

## **MEASUREMENT UNCERTAINTY**

#### **MEASUREMENT UNCERTAINTY BUDGETS PER IEEE 1528:2003**

#### 300-3000 MHz Range

Uncertainty Component	Tolerance (+/- %)	Probability Distribution	Divisor	c <sub>i</sub> (1g)	c <sub>i</sub> (10g)	u <sub>i</sub> (1g) (+/-%)	u <sub>i</sub> (10g) (+/-%)	Vi
Measurement System								
Probe calibration (k=1)	5.5	normal	1	1	1	5.5	5.5	8
Axial isotropy	4.7	rectangular	1.732	0.707	0.707	1.9	1.9	8
Hemispherical isotropy	9.6	rectangular	1.732	0.707	0.707	3.9	3.9	8
Boundary effect	1.0	rectangular	1.732	1	1	0.6	0.6	8
Linearity	4.7	rectangular	1.732	1	1	2.7	2.7	8
System detection limits	1.0	rectangular	1.732	1	1	0.6	0.6	8
Readout electronics	0.3	normal	1	1	1	0.3	0.3	8
Response time	0.8	rectangular	1.732	1	1	0.5	0.5	∞
Integration time	2.6	rectangular	1.732	1	1	1.5	1.5	8
RF ambient conditions - noise	1.7	rectangular	1.732	1	1	1.0	1.0	8
RF Ambient Reflections	0.0	rectangular	1.732	1	1	0.0	0.0	8
Probe positioner mechanical tolerance	0.4	rectangular	1.732	1	1	0.2	0.2	8
Probe positioner with respect to phantom shell	2.9	rectangular	1.732	1	1	1.7	1.7	8
Extrapolation, interpolation, and integration algorithms for max. SAR evaluation	1.0	rectangular	1.732	1	1	0.6	0.6	∞
Test Sample Related								
Device Positioning	2.9	normal	1	1	1	2.9	2.9	145
Device Holder	3.6	normal	1	1	1	3.6	3.6	5
Power Drift	5.0	rectangular	1.732	1	1	2.9	2.9	~
Phantom and tissue parameters								
Phantom Uncertainty - shell thickness tolerances	4.0	rectangular	1.732	1	1	2.3	2.3	∞
Liquid conductivity - deviation from target values	5.0	rectangular	1.732	0.64	0.43	1.8	1.2	∞
Liquid conductivity - measurement uncertainty	6.5	normal	1	0.64	0.43	4.2	2.8	×
Liquid permittivity - deviation from target values	5.0	rectangular	1.732	0.6	0.49	1.7	1.4	∞
Liquid permittivity - measurement uncertainty	3.2	normal	1	0.6	0.49	1.9	1.6	∞
Combined Standard Uncertainty			RSS			11.2	10.6	387
Expanded Measurement Uncertainty (05%, Co	onfidence/		pormal (	(-2)		22.5	21.2	



#### **Probe Calibration**

Please see attached calibration data.

## Equipment ID: SAF

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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 S Swiss Calibration Service

Accreditation No.: SCS 108

Certificate No: ES3-3246\_Nov13

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Client Northwest EMC

	ES3DV3 - SN:32	46	
Calibration procedure(s)	QA CAL-01.v9, C Calibration proce	A CAL-12.v8, QA CAL-23.v5, QA dure for dosimetric E-field probes	CAL-25.v6
Calibration date:	November 19, 20	13	
The measurements and the unc	ertainties with confidence pr	obability are given on the following pages and y facility: environment temperature $(22 \pm 3)^{\circ}$ C a	are part of the certificate. and humidity < 70%.
Calibration Equipment used (M8	TE critical for calibration)		
Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Deference 2 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 3 db Attendator	ONI. 05077 (00.)		i i i i i i i i i i i i i i i i i i i
Reference 20 dB Attenuator	SN: 55277 (20X)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator Reference 30 dB Attenuator	SN: S5277 (20x) SN: S5129 (30b)	04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01738)	Apr-14 Apr-14
Reference 30 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2	SN: S5277 (20x)           SN: S5129 (30b)           SN: 3013	04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01738) 28-Dec-12 (No. ES3-3013_Dec12)	Apr-14 Apr-14 Dec-13
Reference 20 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4	SN: S5277 (20x)           SN: S5129 (30b)           SN: 3013           SN: 660	04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01738) 28-Dec-12 (No. ES3-3013_Dec12) 4-Sep-13 (No. DAE4-660_Sep13)	Apr-14 Apr-14 Dec-13 Sep-14
Reference 20 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4	SN: S5277 (20x) SN: S5129 (30b) SN: 3013 SN: 660	04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01738) 28-Dec-12 (No. ES3-3013_Dec12) 4-Sep-13 (No. DAE4-660_Sep13)	Apr-14 Apr-14 Dec-13 Sep-14 Scheduled Check
Reference 20 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RE generator HP 8648C	SN: S5277 (20x) SN: S5129 (30b) SN: 3013 SN: 660 ID LIS36421101700	04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01738) 28-Dec-12 (No. ES3-3013_Dec12) 4-Sep-13 (No. DAE4-660_Sep13) Check Date (in house) 4-Aug-99 (in house check Apr-13)	Apr-14 Apr-14 Dec-13 Sep-14 Scheduled Check
Reference 3 0B Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	SN: S5277 (20x)           SN: S5129 (30b)           SN: 3013           SN: 660           ID           US3642U01700           US37390585	04-Apr-13 (No. 217-01735)           04-Apr-13 (No. 217-01738)           28-Dec-12 (No. ES3-3013_Dec12)           4-Sep-13 (No. DAE4-660_Sep13)           Check Date (in house)           4-Aug-99 (in house check Apr-13)           18-Oct-01 (in house check Oct-13)	Apr-14 Apr-14 Dec-13 Sep-14 Scheduled Check In house check: Apr-15 In house check: Oct-14
Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	SN: S5277 (20x) SN: S5129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37390585	04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01738) 28-Dec-12 (No. ES3-3013_Dec12) 4-Sep-13 (No. DAE4-660_Sep13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Oct-13)	Apr-14 Apr-14 Dec-13 Sep-14 Scheduled Check In house check: Apr-15 In house check: Oct-14
Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E	SN: S5277 (20x)           SN: S5129 (30b)           SN: 3013           SN: 660           ID           US3642U01700           US37390585           Name	04-Apr-13 (No. 217-01735) 04-Apr-13 (No. 217-01738) 28-Dec-12 (No. ES3-3013_Dec12) 4-Sep-13 (No. DAE4-660_Sep13) Check Date (in house) 4-Aug-99 (in house check Apr-13) 18-Oct-01 (in house check Oct-13) Function	Apr-14 Apr-14 Dec-13 Sep-14 Scheduled Check In house check: Apr-15 In house check: Oct-14 Signature
Reference 3 dB Attenuator Reference 20 dB Attenuator Reference 30 dB Attenuator Reference Probe ES3DV2 DAE4 Secondary Standards RF generator HP 8648C Network Analyzer HP 8753E Calibrated by:	SN: S5277 (20x) SN: S5129 (30b) SN: 3013 SN: 660 ID US3642U01700 US37390585 Name Jeton Kastrati	04-Apr-13 (No. 217-01735)           04-Apr-13 (No. 217-01738)           28-Dec-12 (No. ES3-3013_Dec12)           4-Sep-13 (No. DAE4-660_Sep13)           Check Date (in house)           4-Aug-99 (in house check Apr-13)           18-Oct-01 (in house check Oct-13)           Function           Laboratory Technician	Apr-14 Apr-14 Dec-13 Sep-14 Scheduled Check In house check: Apr-15 In house check: Oct-14 Signature

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Report No. INTE5478

Issued: November 19, 2013

**Calibration Laboratory of** Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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Accreditation No.: SCS 108

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#### Glossary: TSL tissue simulating liquid NORMx,y,z sensitivity in free space sensitivity in TSL / NORMx.v.z ConvF DCP diode compression point CF crest factor (1/duty\_cycle) of the RF signal modulation dependent linearization parameters A, B, C, D o rotation around probe axis Polarization $\phi$ Polarization 9 9 rotation around an axis that is in the plane normal to probe axis (at measurement center). i.e., $\vartheta = 0$ is normal to probe axis **Connector Anale** information used in DASY system to align probe sensor X to the robot coordinate system

#### Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

#### Methods Applied and Interpretation of Parameters:

- NORMx, y, z: Assessed for E-field polarization  $\vartheta = 0$  (f  $\leq 900$  MHz in TEM-cell; f > 1800 MHz; R22 waveguide). NORMx, y, z are only intermediate values, i.e., the uncertainties of NORMx, y, z does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)x, y, z = NORMx, y, z \* frequency response (see Frequency Response Chart). This linearization is ٠ implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCPx, v, z: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal • characteristics
- Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer . Standard for  $f \le 800 \text{ MHz}$ ) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORMx, y, z \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the NORMx (no Report No. Norteinty required). 526/612

# Probe ES3DV3

## SN:3246

Manufactured: May 5, 2009 Calibrated:

November 19, 2013

Calibrated for DASY/EASY Systems (Note: non-compatible with DASY2 system!)

