

Test Laboratory: HCT CO., LTD
EUT Type: Cellular/PCS GSM/GPRS/EDGE(RX Only)Cellular/WCDMA/HSDPA Phone with
Bluetooth and WLAN
Liquid Temperature: 21.2 °C
Ambient Temperature: 21.4 °C
Test Date: Nov.14, 2012

DUT: LG-E615f; Type: bar; Serial: #1

Communication System: GSM 1900; Frequency: 1880 MHz;Duty Cycle: 1:2.77

Medium parameters used: $f = 1880$ MHz; $\sigma = 1.51$ mho/m; $\epsilon_r = 51.5$; $\rho = 1000$ kg/m³

Phantom section: Center Section ; Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

DASY4 Configuration:

- Probe: ET3DV6 - SN1609; ConvF(4.55, 4.55, 4.55); Calibrated: 2012-03-19
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2012-09-18
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA

GSM1900 Hotspot Rear 661 GPRS 3Tx/Area Scan (101x61x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.551 mW/g

GSM1900 Hotspot Rear 661 GPRS 3Tx/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 10.2 V/m; Power Drift = -0.045 dB

Peak SAR (extrapolated) = 0.695 W/kg

SAR(1 g) = 0.472 mW/g; SAR(10 g) = 0.298 mW/g

Maximum value of SAR (measured) = 0.513 mW/g



Test Laboratory: HCT CO., LTD
EUT Type: Cellular/PCS GSM/GPRS/EDGE(RX Only)Cellular/WCDMA/HSDPA Phone with
Bluetooth and WLAN
Liquid Temperature: 21.3 °C
Ambient Temperature: 21.5 °C
Test Date: Nov.13, 2012

DUT: LG-E615f; Type: bar; Serial: #1

Communication System: WCDMA850; Frequency: 836.6 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 836.6$ MHz; $\sigma = 0.919$ mho/m; $\epsilon_r = 40.4$; $\rho = 1000$ kg/m³

Phantom section: Right Section ; Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

DASY4 Configuration:

- Probe: ET3DV6 - SN1609; ConvF(6.36, 6.36, 6.36); Calibrated: 2012-03-19
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2012-09-18
- Phantom: 1800/1900 Phantom; Type: SAM

WCDMA850 Right touch 4183/Area Scan (61x101x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.208 mW/g

WCDMA850 Right touch 4183/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 4.98 V/m; Power Drift = 0.109 dB

Peak SAR (extrapolated) = 0.246 W/kg

SAR(1 g) = 0.192 mW/g; SAR(10 g) = 0.141 mW/g

Maximum value of SAR (measured) = 0.203 mW/g



Test Laboratory: HCT CO., LTD
 EUT Type: Cellular/PCS GSM/GPRS/EDGE(RX Only)Cellular/WCDMA/HSDPA Phone with Bluetooth and WLAN
 Liquid Temperature: 21.3 °C
 Ambient Temperature: 21.5 °C
 Test Date: Nov.13, 2012

DUT: LG-E615f; Type: bar; Serial: #1

Communication System: WCDMA850; Frequency: 836.6 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 836.6$ MHz; $\sigma = 0.997$ mho/m; $\epsilon_r = 53.2$; $\rho = 1000$ kg/m³

Phantom section: Center Section ; Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

DASY4 Configuration:

- Probe: ET3DV6 - SN1609; ConvF(6.24, 6.24, 6.24); Calibrated: 2012-03-19
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2012-09-18
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA

WCDMA850 Hotspot Rear 4183/Area Scan (101x61x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.497 mW/g

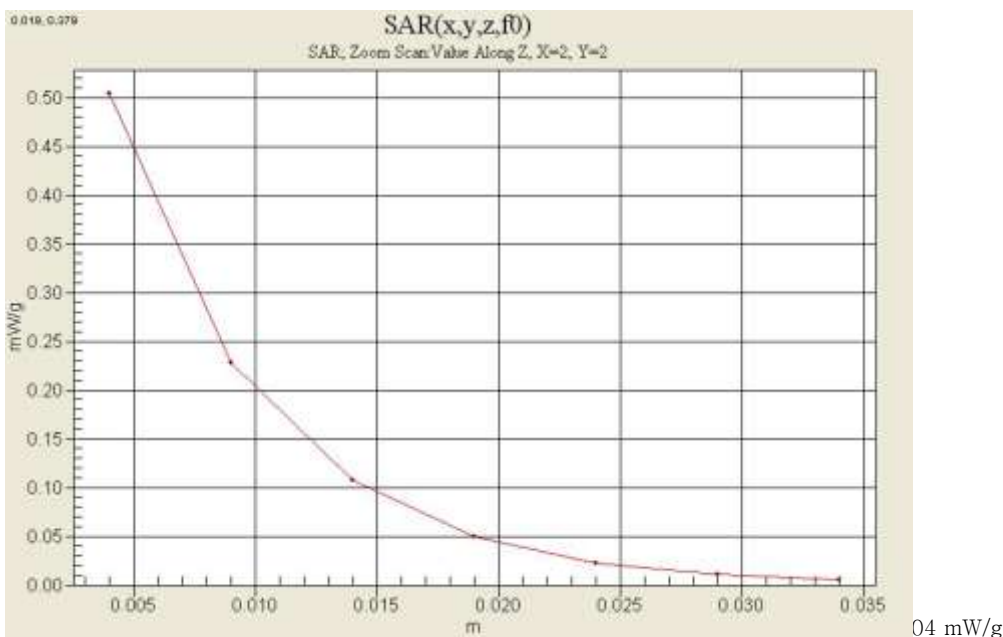
WCDMA850 Hotspot Rear 4183/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 10.2 V/m; Power Drift = 0.073 dB

Peak SAR (extrapolated) = 1.12 W/kg

SAR(1 g) = 0.465 mW/g; SAR(10 g) = 0.225 mW/g

Maximum value of SAR (measured) = 0.5



Test Laboratory: HCT CO., LTD
EUT Type: Cellular/PCS GSM/GPRS/EDGE(RX Only)Cellular/WCDMA/HSDPA Phone with Bluetooth and WLAN
Liquid Temperature: 21.1 °C
Ambient Temperature: 21.3 °C
Test Date: Nov.15, 2012

DUT: LG-E615f; Type: bar; Serial: #1

Communication System: 2450MHz FCC; Frequency: 2412 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2412$ MHz; $\sigma = 1.79$ mho/m; $\epsilon_r = 38.6$; $\rho = 1000$ kg/m³

Phantom section: Left Section ; Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

DASY4 Configuration:

- Probe: ET3DV6 - SN1609; ConvF(4.52, 4.52, 4.52); Calibrated: 2012-03-19
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2012-09-18
- Phantom: 835/900 Phantom ; Type: SAM

802.11b Left touch 1ch 1Mbps/Area Scan (61x101x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.733 mW/g

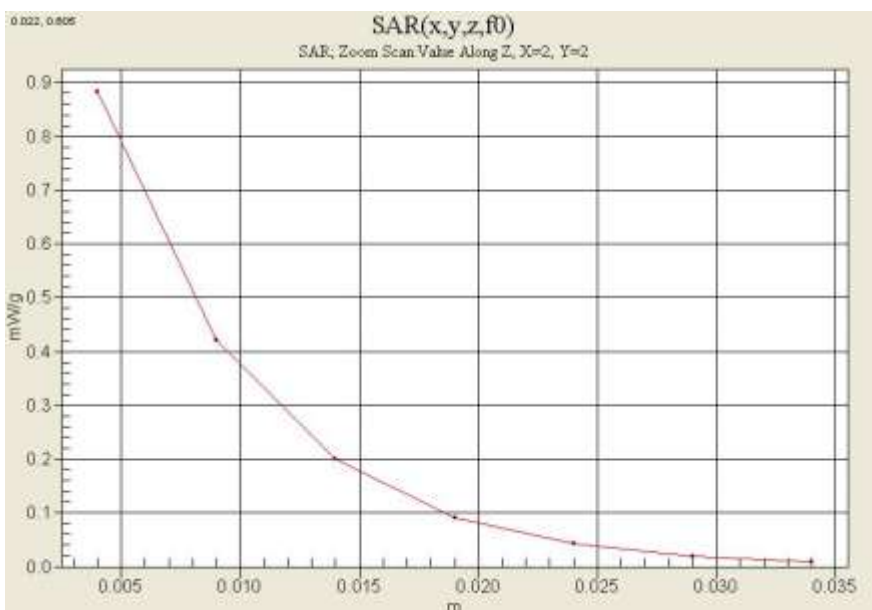
802.11b Left touch 1ch 1Mbps/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 20.5 V/m; Power Drift = 0.111 dB

