV (with auto zero)
Input Bias Current：        < 50 fA
Dimensions：                60 x 60 x 68 mm

## 4.3    Robot

Positioner：                Stäubli Unimation Corp. Robot Model: TX90XL
Repeatability：             ±0.02 mm
No. of Axis：               6

## 4.4    Measurement Server

Processor：                 PC/104 with a 400MHz intel ULV Celeron
I/O-board：                 Link to DAE4 (or DAE3)
                           16-bit A/D converter for surface detection system
                           Digital I/O interface
                           Serial link to robot
                           Direct emergency stop output for robot

## 4.5    Device Holder

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity ε=3 and loss tangent δ=0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.
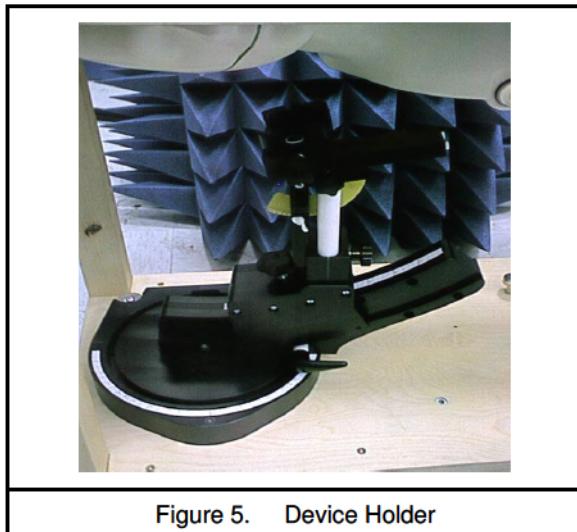


Figure 5.    Device Holder

## 4.6    Oval Flat Phantom - ELI 4.0

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (Oval Flat) phantom defined in IEEE 1528-2013, CENELEC 50361 and IEC 62209. It enables the dosimetric evaluation of wireless portable device 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. 30 liters |
| Dimensions | 190×600×400 mm (H×L×W) |

Table 1.    Specification of ELI 4.0
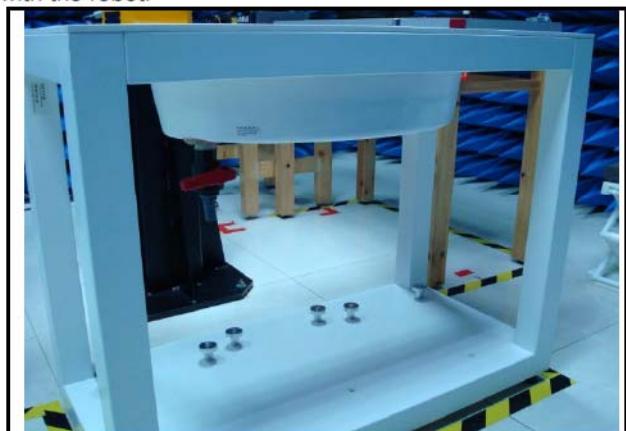


Figure 6.    Oval Flat Phantom

## 4.7 Data Storage and Evaluation

### 4.7.1 Data Storage

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension DA4 or DA5. The post processing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

### 4.7.2 Data Evaluation

The DASY 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 | *Normi, ai0, ai1, ai2* |
| | - Conversion factor | *ConvFi* |
| | - Diode compression point | *dcpi* |
| 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 they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter 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 :
$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

$$H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$
H-field probes :

with      $Vi$      = 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 E-field 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 mW/g
           $Etot$ = total field strength in V/m
           $\sigma$      = conductivity in [mho/m] or [Siemens/m]
           $\rho$      = equivalent tissue density in g/cm3

＊Note : That the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.

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

$$P_{pwe} = \frac{E_{tot}^2}{3770} \qquad or \qquad P_{pwe} = \frac{H_{tot}^2}{37.7}$$

with      $Ppwe$ = equivalent power density of a plane wave in mW/cm2
           $Etot$   = total electric field strength in V/m
           $Htot$   = total magnetic field strength in A/m

# 5.    Tissue Simulating Liquids

The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the tissue.
The dielectric parameters of the liquids were verified prior to the SAR evaluation using an 85070C Dielectric Probe Kit and an E5071B Network Analyzer.