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	1.40	1.23	1.17	± 10.1 %
DCP (mV) <sup>B</sup>	100.6	100.2	101.6	

#### **Modulation Calibration Parameters**

UID	Communication System Name		Α	В	С	D	VR	Unc <sup>E</sup>
			dB	dBõV		dB	mV	(k=2)
0	CW	Х	0.0	0.0	1.0	0.00	168.5	±3.0 %
		Y	0.0	0.0	1.0		150.9	
		Z	0.0	0.0	1.0		147.5	
10021- DAA	GSM-FDD (TDMA, GMSK)	X	28.21	99.8	28.6	9.39	121.9	±1.2 %
		Y	21.04	98.5	27.9		129.5	
		Z	25.53	99.5	28.4		139.6	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

- <sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6).
- <sup>B</sup> Numerical linearization parameter: uncertainty not required.
- <sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
750	41.9	0.89	6.52	6.52	6.52	0.35	1.82	± 12.0 %
835	41.5	0.90	6.34	6.34	6.34	0.47	1.48	± 12.0 %
900	41.5	0.97	6.22	6.22	6.22	0.40	1.63	± 12.0 %
1750	40.1	1.37	5.36	5.36	5.36	0.75	1.18	± 12.0 %
1900	40.0	1.40	5.10	5.10	5.10	0.52	1.47	± 12.0 %

#### **Calibration Parameter Determined in Head Tissue Simulating Media**

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\varepsilon$  and  $\sigma$ ) can be relaxed to  $\pm$  10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\varepsilon$  and  $\sigma$ ) is restricted to  $\pm$  5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>6</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
450	56.7	0.94	7.18	7.18	7.18	0.16	1.80	± 13.3 %
750	55.5	0.96	6.14	6.14	6.14	0.78	1.19	± 12.0 %
835	55.2	0.97	6.12	6.12	6.12	0.45	1.57	± 12.0 %
900	55.0	1.05	6.01	6.01	6.01	0.70	1.25	± 12.0 %
1750	53.4	1.49	5.08	5.08	5.08	0.77	1.32	± 12.0 %
1900	53.3	1.52	4.80	4.80	4.80	0.46	1.67	± 12.0 %

#### **Calibration Parameter Determined in Body Tissue Simulating Media**

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\varepsilon$  and  $\sigma$ ) can be relaxed to  $\pm$  10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\varepsilon$  and  $\sigma$ ) is restricted to  $\pm$  5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

the ConvF uncertainty for indicated target tissue parameters. <sup>G</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



## Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)



## Receiving Pattern ( $\phi$ ), $\vartheta = 0^{\circ}$

Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)



## Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f = 900 MHz)

Uncertainty of Linearity Assessment: ± 0.6% (k=2)



## **Conversion Factor Assessment**

Report No. INTE5478

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#### **Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-6.5
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm



#### **Probe Calibration**

Please see attached calibration data.

## **Equipment ID: SAG**

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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Client Northw

Northwest EMC

Certificate No: EX3-3746\_Nov13

## CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3746					
Calibration procedure(s)	QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes					
Calibration date:	November 15, 2013					
This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI). The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.						
All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.						
Calibration Equipment used (M	1&TE critical for calibration)					

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5277 (20x)	04-Apr-13 (No. 217-01735)	Apr-14
Reference 30 dB Attenuator	SN: S5129 (30b)	04-Apr-13 (No. 217-01738)	Apr-14
Reference Probe ES3DV2	SN: 3013	28-Dec-12 (No. ES3-3013_Dec12)	Dec-13
DAE4	SN: 660	4-Sep-13 (No. DAE4-660_Sep13)	Sep-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-15
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	$( \mathcal{D})$
Approved by:	Katja Pokovic	Technical Manager	Lelly
			Issued: November 16, 2013
This calibration certificate	e shall not be reproduced except in full	without written approval of the lab	oratory.

**Calibration Laboratory of** Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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Accreditation No.: SCS 108

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tissue simulating liquid
sensitivity in free space
sensitivity in TSL / NORMx,y,z
diode compression point
crest factor (1/duty_cycle) of the RF signal
modulation dependent linearization parameters
φ rotation around probe axis
9 rotation around an axis that is in the plane normal to probe axis (at measurement center),
i.e., 9 = 0 is normal to probe axis
information used in DASY system to align probe sensor X to the robot coordinate system

#### Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- b) IEC 62209-1. "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005

#### Methods Applied and Interpretation of Parameters:

- NORMx, v, z: Assessed for E-field polarization  $\vartheta = 0$  (f  $\leq 900$  MHz in TEM-cell; f > 1800 MHz: R22 waveguide). • NORMx, y, z are only intermediate values, i.e., the uncertainties of NORMx, y, z does not affect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- $NORM(f)x, y, z = NORMx, y, z * frequency_response$  (see Frequency Response Chart). This linearization is . implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCPx,y,z: DCP are numerical linearization parameters assessed based on the data of power sweep with CW . signal (no uncertainty required). DCP does not depend on frequency nor media.
- PAR: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal • characteristics
- Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters: Assessed in flat phantom using E-field (or Temperature Transfer • Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORMx, y, z \* ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy): in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle: The angle is assessed using the information gained by determining the NORMx (no uncertainty required). Report No. INTE5478

538/612

# Probe EX3DV4

## SN:3746

Calibrated:

Manufactured: March 26, 2010 November 15, 2013

Calibrated for DASY/EASY Systems (Note: non-compatible with DASY2 system!)

#### **Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm $(\mu V/(V/m)^2)^A$	0.49	0.47	0.50	± 10.1 %
DCP (mV) <sup>B</sup>	95.1	96.8	99.8	

#### Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	С	D dB	VR mV	Unc <sup>E</sup> (k=2)
0	CW	Х	0.0	0.0	1.0	0.00	116.0	±2.5 %
		Y	0.0	0.0	1.0		114.4	
		Z	0.0	0.0	1.0		115.3	
10061- CAA	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)	X	4.27	70.6	19.0	3.60	112.0	±0.7 %
		Y	3.46	70.3	19.5		146.7	
		Z	6.51	80.9	23.9		110.8	
10069- CAA	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps)	X	12.35	71.0	23.8	10.56	123.7	±3.8 %
		Y	10.65	68.7	22.9		104.8	
		Z	11.98	70.7	23.7		121.3	
10077- CAA	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps)	X	11.38	70.4	23.8	11.00	105.9	±3.5 %
		Y	10.68	71.0	24.7		131.5	
		Z	11.00	70.1	23.8		103.8	

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

<sup>A</sup> The uncertainties of NormX,Y,Z do not affect the E<sup>2</sup>-field uncertainty inside TSL (see Pages 5 and 6). <sup>B</sup> Numerical linearization parameter: uncertainty not required.

<sup>&</sup>lt;sup>E</sup> Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

f (MHz) <sup>C</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
2450	39.2	1.80	6.74	6.74	6.74	0.49	0.93	± 12.0 %
2550	39.1	1.91	6.51	6.51	6.51	0.52	0.93	± 12.0 %
5200	36.0	4.66	4.92	4.92	4.92	0.35	1.80	± 13.1 %
5300	35.9	4.76	4.69	4.69	4.69	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.60	4.60	4.60	0.35	1.80	± 13.1 %
5600	35.5	5.07	4.30	4.30	4.30	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.37	4.37	4.37	0.40	1.80	± 13.1 %

#### **Calibration Parameter Determined in Head Tissue Simulating Media**

<sup>c</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\varepsilon$  and  $\sigma$ ) can be relaxed to  $\pm$  10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\varepsilon$  and  $\sigma$ ) is restricted to  $\pm$  5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>6</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

f (MHz) <sup>c</sup>	Relative Permittivity <sup>F</sup>	Conductivity (S/m) <sup>F</sup>	ConvF X	ConvF Y	ConvF Z	Alpha <sup>G</sup>	Depth <sup>G</sup> (mm)	Unct. (k=2)
2450	52.7	1.95	7.03	7.03	7.03	0.80	0.57	± 12.0 %
2550	52.6	2.09	6.78	6.78	6.78	0.80	0.50	± 12.0 %
5200	49.0	5.30	4.25	4.25	4.25	0.45	1.90	± 13.1 %
5300	48.9	5.42	4.04	4.04	4.04	0.45	1.90	± 13.1 %
5500	48.6	5.65	3.95	3.95	3.95	0.45	1.90	± 13.1 %
5600	48.5	5.77	3.78	3.78	3.78	0.45	1.90	± 13.1 %
5800	48.2	6.00	4.16	4.16	4.16	0.45	1.90	± 13.1 %

#### Calibration Parameter Determined in Body Tissue Simulating Media

<sup>C</sup> Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

<sup>F</sup> At frequencies below 3 GHz, the validity of tissue parameters ( $\varepsilon$  and  $\sigma$ ) can be relaxed to  $\pm$  10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ( $\varepsilon$  and  $\sigma$ ) is restricted to  $\pm$  5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

<sup>6</sup> Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.



