

12.SAR Test Results Summary

General Note:

- Per KDB 447498 D01v05r01, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.

Scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.

Reported SAR(W/kg)= Measured SAR(W/kg) Scaling Factor*

- Per KDB 447498 D01v05r01, for each exposure position, if the highest output channel reported SAR≤0.8W/kg, other channels SAR testing are not necessary

12.1. Body-worn SAR Results

<LTE>

Plot No.	Band	Mode	Test Position	Gap (cm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR _{1g} (W/kg)	Reported SAR _{1g} (W/kg)
	LTE Band 5	QPSK_1RB	Front	1	20525	836.5	24.49	25.0	1.12	0.07	0.235	0.26
#1	LTE Band 5	QPSK_1RB	Back	1	20525	836.5	24.49	25.0	1.12	-0.17	0.330	0.37
	LTE Band 5	QPSK_25RB	Front	1	20525	836.5	23.53	24.0	1.11	0.05	0.172	0.19
	LTE Band 5	QPSK_25RB	Back	1	20525	836.5	23.53	24.0	1.11	0.12	0.251	0.28

Plot No.	Band	Mode	Test Position	Gap (cm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR _{1g} (W/kg)	Reported SAR _{1g} (W/kg)
	LTE Band 41	QPSK_1RB	Front	1	41140	2645	24.24	25.0	1.19	-0.02	0.277	0.33
#2	LTE Band 41	QPSK_1RB	Back	1	41140	2645	24.24	25.0	1.19	0.01	0.419	0.50
	LTE Band 41	QPSK_50RB	Front	1	41140	2645	23.08	24.0	1.24	-0.01	0.200	0.25
	LTE Band 41	QPSK_50RB	Back	1	41140	2645	23.08	24.0	1.24	0.02	0.306	0.38

Note:

- CMW500 base station simulator was used to setup the connection with EUT; the frequency band, channel, bandwidth, RB allocation configuration, modulation type are set in the base station simulator to configure EUT transmitting at maximum power and at different configurations which are requested to be reported to FCC, for conducted power measurement and SAR testing.
- Per KDB 941225 D05v02r05, when a properly configured base station simulator is used for the SAR and power measurements, spectrum plots for each RB allocation and offset configuration is not required.
- Per KDB 941225 D05v02r05, start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel.
- Per KDB 941225 D05v02r05, 50% RB allocation for QPSK SAR testing follows 1RB QPSK allocation procedure.
- Per KDB 941225 D05v02r05, for QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg. Otherwise,

SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.

6. Per KDB 941225 D05v02r05, 16QAM output power for each RB allocation configuration is $>$ not $\frac{1}{2}$ dB higher than the same configuration in QPSK and the reported SAR for the QPSK configuration is ≤ 1.45 W/kg; Per KDB 941225 D05v02r05, 16QAM SAR testing is not required.
7. Per KDB 941225 D05v02r05, smaller bandwidth output power for each RB allocation configuration is $>$ not $\frac{1}{2}$ dB higher than the same configuration in the largest supported bandwidth, and the reported SAR for the largest supported bandwidth is ≤ 1.45 W/kg; Per KDB 941225 D05v02r05, smaller bandwidth SAR testing is not required.

<WLAN>

Plot No.	Band	Mode	Test Position	Gap (cm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	D.C Factor	Power Drift (dB)	Measured SAR _{1g} (W/kg)	Reported SAR _{1g} (W/kg)
	WLAN 2.4GHz	802.11b	Front	1	6	2437	17.50	18.0	1.12	1.017	-0.04	0.176	0.18
#3	WLAN 2.4GHz	802.11b	Back	1	6	2437	17.50	18.0	1.12	1.017	-0.07	0.247	0.25

Note:

1. According to the KDB248227 D01, The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit. A maximum transmission duty factor of 98.3% is achievable for WLAN in this project.
2. D.C Factor = $1/98.3\% = 1.017$
3. According to the above table, the initial test position for body is “Back”, and its reported SAR is ≤ 0.4 W/kg. Thus further SAR measurement is not required for the other (remaining) test positions. Because the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
4. When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied. SAR is not required for the following 2.4 GHz OFDM conditions.
 - c) When KDB Publication 447498 D01 SAR test exclusion applies to the OFDM configuration.
 - d) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, the 802.11g/n is not required.

12.2. Hotspot SAR Results

<LTE>

Plot No.	Band	Mode	Test Position	Gap (cm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR _{1g} (W/kg)	Reported SAR _{1g} (W/kg)
	LTE Band 5	QPSK_1RB	Front	1	20525	836.5	24.49	25.0	1.12	0.07	0.235	0.26
#1	LTE Band 5	QPSK_1RB	Back	1	20525	836.5	24.49	25.0	1.12	-0.17	0.330	0.37
	LTE Band 5	QPSK_1RB	Left Side	1	20525	836.5	24.49	25.0	1.12	-0.10	0.156	0.18
	LTE Band 5	QPSK_1RB	Right Side	1	20525	836.5	24.49	25.0	1.12	0.18	0.146	0.16

	LTE Band 5	QPSK_1RB	Top Side	1	20525	836.5	24.49	25.0	1.12	-	-	-
	LTE Band 5	QPSK_1RB	Bottom Side	1	20525	836.5	24.49	25.0	1.12	0.05	0.288	0.32
	LTE Band 5	QPSK_25RB	Front	1	20525	836.5	23.53	24.0	1.11	0.05	0.172	0.19
	LTE Band 5	QPSK_25RB	Back	1	20525	836.5	23.53	24.0	1.11	0.12	0.251	0.28
	LTE Band 5	QPSK_25RB	Left Side	1	20525	836.5	23.53	24.0	1.11	-0.09	0.119	0.13
	LTE Band 5	QPSK_25RB	Right Side	1	20525	836.5	23.53	24.0	1.11	0.15	0.135	0.15
	LTE Band 5	QPSK_25RB	Top Side	1	20525	836.5	23.53	24.0	1.11	-	-	-
	LTE Band 5	QPSK_25RB	Bottom Side	1	20525	836.5	23.53	24.0	1.11	0.06	0.190	0.21

Plot No.	Band	Mode	Test Position	Gap (cm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR _{1g} (W/kg)	Reported SAR _{1g} (W/kg)
	LTE Band 41	QPSK_1RB	Front	1	41140	2645	24.24	25.0	1.19	-0.02	0.277	0.33
#2	LTE Band 41	QPSK_1RB	Back	1	41140	2645	24.24	25.0	1.19	0.01	0.419	0.50
	LTE Band 41	QPSK_1RB	Left Side	1	41140	2645	24.24	25.0	1.19	-0.03	0.184	0.22
	LTE Band 41	QPSK_1RB	Right Side	1	41140	2645	24.24	25.0	1.19	0.02	0.134	0.16
	LTE Band 41	QPSK_1RB	Top Side	1	41140	2645	24.24	25.0	1.19	-	-	-
	LTE Band 41	QPSK_1RB	Bottom Side	1	41140	2645	24.24	25.0	1.19	0.07	0.289	0.34
	LTE Band 41	QPSK_50RB	Front	1	41140	2645	23.08	24.0	1.24	-0.01	0.200	0.25
	LTE Band 41	QPSK_50RB	Back	1	41140	2645	23.08	24.0	1.24	0.02	0.306	0.38
	LTE Band 41	QPSK_50RB	Left Side	1	41140	2645	23.08	24.0	1.24	-0.01	0.133	0.16
	LTE Band 41	QPSK_50RB	Right Side	1	41140	2645	23.08	24.0	1.24	-0.01	0.102	0.13
	LTE Band 41	QPSK_50RB	Top Side	1	41140	2645	23.08	24.0	1.24	-	-	-
	LTE Band 41	QPSK_50RB	Bottom Side	1	41140	2645	23.08	24.0	1.24	0.02	0.224	0.28

Note:

1. CMW500 base station simulator was used to setup the connection with EUT; the frequency band, channel, bandwidth, RB allocation configuration, modulation type are set in the base station simulator to configure EUT transmitting at maximum power and at different configurations which are requested to be reported to FCC, for conducted power measurement and SAR testing.
2. Per KDB 941225 D05v02r05, when a properly configured base station simulator is used for the SAR and power measurements, spectrum plots for each RB allocation and offset configuration is not required.
3. Per KDB 941225 D05v02r05, start with the largest channel bandwidth and measure SAR for QPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel.
4. Per KDB 941225 D05v02r05, 50% RB allocation for QPSK SAR testing follows 1RB QPSK allocation procedure.
5. Per KDB 941225 D05v02r05, for QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.
6. Per KDB 941225 D05v02r05, 16QAM output power for each RB allocation configuration is $> \text{not } \frac{1}{2}$ dB

higher than the same configuration in QPSK and the reported SAR for the QPSK configuration is ≤ 1.45 W/kg; Per KDB 941225D05v02r05, 16QAM SAR testing is not required.