**IEEE SCC-34/SC-2 in 1528 recommended Tissue Dielectric Parameters**
The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in 1528 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 human head.   Other head and body tissue parameters that have not been specified in 1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equation and extrapolated according to the head parameter specified in 1528.

| Target Frequency | Head | | Body | |
|---|---|---|---|---|
| (MHz) | $\varepsilon_r$ | $\sigma$ (S/m) | $\varepsilon_r$ | $\sigma$ (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 |
| 5800 | 35.3 | 5.27 | 48.2 | 6.00 |
| ( $\varepsilon_r$ = relative permittivity, $\sigma$ = conductivity and $\rho$ = 1000 kg/m3 ) | | | | |

Table 2.   Tissue dielectric parameters for head and body phantoms

## 5.1 Ingredients

The following ingredients are used:

- Water: deionized water (pure $H_20$), resistivity ≥ 16 M Ω -as basis for the liquid
- Sugar: refied white sugar (typically 99.7 % sucrose, available as crystal sugar in food shops) -to reduce relative permittivity
- Salt: pure NaCl -to increase conductivity
- Cellulose: Hydroxyethyl-cellulose, medium viscosity (75-125 mPa.s, 2% in water, 20 ˚C), CAS # 54290 -to increase viscosity and to keep sugar in solution.
- Preservative: Preventol D-7 Bayer AG, D-51368 Leverkusen, CAS # 55965-84-9 -to prevent the spread of bacteria and molds
- DGBE: Diethylenglycol-monobuthyl ether (DGBE), Fluka Chemie GmbH, CAS # 112-34-5 -to reduce relative permittivity

## 5.2 Recipes

The following tables give the recipes for tissue simulating liquids to be used in different frequency bands.

Note: The goal dielectric parameters (at 22 ℃) must be achieved within a tolerance of ±5% for ε and ±5% for σ.

| Ingredients (% by weight) | Frequency (MHz) | | | | | | | | | | | | Frequency (GHz) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 750 | | 835 | | 1750 | | 1900 | | 2450 | | 2600 | | 5GHz | |
| Tissue Type | Head | Body | Head | Body | Head | Body | Head | Body | Head | Body | Head | Body | Head | Body |
| Water | 39.28 | 51.30 | 41.45 | 52.40 | 54.50 | 40.20 | 54.90 | 40.40 | 62.70 | 73.20 | 60.30 | 71.40 | 65.5 | 78.6 |
| Salt (NaCl) | 1.47 | 1.42 | 1.45 | 1.50 | 0.17 | 0.49 | 0.18 | 0.50 | 0.50 | 0.10 | 0.60 | 0.20 | 0.00 | 0.00 |
| Sugar | 58.15 | 46.18 | 56.00 | 45.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| HEC | 1.00 | 1.00 | 1.00 | 1.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Bactericide | 0.10 | 0.10 | 0.10 | 0.10 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Triton X-100 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 17.2 | 10.7 |
| DGBE | 0.00 | 0.00 | 0.00 | 0.00 | 45.33 | 59.31 | 44.92 | 59.10 | 36.80 | 26.70 | 39.10 | 28.40 | 0.00 | 0.00 |
| Dielectric Constant | 41.88 | 54.60 | 42.54 | 56.10 | 40.10 | 53.60 | 39.90 | 54.00 | 39.80 | 52.50 | 39.80 | 52.50 | 0.00 | 0.00 |
| Conductivity (S/m) | 0.90 | 0.97 | 0.91 | 0.95 | 1.39 | 1.49 | 1.42 | 1.45 | 1.88 | 1.78 | 1.88 | 1.78 | 0.00 | 0.00 |
| Diethylene Glycol Mono-hexlether | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 17.3 | 10.7 |

