ANTENNA UNDER TEST REPORT

Antenna operating within the 2400.0 MHz - 2483.5 MHz and 3.1GHz-10.6GHz band

Report Reference No	G0M-2403-2495-TFCAUT-V01
Testing Laboratory	Eurofins Product Service GmbH
Address	Storkower Str. 38c 15526 Reichenwalde Germany
Applicant	Jungheinrich AG
Address	Friedrich-Ebert-Damm 129 22047 Hamburg Germany
Equipment under Test (EUT):	
Product Description	UWB-Location-System is able to measure distances between the UWB components
Model(s)	52445054, Anchor
Additional Model(s)	None
Brand Name(s)	zoneCONTROL
Hardware Version(s)	10629
Software Version(s)	0.0.34
FCC ID	2AK6M-52445054

Testing:		
Test Lab Temperature	20 °C - 30 °C	
Test Lab Humidity	25 % - 55 %	
Date of receipt of test item	2022-12-19	
Report:		
Compiled by	Md Abu Bakar Siddique	
Tested by (+ signature) (Responsible for Test)	Md Abu Bakar Siddique	
Approved by (+ signature) (Senior Expert)	Radwan Jaafar	
Date of Issue	2024-11-26	
Total number of pages	35	
General Remarks:		
The test results presented in this report relate only to the object tested. **The results contained in this report reflect the results for this particular model and serial number. It is the responsibility of the manufacturer to ensure that all production models meet the intent of the requirements detailed within this report.** This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.		
Additional Comments:		
None		

VERSION HISTORY

Version History			
Version	Issue Date	Remarks	Revised By
01	2024-11-26	Initial Release	--

ABBREVIATIONS AND ACRONYMS

Acronyms	
Acronym	Description
EUT	Equipment Under Test
AUT	Antenna Under Test
HPBA	Half Power Beam Angle
T_{NOM}	Nominal temperature
V_{NOM}	Nominal supply voltage

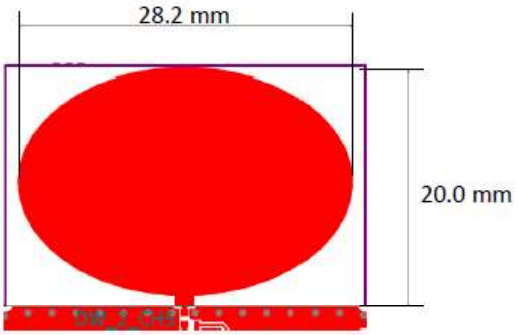
REPORT INDEX

1 Equipment (Test Item) Under Test

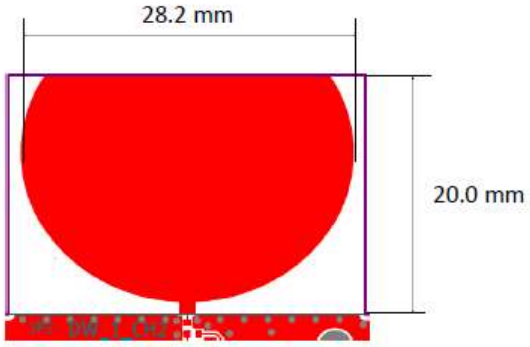
Description	UWB-Location-System is able to measure distances between the UWB components	
Model	52445054, Anchor	
Additional Model(s)	None	
Brand Name(s)	zoneCONTROL	
Sample identification	Serial Number	Test Sample ID
	ID:17:B4:10:03:19:D8	48554
Hardware Version(s)	10629	
Software Version(s)	0.0.34	
Equipment type	End Product	
Radio type	Transceiver	
Assigned frequency range	2400.0 MHz - 2483.5 MHz and 3.1 GHz – 10.6 GHz	
Radio technology	ZigBee 2.4 GHz and Ultra-Wide Band	
Modulation	OQPSK, BPSK with BPM	
Antenna 1	Type	Integrated Antenna
	Model	PCB antenna, UWB 1, IF4
	Manufacturer	Siemens
	Gain	4.81 dBi @ 4.0 GHz 5.99 dBi @ 6.5 GHz
Antenna 2	Type	Integrated Antenna
	Model	PCB antenna, UWB 2, IF2
	Manufacturer	Siemens
	Gain	3.33 dBi @ 4.0 GHz 5.11 dBi @ 6.5 GHz
Antenna 3	Type	Integrated Antenna, RF215, IF1
	Model	PCB antenna
	Manufacturer	Siemens
	Gain	6.15 dBi @ 2.4 GHz
Supply Voltage	V_{NOM}	24 VDC
Operating Temperature	T_{NOM}	20 °C
AC/DC-Adaptor	None	
Manufacturer	Siemens Aktiengesellschaft R&D House CHE DI PA DCP R&D 5 Rochlitzer Str. 19 09111 Chemnitz Germany	

1.3 Anntenna Mechanical Properties

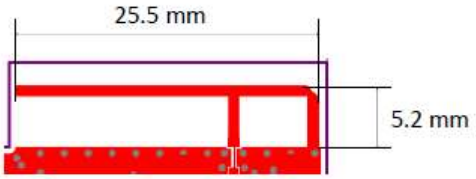
Radio 1 – UWB - Pulse
6000 MHz ... 7000 MHz



Radio 2 – UWB - Pulse
3100 MHz ... 4800 MHz



Radio 3 – ISM - Phase
2400 MHz … 2483.5 MHz



1.4 Support Equipment

Product Type	Device	Manufacturer	Model	Comment
AE	Laptop	HP	ProBook	For setting test modes
AE	PoE Midspan	Microsemi	9001GR	--
AE	USB-Serial-Adapter	Agilon	Not specified	--
CBL	Cable	Siemens	Not specified	From PCB with COM port to EUT
CBL	USB Cable	A-B Cable	Not specified	--
SFT	Radio Mode Setup	Not specified	Not specified	For setting test modes
Description:				
AE	Auxiliary Equipment			
SIM	Simulator			
CBL	Connecting Cable			
SFT	Software			
Comment: --				

1.5 Test Modes

Mode	Description
UWB	Mode = Transmit Modulation = CW (Unmodulated) Power setting = +13 dBm
ZigBee	Mode = Transmit Modulation = CW (Unmodulated) Power setting = +9 dBm

1.6 Test Frequencies

Designator	Mode	Frequency [MHz]
F1	Tx	2440.0
F2	Tx	3993.5
F3	Tx	6489.5

2 Test Conditions and Results

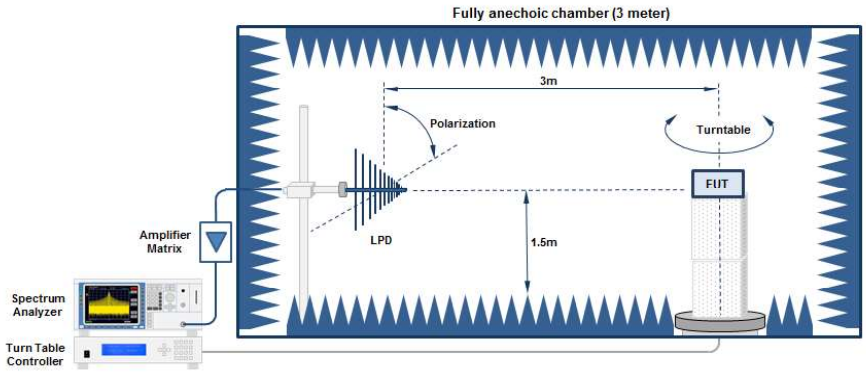
2.1 Test Conditions and Results – Antenna pattern

2.1.1 Information

Test Information	
Operator	Md Abu Bakar Siddique
Measurement uncertainty	± 4.42 dB
Date	2024-11-18

2.1.2 Setup

Test Setup



2.1.3 Equipment

Test Equipment					
Description	Manufacturer	Model	Identifier	Cal. Date	Cal. Due
Anechoic chamber	Frankonia	AC 2	EF01616	2024-07	2025-07
Spectrum analyzer	R&S	FSW43	EF00896	2024-07	2025-07
Antenna	Schwarzbeck	BBHA 9120B	EF01678	2024-05	2027-05

2.1.4 Procedure

Test Procedure

1. EUT set to the test mode and the conducted output power has been determined as reference value
2. EUT is placed on a non-conducting support at the center of a turn table 1.5 m above the ground
3. The Spectrum analyzer is set to the appropriate RBW, and detector.
4. The EIRP is measured and recorded in the azimuth plane through 0° to 360° and in the elevation plane through 0° to 180°.
5. procedure is repeated for horizontal and vertical polarization.

