Prüfbericht-Nr.: *Test Report No.:*	**JP23OV32 001**	**Auftrags-Nr.:** *Order No.:*	**150275898**	**Seite 1 von 9** *Page 1 of 9*
Kunden-Referenz-Nr.: *Client Reference No.:*	N/A	**Auftragsdatum:** *Order Date:*	2023-03-07	
Auftraggeber: *Client:*	T&D Corporation 817-1 Shimadachi, Matsumoto, Nagano 390-0852 Japan			
Prüfgegenstand: *Test Item:*	Data Logger			
Bezeichnung / Typ-Nr.: *Identification / Type No.:*	TR32B	**Serien-Nr.:** *Serial No.:*	AUT-T1	
Auftrags-Inhalt: *Order Content:*	Radio Testing			
Prüfgrundlage: *Test Specification:*	**Antenna Radiation Pattern Measurement**			
Wareneingangsdatum: *Date of Receipt:*	2023-03-20			
Prüfmuster-Nr.: *Test Sample No.:*	A003437590			
Prüfzeitraum: *Testing Period:*	2023-03-29			
Ort der Prüfung: *Place of Testing:*	Yokohama EMC Laboratory			
Prüflaboratorium: *Testing Laboratory:*	TÜV Rheinland Japan Ltd.			
Prüfergebnis*: *Test Result*:*	Pass			

Überprüft von: *Reviewed by:*		**Genehmigt von:** *Authorized by:*	
Datum: 2023-04-04 *Date:*	Daisuke Watanuki	**Datum:** 2023-04-04 *Date:*	Pin Zhang
***Stellung** / Position:*	Inspector	***Stellung** / Position:*	Reviewer

Sonstiges / *Other:*

Zustand des Prüfgegenstandes bei Anlieferung: *Condition of the Test Item at Delivery:*	Prüfmuster vollständig und unbeschädigt *Test item complete and undamaged*

* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
** Legend:*	*P(ass) = passed a.m. test specification(s)*	*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

REVISIONS

Report No.	Issue date	Changes / Remarks
JP23OV32 001	2023-04-04	Original document

Contents

1. General Remarks

1.1 Test Report Purpose

The purpose of this test report is to measure antenna radiation patterns in 3 axes (X/Y/Z) and calculate maximum antenna gains.

1.2 Complementary Materials

There is no attachment to this test report.

2. Test Sites

2.1 Test Facilities

TÜV Rheinland Japan Ltd. – Global Technology Assessment Center
4-25-2 Kita-Yamata, Tsuzuki-ku, Yokohama 224-0021, Japan

The test facility is recognized by the Federal Communications Commission (FCC) as Accredited Testing Laboratory under designation number JP0017.

The test facility is accredited by VLAC (member of ILAC) under number VLAC-017 according to ISO/IEC 17025:2017.

Note: The testing subject to this present report is out of scope of these accreditations.

2.2 List of Test and Measurement Instruments

Table 1: List of Test and Measurement Equipment

Kind of Equipment	Manufacturer	Model Name	Serial Number	Equip. ID	Cal. Interval	Cal. Date	Next Cal.
Measurement Software	TUV Rheinland Japan Ltd.	RF Measurements	2017-12-07	RF-0754	N/A	N/A	N/A
EMI Receiver	Rohde & Schwarz	ESW 44	101751	RF-0809	1 year	2023-09-27	2024-09-27
Signal Generator	Rohde & Schwarz	SMB100A	175171	RF-1191	1 year	2023-01-06	2024-01-06
Horn Antenna (TX)	Schwarzbeck	BBHA9120 B	420	RF-0051	1 year	2022-07-24	2023-07-24
Horn Antenna (RX)	Schwarzbeck	BBHA9120 B	419	RF-0050	N/A	N/A	N/A

Conformance of the used measurement and test equipment with the requirements of ISO/IEC 17025 has been confirmed before testing.

N/A: Not Applicable

3. General Product Information

3.1 Product Function and Intended Use

The **EUT** (**E**quipment **U**nder **T**est) is an antenna for Bluetooth products.

