

11. 5GHz System Validation Dipole (D5GHz V2, S/N: 1020)

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



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Accreditation No.: SCS 108

Client **UL Japan (MTT)**

Certificate No: **D5GHzV2-1020\_Aug07**

**CALIBRATION CERTIFICATE**

Object: **D5GHzV2 - SN: 1020**

Calibration procedure(s): **QA CAL-22.v1  
Calibration procedure for dipole validation kits between 3-6 GHz**

Calibration date: **August 14, 2007**

Condition of the calibrated item: **In Tolerance**

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&TE critical for calibration)

Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	29-Mar-07 (METAS, No. 217-00670)	Mar-08
Power sensor E4412A	MY41495277	29-Mar-07 (METAS, No. 217-00670)	Mar-08
Power sensor E4412A	MY41498087	29-Mar-07 (METAS, No. 217-00670)	Mar-08
Reference 20 dB Attenuator	SN: S5088 (20b)	29-Mar-07 (METAS, No. 217-00671)	Mar-08
Reference 10 dB Attenuator	SN: 5047.2 (10r)	07-Aug-07 (METAS, No. 217-00718)	Aug-08
Reference Probe EX3DV4	SN: 3503	9-Mar-07 (SPEAG, No. EX3-3503_Mar07)	Mar-08
DAE4	SN 601	30-Jan-07 (SPEAG, No. DAE4-601_Jan07)	Jan-08
Secondary Standards	ID #	Check Date (In house)	Scheduled Check
RF generator R&S SMT-06	100005	4-Aug-99 (SPEAG, In house check Nov-05)	In house check: Nov-07
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (SPEAG, In house check Oct-06)	In house check: Oct-07

Calibrated by: Name: **Mike Meili**, Function: **Laboratory Technician**, Signature: *[Signature]*

Approved by: Name: **Katja Pokovic**, Function: **Technical Manager**, Signature: *[Signature]*

Issued: August 17, 2007

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

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**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) IEC Std 62209 Part 2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation, and Procedures"; Part 2: "Procedure to determine the Specific Absorption Rate (SAR) for including accessories and multiple transmitters", Draft Version 0.9, December 2004
- b) 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:**

- c) DASY4 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.

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**Measurement Conditions**

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

DASY Version	DASY4	V4.7
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Area Scan resolution	dx, dy = 10 mm	
Zoom Scan Resolution	dx, dy = 4. mm, dz = 2.5 mm	
Frequency	5200 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

**Head TSL parameters at 5200 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.8 ± 6 %	4.56 mho/m ± 6 %
Head TSL temperature during test	(22.5 ± 0.2) °C	---	----

**SAR result with Head TSL at 5200 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	condition	
SAR measured	250 mW input power	19.3 mW / g
SAR normalized	normalized to 1W	77.2 mW / g
SAR for nominal Head TSL parameters <sup>1</sup>	normalized to 1W	77.0mW / g ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.51 mW / g
SAR normalized	normalized to 1W	22.0 mW / g
SAR for nominal Head TSL parameters <sup>1</sup>	normalized to 1W	22.0 mW / g ± 19.5 % (k=2)

<sup>1</sup> Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities"

**Head TSL parameters at 5500 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.1 ± 6 %	4.86 mho/m ± 6 %
Head TSL temperature during test	(22.5 ± 0.2) °C	----	----

**SAR result with Head TSL at 5500 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	condition	
SAR measured	250 mW input power	19.2 mW / g
SAR normalized	normalized to 1W	76.8 mW / g
SAR for nominal Head TSL parameters <sup>1</sup>	normalized to 1W	<b>76.4 mW / g ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.48 mW / g
SAR normalized	normalized to 1W	21.9 mW / g
SAR for nominal Head TSL parameters <sup>1</sup>	normalized to 1W	<b>21.8 mW / g ± 19.5 % (k=2)</b>

**Head TSL parameters at 5800 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.6 ± 6 %	5.15 mho/m ± 6 %
Head TSL temperature during test	(22.5 ± 0.2) °C	----	----

**SAR result with Head TSL at 5800 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL	condition	
SAR measured	250 mW input power	19.0 mW / g
SAR normalized	normalized to 1W	76.8 mW / g
SAR for nominal Head TSL parameters <sup>1</sup>	normalized to 1W	<b>76.3 mW / g ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.39 mW / g
SAR normalized	normalized to 1W	21.9 mW / g
SAR for nominal Head TSL parameters <sup>1</sup>	normalized to 1W	<b>21.8 mW / g ± 19.5 % (k=2)</b>

<sup>1</sup> Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities"