2.1.5 Results

Test Result – Antenna 1 (UWB1)				
Channel [MHz]	Measuring antenna polarization	Conducted Power [dBm]	Max. rad. Power [dBm e.i.r.p]	Max. antenna gain [dBi]
3993.5	Vertical	-2.99	1.82	4.81
	Horizontal	-2.99	1.35	4.34
6489.5	Vertical	-2.70	3.29	5.99
	Horizontal	-2.70	3.24	5.94

Test Result – Antenna 2 (UWB2)				
Channel [MHz]	Measuring antenna polarization	Conducted Power [dBm]	Max. rad. Power [dBm e.i.r.p]	Max. antenna gain [dBi]
3993.5	Vertical	-2.46	0.87	3.33
	Horizontal	-2.46	0.22	2.68
6489.5	Vertical	-2.46	1.79	4.25
	Horizontal	-2.46	2.65	5.11

Test Result – Antenna 3 (ZB)				
Channel [MHz]	Measuring antenna polarization	Conducted Power [dBm]	Max. rad. Power [dBm e.i.r.p]	Max. antenna gain [dBi]
2440.0	Vertical	5.93	9.14	3.21
	Horizontal	5.93	12.08	6.15

ANNEX A Antenna patterns (Antenna 1)

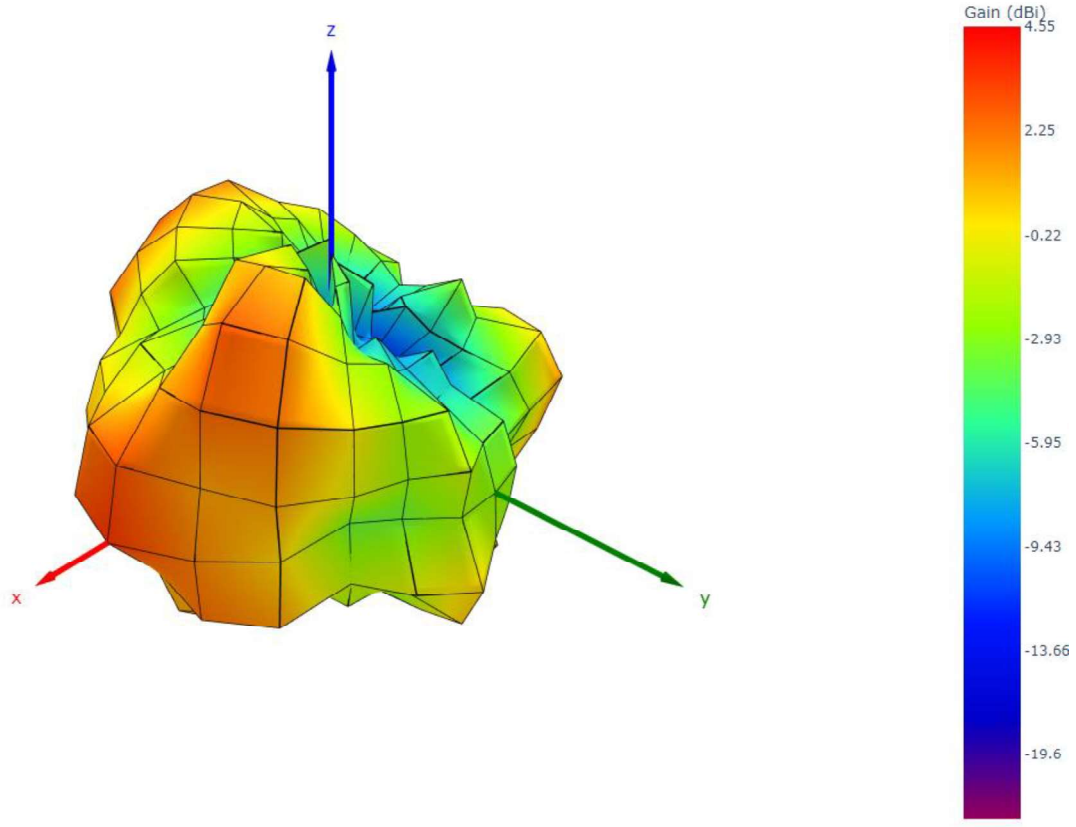
Antenna Pattern 4 GHz UWB1 (Receive antenna vertical)

Project Number:	G0M-2403-2495
Product:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445054, Anchor
EUT Antenna:	PCB antenna
Operating Frequency:	3993.5 MHz
Detector:	RMS
RBW:	1 MHz
VBW:	10 MHz
Sweep Time:	20 ms
Conducted Power:	-2.99 dBm
Operator:	Mr. Siddique
Date:	2024-11-18

Result Summary

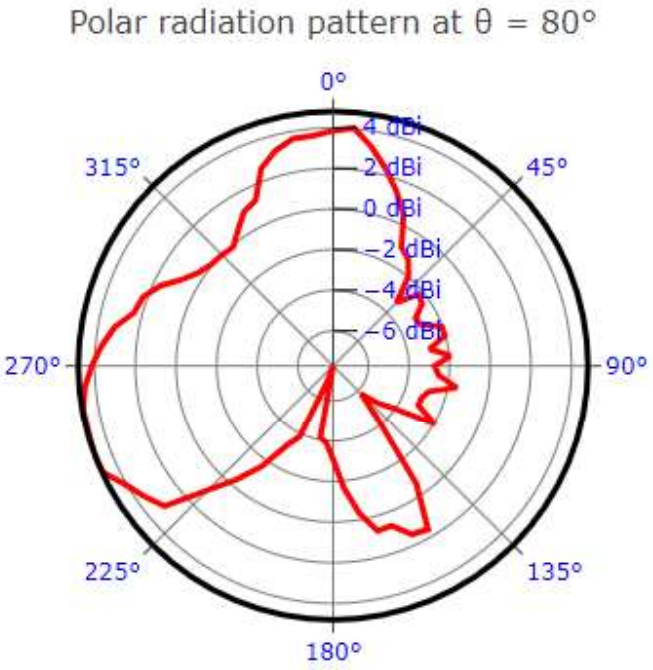
EUT orientation at max power (θ, φ)	HPBA (Azimuth plain)	HPBA (Elevation plain)	Max. rad. power [dBm e.i.r.p.]	Max. antenna gain [dBi]
(80°,258°)	60°	70°	1.82	4.81

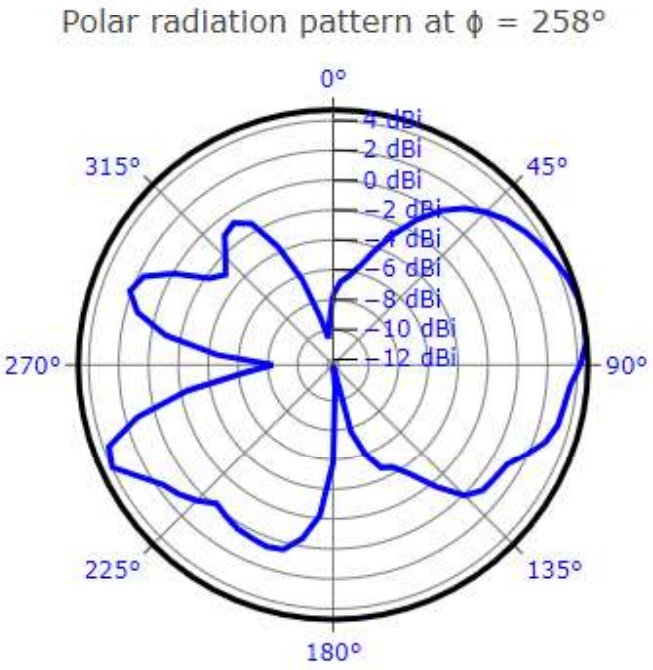
3D Radiation pattern



UWB1-4GHz-Vertical-3D

2D Polar plot at maximum radiation





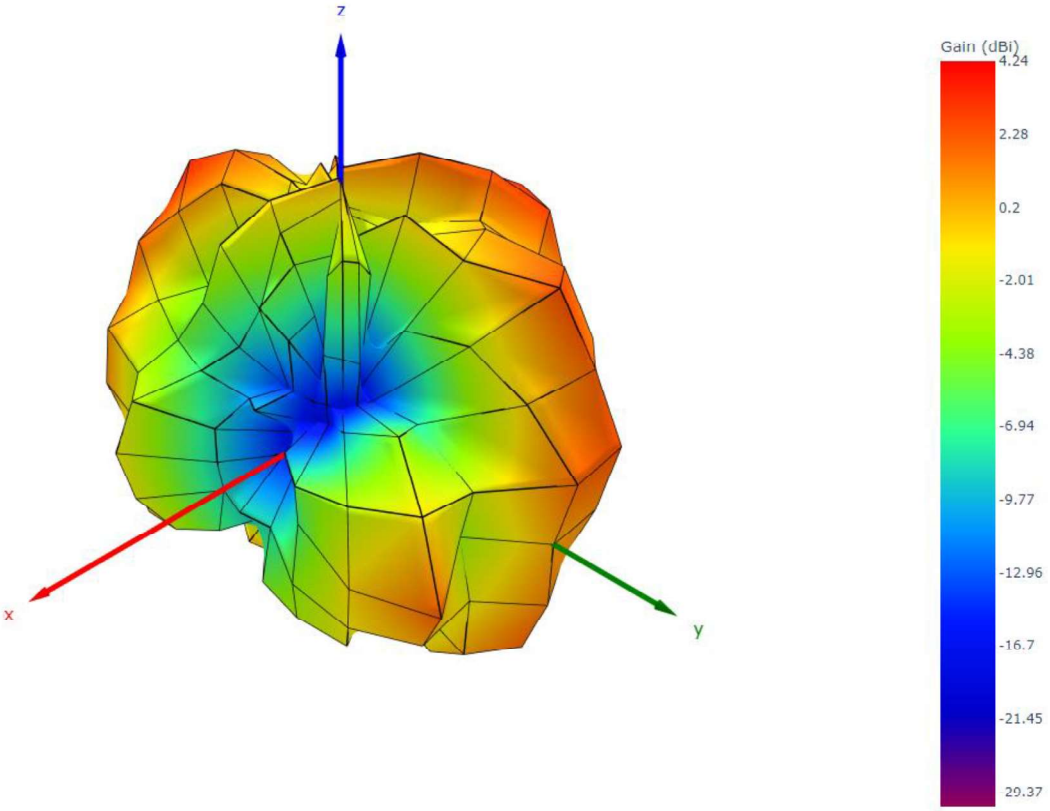
Antenna Pattern 4 GHz UWB1 (Receive antenna horizontal)

Project Number:	G0M-2403-2495
Product:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445054, Anchor
EUT Antenna:	PCB antenna
Operating Frequency:	3993.5 MHz
Detector:	RMS
RBW:	1 MHz
VBW:	10 MHz
Sweep Time:	20 ms
Conducted Power:	-2.99 dBm
Operator:	Mr. Siddique
Date:	2024-11-18

