

Antenna Product Specification

ANTENNA PRODUCT SPECIFICATION

UWB-X5-AOA-U Series (Base Station)

Item	Content	Item	Content
Product Name	UWB-X5-AOA-U Antenna (	Document No.	
Applicable Frequency Band	7.7 GHz – 8.3 GHz	Confidentiality Level	Internal Use Only
Antenna Elements	2 (ANT1, ANT2)	Page Count	See footer
Data Source	CST 3D Full-Wave Electromagnetic Simulation	Compilation Date	2025-12-14

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Date:	Date:	Date:	Date:

Revision History

Version	Date	Description of Revision	Revised by
A0	2025-12-14	Initial release. Prepared on the basis of the CST 3D full-wave electromagnetic simulation results (UWB-X5-AOA-U, Antenna Supplement - V2 Base Station).	

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1 Scope

This specification specifies the terms and definitions, structural and material requirements, electrical performance requirements, environmental conditions, test methods, inspection rules, and the marking, packaging, transportation and storage requirements for the UWB-X5-AOA-U series antennas.

This specification applies to design output confirmation, prototype verification, incoming inspection and mass-production acceptance of the UWB-X5-AOA-U series antennas, and may serve as the basis for the technical agreement and acceptance judgment between the supplier and the customer.

All electrical performance indicators stated in this specification are derived from 3D full-wave electromagnetic simulation (CST) results.

2 Normative References

The contents of the following documents, through normative reference in this document, constitute indispensable provisions of this document. For dated references, only the version corresponding to the stated date applies.

Standard / Document No.	Title
GB/T 2423.1	Environmental Testing for Electric and Electronic Products - Part 2: Test Methods - Test A: Low Temperature
GB/T 2423.2	Environmental Testing for Electric and Electronic Products - Part 2: Test Methods - Test B: High Temperature
GB/T 2423.3	Environmental Testing for Electric and Electronic Products - Part 2: Test Methods - Test Cab: Damp Heat, Steady State
GB/T 2828.1	Sampling Procedures for Inspection by Attributes - Part 1: Sampling Schemes Indexed by Acceptance Quality Limit (AQL) for Lot-by-Lot Inspection
GB/T 191	Packaging - Pictorial Marking for Handling of Goods
IEEE Std 145	IEEE Standard for Definitions of Terms for Antennas
IEEE Std 149	IEEE Standard for Antenna Test Procedures
IPC-6012	Qualification and Performance Specification for Rigid Printed Boards
IEC 61249-2-21	Requirements for Halogen-Free Materials
2011/65/EU (RoHS 2.0)	Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment
UWB-X5-AOA-U_1201 Antenna Description.dwg	UWB-X5-AOA-U TAG-side antenna structure and dimension drawing (internal drawing)
LML-1T1R Antenna Description Drawing.dwg	V2 base-station-side antenna structure and dimension drawing (internal drawing)
UWB-X5-AOA-U ANT REPORT 251214	UWB-X5-AOA-U TAG antenna 3D simulation report (2025-12-14)
Antenna Supplement - V2 Base Station	V2 base station (LML-1T1R) antenna 3D simulation report

3 Terms and Definitions

Term	Definition
Return Loss	The ratio of the reflected power to the incident power at the antenna port, expressed in dB, i.e. $ S_{11} $; the larger the value, the better the matching.
Voltage Standing Wave Ratio (VSWR)	The ratio of the maximum to the minimum value of the standing wave at the port; it is related to the reflection coefficient $ \Gamma $ by $VSWR = (1+ \Gamma)/(1- \Gamma)$.
Total Efficiency	The ratio of the power radiated by the antenna to the power available at the port, including mismatch loss, conductor loss and dielectric loss; it is given in this document both in dB and as a percentage.
Peak Gain	The gain of the antenna in the direction of maximum radiation at a specified frequency point, expressed in dBi.
Port Isolation	In a multi-port antenna, the proportion of the power input at one port that is coupled to another port, expressed as $ S_{21} $ and $ S_{12} $; the smaller the value, the better the isolation.
Polarization	The locus traced by the tip of the electric field vector in the direction of maximum radiation; this product is linearly polarized, and the vertical and horizontal components are given for each pattern cut.
1T1R	A single-transmit, single-receive antenna architecture, i.e. one transmit channel and one receive channel (this product has two independent antenna elements, ANT1 and ANT2).

4 Product Overview and Structural Requirements

4.1 Product Composition

The UWB-X5-AOA-U series antennas are printed circuit board (PCB) trace antennas, consisting of substrate dielectric, bonded prepreg (PP) and etched copper layers. The antenna pattern is etched directly on the PCB; there is no separate feeder or external RF connector, and connection to the RF front end of the complete device is made through pads.

The series includes two application sides, each with two antenna elements (ANT1, ANT2):

Dual antenna elements (ANT1 transmit, ANT2 receive).

4.2 Materials and Stack-up

The PCB stack-up, dielectric thickness and dielectric constant of the antenna area are given in Table 4-1 (data taken from the simulation model; the stack-up used by the supplier for mass production shall be consistent with it, and any material change shall be re-verified).

Table 4-1 PCB Stack-up and Materials (TAG Side UWB-X5-AOA-U)

Layer	Material / Specification	Nominal Thickness (mm)	Dielectric Constant Dk
Top circuit layer	Copper foil (modeled as PEC in simulation)	0.0350	—
Bonded prepreg (PP)	Prepreg 7628 × 1	0.2104	4.43
Inner circuit layer 1	Copper foil (modeled as PEC in simulation)	0.0152	—
Core	Core (0.5 mm H/H oz, copper excluded)	0.5000	4.65
Inner circuit layer 2	Copper foil (modeled as	0.0152	—

Layer	Material / Specification	Nominal Thickness (mm)	Dielectric Constant Dk
	PEC in simulation)		
Bonded prepreg (PP)	Prepreg 7628 × 1	0.2104	4.43
Bottom circuit layer	Copper foil (modeled as PEC in simulation)	0.0350	—
Total	—	1.0212	—

Note: In the simulation model the circuit layers are modeled as perfect electric conductor (PEC); the effects of copper foil surface roughness, solder mask (green oil) and surface finish on loss and frequency are not taken into account.

