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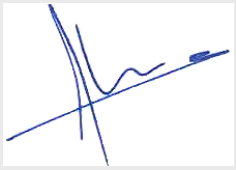
C.I.F. A29 507 456

Test report No:
NIE: 67217RAN.001

Test report
LoRaWAN End-Device RF Performance measurements for All Regions

(*) Identification of item tested	Ultra-secure IoT module with integrated antenna.
(*) Trademark	Onethinx
(*) Model and /or type reference	OTX-18
(*) Other identification of the product	HW version: V1.0 SW version: V1.03
(*) Features	LoRa, LoRaWAN, FSK, Bluetooth, Ultra low power, ultra secure
(*)Manufacturer	Onethinx BV Punterweg 2 8042 PB Zwolle The Netherlands
Test method requested, standard	[1] LoRaWAN End-Device RF Performance measurements for All Regions
Approved by (name / position & signature)	Miguel Lacave Antennas Lab. Manager  2021.04.30 09:32:11 +02'00'
Date of issue	2021-04-28
Report template No	FDT08_22 (*) "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.

DEKRA Testing and Certification, S.A.U. guarantees the reliability of the data presented in this report, which is the result of the measurements and the tests performed to the item under test on the date and under the conditions stated on the report and, it is based on the knowledge and technical facilities available at DEKRA Testing and Certification, S.A.U. at the time of performance of the test.

DEKRA Testing and Certification, S.A.U. is liable to the client for the maintenance of the confidentiality of all information related to the item under test and the results of the test.

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

General conditions

1. This report is only referred to the item that has undergone the test.
2. This report does not constitute or imply on its own an approval of the product by the Certification Bodies or competent Authorities.
3. This document is only valid if complete; no partial reproduction can be made without previous written permission of DEKRA Testing and Certification, S.A.U.
4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA Testing and Certification, S.A.U. and the Accreditation Bodies.

Uncertainty

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

1. CTIA Test plan for mobile station over the air performance. Method of measurement for radiated RF power and receiver performance. April 2019. Revision 3.8.2.
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", “Other identification of the product”, “Features”, “Manufacturer” and “Test sample description”).

2. Information in section “Test sample description”

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
67217/002	Module with integrated antenna	OTX-18	--	2021-01-13
67217/004	AC/DC Power Supply	MAY-BH0004-0001	T2A013200A GS	2021-01-13

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

Test sample description

The sample under tests consist of a full featured ultra-secure IoT module with integrated antenna.

Identification of the client

Company name: Onethinx BV

Postal address: Punterweg 2, 8042 PB Zwolle The Netherlands

Contact person: Rolf Nooteboom

E-mail: rolf@onethinx.com

Telephone: +31 38 850 1000

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2021-03-03
Date (finish)	2021-04-08

Document history

Report number	Date	Description
67217RAN.001	2021-04-28	First release

Environmental conditions

Date	Max. Temp. ºC	Min. Temp. ºC	Max. Hum. %	Min. Hum. %
From 2021-03-03 to 2021-04-08	24.3	20.1	54.7	38.0

Remarks and comments

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

	Equipment	Control Nº
1.	Anechoic chamber ETS LINDGREN AMS-8700	5281
2.	Positioning system controller and RF switch ETS LINDGREN EMCENTER 7000-001	5237
3.	OTA measurement software ETS LINDGREN EMQuest v1.13	5286
4.	Spectrum analyzer ROHDE AND SCHWARZ FSU	2829
5.	LoRa Gateway Semtech IOT868TKLM1 HAL v3.2.0	7213
6.	Step attenuator Vaunix Technology Corporation Lab BrickDigital Attenuator	5409
7.	RF Circulator Channel Microwave Corporation, Model BUL330	1151
8.	RF Isolator Channel Microwave Corporation, Model AUL330	1152
9.	Temperature and Humidity probe, model HWg-STE	5780

Testing has been performed by Francisco José Alcaide.