Result Summary

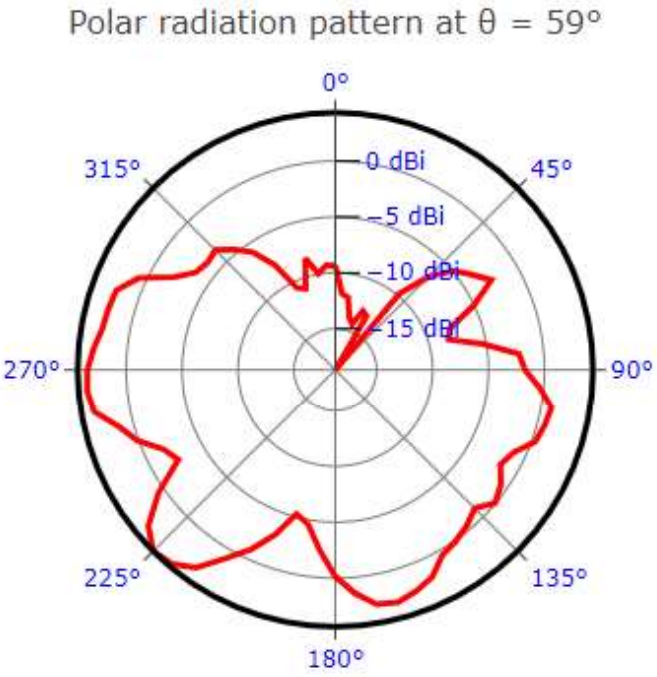
EUT orientation at max power (θ, φ)	HPBA (Azimuth plain)	HPBA (Elevation plain)	Max. rad. power [dBm e.i.r.p.]	Max. antenna gain [dBi]
(59°,224°)	15°	35°	1.35	4.34

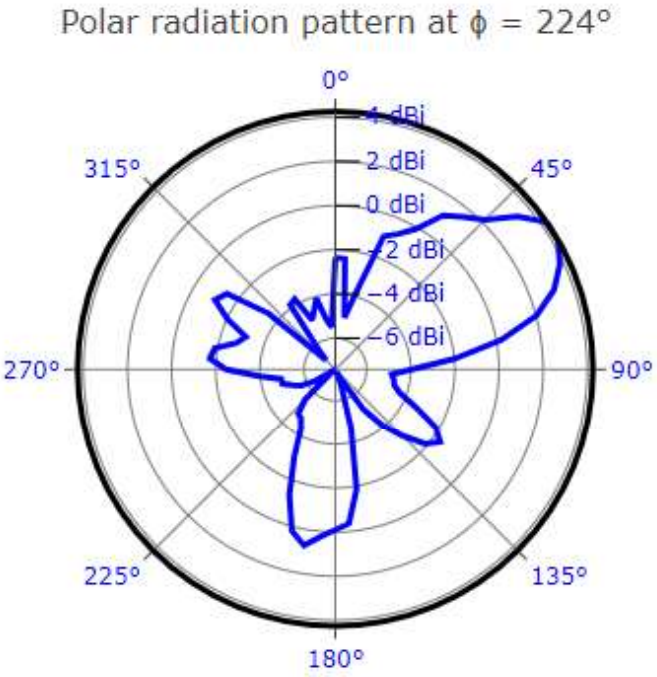
3D Radiation pattern



UWB1-4GHz-Horizontal-3D

2D Polar plot at maximum radiation





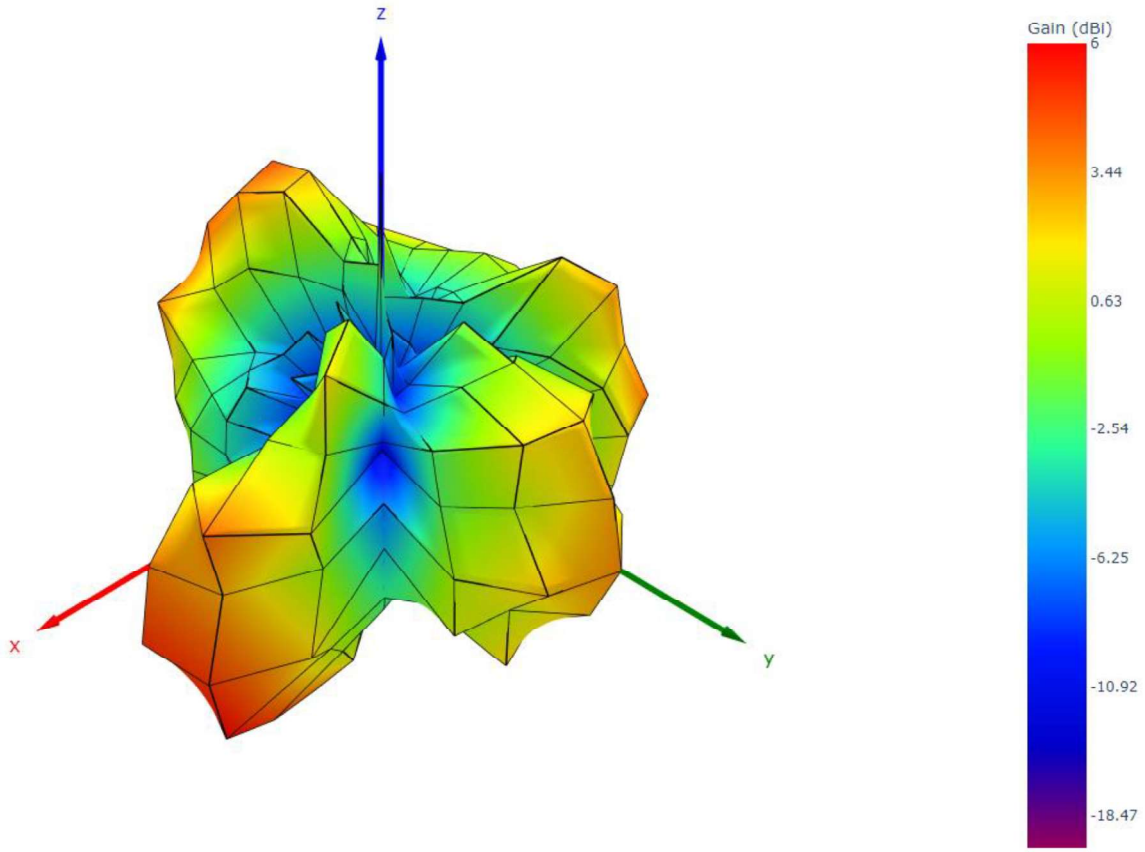
Antenna Pattern 6.5 GHz UWB1 (Receive antenna vertical)

Project Number:	G0M-2403-2495
Product:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445054, Anchor
EUT Antenna:	PCB antenna
Operating Frequency:	6489.5 MHz
Detector:	RMS
RBW:	1 MHz
VBW:	10 MHz
Sweep Time:	20 ms
Conducted Power:	-2.70 dBm
Operator:	Mr. Siddique
Date:	2024-11-18

Result Summary

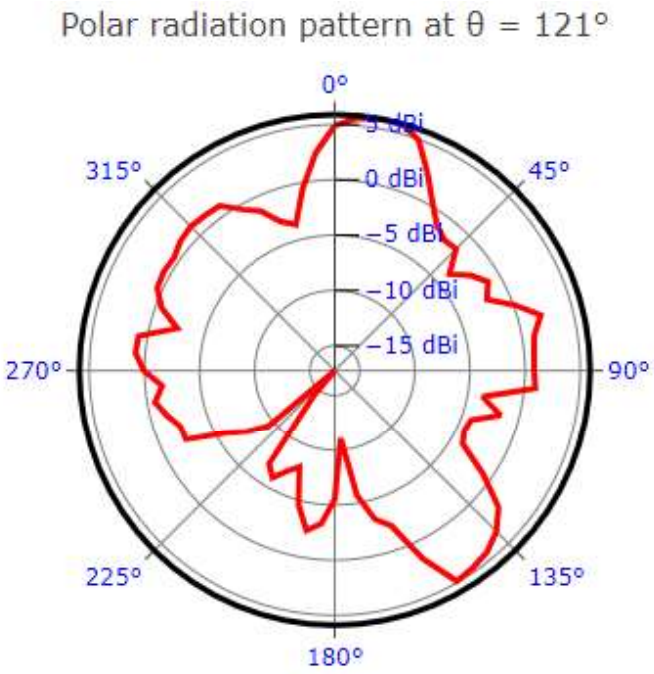
EUT orientation at max power (θ, φ)	HPBA (Azimuth plain)	HPBA (Elevation plain)	Max. rad. power [dBm e.i.r.p.]	Max. antenna gain [dBi]
(121°,16°)	20°	75°	3.29	5.99