3.2 Ratings and System Details

Frequency range:	2402 – 2480MHz
Antenna gain:	0.12dBi
Antenna type:	Pattern antenna (Inverted F)
Antenna mounting type:	Internal

4. Test Setup and Operation Modes

4.1 Test Methodology

The test methodology used is based on TUV Rheinland Japan Ltd. own internal work instruction manual EMC-B-04-902.

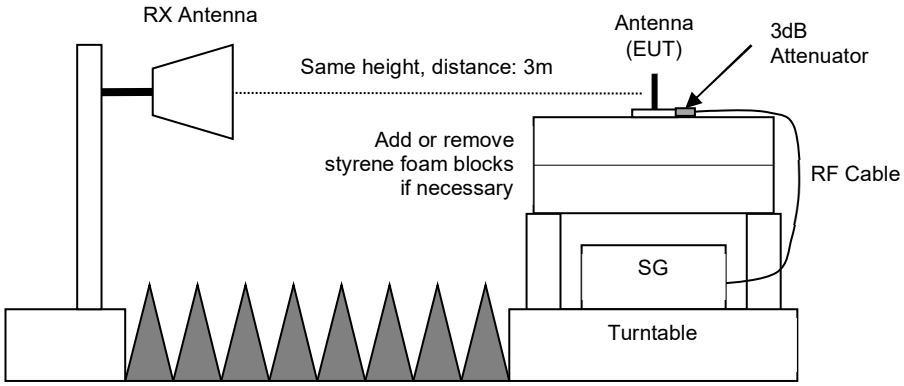
4.2 Operation Modes

Testing was performed at the lowest operating frequency (2402MHz), middle of the specified frequency band (2440MHz) and highest operating frequency (2480MHz) in 3 axes (X/Y/Z).

4.3 Physical Configuration for Testing

- Place a signal generator at the center of the turntable, directly on top of the attached ferrite tiles.
- Pile up styrene foam blocks on the turntable above the signal generator.
- Place the EUT for which antenna pattern must be measured at the center of the turntable on top of the styrene foam blocks, at the same height as the RX antenna. Adjust the EUT height by adding or removing styrene foam blocks if necessary.
- Connect the EUT to the signal generator (SG) using an RF cable and 3dB attenuator.
- Set the frequency of the SG and of the spectrum analyzer (SPA) connected to the RX antenna as required for the antenna pattern measurement. Increase then gradually the SG output power until a clear peak can be observed on the SPA. Make rotations of the turntable for horizontal and vertical RX antenna polarizations and for several EUT orientations (X, Y, Z), and observe the variation of the signal level on the SPA. Adjust if necessary the SG level and the SPA reference level so that the peak remains always visible above the noise floor and within the range of the SPA.

Figure 1: Block Diagram



Note:

For more details, refer to section: Photographs of the Test Set-Up.

5. Test Results of Antenna Pattern Measurement

5.1 Radiated Measurements

5.1.1 Radiated Spurious Emissions of Transmitter

RESULT: **SEE APPENDIX A**

Date of testing: 2023-03-29

Ambient temperature: 23°C
Relative humidity: 48%
Atmospheric pressure: 1009hPa

Measurement distance: 3m
Kind of test site: Full Anechoic Chamber
Tested Frequencies: 2402, 2440 and 2480MHz
Orientations (Axes): X/Y/Z

Table 2: Maximum Antenna Gain

Frequency [MHz]	Max Gain [dBi]	Axis
2402	0.12	Z-X
2440	-1.07	Z-X
2480	-1.69	Y-Z

See Appendix A and B for further details about the measurement result.