Peak SAR (extrapolated) = 1.78 W/kg

SAR(1 g) = 0.750 mW/g; SAR(10 g) = 0.322 mW/g

Maximum value of SAR (measured) = 0.882 mW/g



Test Laboratory: HCT CO., LTD
EUT Type: Cellular/PCS GSM/GPRS/EDGE(RX Only)Cellular/WCDMA/HSDPA Phone with
Bluetooth and WLAN
Liquid Temperature: 21.1 °C
Ambient Temperature: 21.3 °C
Test Date: Nov.15, 2012

DUT: LG-E615f; Type: bar; Serial: #1

Communication System: 2450MHz FCC; Frequency: 2412 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2412$ MHz; $\sigma = 1.89$ mho/m; $\epsilon_r = 53.8$; $\rho = 1000$ kg/m³

Phantom section: Center Section ; Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

DASY4 Configuration:

- Probe: ET3DV6 - SN1609; ConvF(4.01, 4.01, 4.01); Calibrated: 2012-03-19
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2012-09-18
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA

802.11b Hotspot Rear 1Mbps 1ch/Area Scan (101x61x1): Measurement grid: dx=15mm, dy=15mm

Maximum value of SAR (interpolated) = 0.390 mW/g

802.11b Hotspot Rear 1Mbps 1ch/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 5.18 V/m; Power Drift = 0.009 dB

Peak SAR (extrapolated) = 3.04 W/kg

SAR(1 g) = 0.579 mW/g; SAR(10 g) = 0.239 mW/g

Maximum value of SAR (measured) = 0.713 mW/g



Attachment 2. – Dipole Validation Plots

■ Validation Data (835 MHz Head)

Test Laboratory: HCT CO., LTD
Input Power 100 mW (20 dBm)
Liquid Temp: 21.3 °C
Test Date: Nov.13, 2012

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 – SN:441

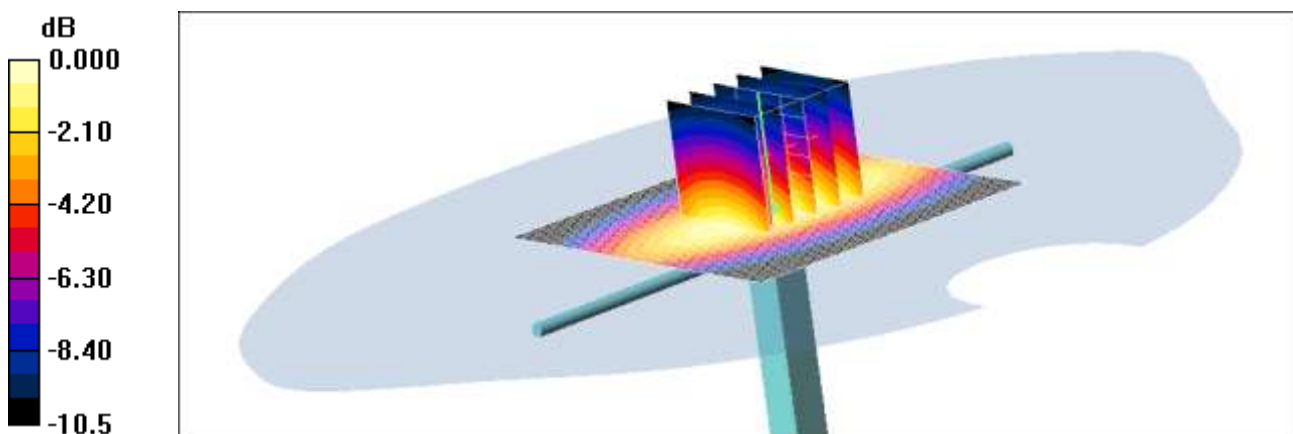
Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 835$ MHz; $\sigma = 0.918$ mho/m; $\epsilon_r = 40.4$; $\rho = 1000$ kg/m³
Phantom section: Flat Section ; Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

DASY4 Configuration:

- Probe: ET3DV6 – SN1609; ConvF(6.36, 6.36, 6.36); Calibrated: 2012-03-19
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2012-09-18
- Phantom: 1800/1900 Phantom; Type: SAM

Validation 835MHz/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 0.998 mW/g

Validation 835MHz/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 34.3 V/m; Power Drift = 0.078 dB
Peak SAR (extrapolated) = 1.39 W/kg
SAR(1 g) = 0.954 mW/g; SAR(10 g) = 0.625 mW/g
Maximum value of SAR (measured) = 1.04 mW/g



0 dB = 1.04mW/g

■ Validation Data (835 MHz Body)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 21.3 °C
Test Date: Nov.13, 2012

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2- SN:441

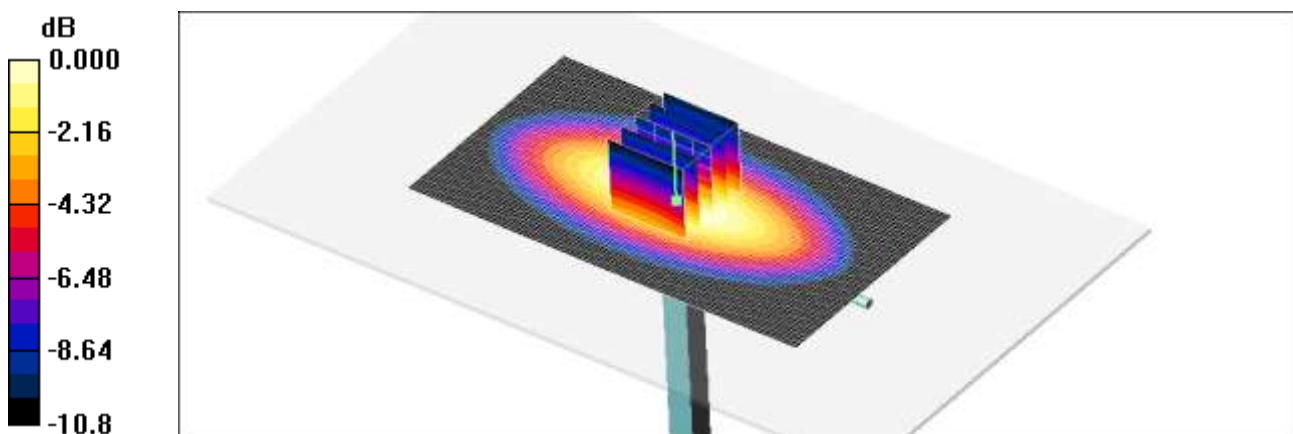
Communication System: CW; Frequency: 835 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 835$ MHz; $\sigma = 0.996$ mho/m; $\epsilon_r = 53.2$; $\rho = 1000$ kg/m³
Phantom section: Center Section ; Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 184

DASY4 Configuration:

- Probe: ET3DV6 - SN1609; ConvF(6.24, 6.24, 6.24); Calibrated: 2012-03-19
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2012-09-18
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA

Validation 835 MHz/Area Scan (111x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 1.06 mW/g

Validation 835 MHz/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 33.8 V/m; Power Drift = -0.015 dB
Peak SAR (extrapolated) = 1.42 W/kg
SAR(1 g) = 0.977 mW/g; SAR(10 g) = 0.635 mW/g
Maximum value of SAR (measured) = 1.06 mW/g



■ Validation Data (1 900 MHz Head)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 21.2 °C
Test Date: Nov.14, 2012

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 – SN:5d032

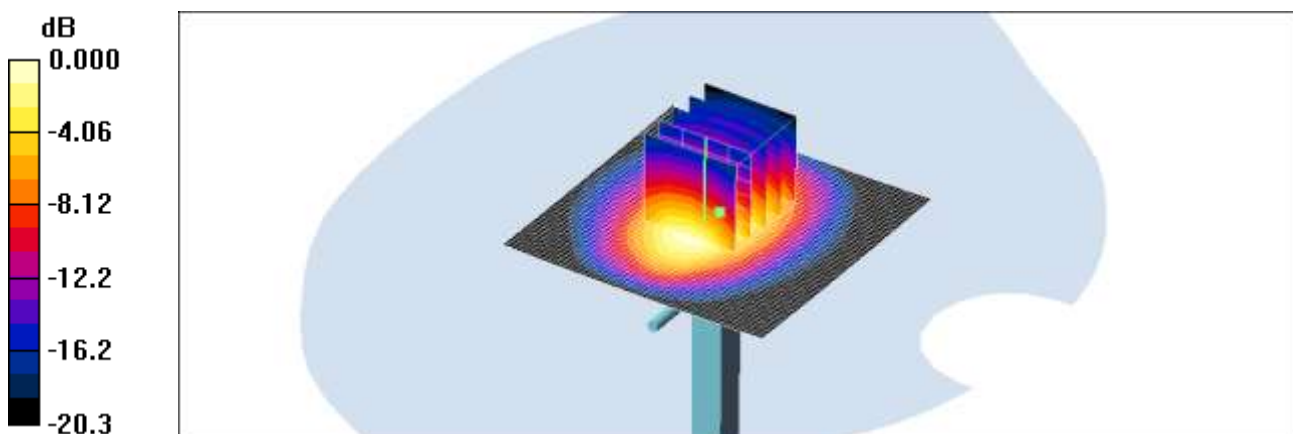
Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 1900$ MHz; $\sigma = 1.46$ mho/m; $\epsilon_r = 38.6$; $\rho = 1000$ kg/m³
Phantom section: Flat Section ; Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