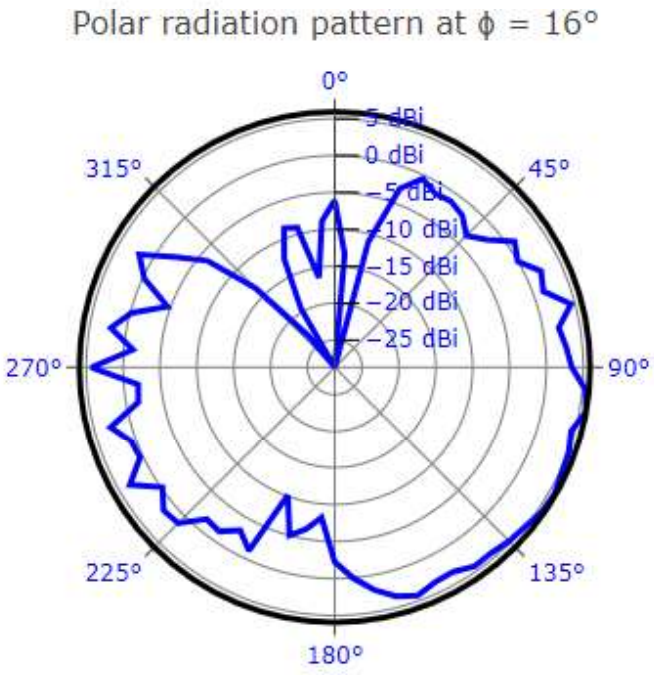
3D Radiation pattern



UWB1-6.5GHz-Vertical-3D

2D Polar plot at maximum radiation





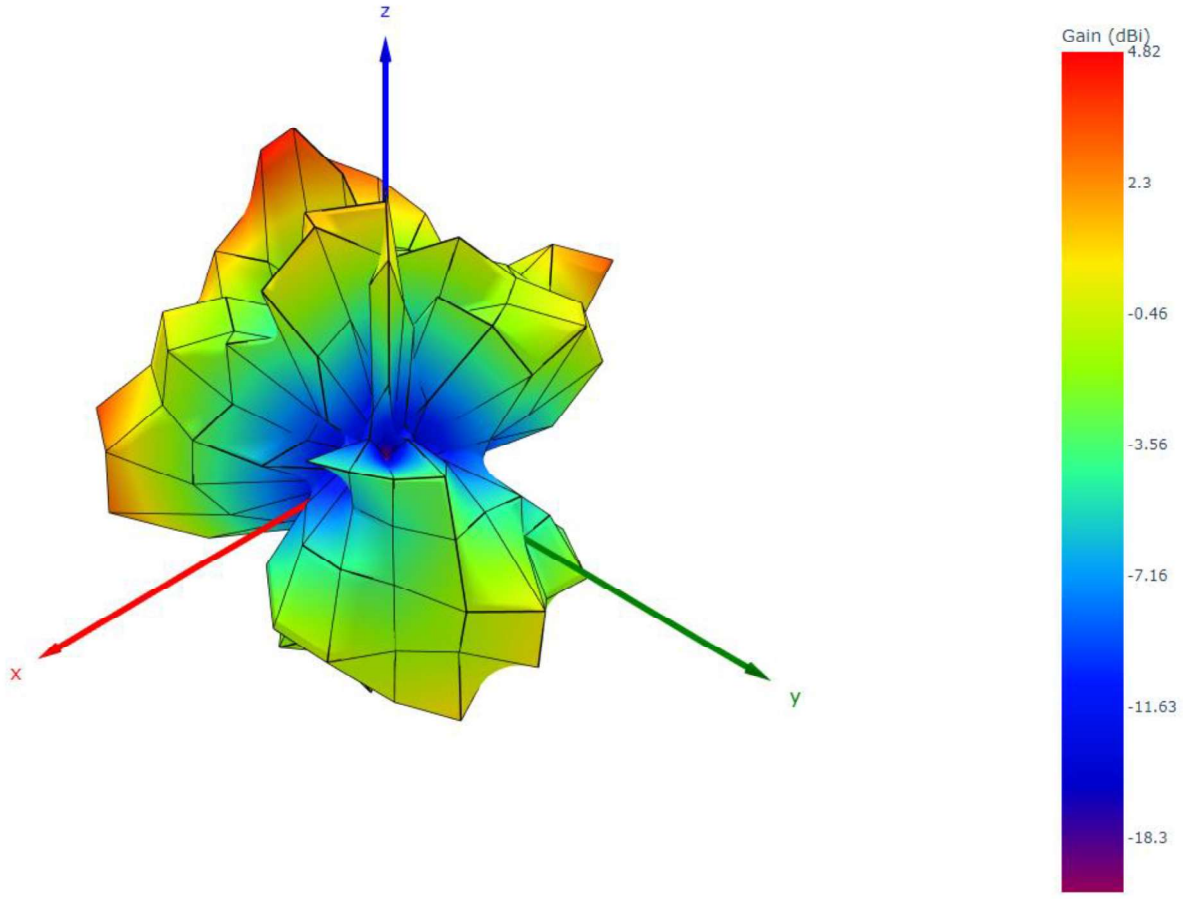
Antenna Pattern 6.5 GHz UWB1 (Receive antenna horizontal)

Project Number:	G0M-2403-2495
Product:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445054, Anchor
EUT Antenna:	PCB antenna
Operating Frequency:	6489.5 MHz
Detector:	RMS
RBW:	1 MHz
VBW:	10 MHz
Sweep Time:	20 ms
Conducted Power:	-2.70 dBm
Operator:	Mr. Siddique
Date:	2024-11-18

Result Summary

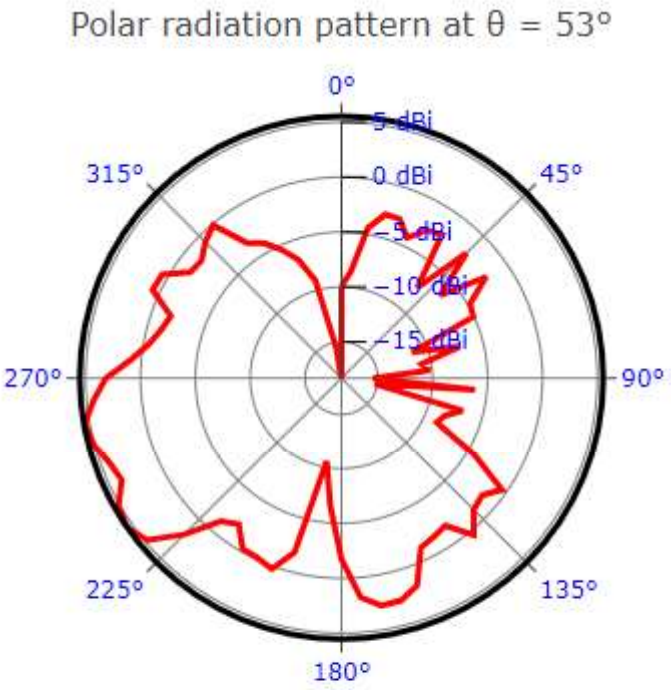
EUT orientation at max power (θ, φ)	HPBA (Azimuth plain)	HPBA (Elevation plain)	Max. rad. power [dBm e.i.r.p.]	Max. antenna gain [dBi]
(53°,235°)	40°	35°	3.24	5.94

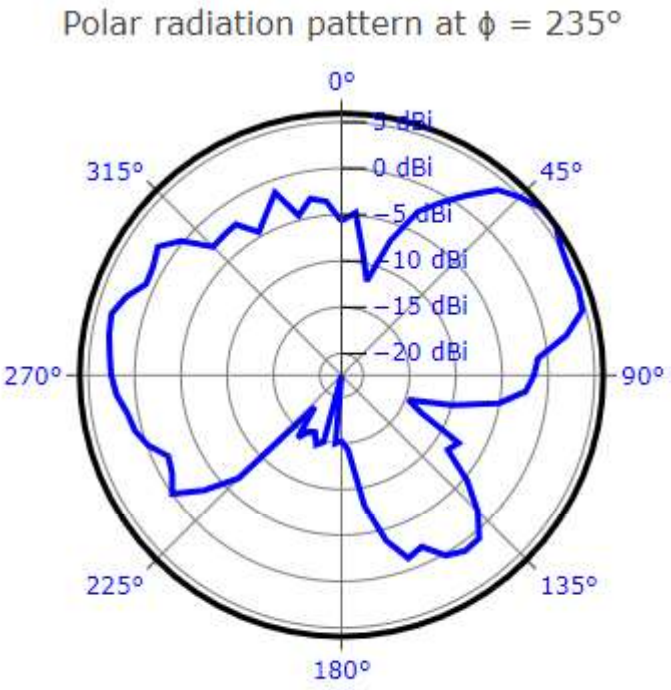
3D Radiation pattern



UWB1-6.5GHz-Horizontal-3D

2D Polar plot at maximum radiation





ANNEX B Antenna patterns (Antenna 2)

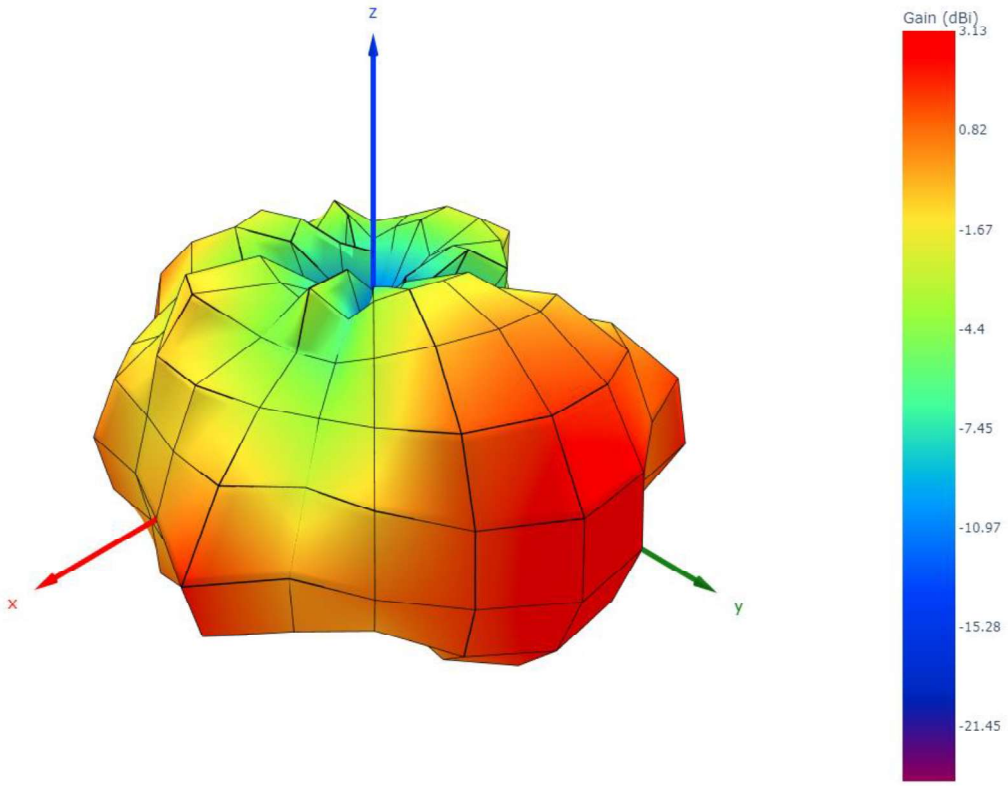
Antenna Pattern 4 GHz UWB2 (Receive antenna vertical)