Appendix A

Details of Measurement Result

TUV Rheinland Japan Ltd.
Global Technology Assessment Center
4-25-2 Kita Yamata, Tsuzuki-ku
Yokohama 224-0021, Japan

TÜVRheinland®

Antenna Pattern Measurement Summary

Manufacturer:	T&D Corporation	Date:	2023-03-29
Product:	Data Logger, TR32B	Temp.:	23 degC
Type Number:	TR32B	Humidity:	48 %
Serial Number:	AUT-T1	Air Press.:	1009 hPa
Operator:	M. Hirata	Loacation:	3m full annechoic chamber

X-Y Axis		Horizontal			Vertical		
		Peak Gain	Angle	3dB Beam	Max. Gain	Angle	3dB Beam
Frequency		dBi	degrees	degrees	dBi	degrees	degrees
Low	2402 MHz	-7.16	275	12	-0.39	292	113
Middle	2440 MHz	-7.88	274	14	-1.00	310	99
High	2480 MHz	-8.75	274	16	-1.90	307	115

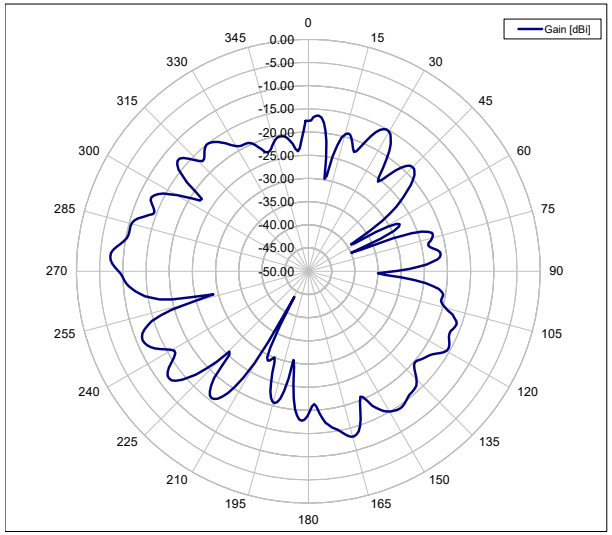
Y-Z Axis		Horizontal			Vertical		
		Peak Gain	Angle	3dB Beam	Max. Gain	Angle	3dB Beam
Frequency		dBi	degrees	degrees	dBi	degrees	degrees
Low	2402 MHz	-0.55	223	97	-5.07	280	82
Middle	2440 MHz	-1.34	333	100	-6.32	261	137
High	2480 MHz	-1.69	214	90	-5.12	267	103

Z-X Axis		Horizontal			Vertical		
		Peak Gain	Angle	3dB Beam	Max. Gain	Angle	3dB Beam
Frequency		dBi	degrees	degrees	dBi	degrees	degrees
Low	2402 MHz	**0.12**	304	80	-8.37	281	55
Middle	2440 MHz	-1.07	302	86	-10.74	285	162
High	2480 MHz	-2.11	310	92	-11.33	265	110

Maximum Antenna Gain:	**0.12 dBi**

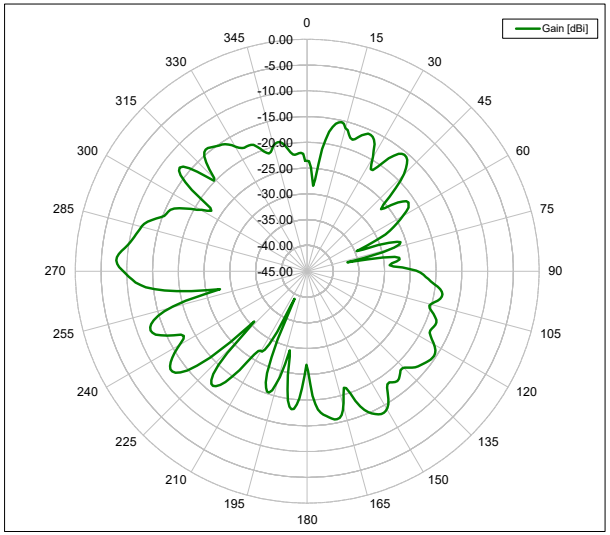
Antenna Gain

Axis:	X-Y	Peak gain:	-7.16 dBi
Polarization:	Horizontal	at angle:	275 °
Frequency:	Low (2402 MHz)	3dB beam width:	12 °



