

SAR Calibration Certificate – Dipole 1750MHz

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



S Schweizerischer Kalibrierdienst
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Accreditation No.: SCS 108

Client UL Japan (PTT)

Certificate No: D1750V2-1089_Mar13

CALIBRATION CERTIFICATE

Object D1750V2 - SN: 1089

Calibration procedure(s) QA CAL-05.v9
Calibration procedure for dipole validation kits above 700 MHz

Calibration date: March 08, 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 $(22 \pm 3)^{\circ}\text{C}$ and humidity $< 70\%$.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter EPM-442A	GB37480704	01-Nov-12 (No. 217-01640)	Oct-13
Power sensor HP 8481A	US37292783	01-Nov-12 (No. 217-01640)	Oct-13
Reference 20 dB Attenuator	SN: 5058 (20k)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.3 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	28-Dec-12 (No. ES3-3205_Dec12)	Dec-13
DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	Jun-13
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-89 (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

Calibrated by:	Name	Function	Signature
	Leif Klysner	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 8, 2013

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:

- 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
- 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:

- 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 Version	DASY5	V52.8.5
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 $\pm$ 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 $\pm$ 0.2) °C	39.1 $\pm$ 6 %	1.35 mho/m $\pm$ 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	9.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	36.8 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.89 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	19.6 W/kg $\pm$ 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 $\pm$ 0.2) °C	51.5 $\pm$ 6 %	1.48 mho/m $\pm$ 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	9.54 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	38.0 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.11 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	20.4 W/kg $\pm$ 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.8 Ω - 0.9 j Ω
Return Loss	- 38.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.8 Ω + 0.1 j Ω
Return Loss	- 27.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.218 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	November 07, 2012

DASY5 Validation Report for Head TSL

Date: 08.03.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1089

Communication System: CW; Frequency: 1750 MHz

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.35$ S/m; $\epsilon_r = 39.1$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(5.18, 5.18, 5.18); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

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

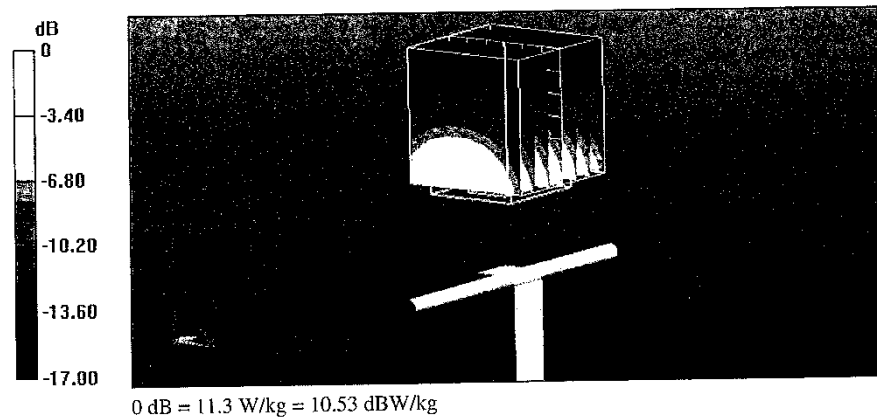
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.140 V/m; Power Drift = 0.00 dB

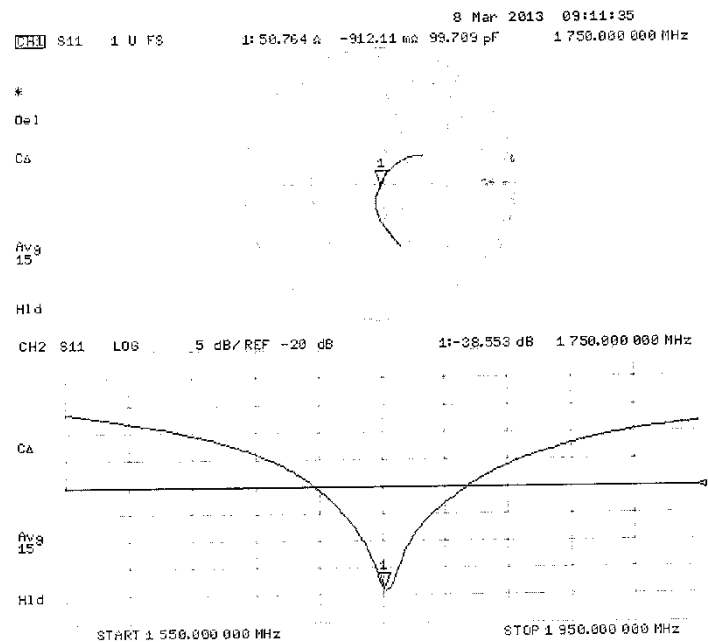
Peak SAR (extrapolated) = 16.4 W/kg

SAR(1 g) = 9.16 W/kg; SAR(10 g) = 4.89 W/kg

Maximum value of SAR (measured) = 11.3 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 08.03.2013