**Body TSL parameters at 5200 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	49.0	5.30 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	47.6 ± 6 %	5.37 mho/m ± 6 %
Body TSL temperature during test	(21.5 ± 0.2) °C	----	----

**SAR result with Body TSL at 5200 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	condition	
SAR measured	250 mW input power	18.6 mW / g
SAR normalized	normalized to 1W	74.4 mW / g
SAR for nominal Body TSL parameters <sup>1</sup>	normalized to 1W	73.7 mW / g ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.28 mW / g
SAR normalized	normalized to 1W	21.1 mW / g
SAR for nominal Body TSL parameters <sup>1</sup>	normalized to 1W	21.0 mW / g ± 19.5 % (k=2)

**Body TSL parameters at 5500 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.6	5.56 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.9 ± 6 %	5.78 mho/m ± 6 %
Body TSL temperature during test	(21.5 ± 0.2) °C	----	----

**SAR result with Body TSL at 5500 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	condition	
SAR measured	250 mW input power	19.0 mW / g
SAR normalized	normalized to 1W	76.0 mW / g
SAR for nominal Body TSL parameters <sup>1</sup>	normalized to 1W	75.2 mW / g ± 19.9 % (k=2)

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.34 mW / g
SAR normalized	normalized to 1W	21.4 mW / g
SAR for nominal Body TSL parameters <sup>1</sup>	normalized to 1W	21.2 mW / g ± 19.5 % (k=2)

<sup>1</sup> Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities"

**Body TSL parameters at 5800 MHz**

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	48.2	6.00 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	46.4 ± 6 %	6.15 mho/m ± 6 %
Body TSL temperature during test	(21.5 ± 0.2) °C	----	----

**SAR result with Body TSL at 5800 MHz**

SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL	condition	
SAR measured	250 mW input power	17.3 mW / g
SAR normalized	normalized to 1W	69.2mW / g
SAR for nominal Body TSL parameters <sup>1</sup>	normalized to 1W	<b>68.4 mW / g ± 19.9 % (k=2)</b>

SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL	condition	
SAR measured	250 mW input power	4.85 mW / g
SAR normalized	normalized to 1W	19.4 mW / g
SAR for nominal Body TSL parameters <sup>1</sup>	normalized to 1W	<b>19.2 mW / g ± 19.5 % (k=2)</b>

<sup>1</sup> Correction to nominal TSL parameters according to c), chapter "SAR Sensitivities"

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**Appendix**

**Antenna Parameters with Head TSL at 5200 MHz**

Impedance, transformed to feed point	50.4 $\Omega$ - 9.6 j $\Omega$
Return Loss	-20.4 dB

**Antenna Parameters with Head TSL at 5500 MHz**

Impedance, transformed to feed point	51.0 $\Omega$ - 3.2 j $\Omega$
Return Loss	-29.6 dB

**Antenna Parameters with Head TSL at 5800 MHz**

Impedance, transformed to feed point	56.4 $\Omega$ - 1.2 j $\Omega$
Return Loss	-24.3 dB

**Antenna Parameters with Body TSL at 5200 MHz**

Impedance, transformed to feed point	49.8 $\Omega$ - 8.2 j $\Omega$
Return Loss	-21.7 dB

**Antenna Parameters with Body TSL at 5500 MHz**

Impedance, transformed to feed point	51.4 $\Omega$ - 2.3 j $\Omega$
Return Loss	-31.4 dB

**Antenna Parameters with Body TSL at 5800 MHz**

Impedance, transformed to feed point	57.9 $\Omega$ + 1.0 j $\Omega$
Return Loss	-22.6 dB

**General Antenna Parameters and Design**

Electrical Delay (one direction)	1.200 ns
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After long term use with 40 W 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. 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	February 05, 2004

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**DASY4 Validation Report for Head TSL**

Date/Time: 14.08.2007 14:25:50

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHz; Serial: D5GHzV2 - SN:1020**

Communication System: CW-5GHz; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz; Duty Cycle: 1:1

Medium: HSL 5800 MHz;

Medium parameters used:  $f = 5200$  MHz;  $\sigma = 4.56$  mho/m;  $\epsilon_r = 35.8$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used:  $f = 5500$  MHz;  $\sigma = 4.86$  mho/m;  $\epsilon_r = 35.1$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used:  $f = 5800$  MHz;  $\sigma = 5.15$  mho/m;  $\epsilon_r = 34.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.56, 5.56, 5.56)ConvF(5.2, 5.2, 5.2)ConvF(4.97, 4.97, 4.97); Calibrated: 09.03.2007
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.01.2007
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**d=10mm, Pin=250mW, f=5200 MHz /Zoom Scan (8x8x10), dist=2mm 2 (8x8x10)/Cube 0:**

Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 75.0 V/m; Power Drift = 0.077 dB

Peak SAR (extrapolated) = 72.7 W/kg

**SAR(1 g) = 19.3 mW/g; SAR(10 g) = 5.51 mW/g**

Maximum value of SAR (measured) = 39.9 mW/g

**d=10mm, Pin=250mW, f=5500 MHz/Zoom Scan (8x8x10), dist=2mm 2 (8x8x10)/Cube 0:**

Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 72.7 V/m; Power Drift = -0.002 dB

Peak SAR (extrapolated) = 74.9 W/kg

**SAR(1 g) = 19.2 mW/g; SAR(10 g) = 5.48 mW/g**

Maximum value of SAR (measured) = 40.5 mW/g

**d=10mm, Pin=250mW, f=5800 MHz/Zoom Scan (8x8x10), dist=2mm (8x8x10)/Cube 0:**

Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 69.2 V/m; Power Drift = 0.076 dB

Peak SAR (extrapolated) = 78.7 W/kg

**SAR(1 g) = 19 mW/g; SAR(10 g) = 5.39 mW/g**

Maximum value of SAR (measured) = 40.4 mW/g

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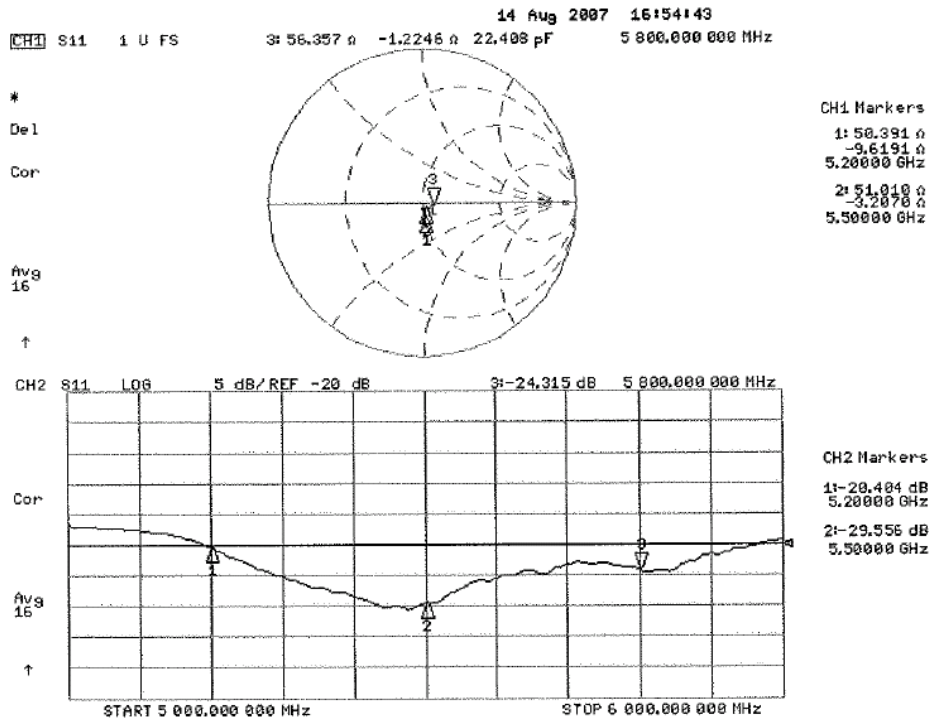
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Impedance Measurement Plot for Head TSL



**DASY4 Validation Report for Body TSL**

Date/Time: 14.08.2007 18:11:53

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 5GHz; Type: D5GHz; Serial: D5GHzV2 - SN:1020**

Communication System: CW-5GHz; Frequency: 5200 MHz, Frequency: 5500 MHz, Frequency: 5800 MHz; Duty Cycle: 1:1

Medium: MSL 5800 MHz;

Medium parameters used:  $f = 5800$  MHz;  $\sigma = 6.2$  mho/m;  $\epsilon_r = 46.5$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used:  $f = 5500$  MHz;  $\sigma = 5.82$  mho/m;  $\epsilon_r = 46.9$ ;  $\rho = 1000$  kg/m<sup>3</sup> Medium parameters used:  $f = 5200$  MHz;  $\sigma = 5.41$  mho/m;  $\epsilon_r = 47.6$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY4 (High Precision Assessment)