Frequency Response of E-Field (TEM-Cell:ifi110 EXX, Waveguide: R22)

Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)



## Receiving Pattern ( $\phi$ ), $\vartheta = 0^{\circ}$

Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)



## Dynamic Range f(SAR<sub>head</sub>) (TEM cell , f = 900 MHz)

Uncertainty of Linearity Assessment: ± 0.6% (k=2)



## **Conversion Factor Assessment**

#### **Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	-137.1
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	2 mm



## **DIPOLE CALIBRATION**

#### **Dipole Calibration**

Key points:

- 1. Dipoles need to be sent to the manufacturer for calibration every 3 years.
- 2. For those years where they are not sent to the manufacturer the following two parameters are verified annually:
  - a. The return-loss. If it deviates by more than 20% from the calibration data or does not meet the required -20 dB return-loss specification, then it fails the verification and must be sent to the manufacturer for repair and calibration.
  - b. The real and imaginary parts of the impedance. If it deviates by more than 5  $\Omega$  from the calibration data, then it fails the verification and must be sent to the manufacturer for repair and calibration.

The return loss and complex impedance were verified to meet the FCC's criteria within one year of the manufacturer's calibration. The calibration data is used for the SAR system verification. The verification data shows that the dipole characteristics have not changed and the calibration data continues to be valid.

Please see attached calibration and verification data.

## **Dipole Verification**

Performed by Northwest EMC, Inc.

ADN

Calibration Certificate/Report         Device Dipole Antenna       SPEAG       SA AAD 175 AA       Cal Date:       061014         Equipment Code:       xADN       Cal Date:       061014         Equipment Code:       xADN       Cal Date:       061014         Customer:       Northwest EMC       Tester:       Varuzhan Kocharyan       Humidity:       39%         Certificate No.:       xADN       061014       Power:       VA       Job Site:       EV Cal Lab         TEST SPECIFICATIONS         TEST PARAMETERS
0327/02dmt         Device       Dipole Antenna       SPEAG       SA AAD 175 AA       Cal Date:       061014         Equipment Code:       xADN       Cal Date:       061014       Temperature:       23C         Customer:       Northwest EMC       Tester:       Varuzhan Kocharyan       Humidity:       39%         Certificate No.:       xADN       061014       Power:       NA       Job Site:       EV Cal Lab         TEST SPECIFICATIONS         TEST PARAMETERS
Device Dipole Antenna     SPEAG     SA AAD 175 AA       Equipment Code:     xADN     Cal Date:     061014       Customer:     Northwest EMC     Tester:     Varuzhan Kocharyan     Humidity:     39%       Certificate No.:     xADN     061014     Power:     N/A     Job Site:     EV Cal Lab       TEST SPECIFICATIONS       Specification:     FCC KDB 865664, Section 3.2.2
Equipment Code: XADN     Cal Date: Us1014       Customer:     Northwest EMC     Tester: Varuzhan Kocharyan     Humidity: 39%       Certificate No.:     XADN     061014     Power: N/A     Job Site: EV Cal Lab       TEST SPECIFICATIONS       Specification: FCC KDB 865664, Section 3.2.2       TEST PARAMETERS
Temperature: 200       Customer:     Northwest EMC     Tester:     Varuzhan Kocharyan     Humidity:     39%       Certificate No.:     xADN     061014     Power:     N/A     Job Site:     EV Cal Lab       TEST SPECIFICATIONS       Specification:     FCC KDB 865664, Section 3.2.2       TEST PARAMETERS
Certificate No.:     xADN     061014     Power:     NA     Job Site:     EV Cal Lab       TEST SPECIFICATIONS       Specification:     FCC KDB 865664, Section 3.2.2       TEST PARAMETERS
TEST SPECIFICATIONS Specification: FCC KDB 865664, Section 3.2.2 TEST PARAMETERS
Specification: FCC KDB 865664, Section 3.2.2 TEST PARAMETERS
TEST PARAMETERS
Device Received In Tolerance: Yes Calibration Frequency : 1750MHz
Equipment Used to perform calibration
Item: Network Analyzer Identifier: NAD Model: Agilent N5230A Calibration Date 5/7/2014
Item: 50 Ohm Termination Identifier: NAHA Model: Agilent 85032-60017 Calibration Date 5/2/2014
tem: Head ISL identifier: SAPA Model: HSL1/50 Calibration Date 24 hour
Item: Body 15L Identifier: Model: Model: Calibration Date 24 Hour
COMMENTS, OPINIONS and INTERPRETATIONS
Measurement Uncertainty
Probability Distribution Impedance (dB) Return Loss (dB)
Expanded uncertainty U (level of normal (k=2) TBD TBD confidence = 95%)
DEVIATIONS FROM TEST STANDARD
None
RESULTS
Pass
This measurement was a calibration verification. (Instrument parameters are within tolerances.)
19 V .
Qant m Tolman
Approved By Tested By

	Verification Data						
EUT	Dipole Antenna						
Model	SA AAD 175 AA	Antenna Parameters with Head TSL					
S/N	XADN	Impedance 50.15- j1.72					
Manufacturer	SPEAG	Return Loss -36.13 dB					
Date	061014	Antenna Parameters with Body TSI					
Temperature	230	Impedance Obms 47.73+ i 3.73					
Humidity	39%	Return Loss dB $-25.22$ dB					
Training	0070						
Operator	Varuzhan Kocharyan						
		-					

## **Dipole Calibration**

Performed by SPEAG (the manufacturer)

ADN

AIN NWEMC Equipment ID: ADN

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst

- C Service suisse d'étalonnage Servizio svizzero di taratura
- S Swiss Calibration Service

Accreditation No.: SCS 108

S

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates Client Northwest EMC

Certificate No: D1750V2-1040\_Dec11

Object	D1750V2 - SN: 1	040	
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	edure for dipole validation kits abo	ove 700 MHz
Calibration date:	December 06, 20	011	
This calibration certificate docum The measurements and the unce	ents the traceability to nati ertainties with confidence p cted in the closed laborato	ional standards, which realize the physical un probability are given on the following pages an rv facility: environment temperature (22 + 3)°(	nits of measurements (SI). nd are part of the certificate. C and humidity < 70%.
Calibration Equipment used (M&	TE critical for calibration)	,	
Calibration Equipment used (M&	TE critical for calibration)	,,,	
Calibration Equipment used (M&	TE critical for calibration)	Cal Date (Certificate No.)	Scheduled Calibration
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	TE critical for calibration)	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05 Oct 11 (No. 217 01451)	Scheduled Calibration Oct-12
Calibration Equipment used (M& <u>Primary Standards</u> Power meter EPM-442A Power sensor HP 8481A Power sensor HP 8481A	TE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (200)	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368)	Scheduled Calibration Oct-12 Oct-12 Apr-12
Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Even-N mismatch combination	TE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047 2 ( 06327	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371)	Scheduled Calibration Oct-12 Oct-12 Apr-12 Apr-12
Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3	TE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 29-Apr-11 (No. ES3-3205 Apr11)	Scheduled Calibration Oct-12 Oct-12 Apr-12 Apr-12 Apr-12
Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	TE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205 SN: 601	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 29-Apr-11 (No. ES3-3205_Apr11) 04-Jul-11 (No. DAE4-601_Jul11)	Scheduled Calibration Oct-12 Oct-12 Apr-12 Apr-12 Apr-12 Jul-12
Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards	TE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID #	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 29-Apr-11 (No. ES3-3205_Apr11) 04-Jul-11 (No. DAE4-601_Jul11) Check Date (in house)	Scheduled Calibration Oct-12 Oct-12 Apr-12 Apr-12 Apr-12 Jul-12 Scheduled Check
Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A	TE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # MY41092317	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 29-Apr-11 (No. ES3-3205_Apr11) 04-Jul-11 (No. DAE4-601_Jul11) Check Date (in house) 18-Oct-02 (in house check Oct-11)	Scheduled Calibration Oct-12 Oct-12 Apr-12 Apr-12 Apr-12 Jul-12 Scheduled Check In house check: Oct-13
Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06	TE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # MY41092317 100005	Cal Date (Certificate No.) 05-Oct-11 (No. 217-01451) 05-Oct-11 (No. 217-01451) 29-Mar-11 (No. 217-01368) 29-Mar-11 (No. 217-01371) 29-Apr-11 (No. ES3-3205_Apr11) 04-Jul-11 (No. DAE4-601_Jul11) Check Date (in house) 18-Oct-02 (in house check Oct-11) 04-Aug-99 (in house check Oct-11)	Scheduled Calibration Oct-12 Oct-12 Apr-12 Apr-12 Apr-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13
Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E	TE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # MY41092317 100005 US37390585 S4206	Cal Date (Certificate No.)         05-Oct-11 (No. 217-01451)         05-Oct-11 (No. 217-01451)         29-Mar-11 (No. 217-01368)         29-Mar-11 (No. 217-01371)         29-Apr-11 (No. ES3-3205_Apr11)         04-Jul-11 (No. DAE4-601_Jul11)         Check Date (in house)         18-Oct-02 (in house check Oct-11)         04-Aug-99 (in house check Oct-11)         18-Oct-01 (in house check Oct-11)	Scheduled Calibration Oct-12 Oct-12 Apr-12 Apr-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-12
Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E	TE critical for calibration) ID # GB37480704 US37292783 SN: 5086 (20g) SN: 5047.2 / 06327 SN: 3205 SN: 601 ID # MY41092317 100005 US37390585 S4206 Name	Cal Date (Certificate No.)         05-Oct-11 (No. 217-01451)         05-Oct-11 (No. 217-01451)         29-Mar-11 (No. 217-01368)         29-Mar-11 (No. 217-01371)         29-Apr-11 (No. ES3-3205_Apr11)         04-Jul-11 (No. DAE4-601_Jul11)         Check Date (in house)         18-Oct-02 (in house check Oct-11)         04-Aug-99 (in house check Oct-11)         18-Oct-01 (in house check Oct-11)	Scheduled Calibration Oct-12 Oct-12 Apr-12 Apr-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-12
Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E Calibrated by:	ID #         GB37480704         US37292783         SN: 5086 (20g)         SN: 5047.2 / 06327         SN: 3205         SN: 601         ID #         MY41092317         100005         US37390585 S4206         Name         Claudio Leubler	Cal Date (Certificate No.)         05-Oct-11 (No. 217-01451)         05-Oct-11 (No. 217-01451)         29-Mar-11 (No. 217-01368)         29-Mar-11 (No. 217-01371)         29-Apr-11 (No. ES3-3205_Apr11)         04-Jul-11 (No. DAE4-601_Jul11)         Check Date (in house)         18-Oct-02 (in house check Oct-11)         04-Aug-99 (in house check Oct-11)         18-Oct-01 (in house check Oct-11)         Laboratory Technician	Scheduled Calibration Oct-12 Oct-12 Apr-12 Apr-12 Jul-12 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-12

## Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





- S Schweizerischer Kalibrierdienst
- C Service suisse d'étalonnage
- Servizio svizzero di taratura
- S Swiss Calibration Service

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

## Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

## Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

## Additional Documentation:

d) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

## **Measurement Conditions**

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1750 MHz ± 1 MHz	

## **Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.6 ± 6 %	1.35 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

## SAR result with Head TSL

SAR averaged over 1 $cm^3$ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.15 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	36.8 mW /g ± 17.0 % (k=2)

SAR averaged over 10 $\text{cm}^3$ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.85 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	19.5 mW /g ± 16.5 % (k=2)

## **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.4	1.49 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.7 ± 6 %	1.45 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	9.22 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	37.6 mW / g ± 17.0 % (k=2)
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL SAR measured	condition 250 mW input power	4.99 mW / g

## Appendix

## Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.5 Ω + 0.8 jΩ	
Return Loss	- 35.7 dB	

### Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.6 Ω + 0.9 jΩ
Return Loss	- 26.6 dB

## **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.219 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

## Additional EUT Data

Manufactured by	SPEAG
Manufactured on	December 02, 2009

## **DASY5 Validation Report for Head TSL**

Date: 06.12.2011

Test Laboratory: SPEAG, Zurich, Switzerland

### DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1040

Communication System: CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz;  $\sigma = 1.35$  mho/m;  $\epsilon_r = 39.6$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.22, 5.22, 5.22); Calibrated: 29.04.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

## Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 94.874 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 16.5290 SAR(1 g) = 9.15 mW/g; SAR(10 g) = 4.85 mW/g Maximum value of SAR (measured) = 11.375 mW/g



0 dB = 11.380 mW/g = 21.12 dB mW/g


## **DASY5 Validation Report for Body TSL**

Date: 05.12.2011

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1040

Communication System: CW; Frequency: 1750 MHz Medium parameters used: f = 1750 MHz;  $\sigma = 1.45$  mho/m;  $\epsilon_r = 53.7$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.85, 4.85, 4.85); Calibrated: 29.04.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

#### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 93.464 V/m; Power Drift = -0.02 dB Peak SAR (extrapolated) = 15.7190 SAR(1 g) = 9.22 mW/g; SAR(10 g) = 4.99 mW/g Maximum value of SAR (measured) = 11.596 mW/g



0 dB = 11.600 mW/g = 21.29 dB mW/g





# **DIPOLE CALIBRATION**

#### **Dipole Calibration**

Key points:

- 1. Dipoles need to be sent to the manufacturer for calibration every 3 years.
- 2. For those years where they are not sent to the manufacturer the following two parameters are verified annually:
  - a. The return-loss. If it deviates by more than 20% from the calibration data or does not meet the required -20 dB return-loss specification, then it fails the verification and must be sent to the manufacturer for repair and calibration.
  - b. The real and imaginary parts of the impedance. If it deviates by more than 5  $\Omega$  from the calibration data, then it fails the verification and must be sent to the manufacturer for repair and calibration.

The return loss and complex impedance were verified to meet the FCC's criteria within one year of the manufacturer's calibration. The calibration data is used for the SAR system verification. The verification data shows that the dipole characteristics have not changed and the calibration data continues to be valid.

Please see attached calibration and verification data.

# **Dipole Verification**

Performed by Northwest EMC, Inc.

ADO

# NWEMC Equipment ID: ADO

EMC Calibration Certificate/Report												
	Device	Dinole Anten	na	SPEAG	SA AAD 190 CB							03/27/02dint
Equipmen	t Code:	ADO	nu	OI EAG	0A AAD 130 0D					Cal Date:	060514	
Equipment									-	Cemperature:	24C	
Cus	stomer:	Northwest EN	IC		Tester:	Varuzhan Koo	charvan			Humidity:	42%	
Certifica	ate No.:	ADO	060514		Power:	N/A				Job Site:	Cal Lab	
TEST SPECIFICATI	ONS											
Specif	ication:	FCC KDB 865	6664, Section 3.2.2									
TEST PARAMETER	s											
Device Re	ceived	In Tolerance:	Yes		Calibration	Frequency :	1900MHz					
				E	quipment Used to	o perform cali	bration					
Item:		Network	Analyzer	Identifier:	NAD	Model:	A	gilent N5230	A	Calil	bration Date	5/7/2014
Item:		50 Ohm T	ermination	Identifier:	NAHA	Model:	Agi	lent 85032-60	017	Calil	bration Date	5/2/2014
Item:		Head	ITSL	Identifier:	SANB	Model:		Head So	olution	Calil	bration Date	24 hour
Item:		Body	/ TSL	Identifier:	SAOA	Model:		Body Solution	ı	Calil	bration Date	24 hour
Item:				Identifier:		Model:				Calil	bration Date	
COMMENTS, OPINIO	ONS and	INTERPRET	ATIONS									
Measurement Unce	rtainty											
			Brobobility Distribution	Impod	anaa (dP)	Boturn I	ooo (dP)					1
			Probability Distribution	impeu		Retuin	.055 (UB)					
Expanded uncertai confidence = 95%)	nty U (le	vel of	normal (k=2)		TBD	TE	D					
DEVIATIONS FROM	TEST S	TANDARD										
None												
RESULTS												
Pass												
This measu	ireme	nt was a	calibration verifica	tion. (Ins	trument par	ameters a	are within	tolerance	es.)			
	_	0							Varura	ntoraris	m	
Want m Tolman												
Approved By	,									Tested By		
	,				CALIBRATION	DATA ATTACH	IED			residu by		

		Verification Data
EUT	Dipole Antenna	
Model	SA AAD 190 CB	Antenna Parameters with Head TSL
S/N	ADO	Impedance 53.8 +i 2.22
Manufacturer	SPEAG	Return Loss -26.6 dB
Data	060514	
Dale	000514	Antonno Paramotoro with Pody TSI
<b>T</b> +	210	
Temperature	240	Impedance, Ohms 44.82+ j 2.62
Humidity	42%	Return Loss, dB -24.2 dB
Operator	Varuzhan Kocharyan	

# **Dipole Calibration** Performed by SPEAG (the manufacturer)

ADO

NWEMC Equipment ID:

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





S Schweizerischer Kalibrierdienst

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- S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### Client Northwest EMC

Certificate No: D1900V2-5d131\_Dec11

Accreditation No.: SCS 108

CALIBRATION C	ERTIFICATE		
Object	D1900V2 - SN: 5d131		
Calibration procedure(s)	QA CAL-05.v8 Calibration proce	dure for dipole validation kits abo	ove 700 MHz
Calibration date:	December 06, 20	)11	
This calibration certificate docum The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T	ents the traceability to nati rtainties with confidence p ted in the closed laborator	ional standards, which realize the physical un robability are given on the following pages ar ry facility: environment temperature $(22 \pm 3)^{\circ}$	nits of measurements (SI). nd are part of the certificate. C and humidity < 70%.
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	05-Oct-11 (No. 217-01451)	Oct-12
Power sensor HP 8481A	US37292783	05-Oct-11 (No. 217-01451)	Oct-12
Reference 20 dB Attenuator	SN: 5086 (20g)	29-Mar-11 (No. 217-01368)	Apr-12
Type-N mismatch combination	SN: 5047.2 / 06327	29-Mar-11 (No. 217-01371)	Apr-12
Reference Probe ES3DV3	SN: 3205	29-Apr-11 (No. ES3-3205_Apr11)	Apr-12
DAE4	SN: 601	04-Jul-11 (No. DAE4-601_Jul11)	Jul-12
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-11)	In house check: Oct-12
	Name	Function	Signature
Calibrated by:	Claudio Leubler	Laboratory Technician	URL
Approved by:	Katja Pokovic	Technical Manager	le Koji
			Issued: December 7, 2011
This calibration certificate shall no	t be reproduced except in	full without written approval of the laboratory	ç

