Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.4 ± 6 %	5.14 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.99 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**79.9 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.8 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	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	35.3 ± 6 %	5.19 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5800 MHz

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	7.88 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**78.7 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.22 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**22.2 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	47.5 Ω - 4.9 jΩ
Return Loss	- 25.0 dB

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	46.5 Ω - 3.0 jΩ
Return Loss	- 26.5 dB

Antenna Parameters with Head TSL at 5300 MHz

Impedance, transformed to feed point	46.3 Ω - 1.1 jΩ
Return Loss	- 27.9 dB

Antenna Parameters with Head TSL at 5500 MHz

Impedance, transformed to feed point	49.5 Ω - 2.3 jΩ
Return Loss	- 32.7 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	53.0 Ω + 1.7 jΩ
Return Loss	- 29.5 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	51.5 Ω - 0.6 jΩ
Return Loss	- 35.8 dB

Antenna Parameters with Head TSL at 5800 MHz

Impedance, transformed to feed point	51.0 Ω - 2.4 jΩ
Return Loss	- 31.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.202 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: 12.06.2024

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1060

Communication System: UID 0 - CW; Frequency: 5200 MHz, Frequency: 5250 MHz, Frequency: 5300 MHz, Frequency: 5500 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz, Frequency: 5800 MHz
Medium parameters used: f = 5200 MHz; σ = 4.55 S/m; ε_r = 36.4; ρ = 1000 kg/m^3
Medium parameters used: f = 5250 MHz; σ = 4.6 S/m; ε_r = 36.3; ρ = 1000 kg/m^3
Medium parameters used: f = 5300 MHz; σ = 4.64 S/m; ε_r = 36.2; ρ = 1000 kg/m^3
Medium parameters used: f = 5500 MHz; σ = 4.86 S/m; ε_r = 35.8; ρ = 1000 kg/m^3
Medium parameters used: f = 5600 MHz; σ = 4.97 S/m; ε_r = 35.6; ρ = 1000 kg/m^3
Medium parameters used: f = 5750 MHz; σ = 5.14 S/m; ε_r = 35.4; ρ = 1000 kg/m^3
Medium parameters used: f = 5800 MHz; σ = 5.19 S/m; ε_r = 35.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.63, 5.63, 5.63) @ 5200 MHz, ConvF(5.39, 5.39, 5.39) @ 5250 MHz, ConvF(5.38, 5.38, 5.38) @ 5300 MHz, ConvF(5.04, 5.04, 5.04) @ 5500 MHz, ConvF(5, 5, 5) @ 5600 MHz, ConvF(4.98, 4.98, 4.98) @ 5750 MHz, ConvF(4.86, 4.86, 4.86) @ 5800 MHz; Calibrated: 07.03.2024
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 22.05.2024
- Phantom: Flat Phantom 5.0 (front); Type: QD000P50AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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 = 75.67 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 27.1 W/kg
SAR(1 g) = 7.64 W/kg; SAR(10 g) = 2.18 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 69.1%
Maximum value of SAR (measured) = 17.7 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 77.05 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 26.8 W/kg
SAR(1 g) = 7.82 W/kg; SAR(10 g) = 2.23 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 70.1%
Maximum value of SAR (measured) = 18.0 W/kg