DASY4 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(4.76, 4.76, 4.76)ConvF(4.63, 4.63, 4.63)ConvF(4.96, 4.96, 4.96); Calibrated: 09.03.2007
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.01.2007
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA
- Measurement SW: DASY4, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

**d=10mm, Pin=250mW, f=5200 MHz, NEW zoom scan settings/Zoom Scan (8x8x10),**

**dist=2mm (8x8x10)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 75.7 V/m; Power Drift = -0.100 dB

Peak SAR (extrapolated) = 66.2 W/kg

**SAR(1 g) = 18.6 mW/g; SAR(10 g) = 5.28 mW/g**

Maximum value of SAR (measured) = 36.4 mW/g

**d=10mm, Pin=250mW, f=5500 MHz/Zoom Scan (8x8x10), dist=2mm (8x8x10)/Cube 0:**

Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 71.4 V/m; Power Drift = -0.008 dB

Peak SAR (extrapolated) = 75.9 W/kg

**SAR(1 g) = 19 mW/g; SAR(10 g) = 5.34 mW/g**

Maximum value of SAR (measured) = 37.8 mW/g

**d=10mm, Pin=250mW, f=5800 MHz/Zoom Scan (8x8x10), dist=2mm (8x8x10)/Cube 0:**

Measurement grid: dx=4mm, dy=4mm, dz=2.5mm

Reference Value = 65.8 V/m; Power Drift = 0.010 dB

Peak SAR (extrapolated) = 68.9 W/kg

**SAR(1 g) = 17.3 mW/g; SAR(10 g) = 4.85 mW/g**

Maximum value of SAR (measured) = 34.9 mW/g

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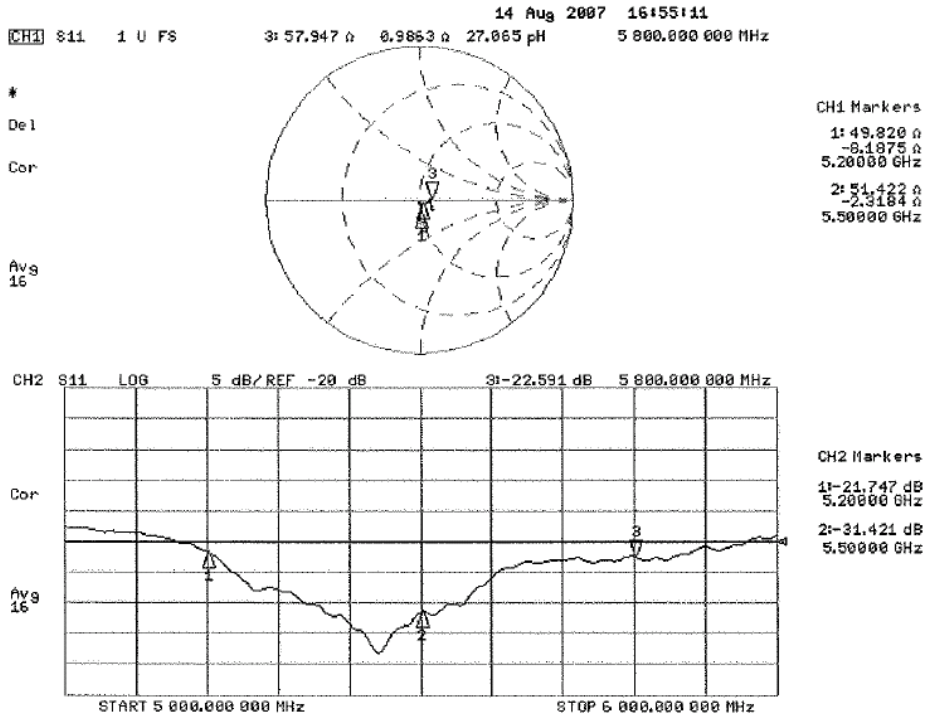
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Impedance Measurement Plot for Body TSL



12. Dosimetric E-Field Probe Calibration (EX3DV3,S/N: 3507)

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Accreditation No.: **SCS 108**