7. Per KDB 941225 D05v02r05, smaller bandwidth output power for each RB allocation configuration is $> \text{not } \frac{1}{2}$ dB higher than the same configuration in the largest supported bandwidth, and the reported SAR for the largest supported bandwidth is ≤ 1.45 W/kg; Per KDB 941225 D05v02r05, smaller bandwidth SAR testing is not required.

<WLAN>

Plot No.	Band	Mode	Test Position	Gap (cm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	D.C Factor	Power Drift (dB)	Measured SAR _{1g} (W/kg)	Reported SAR _{1g} (W/kg)
	WLAN2.4GHz	802.11b	Front	1	6	2437	17.50	18.0	1.12	1.017	-0.04	0.176	0.18
#3	WLAN2.4GHz	802.11b	Back	1	6	2437	17.50	18.0	1.12	1.017	-0.07	0.247	0.25
	WLAN2.4GHz	802.11b	Left Side	1	6	2437	17.50	18.0	1.12	1.017	-	-	-
	WLAN2.4GHz	802.11b	Right Side	1	6	2437	17.50	18.0	1.12	1.017	-0.12	0.109	0.11
	WLAN2.4GHz	802.11b	Top Side	1	6	2437	17.50	18.0	1.12	1.017	-0.03	0.141	0.14
	WLAN2.4GHz	802.11b	Bottom Side	1	6	2437	17.50	18.0	1.12	1.017	-	-	-

Note:

1. According to the KDB248227 D01, The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit. A maximum transmission duty factor of 98.3% is achievable for WLAN in this project.
2. D.C Factor = $1/98.3\% = 1.017$
3. According to the above table, the initial test position for body is “Back”, and its reported SAR is ≤ 0.4 W/kg. Thus further SAR measurement is not required for the other (remaining) test positions. Because the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
4. When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied. SAR is not required for the following 2.4 GHz OFDM conditions.
 - c) When KDB Publication 447498 D01 SAR test exclusion applies to the OFDM configuration.
 - d) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, the 802.11g/n is not required.

13. Simultaneous Transmission Analysis

13.1. Simultaneous TX SAR Considerations

No.	Applicable Simultaneous Transmission
1.	LTE+ WLAN 2.4GHz
2.	LTE + Bluetooth

Note:

1. WLAN 2.4GHz and Bluetooth share the same antenna, and cannot transmit simultaneously.
2. EUT will choose either LTE according to the network signal condition; therefore, LTE cannot transmit simultaneously.

13.2. Evaluation of Simultaneous SAR

<Body Exposure Conditions>

Test Position	WWAN SAR _{1-g} (W/Kg)	WiFi SAR _{1-g} (W/Kg)	MAX. ΣSAR _{1-g} (W/Kg)	SAR _{1-g} Limit (W/Kg)
Front	0.33	0.18	0.51	1.6
Back	0.50	0.25	0.75	1.6

Test Position	WWAN SAR _{1-g} (W/Kg)	BT SAR _{1-g} (W/Kg)	MAX. ΣSAR _{1-g} (W/Kg)	SAR _{1-g} Limit (W/Kg)
Front	0.33	0.09	0.42	1.6
Back	0.50	0.09	0.59	1.6

< Hotspot Exposure Conditions>

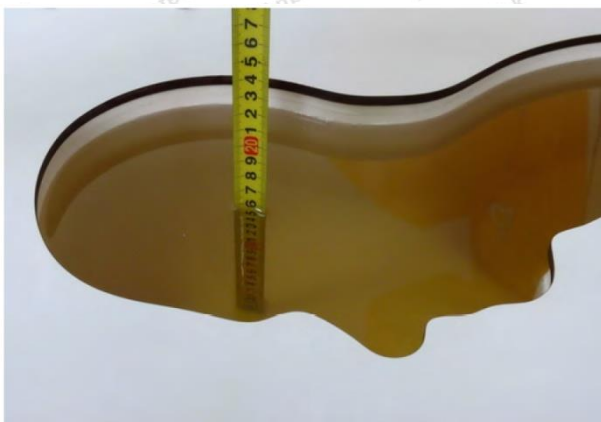
Test Position	WWAN SAR _{1-g} (W/Kg)	WiFi SAR _{1-g} (W/Kg)	MAX. ΣSAR _{1-g} (W/Kg)	SAR _{1-g} Limit (W/Kg)
Front	0.33	0.18	0.51	1.6
Back	0.50	0.25	0.75	1.6
Left Side	0.22	-	0.22	1.6
Right Side	0.16	0.11	0.27	1.6
Top side	-	0.14	0.14	1.6
Bottom Side	0.34	-	0.34	1.6

14.Measurement Uncertainty

Uncertainty component	Tol. (±%)	Prob. dist.	Div.	c_i (1g)	c_i (10g)	$1g$ u_i (±%)	$10g$ u_i (±%)
Measurement system							
Probe calibration($k=1$)	6.1	N	1	1	1	6.1	6.1
Axial isotropy	4.7	R			$\sqrt{0.5}$	1.9	1.9
Hemispherical isotropy	9.6	R		$\sqrt{0.5}$	$\sqrt{0.5}$	3.9	3.9
Boundary effect	1.0	R		1	1	0.6	0.6
Linearity	4.7	R		1	1	2.7	2.7
System detection limits	1.0	R		1	1	0.6	0.6
Modulation response	4.0	R		1	1	2.3	2.3
Readout electronics	1.0	N	1	1	1	1.0	1.0
Response time	0.8	R		1	1	0.5	0.5
Integration time	1.4	R		1	1	0.8	0.8
RF ambient conditions—noise	3.0	R		1	1	1.7	1.7
RF ambient conditions—reflections	3.0	R		1	1	1.7	1.7
Probe positioner mechanical tolerance	0.4	R		1	1	0.2	0.2
Probe positioning with respect to phantom shell	2.9	R		1	1	1.7	1.7
Extrapolation,interpolation,andintegrationsalgorithmsformax.S ARevaluation	2.0	R		1	1	1.2	1.2
Test sample related							
Test sample positioning	2.9	N	1	1	1	2.9	2.9
Device holder uncertainty	3.6	N	1	1	1	3.6	3.6
Output power variation—SAR drift measurement	5.0	R		1	1	2.9	2.9
SAR scaling	0	R		0	0	0	0
Phantom and tissue parameters							
Phantom shell uncertainty—shape, thickness, and permittivity	6.1	R		1	1	3.5	3.5
UncertaintyinSARcorrectionfordeviationsinpermittivityandco	1.9	N	1	1	0.84	1.9	1.6
Liquid conductivity measurement	2.5	N	1	0	0	0.0	0.0
Liquid permittivity measurement	2.5	N	1	0	0	0.0	0.0
Liquid conductivity—temperature uncertainty	3.4	R		0	0	0.0	0.0
Liquid permittivity—temperature uncertainty	0.4	R		0	0	0.0	0.0
Combined standard uncertainty		RSS				10.81	10.72
Expanded uncertainty(95%confidenceinterval)		$k=2$				21.62	21.45

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/Kg, the extensive SAR measurement uncertainty analysis described in IEEE 1528-2013 is not required in SAR reports submitted for equipment approval.