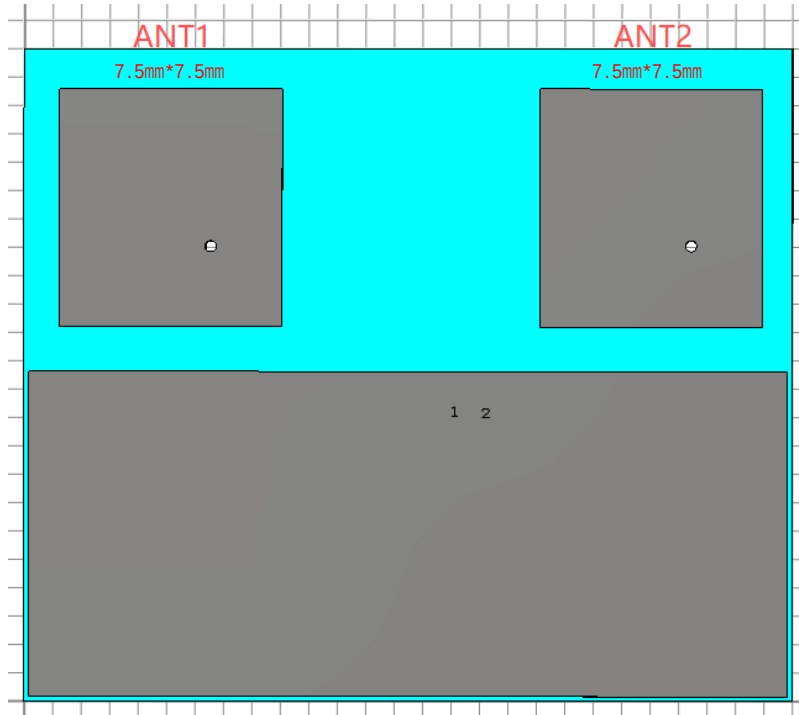
4.3 Outline Dimensions and Interfaces

- The outline dimensions, trace pattern, feed position and tolerances shall be as specified in the drawings: for the TAG side see UWB-X5-AOA-U_1201 Antenna Description.dwg, and for the V2 base station side see LML-1T1R Antenna Description Drawing.dwg.
- Feeding method: direct feeding through PCB pads with a reference impedance of 50 Ω ; the location and polarity definition of the RF port are given in the above drawings.
- This specification does not provide separate outline dimension values; dimensional inspection shall be based solely on the latest version of the drawings.

4.4 Description of Simulation Model Setup

The electrical performance simulation is performed with CST 3D full-wave electromagnetic simulation. The main settings are as follows, for reference when comparing with measured data:

Setting Item	Setting Content
Solver / Mesh	3D full-wave solution with hexahedral mesh; 15 cells per wavelength in the near-model region and 5 cells per wavelength in the far-model region
Port Definition	Discrete edge port, S-parameter excitation, reference impedance 50 Ω
Boundary Conditions	Open boundary (open, add space) in all directions
Material Parameters	Circuit layer: PEC (perfect electric conductor); PP: Dk = 4.43; Core: Dk = 4.65
Simulation Frequency Sweep Range	TAG side: 7.6 GHz – 8.5 GHz; V2 base station side: 7.0 GHz – 9.0 GHz



Mesh Properties - Hexahedral

Maximum cell	
Near to model:	Far from model:
Cells per wavelength: 15	15
☒ Use same setting as near to model	
Cells per max model box edge: 25	1
☐ Use same setting as near to model	
Minimum cell	
Fraction of maximum cell near to model: 30	
☒ Use same setting in all three directions	

Discrete Edge Port

Properties		OK	
Port type: ☒ S-Parameter ☐ Voltage ☐ Current		Cancel	
Name:	1	Apply	
Label:		Preview	
Impedance:	50.0 Ohm	Help	
Radius:	0.0		
☒ Monitor voltage and current			
Location			
Type: ☒ Coordinates ☐ Wire			
X1	Y1	Z1	☒ Use pick
-4.23914359031	-9.08575004471	-2.65	
X2	Y2	Z2	☒ Use pick
-4.50039554087	-9.48936043911	-2.65	

Boundary Conditions ✕

Boundaries Symmetry Planes

☐ Apply in all directions

Xmin: open (add space) Xmax: open (add space)

Ymin: open (add space) Ymax: open (add space)

Zmin: open (add space) Zmax: open (add space)

Cond.: 1000 S/m Open Boundary...

5 Technical Requirements

5.1 Normal Operating Environmental Conditions

Unless otherwise specified, the antenna shall meet the electrical performance requirements of Clause 5.2 of this document under the following conditions:

Item	Requirement	Remarks
Operating Temperature	-40 °C – +85 °C	Recommended value, to be confirmed by the complete device
Storage Temperature	-40 °C – +105 °C	Recommended value, to be confirmed by the complete device
Relative Humidity	5 %RH – 95 %RH (non-condensing)	Recommended value, to be confirmed by the complete device
Atmospheric Pressure	86 kPa – 106 kPa	—
Input Port Impedance	50 Ω (nominal)	—
Maximum Input Power	TBD (per RF front-end specification)	The antenna is a passive device

5.2 Electrical Performance Requirements

Electrical Performance Indicators (7.7 GHz – 8.3 GHz)

