Appendix A.4 Dipole Calibration certificate (D2450V2_895)

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

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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 0108**

Client **KCTL (Dymstec)** Certificate No: **D2450V2-895_Jul20**

CALIBRATION CERTIFICATE

Object	D2450V2 - SN:895
Calibration procedure(s)	QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz
Calibration date:	July 21, 2020

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 NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: BH9394 (20k)	31-Mar-20 (No. 217-03106)	Apr-21
Type-N mismatch combination	SN: 310982 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX3DV4	SN: 7349	29-Jun-20 (No. EX3-7349_Jun20)	Jun-21
DAE4	SN: 601	27-Dec-19 (No. DAE4-601_Dec19)	Dec-20

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

	Name	Function	Signature
Calibrated by:	Jeffrey Katzman	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: July 23, 2020

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Certificate No: D2450V2-895_Jul20 Page 1 of 6

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Accreditation No.: SCS 0108

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) 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
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) 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	V52.10.4
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	38.5 ± 6 %	1.84 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.3 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.4 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.12 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.3 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	55.5 Ω + 3.5 jΩ
Return Loss	- 24.2 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

DASY5 Validation Report for Head TSL

Date: 21.07.2020

Test Laboratory: SPEAG, Zurich, Switzerland

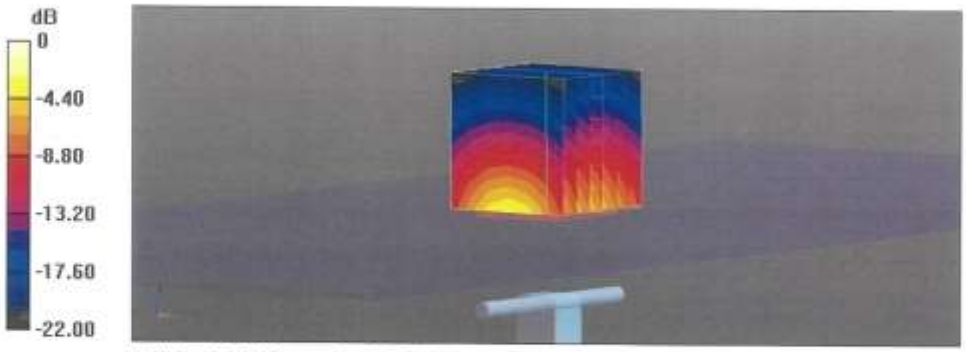
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN: 895

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.84 S/m; ε_r = 38.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

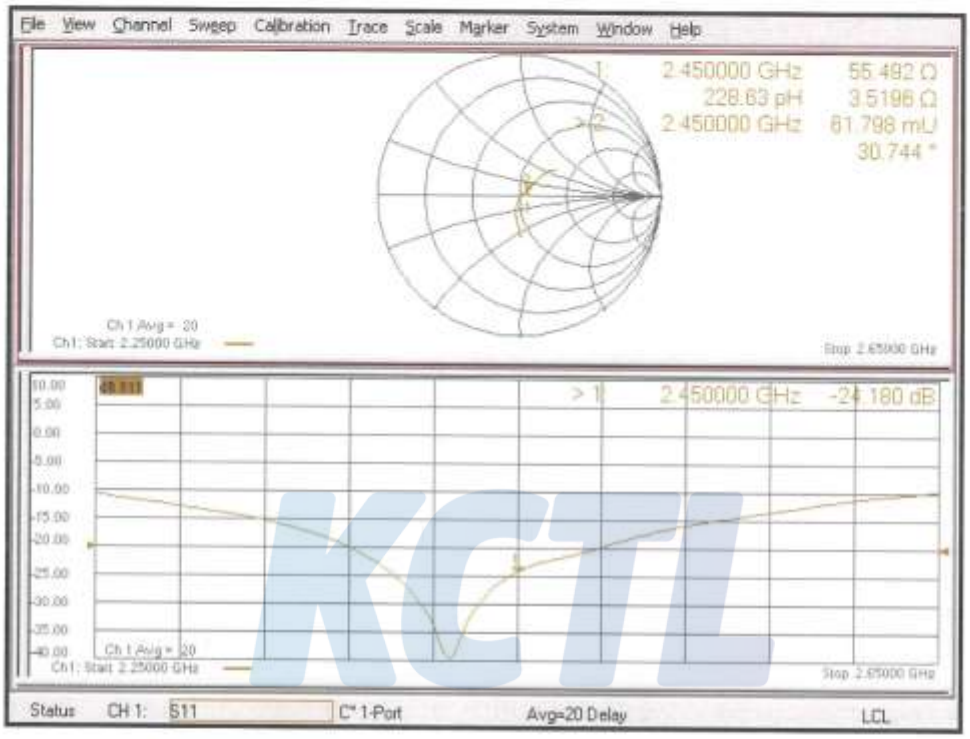
- Probe: EX3DV4 - SN7349; ConvF(7.74, 7.74, 7.74) @ 2450 MHz; Calibrated: 29.06.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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 = 117.4 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 26.4 W/kg
SAR(1 g) = 13.3 W/kg; SAR(10 g) = 6.12 W/kg
Smallest distance from peaks to all points 3 dB below = 9 mm
Ratio of SAR at M2 to SAR at M1 = 50.2%
Maximum value of SAR (measured) = 22.0 W/kg



