DEKRA Testing and Certification, S.A.U.
Parque Tecnológico de Andalucía,
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C.I.F. A29 507 456

Test report No:

NIE: 63665RAN.001A1

Test report
Antenna Gain and Radiation Pattern Tests

(*) Identification of item tested	Android Smartphone
(*) Trademark	NAL Research
(*) Model and /or type reference tested	SHOUT sp™
Other identification of the product	HW version: V1 SW version: N/A
(*) Features	Iridium transceiver (1616.0 – 1626.5 MHz), 2.4 GHz Wi-Fi / Bluetooth, L1 (1575.42 MHz) GPS.
Manufacturer	Company: NAL RESEARCH CORPORATION Postal address: 11100 Endeavor Court, Suite 300 (3rd Floor), Manassas, VA 20109
Test methodology according to	[1] CTIA Test Plan for Wireless Device Over-the-Air Performance: Method of Measurement for Radiated RF Power and Receiver Performance, Version 3.8.2, April 2019.
Approved by (name / position & signature)	Miguel Lacave Antennas Lab Manager 2021.12.16 12:09:01 +01'00'
Date of issue	2021-12-15
Report template No	FAN41_01 (*) "Data provided by the client"

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Competences and guarantees

DEKRA Testing and Certification, S.A.U. is a testing laboratory competent to carry out the tests described in this report.

In order to assure the traceability to other national and international laboratories, DEKRA Testing and Certification, S.A.U. has a calibration and maintenance program for its measurement equipment.

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The results presented in this Test Report apply only to the particular item under test established in this document.

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Uncertainty

Uncertainty (factor k=2) was calculated according to the following documents:

1. CTIA Test Plan for Wireless Device Over-the-Air Performance: Method of Measurement for Radiated RF Power and Receiver Performance, Version 3.8.2, April 2019.
2. FAN06 - OTA SISO CTIA - AMS-8700 Uncertainty report

Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item tested", "Trademark", "Model and/or type reference tested").

DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

Usage of samples

Samples undergoing test have been selected by the client.

Sample M/01 is composed of the following elements:

Control Nº	Description	Model	S/N	Date of reception
63665/003	Android Smartphone	SHOUT sp™	IRID0425G03	2020-01-30
63665/001	Iridium antenna	HARRIS-NEXGEN 8960263-1	18930	2020-01-30
63665/002	Iridium antenna	Maxtenna M1621HCT-GN	Data not provided	2020-01-30

1. Sample M/01 has undergone the test(s) specified in subclause “Test method requested”.

Note 1: For the sake of simplicity Iridium antenna with control number 63665/001 is hereinafter referred to as “Iridium 1” and Iridium antenna with control number 63665/002 is hereinafter referred to as “Iridium 2”.

Note 2: Control No. 63665/003 contains two embedded antennas, one for GNSS and one for WLAN. For GNSS, Maxtena P/N MIA-GPA-15 is used and for WLAN, Molex P/N 146175-0001 is used.

Identification of the client

Company: NAL RESEARCH CORPORATION

Postal address: 11100 Endeavor Court, Suite 300 (3rd Floor), Manassas, VA 20109

Contact person: Andy Schiltz

Phone/E-mail: +1-571-833-2128/aschiltz@nalresearch.com

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2020-02-05
Date (finish)	2020-02-12

Document history

Report number	Date	Description
63665RAN.001	2020-03-06	First release
63665RAN.001A1	2021-12-15	“Usage of samples” section updated to include the part numbers of the WLAN and GPS antennas

Remarks and comments

The instrumentation utilized to perform the tests covered in this test report is listed in the following table.

	Equipment	Serial Number
1.	Anechoic chamber ETS LINDGREN AMS-8700	N.A.
2.	Positioning system controller and RF switch ETS LINDGREN EMCENTER 7000-001	00151214
3.	OTA measurement software ETS LINDGREN EMQuest v1.13	1460
4.	Vector Network Analyzer Keysight Technologies E5071C	MY46104904
5.	Temperature and Humidity probe, model HWg-STE	600380

Tests have been performed by Manuel Garcia.

Appendix A: Test results

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1. TEST CONDITIONS

1.1 Test frequencies

Antenna gain and 3D radiation pattern measurements were performed at different frequencies depending on the antenna under test:

- Iridium antennas: 1616 MHz, 1621 MHz and 1626.5 MHz
- WLAN antenna: 2400 MHz, 2440 MHz and 2485 MHz
- GPS antenna: 1550 MHz, 1575 MHz and 1605 MHz

Test frequencies were selected by the customer.

1.2 Antenna orientation and setup requirements

For the 3D radiation pattern measurements the EUT is rotated along two different spherical axes: theta (θ) and phi (Φ). The relationship between the 3D Cartesian coordinate system (X, Y, Z) and the theta and phi axes is illustrated in the following figure. This coordinate system should be used as reference in all 3D radiation pattern graphs in section 4 as well as test setup photographs in Appendix B.

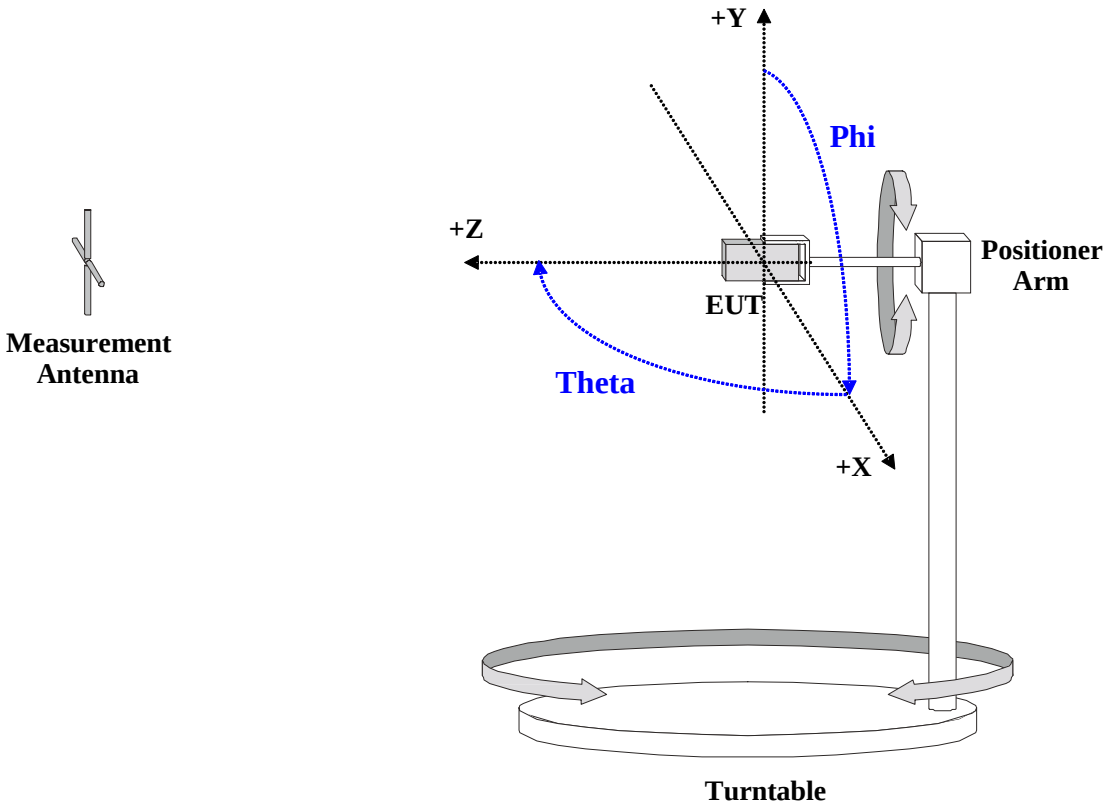


Fig. 1. Coordinate system.

Theta is the spherical axis that rotates along the Cartesian Y axis while Phi is the spherical axis that rotates along the Cartesian Z axis. The initial measurement position (Theta = 0º and Phi = 0º) is illustrated in each of the test setup photographs in Appendix B. The EUT has only one mechanical configuration each and they were tested in the “Free-space” configuration, whereby EUT has been placed directly on a support placed 2 meters away from the measurement antenna.

2. TEST RESULTS

2.1 Antenna gain

The test setup used to derive test results in this clause is illustrated below.

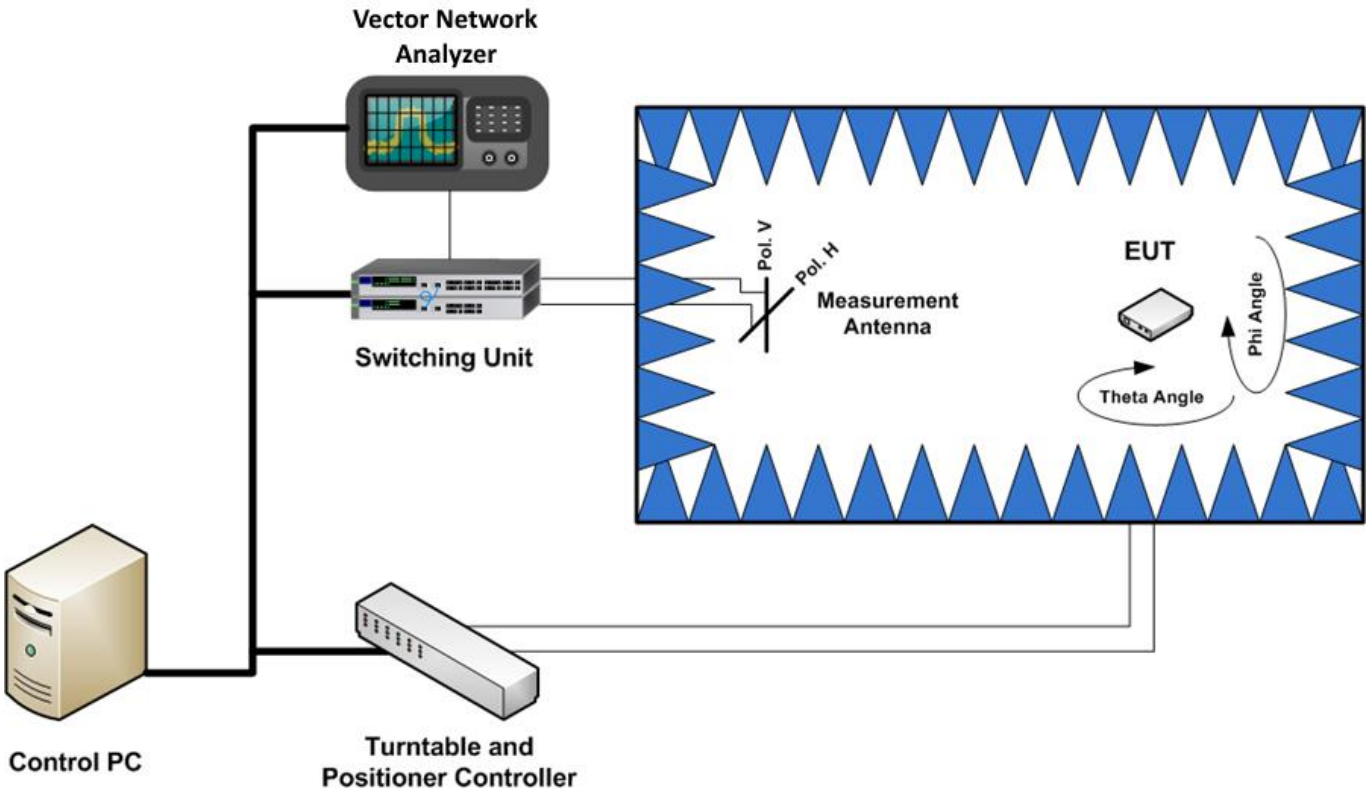


Fig. 2. Equipment and connections for peak antenna gain measurements.

The EUT was placed inside a fully anechoic test system and hold on a multi-axis positioning system (see Figure 9). The EUT was never switched on, all signal excitations were generated by a Vector Network Analyzer (VNA) set to operate on the different test frequencies.

Iridium and WLAN antenna input ports were directly fed with the excitation signals created by the VNA Port 1. Power radiated by the antennas was captured by the measurement antenna (see figure above) and then read by the VNA Port 2. Antenna gain was determined as an S21 parameter in the VNA after applying path corrections (both conducted and radiated path losses).

The GPS antenna gain was not determined with the methodology used for the Iridium and WLAN antennas because the GPS antenna included a Low Noise Amplifier (LNA) at the output of the antenna itself and therefore the excitation signal could not be injected to the GPS antenna input port because it would be exciting the output of the LNA. Instead, the excitation signal was radiated by the measurement antenna and then captured by the GPS antenna. The received power was read by the VNA. The LNA was power supplied using a Bias Tee that allowed using the same RF coaxial cable for this purpose. Antenna gain was determined as an S21 parameter in the VNA after applying path corrections (both conducted and radiated path losses).

Antenna gain measurements were performed at intervals of 15 degrees along the theta and phi axes and at both horizontal and vertical polarizations.

Peak antenna gain calculations are presented below.

Antenna	Frequency (MHz)	Peak Gain (dBi)	Theta Angle (º)	Phi Angle (º)
GPS	1550	26.06	30	300
	1575	25.32	30	300
	1605	21.46	30	0
Iridium 1	1616	0.99	0	0
	1621	1.85	0	0
	1626.5	2.74	0	0
Iridium 2	1616	1.70	0	0
	1621	1.71	0	0
	1626.5	1.40	0	0
WLAN	2400	-6.14	150	0
	2440	-9.20	150	0
	2485	-11.83	150	345

Note: “Iridium 1” and “Iridium 2” are short names used to refer to the two different Iridium antennas used for tests. Details are provided in section “Usage of samples”.

2.2 Antenna Patterns

The antenna gain patterns are illustrated in the following figures. Total gain values are also provided in tabular format.