Testing verdicts

Not applicable ..... :	N/A
Pass..... :	P
Fail..... :	F
Measured ..... :	M
Not measured ..... :	N/M

Summary

Transmitter Performance:

LoRaWAN End-Device RF Performance measurements for All Regions	Verdict				
	N/A	P	F	M	N/M
2 : End-device transmitter performance				X	

Receiver Performance:

LoRaWAN End-Device RF Performance measurements for All Regions	Verdict				
	N/A	P	F	M	N/M
3 : End-device receiver performance				X	

Appendix A: Test results

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1. TEST CONDITIONS

1.1 Power supply (V)

Power supply (V) under test:

Vn = 5.3 V_{DC} supplied by its own AC/DC Power Supply.

1.2 Test frequencies and output power

In all required operating bands the measurements for Total Radiated Power (TRP) and Total Isotropic Sensitivity (TIS) measurements are to be performed on channels and data-rates defined by the standard [1].

The “TX Power” parameter was set to 0 (maximum EIRP), 3 and 6 for TRP tests and 0 for TIS tests.

1.3 EUT orientation and setup requirements

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.

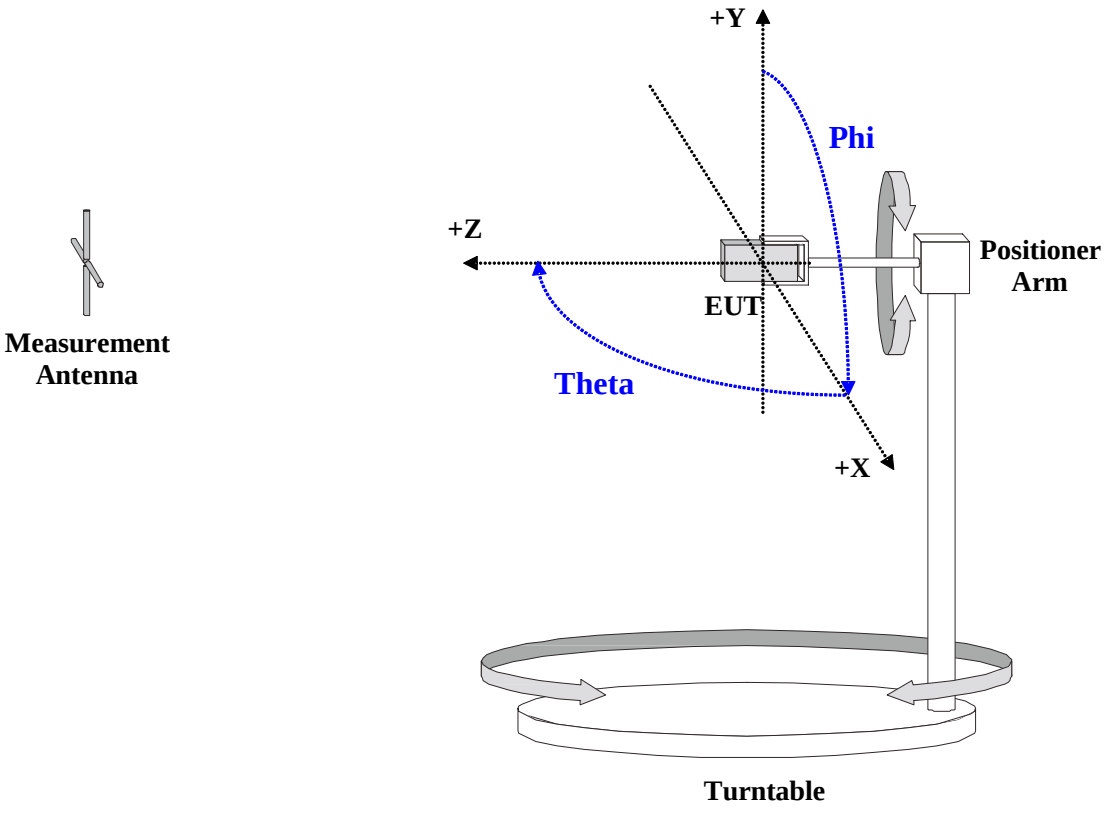

Fig. 1. Coordinate system.