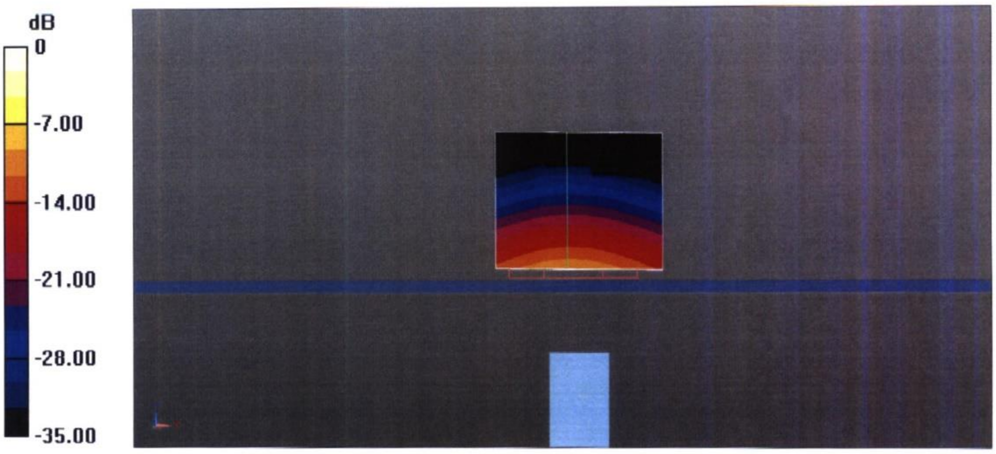
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5300 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 76.66 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 28.3 W/kg
SAR(1 g) = 7.94 W/kg; SAR(10 g) = 2.28 W/kg
Smallest distance from 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) = 18.5 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 = 77.28 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 32.3 W/kg
SAR(1 g) = 8.34 W/kg; SAR(10 g) = 2.37 W/kg
Smallest distance from peaks to all points 3 dB below = 6.8 mm
Ratio of SAR at M2 to SAR at M1 = 66.4%
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 = 76.70 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 30.7 W/kg
SAR(1 g) = 8.17 W/kg; SAR(10 g) = 2.32 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 67.1%
Maximum value of SAR (measured) = 19.6 W/kg

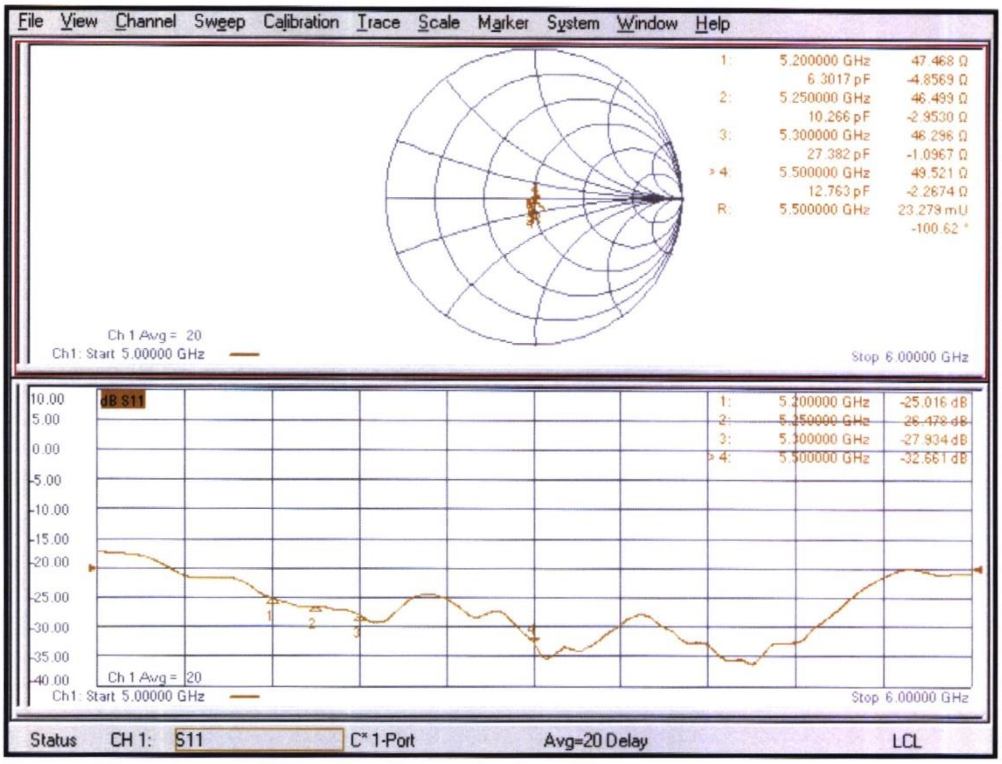
Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 74.11 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 31.5 W/kg
SAR(1 g) = 7.99 W/kg; SAR(10 g) = 2.28 W/kg
Smallest distance from peaks to all points 3 dB below = 7.2 mm
Ratio of SAR at M2 to SAR at M1 = 65.6%
Maximum value of SAR (measured) = 19.3 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 = 74.18 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 31.5 W/kg
SAR(1 g) = 7.88 W/kg; SAR(10 g) = 2.22 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) = 19.3 W/kg