2.2.1 GPS antenna

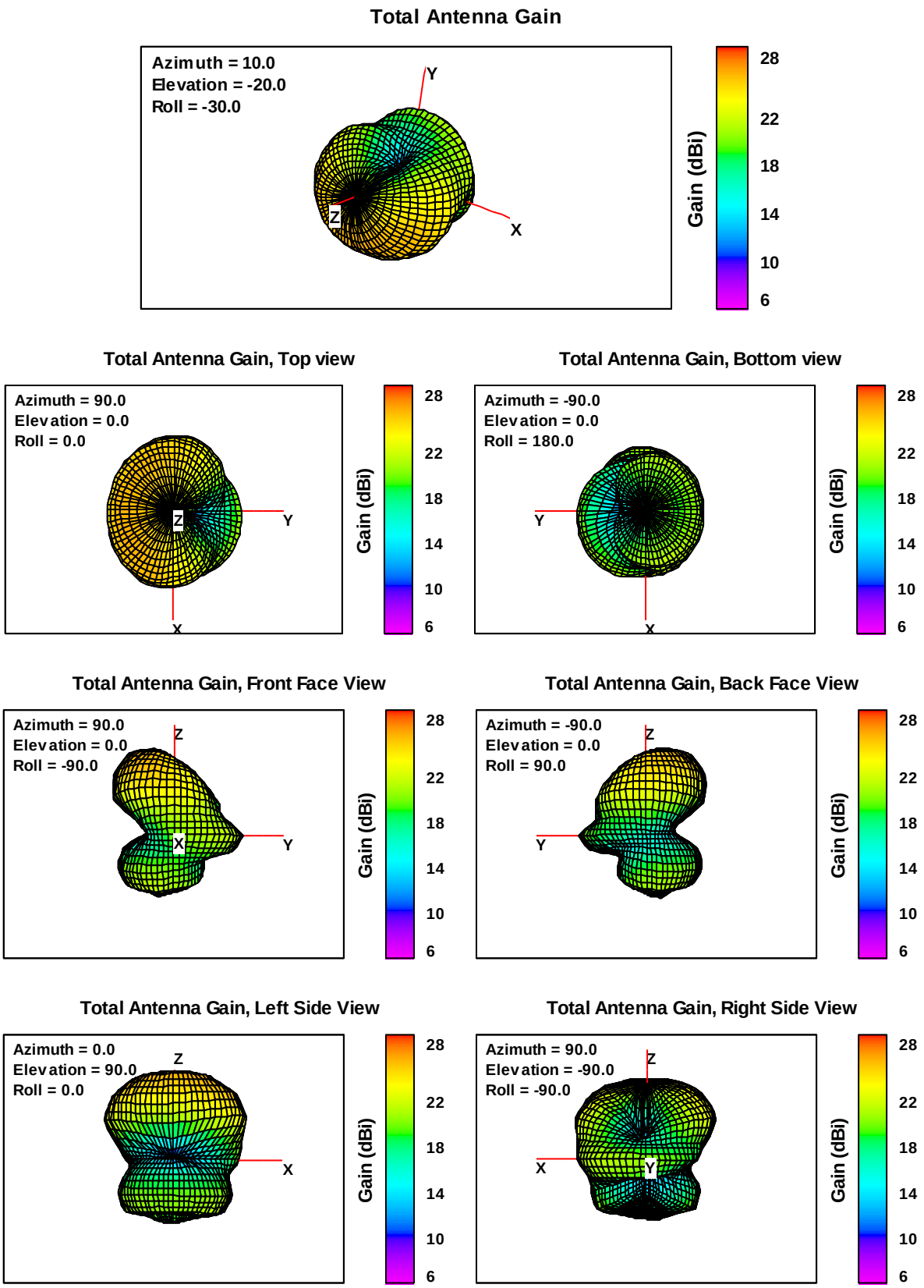


Fig. 3. Total antenna gain, GPS antenna, 1550 MHz.

Theta Angle (°)	0	15	30	45	60	75	90	105	120	135	150	165	180
Phi Angle (°)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)
0	22,62	22,75	23,94	24,43	24,20	21,55	20,24	18,69	20,02	21,24	19,72	17,51	16,77
15	22,62	22,02	22,50	23,57	23,33	21,49	21,27	19,26	18,92	20,78	19,12	16,97	16,77
30	22,62	21,09	20,44	21,80	21,78	20,93	21,79	19,77	17,45	19,69	18,22	15,99	16,77
45	22,62	20,21	17,64	19,05	19,47	19,93	21,90	20,01	15,83	18,13	17,06	14,78	16,77
60	22,62	19,56	14,00	14,94	16,61	18,71	21,71	19,95	14,21	16,20	15,82	13,52	16,77
75	22,62	19,41	11,76	9,90	14,38	17,66	21,35	19,63	12,77	14,30	14,89	12,72	16,77
90	22,62	19,82	14,16	11,87	15,29	17,17	20,88	19,08	11,34	13,28	14,70	12,79	16,77
105	22,62	20,51	17,35	16,55	17,87	17,51	20,38	18,16	10,62	14,03	15,38	13,74	16,77
120	22,62	21,29	19,87	19,72	20,11	18,24	19,81	16,97	12,01	15,89	16,53	15,08	16,77
135	22,62	22,05	21,80	21,89	21,84	18,93	19,11	15,70	14,52	17,85	17,67	16,39	16,77
150	22,62	22,79	23,25	23,36	22,94	19,34	18,19	14,91	16,91	19,43	18,59	17,54	16,77
165	22,62	23,47	24,29	24,34	23,48	19,38	17,08	14,94	18,65	20,56	19,24	18,44	16,77
180	22,62	24,08	25,02	24,88	23,53	18,92	15,94	15,78	19,77	21,23	19,57	19,09	16,77
195	22,62	24,63	25,45	25,03	23,13	17,92	15,03	16,80	20,35	21,50	19,62	19,53	16,77
210	22,62	24,91	25,68	24,91	22,44	16,37	14,49	17,54	20,50	21,44	19,56	19,77	16,77
225	22,62	25,06	25,77	24,67	21,59	14,40	14,06	17,83	20,40	21,20	19,34	19,92	16,77
240	22,62	25,17	25,79	24,37	20,74	11,93	13,50	17,88	20,20	20,94	19,07	20,07	16,77
255	22,62	25,24	25,84	24,19	20,29	9,06	12,60	17,72	20,06	20,67	18,96	20,02	16,77
270	22,62	25,30	25,92	24,25	20,53	7,98	11,30	17,50	20,08	20,62	19,01	19,99	16,77
285	22,62	25,26	26,01	24,54	21,31	10,40	10,21	17,31	20,29	20,79	19,23	19,88	16,77
300	22,62	25,15	26,06	24,96	22,36	13,91	10,79	17,24	20,64	21,13	19,56	19,74	16,77
315	22,62	24,84	25,97	25,36	23,36	16,84	13,26	17,32	20,95	21,52	19,85	19,52	16,77
330	22,62	24,40	25,60	25,61	24,11	19,07	16,14	17,51	21,02	21,82	20,03	19,22	16,77
345	22,62	23,75	25,19	25,54	24,36	20,57	17,89	17,93	20,87	21,94	20,04	18,86	16,77
360	22,62	22,75	23,94	24,43	24,20	21,55	20,24	18,69	20,02	21,24	19,72	17,51	16,77

Total antenna gain, GPS antenna, 1550 MHz

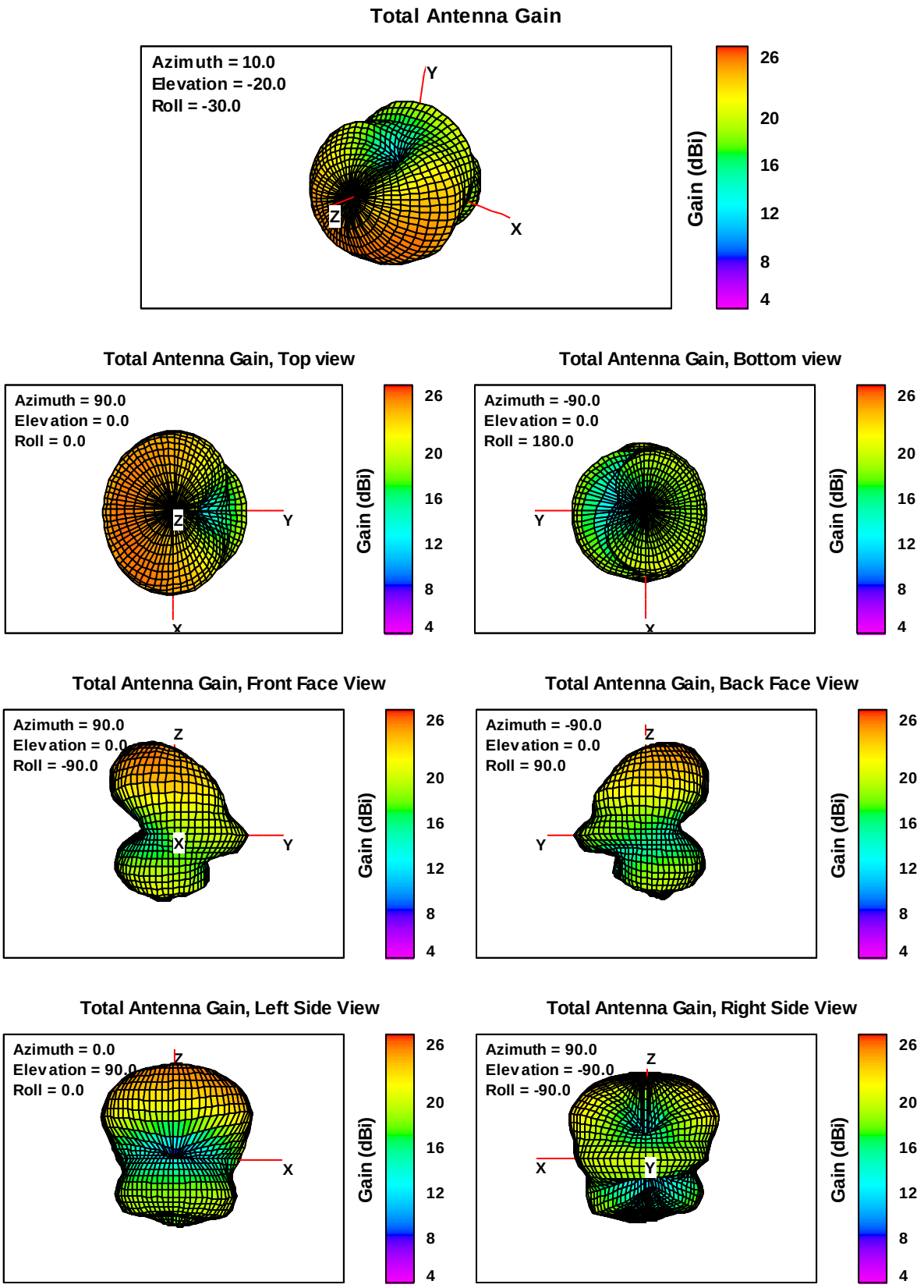


Fig. 4. Total antenna gain, GPS antenna, 1575 MHz.

Theta Angle (°)	0	15	30	45	60	75	90	105	120	135	150	165	180
Phi Angle (°)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)
0	21,98	22,48	23,81	24,24	23,85	20,47	18,33	17,11	19,41	20,63	18,94	17,41	15,04
15	21,98	21,83	22,62	23,56	23,22	20,53	19,48	17,57	18,31	20,34	18,51	17,03	15,04
30	21,98	20,99	20,93	22,08	21,94	20,10	20,18	18,07	16,67	19,48	17,72	16,20	15,04
45	21,98	20,18	18,68	19,80	19,99	19,17	20,47	18,41	14,70	18,12	16,55	15,04	15,04
60	21,98	19,55	15,83	16,46	17,46	17,97	20,49	18,53	12,53	16,34	15,01	13,47	15,04
75	21,98	19,27	13,31	11,73	14,95	16,87	20,37	18,43	10,59	14,31	13,35	11,53	15,04
90	21,98	19,46	13,54	9,06	14,46	16,29	20,16	18,13	8,63	12,51	11,96	9,14	15,04
105	21,98	19,88	15,93	13,52	16,37	16,54	19,93	17,45	7,31	12,04	11,78	7,29	15,04
120	21,98	20,49	18,39	17,38	18,59	17,24	19,62	16,50	9,08	13,47	13,02	8,08	15,04
135	21,98	21,12	20,44	20,00	20,44	17,98	19,15	15,38	12,45	15,59	14,74	10,56	15,04
150	21,98	21,78	21,98	21,79	21,66	18,49	18,42	14,63	15,32	17,43	16,17	12,95	15,04
165	21,98	22,40	23,12	23,00	22,33	18,63	17,43	14,46	17,29	18,74	17,20	14,78	15,04
180	21,98	22,99	23,95	23,72	22,49	18,29	16,25	15,00	18,52	19,51	17,79	16,10	15,04
195	21,98	23,62	24,47	24,00	22,17	17,41	15,09	15,78	19,13	19,82	17,99	17,03	15,04
210	21,98	23,94	24,78	23,95	21,47	15,97	14,23	16,40	19,27	19,76	18,00	17,64	15,04
225	21,98	24,22	24,94	23,74	20,55	14,12	13,70	16,75	19,11	19,50	17,83	18,08	15,04
240	21,98	24,42	25,00	23,41	19,50	11,62	13,28	16,86	18,85	19,15	17,56	18,42	15,04
255	21,98	24,60	25,07	23,18	18,76	8,57	12,87	16,81	18,67	18,83	17,46	18,58	15,04
270	21,98	24,71	25,14	23,22	18,81	5,60	12,34	16,70	18,70	18,78	17,53	18,75	15,04
285	21,98	24,67	25,24	23,54	19,65	6,39	11,82	16,62	18,96	19,03	17,79	18,83	15,04
300	21,98	24,56	25,32	24,07	20,94	10,69	11,67	16,56	19,41	19,54	18,22	18,87	15,04
315	21,98	24,27	25,28	24,62	22,25	14,46	12,47	16,49	19,85	20,15	18,65	18,82	15,04
330	21,98	23,90	25,02	25,02	23,28	17,31	14,36	16,39	20,05	20,68	18,97	18,68	15,04
345	21,98	23,36	24,71	25,11	23,69	19,25	15,87	16,47	20,00	21,04	19,10	18,50	15,04
360	21,98	22,48	23,81	24,24	23,85	20,47	18,33	17,11	19,41	20,63	18,94	17,41	15,04