Salt: 99+% Pure Sodium Chloride        Sugar: 98+% Pure Sucrose

Water: De-ionized, 16 MΩ+ resistivity        HEC: Hydroxyethyl Cellulose
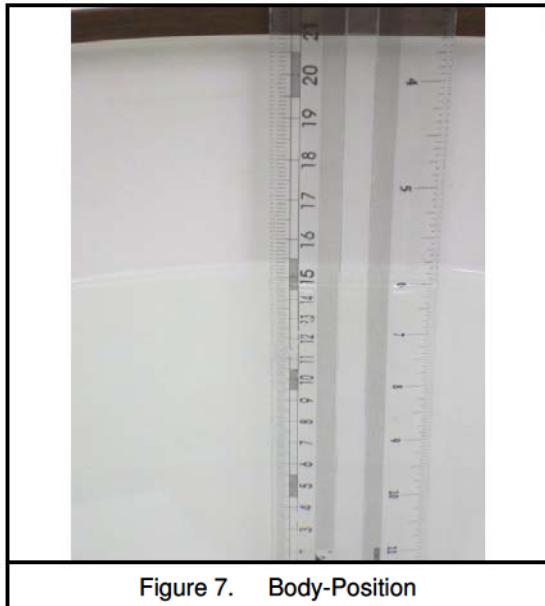
DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]

Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

## 5.3 Liquid Depth

According to KDB865664 ,the depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm with ≤ ± 0.5 cm variation for SAR measurements ≤ 3 GHz and ≥ 10.0 cm with ≤ ± 0.5 cm variation for measurements > 3 GHz.



Figure 7.    Body-Position

# 6. SAR Testing with RF Transmitters

## 6.1 SAR Testing with GSM/GPRS/EGPRS Transmitters

Configure the basestation to support GMSK and 8PSK call respectively, and set timeslot transmission for GMSK GSM/GPRS and 8PSK EDGE. Measure and record power outputs for both modulations, that test is applicable.

## 6.2 SAR Testing with WCDMA Transmitters

The following tests were completed according to the test requirements outlined in section 5.2 of the 3GPP TS34.121-1 specification. The DUT supports power Class 3, which has a nominal maximum output power of 24 dBm (+1.7/-3.7).

- Step 1: set a Test Mode 1 loop back with a 12.2kbps Reference Measurement Channel (RMC).
- Step 2: set and send continuously up power control commands to the device.
- Step 3: measure the power at the device antenna connector using the power meter with average detector and test SAR

## 6.3 SAR Testing with HSDPA Transmitters

**HSDPA Date Devices setup for SAR Measurement**

HSDPA should be configured according to the UE category of a test device. The number of HS-DSCH/HS-PDSCHs, HARQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the H-set. To maintain a consistent test configuration and stable transmission conditions, QPSK is used in the H-set for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 4 ms with a CQI repetition factor of 2 to maintain a constant rate of active CQI slots. DPCCH and DPDCH gain factors($\beta c$, $\beta d$), and HS-DPCCH power offset parameters ($\Delta$ACK, $\Delta$NACK, $\Delta$CQI) should be set according to values indicated in the Table below. The CQI value is determined by the UE category, transport block size, number of HS-PDSCHs and modulation used in the H-set.

| Setup for Release 5 HSDPA | | | | | | | |
|---|---|---|---|---|---|---|---|
| Sub-test | $\beta c$ | $\beta d$ | $\beta d$ (SF) | $\beta c/\beta d$ | $\beta hs$[1,2] | CM[3] (dB) | MRP[3] (dB) |
| 1 | 2/15 | 15/15 | 64 | 2/15 | 4/15 | 0.0 | 0.0 |
| 2 | 12/15(4) | 15/15(4) | 64 | 12/15(4) | 24/15 | 1.0 | 0.0 |
| 3 | 15/15 | 8/15 | 64 | 15/8 | 30/15 | 1.5 | 0.5 |
| 4 | 15/15 | 4/15 | 64 | 15/4 | 30/15 | 1.5 | 0.5 |