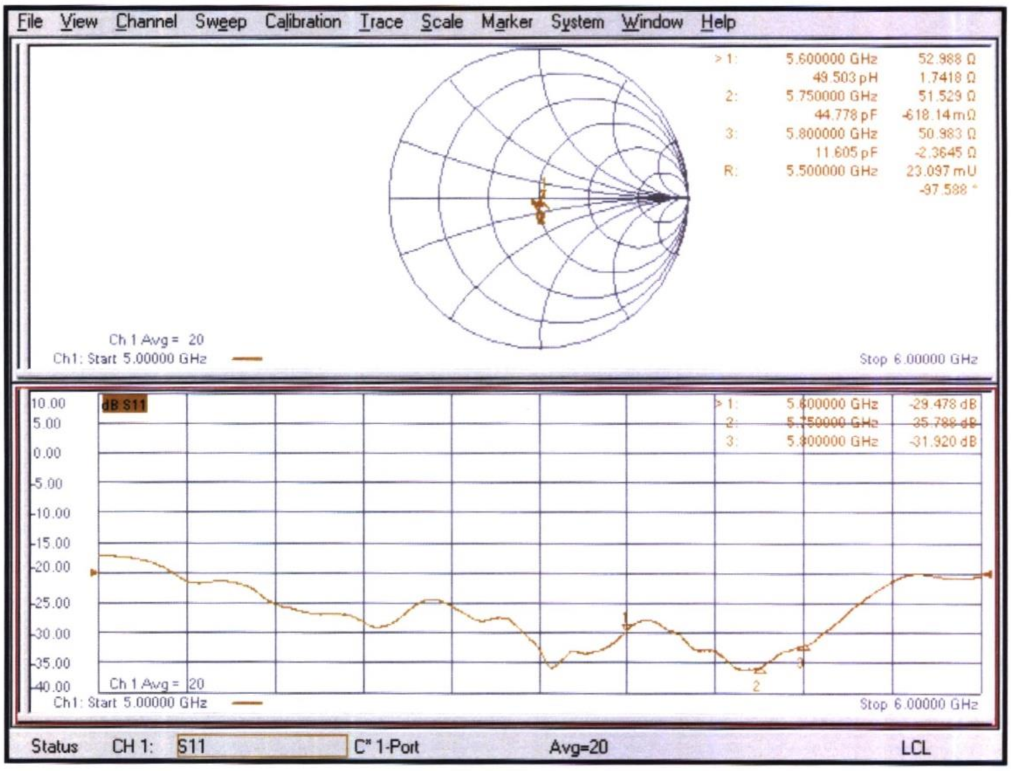


0 dB = 20.0 W/kg = 13.02 dBW/kg

Impedance Measurement Plot for Head TSL (5200, 5250, 5300, 5500 MHz)



Impedance Measurement Plot for Head TSL (5600, 5750, 5800 MHz)

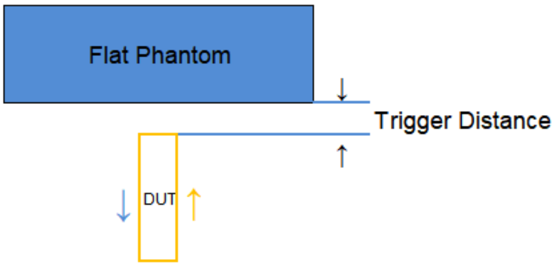


ANNEX I Sensor Triggering Data Summary

Procedures for determining proximity sensor triggering distances:

The device was tested by the test lab to determine the proximity sensor triggering distances for the Front/Back/Left/Top/Bottom side of the device. To ensure all production units are compliant, the smallest separation distance determined by the sensor triggering minus 1 mm, must be used as the test separation distance for SAR testing.