Client **UL Japan (MTT)**

Certificate No: **EX3-3507\_Jun07**

CALIBRATION CERTIFICATE			
Object	EX3DV3 - SN:3507		
Calibration procedure(s)	QA CAL-01.v6 and QA CAL-14.v3 Calibration procedure for dosimetric E-field probes		
Calibration date:	June 15, 2007		
Condition of the calibrated item	In Tolerance		
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&TE critical for calibration)			
Primary Standards	ID #	Cal Date (Calibrated by, Certificate No.)	Scheduled Calibration
Power meter E4419B	QB41293874	29-Mar-07 (METAS, No. 217-00670)	Mar-08
Power sensor E4412A	MY41495277	29-Mar-07 (METAS, No. 217-00670)	Mar-08
Power sensor E4412A	MY41498087	29-Mar-07 (METAS, No. 217-00670)	Mar-08
Reference 3 dB Attenuator	SN: S5054 (3c)	10-Aug-06 (METAS, No. 217-00592)	Aug-07
Reference 20 dB Attenuator	SN: S5086 (20b)	29-Mar-07 (METAS, No. 217-00671)	Mar-08
Reference 30 dB Attenuator	SN: S5129 (30b)	10-Aug-06 (METAS, No. 217-00593)	Aug-07
Reference Probe ES3DV2	SN: 3013	4-Jan-07 (SPEAG, No. ES3-3013_Jan07)	Jan-08
D4E4	SN: 654	20-Apr-07 (SPEAG, No. D4E4-654_Apr07)	Apr-08
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (SPEAG, in house check Nov-05)	In house check: Nov-07
Network Analyzer HP 8753E	US37390585	18-Oct-01 (SPEAG, in house check Oct-06)	In house check: Oct-07
Calibrated by:	Name Katja Pokovic	Function Technical Manager	Signature 
Approved by:	Fin Bornholt	R&D Director	
Issued: June 15, 2007			
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

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**Glossary:**

TSL tissue simulating liquid  
NORM<sub>x,y,z</sub> sensitivity in free space  
ConvF sensitivity in TSL / NORM<sub>x,y,z</sub>  
DCP diode compression point  
Polarization  $\varphi$   $\varphi$  rotation around probe axis  
Polarization  $\vartheta$   $\vartheta$  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

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

- 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
- 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:**

- NORM<sub>x,y,z</sub>**: Assessed for E-field polarization  $\vartheta = 0$  ( $f \leq 900$  MHz in TEM-cell;  $f > 1800$  MHz: R22 waveguide). NORM<sub>x,y,z</sub> are only intermediate values, i.e., the uncertainties of NORM<sub>x,y,z</sub> does not effect the E<sup>2</sup>-field uncertainty inside TSL (see below ConvF).
- NORM(f)<sub>x,y,z</sub>** = NORM<sub>x,y,z</sub> \* 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.
- DCP<sub>x,y,z</sub>**: DCP are numerical linearization parameters assessed based on the data of power sweep (no uncertainty required). DCP does not depend on frequency nor media.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for  $f \leq 800$  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 NORM<sub>x,y,z</sub> \* 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  $\pm 50$  MHz to  $\pm 100$  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.

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EX3DV3 SN:3507

June 15, 2007

# Probe EX3DV3

## SN:3507

Manufactured:	December 15, 2003
Last calibrated:	May 26, 2006
Repaired:	June 1, 2007
Recalibrated:	June 15, 2007

Calibrated for DASYS Systems

(Note: non-compatible with DASYS2 system!)

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## DASY - Parameters of Probe: EX3DV3 SN:3507

Sensitivity in Free Space <sup>A</sup>			Diode Compression <sup>B</sup>	
NormX	0.750 ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$	DCP X	97 mV
NormY	0.710 ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$	DCP Y	94 mV
NormZ	0.700 ± 10.1%	$\mu\text{V}/(\text{V}/\text{m})^2$	DCP Z	92 mV

### Sensitivity in Tissue Simulating Liquid (Conversion Factors)

Please see Page 8.

### Boundary Effect

TSL                    900 MHz    Typical SAR gradient: 5 % per mm

Sensor Center to Phantom Surface Distance		2.0 mm	3.0 mm
SAR <sub>be</sub> [%]	Without Correction Algorithm	3.8	1.6
SAR <sub>be</sub> [%]	With Correction Algorithm	0.0	0.0

TSL                    1810 MHz    Typical SAR gradient: 10 % per mm

Sensor Center to Phantom Surface Distance		2.0 mm	3.0 mm
SAR <sub>be</sub> [%]	Without Correction Algorithm	4.5	3.5
SAR <sub>be</sub> [%]	With Correction Algorithm	0.2	0.4

### Sensor Offset

Probe Tip to Sensor Center                    1.0 mm

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 Page 8).

<sup>B</sup> Numerical linearization parameter: uncertainty not required.