Project Number:	G0M-2403-2495
Product:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445054, Anchor
EUT Antenna:	PCB antenna
Operating Frequency:	3993.5 MHz
Detector:	RMS
RBW:	1 MHz
VBW:	10 MHz
Sweep Time:	20 ms
Conducted Power:	-2.46 dBm
Operator:	Mr. Siddique
Date:	2024-11-18

Result Summary

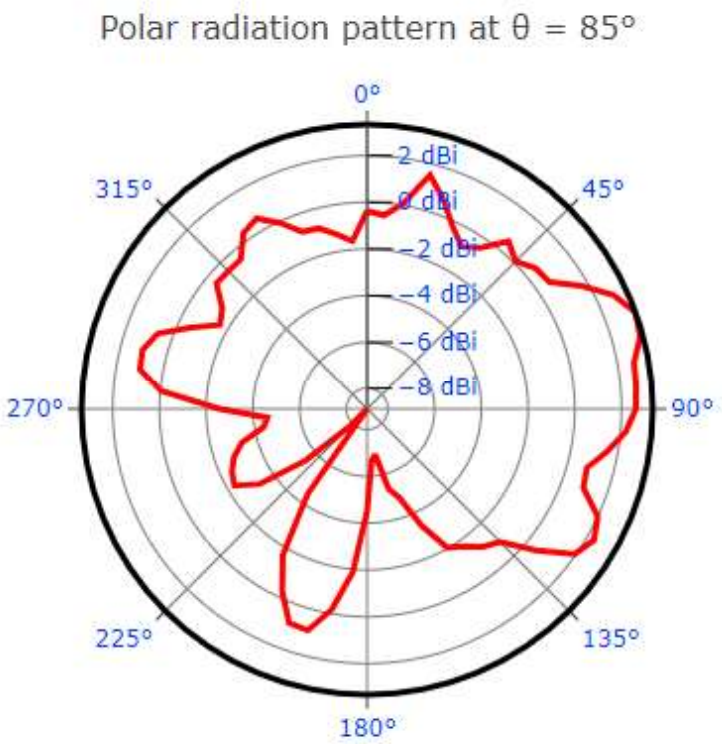
EUT orientation at max power (θ, φ)	HPBA (Azimuth plain)	HPBA (Elevation plain)	Max. rad. power [dBm e.i.r.p.]	Max. antenna gain [dBi]
(85°,72°)	80°	95°	0.87	3.33

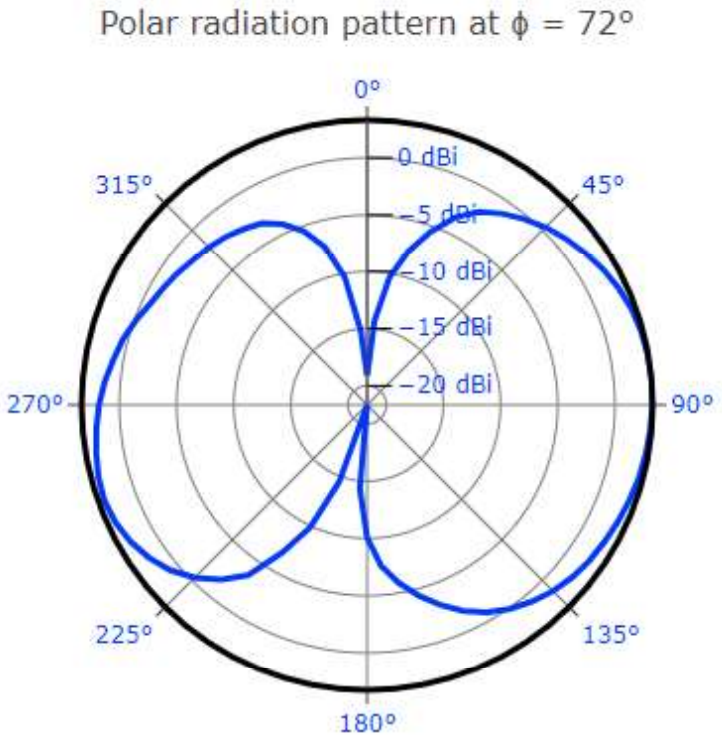
3D Radiation pattern



UWB2-4GHz-Vertical-3D

2D Polar plot at maximum radiation





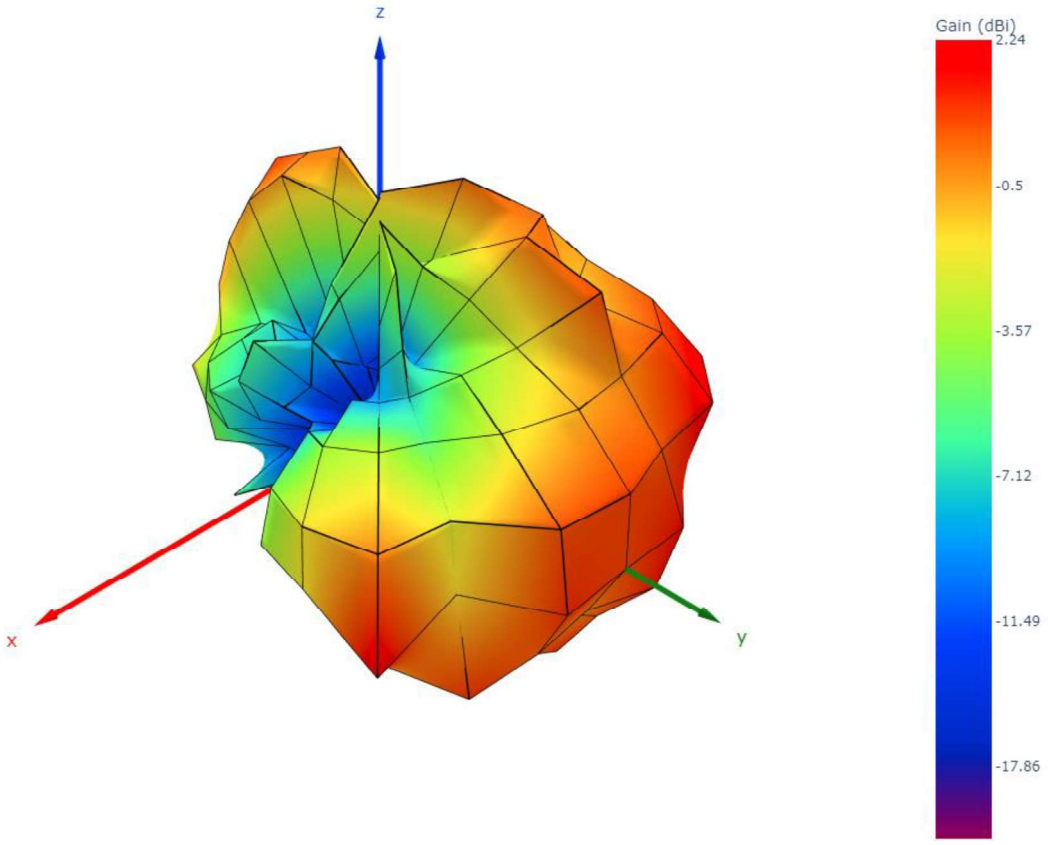
Antenna Pattern 4 GHz UWB2 (Receive antenna horizontal)

Project Number:	G0M-2403-2495
Product:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445054, Anchor
EUT Antenna:	PCB antenna
Operating Frequency:	3993.5 MHz
Detector:	RMS
RBW:	1 MHz
VBW:	10 MHz
Sweep Time:	20 ms
Conducted Power:	-2.46 dBm
Operator:	Mr. Siddique
Date:	2024-11-18

Result Summary

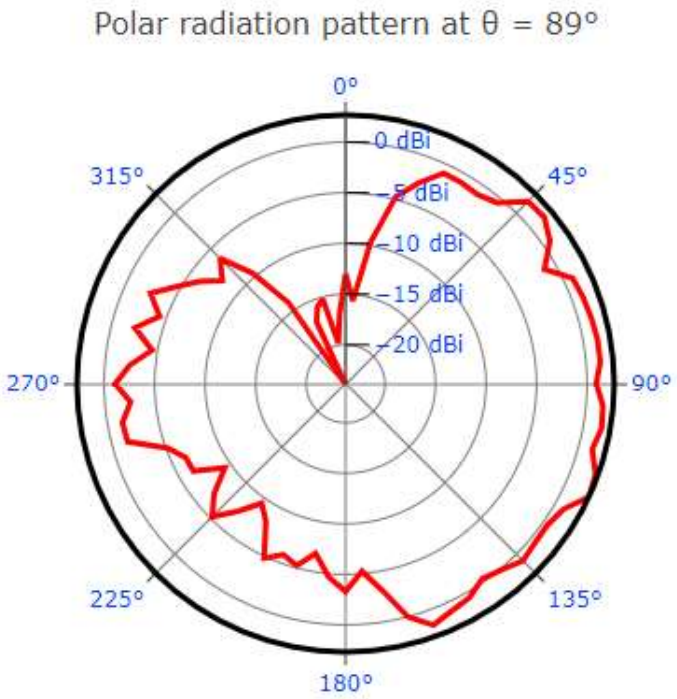
EUT orientation at max power (θ, φ)	HPBA (Azimuth plain)	HPBA (Elevation plain)	Max. rad. power [dBm e.i.r.p.]	Max. antenna gain [dBi]
(89°,48°)	100°	30°	0.22	2.68