Total antenna gain, GPS antenna, 1575 MHz

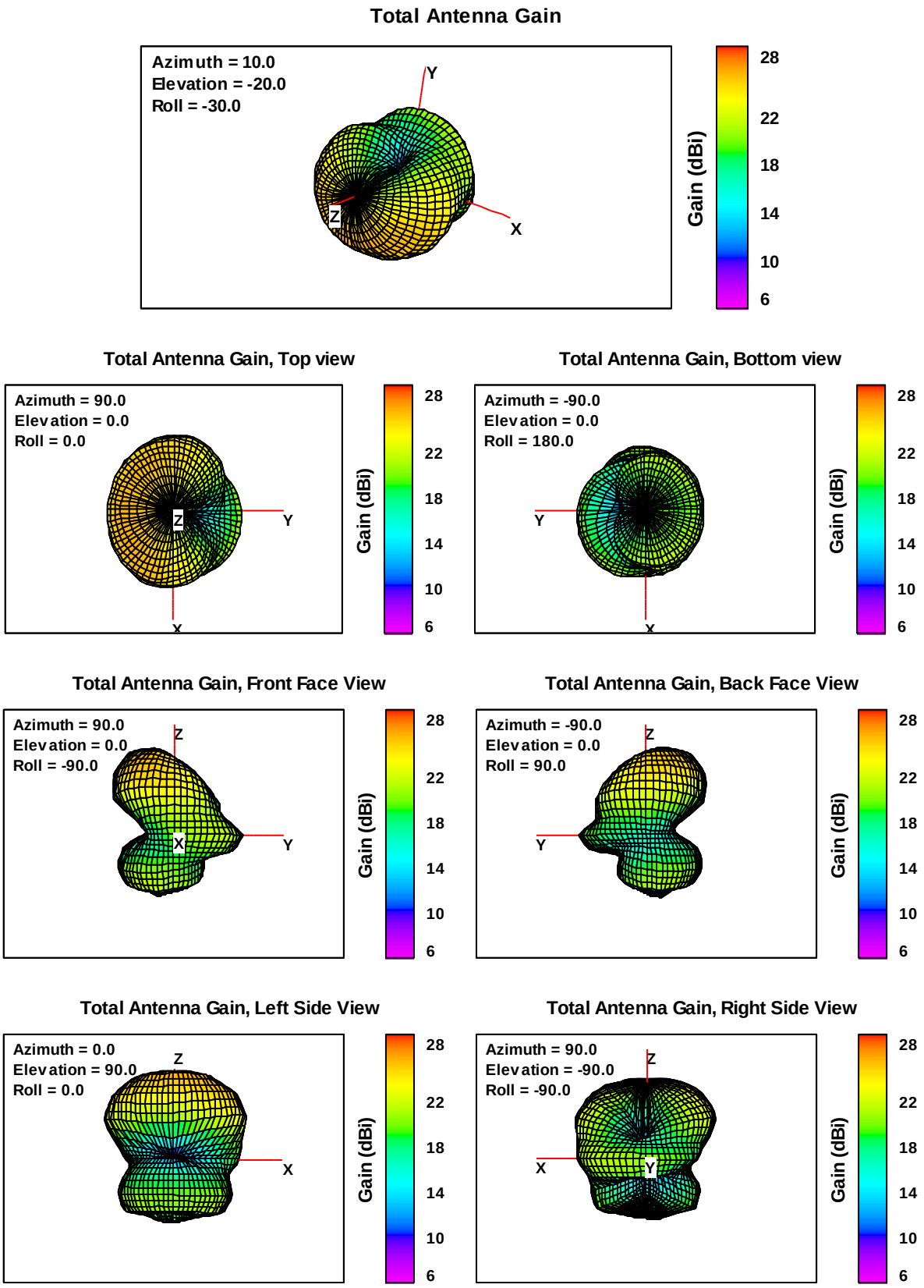


Fig. 5. Total antenna gain, GPS antenna, 1605 MHz.

Theta Angle (°)	0	15	30	45	60	75	90	105	120	135	150	165	180
Phi Angle (°)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)
0	19,82	20,77	21,46	20,63	19,70	17,78	17,04	17,28	18,74	18,87	15,95	19,60	19,79
15	19,82	20,56	21,13	20,40	19,57	17,64	16,30	16,70	18,13	18,85	16,20	19,67	19,79
30	19,82	20,14	20,56	19,73	18,93	16,92	15,09	15,59	17,02	18,53	16,20	19,67	19,79
45	19,82	19,60	19,79	18,62	17,80	15,64	13,43	14,20	15,48	17,96	16,02	19,55	19,79
60	19,82	19,02	18,86	17,13	16,20	13,68	11,49	12,76	13,68	17,22	15,61	19,34	19,79
75	19,82	18,50	17,90	15,37	14,18	11,09	10,09	11,74	11,96	16,45	15,00	19,09	19,79
90	19,82	18,11	16,95	13,47	11,92	8,59	10,70	11,71	10,76	15,69	14,16	18,73	19,79
105	19,82	17,84	16,14	11,78	9,99	8,66	12,89	12,74	10,53	14,99	13,17	18,39	19,79
120	19,82	17,76	15,58	10,80	9,44	11,22	15,17	14,02	11,06	14,33	12,10	18,16	19,79
135	19,82	17,81	15,50	10,91	10,65	13,82	16,99	15,20	12,15	13,79	11,22	17,95	19,79
150	19,82	18,03	15,81	11,98	12,65	15,84	18,30	16,23	13,49	13,57	10,99	17,80	19,79
165	19,82	18,30	16,40	13,42	14,57	17,35	19,07	16,97	14,65	13,74	11,39	17,70	19,79
180	19,82	18,59	17,10	14,86	16,10	18,32	19,29	17,34	15,34	14,12	12,02	17,55	19,79
195	19,82	18,86	17,71	16,02	17,09	18,71	18,92	17,17	15,38	14,41	12,53	17,38	19,79
210	19,82	19,06	18,24	16,81	17,49	18,48	17,87	16,29	14,58	14,43	12,73	17,17	19,79
225	19,82	19,30	18,66	17,23	17,21	17,60	15,95	14,51	12,60	14,11	12,62	16,95	19,79
240	19,82	19,50	18,99	17,30	16,38	15,96	13,05	11,37	8,99	13,63	12,26	16,88	19,79
255	19,82	19,75	19,30	17,19	15,13	13,56	9,39	7,16	2,68	13,36	11,85	17,02	19,79
270	19,82	19,94	19,68	17,18	14,08	11,05	8,59	6,93	4,93	13,61	11,68	17,32	19,79
285	19,82	20,25	20,14	17,52	14,12	10,47	11,60	11,23	10,98	14,49	12,03	17,77	19,79
300	19,82	20,56	20,61	18,24	15,37	12,41	14,28	14,36	14,59	15,70	12,92	18,27	19,79
315	19,82	20,83	21,04	19,12	16,96	14,62	15,98	16,30	16,76	16,91	13,97	18,75	19,79
330	19,82	20,99	21,36	19,97	18,30	16,27	16,90	17,35	18,06	17,88	14,92	19,16	19,79
345	19,82	21,02	21,44	20,55	18,93	17,33	17,19	17,71	18,53	18,57	15,45	19,49	19,79
360	19,82	20,77	21,46	20,63	19,70	17,78	17,04	17,28	18,74	18,87	15,95	19,60	19,79

Total antenna gain, GPS antenna, 1605 MHz

2.2.2 Iridium antenna 1

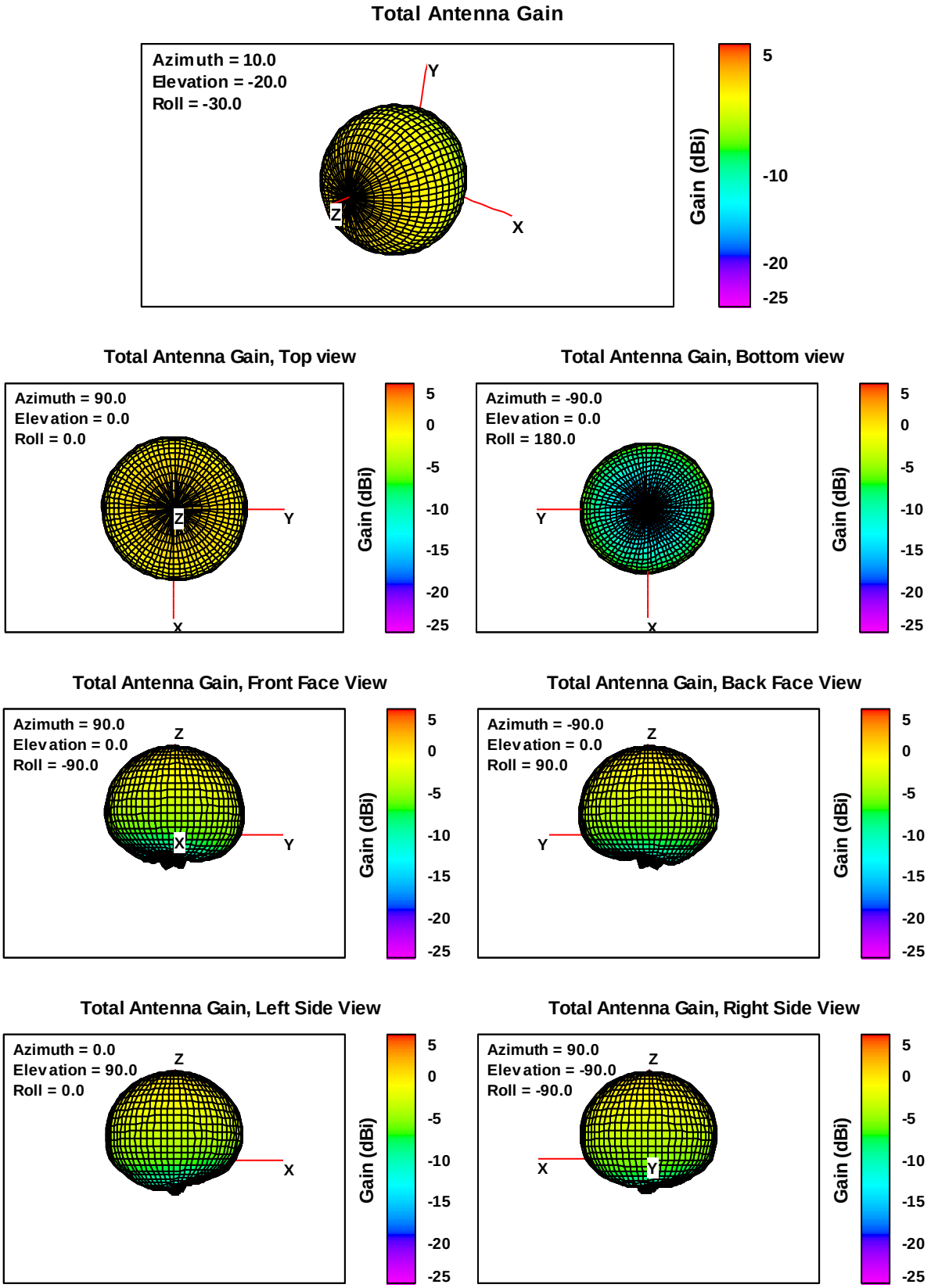


Fig. 6. Total antenna gain, Iridium 1 antenna, 1616 MHz.

Theta Angle (°)	0	15	30	45	60	75	90	105	120	135	150	165	180
Phi Angle (°)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)
0	0,99	0,86	0,26	-0,67	-2,09	-4,11	-6,60	-9,81	-14,03	-15,68	-18,03	-15,57	-15,80
15	0,99	0,84	0,28	-0,66	-2,01	-3,97	-6,19	-9,33	-12,99	-15,06	-17,27	-15,31	-15,80
30	0,99	0,81	0,32	-0,67	-1,94	-3,80	-5,78	-8,59	-12,28	-14,39	-16,85	-14,90	-15,80
45	0,99	0,80	0,37	-0,58	-1,85	-3,65	-5,40	-8,00	-11,37	-14,03	-16,88	-14,81	-15,80
60	0,99	0,80	0,38	-0,58	-1,88	-3,55	-5,25	-7,65	-10,97	-13,84	-17,19	-14,61	-15,80
75	0,99	0,79	0,39	-0,60	-1,93	-3,52	-5,24	-7,56	-10,89	-14,12	-18,01	-14,55	-15,80
90	0,99	0,81	0,40	-0,65	-2,05	-3,59	-5,32	-7,71	-11,23	-14,78	-19,13	-14,63	-15,80
105	0,99	0,83	0,36	-0,71	-2,20	-3,72	-5,52	-7,98	-11,89	-15,63	-20,24	-14,95	-15,80
120	0,99	0,83	0,34	-0,79	-2,30	-3,79	-5,80	-8,49	-12,79	-16,70	-20,92	-15,28	-15,80
135	0,99	0,84	0,33	-0,83	-2,34	-3,94	-6,04	-9,08	-13,60	-17,69	-20,68	-15,87	-15,80
150	0,99	0,86	0,29	-0,83	-2,26	-3,98	-6,26	-9,45	-13,93	-17,45	-20,03	-16,31	-15,80
165	0,99	0,85	0,32	-0,75	-2,21	-4,03	-6,21	-9,65	-13,50	-16,70	-18,86	-16,89	-15,80
180	0,99	0,87	0,37	-0,64	-2,07	-4,00	-6,05	-9,48	-12,67	-15,38	-17,81	-16,96	-15,80
195	0,99	0,87	0,39	-0,57	-1,99	-3,94	-5,79	-9,17	-11,78	-14,18	-16,82	-16,86	-15,80
210	0,99	0,90	0,43	-0,51	-1,99	-3,81	-5,55	-8,89	-11,21	-13,38	-16,25	-16,38	-15,80
225	0,99	0,92	0,46	-0,48	-1,97	-3,69	-5,38	-8,68	-10,86	-12,84	-15,62	-15,58	-15,80
240	0,99	0,93	0,45	-0,50	-2,00	-3,61	-5,40	-8,74	-10,87	-12,71	-15,38	-14,93	-15,80
255	0,99	0,93	0,43	-0,56	-2,03	-3,61	-5,50	-8,81	-11,15	-13,03	-15,51	-14,48	-15,80
270	0,99	0,94	0,38	-0,60	-2,07	-3,66	-5,73	-9,17	-11,62	-13,66	-16,03	-14,38	-15,80
285	0,99	0,93	0,33	-0,66	-2,18	-3,81	-6,17	-9,67	-12,54	-14,57	-16,85	-14,21	-15,80
300	0,99	0,95	0,25	-0,74	-2,22	-3,99	-6,60	-10,29	-13,35	-15,79	-18,07	-14,62	-15,80
315	0,99	0,91	0,19	-0,75	-2,28	-4,19	-6,92	-10,80	-14,16	-16,63	-19,06	-15,13	-15,80
330	0,99	0,94	0,19	-0,79	-2,26	-4,29	-7,08	-11,08	-14,68	-16,98	-19,38	-15,75	-15,80
345	0,99	0,91	0,21	-0,77	-2,22	-4,27	-7,01	-10,93	-14,51	-16,51	-19,06	-16,05	-15,80
360	0,99	0,86	0,26	-0,67	-2,09	-4,11	-6,60	-9,81	-14,03	-15,68	-18,03	-15,57	-15,80