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.

End-device transmitter performance

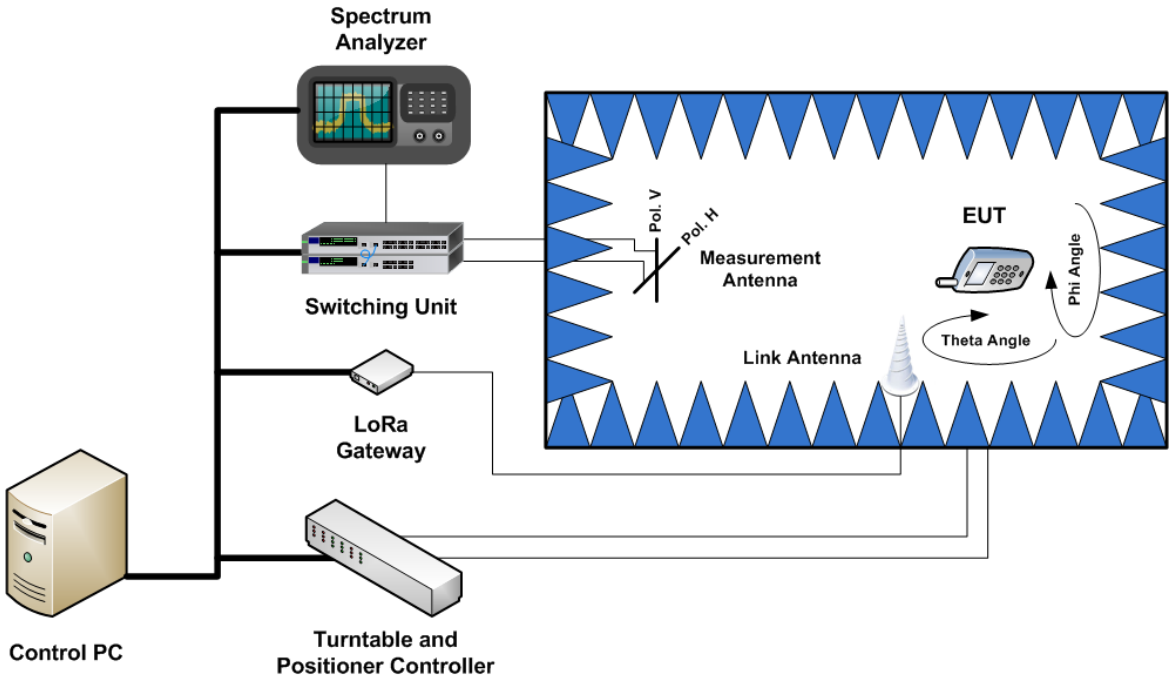

Fig. 2. Transmitter performance test connection diagram.