Appendix A. Test Setup Photos



Liquid depth in the head phantom (900MHz)



Liquid depth in the body phantom (900MHz)



Liquid depth in the head phantom (2450MHz)



Liquid depth in the body phantom (2450MHz)



Liquid depth in the head phantom (2600MHz)



Liquid depth in the body phantom (2600MHz)



Body-worn Front Side (10mm)



Body-worn Rear Side (10mm)



Front Side (10mm)



Rear Side (10mm)



Left Side (10mm)



Right Side (10mm)



Top Side (10mm)



Bottom Side (10mm)

Appendix B. Plots of SAR System Check

Date: 11/19/2018

Program Name: System Performance Check at 900 MHz Body

Communication System: CW; Frequency: 900 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 900$ MHz; $\sigma = 1.02$ mho/m; $\epsilon_r = 56.21$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(9.82, 9.82, 9.82); Calibrated: 05/12/2018;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn760; Calibrated: 9/18/2018
- Phantom: SAM 2; Type: SAM; Serial: TP-1432
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

d=15mm, Pin=250mW/Area Scan (61x131x1): Interpolated grid: dx=1.5mm, dy=1.5mm

Maximum value of SAR (interpolated) = 3.12 mW/g

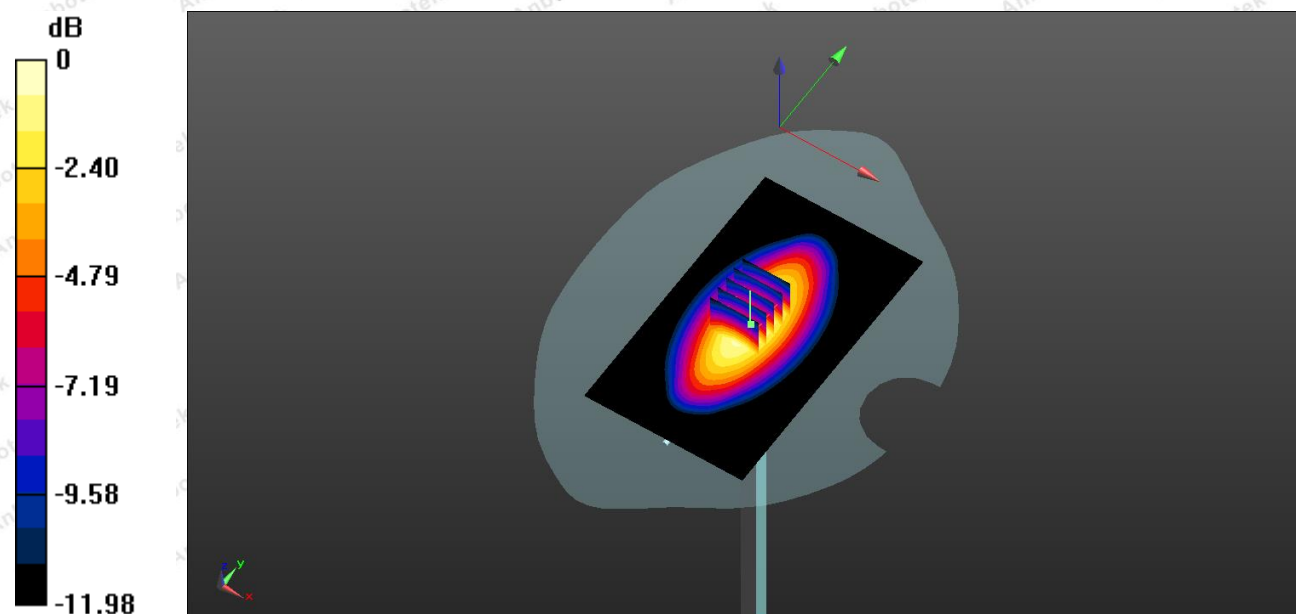
d=15mm, Pin=250mW/Zoom Scan (7X7x7) /Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 62.1 V/m; Power Drift = -0.08 dB

Peak SAR (extrapolated) = 4.06 mW/g

SAR(1 g) = 2.57 mW/g; SAR(10 g) = 1.64 mW/g

Maximum value of SAR (measured) = 3.16 W/kg



0 dB = 3.16 mW/g

Date: 11/20/2018

Program Name: System Performance Check Body at 2450 MHz

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.90$ mho/m; $\epsilon_r = 50.59$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(7.53, 7.53, 7.53); Calibrated: 05/12/2018;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn760; Calibrated: 9/18/2018
- Phantom: SAM 2; Type: SAM; Serial: TP-1432
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

d=10mm, Pin=250mW/Area Scan (91x91x1): Interpolated grid: dx=1.2mm, dy=1.2mm

Maximum value of SAR (interpolated) = 16.2 mW/g

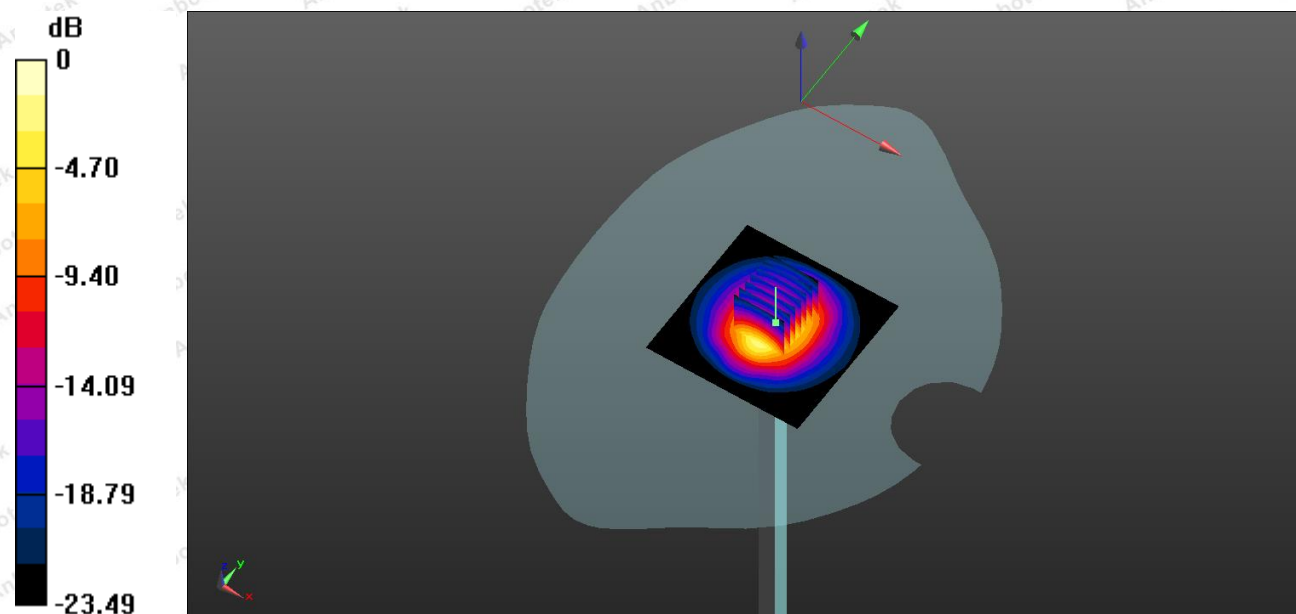
d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 89.5 V/m; Power Drift = 0.17 dB

Peak SAR (extrapolated) = 27.0 W/kg

SAR(1 g) = 13.5 mW/g; SAR(10 g) = 6.34 mW/g

Maximum value of SAR (measured) = 15.4 mW/g



0 dB = 15.4 mW/g

Date: 11/20/2018

Program Name: System Performance Check Body at 2600 MHz

Communication System: CW; Frequency: 2600 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 2600$ MHz; $\sigma = 2.14$ S/m; $\epsilon_r = 51.12$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(7.38, 7.38, 7.38); Calibrated: 05/12/2018;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn760; Calibrated: 9/18/2018
- Phantom: SAM 2; Type: SAM; Serial: TP-1432
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