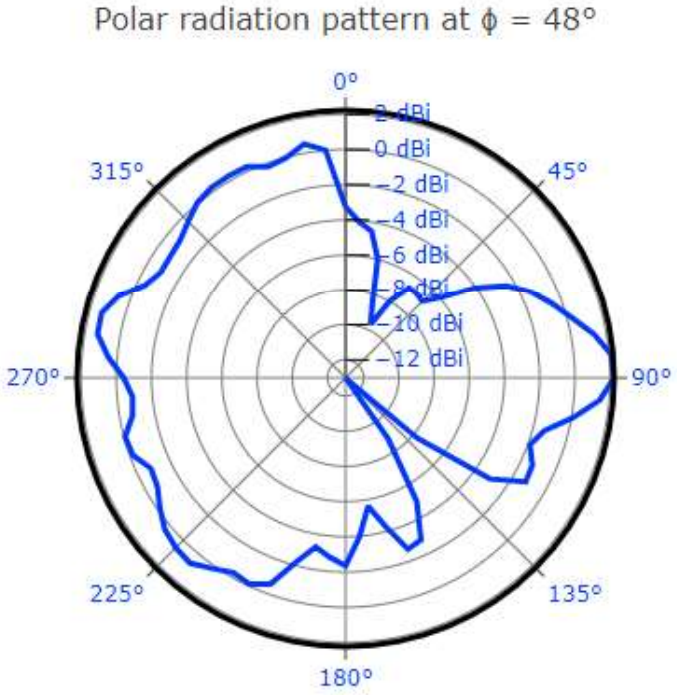
3D Radiation pattern



UWB2-4GHz-Horizontal-3D

2D Polar plot at maximum radiation





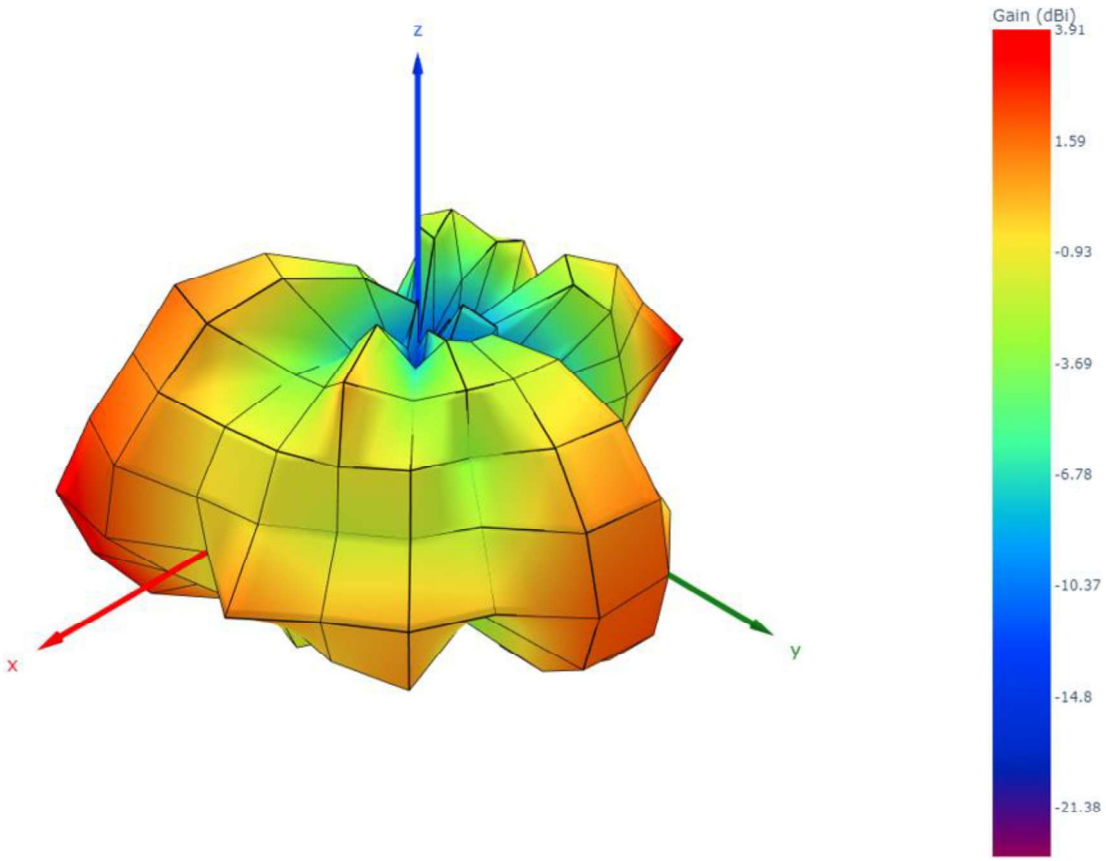
Antenna Pattern 6.5 GHz UWB2 (Receive antenna vertical)

Project Number:	G0M-2403-2495
Product:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445054, Anchor
EUT Antenna:	PCB antenna
Operating Frequency:	6489.5 MHz
Detector:	RMS
RBW:	1 MHz
VBW:	10 MHz
Sweep Time:	20 ms
Conducted Power:	-2.46 dBm
Operator:	Mr. Siddique
Date:	2024-11-18

Result Summary

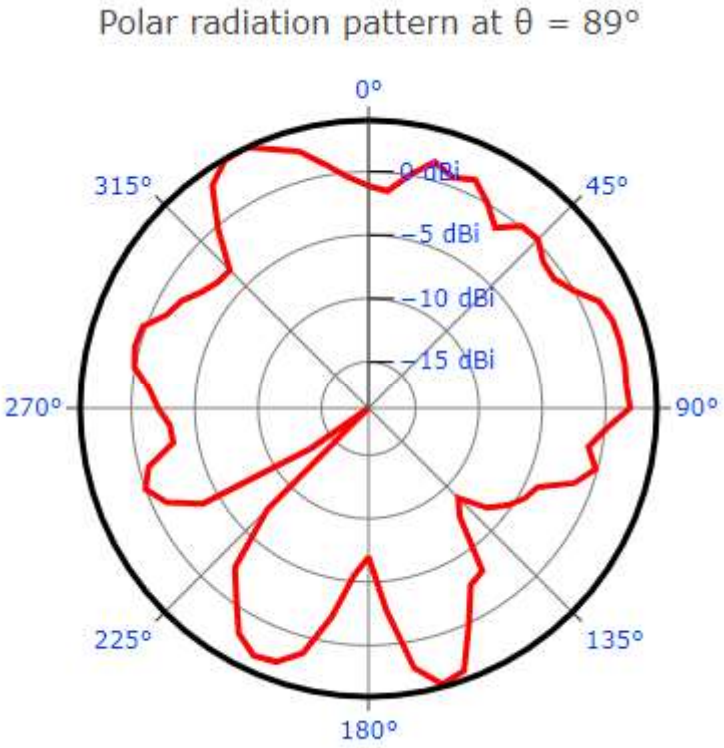
EUT orientation at max power (θ, φ)	HPBA (Azimuth plain)	HPBA (Elevation plain)	Max. rad. power [dBm e.i.r.p.]	Max. antenna gain [dBi]
(89°,333°)	20°	80°	1.79	4.25