Item	Unit	Specification Limit	Typical Simulation Values (ANT1 / ANT2)	Judgment
Operating Frequency Range	GHz	7.70 – 8.30	7.60 – 8.50 (simulation sweep)	—
Center Frequency	GHz	8.0	8.0	—
Number of Ports / Impedance	- / Ω	2 / 50	2 / 50	Compliant
Return Loss S11	dB	≥ 6 (full band) ≥ 10 (in-band matching region)	7.70 GHz: -5.0 / -5.6 7.90 GHz: -10.8 / -10.9 8.00 GHz: -7.3 / -8.0 8.10 GHz: -7.9 / -9.4 8.20 GHz: -15.7 / -13.9	See Note 1
Voltage Standing Wave Ratio (VSWR)	—	≤ 3.0 (full band)	8.00 GHz: 2.5 / 2.3	Compliant
S11 ≤ 10 dB Bandwidth	MHz	≥ 250	ANT1: 7.793–7.918 and 8.147–8.330 ANT2: 7.779–7.921 and 8.113–8.255	See Note 1
S11 ≤ 6 dB Bandwidth	MHz	≥ 600	ANT1: 686 (7.725–8.411) ANT2: 635 (7.710–8.345)	Compliant
Minimum Return Loss	dB	≤ -12 (target)	ANT1: -39.8 @ 8.216 GHz ANT2: -13.9 @ 8.196 GHz	Compliant
Peak Gain	dBi	5.62	ANT1: 5.62; ANT2: 5.48	Compliant
Total Efficiency @ 8.0 GHz	dB / %	≥ -2.0 dB (63%)	ANT1: -0.92 dB (81%) ANT2: -0.75 dB (84%)	Compliant
Total Efficiency (7.71–8.23 GHz)	dB / %	≥ -2.5 dB (56%)	ANT1: -1.69 – -0.18 (68%–96%) ANT2: -1.46 – -0.49 (71%–89%)	Compliant
Polarization Mode	—	Linear polarization	Linear polarization (for the vertical/horizontal components see the patterns in Appendix A)	Compliant
Port Isolation S21	dB	TBD	Isolation data between ANT1 and ANT2 are not provided in this simulation	See Note 2

Note 1: This antenna exhibits dual-resonance characteristics, with two resonance points at approximately 7.87 GHz and 8.22 GHz respectively; at the center frequency of 8.0 GHz the return loss is approximately -7 dB to -8 dB (VSWR 2.3–2.5). If the complete device imposes stricter matching requirements near 8.0 GHz, optimization shall be made in the next version of the matching network.

5.3 Appearance and Structural Requirements

- The antenna pattern shall be complete, free of broken traces and short circuits, and the etched edges shall be free of obvious burrs and notches;

- The board surface shall be clean, free of stains, oxidation, scratches, delamination, bubbles and other defects that affect electrical performance;
- The feed pads shall have good solderability, with no exposed copper oxidation and no solder mask coverage;
- The outline dimensions and trace pattern shall comply with the drawings listed in Clause 4.3.

5.4 Environmental and Hazardous Substance Requirements

- The product shall comply with the requirements of RoHS 2.0 (2011/65/EU) and REACH;
- If halogen-free is required by the customer, the product shall comply with IEC 61249-2-21 (Br $\leq$ 900 ppm, Cl $\leq$ 900 ppm, Br+Cl $\leq$ 1500 ppm);
- The above compliance shall be supported by a valid test report or declaration of conformity provided by the supplier (this requirement is to be finalized after confirmation by the supplier).

6 Test Methods

6.1 Test Conditions

Unless otherwise specified, measurements shall be carried out at a temperature of 15 °C – 35 °C, a relative humidity of 20 %RH – 75 %RH and an atmospheric pressure of 86 kPa – 106 kPa; the antenna under test shall be installed on the complete device or on an equivalent fixture consistent with the actual conditions of use.

6.2 Return Loss and VSWR

Measurement shall be made with a vector network analyzer (VNA); SOLT or TRL calibration shall be performed before measurement, with the calibration reference plane extended to the antenna feed pad; the sweep range shall cover 7.0 GHz – 9.0 GHz, and the $|S_{11}|$ and $|S_{22}|$ curves and the VSWR shall be recorded.

6.3 Port Isolation

Measurement shall be made with a two-port vector network analyzer, with port 1 connected to ANT1 and port 2 connected to ANT2, and $|S_{21}|$ and $|S_{12}|$ shall be recorded; the non-excited port shall be terminated with a matching load.

6.4 Gain, Radiation Pattern and Efficiency

Measurement shall be made in a microwave anechoic chamber under far-field conditions (test distance $R \geq 2D^2/\lambda$, where D is the maximum aperture dimension of the antenna and λ is the operating wavelength), or with a near-field / compact range system whose equivalence has been verified. A standard gain antenna shall be used for gain calibration; the 3D peak gain, the patterns of each cut (XZ, YZ, XY) and the vertical and horizontal polarization components shall be recorded, and the total efficiency shall be calculated by the pattern integration method.

6.5 Acceptance Criteria

Test values that meet the “Specification Limit” in Tables 5-1 and 5-2 shall be judged as acceptable; if any item fails, the batch shall be judged as unacceptable and shall be handled in accordance with Clause 7.

7 Inspection Rules

7.1 Inspection Classification

Inspection is classified into factory inspection and type inspection.

7.2 Factory Inspection

Inspection Item	Inspection Method	Sampling and Acceptance
Appearance and Structure	Visual / microscopic inspection	GB/T 2828.1, General Inspection Level II, AQL 1.0
Outline Dimensions	Measure key dimensions according to the drawing	5 pieces sampled per batch, 0 defectives allowed
Return Loss S ₁₁ , S ₂₂	Clause 6.2	5 pieces sampled per batch, 0 defectives allowed
Isolation S ₂₁ , S ₁₂	Clause 6.3	3 pieces sampled per batch, 0 defectives allowed
Packaging and Marking	Visual inspection	Inspect every carton

7.3 Type Inspection

Type inspection shall be carried out in any of the following cases: qualification of a new product or transfer of production to another plant; major changes in structure, material or process; resumption of production after more than half a year of suspension; significant difference between the factory inspection results and those of the previous type inspection; when required by the customer or by the quality system.

Type inspection covers all items of Clause 5 of this document, among which gain, radiation pattern and efficiency (Clause 6.4) are newly added mandatory items. Once measured data are available, the specification limits in Tables 5-1 and 5-2 shall be re-verified against the measured distribution, and this specification shall be upgraded to a new version.

8 Marking, Packaging, Transportation and Storage

8.1 Marking

Each piece (or each smallest packaging unit) shall be clearly marked with: product name and model, antenna element number (ANT1/ANT2), production lot number or date code, supplier code, and the RoHS mark (if applicable).

8.2 Packaging

Anti-static packaging shall be used, with a desiccant enclosed; the outer packaging shall protect the product against compression, vibration and moisture during transportation, and the pictorial marking for handling of goods shall comply with GB/T 191.