DASY4 Configuration:

- Probe: ET3DV6 – SN1609; ConvF(5.26, 5.26, 5.26); Calibrated: 2012-03-19
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2012-09-18
- Phantom: 835/900 Phantom ; Type: SAM

Dipole 1900MHz Validation/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 4.64 mW/g

Dipole 1900MHz Validation/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 57.4 V/m; Power Drift = -0.007 dB
Peak SAR (extrapolated) = 6.86 W/kg
SAR(1 g) = 3.92 mW/g; SAR(10 g) = 2.01 mW/g
Maximum value of SAR (measured) = 4.38 mW/g



■ Validation Data (1 900 MHz Body)

Test Laboratory: HCT CO., LTD
Input Power 100 mW (20 dBm)
Liquid Temp: 21.2 °C
Test Date: Nov.14, 2012

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 – SN:5d032

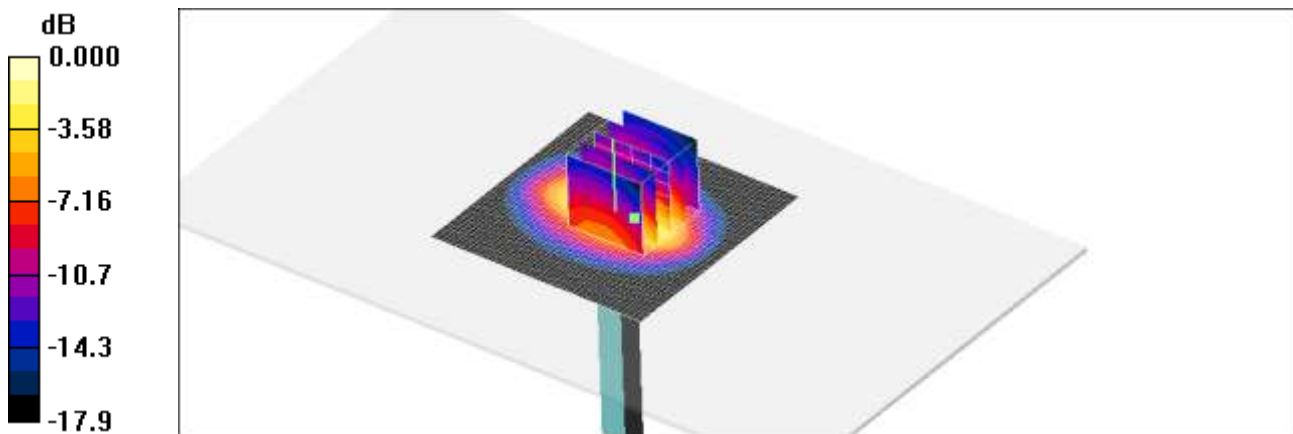
Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 1900$ MHz; $\sigma = 1.53$ mho/m; $\epsilon_r = 51.4$; $\rho = 1000$ kg/m³
Phantom section: Center Section ; Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 184

DASY4 Configuration:

- Probe: ET3DV6 – SN1609; ConvF(4.55, 4.55, 4.55); Calibrated: 2012-03-19
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2012-09-18
- Phantom: Triple Flat Phantom 5.1C_20120905; Type: QD 000 P51 CA

Validation 1900 MHz/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 4.57 mW/g

Validation 1900 MHz/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 57.4 V/m; Power Drift = -0.029 dB
Peak SAR (extrapolated) = 6.21 W/kg
SAR(1 g) = 3.9 mW/g; SAR(10 g) = 2.13 mW/g
Maximum value of SAR (measured) = 4.38 mW/g



■ Validation Data (2 450 MHz Head)

Test Laboratory: HCT CO., LTD
Input Power: 100 mW (20 dBm)
Liquid Temp: 21.1 °C
Test Date: Nov.15, 2012

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 – SN:743

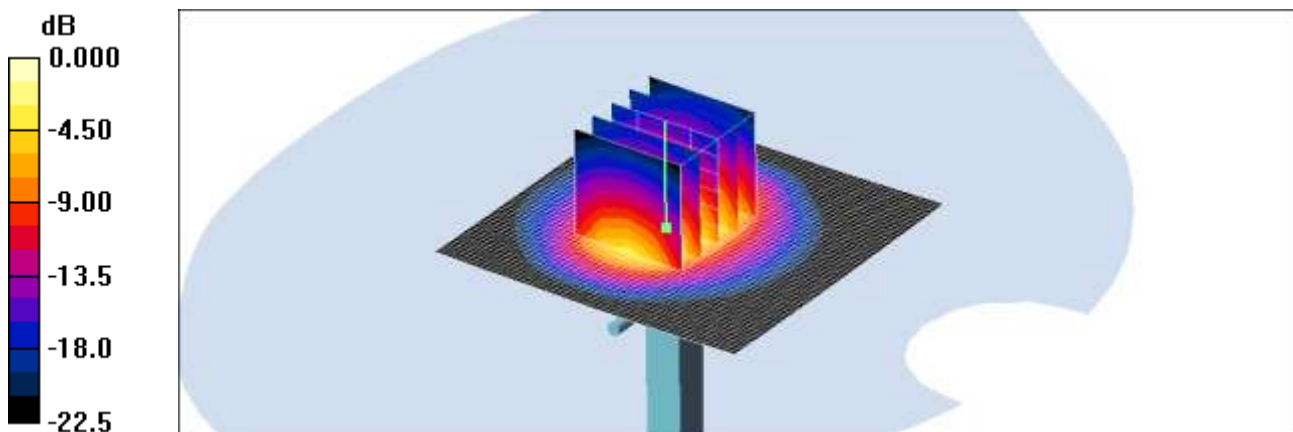
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.84$ mho/m; $\epsilon_r = 38.2$; $\rho = 1000$ kg/m³
Phantom section: Flat Section ; Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

DASY4 Configuration:

- Probe: ET3DV6 – SN1609; ConvF(4.52, 4.52, 4.52); Calibrated: 2012-03-19
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2012-09-18
- Phantom: SAM 1800/1900 MHz; Type: SAM

Validation 2450MHz/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 6.45 mW/g

Validation 2450MHz/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 60.1 V/m; Power Drift = -0.081 dB
Peak SAR (extrapolated) = 12.2 W/kg
SAR(1 g) = 5.37 mW/g; SAR(10 g) = 2.47 mW/g
Maximum value of SAR (measured) = 5.95 mW/g



0 dB = 5.95mW/g

■ Validation Data (2 450 MHz Body)

Test Laboratory: HCT CO., LTD
Input Power 100 mW (20 dBm)
Liquid Temp: 21.1 °C
Test Date: Nov.15, 2012

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 – SN:743

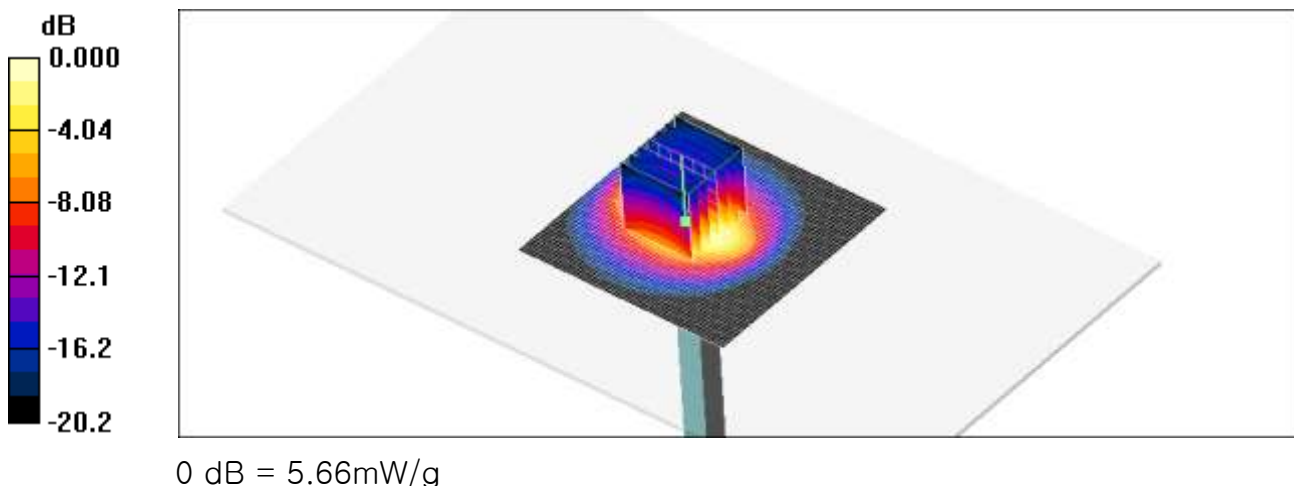
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.94$ mho/m; $\epsilon_r = 53.6$; $\rho = 1000$ kg/m³
Phantom section: Center Section ; Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 184