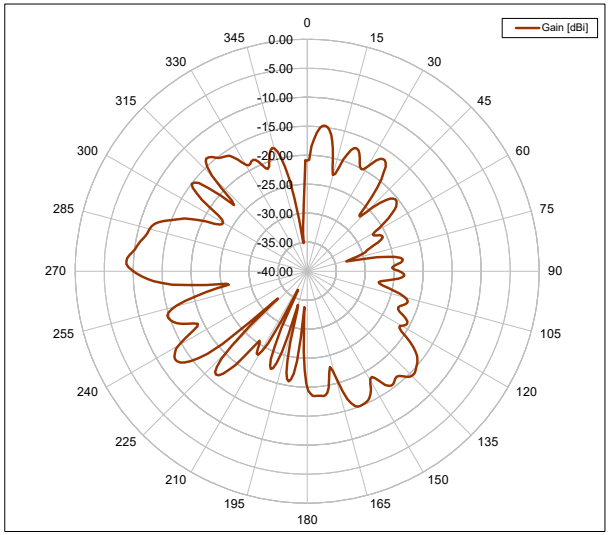
Antenna Gain

Axis:	X-Y	Peak gain:	-7.88 dBi
Polarization:	Horizontal	at angle:	274 °
Frequency:	Middle (2440 MHz)	3dB beam width:	14 °



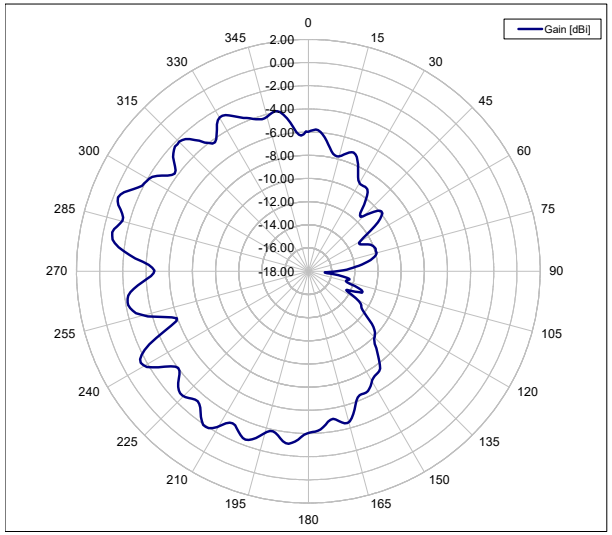
Antenna Gain

Axis:	X-Y	Peak gain:	-8.75 dBi
Polarization:	Horizontal	at angle:	274 °
Frequency:	High (2480 MHz)	3dB beam width:	16 °



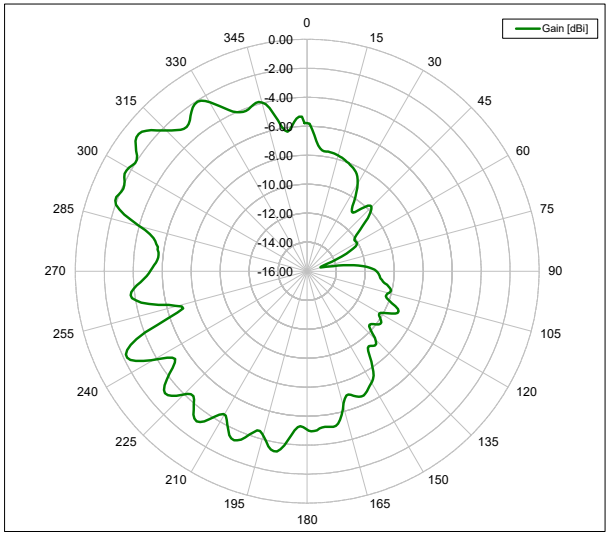
Antenna Gain

Axis:	X-Y	Peak gain:	-0.39 dBi
Polarization:	Vertical	at angle:	292 °
Frequency:	Low (2402 MHz)	3dB beam width:	113 °