d=10mm, Pin=250mW/Area Scan (91x91x1): Interpolated grid: dx=1.2mm, dy=1.2mm

Maximum value of SAR (interpolated) = 24.6 mW/g

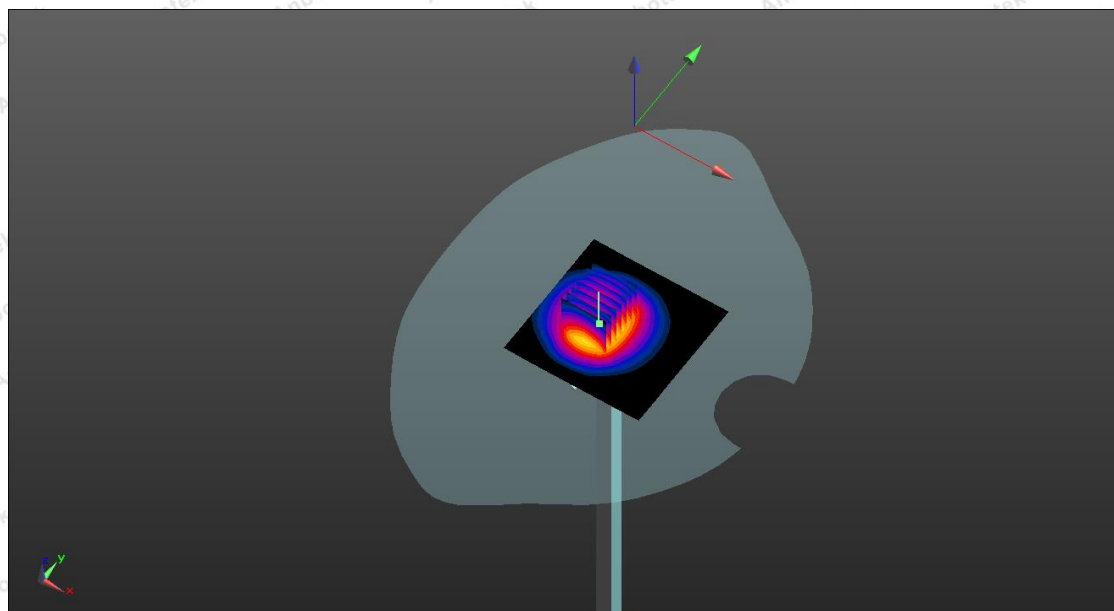
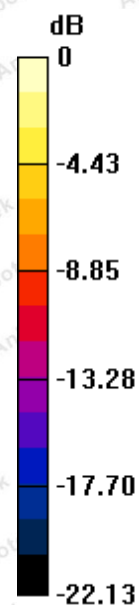
d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 108.4 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 30.0 W/kg

SAR(1 g) = 13.8 mW/g; SAR(10 g) = 6.01 mW/g

Maximum value of SAR (measured) = 23.8 mW/g



0 dB = 23.8 mW/g

Appendix C. Plots of SAR Test Data

Test mode:	LTE Band 5	Test Position:	Rear Side	Test Plot:	1
------------	------------	----------------	-----------	------------	---

Date: 11/19/2018

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

Medium parameters used (interpolated): $f=836.6$ MHz; $\sigma=0.97$ S/m; $\epsilon=55.10$; $\rho=1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(9.88, 9.88, 9.88); Calibrated: 05/12/2018;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn760; Calibrated: 9/18/2018
- Phantom: SAM 2; Type: SAM; Serial: TP-1432
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

Area Scan (51x111x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.345 mW/g

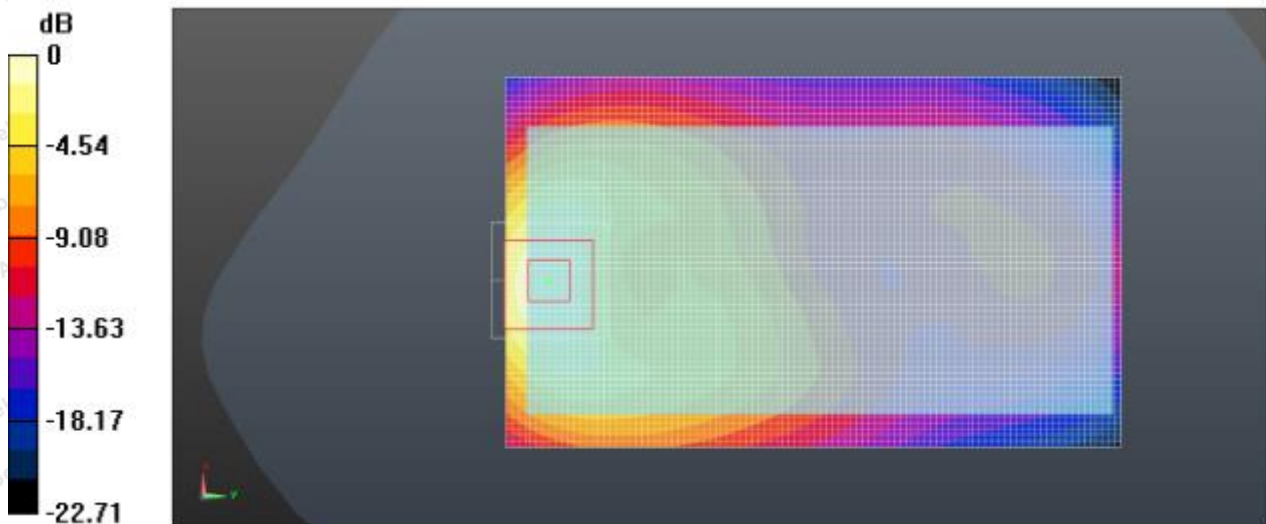
Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 6.796 V/m; Power Drift = -0.17 dB

Peak SAR (extrapolated) = 0.490 mW/g

SAR(1 g) = 0.330 mW/g; SAR(10 g) = 0.207 mW/g

Maximum value of SAR (measured) = 0.350 W/kg



Rear Side (LTE Band 5 Middle Channel)

Test mode:	LTE Band 41	Test Position:	Rear Side	Test Plot:	2
------------	-------------	----------------	-----------	------------	---

Date: 11/20/2018

Communication System: Generic LTE; Frequency: 2645 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 2645$ MHz; $\sigma = 2.15$ mho/m; $\epsilon_r = 50.36$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(7.38, 7.38, 7.38); Calibrated: 05/12/2018;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn760; Calibrated: 9/18/2018
- Phantom: SAM 2; Type: SAM; Serial: TP-1432
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

Area Scan (51x111x1): Interpolated grid: $dx=1.500$ mm, $dy=1.500$ mm

Maximum value of SAR (interpolated) = 0.437 mW/g

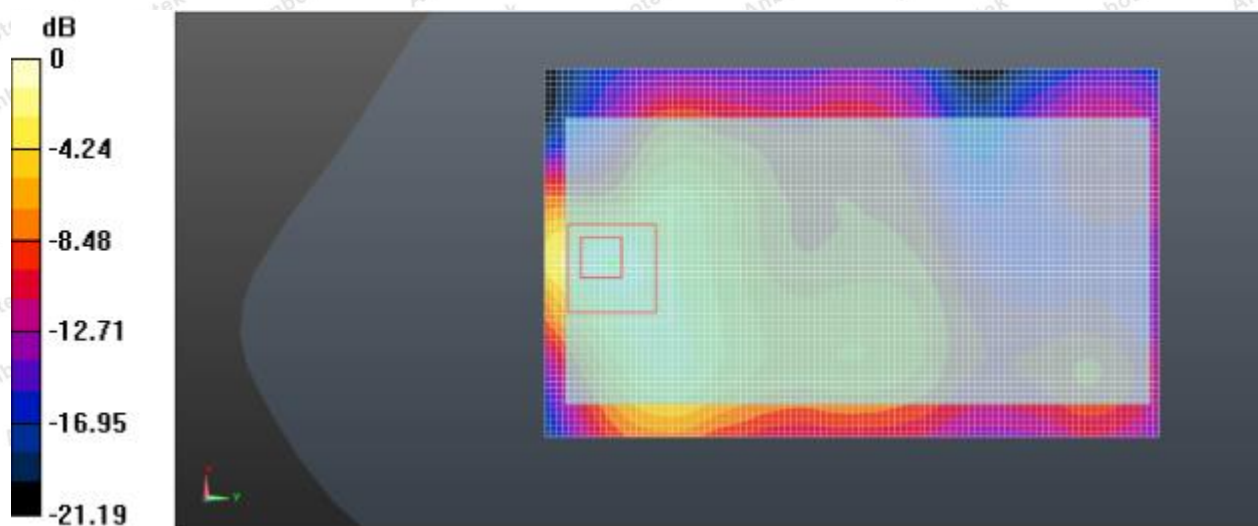
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 10.262 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 0.775 mW/g

SAR(1 g) = 0.419 mW/g; SAR(10 g) = 0.322 mW/g

Maximum value of SAR (measured) = 0.471 W/kg



Rear Side (LTE Band 41 Middle Channel)