0 dB = 22.0 W/kg = 13.42 dBW/kg

Impedance Measurement Plot for Head TSL



Appendix A.5 Dipole Calibration certificate (D5GHzV2_1134)

Calibration Laboratory of
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Accreditation No.: SCS 0108

Client KCTL (Dymstec)

Certificate No: D5GHzV2-1134_May20

CALIBRATION CERTIFICATE

Object	D5GHzV2 - SN:1134
Calibration procedure(s)	QA CAL-22.v4 Calibration Procedure for SAR Validation Sources between 3-6 GHz
Calibration date:	May 20, 2020

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 NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: BH9394 (20k)	31-Mar-20 (No. 217-03106)	Apr-21
Type-N mismatch combination	SN: 310982 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX3DV4	SN: 3503	31-Dec-19 (No. EX3-3503_Dec19)	Dec-20
DAE4	SN: 601	27-Dec-19 (No. DAE4-601_Dec19)	Dec-20

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Feb-19)	In house check: Oct-20
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-18)	In house check: Oct-20
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-18)	In house check: Oct-20
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-19)	In house check: Oct-20

	Name	Function	Signature
Calibrated by:	Jeffrey Katzman	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: May 20, 2020

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Certificate No: D5GHzV2-1134_May20 Page 1 of 9

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Accreditation No.: SCS 0108

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) 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
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) 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	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 10.0 mm, dz = 10.0 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5200 MHz ± 1 MHz 5300 MHz ± 1 MHz 5500 MHz ± 1 MHz 5600 MHz ± 1 MHz 5800 MHz ± 1 MHz	

Head TSL parameters at 5200 MHz

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	36.0	4.66 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.4 ± 6 %	4.49 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 5200 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.93 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.0 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.25 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.4 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5300 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.3 ± 6 %	4.60 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 5300 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.26 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**82.3 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.2 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5500 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.6	4.96 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.0 ± 6 %	4.80 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 5500 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.64 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**86.0 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.43 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.2 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.8 ± 6 %	4.90 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.46 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**84.1 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**23.8 W/kg ± 19.5 % (k=2)**

Head TSL parameters at 5800 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.3	5.27 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	34.5 ± 6 %	5.11 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.20 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**81.5 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.29 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.7 W/kg ± 19.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5200 MHz

Impedance, transformed to feed point	48.8 Ω - 9.8 jΩ
Return Loss	- 20.1 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	49.5 Ω - 7.8 jΩ
Return Loss	- 22.1 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	51.2 Ω - 4.0 jΩ
Return Loss	- 27.8 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	53.7 Ω - 3.1 jΩ
Return Loss	- 26.6 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	54.1 Ω - 3.7 jΩ
Return Loss	- 25.4 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.203 ns

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

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG

DASY5 Validation Report for Head TSL

Date: 20.05.2020

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1134

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.49 S/m; ε_r = 35.4; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5300 MHz; σ = 4.60 S/m; ε_r = 35.3; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5500 MHz; σ = 4.80 S/m; ε_r = 35.0; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5600 MHz; σ = 4.90 S/m; ε_r = 34.8; ρ = 1000 kg/m^3 ,
Medium parameters used: f = 5800 MHz; σ = 5.11 S/m; ε_r = 34.5; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.8, 5.8, 5.8) @ 5200 MHz, ConvF(5.49, 5.49, 5.49) @ 5300 MHz, ConvF(5.25, 5.25, 5.25) @ 5500 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.01, 5.01, 5.01) @ 5800 MHz; Calibrated: 31.12.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 27.12.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