#### Calibration Laboratory of

Schmid & Partner **Engineering AG** Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst

S Service suisse d'étalonnage C

Servizio svizzero di taratura

S Swiss Calibration Service

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### Glossarv:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

## Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)". February 2005
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields: Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

## Additional Documentation:

d) DASY4/5 System Handbook

## Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end • of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole . positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point. . No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power. .
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna . connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

#### Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 1 MHz	

#### **Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.5 ± 6 %	1.44 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 $\text{cm}^3$ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.3 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	40.4 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.36 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	21.2 mW /g ± 16.5 % (k=2)

#### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	53.5 ± 6 %	1.54 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	0.555.5	

### SAR result with Body TSL

SAR averaged over 1 $\text{cm}^3$ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	10.2 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	40.5 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.38 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	21.4 mW / g ± 16.5 % (k=2)

## Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.8 Ω + 6.0 jΩ
Return Loss	- 23.3 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.1 Ω + 6.3 jΩ
Return Loss	- 23.4 dB

#### General Antenna Parameters and Design

Electrical Delay (one direction)	1.203 ns
----------------------------------	----------

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

#### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	April 14, 2010

### **DASY5 Validation Report for Head TSL**

Date: 06.12.2011

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d131

Communication System: CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.44 mho/m;  $\epsilon_r$  = 39.5;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.01, 5.01, 5.01); Calibrated: 29.04.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

#### Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 98.238 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 18.9380 SAR(1 g) = 10.3 mW/g; SAR(10 g) = 5.36 mW/g Maximum value of SAR (measured) = 12.840 mW/g



0 dB = 12.840 mW/g = 22.17 dB mW/g



## **DASY5 Validation Report for Body TSL**

Date: 05.12.2011

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d131

Communication System: CW; Frequency: 1900 MHz Medium parameters used: f = 1900 MHz;  $\sigma$  = 1.54 mho/m;  $\epsilon_r$  = 53.5;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.62, 4.62, 4.62); Calibrated: 29.04.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

#### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 95.899 V/m; Power Drift = -0.03 dB Peak SAR (extrapolated) = 17.7320 SAR(1 g) = 10.2 mW/g; SAR(10 g) = 5.38 mW/g Maximum value of SAR (measured) = 12.867 mW/g



0 dB = 12.870 mW/g = 22.19 dB mW/g





# **DIPOLE CALIBRATION**

#### **Dipole Calibration**

Key points:

- 1. Dipoles need to be sent to the manufacturer for calibration every 3 years.
- 2. For those years where they are not sent to the manufacturer the following two parameters are verified annually:
  - a. The return-loss. If it deviates by more than 20% from the calibration data or does not meet the required -20 dB return-loss specification, then it fails the verification and must be sent to the manufacturer for repair and calibration.
  - b. The real and imaginary parts of the impedance. If it deviates by more than 5  $\Omega$  from the calibration data, then it fails the verification and must be sent to the manufacturer for repair and calibration.

The return loss and complex impedance were verified to meet the FCC's criteria within one year of the manufacturer's calibration. The calibration data is used for the SAR system verification. The verification data shows that the dipole characteristics have not changed and the calibration data continues to be valid.

Please see attached calibration and verification data.

# **Dipole Verification**

Performed by Northwest EMC, Inc.

ADP

NWEMC Equipment ID: ADP

NORTHWEST			Colibro	lion Co	tificato	Dene	-4			
EMC			Jandra	tion Ce	rtificate	керо	rt			02/27/02dast
Davias Dinala Anto			SPEAG	SAR000						03/27/02011
Equipment Code: ADB	iiid		SFEAG	JARJUU					Cal Data: 111112	
Equipment Code. ADP								-	Car Date: 111413	
Customor: Northwast E	MC			Tostor	Varuzhan Kor	hanvan			Humidity: 40%	
Castificate No : ADB	111412			Power		silaryan			Humany, 40%	
	111413			Power.	N/A				300 Sile. EV10	
Specification: Northwest E	MC	Year				Method:	ECC KDB 86	5664 Section	3 2 2	
		rear.				metriou.	10010000	, occaion a	5.2.2	
Device Received In Tolerance	Ves			Calibratio	Frequency	900MHz				
			Ea	uinment Used	to perform ca	libration		I		
Itom: Notwork	Analyzor			NA I	Model:		Agilant E5061		Calibration Da	to 3/2//2011
Item: 50 Ohm	Termination		Identifier:	NAHA	Model:	۰ ۸۰:	ilent 85032_60	017	Calibration Dr	te 5/6/2013
Item: 10dB A	ttenuator		Identifier:	RCD	Model:	Agi	SA6021-10	•17	Calibration Da	te 4/15/2013
Item: Hea	d TSI		Identifier:	SAS	Model		Head Solution	1	Calibration Da	te 8/28/2013
Item: Bor			Identifier:	SAT	Model:		Body Solution		Calibration Da	te 8/28/2013
COMMENTS OPINIONS and INTERPRET			identilier.	341	Model.		Body Solution	1	Galibration Da	0/20/2013
	ATIONS									
Measurement Uncertainty										
	Probability	Distribution	Impeda	nce (dB)	Return L	oss (dB)				7
						,				
Expanded uncertainty U (level of	norma	l (k=2)	Т	BD	TE	BD				
DEVIATIONS FROM TEST STANDARD										
None										
RESULTS										
Pass										
This measurement was a	a calibrati	on verifie	cation. (Ir	nstrument	paramet	ers are w	ithin tole	erances.)		
								19	V .	
Quit m Tolm	a-							Varuza	nhowingan	
Sand action	-							U		
Approved By									Tested By	
				CALIBRATION	DATA ATTAC	HED				

		Verification Data
EUT	Dipole Antenna	
Model	SAR900	Antenna Parameters with Head TSL
S/N	ADP	Impedance 51.92 -i1.84
Manufacturer	SPEAG	Return Loss -27 8 dB
Date	111413	
Date	111413	Antenna Parameters with Body TSI
Tomporaturo	230	Impedance Ohme 40.77 i3.11
Lumidity	230	Interventions 49.77-jo.11
numially	40%	Return Loss, ub -20.4 ub
Operator	Varuzhan Kaabaryan	
Operator	varuznan Kocharyan	

# **Dipole Calibration**

Performed by SPEAG (the manufacturer)

ADP

NWEMC Equipment ID ADP

**Calibration Laboratory of** Schmid & Partner **Engineering AG** Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service

Accreditation No.: SCS 108

Certificate No: D900V2-1d106\_Dec11

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**Northwest EMC** Client

CALIBRATION C	CERTIFICATE		the second second		
Object	D900V2 - SN: 1d106				
Calibration procedure(s)	QA CAL-05.v8 Calibration procedure for dipole validation kits above 700 MHz				
Calibration date:	December 02, 20	011			
This calibration certificate docum The measurements and the unce All calibrations have been conduc Calibration Equipment used (M&T	ents the traceability to nati rtainties with confidence p cted in the closed laborator TE critical for calibration)	onal standards, which realize the physical un robability are given on the following pages ar ry facility: environment temperature (22 $\pm$ 3)°	its of measurements (SI). Ind are part of the certificate. C and humidity < 70%.		
	lup #				
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration		
Power meter EPM-442A	GB3/480/04	05-Oct-11 (No. 217-01451)	Oct-12		
Power sensor HP 8481A	0537292783	05-Oct-11 (No. 217-01451)	Oct-12		
Reference 20 dB Attenuator	SN: 5086 (20g)	29-Mar-11 (No. 217-01368)	Apr-12		
Petereneo Broke ES2DV2	SN: 5047.27 00327	29-Mar-11 (No. 217-01371)	Apr-12		
Reference Probe ES3DV3	SN: 3205	29-Apr-11 (No. ES3-3205_Apr11)	Apr-12		
DAE4	1 314. 001	04-Jul-11 (NO. DAE4-601_Jul11)	Jul-12		
Secondary Standards	ח #	Check Date (in house)	Scheduled Check		
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13		
BE generator B&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13		
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-11)	In house check: Oct-12		
	Name	Function	Signature		
Calibrated by:	Claudio Leubler	Laboratory Technician	121		
Approved by:	Katja Pokovic	Technical Manager	Sellet's		
			Issued: December 5, 2011		

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#### Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





S

Schweizerischer Kalibrierdienst

Service suisse d'étalonnage С

Servizio svizzero di taratura S

Swiss Calibration Service

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

#### Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

#### Additional Documentation:

d) DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

- Measurement Conditions: Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay: One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

#### **Measurement Conditions**

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.0
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	900 MHz ± 1 MHz	

#### **Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.97 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.9 ± 6 %	0.96 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.66 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	10.7 mW /g ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.71 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	6.87 mW /g ± 16.5 % (k=2)

#### Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.0	1.05 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	52.8 ± 6 %	1.05 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

#### SAR result with Body TSL

SAR averaged over 1 $cm^3$ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.76 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	10.9 mW / g ± 17.0 % (k=2)

SAR averaged over 10 $\rm cm^3$ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.77 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	7.04 mW / g ± 16.5 % (k=2)