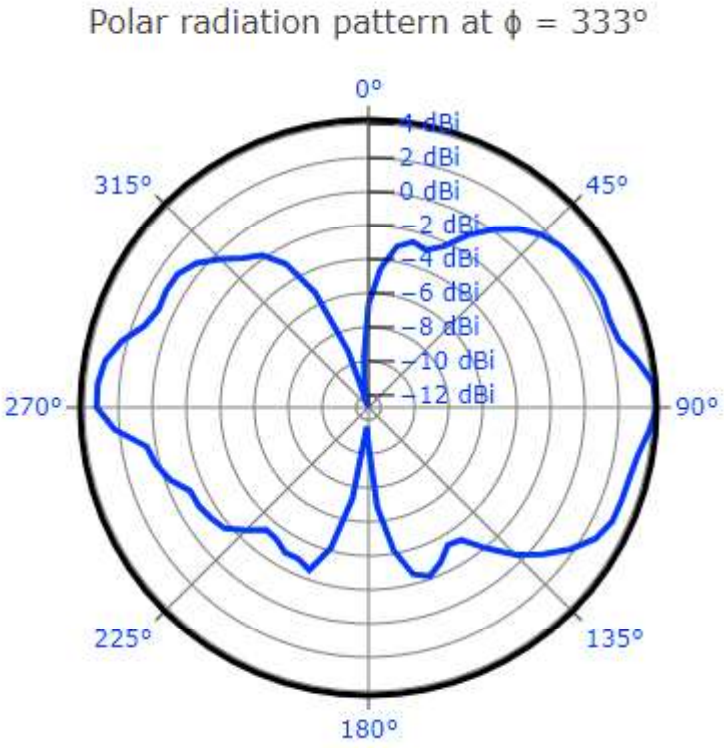
3D Radiation pattern



UWB2-6.5GHz-Vertical-3D

2D Polar plot at maximum radiation





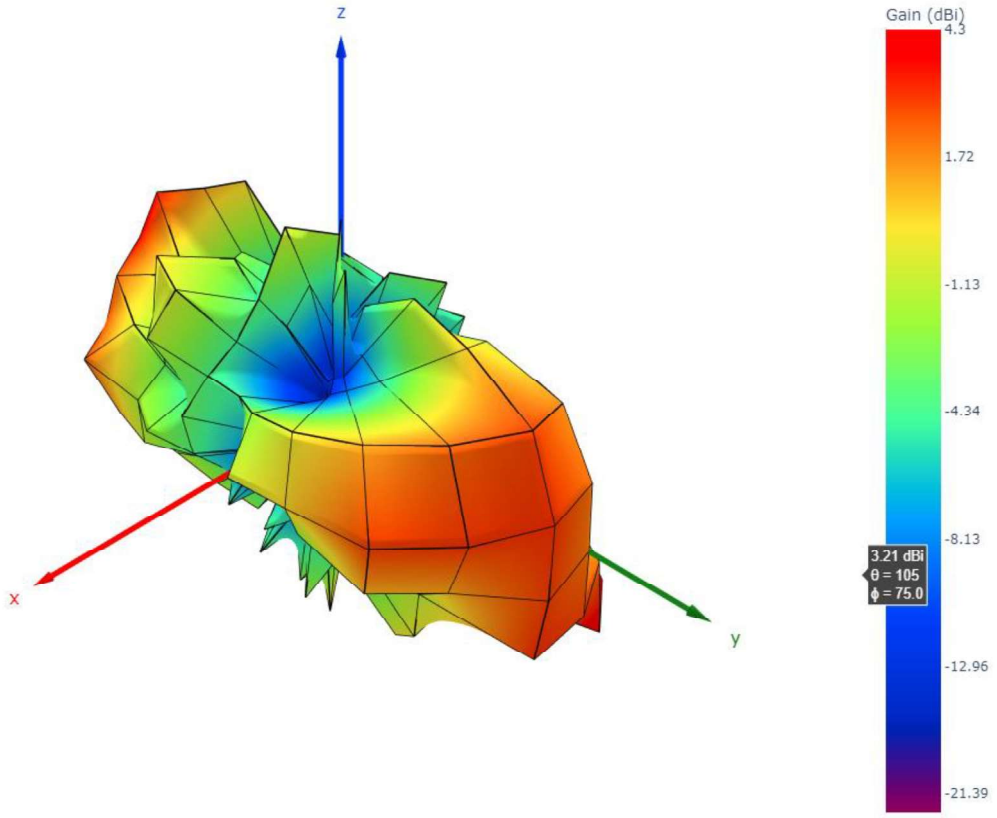
Antenna Pattern 6.5 GHz UWB2 (Receive antenna horizontal)

Project Number:	G0M-2403-2495
Product:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445054, Anchor
EUT Antenna:	PCB antenna
Operating Frequency:	6489.5 MHz
Detector:	RMS
RBW:	1 MHz
VBW:	10 MHz
Sweep Time:	20 ms
Conducted Power:	-2.46 dBm
Operator:	Mr. Siddique
Date:	2024-11-18

Result Summary

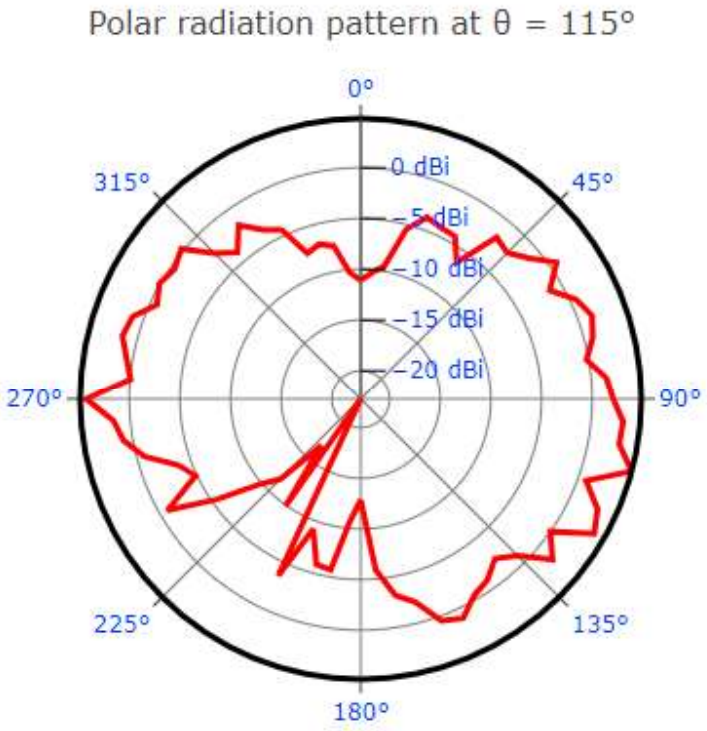
EUT orientation at max power (θ, φ)	HPBA (Azimuth plain)	HPBA (Elevation plain)	Max. rad. power [dBm e.i.r.p.]	Max. antenna gain [dBi]
(115°,104°)	15°	20°	2.65	5.11

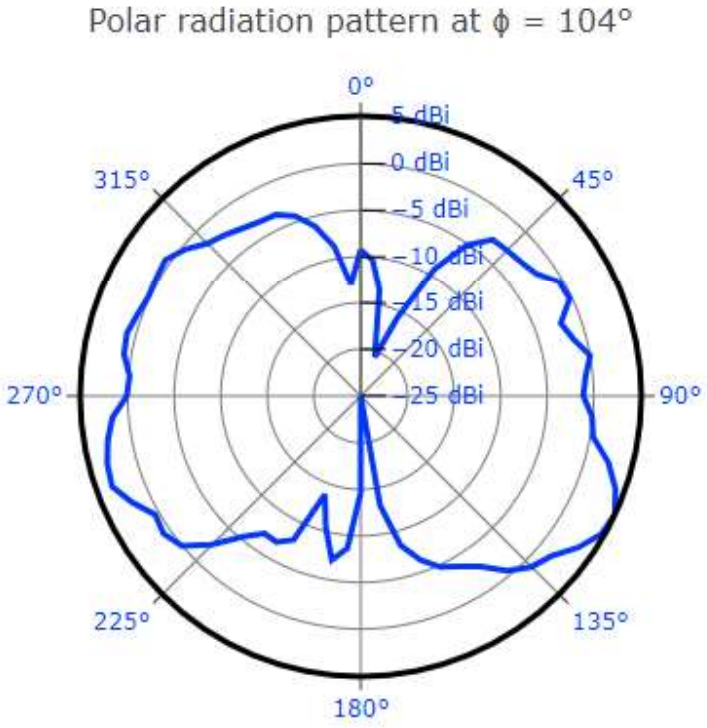
3D Radiation pattern



UWB2-6.5GHz-Horizontal-3D

2D Polar plot at maximum radiation





ANNEX C Antenna patterns (Antenna 3)

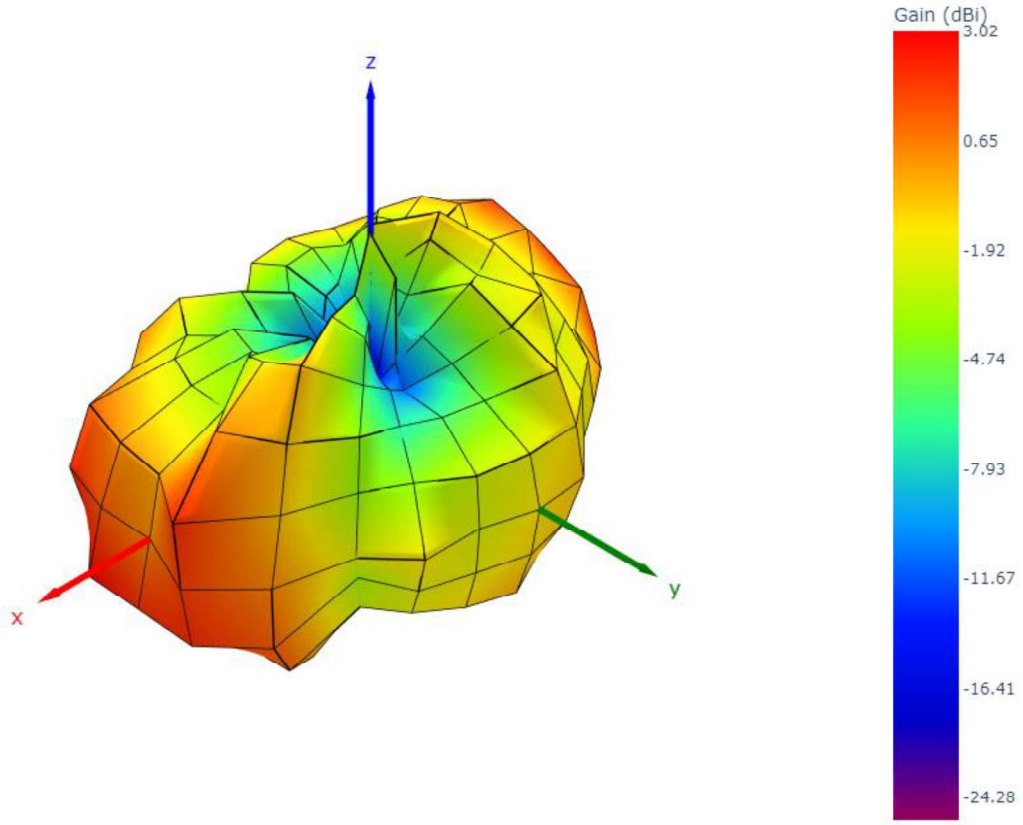
Antenna Pattern 2.4 GHz ZB (Receive antenna vertical)

Project Number:	G0M-2403-2495
Product:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445054, Anchor
EUT Antenna:	PCB antenna
Operating Frequency:	2440 MHz
Detector:	RMS
RBW:	1 MHz
VBW:	10 MHz
Sweep Time:	20 ms
Conducted Power:	5.93 dBm
Operator:	Mr. Siddique
Date:	2024-11-18