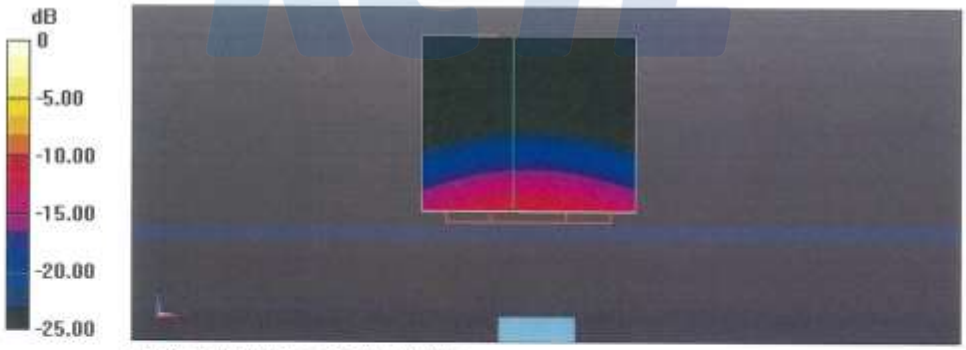
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5200 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 76.98 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 28.4 W/kg
SAR(1 g) = 7.93 W/kg; SAR(10 g) = 2.25 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 68.9%
Maximum value of SAR (measured) = 17.8 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 78.24 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 29.7 W/kg
SAR(1 g) = 8.26 W/kg; SAR(10 g) = 2.34 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 68.8%
Maximum value of SAR (measured) = 18.6 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5500 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 77.84 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 33.6 W/kg
SAR(1 g) = 8.64 W/kg; SAR(10 g) = 2.43 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 66.2%
Maximum value of SAR (measured) = 20.0 W/kg

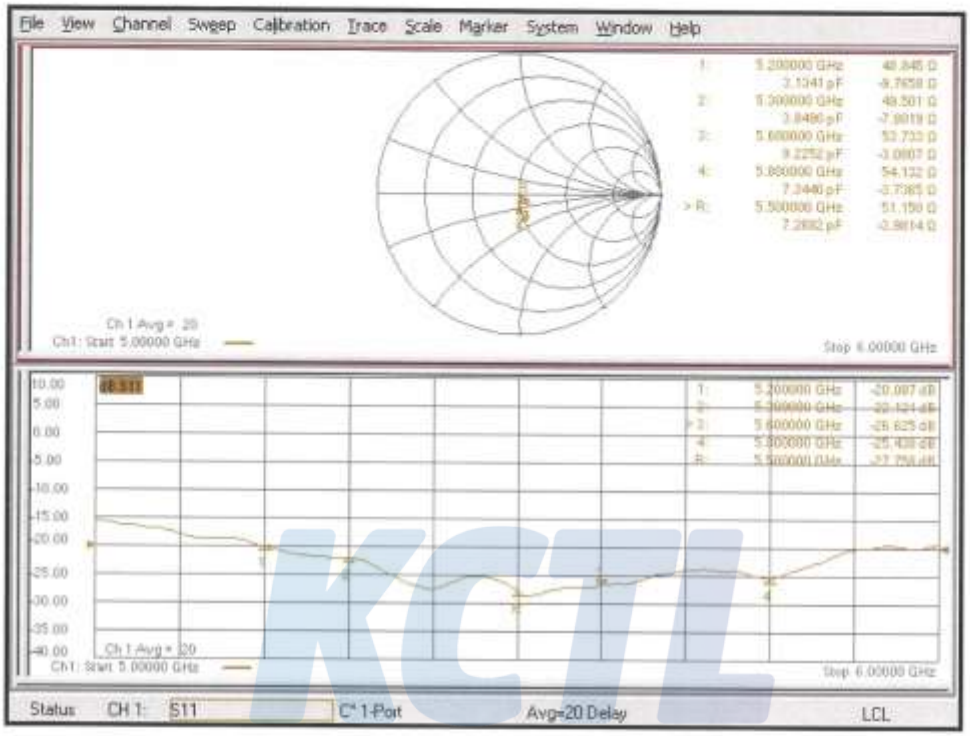
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 77.98 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 31.8 W/kg
SAR(1 g) = 8.46 W/kg; SAR(10 g) = 2.4 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 66.9%
Maximum value of SAR (measured) = 19.8 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5800 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 75.71 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 33.0 W/kg
SAR(1 g) = 8.20 W/kg; SAR(10 g) = 2.29 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 65.1%
Maximum value of SAR (measured) = 19.5 W/kg



0 dB = 20.0 W/kg = 13.01 dBW/kg

Impedance Measurement Plot for Head TSL



Appendix B. SAR Tissue Specification

The brain mixtures consist of a viscous gel using hydrox-ethl cellullose(HEC) gelling agent and saline solution. Preservation with a bacteriacide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue.