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN: 1089

Communication System: CW; Frequency: 1750 MHz

Medium parameters used: $f = 1750$ MHz; $\sigma = 1.48$ S/m; $\epsilon_r = 51.5$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.83, 4.83, 4.83); Calibrated: 28.12.2012;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.5(1059); SEMCAD X 14.6.8(7028)

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

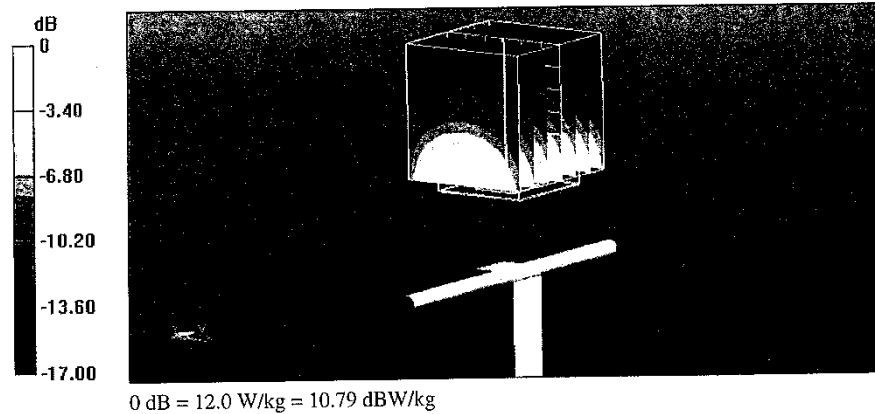
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 94.140 V/m; Power Drift = 0.00 dB

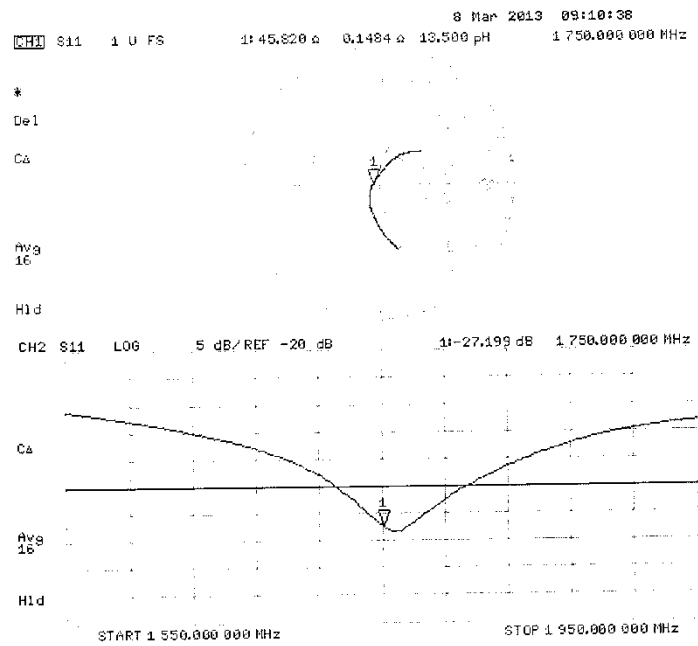
Peak SAR (extrapolated) = 16.4 W/kg

SAR(1 g) = 9.54 W/kg; SAR(10 g) = 5.11 W/kg

Maximum value of SAR (measured) = 12.0 W/kg



Impedance Measurement Plot for Body TSL



D1750V2 Calibration for Impedance and Return-loss

Equipment	Dipole Antenna	Model	D1750V2
Manufacture	Schmid&Partner Engineering AG	Serial	1089
Tested by	Tomohisa Nakagawa		