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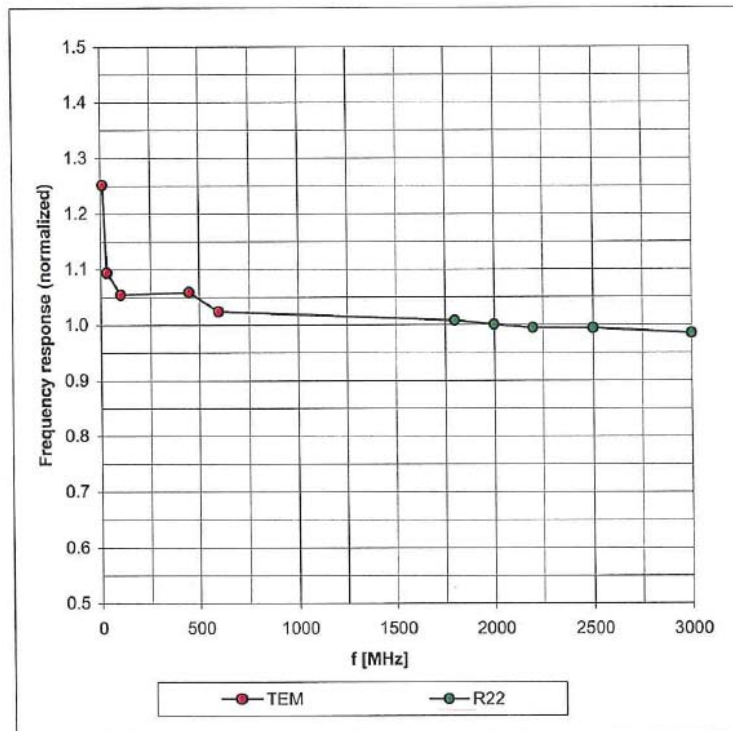
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EX3DV3 SN:3507

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### Frequency Response of E-Field

(TEM-Cell:ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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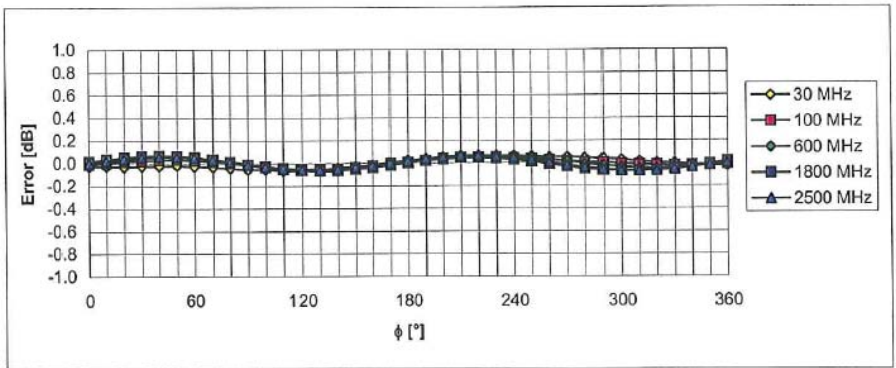
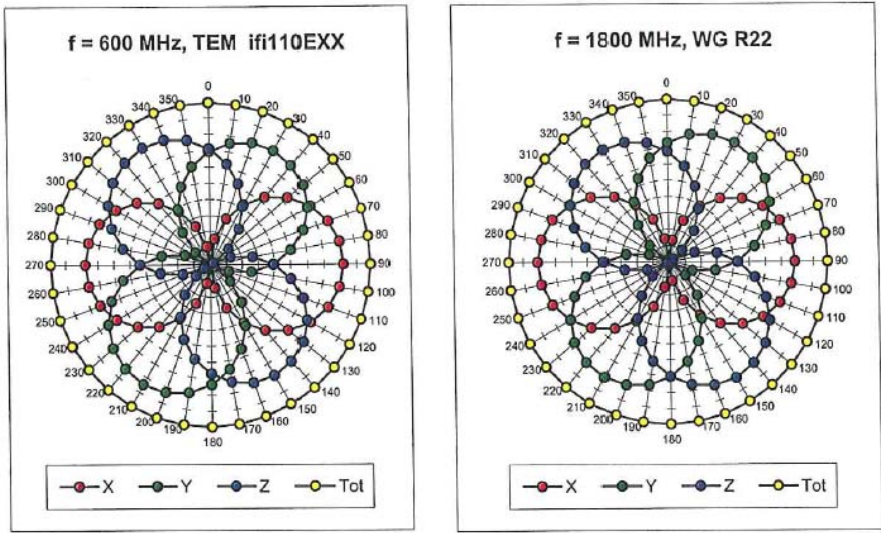
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### Receiving Pattern ( $\phi$ ), $\vartheta = 0^\circ$