8.3 Transportation

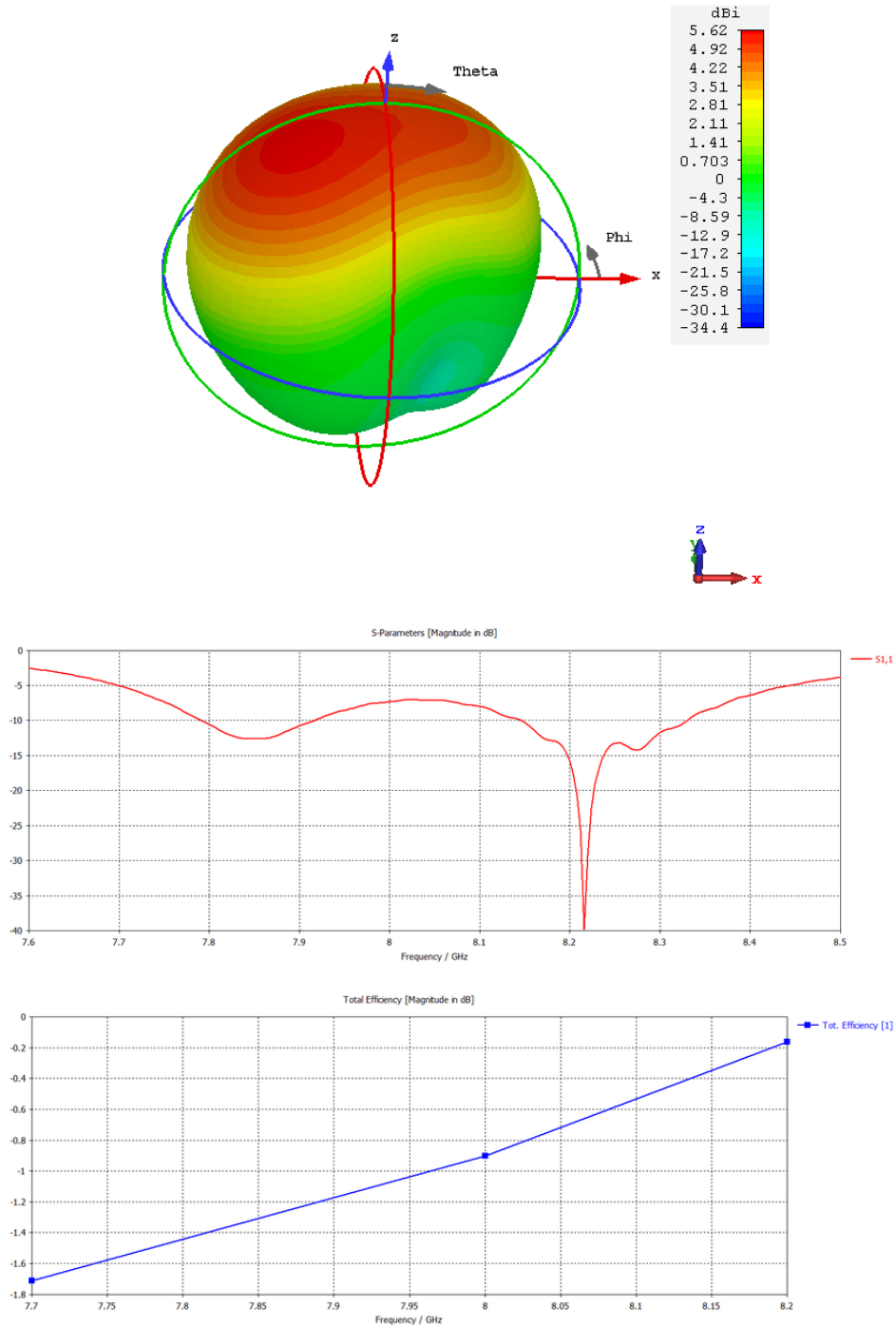
During transportation the product shall be protected from rain, direct sunlight, heavy pressure and severe impact, and shall not be shipped together with corrosive substances.

8.4 Storage

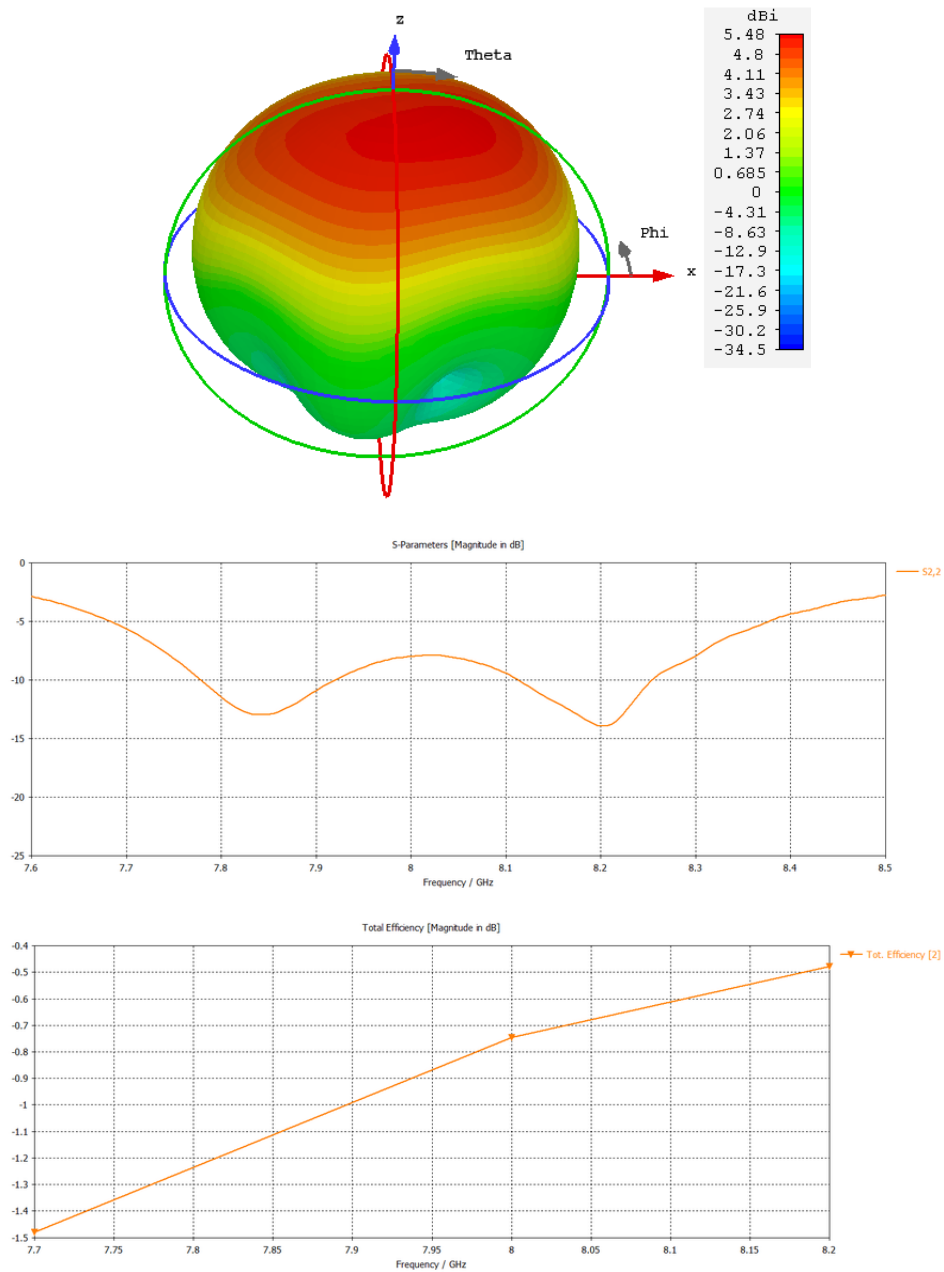
The product shall be stored in a ventilated, dry and non-corrosive-gas environment at a temperature of $-10\text{ }^{\circ}\text{C} - +40\text{ }^{\circ}\text{C}$ and a relative humidity of $\leq 75\text{ \%RH}$; counted from the date of production, the valid storage period is 12 months under normal storage conditions, and re-inspection is required before use after expiry.