Total antenna gain, Iridium 1 antenna, 1616 MHz

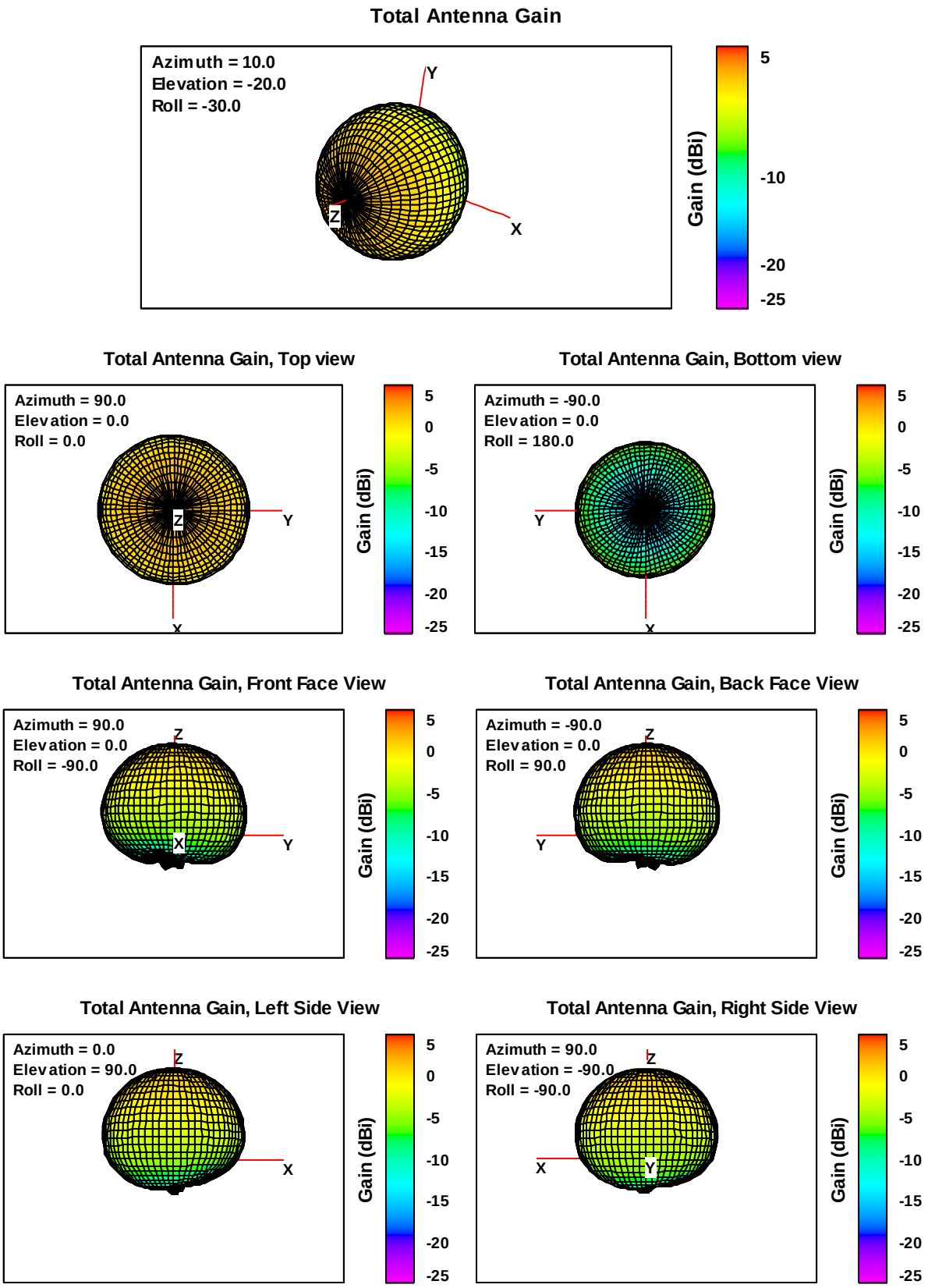


Fig. 7. Total antenna gain, Iridium 1 antenna, 1621 MHz.

Theta Angle (°)	0	15	30	45	60	75	90	105	120	135	150	165	180
Phi Angle (°)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)
0	1,85	1,74	1,17	0,16	-1,24	-3,22	-5,69	-9,09	-13,40	-15,26	-18,32	-15,46	-15,79
15	1,85	1,72	1,19	0,19	-1,17	-3,07	-5,30	-8,55	-12,20	-14,67	-17,56	-15,25	-15,79
30	1,85	1,71	1,22	0,26	-1,07	-2,90	-4,91	-7,74	-11,07	-13,91	-17,16	-14,92	-15,79
45	1,85	1,67	1,27	0,31	-0,97	-2,70	-4,54	-7,04	-10,12	-13,29	-17,06	-14,70	-15,79
60	1,85	1,66	1,28	0,34	-0,95	-2,59	-4,40	-6,62	-9,60	-12,99	-17,64	-14,75	-15,79
75	1,85	1,63	1,27	0,31	-0,99	-2,59	-4,31	-6,50	-9,43	-13,00	-18,36	-14,73	-15,79
90	1,85	1,65	1,25	0,27	-1,11	-2,68	-4,39	-6,54	-9,62	-13,45	-19,52	-14,95	-15,79
105	1,85	1,66	1,26	0,22	-1,24	-2,80	-4,62	-6,80	-10,25	-14,31	-20,75	-15,49	-15,79
120	1,85	1,69	1,24	0,15	-1,39	-2,95	-4,93	-7,27	-11,20	-15,65	-22,27	-16,02	-15,79
135	1,85	1,72	1,25	0,09	-1,48	-3,04	-5,24	-7,84	-12,26	-16,92	-21,77	-16,63	-15,79
150	1,85	1,74	1,23	0,08	-1,46	-3,18	-5,43	-8,26	-12,82	-17,41	-20,61	-17,58	-15,79
165	1,85	1,77	1,23	0,12	-1,39	-3,19	-5,46	-8,53	-12,73	-16,77	-19,18	-18,10	-15,79
180	1,85	1,78	1,29	0,20	-1,25	-3,15	-5,33	-8,52	-11,86	-15,66	-17,89	-18,06	-15,79
195	1,85	1,81	1,31	0,30	-1,17	-3,10	-5,03	-8,19	-10,99	-14,37	-16,97	-17,46	-15,79
210	1,85	1,80	1,34	0,36	-1,12	-2,98	-4,76	-7,84	-10,36	-13,40	-16,30	-16,88	-15,79
225	1,85	1,83	1,38	0,40	-1,08	-2,78	-4,53	-7,51	-9,96	-12,89	-15,88	-15,88	-15,79
240	1,85	1,83	1,38	0,40	-1,09	-2,69	-4,36	-7,46	-9,83	-12,60	-15,63	-15,12	-15,79
255	1,85	1,83	1,36	0,37	-1,14	-2,62	-4,44	-7,49	-10,00	-12,78	-15,69	-14,41	-15,79
270	1,85	1,84	1,31	0,30	-1,19	-2,66	-4,66	-7,81	-10,53	-13,25	-16,31	-14,21	-15,79
285	1,85	1,83	1,25	0,22	-1,26	-2,75	-5,00	-8,31	-11,25	-14,01	-17,52	-14,23	-15,79
300	1,85	1,80	1,18	0,17	-1,32	-2,97	-5,45	-8,95	-12,21	-15,06	-18,74	-14,79	-15,79
315	1,85	1,79	1,13	0,10	-1,37	-3,17	-5,85	-9,67	-13,26	-15,72	-20,28	-15,28	-15,79
330	1,85	1,78	1,10	0,10	-1,42	-3,32	-6,02	-10,13	-13,90	-16,13	-20,49	-16,01	-15,79
345	1,85	1,79	1,15	0,10	-1,38	-3,32	-6,06	-10,06	-13,96	-15,96	-19,68	-16,19	-15,79
360	1,85	1,74	1,17	0,16	-1,24	-3,22	-5,69	-9,09	-13,40	-15,26	-18,32	-15,46	-15,79

Total antenna gain, Iridium 1 antenna, 1621 MHz

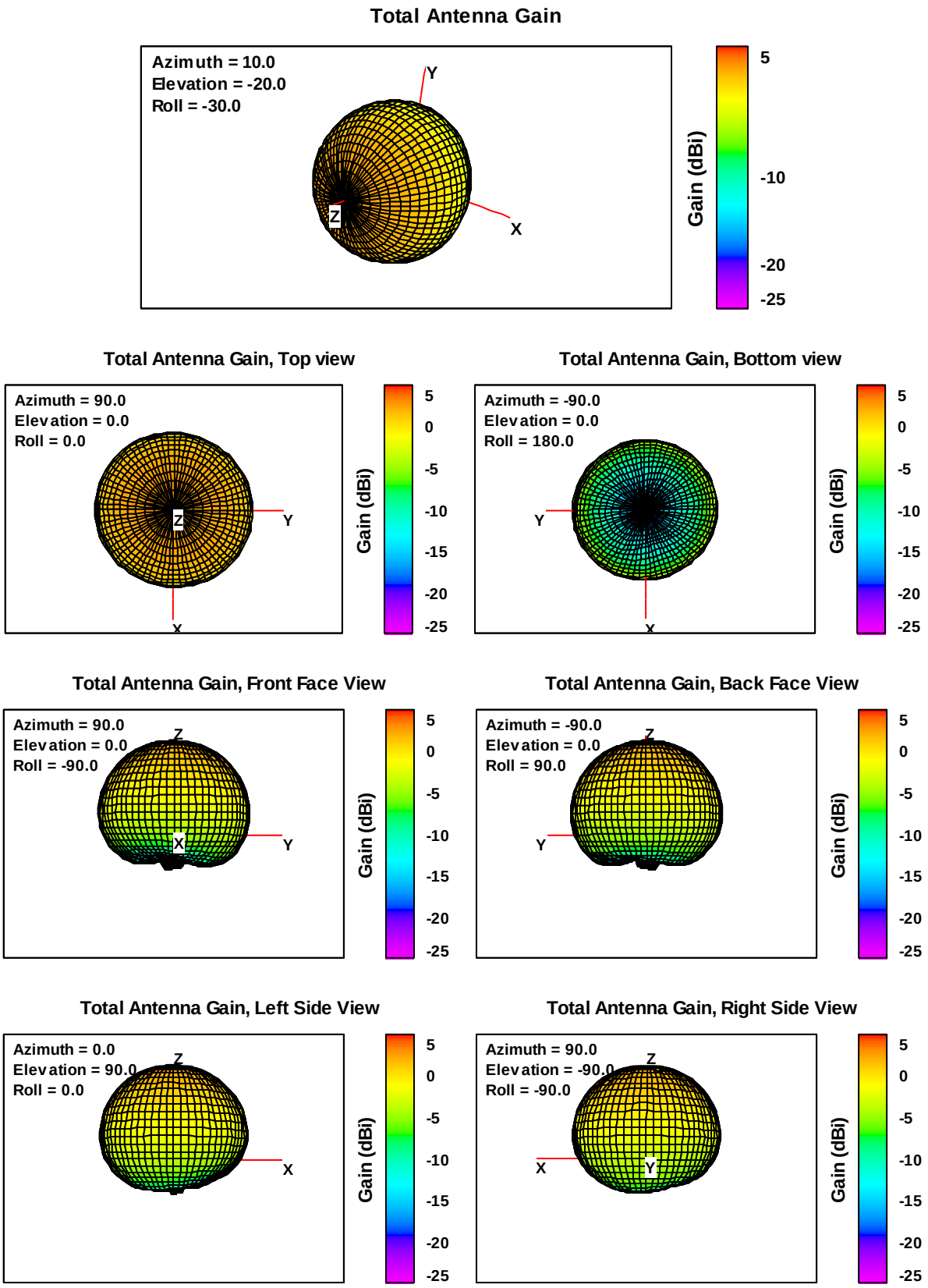


Fig. 8. Total antenna gain, Iridium 1 antenna, 1626.5 MHz.