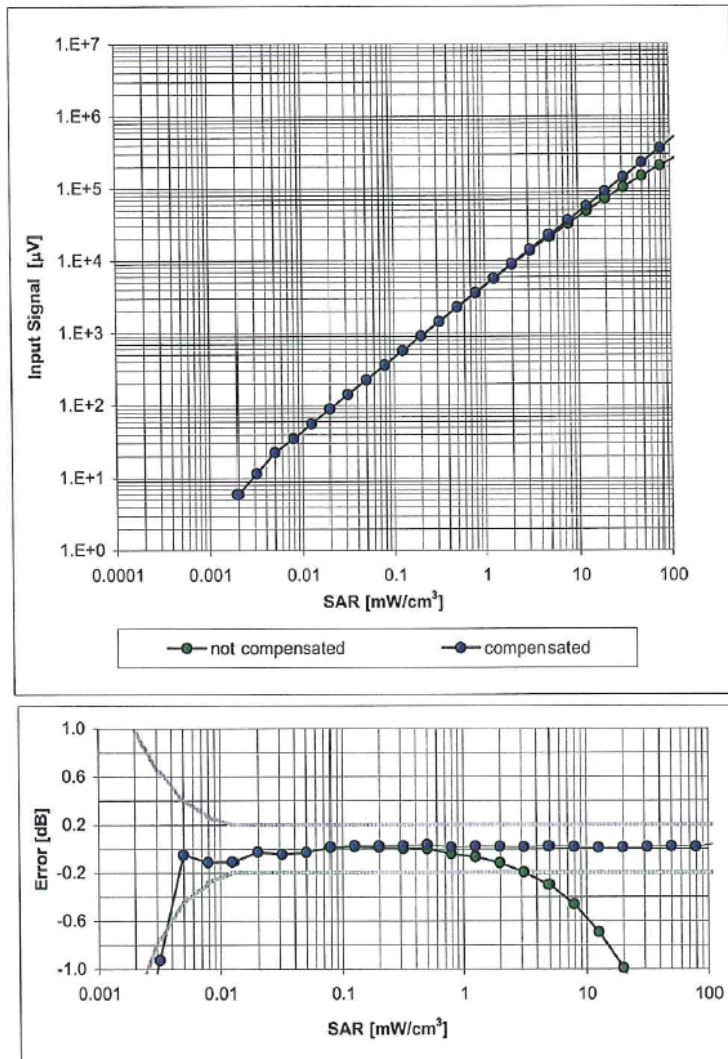


Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  ( $k=2$ )

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### Dynamic Range f(SAR<sub>head</sub>) (Waveguide R22, f = 1800 MHz)

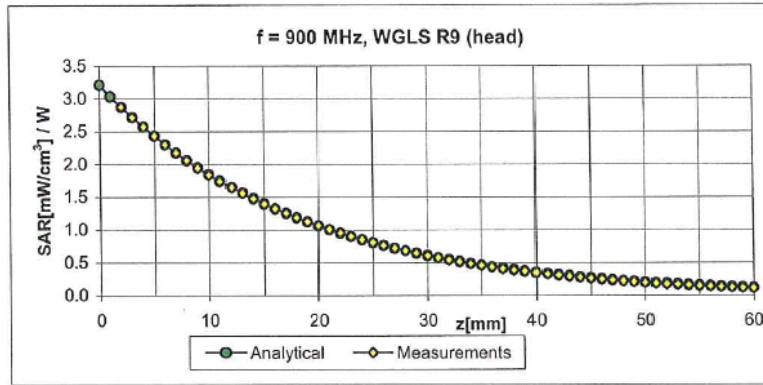


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  (k=2)

EX3DV3 SN:3507

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### Conversion Factor Assessment