Test mode:	WLAN 802.11b	Test Position:	Rear Side	Test Plot:	3
------------	--------------	----------------	-----------	------------	---

Date: 11/20/2018

Communication System: Customer System; Frequency: 2437.0 MHz;

Medium parameters used (interpolated): $f = 2437.0$ MHz; $\sigma = 1.90$ S/m; $\epsilon_r = 50.63$; $\rho = 1000$ kg/m³

Phantom section : Flat Section

DASY5 Configuration:

- Probe: EX3DV4 – SN7396; ConvF(7.53, 7.53, 7.53); Calibrated: 05/12/2018;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn760; Calibrated: 9/18/2018
- Phantom: SAM 2; Type: SAM; Serial: TP-1432
- Measurement SW: DASY5, V4.7 Build 53; Postprocessing SW: SEMCAD, V1.8 Build 172

Area Scan (51x111x1): Interpolated grid: $dx = 1.200$ mm, $dy = 1.200$ mm

Maximum value of SAR (interpolated) = 0.323 mW/g

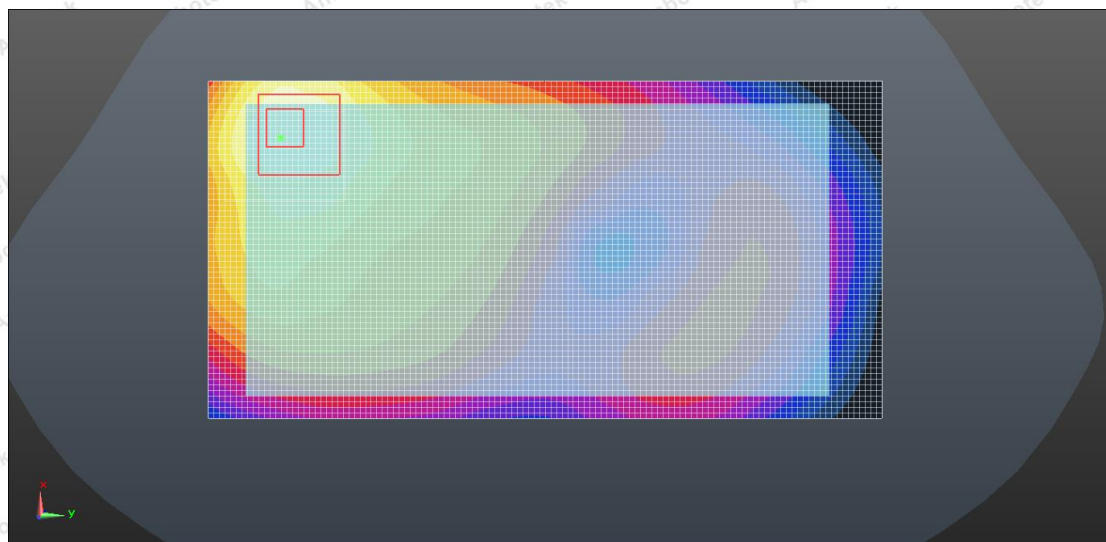
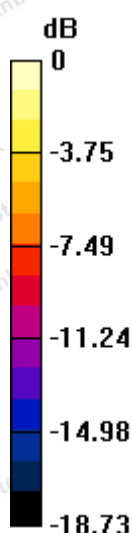
Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx = 5$ mm, $dy = 5$ mm, $dz = 5$ mm

Reference Value = 3.276 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 0.331 mW/g

SAR(1 g) = 0.247 mW/g; SAR(10 g) = 0.124 mW/g

Maximum value of SAR (measured) = 0.326 W/kg



Rear side (WLAN 802.11b)

Appendix D. DASY5 System Calibration Certificate



In Collaboration with
s p e a g
CALIBRATION LABORATORY



中国认可
国际互认
校准
CALIBRATION
CNAS L0570

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

Client **Anbotech (Auden)**

Certificate No: **Z17-97061**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:7396**

Calibration Procedure(s) **FF-Z11-004-01**
Calibration Procedures for Dosimetric E-field Probes

Calibration date: **May 12, 2018**

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)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	27-Jun-16 (CTTL, No.J16X04777)	Jun-17
Power sensor NRP-Z91	101547	27-Jun-16 (CTTL, No.J16X04777)	Jun-17
Power sensor NRP-Z91	101548	27-Jun-16 (CTTL, No.J16X04777)	Jun-17
Reference10dBAttenuator	18N50W-10dB	13-Mar-16(CTTL,No.J16X01547)	Mar-18
Reference20dBAttenuator	18N50W-20dB	13-Mar-16(CTTL, No.J16X01548)	Mar-18
Reference Probe EX3DV4	SN 7433	26-Sep-16(SPEAG,No.EX3-7433_Sep16)	Sep-17
DAE4	SN 549	13-Dec-16(SPEAG, No.DAE4-549_Dec16)	Dec -17
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
SignalGeneratorMG3700A	6201052605	27-Jun-16 (CTTL, No.J16X04776)	Jun-17
Network Analyzer E5071C	MY46110673	13-Jan-17 (CTTL, No.J17X00285)	Jan -18

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: May 26, 2017

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

Certificate No: Z17-97061

Page 1 of 11



In Collaboration with

s p e a g**CALIBRATION LABORATORY**

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China

Tel: +86-10-62304633-2218

Fax: +86-10-62304633-2209

E-mail: cttl@chinattl.com

Http://www.chinattl.cn

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,D	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 $\theta=0$ is normal to probe axis

Connector Angle information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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 300MHz to 3GHz)", February 2005
- IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\theta=0$ ($f \leq 900\text{MHz}$ in TEM-cell; $f > 1800\text{MHz}$: waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not effect the E^2 -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 (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 $f \leq 800\text{MHz}$) and inside waveguide using analytical field distributions based on power measurements for $f > 800\text{MHz}$. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued 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 $\pm 50\text{MHz}$ to $\pm 100\text{MHz}$.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).



In Collaboration with

s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: ttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

Probe EX3DV4

SN: 7396

Calibrated: May 12, 2018

Calibrated for DASY/EASY Systems

(Note: non-compatible with DASY2 system!)



In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7396

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.54	0.53	0.50	±10.0%
DCP(mV) ^B	97.8	104.5	102.5	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	199.9	±2.4%
		Y	0.0	0.0	1.0		203.3	
		Z	0.0	0.0	1.0		195.0	

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 Norm X, Y, Z do not affect the E²-field uncertainty inside TSL (see Page 5 and Page 6).
^B Numerical linearization parameter: uncertainty not required.
^E Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.



In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: ttl@chinattl.com Http://www.chinattl.cn

DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7396

Calibration Parameter Determined in Head Tissue Simulating Media

f [MHz] ^C	Relative Permittivity ^F	Conductivity (S/m) ^F	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unct. (k=2)
750	41.9	0.89	9.82	9.82	9.82	0.30	0.85	± 12.1%
835	41.5	0.90	9.71	9.71	9.71	0.15	1.36	± 12.1%
900	41.5	0.97	9.87	9.87	9.87	0.16	1.37	± 12.1%
1750	40.1	1.37	8.61	8.61	8.61	0.25	1.04	± 12.1%
1900	40.0	1.40	8.13	8.13	8.13	0.24	1.01	± 12.1%
2100	39.8	1.49	8.14	8.14	8.14	0.24	1.04	± 12.1%
2300	39.5	1.67	7.85	7.85	7.85	0.40	0.75	± 12.1%
2450	39.2	1.80	7.57	7.57	7.57	0.50	0.75	± 12.1%
2600	39.0	1.96	7.38	7.38	7.38	0.64	0.68	± 12.1%
5250	35.9	4.71	5.33	5.33	5.33	0.45	1.30	± 13.3%
5600	35.5	5.07	4.89	4.89	4.89	0.45	1.35	± 13.3%
5750	35.4	5.22	4.92	4.92	4.92	0.45	1.45	± 13.3%

^C Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

^F At frequency 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.