Frequency (㎒)	**750 ~ 835**		**1 750**		**1 900**		**2 450**		**5 200 ~ 5 800**	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Ingredient	**% by weight**									
Water	40.29	51.97	53.00	68.00	55.00	70.50	72.00	73.00	65.52	80.00
Salt (NaCl)	1.38	0.93	0.40	0.20	0.35	0.30	0.10	0.10	0	0
Sugar	57.90	47.00	0	0	0	0	0	0	0	0
HEC	0.24	0	0	0	0	0	0	0	0	0
Bactericide	0.19	0.10	0	0	0	0	0	0	0	0
Triton X-100	0	0	0	0	0	0	20.00	0	17.24	0
DGBE	0	0	46.60	31.80	44.65	29.20	0	26.90	0	0
Diethylene glycol hexyl ether	0	0	0	0	0	0	7.90	0	17.24	0
Polysorbate (Tween) 80	0	0	0	0	0	0	0	0	0	20.00
Tissue parameter target by C. Gabriel and G. Harts grove.										

Salt: 99 % Pure Sodium Chloride
Sucrose: 98 % Pure Sucrose
Water: De-ionized, 16 M resistivity
HEC: Hydroxyethyl Cellulose
DGBE: 99 % Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy) ethanol]
Triton X-100(ultra-pure): Polyethylene glycol mono[4-(1,1,3,3-tetramethybutyl)phenyl] ether

Appendix C. Power Reduction Verification

Hall Effect and Gravity Sensor Guidance (Nov. 2019 TCB Workshop Notes)

The Power verification was performed according to the following procedure:

Step 1) With the lid is in closed mode (0 degrees), open the screen in 10 degree steps until laptop mode or tablet mode is obtained.

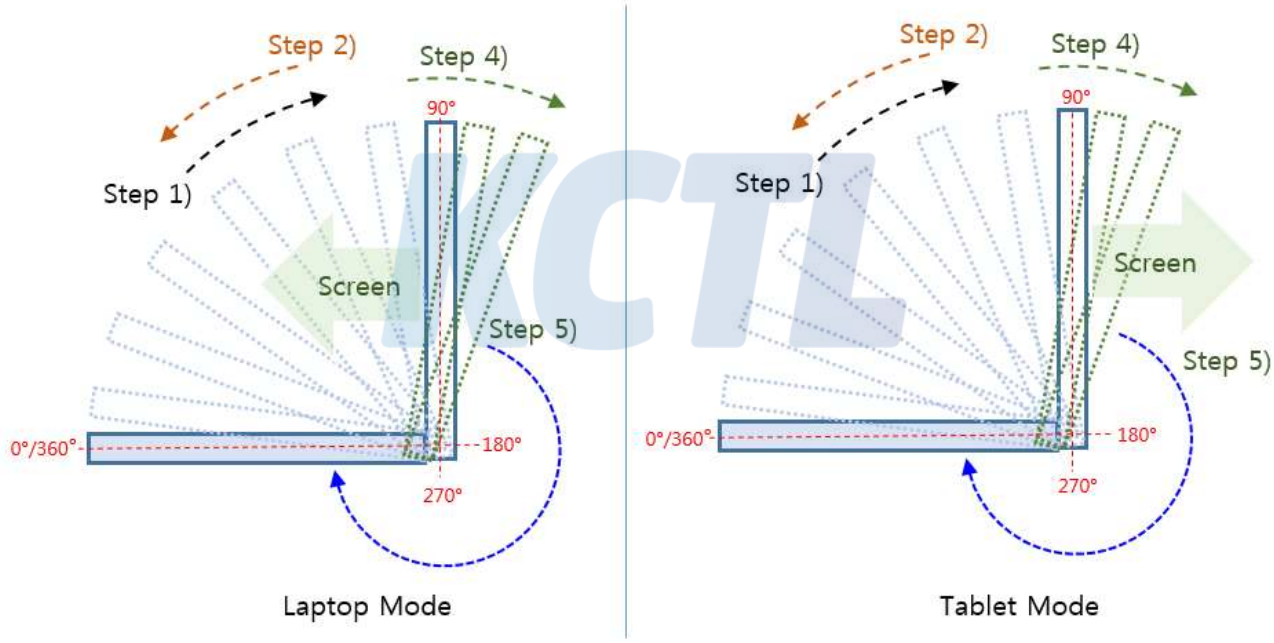
Step 2) Lower the screen 5 degrees. Closed mode should be reobtained. If not keep lowering in 5 degree steps.