1. Test environment

Date	August 20, 2015		
Ambient Temperature	24.0 deg.C	Relative humidity	50%RH

2. Equipment used

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
EST-54	Network Analyzer	Hewlett Packard	8753ES	US39171615	SAR	2015/05/05 * 12
EST-08	Calibration Kit	Agilent	85032B	3217A12903	SAR	2015/05/04 * 12
MOS-26	Thermo-Hygrometer	CUSTOM	CTH-201	A08Q29	SAR	2015/04/28 * 12
MPSAM-02	SAM Phantom	Schmid&Partner Engineering AG	QD000P40CB	1333	SAR	2015/05/11 * 12
MPF-02	2mm Oval Flat Phantom	Schmid&Partner Engineering AG	QDOVA001BB	1045	SAR	2015/05/11 * 12
HSL1750						Daily check
MSL1750						Daily check
SAR room3						Daily check

3. Test Result

Impeadance,Transformed to feed point	Head	Deviation	Tolerance	Result
Calibration (SPEAG) 2013/03/08	50.8 Ω -0.9j Ω	-	-	-
Calibration(ULJ)2015/08/20	48.4 Ω -0.9j Ω	-2.4 Ω +0j Ω	+/-5 Ω +/-5j Ω	Complied

Return loss	Head(dB)	Deviation(dB)	Tolerance	Result
Calibration (SPEAG) 2013/03/08	-38.6	-	-38.6 * +/-20%	-
Calibration(ULJ)2015/08/20	-34.6	-4.00	-30.88 to -46.32 dB	Complied

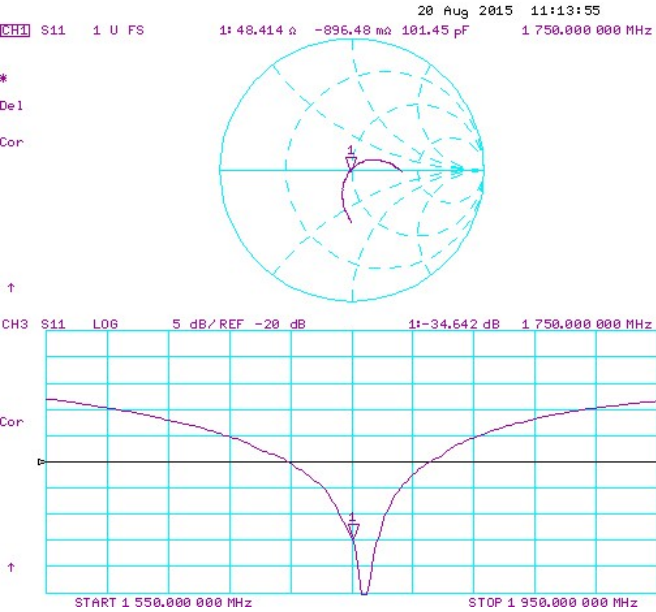
Impeadance,Transformed to feed point	Body	Deviation	Tolerance	Result
Calibration (SPEAG) 2013/03/08	45.8 Ω +0.1j Ω	-	-	-
Calibration(ULJ) 2015/8/20	45.1 Ω -3.3 Ω	0.7 Ω -3.4j Ω	+/-5 Ω +/-5j Ω	Complied

Return loss	Body (dB)	Deviation (dB)	Tolerance	Result
Calibration (SPEAG) 2013/03/08	-27.2	-	-27.2 * +/-20%	-
Calibration(ULJ) 2015/8/20	-24.15	-3.05	-21.76 to -32.64 dB	Complied

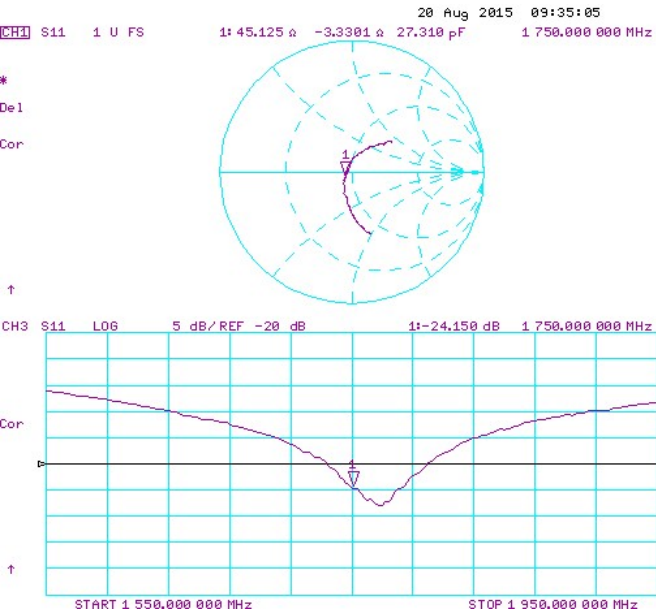
*Tolerance : According to the KDB450824D02