Note

1. $\Delta_{ACK}$, $\Delta_{NACK}$ and $\Delta_{CQI}$ = 8 $\Leftrightarrow$ Ahs = $\beta hs/\beta c$ = 30/15 $\Leftrightarrow$ $\beta hs$= 30/15 *$\beta c$
2. For theHS-DPCCH power mask requirement test in clause 5.2C, 5.7A, and the Error Vector Magnitude(EVM) with HS-DPCCH test in clause 5.13.1A and HSDPA EVM with phase discontinuity in clause 5.13.1AA, $\Delta_{ACK}$ and $\Delta_{NACK}$ = 30/15 with $\beta hs$ = 30/15 *$\beta c$ and $\Delta_{CQI}$ = 24/15 with $\beta hs$ = 24/15*$\beta c$
3. CM = 1 for $\beta c/\beta d$ =12/15, $\beta hs/\beta c$=24/15. For all other combinations of DPDCH, DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.
4. For subtest 2 the $\beta c/\beta d$ ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to $\beta c$ = 11/15 and $\beta d$ = 15/15.

**HSPA Date Devices setup for SAR Measurement.**

The following procedures are applicable to HSPA (HSUPA/HSDPA) data devices operating under 3GPP Release 6. Body exposure conditions generally apply to these devices, including handsets and data modems operating in various electronic devices. HSUPA operates in conjunction with WCDMA and HSDPA. SAR is initially measured in WCDMA test configurations without HSPA. The default test configuration is to establish a radio link between the DUT and a communication test set to configure a 12.2 kbps RMC (reference measurement channel) in Test Loop Mode 1. SAR for HSPA is selectively measured with HS-DPCCH, EDPCCH and E-DPDCH, all enabled, along with a 12.2 kbps RMC using the highest SAR configuration in WCDMA with 12.2 kbps RMC only. An FRC is configured according to HSDPCCH Sub-test 1 using H-set 1 and QPSK. HSPA is configured according to E-DCH Subtest 5 requirements. SAR for other HSPA sub-test configurations is also confirmed selectively according to output power, exposure conditions and E-DCH UE Category. Maximum output power is verified according to procedures in applicable versions of 3GPP TS 34.121 and SAR must be measured according to these maximum output conditions. The UE Categories for HSDPCCH and HSPA should be clearly identified in the SAR report. The following procedures are applicable only if Maximum Power Reduction (MPR) is implemented according to Cubic Metric (CM) requirements.

When voice transmission and head exposure conditions are applicable to a WCDMA/HSPA data device, head exposure is measured according to the 'Head SAR Measurements' procedures in the 'WCDMA Handsets' section of this document. SAR for body exposure configurations are measured according to the 'Body SAR Measurements' procedures in the 'WCDMA Handsets' section of this document. In addition, body SAR is also measured for HSPA when the maximum average output of each RF channel with HSPA active is at least ¼ dB higher than that measured without HSPA using 12.2 kbps RMC or the maximum SAR for 12.2 kbps RMC is above 75% of the SAR limit. Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 with power control algorithm 2, according to the highest body SAR configuration in 12.2 kbps RMC without HSPA. When VOIP is applicable for head exposure, SAR is not required when the maximum output of each RF channel with HSPA is less than ¼ dB higher than that measured using 12.2 kbps RMC; otherwise, the same HSPA configuration used for body measurements should be used to test for head exposure.

Due to inner loop power control requirements in HSPA, a commercial communication test set should be used for the output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and E-DCH configurations for HSPA should be configured according to the β values indicated below as well as other applicable procedures described in the 'WCDMA Handset' and 'Release 5 HSDPA Data Devices' sections of this document.

The highest body SAR measured in Antenna Extended & Retracted configurations on a channel in 12.2 kbps RMC. The possible channels are the High, Middle & Low channel. Contact the FCC Laboratory for test and approval requirements if the maximum output power measured in E-DCH Sub-test 2 - 4 is higher than Sub-test 5.