Theta Angle (°)	0	15	30	45	60	75	90	105	120	135	150	165	180
Phi Angle (°)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)
0	2,74	2,65	2,15	1,10	-0,42	-2,36	-4,84	-8,38	-12,72	-14,73	-18,51	-15,05	-14,83
15	2,74	2,64	2,15	1,10	-0,35	-2,29	-4,49	-7,81	-11,49	-14,15	-17,93	-14,85	-14,83
30	2,74	2,59	2,18	1,18	-0,22	-2,07	-4,11	-7,03	-10,09	-13,33	-17,36	-14,57	-14,83
45	2,74	2,57	2,21	1,24	-0,06	-1,81	-3,71	-6,22	-8,88	-12,38	-17,25	-14,75	-14,83
60	2,74	2,54	2,18	1,28	-0,03	-1,69	-3,51	-5,67	-8,29	-11,84	-17,20	-14,97	-14,83
75	2,74	2,52	2,18	1,27	-0,01	-1,64	-3,40	-5,40	-7,94	-11,64	-17,78	-15,15	-14,83
90	2,74	2,49	2,17	1,24	-0,07	-1,70	-3,48	-5,37	-8,03	-11,71	-18,61	-15,45	-14,83
105	2,74	2,50	2,17	1,18	-0,26	-1,84	-3,72	-5,56	-8,59	-12,41	-20,01	-16,19	-14,83
120	2,74	2,52	2,17	1,10	-0,40	-2,04	-4,11	-5,99	-9,53	-13,48	-20,76	-16,92	-14,83
135	2,74	2,58	2,16	1,06	-0,57	-2,21	-4,44	-6,53	-10,56	-14,85	-21,05	-17,53	-14,83
150	2,74	2,61	2,16	1,03	-0,62	-2,36	-4,69	-7,15	-11,38	-15,88	-20,03	-18,41	-14,83
165	2,74	2,65	2,19	1,06	-0,57	-2,41	-4,81	-7,58	-11,57	-16,22	-18,79	-18,91	-14,83
180	2,74	2,71	2,22	1,10	-0,47	-2,39	-4,62	-7,61	-10,96	-15,68	-17,64	-18,69	-14,83
195	2,74	2,71	2,26	1,17	-0,35	-2,30	-4,34	-7,36	-10,12	-14,50	-16,86	-18,14	-14,83
210	2,74	2,73	2,29	1,22	-0,23	-2,14	-4,00	-6,91	-9,31	-13,58	-16,28	-17,28	-14,83
225	2,74	2,73	2,32	1,30	-0,18	-1,96	-3,69	-6,45	-8,75	-12,82	-15,86	-16,25	-14,83
240	2,74	2,72	2,32	1,32	-0,16	-1,75	-3,48	-6,22	-8,61	-12,45	-15,85	-15,22	-14,83
255	2,74	2,74	2,34	1,31	-0,19	-1,66	-3,44	-6,17	-8,67	-12,43	-16,17	-14,54	-14,83
270	2,74	2,72	2,29	1,24	-0,23	-1,66	-3,59	-6,42	-9,08	-12,65	-16,83	-14,22	-14,83
285	2,74	2,70	2,23	1,18	-0,33	-1,78	-3,92	-6,90	-9,77	-13,11	-18,09	-14,45	-14,83
300	2,74	2,69	2,15	1,07	-0,42	-1,98	-4,32	-7,59	-10,75	-13,64	-19,67	-14,83	-14,83
315	2,74	2,67	2,08	1,03	-0,49	-2,17	-4,73	-8,36	-11,91	-14,17	-20,99	-15,45	-14,83
330	2,74	2,67	2,04	0,98	-0,55	-2,34	-5,00	-8,95	-12,91	-14,54	-20,68	-15,81	-14,83
345	2,74	2,66	2,07	1,00	-0,54	-2,42	-5,11	-9,15	-13,25	-14,83	-19,71	-15,75	-14,83
360	2,74	2,65	2,15	1,10	-0,42	-2,36	-4,84	-8,38	-12,72	-14,73	-18,51	-15,05	-14,83

Total antenna gain, Iridium 1 antenna, 1626.5 MHz

2.2.3 Iridium antenna 2

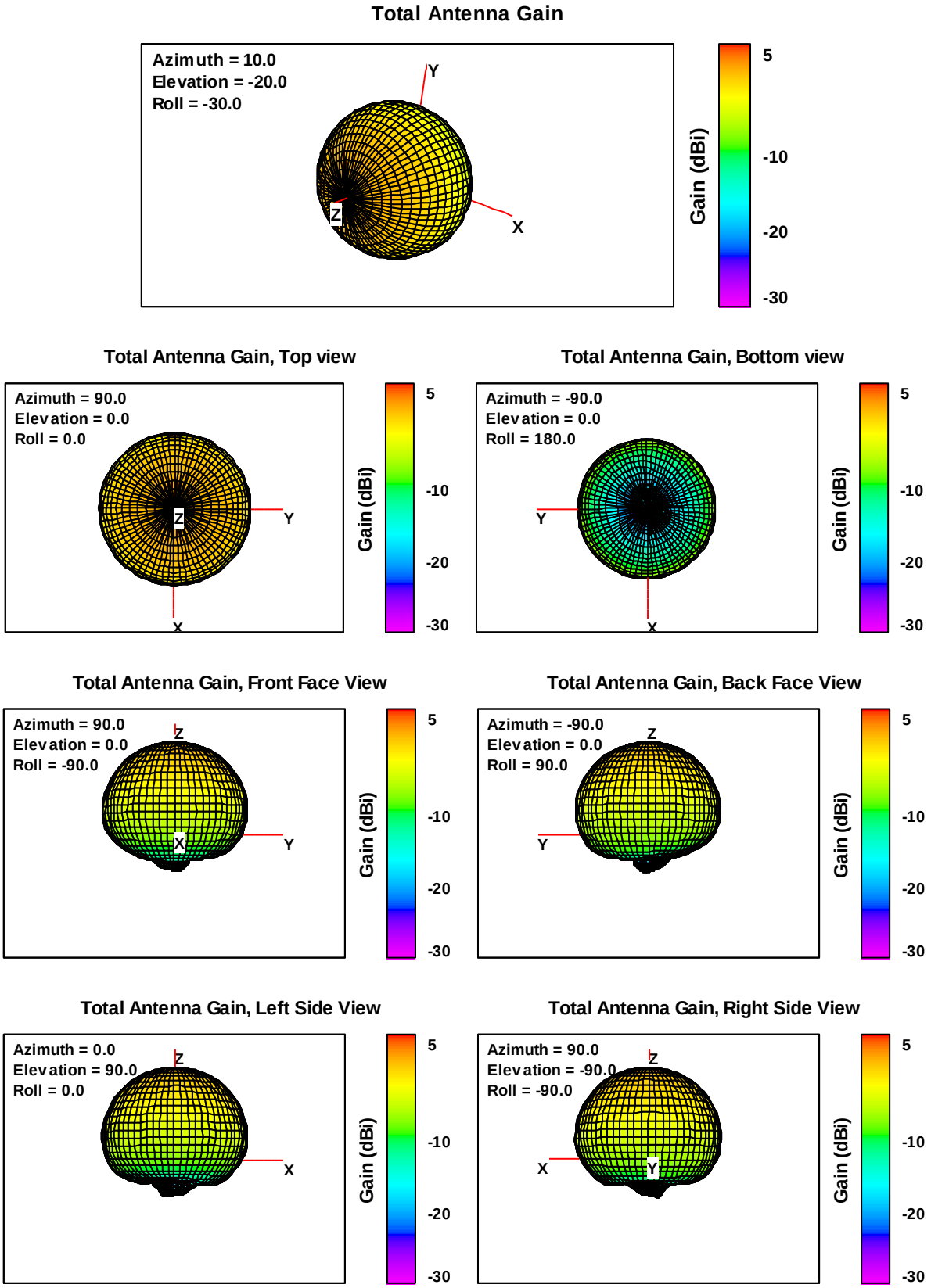


Fig. 9. Total antenna gain, Iridium 2 antenna, 1616 MHz.

Theta Angle (°)	0	15	30	45	60	75	90	105	120	135	150	165	180
Phi Angle (°)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)
0	1,70	1,57	1,11	-0,15	-1,79	-3,59	-6,20	-9,62	-12,48	-18,08	-20,10	-19,20	-17,60
15	1,70	1,56	1,14	-0,10	-1,76	-3,62	-6,21	-9,67	-12,82	-18,56	-20,61	-20,01	-17,60
30	1,70	1,52	1,14	-0,08	-1,74	-3,69	-6,24	-9,75	-13,21	-19,41	-21,14	-20,42	-17,60
45	1,70	1,53	1,17	-0,06	-1,69	-3,72	-6,32	-9,78	-13,52	-21,05	-21,45	-20,59	-17,60
60	1,70	1,53	1,14	-0,09	-1,71	-3,74	-6,44	-9,72	-14,01	-23,33	-21,37	-20,08	-17,60
75	1,70	1,53	1,10	-0,13	-1,73	-3,80	-6,46	-9,66	-14,00	-26,36	-20,65	-19,23	-17,60
90	1,70	1,51	1,05	-0,18	-1,73	-3,84	-6,47	-9,46	-14,01	-26,15	-19,66	-18,23	-17,60
105	1,70	1,47	1,00	-0,23	-1,75	-3,84	-6,37	-9,25	-13,85	-23,40	-19,06	-17,50	-17,60
120	1,70	1,45	0,97	-0,29	-1,80	-3,92	-6,24	-9,07	-13,58	-21,15	-18,30	-17,10	-17,60
135	1,70	1,43	0,93	-0,33	-1,84	-3,96	-6,21	-8,94	-13,57	-19,72	-17,95	-16,78	-17,60
150	1,70	1,45	0,91	-0,38	-1,87	-3,95	-6,14	-8,94	-13,54	-18,76	-17,91	-16,45	-17,60
165	1,70	1,43	0,88	-0,42	-1,96	-4,02	-6,18	-9,06	-13,65	-18,58	-18,14	-16,50	-17,60
180	1,70	1,45	0,84	-0,46	-2,02	-4,11	-6,22	-9,31	-14,28	-18,52	-18,37	-16,56	-17,60
195	1,70	1,46	0,81	-0,49	-2,10	-4,20	-6,32	-9,64	-15,01	-18,85	-18,78	-16,78	-17,60
210	1,70	1,47	0,79	-0,55	-2,15	-4,30	-6,55	-10,27	-15,83	-19,67	-19,27	-17,03	-17,60
225	1,70	1,45	0,74	-0,58	-2,21	-4,31	-6,70	-10,87	-16,68	-20,14	-19,59	-17,34	-17,60
240	1,70	1,45	0,77	-0,59	-2,24	-4,34	-6,83	-11,38	-17,12	-20,16	-19,55	-17,49	-17,60
255	1,70	1,44	0,78	-0,57	-2,24	-4,33	-6,95	-11,60	-16,88	-19,87	-19,12	-17,73	-17,60
270	1,70	1,46	0,79	-0,59	-2,21	-4,29	-7,00	-11,61	-16,29	-18,99	-18,61	-17,66	-17,60
285	1,70	1,45	0,84	-0,52	-2,13	-4,20	-6,94	-11,31	-15,33	-18,32	-17,93	-17,54	-17,60
300	1,70	1,48	0,85	-0,48	-2,11	-4,10	-6,84	-10,87	-14,55	-17,66	-17,54	-17,39	-17,60
315	1,70	1,50	0,91	-0,42	-2,01	-3,98	-6,65	-10,46	-13,72	-17,60	-17,52	-17,31	-17,60
330	1,70	1,53	0,96	-0,31	-1,95	-3,82	-6,49	-10,00	-13,06	-17,88	-17,98	-17,46	-17,60
345	1,70	1,54	0,99	-0,25	-1,91	-3,71	-6,38	-9,77	-12,90	-17,99	-18,47	-18,05	-17,60
360	1,70	1,57	1,11	-0,15	-1,79	-3,59	-6,20	-9,62	-12,48	-18,08	-20,10	-19,20	-17,60

Total antenna gain, Iridium 2 antenna, 1616 MHz

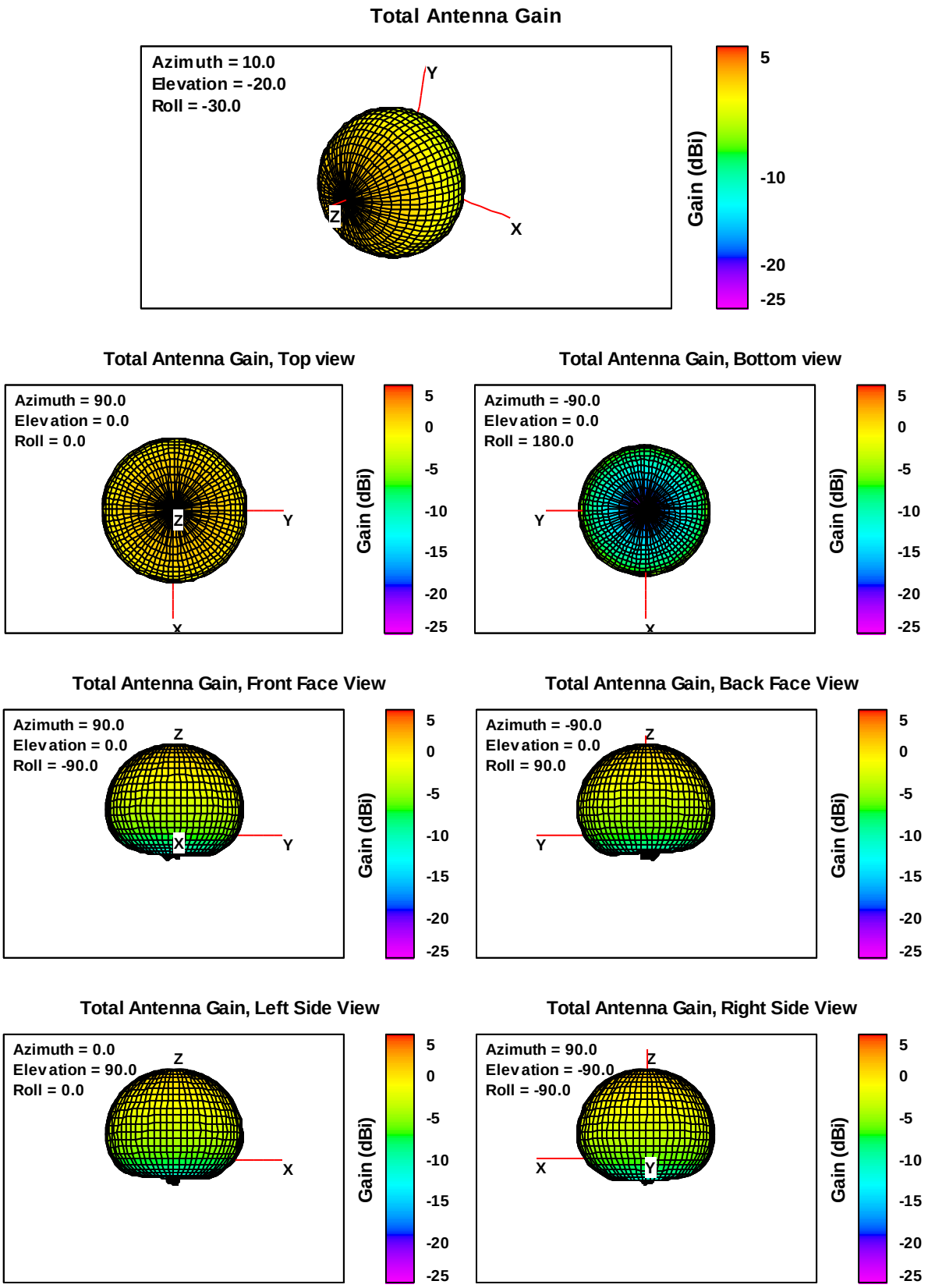


Fig. 10. Total antenna gain, Iridium 2 antenna, 1621 MHz.