f [MHz]	Validity [MHz] <sup>c</sup>	TSL	Permittivity	Conductivity	Alpha	Depth	ConvF Uncertainty
900	± 50 / ± 100	Head	41.5 ± 5%	0.97 ± 5%	0.55	0.80	10.05 ± 11.0% (k=2)
1640	± 50 / ± 100	Head	40.3 ± 5%	1.29 ± 5%	0.22	1.00	9.61 ± 11.0% (k=2)
1810	± 50 / ± 100	Head	40.0 ± 5%	1.40 ± 5%	0.17	1.00	8.82 ± 11.0% (k=2)
2000	± 50 / ± 100	Head	40.0 ± 5%	1.40 ± 5%	0.34	1.00	8.28 ± 11.0% (k=2)
2450	± 50 / ± 100	Head	39.2 ± 5%	1.80 ± 5%	0.29	1.00	8.05 ± 11.8% (k=2)
5200	± 50 / ± 100	Head	36.0 ± 5%	4.66 ± 5%	0.32	1.75	5.46 ± 13.1% (k=2)
5500	± 50 / ± 100	Head	35.6 ± 5%	4.96 ± 5%	0.30	1.75	5.05 ± 13.1% (k=2)
5800	± 50 / ± 100	Head	35.3 ± 5%	5.27 ± 5%	0.32	1.75	4.80 ± 13.1% (k=2)
900	± 50 / ± 100	Body	55.0 ± 5%	1.05 ± 5%	0.55	0.80	9.69 ± 11.0% (k=2)
1640	± 50 / ± 100	Body	53.8 ± 5%	1.40 ± 5%	0.10	1.18	9.66 ± 11.0% (k=2)
1810	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.12	1.34	8.93 ± 11.0% (k=2)
2000	± 50 / ± 100	Body	53.3 ± 5%	1.52 ± 5%	0.37	1.00	8.33 ± 11.0% (k=2)
2450	± 50 / ± 100	Body	52.7 ± 5%	1.95 ± 5%	0.40	1.00	8.00 ± 11.8% (k=2)
5200	± 50 / ± 100	Body	49.0 ± 5%	5.30 ± 5%	0.35	1.80	4.68 ± 13.1% (k=2)
5500	± 50 / ± 100	Body	48.6 ± 5%	5.65 ± 5%	0.32	1.80	4.33 ± 13.1% (k=2)
5800	± 50 / ± 100	Body	48.2 ± 5%	6.00 ± 5%	0.30	1.80	4.55 ± 13.1% (k=2)

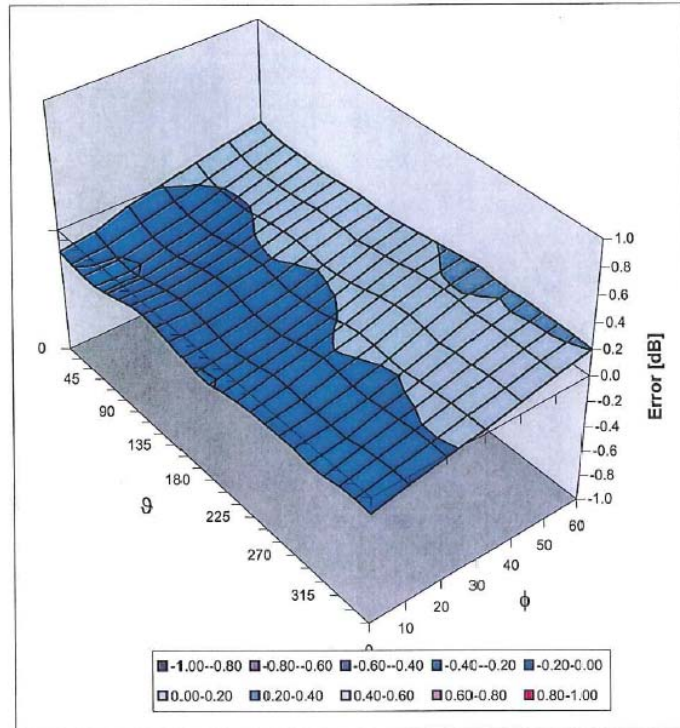
<sup>c</sup> The validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2). The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

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### Deviation from Isotropy in HSL

Error ( $\phi$ ,  $\theta$ ),  $f = 900$  MHz



Uncertainty of Spherical Isotropy Assessment:  $\pm 2.6\%$  ( $k=2$ )

### 13. References

- [1]ANSI, ANSI/IEEE C95.1-1992: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz, The Institute of Electrical and Electronics Engineers, Inc., New York, NY 10017, 1992.
- [2] Katja Pokovic, Thomas Schmid, and Niels Kuster, "Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies", in ICECOM '97, Dubrovnik, October 15-17, 1997, pp. 120-124.
- [3] Katja Pokovic, Thomas Schmid, and Niels Kuster, "E\_ field probe with improved isotropy in brain simulating liquids", in Proceedings of the ELMAR, Zadar, Croatia, 23-25 June, 1996, pp.172-175.
- [4] W. Gander, Computermathematik, Birkhaeuser, Basel, 1992.
- [5] W. H. Press, S. A. Teukolsky, W. T. Vetterling, and B. P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, Second Edition, Cambridge University Press, 1992.
- [6]SPEAG uncertainty document for DASY 4 System from SPEAG (Shimid & Partner Engineering AG).
- [7]SPEAG uncertainty document for "the 5-6GHz Extension" from SPEAG (Shimid & Partner Engineering AG).

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