The Proximity sensor triggering distance measurement method are as below:



The following table is the summary of the trigger distance.

Antenna	Band	Trigger distance-Front side		Trigger distance-Back side		Trigger distance-Left side		Trigger distance-Top side		Trigger distance-Bottom side	
		Moving toward Phantom	Moving away from Phantom	Moving toward Phantom	Moving away from Phantom	Moving toward Phantom	Moving away from Phantom	Moving toward Phantom	Moving away from Phantom	Moving toward Phantom	Moving away from Phantom
ANT 1	LTE Band 2	30 mm	30 mm	32 mm	32 mm	50 mm	50 mm	N/A	N/A	50 mm	50 mm
ANT 1	LTE Band 4	30 mm	30 mm	32 mm	32 mm	50 mm	50 mm	N/A	N/A	50 mm	50 mm
ANT 1	LTE Band 25	30 mm	30 mm	32 mm	32 mm	50 mm	50 mm	N/A	N/A	50 mm	50 mm
ANT 1	LTE Band 66	30 mm	30 mm	32 mm	32 mm	50 mm	50 mm	N/A	N/A	50 mm	50 mm
ANT 1	NR Band n25	30 mm	30 mm	32 mm	32 mm	50 mm	50 mm	N/A	N/A	50 mm	50 mm
ANT 1	NR Band n66	30 mm	30 mm	32 mm	32 mm	50 mm	50 mm	N/A	N/A	50 mm	50 mm
ANT 2	NR Band n41	17 mm	17 mm	25 mm	25 mm	10 mm	10 mm	20 mm	20 mm	N/A	N/A

The following tables summarize the key power reduction information for proximity sensor.

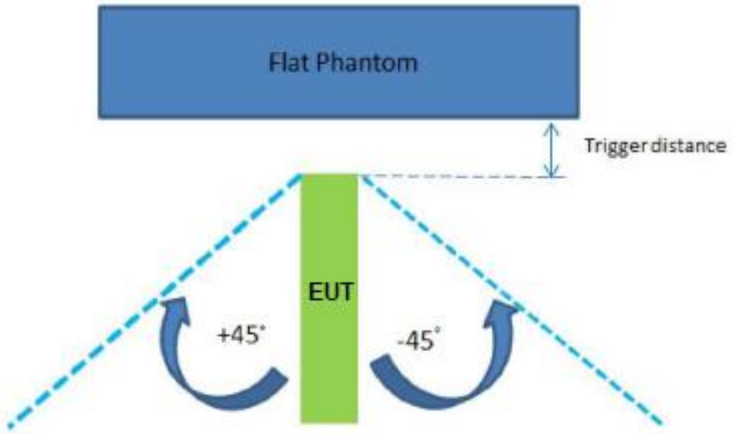
Antenna	Band	Test position	Sensor Trigger Distance range (DUT to Phantom)	Power reduction amount(dB)
ANT 1	LTE B2 QPSK	Front side	0 mm≤distance≤30 mm	6.0
			distance>30 mm	0.0
		Back side	0 mm≤distance≤32 mm	6.0
			distance>32 mm	0.0
		Left side	0 mm≤distance≤50 mm	6.0
			distance>50 mm	0.0
		Right side	N/A	0.0
		Top side	N/A	0.0
		Bottom side	0 mm≤distance≤50 mm	6.0
			distance>50 mm	0.0
ANT 1	LTE B4 QPSK	Front side	0 mm≤distance≤30 mm	4.5
			distance>30 mm	0.0
		Back side	0 mm≤distance≤32 mm	4.5
			distance>32 mm	0.0