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



In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7396

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 ^G	Depth ^G (mm)	Unct. (k=2)
750	55.5	0.96	10.09	10.09	10.09	0.30	0.90	± 12.1%
835	55.2	0.97	9.88	9.88	9.88	0.19	1.32	± 12.1%
900	55.0	1.05	9.82	9.82	9.82	0.23	1.15	± 12.1%
1750	53.4	1.49	8.24	8.24	8.24	0.24	1.06	± 12.1%
1900	53.3	1.52	7.97	7.97	7.97	0.19	1.24	± 12.1%
2100	53.2	1.62	8.18	8.18	8.18	0.19	1.39	± 12.1%
2300	52.9	1.81	7.88	7.88	7.88	0.55	0.80	± 12.1%
2450	52.7	1.95	7.53	7.53	7.53	0.46	0.89	± 12.1%
2600	52.5	2.16	7.38	7.38	7.38	0.52	0.80	± 12.1%
5250	48.9	5.36	4.93	4.93	4.93	0.45	1.80	± 13.3%
5600	48.5	5.77	4.19	4.19	4.19	0.48	1.90	± 13.3%
5750	48.3	5.94	4.52	4.52	4.52	0.48	1.95	± 13.3%

^C Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Above 5 GHz frequency validity can be extended to ± 110 MHz.

^F At frequency 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.

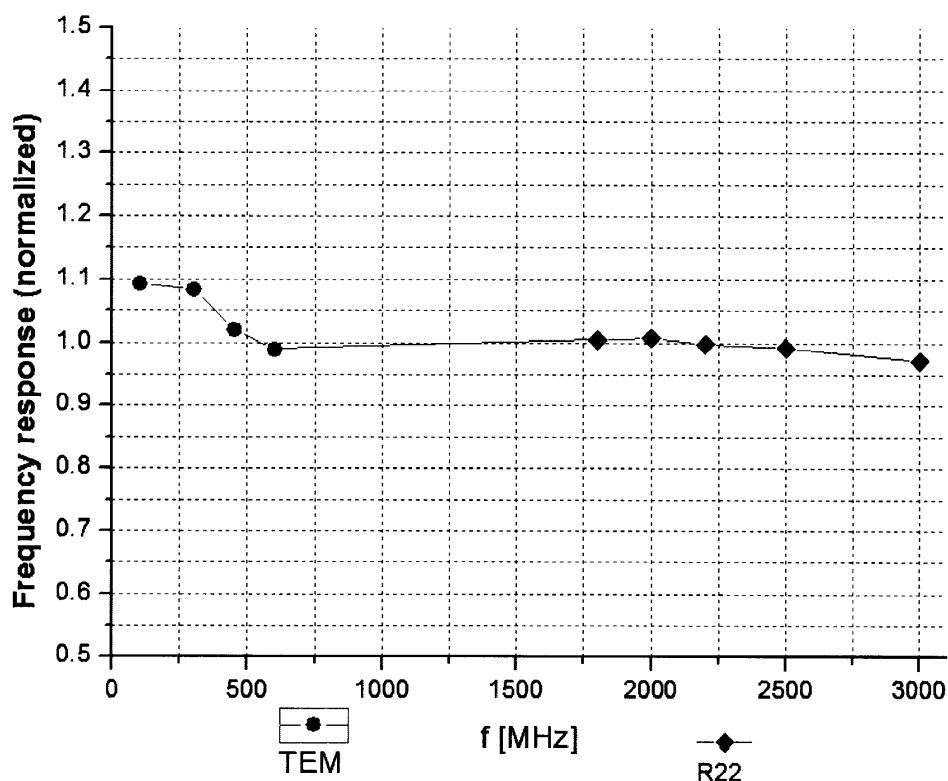
^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from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



In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

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



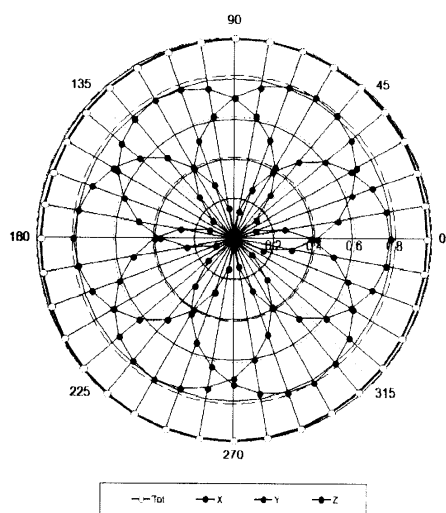
Uncertainty of Frequency Response of E-field: $\pm 7.4\%$ ($k=2$)



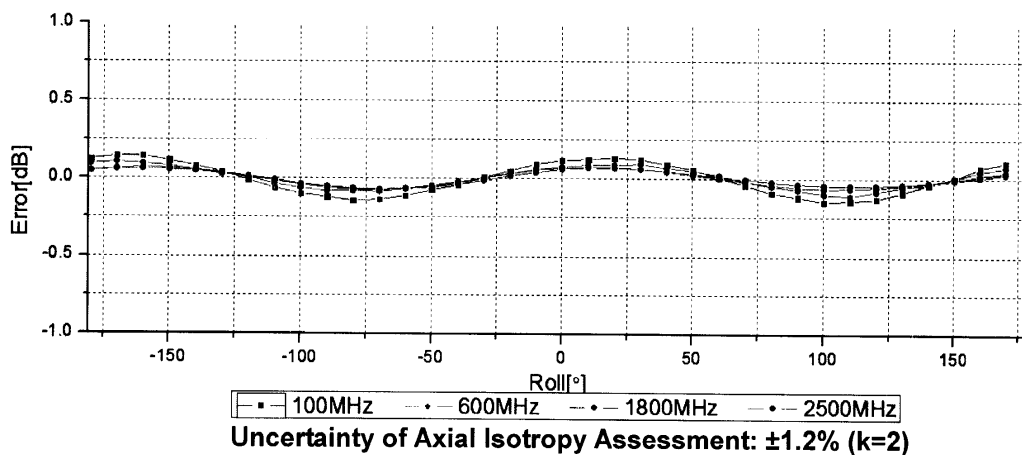
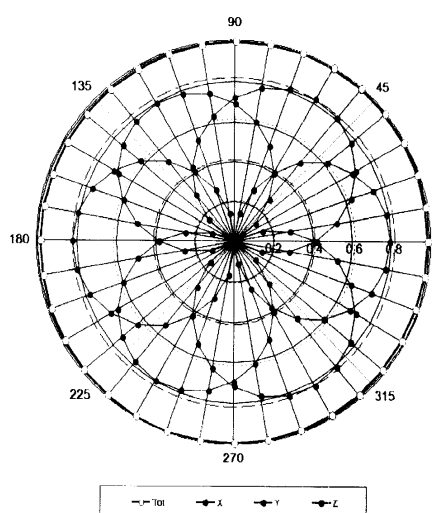
Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