Step 3) Open the screen in 1 degree steps until laptop mode or tablet mode is reobtained.

Step 4) Continue opening the screen in 1 degree steps until at least 5 degrees past where laptop mode or tablet mode (90 degree) was obtained.

Step 5) Then continue opening the screen in 10 degree steps until tablet mode or laptop mode is obtained.

Step 6) Power measurements should be taken at each step.



※ Step 3 identified the 20 degree range from the power reduction angle to the up and down angle by 1 degree.

Laptop Mode / Antenna 1(Main)

Step 1) With the lid is in closed mode (0 degrees), open the screen in 10 degree steps until laptop mode is obtained.

Band	Mode	Degrees	0	10	20	30	40	50	60	70	80	90
2.4 GHz	802.11b	dBm	Screen Off			14.44	14.50	14.45	14.58	14.62	14.65	14.59
U-NII-2C	802.11ac (BW 80)					11.44	11.05	11.28	11.61	11.10	11.83	11.97
U-NII-3						11.78	11.56	11.89	11.95	11.74	11.92	11.85

Step 2) Lower the screen 5 degrees. Closed mode should be reobtained. If not keep lowering in 5 degree steps.

Band	Mode	Degrees	85	80	75	65	55	45	35	25	15	5
2.4 GHz	802.11b	dBm	14.56	14.44	14.40	14.50	14.45	14.44	14.41	Screen Off		
U-NII-2C	802.11ac (BW 80)		11.44	11.05	11.28	11.61	11.10	11.83	11.97			
U-NII-3			11.78	11.56	11.89	11.95	11.74	11.92	11.85			

Step 4) Continue opening the screen in 1 degree steps until at least 5 degrees past where laptop mode was obtained.

Band	Mode	Degrees	91	92	93	94	95	96	97	98	99	100
2.4 GHz	802.11b	dBm	14.44	14.61	14.37	14.65	14.53	14.51	14.53	14.61	14.36	14.43
U-NII-2C	802.11ac (BW 80)		11.44	11.05	11.28	11.61	11.10	11.83	11.97	11.47	11.64	11.40
U-NII-3			11.78	11.56	11.89	11.95	11.74	11.92	11.85	11.87	11.32	11.85

Step 5) Then continue opening the screen in 10 degree steps until tablet mode is obtained.

Band	Mode	Degrees	110	120	130	140	150	160	170	180	190	200	210	220	230
2.4 GHz	802.11b	dBm	14.49	14.59	14.38	14.49	14.61	14.62	14.42	14.50	14.44	13.01	13.02	13.10	13.09
U-NII-2C	802.11ac (BW 80)		11.12	11.42	11.18	11.89	11.15	11.89	11.98	11.19	11.93	9.92	9.00	9.67	9.41
U-NII-3			11.88	11.78	11.38	11.08	11.84	11.39	11.96	11.86	11.91	9.88	9.69	9.02	9.65

Step 5 - Continue) Then continue opening the screen in 10 degree steps until tablet mode is obtained.

Band	Mode	Degrees	240	250	260	270	280	290	300	310	320	330	340	350	360
2.4 GHz	802.11b	dBm	13.07	13.06	13.11	13.11	13.15	13.09	13.04	13.07	13.08	13.01	13.01	13.05	13.10
U-NII-2C	802.11ac (BW 80)		9.92	9.00	9.67	9.41	9.23	9.29	10.00	9.67	9.45	9.32	9.95	9.32	9.25
U-NII-3			9.88	9.69	9.02	9.65	9.35	9.26	9.64	9.42	9.48	9.61	9.35	9.53	9.02

Step 3) Open the screen in 1 degree steps until laptop mode is reobtained.
(Step 3 identified the 20 degree range from the power reduction angle to the up and down angle by 1 degree.)