DASY4 Configuration:

- Probe: ET3DV6 – SN1609; ConvF(4.01, 4.01, 4.01); Calibrated: 2012-03-19
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn869; Calibrated: 2012-09-18
- Phantom: Triple Flat Phantom 5.1C_20120905; Type: QD 000 P51 CA

Validation 2450MHz/Area Scan (61x61x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (interpolated) = 6.29 mW/g

Validation 2450MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 54.5 V/m; Power Drift = -0.019 dB
Peak SAR (extrapolated) = 13.2 W/kg
SAR(1 g) = 5.25 mW/g; SAR(10 g) = 2.5 mW/g
Maximum value of SAR (measured) = 5.66 mW/g



■ Dielectric Parameter (835 MHz Head)

Title LG-E615f
SubTitle 835MHz
Test Date Nov.13, 2012

Frequency	e'	e''
800000000.0000	40.7432	19.9123
805000000.0000	40.6865	19.8771
810000000.0000	40.6260	19.8649
815000000.0000	40.5691	19.8628
820000000.0000	40.5640	19.8310
825000000.0000	40.4950	19.8167
830000000.0000	40.4700	19.7854
835000000.0000	40.4113	19.7636
840000000.0000	40.3898	19.7216
845000000.0000	40.3398	19.6878
850000000.0000	40.2696	19.6910
855000000.0000	40.2256	19.6357
860000000.0000	40.1887	19.6405
865000000.0000	40.1150	19.5842
870000000.0000	40.0677	19.5466
875000000.0000	39.9984	19.5359
880000000.0000	39.9314	19.5299
885000000.0000	39.8621	19.4948
890000000.0000	39.8010	19.4678
895000000.0000	39.7454	19.4398
900000000.0000	39.6892	19.4073

■ Dielectric Parameter (835 MHz Body)

Title LG-E615f
 SubTitle 835MHz
 Test Date Nov.13, 2012

Frequency	e'	e''
800000000.0000	53.4076	21.7693
805000000.0000	53.4179	21.7069
810000000.0000	53.3576	21.6355
815000000.0000	53.3350	21.6528
820000000.0000	53.3462	21.5572
825000000.0000	53.2620	21.4906
830000000.0000	53.2513	21.4872
835000000.0000	53.2024	21.4367
840000000.0000	53.1923	21.4001
845000000.0000	53.1463	21.3986
850000000.0000	53.1223	21.3945
855000000.0000	53.0835	21.4067
860000000.0000	52.9997	21.3814
865000000.0000	52.9877	21.4160
870000000.0000	52.9531	21.4158
875000000.0000	52.8761	21.4422
880000000.0000	52.8434	21.4412
885000000.0000	52.8789	21.4780
890000000.0000	52.8556	21.4416
895000000.0000	52.8368	21.3878
900000000.0000	52.8123	21.3994

Dielectric Parameter (1 900 MHz Head)

Title LG-E615f
SubTitle 1 900MHz
Test Date Nov.14, 2012

Frequency	e'	e''
1800000000.0000	39.1057	13.5996
1810000000.0000	39.0597	13.6437
1820000000.0000	39.0178	13.6370
1830000000.0000	38.9592	13.6107
1840000000.0000	38.9188	13.6578
1850000000.0000	38.8446	13.6715
1860000000.0000	38.7865	13.6998
1870000000.0000	38.7526	13.7313
1880000000.0000	38.7024	13.7344
1890000000.0000	38.6791	13.7744
1900000000.0000	38.6438	13.8218
1910000000.0000	38.6312	13.8373
1920000000.0000	38.5625	13.8556
1930000000.0000	38.5337	13.8932
1940000000.0000	38.4748	13.8999
1950000000.0000	38.4196	13.9106
1960000000.0000	38.3492	13.9371
1970000000.0000	38.3269	13.9594
1980000000.0000	38.2679	13.9908
1990000000.0000	38.2184	13.9990
2000000000.0000	38.1847	14.0435

■ Dielectric Parameter (1 900 MHz Body)

Title LG-E615f
SubTitle 1 900MHz
Test Date Nov.14, 2012

Frequency	e'	e''
1850000000.0000	51.5769	14.3673
1855000000.0000	51.5577	14.3816
1860000000.0000	51.5416	14.3920
1865000000.0000	51.5222	14.3996
1870000000.0000	51.5021	14.4007
1875000000.0000	51.5022	14.4048
1880000000.0000	51.4912	14.4171
1885000000.0000	51.4978	14.4358
1890000000.0000	51.4853	14.4352
1895000000.0000	51.4629	14.4490
1900000000.0000	51.4360	14.4538
1905000000.0000	51.4275	14.4601
1910000000.0000	51.4059	14.4542
1915000000.0000	51.3917	14.4693
1920000000.0000	51.3636	14.4852
1925000000.0000	51.3560	14.5149
1930000000.0000	51.3437	14.5165
1935000000.0000	51.3331	14.5080
1940000000.0000	51.3263	14.5180
1945000000.0000	51.2766	14.5360
1950000000.0000	51.2716	14.5517

■ Dielectric Parameter (2 450 MHz Head)

Title LG-E615f
SubTitle 2 450MHz
Test Date Nov.15, 2012

Frequency	e'	e''
2400000000.0000	38.6101	13.3359
2405000000.0000	38.6100	13.3453
2410000000.0000	38.6074	13.3514
2415000000.0000	38.5931	13.3532
2420000000.0000	38.5582	13.3665
2425000000.0000	38.5104	13.3906
2430000000.0000	38.4560	13.4065
2435000000.0000	38.3994	13.4492
2440000000.0000	38.3281	13.4572
2445000000.0000	38.2496	13.4825
2450000000.0000	38.1740	13.5111
2455000000.0000	38.1079	13.5374
2460000000.0000	38.0594	13.5713
2465000000.0000	38.0268	13.5977
2470000000.0000	37.9832	13.6170
2475000000.0000	37.9694	13.6390
2480000000.0000	37.9598	13.6658
2485000000.0000	37.9687	13.6882
2490000000.0000	37.9968	13.6809
2495000000.0000	38.0186	13.6789
2500000000.0000	38.0492	13.6775

■ Dielectric Parameter (2 450 MHz Body)

Title LG-E615f
SubTitle 2 450MHz
Test Date Nov.15, 2012

Frequency	e'	e''
2400000000.0000	53.8154	14.0506
2405000000.0000	53.8193	14.0790
2410000000.0000	53.7970	14.0872
2415000000.0000	53.7801	14.1081
2420000000.0000	53.7385	14.1188
2425000000.0000	53.7410	14.1417
2430000000.0000	53.7311	14.1697
2435000000.0000	53.7053	14.1797
2440000000.0000	53.6713	14.1773
2445000000.0000	53.6443	14.2209
2450000000.0000	53.6297	14.2558
2455000000.0000	53.6274	14.2586
2460000000.0000	53.5900	14.2935
2465000000.0000	53.5620	14.3000
2470000000.0000	53.5430	14.3419
2475000000.0000	53.5381	14.3648
2480000000.0000	53.5173	14.4018
2485000000.0000	53.5151	14.4173
2490000000.0000	53.4866	14.4336
2495000000.0000	53.4761	14.4770
2500000000.0000	53.4567	14.4850

Attachment 3. – Probe Calibration Data

Calibration Laboratory of
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Zeughausstrasse 43, 8004 Zurich, Switzerland



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Accreditation No.: SCS 108

Client HCT (Dymstec)

Certificate No: ET3-1609_Mar12

CALIBRATION CERTIFICATE

Object ET3DV6 - SN:1609

Calibration procedure(s) QA CAL-01.v8, QA CAL-12.v7, QA CAL-23.v4, QA CAL-25.v4
Calibration procedure for dosimetric E-field probes

Calibration date: March 19, 2012

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 (Certificate No.)	Scheduled Calibration
Power meter E4419B	GB41293874	31-Mar-11 (No. 217-01372)	Apr-12
Power sensor E4412A	MY41495087	31-Mar-11 (No. 217-01372)	Apr-12
Reference 3 dB Attenuator	SN: 55054 (3c)	29-Mar-11 (No. 217-01369)	Apr-12
Reference 20 dB Attenuator	SN: 55086 (20b)	29-Mar-11 (No. 217-01367)	Apr-12
Reference 30 dB Attenuator	SN: 55129 (30b)	29-Mar-11 (No. 217-01370)	Apr-12
Reference Probe ES3DV2	SN: 3013	29-Dec-11 (No. ES3-3013_Dec11)	Dec-12
DAE4	SN: 654	3-May-11 (No. DAE4-654_May11)	May-12
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-11)	In house check: Apr-13
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-11)	In house check: Oct-12

	Name	Function	Signature
Calibrated by:	Jeton Kestrali	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 19, 2012

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Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,y,z}
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., θ = 0 is normal to probe axis

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

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}: Assessed for E-field polarization θ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z} = NORM_{x,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.
- DCP_{x,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
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; VR_{x,y,z}: A, B, C 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 NORM_{x,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.