Certificate No: D900V2-1d106\_Dec11

## Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.1 Ω - 6.7 jΩ
Return Loss	- 23.6 dB

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	48.4 Ω - 8.1 jΩ
Return Loss	- 21.6 dB

#### **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.412 ns
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After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

#### Additional EUT Data

Manufactured by	SPEAG
Manufactured on	September 22, 2009

## **DASY5 Validation Report for Head TSL**

Date: 02.12.2011

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 1d106

Communication System: CW; Frequency: 900 MHz Medium parameters used: f = 900 MHz;  $\sigma = 0.96$  mho/m;  $\epsilon_r = 40.9$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.97, 5.97, 5.97); Calibrated: 29.04.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

#### Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 58.677 V/m; Power Drift = 0.00032 dB Peak SAR (extrapolated) = 3.9750 **SAR(1 g) = 2.66 mW/g; SAR(10 g) = 1.71 mW/g** Maximum value of SAR (measured) = 3.109 mW/g



0 dB = 3.110 mW/g = 9.86 dB mW/g



### **DASY5 Validation Report for Body TSL**

Date: 02.12.2011

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 1d106

Communication System: CW; Frequency: 900 MHz Medium parameters used: f = 900 MHz;  $\sigma$  = 1.05 mho/m;  $\epsilon_r$  = 52.8;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(5.94, 5.94, 5.94); Calibrated: 29.04.2011
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.0(692); SEMCAD X 14.6.4(4989)

#### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 56.642 V/m; Power Drift = 0.03 dB Peak SAR (extrapolated) = 4.1920 SAR(1 g) = 2.76 mW/g; SAR(10 g) = 1.77 mW/g Maximum value of SAR (measured) = 3.211 mW/g



0 dB = 3.210 mW/g = 10.13 dB mW/g





# **DIPOLE CALIBRATION**

#### **Dipole Calibration**

Key points:

- 1. Dipoles need to be sent to the manufacturer for calibration every 3 years.
- 2. For those years where they are not sent to the manufacturer the following two parameters are verified annually:
  - a. The return-loss. If it deviates by more than 20% from the calibration data or does not meet the required -20 dB return-loss specification, then it fails the verification and must be sent to the manufacturer for repair and calibration.
  - b. The real and imaginary parts of the impedance. If it deviates by more than 5  $\Omega$  from the calibration data, then it fails the verification and must be sent to the manufacturer for repair and calibration.

The return loss and complex impedance were verified to meet the FCC's criteria within one year of the manufacturer's calibration. The calibration data is used for the SAR system verification. The verification data shows that the dipole characteristics have not changed and the calibration data continues to be valid.

Please see attached calibration and verification data.

# **Dipole Verification**

Performed by Northwest EMC, Inc.

ADQ

NORTHWEST			Calibra	tion Certi	ficate &	Report	•				
EMC			Callord			riopon					03/27/02dmt
Device Dipo	le Antenna		SPEAG	D750V3							
Equipment Code: ADQ									Cal Date:	070914	
									Temperature:	25.3C	
Customer: North	hwest EMC			Tester:	Carl Engholm				Humidity:	45%	
Certificate No.: ADQ	07091	4		Power:	N/A				Job Site:	EV CAL	
TEST SPECIFICATIONS											
Specification: North	hwest EMC	Year:	2013			Method:	KDB 450824 D	02 Dipole SAF	R Validation Ve	rification v01r0	11
TEST PARAMETERS								·			
Device Received In To	olerance: Yes			Calibratio	on Frequency :	750 MHz					
				Equipment Used to	perform calib	ration					
Item:	Network Analy	zer	Identifier:	NAD	Model:		Aailent N5230A		L	ast Cal Date:	5/7/2014
Item:	3.5mm Ecal Mod	dule	Identifier:	NADA	Model:	Agi	lent N4691-600	04	L	ast Cal Date:	5/29/2014
Item:	Body TSL		Identifier:	SAZ	Model:		Body Solution		L	ast Cal Date:	24 hours
Item:			Identifier:		Model		,		-	ast Cal Date:	
Item:			Identifier:		Model				1	ast Cal Date:	
COMMENTS OPINIONS and INTE	RPRETATION	s			mouch.					act our pate.	
		5									
Measurement Uncertainty											
	Pr	obability Distribution	Imne	dance (dB)	Return I	oss (dB)					1
		obability Biotribution	pc		riotani L	000 (ub)					
Expanded uncertainty U (level of		normal (k=2)		TBD	TE	3D					
confidence = 95%)											
DEVIATIONS FROM TEST STAN											
None	DAND										
RESULTS											
Pass											
This measurement	was a cali	bration verifica	tion. (Ins	strument para	ameters a	re within t	olerances	5.)			
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Qant m To	elma							Ca	xing	win	
									/	<u> </u>	
Approved By									Tested By		
				CALIBRATION	DATA ATTACH	IED					

		Verification Data			
EUT	Dipole Antenna	750MHz			
Model	D750V3 Antenna Parameters with Head TSL				
S/N	ADQ	Impedance, Ohms	N/A		
Manufacturer	SPEAG	Return Loss, dB	N/A		
Date	7/9/2014				
		Antenna Parameters v	vith Body TSL		
Temperature	25.3C	Impedance, Ohms	51.8 - j1.3		
Humidity	45%	Return Loss, dB	-33.0		

# **Dipole Calibration**

Performed by SPEAG (the manufacturer)

ADQ

#### Calibration Laboratory of

Schmid & Partner **Engineering AG** Zeughausstrasse 43, 8004 Zurich, Switzerland



Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service NWEMC Equipment ID: ADQ

Accreditation No.: SCS 108

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Accredited by the Swiss Accreditation Service (SAS)