Appendix A Simulation Data Charts - TAG Side (UWB-X5-AOA-U)

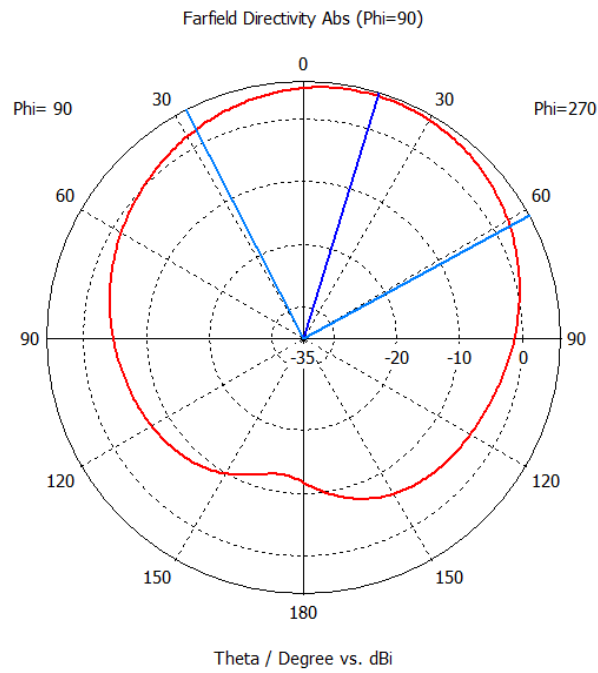
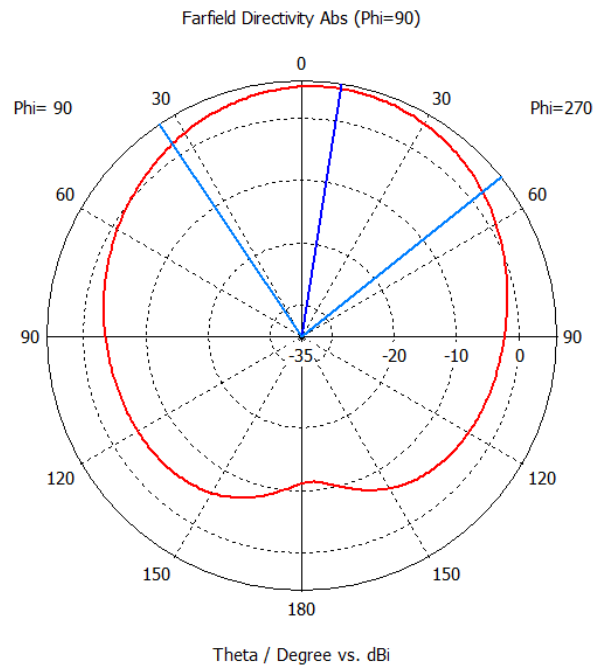
A.1 ANT1