ET3DV6 - SN:1609

March 19, 2012

Probe ET3DV6

SN:1609

Manufactured: July 27, 2001
Calibrated: March 19, 2012

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

ET3DV6- SN:1609

March 19, 2012

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1609

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V/m})^{\text{A}}$)	2.01	1.81	1.82	$\pm 10.1 \%$
DCP (mV) ^B	97.7	97.4	98.1	

Modulation Calibration Parameters

UID	Communication System Name	PAR		A dB	B dB	C dB	VR mV	Unc ^C (k=2)
10000	CW	0.00	X	0.00	0.00	1.00	112.2	$\pm 2.2 \%$
			Y	0.00	0.00	1.00	107.9	
			Z	0.00	0.00	1.00	109.9	

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%.

^A The uncertainties of NormX, Y, Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Numerical linearization parameter, uncertainty not required.

^C Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

ET3DV6-SN:1609

March 19, 2012

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1609

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^c	Relative Permittivity ^d	Conductivity (S/m) ^d	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
450	43.5	0.87	7.32	7.32	7.32	0.21	2.26	± 13.4 %
750	41.9	0.89	6.68	6.68	6.68	0.39	2.46	± 12.0 %
835	41.5	0.90	6.36	6.36	6.36	0.32	2.79	± 12.0 %
900	41.5	0.97	6.25	6.25	6.25	0.33	3.00	± 12.0 %
1450	40.5	1.20	5.48	5.48	5.48	0.44	3.00	± 12.0 %
1750	40.1	1.37	5.50	5.50	5.50	0.74	2.42	± 12.0 %
1900	40.0	1.40	5.26	5.26	5.26	0.80	2.18	± 12.0 %
1950	40.0	1.40	5.04	5.04	5.04	0.80	2.09	± 12.0 %
2450	39.2	1.80	4.52	4.52	4.52	0.80	1.90	± 12.0 %

^c 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.

^d At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

ET3DV6-SN:1609

March 19, 2012

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1609

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha	Depth (mm)	Unct. (k=2)
450	56.7	0.94	7.73	7.73	7.73	0.15	2.32	± 13.4 %
750	55.5	0.96	6.38	6.38	6.38	0.29	3.00	± 12.0 %
835	55.2	0.97	6.24	6.24	6.24	0.39	2.51	± 12.0 %
1750	53.4	1.49	4.80	4.80	4.80	0.80	2.57	± 12.0 %
1900	53.3	1.52	4.55	4.55	4.55	0.80	2.50	± 12.0 %
2450	52.7	1.95	4.01	4.01	4.01	0.70	1.23	± 12.0 %

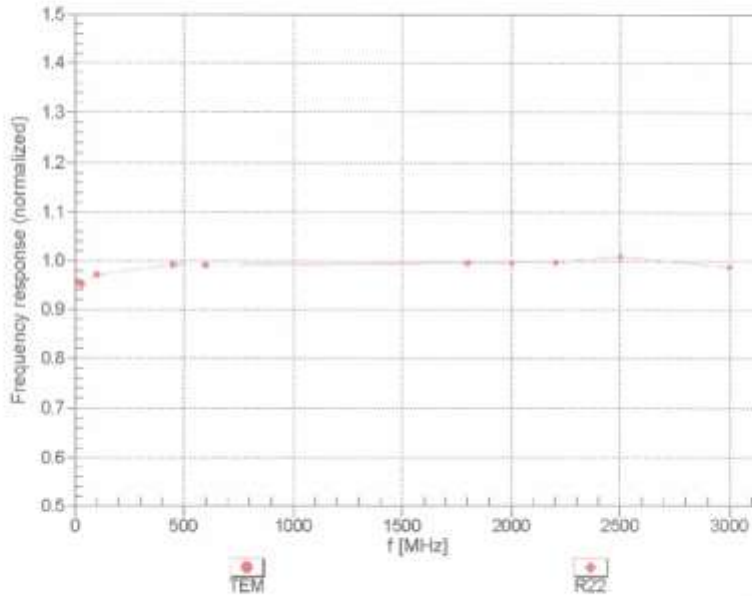
^C Frequency validity of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), also it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) 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 (ϵ and σ) is restricted to $\pm 5\%$. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

ET3DV6-SN:1609

March 19, 2012

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



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

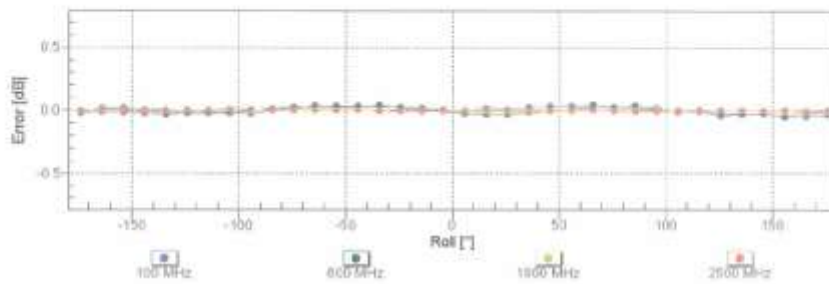
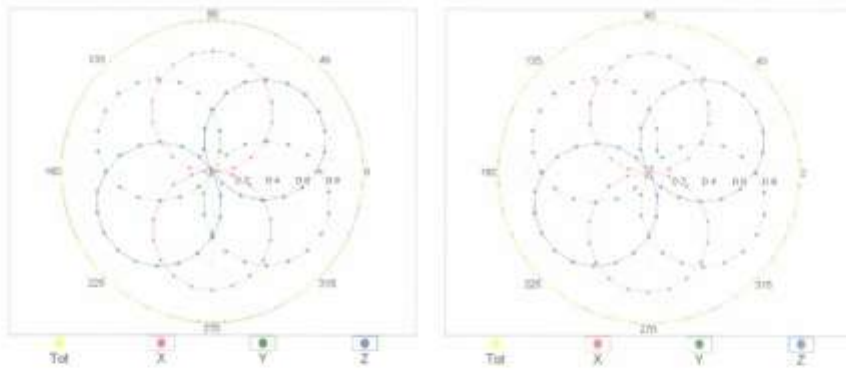
ET3DV6-SN:1609

March 19, 2012

Receiving Pattern (ϕ), $\theta = 0^\circ$

f=600 MHz,TEM

f=1800 MHz,R22

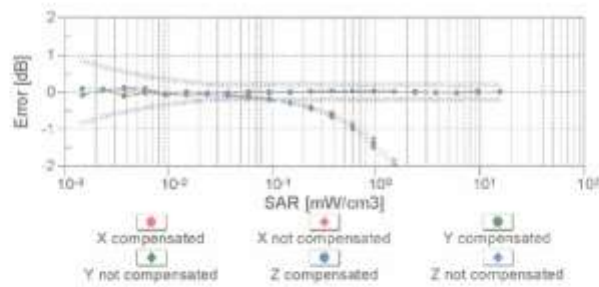
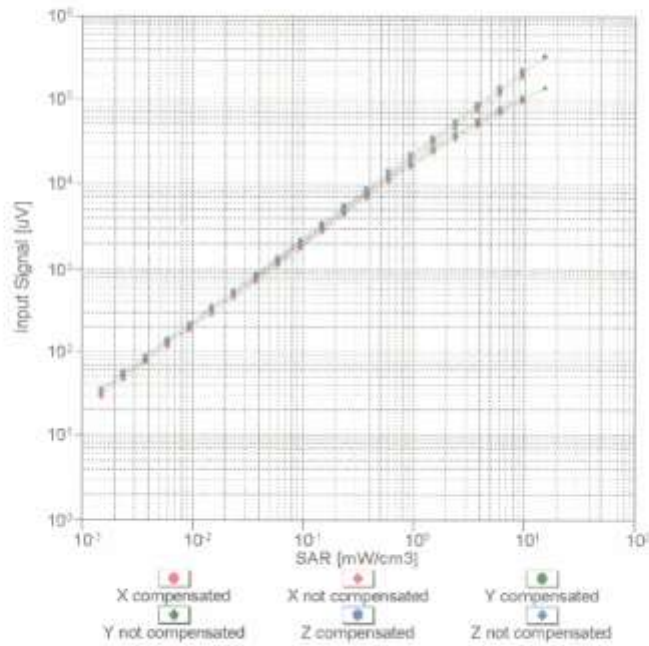


Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ (k=2)

ET3DV6- SN:1609

March 19, 2012

Dynamic Range f(SAR_{head})
(TEM cell , f = 900 MHz)

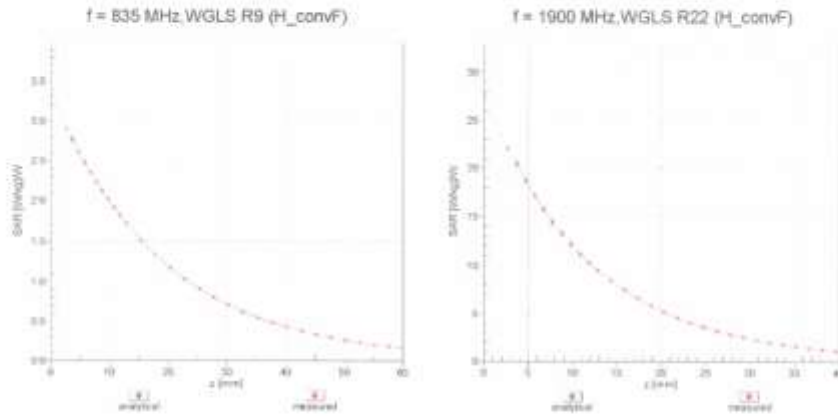


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

ET3DV6- SN:1609

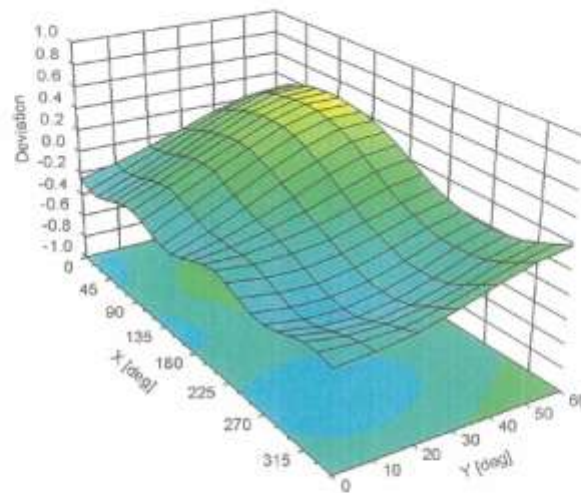
March 19, 2012

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), $f = 900$ MHz



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

ET3DV6- SN:1609

March 19, 2012

DASY/EASY - Parameters of Probe: ET3DV6 - SN:1609**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	Not applicable
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	6.8 mm
Probe Tip to Sensor X Calibration Point	2.7 mm
Probe Tip to Sensor Y Calibration Point	2.7 mm
Probe Tip to Sensor Z Calibration Point	2.7 mm
Recommended Measurement Distance from Surface	4 mm

Attachment 4. – Dipole Calibration Data

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Accreditation No.: **SCS 108**

Client **HCT (Dymstec)**

Certificate No: **D835V2-441_May12**

CALIBRATION CERTIFICATE			
Object	D835V2 - SN: 441		
Calibration procedure(s)	QA CAL-05.v8 Calibration procedure for dipole validation kits above 700 MHz		
Calibration date:	May 16, 2012		
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&E critical for calibration)			
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: 5058 (20k)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.2 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	30-Dec-11 (No. ES3-3205_Dec11)	Dec-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
Calibrated by:	Name Israel El-Naouq	Function Laboratory Technician	Signature
Approved by:	Name Katja Pokovic	Function Technical Manager	Signature
			Issued: May 16, 2012
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			

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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:

- 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	V52.8.1
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	835 MHz \pm 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	41.5	0.90 mho/m
Measured Head TSL parameters	(22.0 \pm 0.2) °C	40.6 \pm 6 %	0.89 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	2.35 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	9.43 mW / g \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.54 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	6.18 mW / g \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	55.2	0.97 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	54.3 \pm 6 %	1.00 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	2.44 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	9.50 mW / g \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	1.60 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	6.27 mW / g \pm 16.5 % (k=2)

Appendix**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	51.1 Ω - 5.8 $\mu\Omega$
Return Loss	-24.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.0 Ω - 8.1 $\mu\Omega$
Return Loss	-21.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.372 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	March 09, 2001

DASY5 Validation Report for Head TSL

Date: 16.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 441

Communication System: CW; Frequency: 835 MHz

Medium parameters used: $f = 835$ MHz; $\sigma = 0.89$ mho/m; $\epsilon_r = 40.6$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.07, 6.07, 6.07); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm 2/Zoom Scan (7x7x7)/Cube 0:

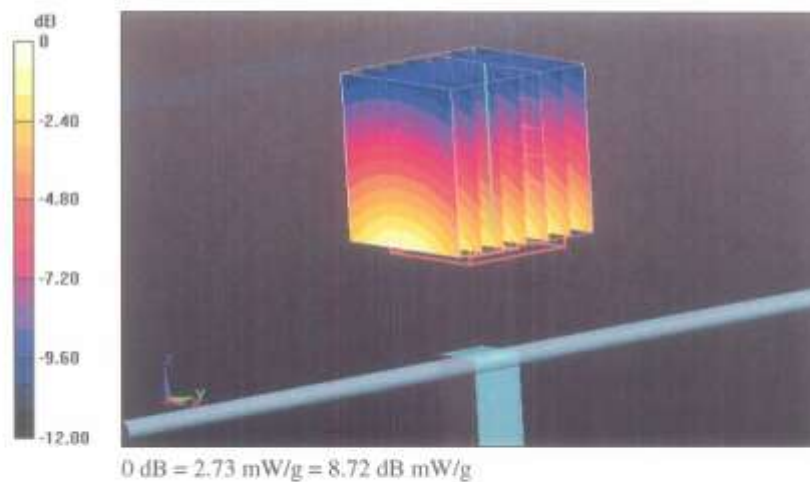
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 57.129 V/m; Power Drift = 0.00 dB

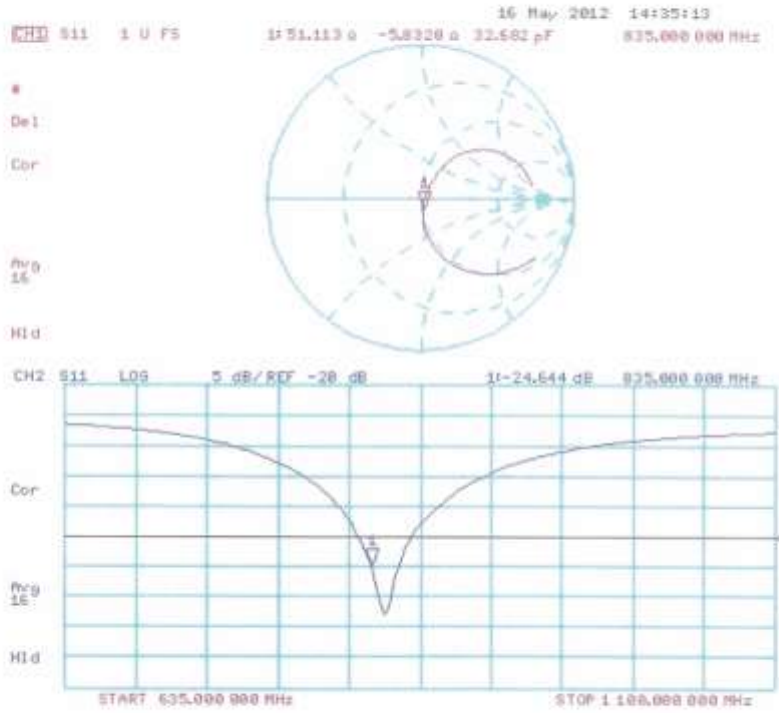
Peak SAR (extrapolated) = 3.474 mW/g

SAR(1 g) = 2.35 mW/g; SAR(10 g) = 1.54 mW/g

Maximum value of SAR (measured) = 2.73 mW/g



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 16.05.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 835 MHz; Type: D835V2; Serial: D835V2 - SN: 441