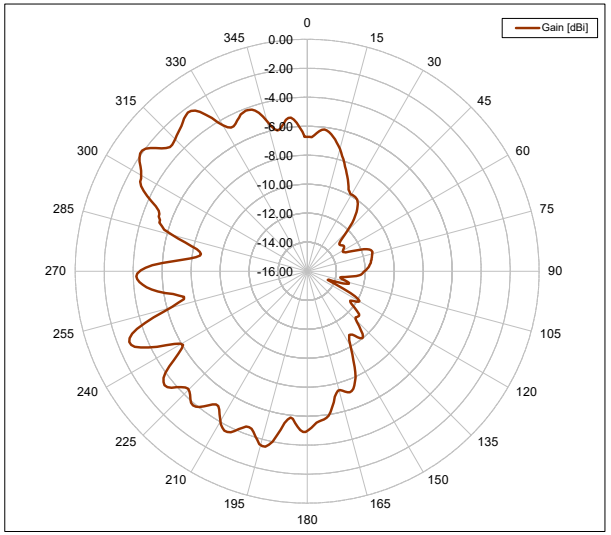
Antenna Gain

Axis:	X-Y	Peak gain:	-1.00 dBi
Polarization:	Vertical	at angle:	310 °
Frequency:	Middle (2440 MHz)	3dB beam width:	99 °



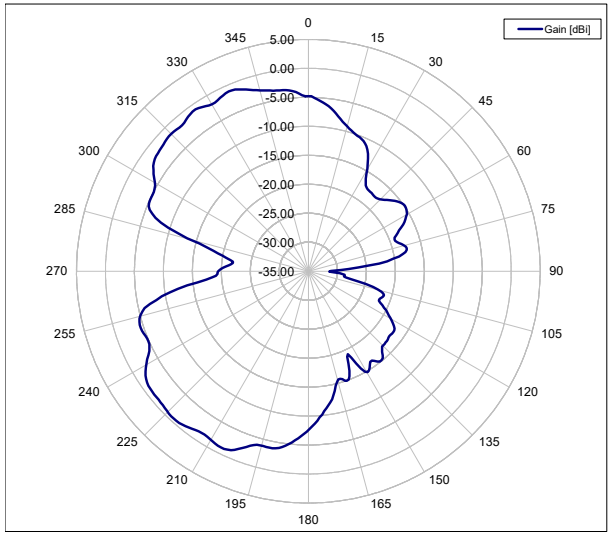
Antenna Gain

Axis:	X-Y	Peak gain:	-1.90 dBi
Polarization:	Vertical	at angle:	307 °
Frequency:	High (2480 MHz)	3dB beam width:	115 °



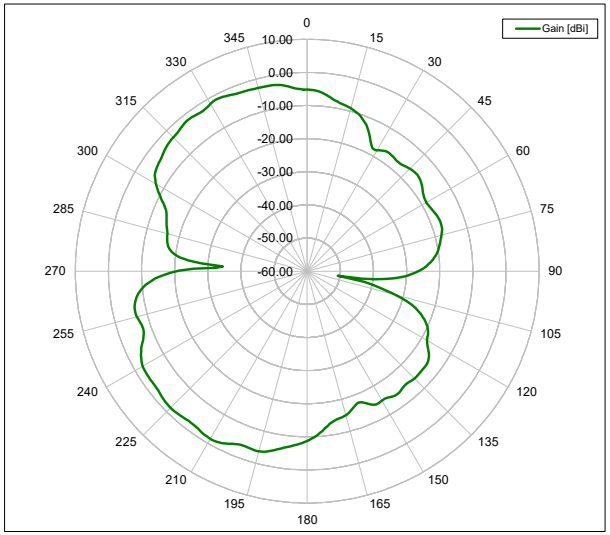
Antenna Gain

Axis:	Y-Z	Peak gain:	-0.55 dBi
Polarization:	Horizontal	at angle:	223 °
Frequency:	Low (2402 MHz)	3dB beam width:	97 °