Result Summary

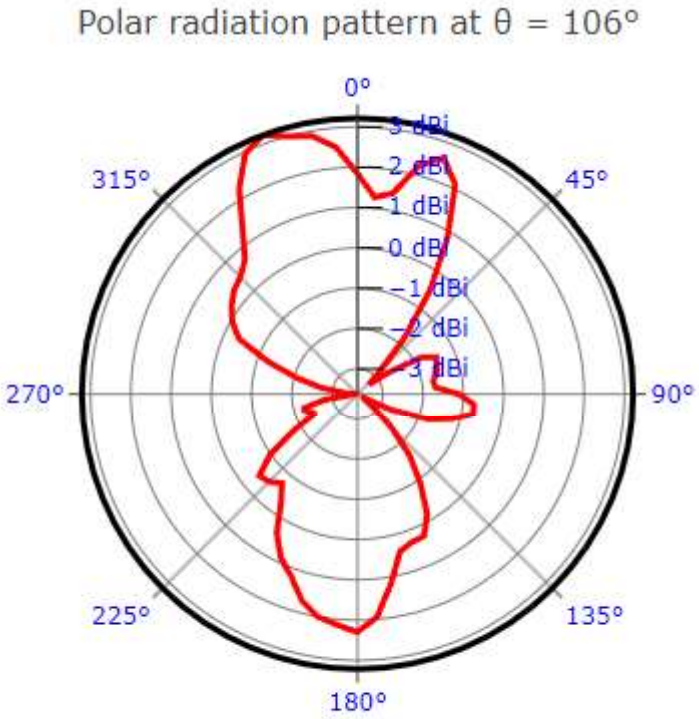
EUT orientation at max power (θ, φ)	HPBA (Azimuth plain)	HPBA (Elevation plain)	Max. rad. power [dBm e.i.r.p.]	Max. antenna gain [dBi]
(106°,338°)	80°	45°	9.14	3.21

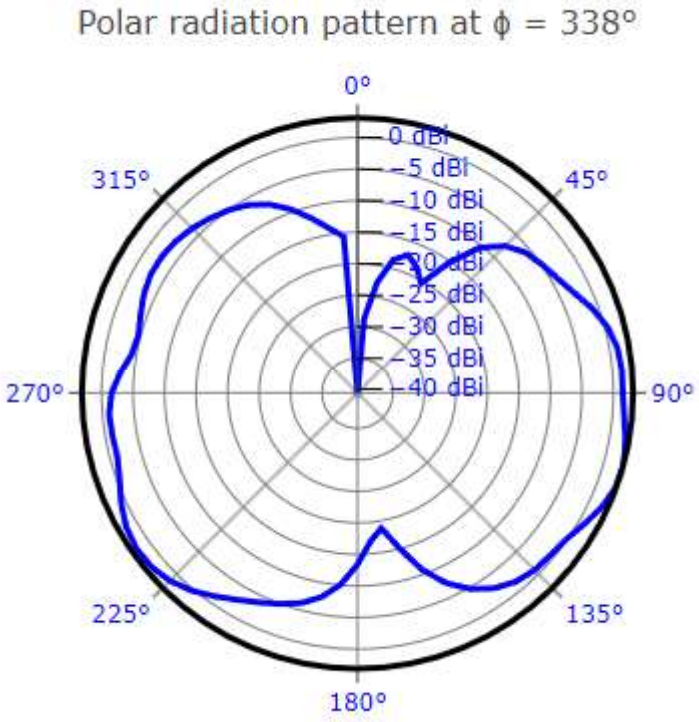
3D Radiation pattern



ZB-2.4GHz-Vertical-3D

2D Polar plot at maximum radiation





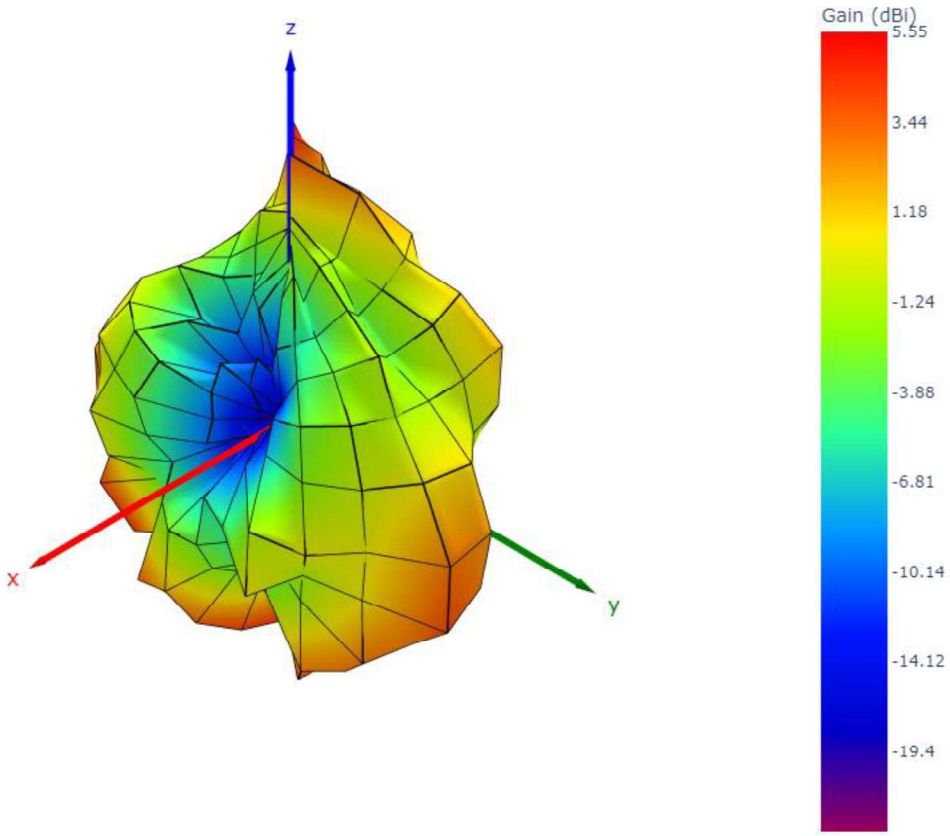
Antenna Pattern 2.4 GHz ZB (Receive antenna horizontal)

Project Number:	G0M-2403-2495
Product:	UWB-Location-System is able to measure distances between the UWB components
Model:	52445054, Anchor
EUT Antenna:	PCB antenna
Operating Frequency:	2440 MHz
Detector:	RMS
RBW:	1 MHz
VBW:	10 MHz
Sweep Time:	20 ms
Conducted Power:	5.93 dBm
Operator:	Mr. Siddique
Date:	2024-11-18

Result Summary

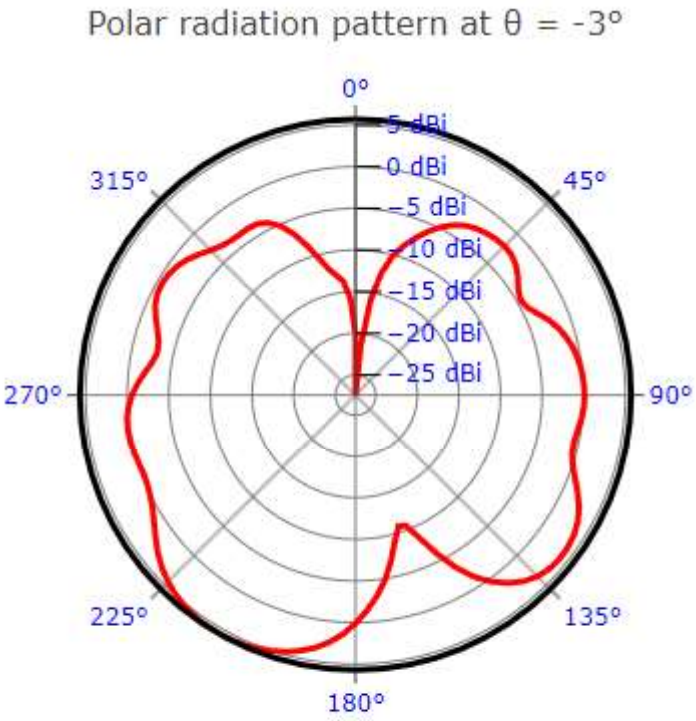
EUT orientation at max power (θ, φ)	HPBA (Azimuth plain)	HPBA (Elevation plain)	Max. rad. power [dBm e.i.r.p.]	Max. antenna gain [dBi]
(-3°,209°)	42°	48°	12.08	6.15

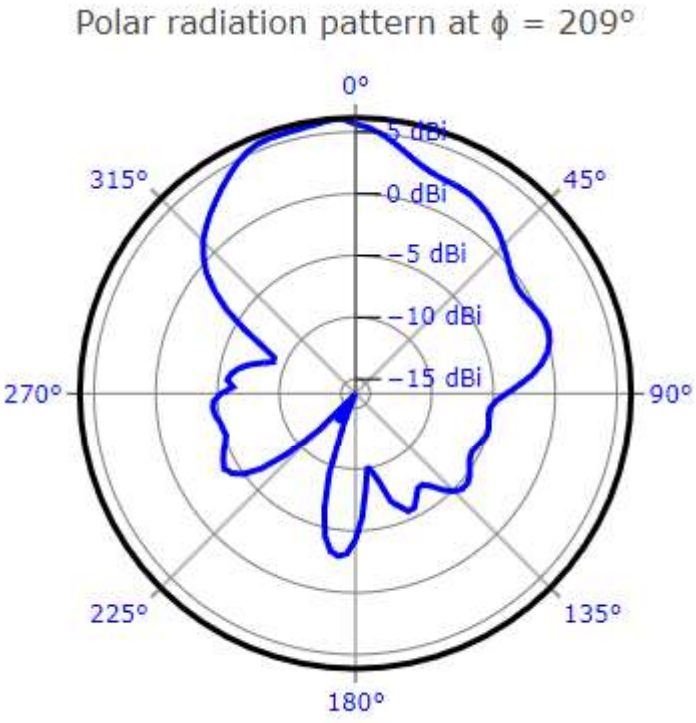
3D Radiation pattern



ZB-2.4GHz-Horizontal-3D

2D Polar plot at maximum radiation





= = END OF TEST REPORT = = =