| Setup for Release 6 HSPA / Release 7 HSPA+ | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sub-test | βc | βd | βd (SF) | βc/βd | βhs[1] | βec | βed | Bed (SF) | Bed (codes) | CM[2] (dB) | MPR (dB) | AG[4] Index | E-TFCI |
| 1 | 11/15[3] | 15/15[3] | 64 | 11/15[3] | 22/15 | 209/225 | 1039/225 | 4 | 1 | 1.0 | 0.0 | 20 | 75 |
| 2 | 6/15 | 15/15 | 64 | 6/15 | 12/15 | 12/15 | 94/75 | 4 | 1 | 3.0 | 2.0 | 12 | 67 |
| 3 | 15/15 | 9/15 | 64 | 15/9 | 30/15 | 30/15 | βed1: 47/15 βed2: 47/15 | 4 | 2 | 2.0 | 1.0 | 15 | 92 |
| 4 | 2/15 | 15/15 | 64 | 2/15 | 4/15 | 2/15 | 56/75 | 4 | 1 | 3.0 | 2.0 | 17 | 71 |
| 5 | 15/15[4] | 15/15[4] | 64 | 15/15[4] | 30/15 | 24/15 | 134/15 | 4 | 1 | 1.0 | 0.0 | 21 | 81 |

Note

1. $\Delta_{ACK}$, $\Delta_{NACK}$ and $\Delta_{CQI} = 8 \Leftrightarrow$ Ahs = βhs/βc = 30/15 $\Leftrightarrow$ βhs= 30/15 *βc.
2. CM = 1 for βc/βd =12/15, βhs/βc=24/15. For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.
3. For subtest 1 the βc/βd ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to βc = 10/15 and βd = 15/15.
4. For subtest 5 the βc/βd ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to βc = 14/15 and βd = 15/15.
5. Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g.
6. βed can not be set directly; it is set by Absolute Grant Value.

## 6.4    SAR Testing with 802.11 Transmitters

SAR test reduction for 802.11 Wi-Fi transmission mode configurations are considered separately for DSSS and OFDM. An initial test position is determined to reduce the number of tests required for certain exposure configurations with multiple test positions. An initial test configuration is determined for each frequency band and aggregated band according to maximum output power, channel bandwidth, wireless mode configurations and other operating parameters to streamline the measurement requirements. For 2.4 GHz DSSS, either the initial test position or DSSS procedure is applied to reduce the number of SAR tests; these are mutually exclusive. For OFDM, an initial test position is only applicable to next to the ear, UMPC mini-tablet and hotspot mode configurations, which is tested using the initial test configuration to facilitate test reduction. For other exposure conditions with a fixed test position, SAR test reduction is determined using only the initial test configuration.

The multiple test positions require SAR measurements in head, hotspot mode or UMPC mini-tablet configurations may be reduced according to the highest reported SAR determined using the initial test position(s) by applying the DSSS or OFDM SAR measurement procedures in the required wireless mode test configuration(s). The initial test position(s) is measured using the highest measured maximum output power channel in the required wireless mode test configuration(s). When the reported SAR for the initial test position is:

- ≤ 0.4 W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- > 0.4 W/kg, SAR is repeated using the same wireless mode test configuration tested in the initial test position to measure the subsequent next closet/smallest test separation distance and maximum coupling test position, on the highest maximum output power channel, until the reported SAR is ≤ 0.8 W/kg or all required test positions are tested.
  - ➢ For subsequent test positions with equivalent test separation distance or when exposure is dominated by coupling conditions, the position for maximum coupling condition should be tested.
  - ➢ When it is unclear, all equivalent conditions must be tested.

- For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is > 0.8 W/kg, measure the SAR for these positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required test channels are considered.
  - ➢ The additional power measurements required for this step should be limited to those necessary for identifying subsequent highest output power channels to apply the test reduction.

- When the specified maximum output power is the same for both UNII 1 and UNII 2A, begin SAR measurements in UNII 2A with the channel with the highest measured output power. If the reported SAR for UNII 2A is ≤ 1.2 W/kg, SAR is not required for UNII 1; otherwise treat the remaining bands separately and test them independently for SAR.
- When the specified maximum output power is different between UNII 1 and UNII 2A, begin SAR with the band that has the higher specified maximum output. If the highest reported SAR for the band with the highest specified power is ≤ 1.2 W/kg, testing for the band with the lower specified output power is not required; otherwise test the remaining bands independently for SAR.

To determine the initial test position, Area Scans were performed to determine the position with the Maximum Value of SAR (measured). The position that produced the highest Maximum Value of SAR is considered the worst case position; thus used as the initial test position.