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

f=600 MHz, TEM



f=1800 MHz, R22

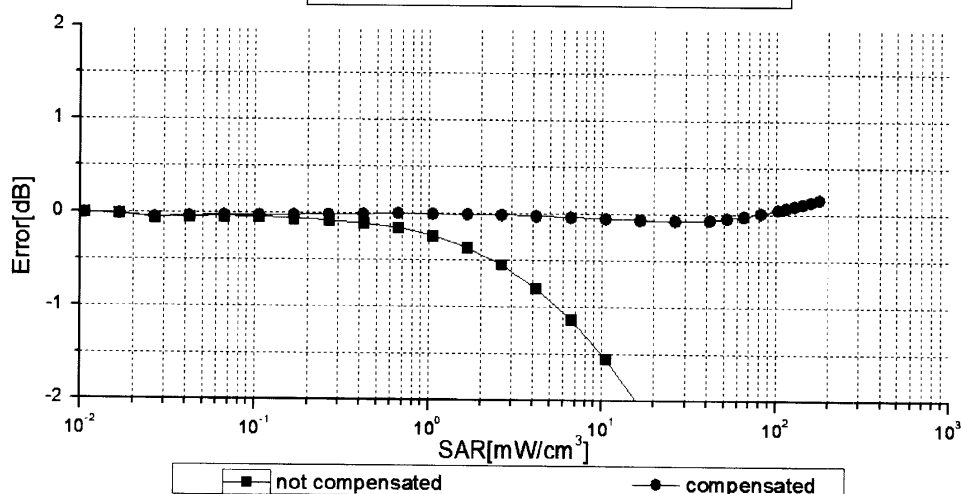
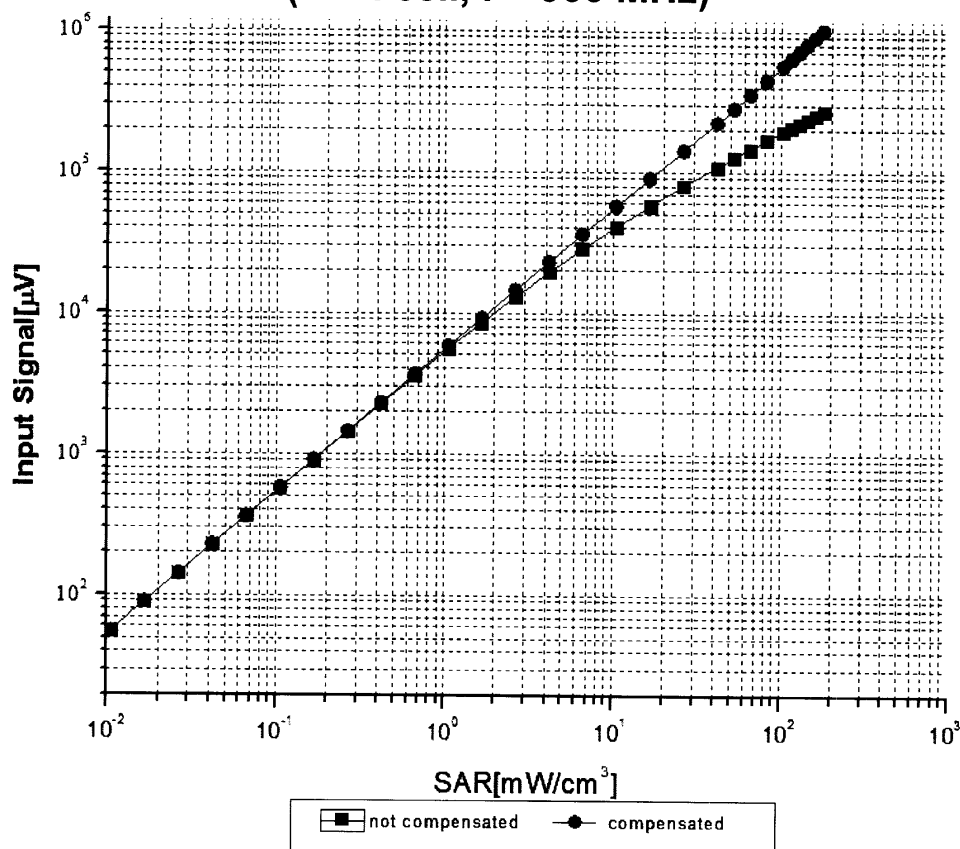




In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

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



Uncertainty of Linearity Assessment: $\pm 0.9\%$ ($k=2$)



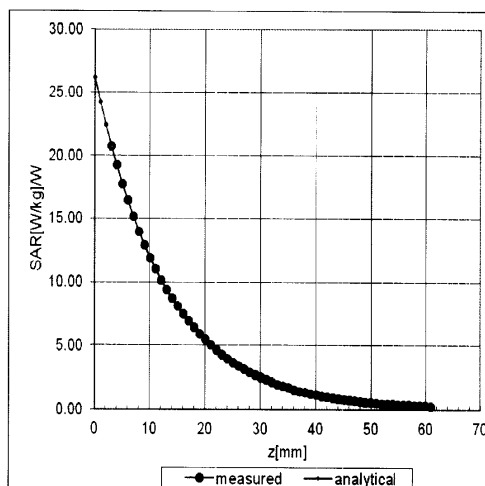
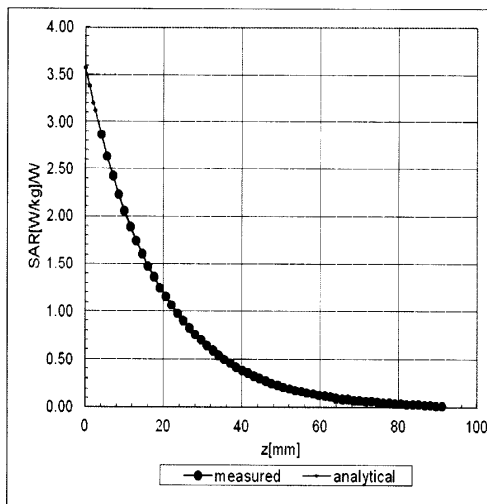
In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

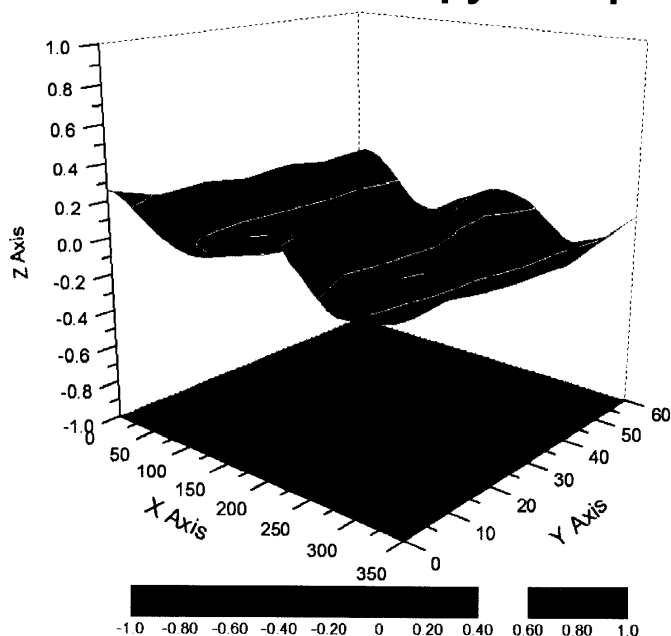
Conversion Factor Assessment

f=900 MHz, WGLS R9(H_convF)

f=1750 MHz, WGLS R22(H_convF)



Deviation from Isotropy in Liquid



Uncertainty of Spherical Isotropy Assessment: $\pm 3.2\%$ (K=2)

In Collaboration with
s p e a g
CALIBRATION LABORATORYAdd: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)**DASY/EASY – Parameters of Probe: EX3DV4 – SN: 7396****Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	156.9
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disable
Probe Overall Length	337mm
Probe Body Diameter	10mm
Tip Length	9mm
Tip Diameter	2.5mm
Probe Tip to Sensor X Calibration Point	1mm
Probe Tip to Sensor Y Calibration Point	1mm
Probe Tip to Sensor Z Calibration Point	1mm
Recommended Measurement Distance from Surface	1.4mm

In Collaboration with
s p e a g
CALIBRATION LABORATORY中国认可
国际互认
校准
CALIBRATION
CNAS L0570Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: ctl@chinattl.com <http://www.chinattl.cn>Client : **Sunway_SZ**

Certificate No: Z18-60377

CALIBRATION CERTIFICATE

Object

DAE4 - SN: 760

Calibration Procedure(s)

FF-Z11-002-01

Calibration Procedure for the Data Acquisition Electronics
(DAEx)

Calibration date:

September 18, 2018

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
Process Calibrator 753	1971018	20-Jun-18 (CTTL, No.J18X05034)	June-19

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: September 20, 2018

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

Certificate No: Z18-60377

Page 1 of 3



In Collaboration with

s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China

Tel: +86-10-62304633-2512

Fax: +86-10-62304633-2504

E-mail: cttl@chinattl.com

Http://www.chinattl.cn

Glossary:

DAE

data acquisition electronics

Connector angle

information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters:

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle:* The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The report provide only calibration results for DAE, it does not contain other performance test results.