		Left side	0 mm≤distance≤50 mm	4.5
			distance>50 mm	0.0
		Right side	N/A	0.0
		Top side	N/A	0.0
		Bottom side	0 mm≤distance≤50 mm	4.5
			distance>50 mm	0.0
ANT 1	LTE B25 QPSK	Front side	0 mm≤distance≤30 mm	4.5
			distance>30 mm	0.0
		Back side	0 mm≤distance≤32 mm	4.5
			distance>32 mm	0.0
		Left side	0 mm≤distance≤50 mm	4.5
			distance>50 mm	0.0
		Right side	N/A	0.0
		Top side	N/A	0.0
		Bottom side	0 mm≤distance≤50 mm	4.5
			distance>50 mm	0.0
ANT 1	LTE B66 QPSK	Front side	0 mm≤distance≤30 mm	4.5
			distance>30 mm	0.0
		Back side	0 mm≤distance≤32 mm	4.5
			distance>32 mm	0.0
		Left side	0 mm≤distance≤50 mm	4.5
			distance>50 mm	0.0
		Right side	N/A	0.0
		Top side	N/A	0.0
		Bottom side	0 mm≤distance≤50 mm	4.5
			distance>50 mm	0.0
ANT 1	NR n25 DFT-s-OFDM QPSK	Front side	0 mm≤distance≤30 mm	5.0
			distance>30 mm	0.0
		Back side	0 mm≤distance≤32 mm	5.0
			distance>32 mm	0.0
		Left side	0 mm≤distance≤50 mm	5.0
			distance>50 mm	0.0
		Right side	N/A	0.0
		Top side	N/A	0.0
		Bottom side	0 mm≤distance≤50 mm	5.0
			distance>50 mm	0.0
ANT 1	NR n66 DFT-s-OFDM QPSK	Front side	0 mm≤distance≤30 mm	5.0
			distance>30 mm	0.0
		Back side	0 mm≤distance≤32 mm	5.0
			distance>32 mm	0.0
		Left side	0 mm≤distance≤50 mm	5.0
			distance>50 mm	0.0
		Right side	N/A	0.0

		Top side	N/A	0.0
		Bottom side	0 mm≤distance≤50 mm	5.0
			distance>50 mm	0.0
ANT 2	NR n41 DFT-s-OFDM QPSK	Front side	0 mm≤distance≤17 mm	7.0
			distance>17 mm	0.0
		Back side	0 mm≤distance≤25 mm	7.0
			distance>25 mm	0.0
		Left side	0 mm≤distance≤10 mm	7.0
			distance>10 mm	0.0
		Right side	N/A	0.0
		Top side	0 mm≤distance≤20 mm	7.0
			distance>20 mm	0.0
		Bottom side	N/A	0.0

Tilt Angle Influences to Proximity Sensor Triggering:

The following procedure is used to determine the tilt angle influences to proximity sensor triggering.



Summary of tilt angle:

Antenna	Test position	Minimum trigger distance at which power reduction was maintained over ±45°	Power Reduction Status										
			-45°	-35°	-25°	-15°	-5°	0°	5°	15°	25°	35°	45°
ANT 1	Front side	30 mm	on	on	on	on	on	on	on	on	on	on	on
ANT 1	Back side	32 mm	on	on	on	on	on	on	on	on	on	on	on
ANT 1	Left side	50 mm	on	on	on	on	on	on	on	on	on	on	on
ANT 1	Bottom side	50 mm	on	on	on	on	on	on	on	on	on	on	on
ANT 2	Front side	17 mm	on	on	on	on	on	on	on	on	on	on	on

ANT 2	Back side	25 mm	on	on	on	on	on	on	on	on	on	on	on
ANT 2	Left side	10 mm	on	on	on	on	on	on	on	on	on	on	on
ANT 2	Top side	20 mm	on	on	on	on	on	on	on	on	on	on	on

Proximity Sensor Coverage Area:

Proximity Sensor Coverage Area are not request when the antenna and sensor are collocated and the peak SAR location is overlapping with the sensor.

ANNEX J Accreditation Certificate

Accredited Laboratory

A2LA has accredited

TELECOMMUNICATION TECHNOLOGY LABS, CAICT

Beijing, People's Republic of China

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 *General requirements for the competence of testing and calibration laboratories*. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (*refer to joint ISO-ILAC-IAF Communiqué dated April 2017*).

Presented this 23rd day of July 2024.

Mr. Trace McInturff, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 7049.01
Valid to July 31, 2026

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.