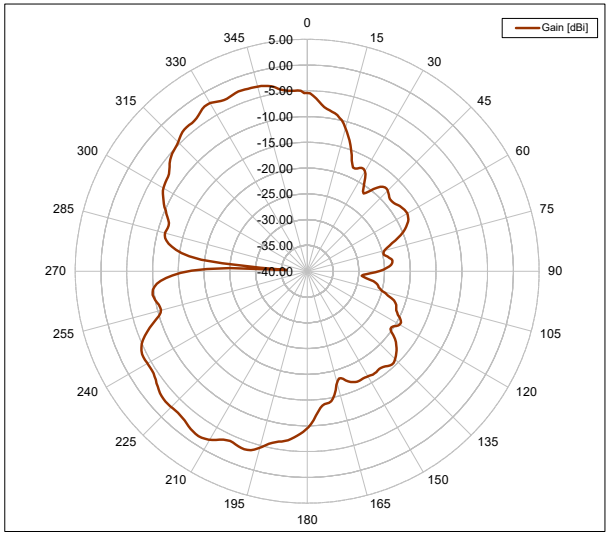
Antenna Gain

Axis:	Y-Z	Peak gain:	-1.34 dBi
Polarization:	Horizontal	at angle:	333 °
Frequency:	Middle (2440 MHz)	3dB beam width:	100 °



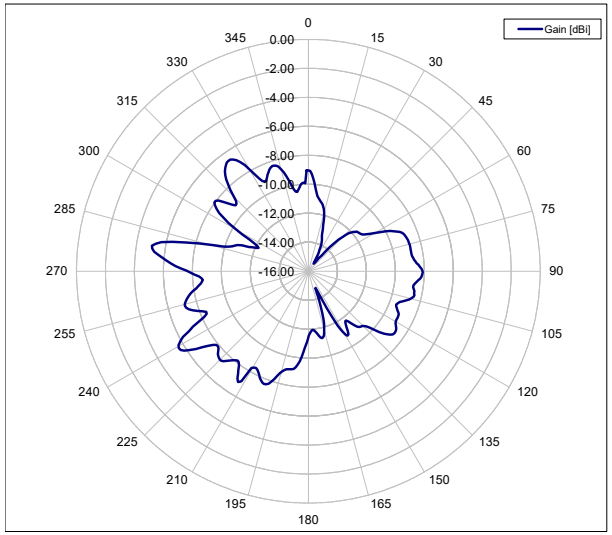
Antenna Gain

Axis:	Y-Z	Peak gain:	-1.69 dBi
Polarization:	Horizontal	at angle:	214 °
Frequency:	High (2480 MHz)	3dB beam width:	90 °



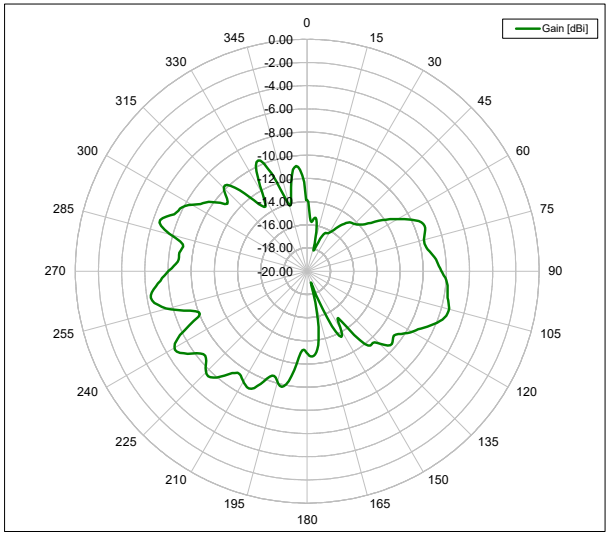
Antenna Gain

Axis:	Y-Z	Peak gain:	-5.07 dBi
Polarization:	Vertical	at angle:	280 °
Frequency:	Low (2402 MHz)	3dB beam width:	82 °