Measurement Plots

<Head Liquid>



<Body Liquid>



D1750V2 Calibration for Impedance and Return-loss

Equipment	Dipole Antenna	Model	D1750V2
Manufacture	Schmid&Partner Engineering AG	Serial	1089
Tested by	Tomohisa Nakagawa		

1. Test environment

Date	August 25, 2014		
Ambient Temperature	24.0 deg.C	Relative humidity	50%RH

2. Equipment used

Control No.	Instrument	Manufacturer	Model No	Serial No	Test Item	Calibration Date * Interval(month)
EST-08	Network Analyzer	Hewlett Packard	8753ES	US39174808	SAR	2014/05/09 * 12
EST-08	Calibration Kit	Agilent	85032B	3217A12903	SAR	2014/05/09 * 12
MOS-30	Thermo-Hygrometer	CUSTOM	CTH-201	3001	SAR	2014/07/06* 12
MPSAM-02	SAM Phantom	Schmid&Partner Engineering AG	QD000P40CB	1333	SAR	2014/05/30* 12
MPF-02	2mm Oval Flat Phantom	Schmid&Partner Engineering AG	QDOVA001BB	1045	SAR	2014/05/30* 12
HSL1750						Daily check
MSL1750						Daily check
SAR room3						Daily check

3. Test Result

Impeadance,Transformed to feed point	Head	Deviation	Tolerance	Result
Calibration (SPEAG) 2013/03/08	50.8 Ω -0.9j Ω	-	-	-
Calibration(ULJ) 2014/08/25	49.6 Ω -1.7j Ω	-1.2 Ω -0.8j Ω	+/-5 Ω +/-5j Ω	Complied
Return loss	Head(dB)	Deviation(dB)	Tolerance	Result
Calibration (SPEAG) 2013/03/08	-38.6	-	-38.6 * +/-20%	-
Calibration(ULJ) 2014/08/25	-35.005	-3.60	-30.88 to -46.32 dB	Complied

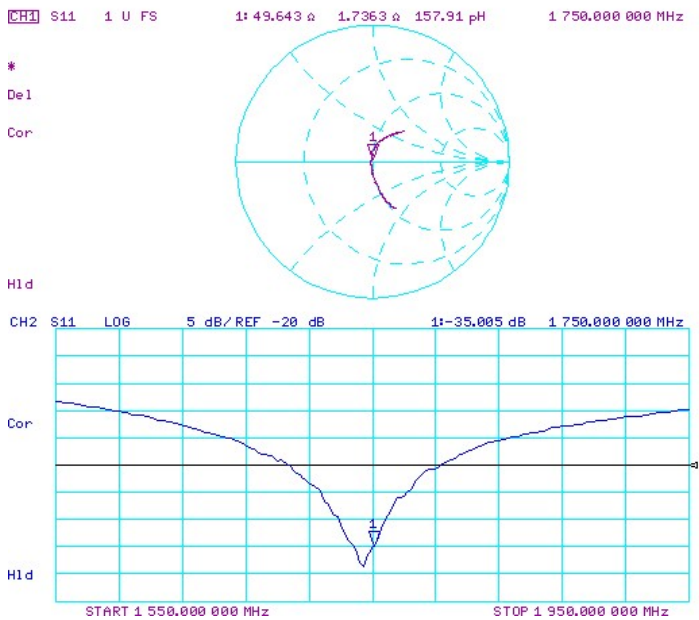
Impeadance,Transformed to feed point	Body	Deviation	Tolerance	Result
Calibration (SPEAG) 2013/03/08	45.8 Ω +0.1j Ω	-	-	-
Calibration(ULJ) 2014/08/25	45.6 Ω -2.8 Ω	-0.2 Ω -2.9j Ω	+/-5 Ω +/-5j Ω	Complied

Return loss	Body (dB)	Deviation (dB)	Tolerance	Result
Calibration (SPEAG) 2013/03/08	-27.2	-	-27.2 * +/-20%	-
Calibration(ULJ) 2014/08/25	-25.199	-2.001	-21.76 to -32.64 dB	Complied

*Tolerance : According to the KDB450824D02

Measurement Plots

<Head Liquid>



<Body Liquid>