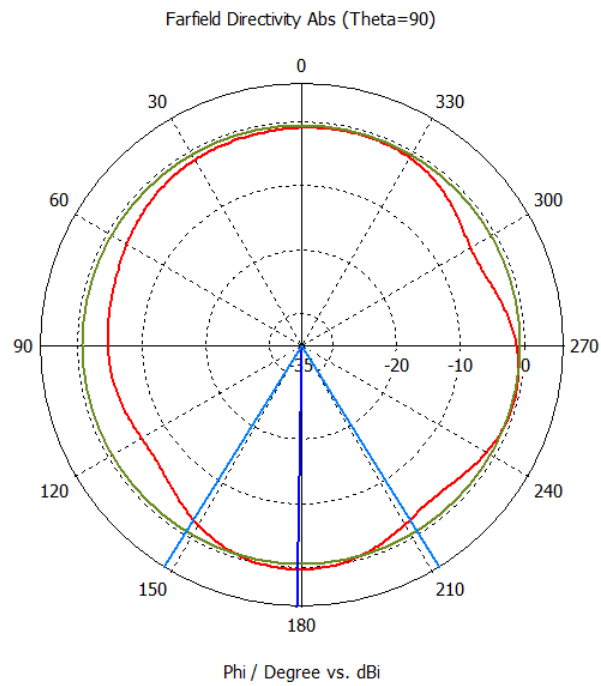
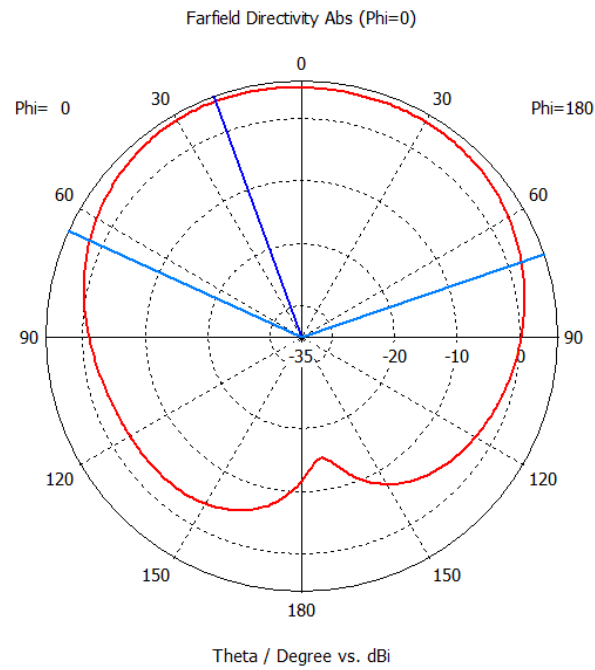