Theta Angle (°)	0	15	30	45	60	75	90	105	120	135	150	165	180
Phi Angle (°)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)
0	1,71	1,61	1,11	-0,12	-1,80	-3,63	-6,48	-10,19	-13,02	-19,29	-21,88	-20,42	-18,45
15	1,71	1,58	1,17	-0,06	-1,78	-3,63	-6,35	-10,07	-13,01	-19,67	-22,03	-20,30	-18,45
30	1,71	1,57	1,19	-0,02	-1,72	-3,63	-6,26	-9,93	-12,93	-19,98	-22,05	-19,76	-18,45
45	1,71	1,55	1,21	0,03	-1,63	-3,58	-6,18	-9,66	-12,80	-20,51	-22,83	-19,67	-18,45
60	1,71	1,56	1,20	0,01	-1,60	-3,57	-6,16	-9,44	-12,74	-21,28	-23,33	-18,92	-18,45
75	1,71	1,56	1,15	-0,03	-1,62	-3,62	-6,21	-9,18	-12,74	-21,50	-23,11	-18,31	-18,45
90	1,71	1,53	1,09	-0,12	-1,65	-3,64	-6,26	-9,08	-12,70	-22,05	-23,34	-17,97	-18,45
105	1,71	1,52	1,05	-0,18	-1,71	-3,75	-6,31	-8,97	-12,80	-21,85	-22,84	-17,63	-18,45
120	1,71	1,49	0,98	-0,25	-1,79	-3,86	-6,38	-9,03	-13,10	-21,74	-22,28	-17,58	-18,45
135	1,71	1,47	0,94	-0,30	-1,87	-3,94	-6,45	-9,21	-13,54	-21,89	-21,95	-17,34	-18,45
150	1,71	1,48	0,92	-0,35	-1,93	-4,07	-6,49	-9,37	-13,95	-21,83	-21,96	-17,49	-18,45
165	1,71	1,48	0,91	-0,37	-1,97	-4,15	-6,51	-9,60	-14,27	-22,07	-21,61	-17,77	-18,45
180	1,71	1,51	0,88	-0,41	-2,02	-4,24	-6,55	-9,78	-14,68	-22,16	-21,13	-17,72	-18,45
195	1,71	1,51	0,88	-0,41	-2,06	-4,26	-6,54	-9,88	-15,01	-22,21	-20,50	-17,97	-18,45
210	1,71	1,52	0,88	-0,44	-2,10	-4,31	-6,59	-10,10	-15,32	-21,63	-20,04	-17,76	-18,45
225	1,71	1,51	0,87	-0,45	-2,14	-4,22	-6,55	-10,24	-15,55	-21,01	-19,22	-17,57	-18,45
240	1,71	1,51	0,86	-0,49	-2,09	-4,19	-6,55	-10,43	-15,51	-19,86	-18,63	-17,41	-18,45
255	1,71	1,52	0,87	-0,48	-2,06	-4,09	-6,61	-10,48	-15,40	-19,15	-18,22	-17,40	-18,45
270	1,71	1,51	0,90	-0,46	-2,06	-4,08	-6,72	-10,57	-15,07	-18,89	-17,94	-17,03	-18,45
285	1,71	1,53	0,90	-0,46	-2,01	-4,03	-6,79	-10,57	-14,70	-18,66	-18,12	-17,09	-18,45
300	1,71	1,53	0,92	-0,41	-1,99	-3,99	-6,86	-10,61	-14,30	-19,11	-18,54	-17,21	-18,45
315	1,71	1,53	0,96	-0,37	-1,95	-3,96	-6,84	-10,63	-13,95	-19,21	-19,42	-17,81	-18,45
330	1,71	1,56	1,00	-0,29	-1,91	-3,87	-6,80	-10,52	-13,54	-19,44	-20,22	-18,74	-18,45
345	1,71	1,59	1,03	-0,23	-1,90	-3,80	-6,72	-10,50	-13,43	-19,42	-20,78	-19,40	-18,45
360	1,71	1,61	1,11	-0,12	-1,80	-3,63	-6,48	-10,19	-13,02	-19,29	-21,88	-20,42	-18,45

Total antenna gain, Iridium 2 antenna, 1621 MHz

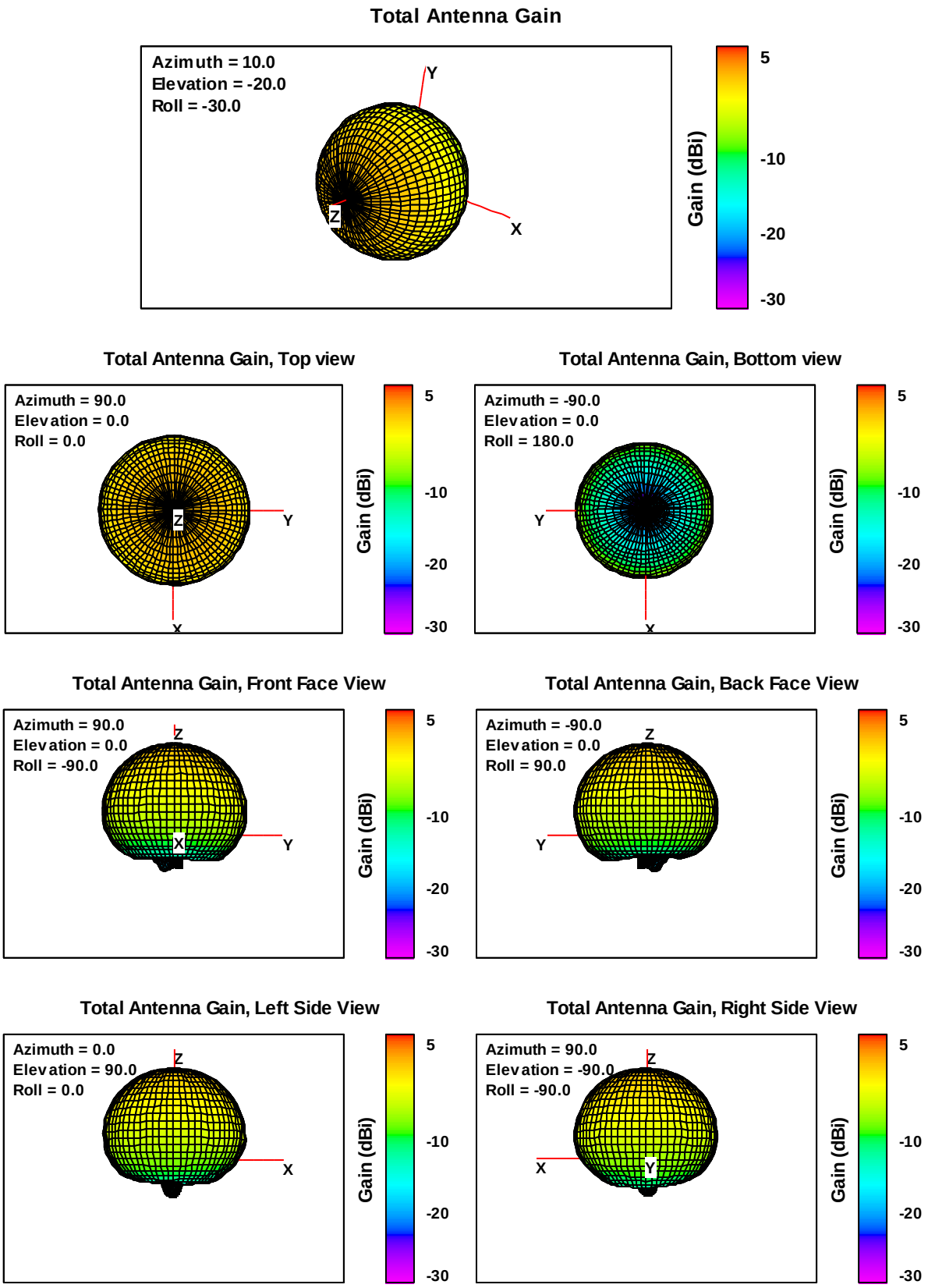


Fig. 11. Total antenna gain, Iridium 2 antenna, 1626.5 MHz.

Theta Angle (°)	0	15	30	45	60	75	90	105	120	135	150	165	180
Phi Angle (°)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)
0	1,40	1,32	0,84	-0,44	-2,21	-4,12	-7,16	-11,27	-14,22	-20,54	-22,88	-19,97	-18,75
15	1,40	1,30	0,87	-0,37	-2,15	-4,10	-6,96	-11,17	-13,96	-20,88	-23,19	-19,39	-18,75
30	1,40	1,26	0,90	-0,31	-2,05	-4,05	-6,77	-10,71	-13,38	-20,83	-23,99	-18,66	-18,75
45	1,40	1,26	0,90	-0,24	-1,93	-3,93	-6,44	-10,04	-12,66	-20,17	-24,89	-18,21	-18,75
60	1,40	1,25	0,90	-0,23	-1,87	-3,82	-6,37	-9,59	-12,22	-19,29	-25,34	-17,82	-18,75
75	1,40	1,23	0,86	-0,29	-1,85	-3,79	-6,31	-9,27	-11,88	-18,64	-25,78	-17,77	-18,75
90	1,40	1,24	0,79	-0,38	-1,89	-3,81	-6,36	-9,03	-11,90	-18,47	-26,76	-18,01	-18,75
105	1,40	1,19	0,71	-0,43	-1,96	-3,94	-6,47	-9,09	-12,16	-18,62	-27,19	-18,07	-18,75
120	1,40	1,18	0,65	-0,54	-2,09	-4,13	-6,73	-9,25	-12,77	-19,31	-27,95	-18,15	-18,75
135	1,40	1,15	0,63	-0,63	-2,22	-4,35	-7,02	-9,62	-13,59	-20,59	-29,15	-18,59	-18,75
150	1,40	1,15	0,58	-0,67	-2,32	-4,54	-7,21	-10,14	-14,29	-22,17	-28,47	-18,61	-18,75
165	1,40	1,17	0,58	-0,72	-2,37	-4,68	-7,37	-10,49	-15,00	-24,53	-26,88	-18,80	-18,75
180	1,40	1,20	0,59	-0,74	-2,42	-4,77	-7,41	-10,74	-15,46	-27,17	-24,26	-18,43	-18,75
195	1,40	1,21	0,58	-0,72	-2,41	-4,79	-7,30	-10,77	-15,49	-27,65	-22,49	-17,97	-18,75
210	1,40	1,22	0,59	-0,75	-2,43	-4,70	-7,14	-10,48	-15,14	-24,75	-20,44	-17,56	-18,75
225	1,40	1,21	0,59	-0,74	-2,37	-4,56	-6,92	-10,26	-14,95	-22,19	-19,25	-17,21	-18,75
240	1,40	1,22	0,59	-0,75	-2,31	-4,38	-6,75	-9,97	-14,47	-20,35	-18,62	-16,65	-18,75
255	1,40	1,21	0,63	-0,73	-2,26	-4,27	-6,71	-9,78	-14,11	-19,11	-18,16	-16,49	-18,75
270	1,40	1,22	0,62	-0,75	-2,23	-4,21	-6,78	-9,90	-14,02	-18,89	-18,24	-16,49	-18,75
285	1,40	1,22	0,62	-0,74	-2,26	-4,22	-6,98	-10,11	-13,79	-18,68	-19,09	-16,71	-18,75
300	1,40	1,22	0,62	-0,71	-2,24	-4,24	-7,18	-10,37	-13,81	-19,11	-20,22	-17,42	-18,75
315	1,40	1,23	0,66	-0,69	-2,23	-4,22	-7,26	-10,91	-13,84	-19,40	-21,93	-18,61	-18,75
330	1,40	1,25	0,70	-0,65	-2,29	-4,20	-7,38	-11,22	-14,07	-19,57	-22,39	-19,70	-18,75
345	1,40	1,28	0,73	-0,57	-2,30	-4,16	-7,43	-11,48	-14,20	-19,97	-22,61	-20,37	-18,75
360	1,40	1,32	0,84	-0,44	-2,21	-4,12	-7,16	-11,27	-14,22	-20,54	-22,88	-19,97	-18,75

Total antenna gain, Iridium 2 antenna, 1626.5 MHz

2.2.4 WLAN antenna

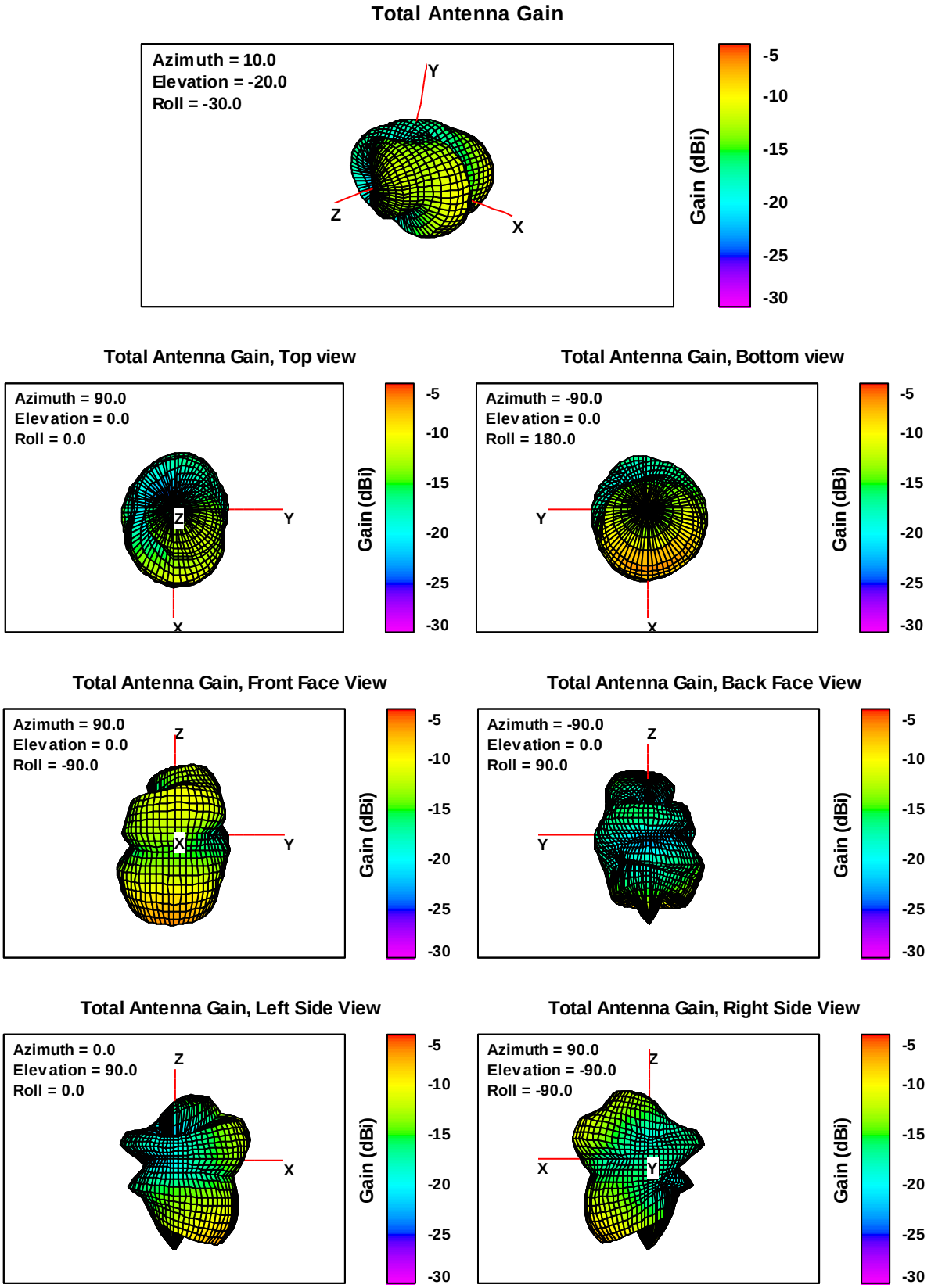


Fig. 12. Total antenna gain, WLAN antenna, 2400 MHz.