Communication System: CW; Frequency: 835 MHz

Medium parameters used: $f = 835$ MHz; $\sigma = 1$ mho/m; $\epsilon_r = 54.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(6.02, 6.02, 6.02); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.07.2011
- Phantom: Flat Phantom 4.9L; Type: QD000P49AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

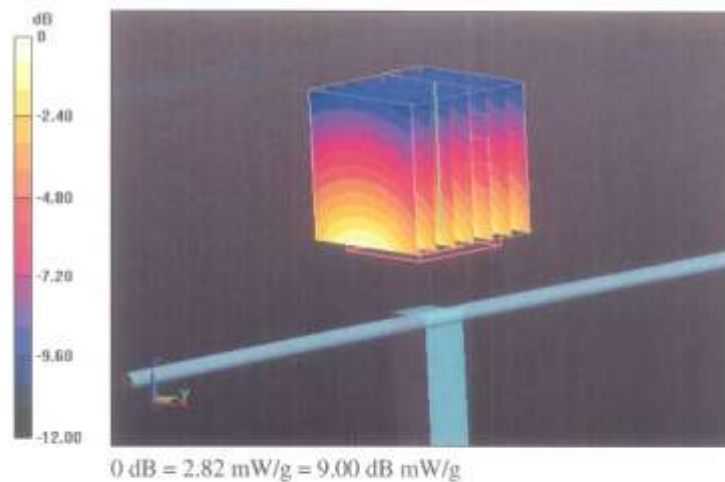
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 55.054 V/m; Power Drift = 0.03 dB

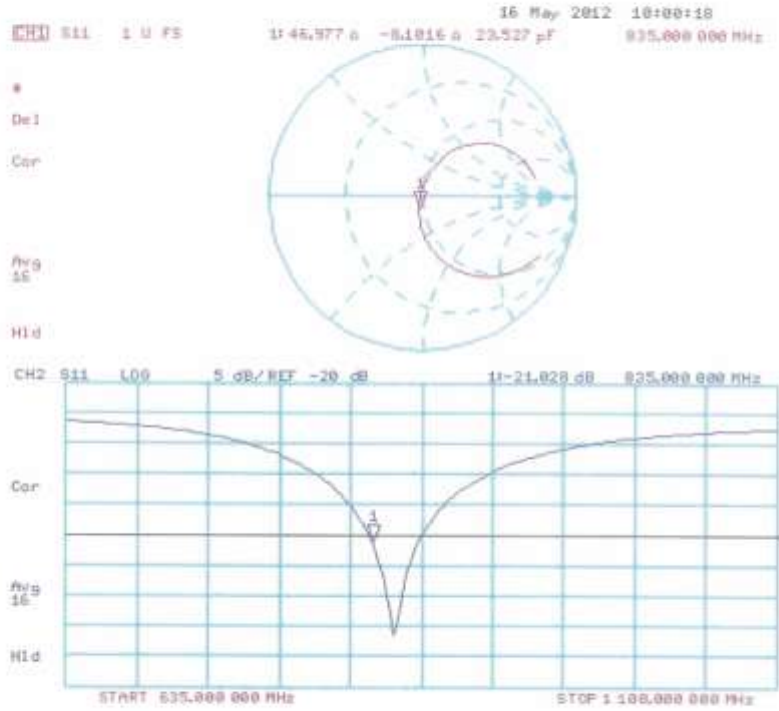
Peak SAR (extrapolated) = 3.533 mW/g

SAR(1 g) = 2.44 mW/g; SAR(10 g) = 1.6 mW/g

Maximum value of SAR (measured) = 2.82 mW/g



Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 108

Client HCT (Dymstec)

Certificate No: D1900V2-5d032_Jul12

CALIBRATION CERTIFICATE

Object D1900V2 - SN: 5d032

Calibration procedure(s) QA CAL-05.v8
Calibration procedure for dipole validation kits above 700 MHz.

Calibration date: July 20, 2012

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 (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: 5058 (20k)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.2 / 06327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES32V3	SN: 3205	30-Dec-11 (No. ES3-3205_Dec11)	Dec-12
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-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

Calibrated by:	Name Dimce Iliev	Function Laboratory Technician	Signature
Approved by:	Name Katja Pokovic	Function Technical Manager	Signature

Issued: July 20, 2012

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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:

- 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	V52.8.1
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 \pm 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 \pm 0.2) °C	39.9 \pm 6 %	1.38 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	9.68 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	39.0 mW / g \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.11 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	20.5 mW / g \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	53.3	1.52 mho/m
Measured Body TSL parameters	(22.0 \pm 0.2) °C	52.6 \pm 6 %	1.52 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	10.0 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	39.9 mW / g \pm 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.30 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	21.2 mW / g \pm 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	50.0 Ω + 3.1 jΩ
Return Loss	-30.1 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	46.2 Ω + 3.7 jΩ
Return Loss	-25.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.194 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	March 17, 2003

DASY5 Validation Report for Head TSL

Date: 20.07.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d032

Communication System: CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.38$ mho/m; $\epsilon_r = 39.9$; $\rho = 1000$ kg/m³

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: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

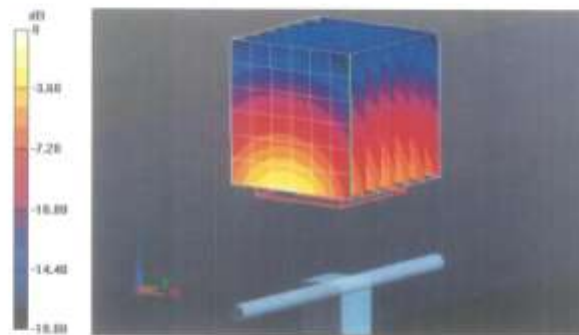
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 96.864 V/m; Power Drift = 0.03 dB

Peak SAR (extrapolated) = 17.209 mW/g

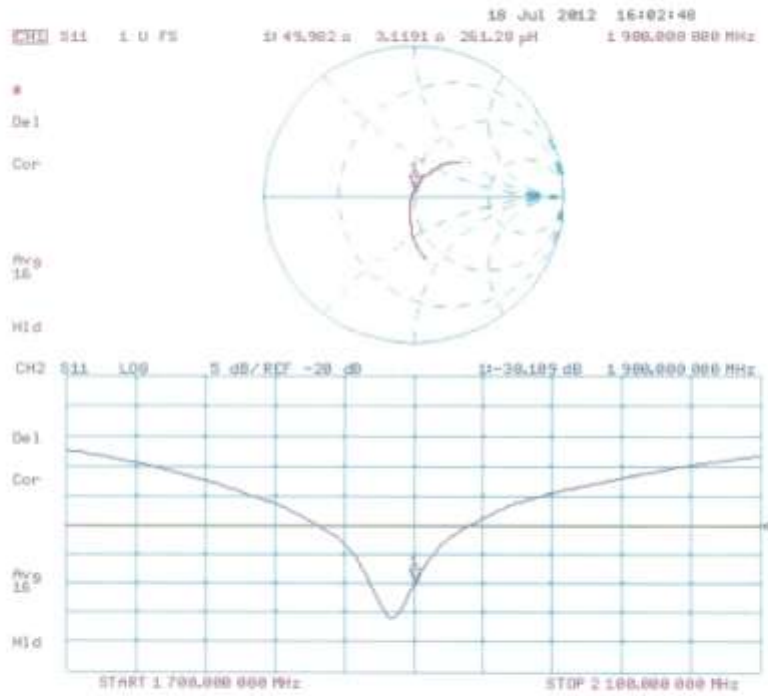
SAR(1 g) = 9.68 mW/g; SAR(10 g) = 5.11 mW/g

Maximum value of SAR (measured) = 12.1 mW/g



0 dB = 12.1 mW/g = 21.66 dB mW/g

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 20.07.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN: 5d032

Communication System: CW; Frequency: 1900 MHz

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.52$ mho/m; $\epsilon_r = 52.6$; $\rho = 1000$ kg/m³

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: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.1(838); SEMCAD X 14.6.5(6469)

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

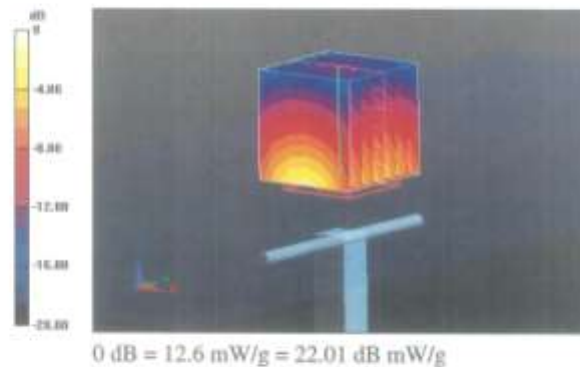
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.470 V/m; Power Drift = -0.00 dB