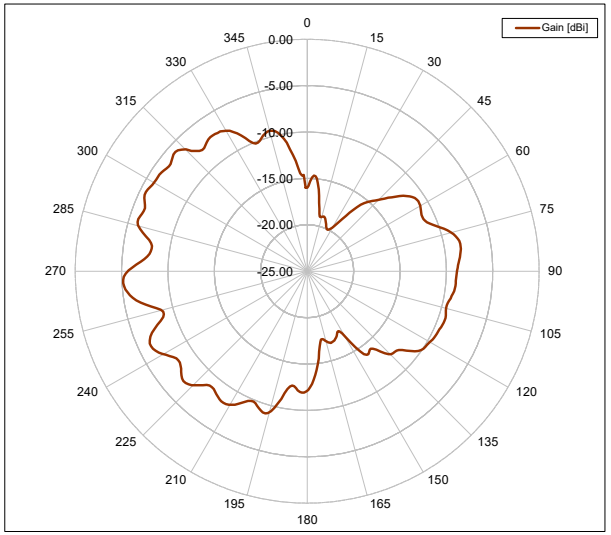
Antenna Gain

Axis:	Y-Z	Peak gain:	-6.32 dBi
Polarization:	Vertical	at angle:	261 °
Frequency:	Middle (2440 MHz)	3dB beam width:	137 °



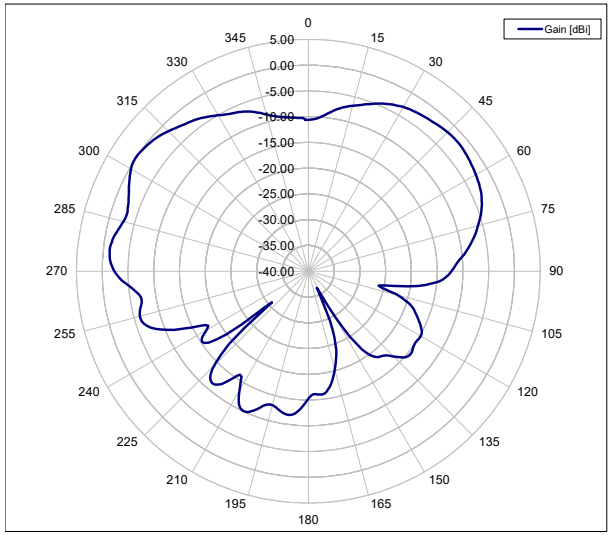
Antenna Gain

Axis:	Y-Z	Peak gain:	-5.12 dBi
Polarization:	Vertical	at angle:	267 °
Frequency:	High (2480 MHz)	3dB beam width:	103 °



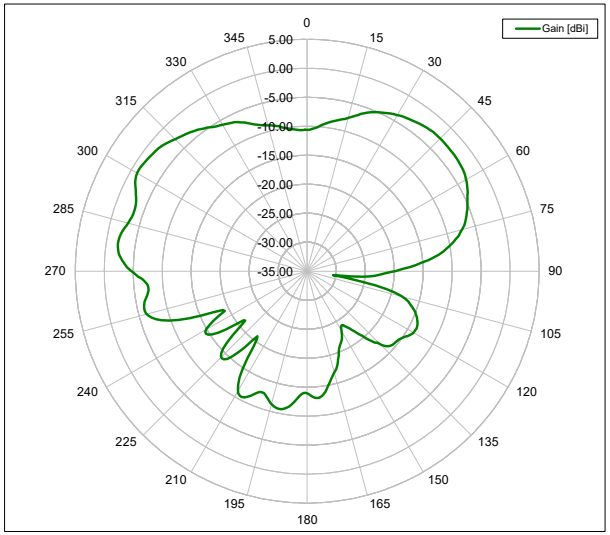
Antenna Gain

Axis:	Z-X	Peak gain:	0.12 dBi
Polarization:	Horizontal	at angle:	304 °
Frequency:	Low (2402 MHz)	3dB beam width:	80 °