Band	Mode	Degrees	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205
2.4 GHz	802.11b	dBm	14.59	14.72	14.60	14.69	14.58	14.65	14.64	14.60	14.58	14.69	13.08	13.10	13.04	13.10	13.03	13.09	13.08	13.11	13.05	13.00	13.08
U-NII-2C	802.11ac (BW 80)		11.12	11.42	11.18	11.89	11.15	11.89	11.98	11.19	11.93	11.94	9.92	9.00	9.67	9.41	9.23	9.29	10.00	9.67	9.45	9.32	9.92
U-NII-3			11.88	11.78	11.38	11.08	11.84	11.39	11.96	11.86	11.91	11.69	9.88	9.69	9.02	9.65	9.35	9.26	9.64	9.42	9.48	9.61	9.88

Laptop Mode / Antenna 2(Aux)												
Step 1) With the lid is in closed mode (0 degrees), open the screen in 10 degree steps until laptop mode is obtained.												
Band	**Mode**	**Degrees**	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**
2.4 GHz	802.11b	dBm	Screen Off (No signal)			14.80	14.46	14.55	14.53	14.33	14.21	14.71
U-NII-2C	802.11ac (BW 80)					11.76	11.43	11.74	11.28	11.60	11.60	11.58
U-NII-3						11.25	11.77	11.39	11.58	11.69	11.40	11.24
Step 2) Lower the screen 5 degrees. Closed mode should be reobtained. If not keep lowering in 5 degree steps.												
Band	**Mode**	**Degrees**	**85**	**80**	**75**	**65**	**55**	**45**	**35**	**25**	**15**	**5**
2.4 GHz	802.11b	dBm	14.53	14.66	14.38	14.75	14.57	14.64	14.66	Screen Off (No signal)		
U-NII-2C	802.11ac (BW 80)		11.24	11.27	11.49	11.26	11.46	11.41	11.25			
U-NII-3			11.21	11.37	11.77	11.73	11.42	11.62	11.76			
Step 4) Continue opening the screen in 1 degree steps until at least 5 degrees past where laptop mode was obtained.												
Band	**Mode**	**Degrees**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
2.4 GHz	802.11b	dBm	14.67	14.21	14.29	14.29	14.38	14.29	14.60	14.73	14.35	14.23
U-NII-2C	802.11ac (BW 80)		11.50	11.33	11.30	11.67	11.44	11.24	11.40	11.32	11.60	11.55
U-NII-3			11.77	11.58	11.63	11.42	11.37	11.37	11.77	11.40	11.46	11.47
Step 5) Then continue opening the screen in 10 degree steps until tablet mode is obtained.															
Band	**Mode**	**Degrees**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**	**210**	**220**	**230**
2.4 GHz	802.11b	dBm	14.80	14.46	14.55	14.53	14.33	14.21	14.71	14.61	14.20	12.86	13.27	12.96	13.07
U-NII-2C	802.11ac (BW 80)		11.69	11.30	11.21	11.45	11.60	11.57	11.79	11.67	11.50	9.61	9.23	9.26	9.34
U-NII-3			11.64	11.78	11.45	11.66	11.22	11.60	11.20	11.35	11.24	9.33	9.27	9.53	9.38
Step 5 - Continue) Then continue opening the screen in 10 degree steps until tablet mode is obtained.															
Band	**Mode**	**Degrees**	**240**	**250**	**260**	**270**	**280**	**290**	**300**	**310**	**320**	**330**	**340**	**350**	**360**
2.4 GHz	802.11b	dBm	12.86	13.27	12.96	13.07	13.06	12.99	13.17	12.87	13.24	13.27	12.74	12.86	12.94
U-NII-2C	802.11ac (BW 80)		9.61	9.23	9.26	9.34	9.55	9.26	9.43	9.55	9.46	9.30	9.73	9.55	9.52
U-NII-3			9.33	9.27	9.53	9.38	9.44	9.65	9.24	9.35	9.38	9.28	9.75	9.22	9.63
Step 3) Open the screen in 1 degree steps until tablet mode is reobtained. (Step 3 identified the 20 degree range from the power reduction angle to the up and down angle by 1 degree.)																							
Band	**Mode**	**Degrees**	**185**	**186**	**187**	**188**	**189**	**190**	**191**	**192**	**193**	**194**	**195**	**196**	**197**	**198**	**199**	**200**	**201**	**202**	**203**	**204**	**205**
2.4 GHz	802.11b	dBm	14.80	14.46	14.55	14.53	14.33	14.21	14.71	14.61	14.20	14.33	13.50	13.05	12.94	12.87	13.22	12.99	13.28	12.99	12.74	12.72	13.18
U-NII-2C	802.11ac (BW 80)		11.69	11.30	11.21	11.45	11.60	11.57	11.79	11.67	11.50	11.74	9.61	9.23	9.26	9.34	9.55	9.26	9.43	9.55	9.46	9.30	9.61
U-NII-3			11.64	11.78	11.45	11.66	11.22	11.60	11.20	11.35	11.24	11.46	9.33	9.27	9.53	9.38	9.44	9.65	9.24	9.35	9.38	9.28	9.33