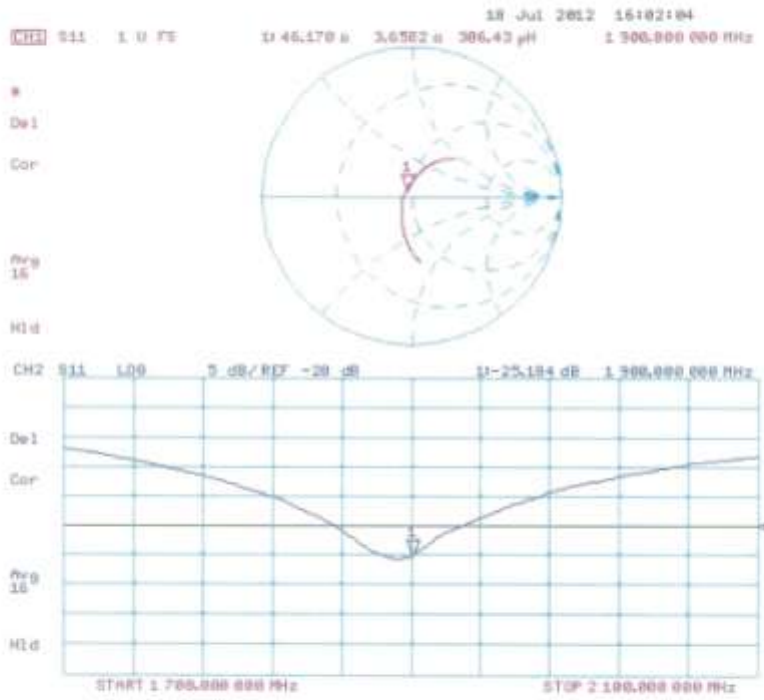
Peak SAR (extrapolated) = 17.332 mW/g

SAR(1 g) = 10 mW/g; SAR(10 g) = 5.3 mW/g

Maximum value of SAR (measured) = 12.6 mW/g



Impedance Measurement Plot for Body TSL



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Accreditation No.: SCS 108

Client **HCT (Dymstec)**

Certificate No: D2450V2-743_Aug12

CALIBRATION CERTIFICATE			
Object	D2450V2 - SN: 743		
Calibration procedure(s)	QA CAL-05.v8 Calibration procedure for dipole validation kits above 700 MHz		
Calibration date:	August 23, 2012		
<p>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.</p> <p>All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.</p> <p>Calibration Equipment used (M&TE critical for calibration)</p>			
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 B481A	US37292783	05-Oct-11 (No. 217-01451)	Oct-12
Reference 20 dB Attenuator	SN: 5058 (20k)	27-Mar-12 (No. 217-01530)	Apr-13
Type-N mismatch combination	SN: 5047.2 / 08327	27-Mar-12 (No. 217-01533)	Apr-13
Reference Probe ES3DV3	SN: 3205	30-Dec-11 (No. ES3-3205_Dec11)	Dec-12
DAE4	SN: 601	27-Jun-12 (No. DAE4-601_Jun12)	Jun-13
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power sensor HP B481A	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
Calibrated by:	Name: Ihsan El-Naouq	Function: Laboratory Technician	Signature:
Approved by:	Katja Polkovic	Technical Manager	
			Issued: August 23, 2012
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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:

- 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	V52.8.2
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	-dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	39.2 ± 6 %	1.81 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	13.2 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	52.7 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.18 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	24.7 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	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.3 ± 6 %	1.99 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	13.0 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	51.2 mW / g ± 17.0 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	6.10 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	24.2 mW / g ± 16.5 % (k=2)

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.0 Ω + 4.7 jΩ
Return Loss	- 24.6 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.9 Ω + 6.5 jΩ
Return Loss	- 23.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.158 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 01, 2003

DASY5 Validation Report for Head TSL

Date: 23.08.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 743

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.81$ mho/m; $\epsilon_r = 39.2$; $\rho = 1000$ kg/m³

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: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

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

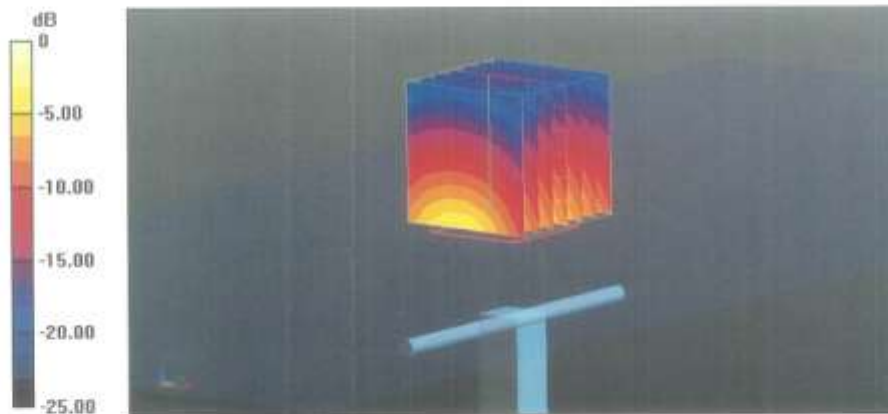
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 98.554 V/m; Power Drift = 0.01 dB

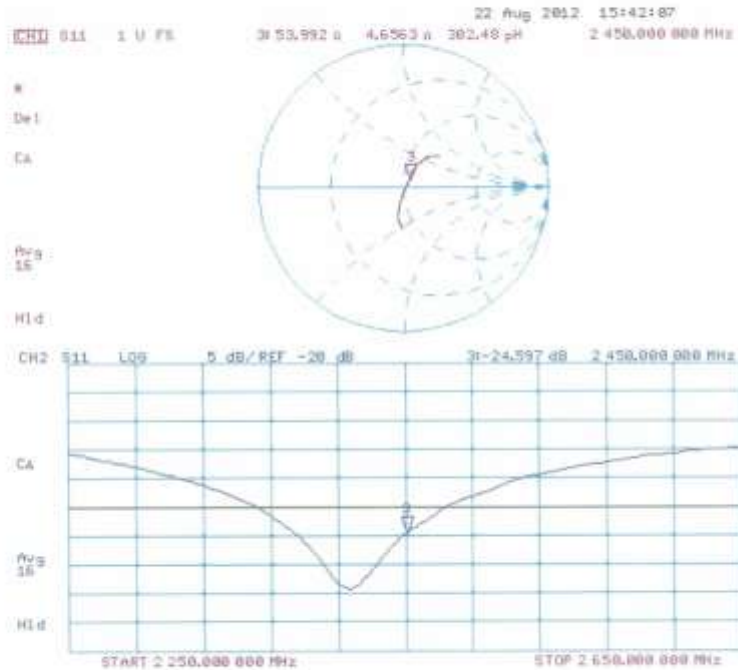
Peak SAR (extrapolated) = 26.584 mW/g

SAR(1 g) = 13.2 mW/g; SAR(10 g) = 6.18 mW/g

Maximum value of SAR (measured) = 16.5 W/kg



Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 22.08.2012

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 743

Communication System: CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.99$ mho/m; $\epsilon_r = 51.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: ES3DV3 - SN3205; ConvF(4.26, 4.26, 4.26); Calibrated: 30.12.2011;
- Sensor-Surface: 3mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.06.2012
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.2(969); SEMCAD X 14.6.6(6824)

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

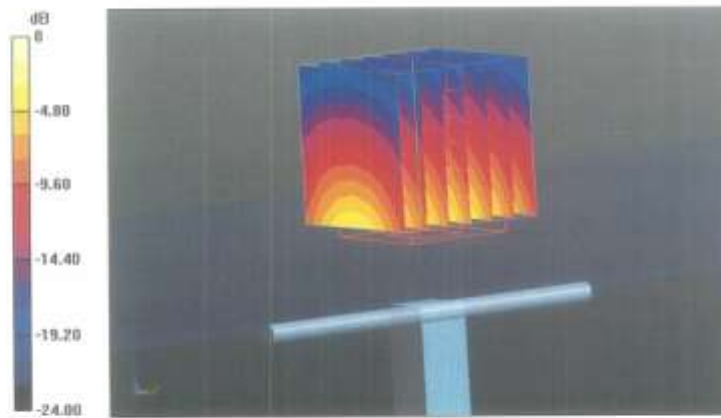
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 95.699 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 26.489 mW/g

SAR(1 g) = 13 mW/g; SAR(10 g) = 6.1 mW/g

Maximum value of SAR (measured) = 16.9 W/kg



0 dB = 16.9 W/kg = 24.56 dB W/kg

Impedance Measurement Plot for Body TSL