Theta Angle (°)	0	15	30	45	60	75	90	105	120	135	150	165	180
Phi Angle (°)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)
0	-16,59	-13,46	-12,53	-13,81	-10,31	-10,50	-13,05	-15,39	-11,93	-8,14	-6,14	-15,00	-7,50
15	-16,59	-13,31	-11,82	-13,08	-10,30	-10,59	-14,24	-15,60	-11,96	-8,55	-6,53	-14,53	-7,50
30	-16,59	-13,17	-11,39	-12,55	-10,96	-11,49	-16,28	-15,81	-12,22	-9,40	-7,28	-14,27	-7,50
45	-16,59	-13,26	-11,38	-12,51	-12,67	-13,25	-18,42	-15,93	-12,92	-10,76	-8,25	-14,19	-7,50
60	-16,59	-13,49	-11,79	-13,04	-15,13	-15,78	-18,73	-15,47	-14,02	-12,52	-9,43	-14,20	-7,50
75	-16,59	-13,87	-12,57	-13,83	-18,01	-17,95	-17,57	-15,41	-15,63	-14,93	-10,80	-14,10	-7,50
90	-16,59	-14,58	-13,58	-14,79	-19,42	-18,38	-16,64	-16,12	-17,51	-17,58	-12,08	-14,07	-7,50
105	-16,59	-15,52	-15,02	-15,83	-19,22	-17,70	-16,56	-17,36	-19,27	-19,53	-13,26	-14,12	-7,50
120	-16,59	-16,67	-16,74	-16,83	-18,02	-16,91	-17,19	-19,20	-19,97	-20,37	-14,43	-13,71	-7,50
135	-16,59	-17,97	-18,82	-17,58	-16,77	-16,29	-18,34	-20,93	-19,42	-20,39	-15,48	-13,42	-7,50
150	-16,59	-19,63	-21,23	-18,72	-16,08	-15,73	-19,59	-21,96	-18,25	-19,98	-16,28	-13,07	-7,50
165	-16,59	-21,01	-23,61	-20,03	-15,89	-15,60	-21,07	-23,06	-17,55	-19,87	-16,88	-12,96	-7,50
180	-16,59	-21,80	-25,53	-22,33	-16,31	-15,86	-22,07	-24,02	-17,07	-19,40	-17,13	-12,93	-7,50
195	-16,59	-21,36	-24,90	-25,36	-17,03	-16,69	-22,57	-22,67	-16,51	-18,52	-16,68	-13,22	-7,50
210	-16,59	-20,35	-23,43	-26,37	-17,67	-17,48	-22,50	-20,77	-15,98	-17,46	-15,94	-13,57	-7,50
225	-16,59	-19,11	-21,51	-24,88	-17,93	-17,70	-22,30	-19,37	-15,82	-16,50	-14,84	-14,10	-7,50
240	-16,59	-17,78	-19,99	-23,88	-18,74	-18,08	-21,97	-18,79	-15,31	-15,71	-13,54	-14,60	-7,50
255	-16,59	-16,77	-18,69	-24,15	-19,49	-18,92	-21,83	-18,88	-14,68	-14,46	-12,08	-15,05	-7,50
270	-16,59	-15,82	-17,42	-25,21	-19,66	-19,25	-20,47	-19,01	-13,90	-13,09	-10,65	-15,29	-7,50
285	-16,59	-15,22	-16,35	-25,52	-18,58	-18,26	-17,94	-18,98	-13,29	-11,60	-9,38	-15,44	-7,50
300	-16,59	-14,62	-15,51	-23,66	-16,37	-16,60	-15,70	-18,17	-12,74	-10,38	-8,20	-15,38	-7,50
315	-16,59	-14,16	-14,76	-21,02	-14,20	-14,58	-14,03	-16,74	-12,40	-9,53	-7,28	-15,14	-7,50
330	-16,59	-13,88	-13,98	-18,58	-12,44	-12,79	-12,95	-15,56	-12,26	-8,90	-6,61	-14,73	-7,50
345	-16,59	-13,55	-13,35	-16,57	-11,47	-11,43	-12,49	-14,85	-12,32	-8,58	-6,33	-14,40	-7,50
360	-16,59	-13,46	-12,53	-13,81	-10,31	-10,50	-13,05	-15,39	-11,93	-8,14	-6,14	-15,00	-7,50

Total antenna gain, WLAN antenna, 2400 MHz

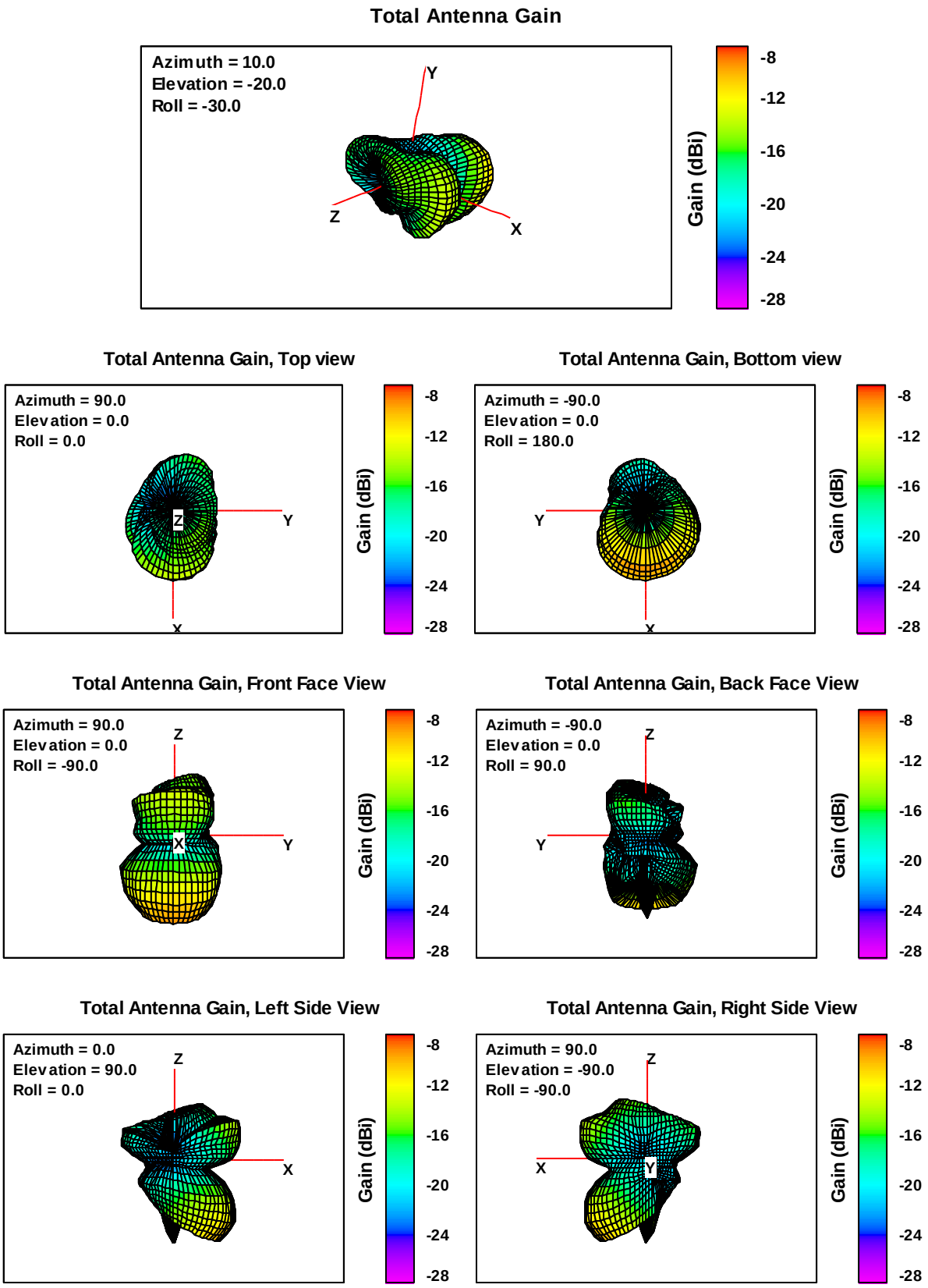


Fig. 13. Total antenna gain, WLAN antenna, 2440 MHz.

Theta Angle (°)	0	15	30	45	60	75	90	105	120	135	150	165	180
Phi Angle (°)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)
0	-20,13	-17,45	-15,88	-15,67	-12,94	-14,31	-16,25	-21,50	-14,70	-10,42	-9,20	-19,46	-11,33
15	-20,13	-17,29	-15,28	-15,51	-13,11	-14,47	-16,81	-21,18	-14,45	-10,61	-9,36	-19,00	-11,33
30	-20,13	-17,34	-14,78	-15,51	-14,04	-15,32	-18,20	-19,80	-14,11	-11,15	-9,87	-18,74	-11,33
45	-20,13	-17,53	-14,76	-15,80	-16,00	-17,14	-20,37	-18,80	-14,66	-12,39	-10,82	-18,72	-11,33
60	-20,13	-17,65	-15,08	-16,37	-18,84	-20,03	-21,54	-18,25	-16,05	-14,12	-11,97	-18,44	-11,33
75	-20,13	-17,90	-15,47	-16,83	-21,91	-22,38	-21,39	-18,54	-18,42	-16,54	-13,39	-18,59	-11,33
90	-20,13	-18,30	-16,02	-16,82	-22,04	-22,43	-20,83	-19,58	-21,26	-18,91	-14,72	-18,52	-11,33
105	-20,13	-18,82	-16,64	-16,58	-19,85	-20,89	-20,57	-20,92	-22,86	-20,91	-16,07	-18,68	-11,33
120	-20,13	-19,78	-17,53	-16,33	-17,91	-19,81	-20,83	-21,41	-21,89	-21,79	-17,40	-18,37	-11,33
135	-20,13	-20,73	-18,84	-16,54	-16,36	-18,78	-20,98	-21,10	-20,58	-22,32	-19,10	-18,11	-11,33
150	-20,13	-21,84	-20,58	-17,04	-15,57	-17,75	-21,47	-21,17	-20,07	-24,19	-20,73	-17,84	-11,33
165	-20,13	-23,24	-23,01	-18,49	-15,61	-17,20	-21,19	-22,44	-20,22	-25,53	-21,89	-17,45	-11,33
180	-20,13	-23,75	-25,65	-21,18	-16,38	-17,20	-21,15	-23,66	-20,10	-23,99	-21,86	-17,44	-11,33
195	-20,13	-23,11	-25,73	-24,77	-17,58	-18,09	-21,21	-23,35	-19,70	-21,14	-20,37	-17,46	-11,33
210	-20,13	-21,93	-23,46	-26,44	-19,25	-19,16	-21,99	-23,04	-18,75	-19,35	-18,88	-17,48	-11,33
225	-20,13	-20,81	-21,74	-25,39	-20,99	-19,87	-22,95	-22,97	-18,62	-18,05	-17,62	-17,89	-11,33
240	-20,13	-19,90	-20,61	-24,37	-23,53	-20,08	-22,89	-23,83	-18,55	-17,49	-16,75	-18,23	-11,33
255	-20,13	-19,24	-19,64	-25,32	-27,63	-21,36	-22,81	-23,65	-18,02	-16,77	-15,54	-18,76	-11,33
270	-20,13	-18,93	-19,22	-26,57	-27,97	-22,85	-22,06	-23,10	-16,91	-15,65	-14,34	-19,36	-11,33
285	-20,13	-18,55	-18,68	-25,56	-21,88	-22,93	-20,59	-22,09	-15,63	-14,20	-13,07	-19,93	-11,33
300	-20,13	-18,35	-18,30	-22,39	-18,03	-20,35	-19,05	-21,11	-14,81	-12,90	-11,77	-20,37	-11,33
315	-20,13	-18,04	-17,69	-20,22	-15,43	-18,07	-17,67	-20,58	-14,57	-11,96	-10,65	-20,30	-11,33
330	-20,13	-17,66	-17,16	-18,39	-13,88	-16,28	-16,87	-20,67	-14,64	-11,23	-9,83	-19,88	-11,33
345	-20,13	-17,34	-16,62	-17,11	-13,20	-15,08	-16,49	-21,05	-15,01	-10,88	-9,38	-19,35	-11,33
360	-20,13	-17,45	-15,88	-15,67	-12,94	-14,31	-16,25	-21,50	-14,70	-10,42	-9,20	-19,46	-11,33