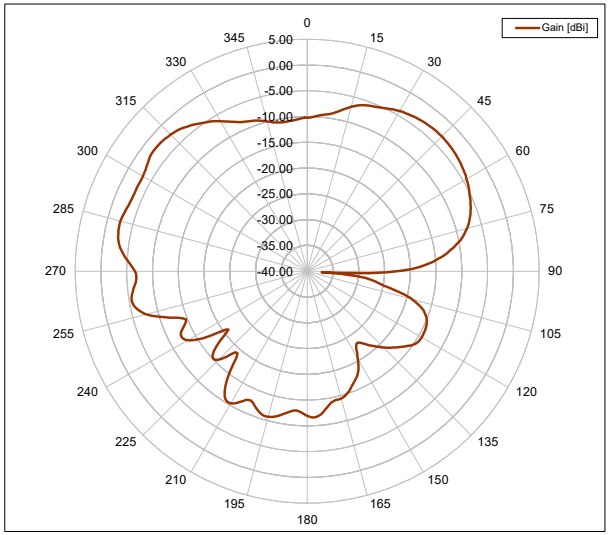
Antenna Gain

Axis:	Z-X	Peak gain:	-1.07 dBi
Polarization:	Horizontal	at angle:	302 °
Frequency:	Middle (2440 MHz)	3dB beam width:	86 °



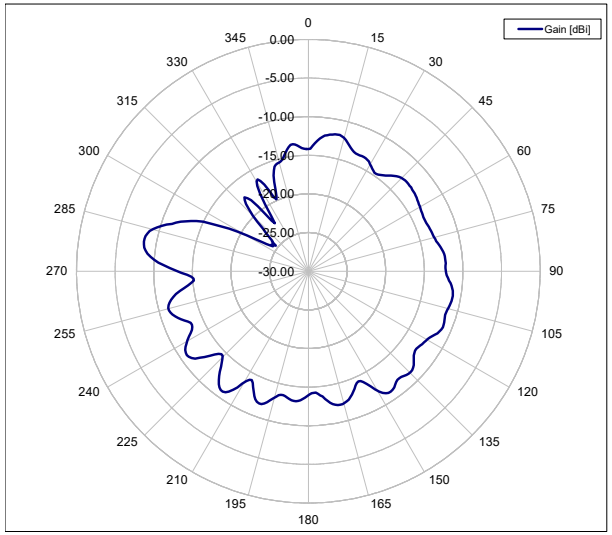
Antenna Gain

Axis:	Z-X	Peak gain:	-2.11 dBi
Polarization:	Horizontal	at angle:	310 °
Frequency:	High (2480 MHz)	3dB beam width:	92 °



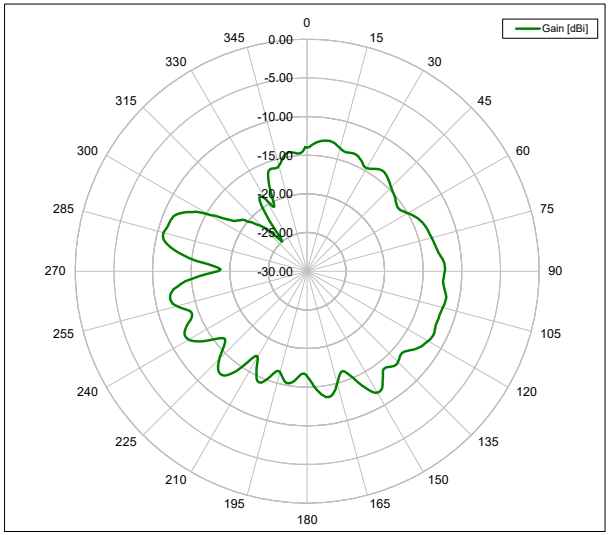
Antenna Gain

Axis:	Z-X	Peak gain:	-8.37 dBi
Polarization:	Vertical	at angle:	281 °
Frequency:	Low (2402 MHz)	3dB beam width:	55 °



Antenna Gain

Axis:	Z-X	Peak gain:	-10.74 dBi
Polarization:	Vertical	at angle:	285 °
Frequency:	Middle (2440 MHz)	3dB beam width:	162 °



Antenna Gain

Axis:	Z-X	Peak gain:	-11.33 dBi
Polarization:	Vertical	at angle:	265 °
Frequency:	High (2480 MHz)	3dB beam width:	110 °