Tablet Mode / Antenna 1(Main)												
Step 1) With the lid is in closed mode (0 degrees), open the screen in 10 degree steps until tablet mode is obtained.												
Band	**Mode**	**Degrees**	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**
2.4 GHz	802.11b	dBm	13.16	12.97	13.19	13.21	13.13	12.71	12.85	12.77	12.89	12.97
U-NII-2C	802.11ac (BW 80)		9.50	9.75	9.20	9.77	9.71	9.54	9.72	9.67	9.25	9.68
U-NII-3			9.53	9.50	9.40	9.68	9.32	9.62	9.29	9.72	9.34	9.67
Step 2) Lower the screen 5 degrees. Closed mode should be reobtained. If not keep lowering in 5 degree steps.												
Band	**Mode**	**Degrees**	**85**	**80**	**75**	**65**	**55**	**45**	**35**	**25**	**15**	**5**
2.4 GHz	802.11b	dBm	13.04	13.13	13.22	12.98	13.20	12.87	12.76	13.04	12.93	13.29
U-NII-2C	802.11ac (BW 80)		9.42	9.75	9.34	9.45	9.72	9.28	9.32	9.40	9.61	9.25
U-NII-3			9.33	9.43	9.68	9.25	9.43	9.57	9.27	9.58	9.79	9.23
Step 4) Continue opening the screen in 1 degree steps until at least 5 degrees past where tablet mode was obtained.												
Band	**Mode**	**Degrees**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
2.4 GHz	802.11b	dBm	12.85	12.83	13.19	13.22	13.17	13.21	13.22	13.20	13.17	12.83
U-NII-2C	802.11ac (BW 80)		9.52	9.78	9.60	9.66	9.34	9.48	9.32	9.71	9.70	9.60
U-NII-3			9.22	9.22	9.50	9.34	9.45	9.22	9.37	9.73	9.40	9.24
Step 5) Then continue opening the screen in 10 degree steps until laptop mode is obtained.															
Band	**Mode**	**Degrees**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**	**210**	**220**	**230**
2.4 GHz	802.11b	dBm	12.96	13.12	12.83	12.77	12.85	13.17	13.08	12.78	12.87	13.18	13.06	12.78	12.96
U-NII-2C	802.11ac (BW 80)		9.44	9.76	9.30	9.45	9.77	9.57	9.57	9.27	9.40	9.56	9.40	9.55	9.27
U-NII-3			9.49	9.27	9.63	9.50	9.49	9.56	9.55	9.20	9.25	9.24	9.47	9.42	9.43
Step 5 - Continue) Then continue opening the screen in 10 degree steps until laptop mode is obtained.															
Band	**Mode**	**Degrees**	**240**	**250**	**260**	**270**	**280**	**290**	**300**	**310**	**320**	**330**	**340**	**350**	**360**
2.4 GHz	802.11b	dBm	13.25	14.36	14.58	14.54	14.44	14.25	14.61	14.79	14.66	14.58	**Screen Off (No signal)**		
U-NII-2C	802.11ac (BW 80)		9.20	11.39	11.20	11.62	11.34	11.30	11.40	11.62	11.80	11.20			
U-NII-3			9.27	11.33	11.26	11.57	11.32	11.46	11.24	11.31	11.49	11.26			
Step 3) Open the screen in 1 degree steps until tablet mode is reobtained. (Step 3 identified the 20 degree range from the power reduction angle to the up and down angle by 1 degree.)																						
Band	**Mode**	**Degrees**	**240**	**241**	**242**	**243**	**244**	**245**	**246**	**247**	**248**	**249**	**250**	**251**	**252**	**253**	**254**	**205**	**206**	**207**	**208**	**209**	**210**
2.4 GHz	802.11b	dBm	13.13	12.97	13.04	13.16	13.03	13.30	13.07	12.81	13.29	12.76	14.61	14.45	14.71	14.26	14.57	14.56	14.24	14.33	14.25	14.63	14.61
U-NII-2C	802.11ac (BW 80)		9.79	9.59	9.21	9.63	9.26	9.57	9.59	9.73	9.62	9.34	11.63	11.70	11.75	11.51	11.43	11.77	11.65	11.43	11.71	11.78	11.63
U-NII-3			9.77	9.76	9.62	9.66	9.34	9.64	9.80	9.28	9.71	9.43	11.66	11.37	11.77	11.58	11.55	11.75	11.59	11.80	11.53	11.65	11.66