In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2512 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com Http://www.chinattl.cn

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV, full range = -100...+300 mV

Low Range: 1LSB = 61nV, full range = -1.....+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	403.779 ± 0.15% (k=2)	405.055 ± 0.15% (k=2)	405.351 ± 0.15% (k=2)
Low Range	3.96958 ± 0.7% (k=2)	3.98244 ± 0.7% (k=2)	3.95999 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	248° ± 1 °
---	------------

In Collaboration with
s p e a g
CALIBRATION LABORATORY中国认可
国际互认
校准
CALIBRATION
CNAS L0570Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com Http://www.chinattl.cn

Client: Sunway

Certificate No: Z16-97102

CALIBRATION CERTIFICATE

Object: D900V2 - SN: 1d086

Calibration Procedure(s):
FD-Z11-2-003-01
Calibration Procedures for dipole validation kits

Calibration date: July 1, 2016

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&T critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	27-Jun-16 (CTTL, No.J16X04777)	Jun-17
Power sensor NRP-Z91	101547	27-Jun-16 (CTTL, No.J16X04777)	Jun-17
Reference Probe EX3DV4	SN 7307	19-Feb-16(SPEAG, No.EX3-7307_Feb16)	Feb-17
DAE4	SN 771	02-Feb-16(CTTL-SPEAG, No.Z16-97011)	Feb-17
Secondary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Signal Generator E4438C	MY49071430	01-Feb-16 (CTTL, No.J16X00893)	Jan-17
Network Analyzer E5071C	MY46110673	26-Jan-16 (CTTL, No.J16X00894)	Jan-17

	Name	Function	Signature
Calibrated by:	Zhao Jing	SAR Test Engineer	
Reviewed by:	Qi Diaryuan	SAR Project Leader	
Approved by:	Lu Bingsong	Deputy Director of the laboratory	

Issued: July 4, 2016

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

Certificate No: Z16-97102

Page 1 of 8



In Collaboration with

s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: ttl@chinatll.com Http://www.chinatll.cn

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 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
- 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 300MHz to 3GHz)", February 2005
- IEC 62209-2, "Procedure to measure the Specific Absorption Rate (SAR) For wireless communication devices used in close proximity to the human body (frequency range of 30MHz to 6GHz)", March 2010
- KDB865664, SAR Measurement Requirements for 100 MHz to 6 GHz

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%.



In Collaboration with

s p e a g
 CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
 Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
 E-mail: cntl@chinattl.com Http://www.chinattl.cn

Measurement Conditions

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

DASY Version	DASY52	52.8.8.1258
Extrapolation	Advanced Extrapolation	
Phantom	Triple Flat Phantom 5.1C	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	900 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	0.97 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	41.2 $\pm$ 6 %	0.99 mho/m $\pm$ 6 %
Head TSL temperature change during test	<1.0 °C	---	---

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.72 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	10.7 mW / g $\pm$ 20.8 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Head TSL	Condition	
SAR measured	250 mW input power	1.74 mW / g
SAR for nominal Head TSL parameters	normalized to 1W	6.88 mW / g $\pm$ 20.4 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	55.0	1.05 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	55.1 $\pm$ 6 %	1.07 mho/m $\pm$ 6 %
Body TSL temperature change during test	<1.0 °C	---	---

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	2.74 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	10.9 mW / g $\pm$ 20.8 % (k=2)
SAR averaged over 10 cm^3 (10 g) of Body TSL	Condition	
SAR measured	250 mW input power	1.80 mW / g
SAR for nominal Body TSL parameters	normalized to 1W	7.14 mW / g $\pm$ 20.4 % (k=2)

Certificate No: Z16-971102

Page 3 of 8



In Collaboration with

s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com Http://www.chinattl.cn

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.9Ω- 7.86jΩ
Return Loss	- 22.1dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	45.9Ω- 8.14jΩ
Return Loss	- 20.5dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.514 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
-----------------	-------



In Collaboration with

s p e a k
 CALIBRATION LABORATORY

Add: No.31 Xueyuan Road, Haidian District, Beijing, 100191, China

Tel: +86-10-62304633-2079

E-mail: cttl@chinattl.com

Fax: +86-10-62304633-2504

Http://www.chinattl.cn

DASY5 Validation Report for Head TSL

Date: 07.01.2016

Test Laboratory: CTTL, Beijing, China

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN: 1d086

Communication System: UID 0, CW; Frequency: 900 MHz; Duty Cycle: 1:1

Medium parameters used: $f = 900 \text{ MHz}$; $\sigma = 0.988 \text{ S/m}$; $\epsilon_r = 41.16$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Center Section

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

DASY5 Configuration:

- Probe: EX3DV4 - SN7307; ConvF(9.82, 9.82, 9.82); Calibrated: 2/19/2016;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn771; Calibrated: 2016-02-02
- Phantom: Triple Flat Phantom 5.1C; Type: QD 000 P51 CA; Serial: 1161/1
- Measurement SW: DASY52, Version 52.8(8); SEMCAD X Version 14.6.10 (7372)

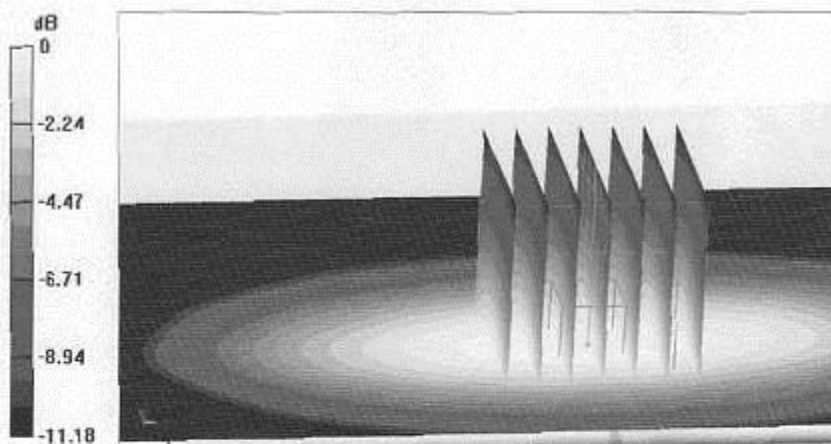
Dipole Calibration/Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 48.86 V/m; Power Drift = 0.01 dB

Peak SAR (extrapolated) = 4.13 W/kg

SAR(1 g) = 2.72 W/kg; SAR(10 g) = 1.74 W/kg

Maximum value of SAR (measured) = 3.49 W/kg

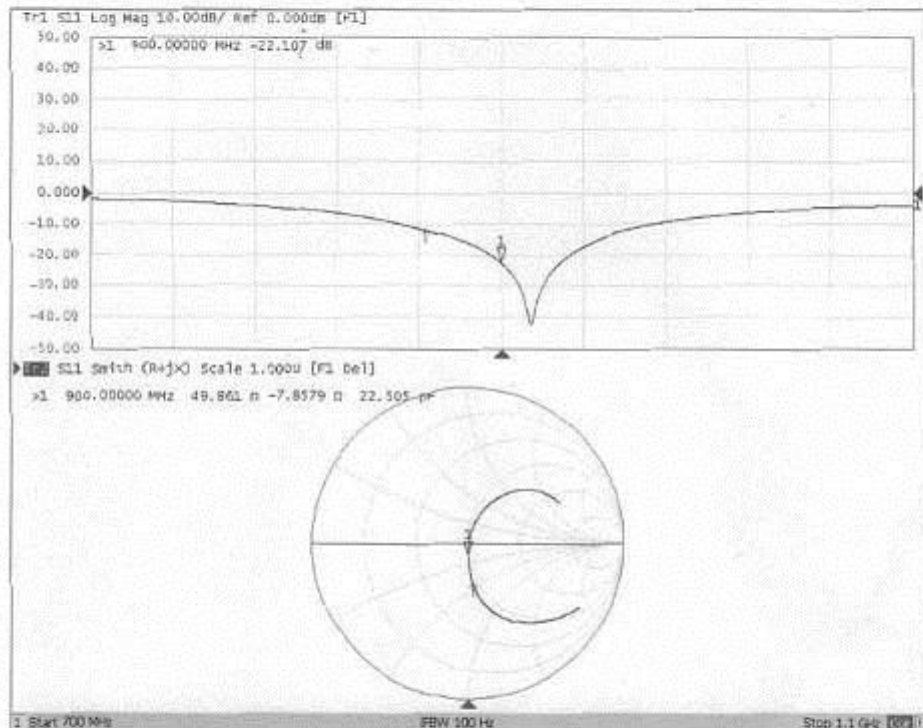
**0 dB = 3.49 W/kg = 5.43 dBW/kg**



In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.31 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com Http://www.chinattl.cn

Impedance Measurement Plot for Head TSL



Certificate No: Z16-97102

Page 6 of 8