The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### Nortwest EMC Client

Certificate No: D750V3-1094\_Jul13

Object	D750V3 - SN: 10	94	
Calibration procedure(s)	QA CAL-05.v9 Calibration proce	dure for dipole validation kits ab	ove 700 MHz
Calibration date:	July 04, 2013		
This calibration certificate docum The measurements and the unce	nents the traceability to nati ertainties with confidence p	onal standards, which realize the physical un robability are given on the following pages a	nits of measurements (SI). nd are part of the certificate.
All calibrations have been condu	cted in the closed laborator	ry facility: environment temperature (22 $\pm$ 3)°	°C and humidity < 70%.
Il calibrations have been condu Calibration Equipment used (M& Primary Standards	cted in the closed laborator TE critical for calibration)	ry facility: environment temperature (22 ± 3)° Cal Date (Certificate No.)	°C and humidity < 70%. Scheduled Calibration
Il calibrations have been condu alibration Equipment used (M& rimary Standards ower meter EPM-442A	cted in the closed laborator TE critical for calibration) ID # GB37480704	Cal Date (Certificate No.) 01-Nov-12 (No. 217-01640)	C and humidity < 70%. Scheduled Calibration Oct-13
Il calibrations have been condu alibration Equipment used (M& rimary Standards ower meter EPM-442A ower sensor HP 8481A	cted in the closed laborator TE critical for calibration) ID # GB37480704 US37292783	Cal Date (Certificate No.) 01-Nov-12 (No. 217-01640) 01-Nov-12 (No. 217-01640)	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13
Il calibrations have been condu alibration Equipment used (M& rimary Standards ower meter EPM-442A ower sensor HP 8481A eference 20 dB Attenuator	cted in the closed laborator TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k)	Cal Date (Certificate No.) 01-Nov-12 (No. 217-01640) 01-Nov-12 (No. 217-01640) 04-Apr-13 (No. 217-01736)	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13 Apr-14
Il calibrations have been condu alibration Equipment used (M& rimary Standards ower meter EPM-442A ower sensor HP 8481A eference 20 dB Attenuator /pe-N mismatch combination	cted in the closed laborator TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5047.3 / 06327	Cal Date (Certificate No.) 01-Nov-12 (No. 217-01640) 01-Nov-12 (No. 217-01640) 04-Apr-13 (No. 217-01736) 04-Apr-13 (No. 217-01739)	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13 Apr-14 Apr-14
Il calibrations have been condu alibration Equipment used (M& rimary Standards ower meter EPM-442A ower sensor HP 8481A eference 20 dB Attenuator /pe-N mismatch combination eference Probe ES3DV3	cted in the closed laborator TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5047.3 / 06327 SN: 3205	Cal Date (Certificate No.) 01-Nov-12 (No. 217-01640) 01-Nov-12 (No. 217-01640) 04-Apr-13 (No. 217-01736) 04-Apr-13 (No. 217-01739) 28-Dec-12 (No. ES3-3205_Dec12)	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13 Apr-14 Apr-14 Dec-13
All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4	cted in the closed laborator TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5047.3 / 06327 SN: 3205 SN: 601	Cal Date (Certificate No.) 01-Nov-12 (No. 217-01640) 01-Nov-12 (No. 217-01640) 04-Apr-13 (No. 217-01736) 04-Apr-13 (No. 217-01739) 28-Dec-12 (No. ES3-3205_Dec12) 25-Apr-13 (No. DAE4-601_Apr13)	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13 Apr-14 Apr-14 Dec-13 Apr-14
All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Recondary Standards	cted in the closed laborator TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5047.3 / 06327 SN: 3205 SN: 601 ID #	Cal Date (Certificate No.) 01-Nov-12 (No. 217-01640) 01-Nov-12 (No. 217-01640) 04-Apr-13 (No. 217-01736) 04-Apr-13 (No. 217-01739) 28-Dec-12 (No. ES3-3205_Dec12) 25-Apr-13 (No. DAE4-601_Apr13) Check Date (in house)	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13 Apr-14 Apr-14 Dec-13 Apr-14 Scheduled Check
All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A	cted in the closed laborator   TE critical for calibration)   ID #   GB37480704   US37292783   SN: 5058 (20k)   SN: 5047.3 / 06327   SN: 3205   SN: 601   ID #   MY41092317	Cal Date (Certificate No.) 01-Nov-12 (No. 217-01640) 01-Nov-12 (No. 217-01640) 04-Apr-13 (No. 217-01736) 04-Apr-13 (No. 217-01739) 28-Dec-12 (No. ES3-3205_Dec12) 25-Apr-13 (No. DAE4-601_Apr13) Check Date (in house) 18-Oct-02 (in house check Oct-11)	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13 Apr-14 Apr-14 Dec-13 Apr-14 Scheduled Check In house check: Oct-13
All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06	cted in the closed laborator   TE critical for calibration)   ID #   GB37480704   US37292783   SN: 5058 (20k)   SN: 5047.3 / 06327   SN: 3205   SN: 601   ID #   MY41092317   100005	Cal Date (Certificate No.) 01-Nov-12 (No. 217-01640) 01-Nov-12 (No. 217-01640) 04-Apr-13 (No. 217-01736) 04-Apr-13 (No. 217-01739) 28-Dec-12 (No. ES3-3205_Dec12) 25-Apr-13 (No. DAE4-601_Apr13) Check Date (in house) 18-Oct-02 (in house check Oct-11) 04-Aug-99 (in house check Oct-11)	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13 Apr-14 Apr-14 Dec-13 Apr-14 Dec-13 Apr-14 Scheduled Check In house check: Oct-13 In house check: Oct-13
All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E	cted in the closed laborator   TE critical for calibration)   ID #   GB37480704   US37292783   SN: 5058 (20k)   SN: 5047.3 / 06327   SN: 3205   SN: 601   ID #   MY41092317   100005   US37390585 S4206	Cal Date (Certificate No.) 01-Nov-12 (No. 217-01640) 01-Nov-12 (No. 217-01640) 04-Apr-13 (No. 217-01736) 04-Apr-13 (No. 217-01739) 28-Dec-12 (No. ES3-3205_Dec12) 25-Apr-13 (No. DAE4-601_Apr13) Check Date (in house) 18-Oct-02 (in house check Oct-11) 04-Aug-99 (in house check Oct-12)	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13 Apr-14 Dec-13 Apr-14 Dec-13 Apr-14 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-13
All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E	cted in the closed laborator TE critical for calibration) ID # GB37480704 US37292783 SN: 5058 (20k) SN: 5047.3 / 06327 SN: 3205 SN: 601 ID # MY41092317 100005 US37390585 S4206 Name	Cal Date (Certificate No.) 01-Nov-12 (No. 217-01640) 01-Nov-12 (No. 217-01640) 04-Apr-13 (No. 217-01736) 04-Apr-13 (No. 217-01739) 28-Dec-12 (No. ES3-3205_Dec12) 25-Apr-13 (No. DAE4-601_Apr13) Check Date (in house) 18-Oct-02 (in house check Oct-11) 04-Aug-99 (in house check Oct-12) Eunction	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13 Apr-14 Apr-14 Dec-13 Apr-14 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-13 Signature
All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E	cted in the closed laborator   TE critical for calibration)   ID #   GB37480704   US37292783   SN: 5058 (20k)   SN: 5047.3 / 06327   SN: 3205   SN: 601   ID #   MY41092317   100005   US37390585 S4206	Cal Date (Certificate No.)   01-Nov-12 (No. 217-01640)   01-Nov-12 (No. 217-01640)   04-Apr-13 (No. 217-01736)   04-Apr-13 (No. 217-01739)   28-Dec-12 (No. ES3-3205_Dec12)   25-Apr-13 (No. DAE4-601_Apr13)   Check Date (in house)   18-Oct-02 (in house check Oct-11)   04-Aug-99 (in house check Oct-12)	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13 Apr-14 Apr-14 Dec-13 Apr-14 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-13 In house check: Oct-13 In house check: Oct-13
All calibrations have been condu Calibration Equipment used (M& Primary Standards Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 Secondary Standards Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E	cted in the closed laborator   TE critical for calibration)   ID #   GB37480704   US37292783   SN: 5058 (20k)   SN: 5047.3 / 06327   SN: 3205   SN: 601   ID #   MY41092317   100005   US37390585 S4206   Name   Leif Klysner	Cal Date (Certificate No.)   01-Nov-12 (No. 217-01640)   01-Nov-12 (No. 217-01640)   04-Apr-13 (No. 217-01736)   04-Apr-13 (No. 217-01739)   28-Dec-12 (No. ES3-3205_Dec12)   25-Apr-13 (No. DAE4-601_Apr13)   Check Date (in house)   18-Oct-02 (in house check Oct-11)   04-Aug-99 (in house check Oct-12)	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13 Apr-14 Apr-14 Dec-13 Apr-14 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-13 Signature Sey May
All calibrations have been condu Calibration Equipment used (M& <u>Primary Standards</u> Power meter EPM-442A Power sensor HP 8481A Reference 20 dB Attenuator Type-N mismatch combination Reference Probe ES3DV3 DAE4 <u>Secondary Standards</u> Power sensor HP 8481A RF generator R&S SMT-06 Network Analyzer HP 8753E Calibrated by:	cted in the closed laborator   TE critical for calibration)   ID #   GB37480704   US37292783   SN: 5058 (20k)   SN: 5047.3 / 06327   SN: 3205   SN: 601   ID #   MY41092317   100005   US37390585 S4206   Name   Leif Klysner	Cal Date (Certificate No.)   01-Nov-12 (No. 217-01640)   01-Nov-12 (No. 217-01640)   04-Apr-13 (No. 217-01736)   04-Apr-13 (No. 217-01739)   28-Dec-12 (No. ES3-3205_Dec12)   25-Apr-13 (No. DAE4-601_Apr13)   Check Date (in house)   18-Oct-02 (in house check Oct-11)   04-Aug-99 (in house check Oct-12)   Function   Laboratory Technician	C and humidity < 70%. Scheduled Calibration Oct-13 Oct-13 Apr-14 Dec-13 Apr-14 Scheduled Check In house check: Oct-13 In house check: Oct-13 In house check: Oct-13 Signature Sef Million

#### Calibration Laboratory of

Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





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Schweizerischer Kalibrierdienst Service suisse d'étalonnage Servizio svizzero di taratura Swiss Calibration Service

Accreditation No.: SCS 108

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

#### Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

#### Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) Federal Communications Commission Office of Engineering & Technology (FCC OET), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields; Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", Supplement C (Edition 01-01) to Bulletin 65

#### Additional Documentation:

d) DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

#### Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Varcian	DACVE	VE0.9.7
DAST VEISION	DASTS	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	750 MHz ± 1 MHz	

#### **Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.9	0.89 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	42.0 ± 6 %	0.90 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

#### SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.17 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	8.61 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.43 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	5.68 W/kg ± 16.5 % (k=2)

#### **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.5	0.96 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	55.1 ± 6 %	0.98 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.25 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	8.85 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.49 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	5.88 W/kg ± 16.5 % (k=2)
#### Appendix

## Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.8 Ω - 0.4 jΩ		
Return Loss	- 28.8 dB		

## Antenna Parameters with Body TSL

Impedance, transformed to feed point	49.4 Ω - 2.7 jΩ		
Return Loss	- 31.2 dB		

## **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.033 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

## Additional EUT Data

Manufactured by	SPEAG		
Manufactured on	April 11, 2013		

#### DASY5 Validation Report for Head TSL

Date: 04.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1094

Communication System: UID 0 - CW ; Frequency: 750 MHz Medium parameters used: f = 750 MHz;  $\sigma$  = 0.9 S/m;  $\epsilon_r$  = 42;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.28, 6.28, 6.28); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 53.310 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 3.27 W/kg SAR(1 g) = 2.17 W/kg; SAR(10 g) = 1.43 W/kg Maximum value of SAR (measured) = 2.53 W/kg



0 dB = 2.53 W/kg = 4.03 dBW/kg

#### Impedance Measurement Plot for Head TSL



#### DASY5 Validation Report for Body TSL

Date: 04.07.2013

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 750 MHz; Type: D750V3; Serial: D750V3 - SN: 1094

Communication System: UID 0 - CW ; Frequency: 750 MHz Medium parameters used: f = 750 MHz;  $\sigma = 0.98$  S/m;  $\varepsilon_r = 55.1$ ;  $\rho = 1000$  kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(6.11, 6.11, 6.11); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

#### Dipole Calibration for Body Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 53.310 V/m; Power Drift = 0.00 dB Peak SAR (extrapolated) = 3.27 W/kg SAR(1 g) = 2.25 W/kg; SAR(10 g) = 1.49 W/kg Maximum value of SAR (measured) = 2.60 W/kg



0 dB = 2.60 W/kg = 4.15 dBW/kg

#### Impedance Measurement Plot for Body TSL





# **DIPOLE CALIBRATION**

#### **Dipole Calibration**

Key points:

- 1. Dipoles need to be sent to the manufacturer for calibration every 3 years.
- 2. For those years where they are not sent to the manufacturer the following two parameters are verified annually:
  - a. The return-loss. If it deviates by more than 20% from the calibration data or does not meet the required -20 dB return-loss specification, then it fails the verification and must be sent to the manufacturer for repair and calibration.
  - b. The real and imaginary parts of the impedance. If it deviates by more than 5  $\Omega$  from the calibration data, then it fails the verification and must be sent to the manufacturer for repair and calibration.