Tablet Mode / Antenna 2(Aux)												
Step 1) With the lid is in closed mode (0 degrees), open the screen in 10 degree steps until laptop mode is obtained.												
Band	**Mode**	**Degrees**	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**
2.4 GHz	802.11b	dBm	13.30	13.12	12.78	12.87	12.77	13.24	12.89	12.99	13.29	13.10
U-NII-2C	802.11ac (BW 80)		9.46	9.21	9.35	9.56	9.23	9.43	9.39	9.69	9.51	9.29
U-NII-3			9.40	9.36	9.63	9.32	9.68	9.80	9.50	9.39	9.29	9.48
Step 2) Lower the screen 5 degrees. Closed mode should be reobtained. If not keep lowering in 5 degree steps.												
Band	**Mode**	**Degrees**	**85**	**80**	**75**	**65**	**55**	**45**	**35**	**25**	**15**	**5**
2.4 GHz	802.11b	dBm	13.06	13.28	12.72	12.76	13.29	12.86	13.05	13.07	13.05	13.14
U-NII-2C	802.11ac (BW 80)		9.74	9.47	9.78	9.30	9.49	9.20	9.48	9.30	9.57	9.21
U-NII-3			9.31	9.43	9.63	9.25	9.68	9.70	9.63	9.38	9.42	9.44
Step 4) Continue opening the screen in 1 degree steps until at least 5 degrees past where laptop mode was obtained.												
Band	**Mode**	**Degrees**	**91**	**92**	**93**	**94**	**95**	**96**	**97**	**98**	**99**	**100**
2.4 GHz	802.11b	dBm	13.16	12.87	13.07	13.14	13.05	13.28	13.23	12.92	13.26	12.88
U-NII-2C	802.11ac (BW 80)		9.32	9.24	9.58	9.73	9.43	9.63	9.79	9.65	9.26	9.46
U-NII-3			9.71	9.21	9.21	9.75	9.39	9.25	9.63	9.41	9.80	9.42
Step 5) Then continue opening the screen in 10 degree steps until laptop mode is obtained.														
Band	**Mode**	**Degrees**	**110**	**120**	**130**	**140**	**150**	**160**	**170**	**180**	**190**	**200**	**210**	**220**	**230**
2.4 GHz	802.11b	dBm	13.30	12.72	13.07	12.87	12.77	13.18	13.06	12.83	13.09	13.30	12.93	13.07	13.01
U-NII-2C	802.11ac (BW 80)		9.69	9.25	9.56	9.52	9.51	9.49	9.30	9.22	9.33	9.47	9.47	9.77	9.25
U-NII-3			9.61	9.23	9.66	9.47	9.44	9.26	9.41	9.48	9.45	9.42	9.61	9.52	9.66
Step 5 - Continue) Then continue opening the screen in 10 degree steps until laptop mode is obtained.															
Band	**Mode**	**Degrees**	**240**	**250**	**260**	**270**	**280**	**290**	**300**	**310**	**320**	**330**	**340**	**350**	**360**
2.4 GHz	802.11b	dBm	13.00	14.28	14.45	14.53	14.61	14.44	14.65	14.61	14.69	14.71	**Screen Off (No signal)**		
U-NII-2C	802.11ac (BW 80)		9.40	11.60	11.40	11.68	11.40	11.42	11.66	11.60	11.62	11.55			
U-NII-3			9.20	11.73	11.77	11.21	11.50	11.78	11.23	11.67	11.52	11.50			

Step 3) Open the screen in 1 degree steps until laptop mode is reobtained.
(Step 3 identified the 20 degree range from the power reduction angle to the up and down angle by 1 degree.)

Band	**Mode**	**Degrees**	**240**	**241**	**242**	**243**	**244**	**245**	**246**	**247**	**248**	**249**	**250**	**251**	**252**	**253**	**254**	**205**	**206**	**207**	**208**	**209**	**210**
2.4 GHz	802.11b	dBm	13.18	13.04	12.70	13.15	13.04	13.00	13.26	12.86	13.14	13.04	14.67	14.45	14.30	14.29	14.37	14.28	14.45	14.53	14.61	14.44	14.65
U-NII-2C	802.11ac (BW 80)		9.76	9.55	9.55	9.23	9.23	9.40	9.76	9.57	9.24	9.67	11.27	11.33	11.58	11.49	11.46	11.60	11.40	11.68	11.40	11.42	11.23
U-NII-3			9.24	9.53	9.48	9.68	9.64	9.20	9.62	9.65	9.61	9.64	11.74	11.69	11.43	11.47	11.61	11.73	11.77	11.21	11.50	11.78	11.71