Total antenna gain, WLAN antenna, 2440 MHz

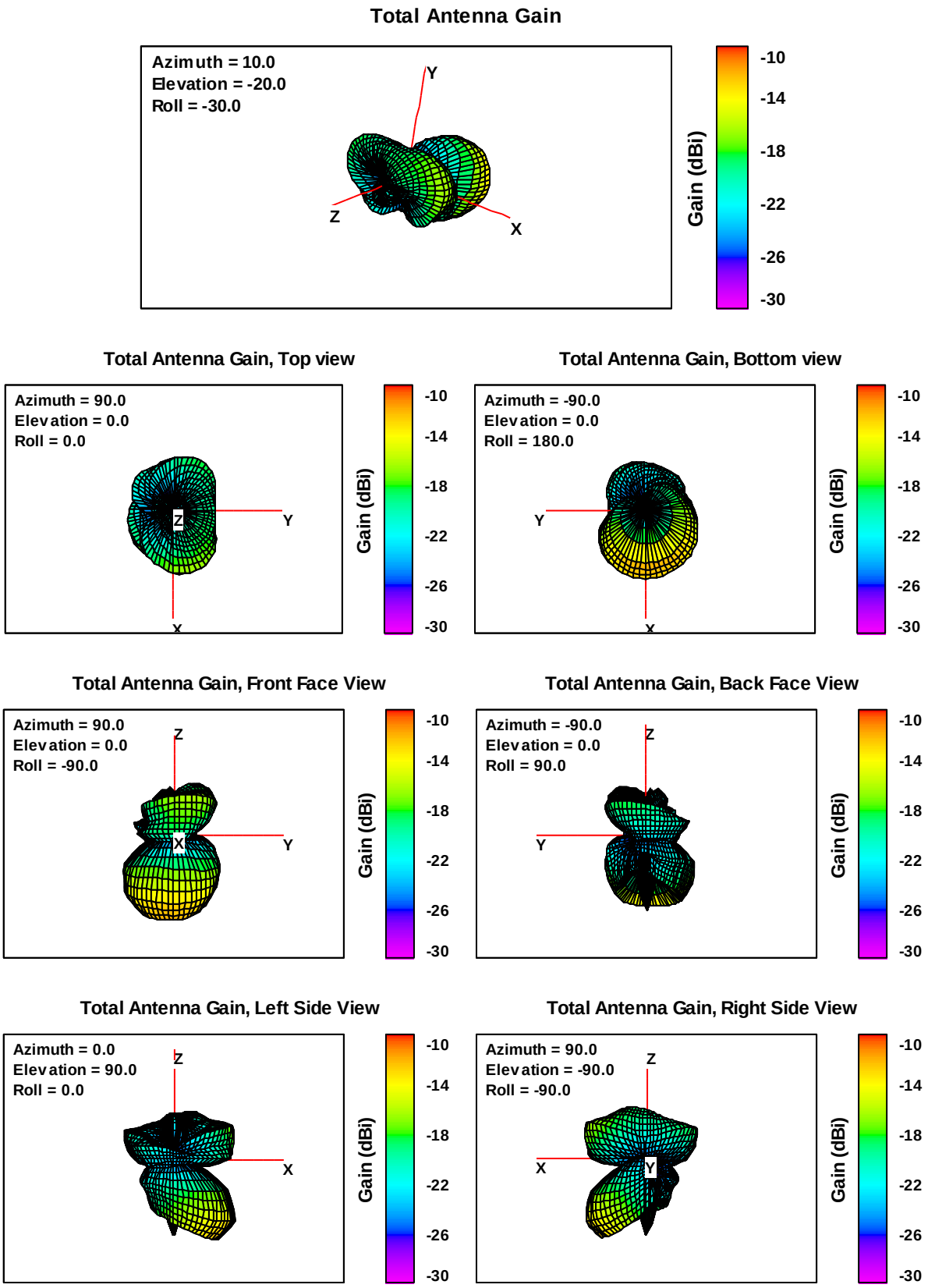


Fig. 14. Total antenna gain, WLAN antenna, 2485 MHz.

Theta Angle (°)	0	15	30	45	60	75	90	105	120	135	150	165	180
Phi Angle (°)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)	Gain (dBi)
0	-22,52	-21,53	-21,48	-19,91	-16,21	-17,59	-18,70	-25,96	-17,48	-12,72	-11,90	-24,45	-14,99
15	-22,52	-21,22	-19,97	-19,02	-15,92	-17,49	-19,92	-26,05	-17,28	-13,08	-12,12	-24,24	-14,99
30	-22,52	-21,04	-18,89	-18,23	-16,25	-18,42	-22,38	-24,35	-16,82	-13,74	-12,91	-24,04	-14,99
45	-22,52	-21,07	-18,62	-17,99	-17,37	-20,41	-25,46	-22,55	-17,27	-15,01	-14,06	-24,11	-14,99
60	-22,52	-21,34	-18,50	-18,33	-19,35	-23,33	-26,07	-21,35	-18,35	-16,81	-15,65	-24,09	-14,99
75	-22,52	-21,51	-18,76	-18,87	-21,27	-25,48	-25,29	-21,56	-20,42	-19,22	-17,36	-23,59	-14,99
90	-22,52	-21,87	-19,13	-19,21	-21,56	-25,50	-25,49	-23,27	-23,54	-21,91	-19,05	-23,12	-14,99
105	-22,52	-22,27	-19,64	-19,33	-20,76	-23,95	-27,19	-26,12	-26,69	-24,10	-20,54	-22,69	-14,99
120	-22,52	-22,65	-20,36	-19,41	-19,30	-22,79	-27,80	-27,50	-26,60	-25,65	-21,74	-22,18	-14,99
135	-22,52	-23,02	-21,40	-19,53	-18,12	-21,73	-26,12	-26,15	-25,30	-26,46	-23,33	-21,63	-14,99
150	-22,52	-23,37	-22,65	-20,30	-17,74	-20,62	-24,10	-25,12	-24,11	-28,34	-24,67	-21,61	-14,99
165	-22,52	-23,64	-24,05	-21,88	-17,99	-20,07	-22,82	-24,98	-23,61	-28,57	-24,89	-21,38	-14,99
180	-22,52	-23,25	-24,95	-24,58	-18,63	-19,96	-22,05	-25,27	-22,94	-25,84	-22,94	-21,56	-14,99
195	-22,52	-22,36	-24,54	-27,09	-19,60	-20,23	-21,77	-24,99	-22,04	-23,29	-21,04	-21,57	-14,99
210	-22,52	-21,72	-23,79	-27,33	-20,84	-20,27	-22,02	-24,22	-21,28	-21,39	-19,64	-21,87	-14,99
225	-22,52	-21,29	-22,82	-25,77	-22,27	-19,90	-22,05	-23,45	-20,87	-20,30	-18,54	-22,09	-14,99
240	-22,52	-21,00	-22,37	-25,27	-24,11	-20,19	-22,54	-23,61	-20,73	-19,83	-17,85	-22,73	-14,99
255	-22,52	-20,65	-21,75	-25,46	-27,48	-21,34	-23,12	-24,03	-20,17	-19,04	-17,13	-23,31	-14,99
270	-22,52	-20,76	-21,77	-26,22	-29,60	-23,40	-23,24	-24,65	-19,18	-17,81	-16,07	-24,25	-14,99
285	-22,52	-20,85	-21,96	-26,09	-25,94	-25,29	-22,87	-25,73	-18,42	-16,27	-14,95	-24,93	-14,99
300	-22,52	-20,99	-22,24	-25,15	-22,49	-24,86	-22,06	-25,91	-17,99	-14,84	-13,79	-25,13	-14,99
315	-22,52	-20,90	-22,93	-24,73	-19,87	-22,99	-20,49	-25,62	-17,81	-13,87	-12,83	-24,89	-14,99
330	-22,52	-20,89	-22,83	-23,52	-18,30	-20,80	-19,24	-24,99	-18,08	-13,32	-12,12	-24,71	-14,99
345	-22,52	-20,33	-22,51	-22,16	-17,30	-19,27	-18,72	-24,64	-18,30	-12,98	-11,83	-23,91	-14,99
360	-22,52	-21,53	-21,48	-19,91	-16,21	-17,59	-18,70	-25,96	-17,48	-12,72	-11,90	-24,45	-14,99

Total antenna gain, WLAN antenna, 2485 MHz

Appendix B: Photographs

Equipment under test:

Front and back views:

Fig 15. Front view (“Iridium 1” antenna).

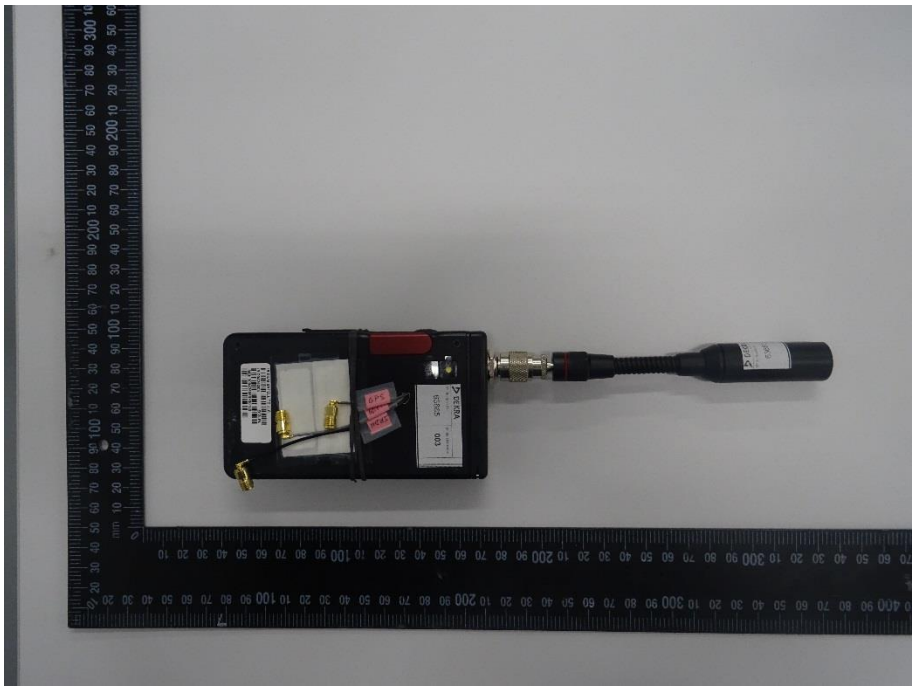
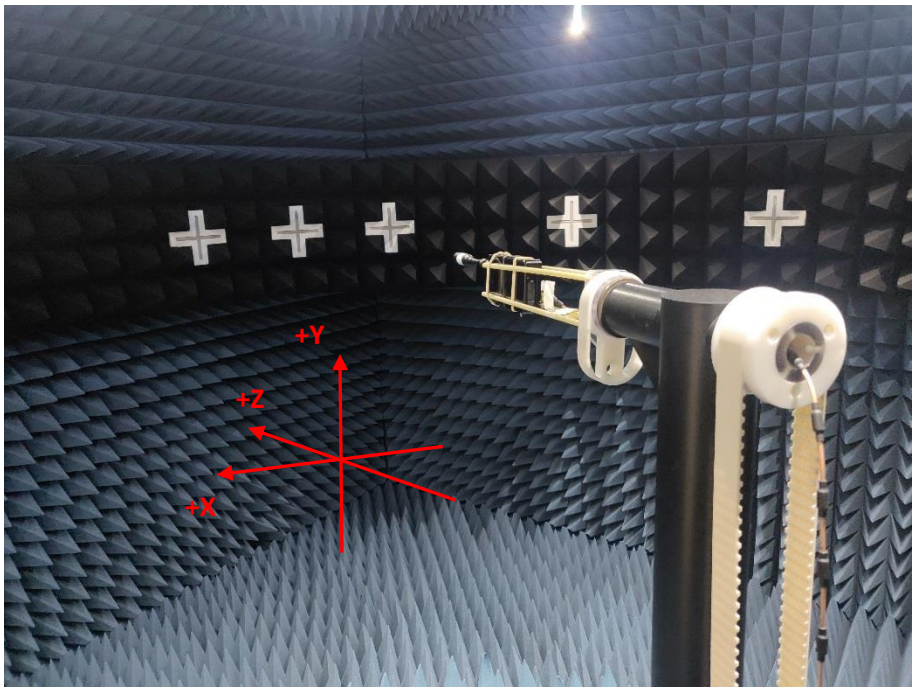


Fig 16. Back view (“Iridium 2” antenna).

Test set:

- **Free Space set-up: Initial position: Theta = 0º, Phi = 0º**



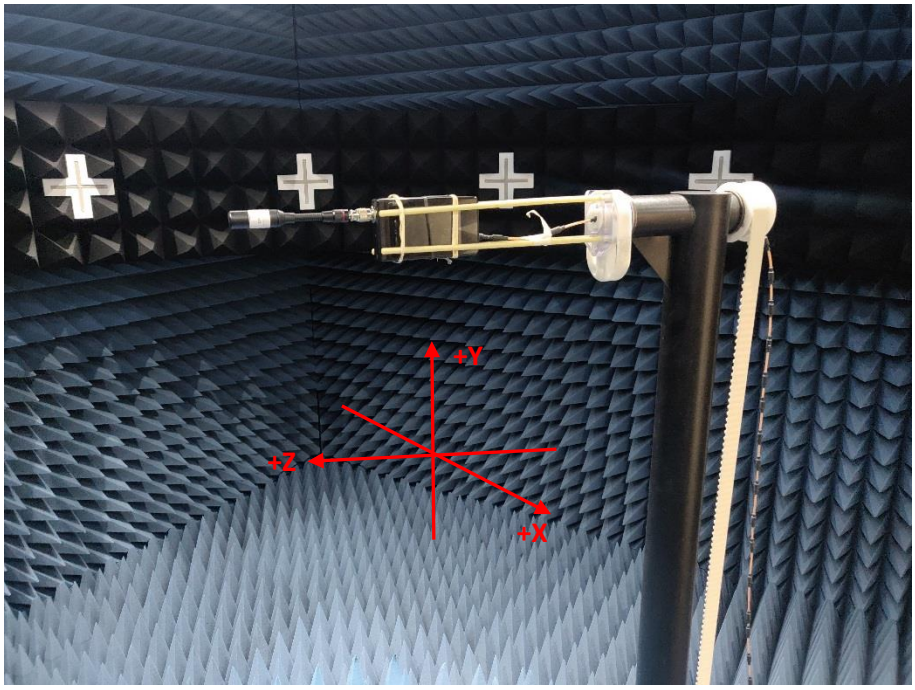


Fig 17. Free Space configuration set-up view.