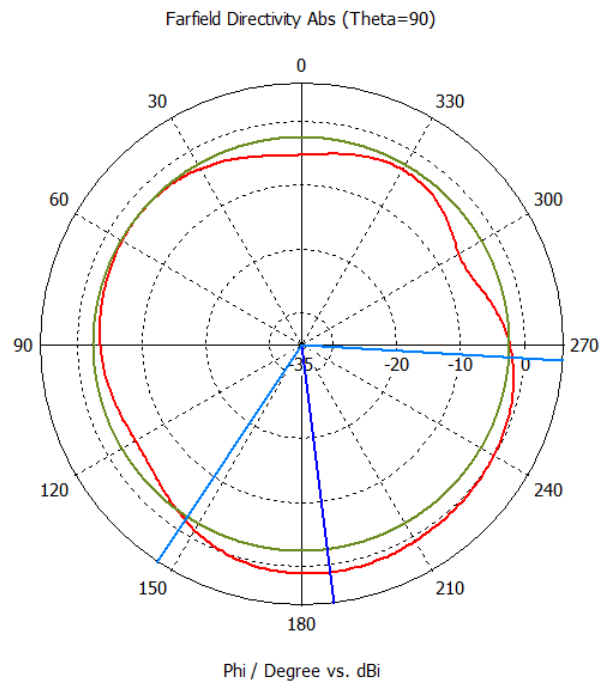
A.2 ANT2



A.3 2D Radiation Patterns and Polarization

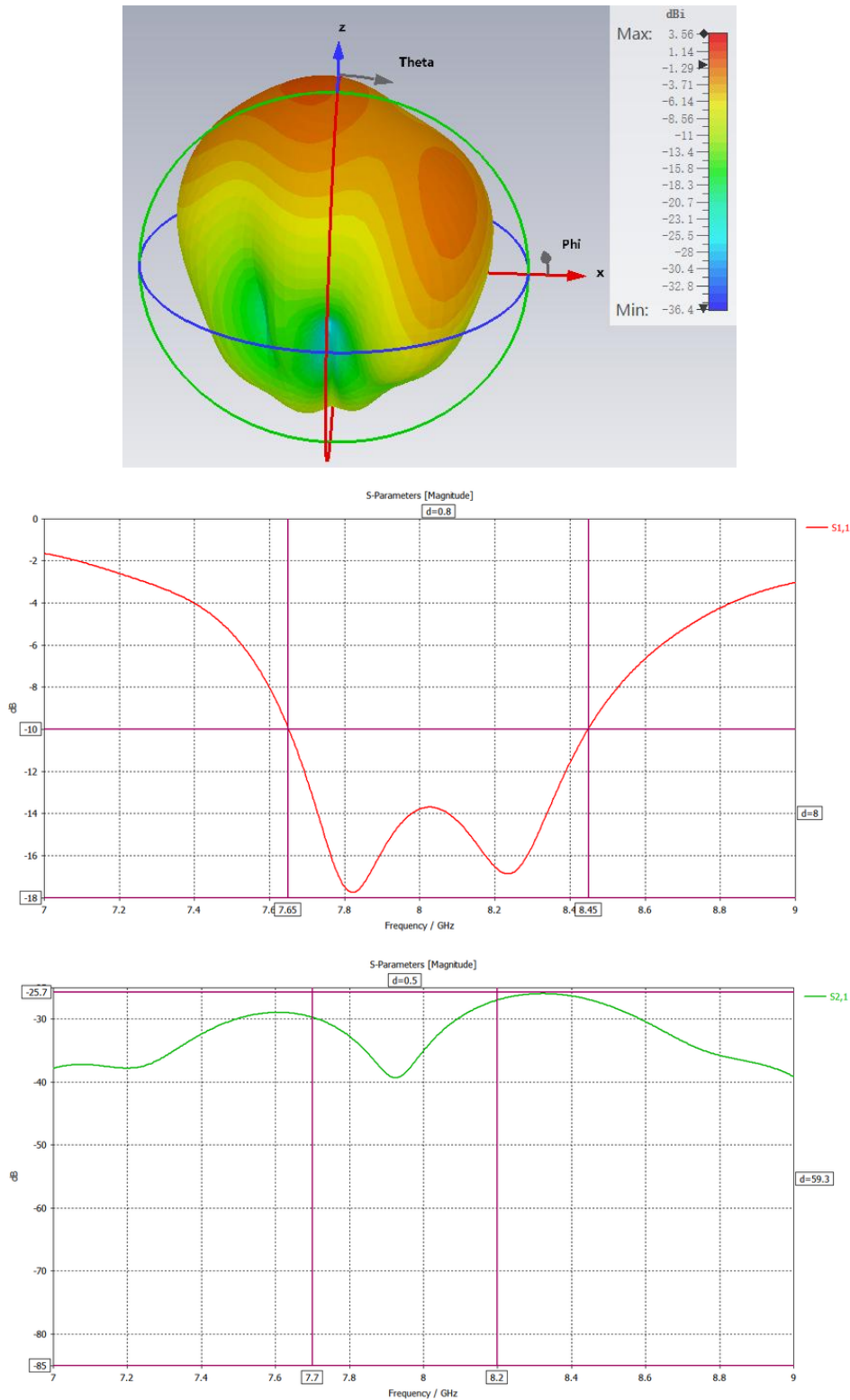


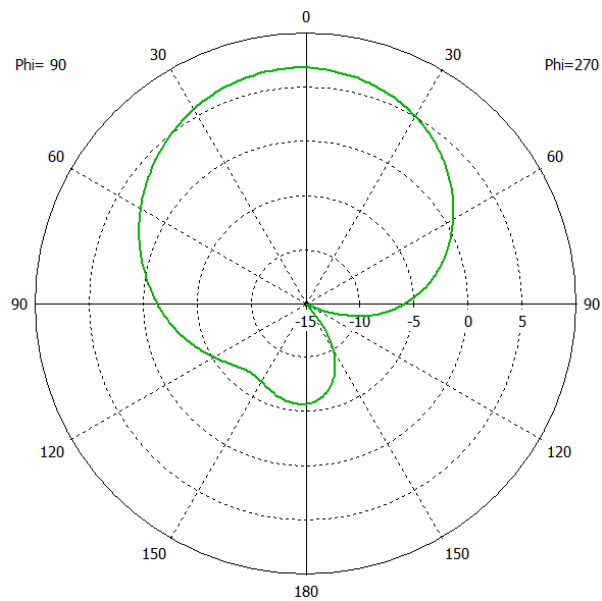
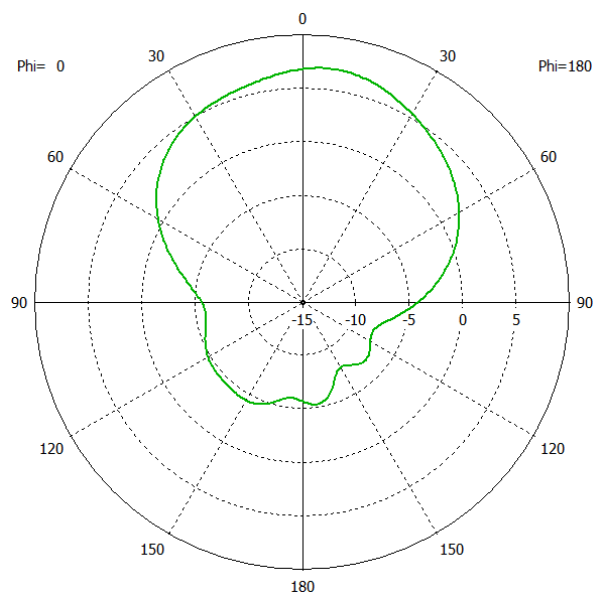
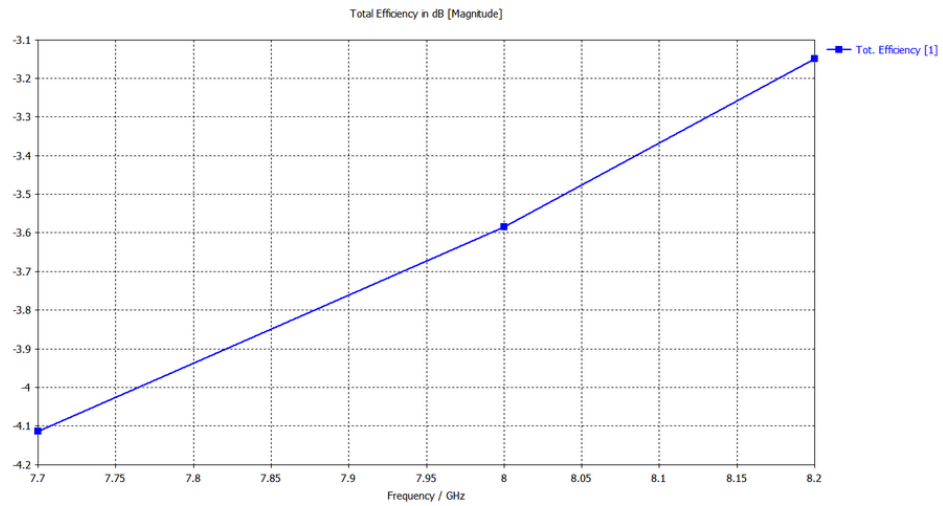