The return loss and complex impedance were verified to meet the FCC's criteria within one year of the manufacturer's calibration. The calibration data is used for the SAR system verification. The verification data shows that the dipole characteristics have not changed and the calibration data continues to be valid.

Please see attached calibration and verification data.

## **Dipole Verification**

Performed by Northwest EMC, Inc.

ADR

NORTHWEST				(	Calibra	tion Certi	ficate &	Report					
EMC													03/27/02dmt
	Device	Dipole Antenn	a		SPEAG	D2600V2							
Equ	uipment Code:	ADR									Cal Date:	081314	
											Temperature:	20C	
	Customer:	Northwest EM	IC			Tester:	Carl Engholm				Humidity:	49%	
c	Certificate No.:	ADR	081314			Power:	N/A				Job Site:	EV CAL	
TEST SPECIF	CATIONS												
	Specification:	Northwest EM	IC	Year:	2014			Method: KDB 45	50824 D	02 Dipole SAR	Validation Ve	rification v01r0	1
TEST PARAM	IETERS												
De	evice Received	I In Tolerance:	Yes			Calibratio	on Frequency :	2600 MHz					
						Equipment Used to	o perform calib	ration					
Item:		Network	Analyzer		Identifier:	NAD	Model:	Agilent I	N5230A		La	st Cal. Date:	5/7/2014
Item:		3.5mm Ec	al Module		Identifier:	NADA	Model:	Agilent N46	691-6000	04	La	st Cal. Date:	5/29/2014
Item:		Body	TSL		Identifier:	SBA	Model:	Body S	olution		La	st Cal. Date:	24 hours
Item:					Identifier:		Model:				La	st Cal. Date:	
Item:					Identifier:		Model:				La	st Cal. Date:	
COMMENTS,	OPINIONS and	INTERPRETA	TIONS										
Mossurement	Uncortainty												
measurement	oncertainty							<u>.</u>					
			Probability	Distribution	Impe	dance (dB)	Return L	loss (dB)					
Expanded und	certaintv U (lev	el of	norma	l (k=2)		TBD	TE	3D					
confidence = 9	95%)												
DEVIATIONS None	FROM TEST S	TANDARD											
RESULTS													
Pass													
This m	neasurem	ent was a	calibratio	n verifica	tion. (Ins	strument para	ameters a	re within tolera	ances	.)			
	Andrea												
Qan	Am	Tol								Ca	xing	when	
									_	-	/		
Approve	ed By										Tested By		
						CALIBRATION I	DATA ATTACH	IED					

	Verification Data					
<b>EUT</b> Model S/N Manufacturer Date Temperature Humidity	Dipole Antenna D2600V2 ADR SPEAG 8/13/2014 20C 49%	2600MHz   Antenna Parameters with Head TSL   Impedance, Ohms N/A   Return Loss, dB N/A   Antenna Parameters with Body TSL   Impedance, Ohms 47.0 - j5.3   Return Loss, dB -22.5				
Humidity	49%	Return Loss, dB -22.5				

## **Dipole Calibration**

Performed by SPEAG (the manufacturer)

ADR

**Calibration Laboratory of** Schmid & Partner **Engineering AG** Zeughausstrasse 43, 8004 Zurich, Switzerland





Schweizerischer Kalibrierdienst Service suisse d'étalonnage

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**Swiss Calibration Service** 

Accreditation No.: SCS 108

S

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

**Northwest EMC** Client

Certificate No: D2600V2-1068\_Aug13

CALIBRATION C	ERTIFICATE		
Object	D2600V2 - SN: 1	068	
Calibration procedure(s)	QA CAL-05.v9 Calibration proce	dure for dipole validation kits ab	ove 700 MHz
Calibration date:	August 30, 2013		
This calibration certificate docume The measurements and the uncer All calibrations have been conduc Calibration Equipment used (M&T	ents the traceability to nati rtainties with confidence p sted in the closed laborato "E critical for calibration)	ional standards, which realize the physical u robability are given on the following pages a ry facility: environment temperature (22 ± 3)	nits of measurements (SI). nd are part of the certificate. °C and humidity < 70%.
Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
ower sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
eference 20 dB Attenuator	SN: 5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
ype-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
eference Probe ES3DV3 AE4	SN: 3205 SN: 601	28-Dec-12 (No. ES3-3205_Dec12) 25-Apr-13 (No. DAE4-601_Apr13)	Dec-13 Apr-14
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP 8481A	MY41092317	18-Oct-02 (in house check Oct-11)	In house check: Oct-13
RF generator R&S SMT-06	100005	04-Aug-99 (in house check Oct-11)	In house check: Oct-13
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-12)	In house check: Oct-13
	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	Jahan & Dages
Approved by:	Katja Pokovic	Technical Manager	Jol 14
Report No. INTE5478			Issued: Aug 605/612013
This calibration certificate shall no	t he reproduced except in	full without written approval of the laborator	v

Calibration Laboratory of Schmid & Partner Engineering AG Zeughausstrasse 43, 8004 Zurich, Switzerland





S

Schweizerischer Kalibrierdienst

- Service suisse d'étalonnage
- C Servizio svizzero di taratura
- S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS) The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates Accreditation No.: SCS 108

#### **Glossary:**

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

## Calibration is Performed According to the Following Standards:

- a) IEEE Std 1528-2003, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", December 2003
- b) IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- c) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## **Additional Documentation:**

d) DASY4/5 System Handbook

#### Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL: The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss: These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured: SAR measured at the stated antenna input power.
- SAR normalized: SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters: The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Report No. INTE5478

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#### **Measurement Conditions**

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2600 MHz ± 1 MHz	

## **Head TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.0	1.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.2 ± 6 %	1.97 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C		

## SAR result with Head TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	Condition		
SAR measured	250 mW input power	14.5 W/kg	
SAR for nominal Head TSL parameters	normalized to 1W	57.2 W/kg ± 17.0 % (k=2)	
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition		
SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL SAR measured	condition 250 mW input power	6.46 W/kg	

## **Body TSL parameters**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	52.5	2.16 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	50.1 ± 6 %	2.21 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C		

## SAR result with Body TSL

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	14.3 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	56.0 W/kg ± 17.0 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.31 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	24.9 W/kg ± 16.5 % (k=2)

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## Appendix

#### Antenna Parameters with Head TSL

Impedance, transformed to feed point	48.0 Ω - 5.5 jΩ	
Return Loss	- 24.5 dB	

#### Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.8 Ω - 4.4 jΩ	
Return Loss	- 22.8 dB	

#### **General Antenna Parameters and Design**

Electrical Delay (one direction)	1.149 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.

No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

#### **Additional EUT Data**

Manufactured by	SPEAG
Manufactured on	July 17, 2013

#### **DASY5 Validation Report for Head TSL**

Date: 30.08.2013

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1068

Communication System: UID 0 - CW ; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma$  = 1.97 S/m;  $\epsilon_r$  = 37.2;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.45, 4.45, 4.45); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

## Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mmReference Value = 101.7 V/m; Power Drift = 0.06 dB Peak SAR (extrapolated) = 30.9 W/kg SAR(1 g) = 14.5 W/kg; SAR(10 g) = 6.46 W/kg Maximum value of SAR (measured) = 18.7 W/kg



0 dB = 18.7 W/kg = 12.72 dBW/kg



#### **DASY5 Validation Report for Body TSL**

Date: 30.08.2013

Test Laboratory: SPEAG, Zurich, Switzerland

#### DUT: Dipole 2600 MHz; Type: D2600V2; Serial: D2600V2 - SN: 1068

Communication System: UID 0 - CW ; Frequency: 2600 MHz Medium parameters used: f = 2600 MHz;  $\sigma$  = 2.21 S/m;  $\epsilon_r$  = 50.1;  $\rho$  = 1000 kg/m<sup>3</sup> Phantom section: Flat Section Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

#### DASY52 Configuration:

- Probe: ES3DV3 SN3205; ConvF(4.32, 4.32, 4.32); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 25.04.2013
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

#### Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm Reference Value = 95.390 V/m; Power Drift = 0.04 dB Peak SAR (extrapolated) = 31.2 W/kg SAR(1 g) = 14.3 W/kg; SAR(10 g) = 6.31 W/kg Maximum value of SAR (measured) = 19.1 W/kg



0 dB = 19.1 W/kg = 12.81 dBW/kg