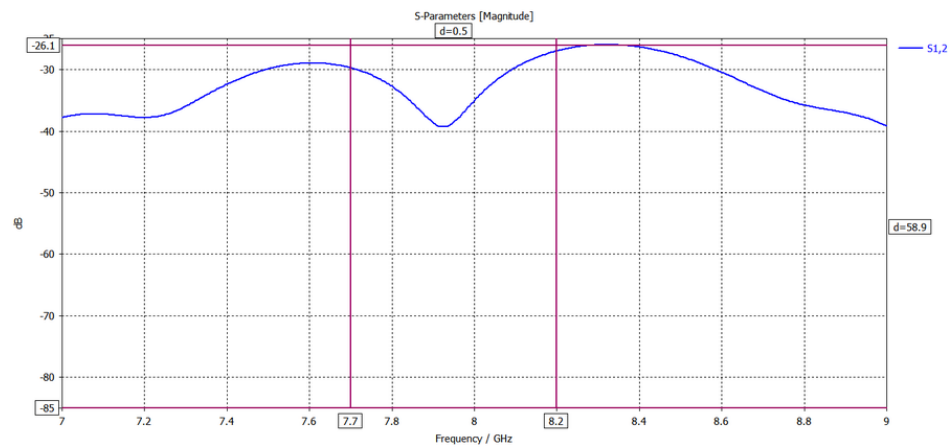
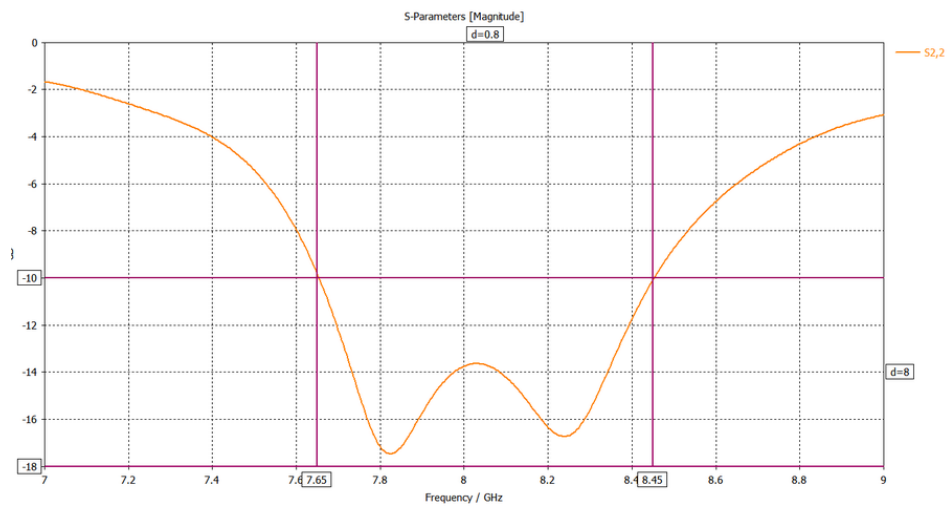
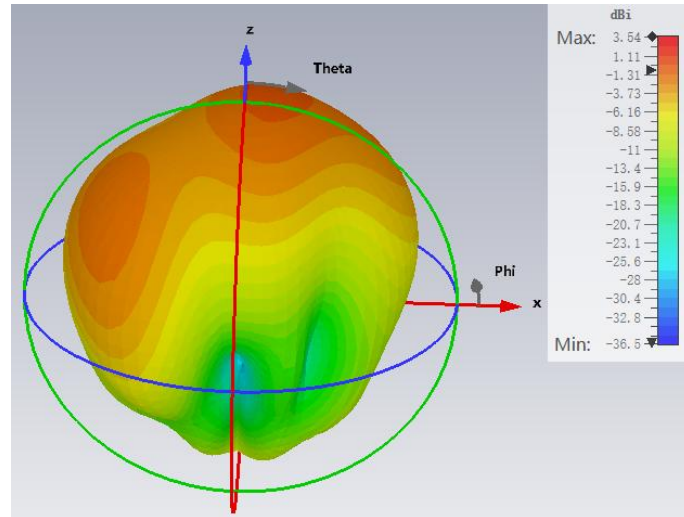
Appendix B Simulation Data Charts - V2 Base Station Side (LML-1T1R)

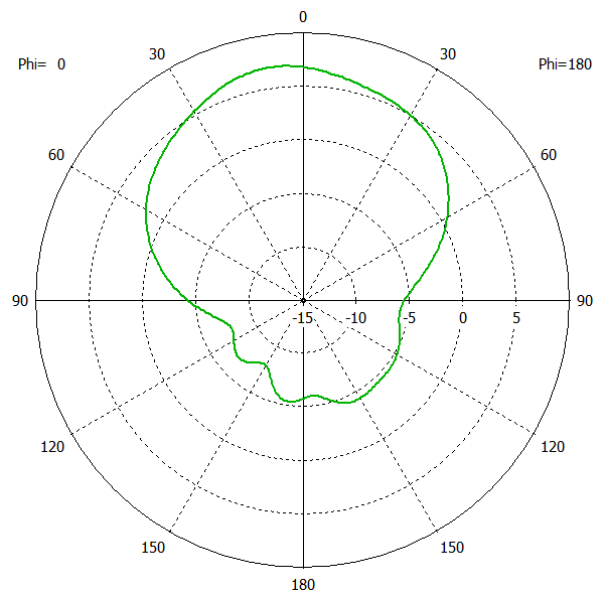
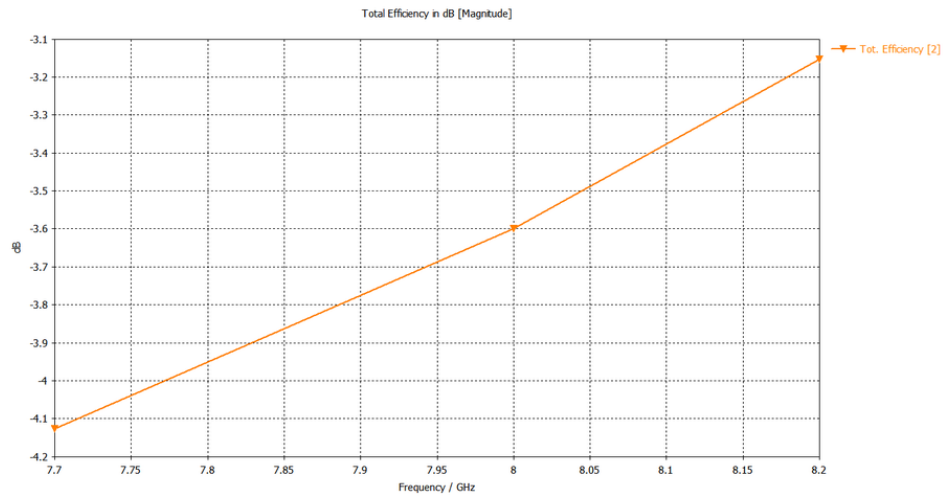
B.1 ANT1 (Transmit)





B.2 ANT2 (Receive)





Appendix C List of Associated Drawings and Documents

Document Name	No. / Version	Purpose
UWB-X5-AOA-U_1201 Antenna Description.dwg (.dxf)	UWB-X5-AOA-U_1201	TAG-side antenna structure, traces and dimensions
LML-1T1R Antenna Description Drawing.dwg	LML-1T1R	V2 base-station-side antenna structure, traces and dimensions
UWB-X5-AOA-U ANT REPORT 251214.pptx	2025-12-14	TAG-side 3D simulation report (data source of this specification)
Antenna Supplement - V2 Base Station.pptx	—	V2 base-station-side 3D simulation report (data source of this specification)

— End of this Specification —