End-device receiver performance

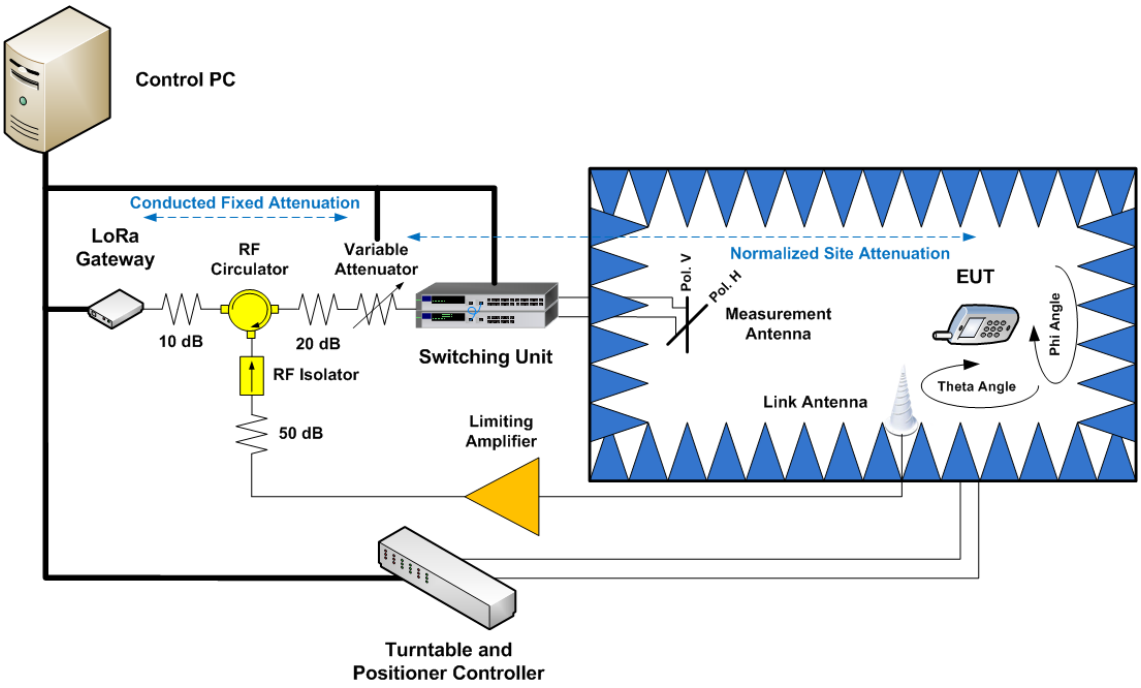

Fig. 3. Receiver performance test connection diagram.

2. TEST RESULTS

2.1 Transmitter performance

Frequency (MHz)	TX Power parameter	TRP (dBm)	Maximum EIRP				
			Horizontal EIRP (dBm)	Vertical EIRP (dBm)	Total EIRP (dBm)	Theta (º)	Phi (º)
863.1	0	4.26	7.57	2.30	8.70	150	120
	3	N/A	0.09	2.02	4.17	150	120
	6	N/A	-11.43	-4.26	-3.50	150	120
865.1	0	3.88	6.10	5.64	8.89	150	350
	3	N/A	-1.71	2.07	3.59	150	350
	6	N/A	-7.19	-9.06	-5.01	150	350
868.3	0	3.48	6.69	4.09	8.59	150	15
	3	N/A	-1.04	-6.33	0.08	150	15
	6	N/A	-7.03	-21.68	-6.89	150	15
869.525	0	5.66	8.85	8.99	11.93	150	350

2.2 Receiver performance

Frequency (MHz)		863.1	865.1	869.525	
Spreading Factor		SF12 (DR0)	SF12 (DR0)	SF12 (DR0)	SF7 (DR5)
TIS (dBm)		-120.95	-118.34	-119.33	-86.41
Measured EIS	EIS (dBm)	-123.95	-118.14	-115.88	-82,96
	PER (%)	5.00	5.00	5.00	1,60
	Polarization	Horizontal	Horizontal	Vertical	Vertical
	Theta (º)	150	150	135	135
	Phi (º)	180	255	60	60
GW Tx Power (dBm)		12.86	15.31	16.90	16.90
Forward path attenuation (dB)		-136.81	-132.96	-132.78	-99.86
Normalized Site Attenuation (NSA) (dB)[1]		-48.41	-48.47	-48.30	-48.30
Conducted fixed attenuation (dB)[1]		-88.40	-84.49	-84.48	-51.56
RF Path attenuation step size (dB)		0.50	0.50	0.50	0.50

[1] For details on what elements are accounted for in Normalized Site Attenuation and Conducted Fixed Attenuation components see Figure 3.

3. EXPANDED MEASUREMENT UNCERTAINTIES

The expanded measurement uncertainties are listed below for the different frequency bands. These uncertainties refer to a coverage factor of 2, corresponding to 95% confidence level.

The expanded measurement uncertainties listed below were derived following the methodology described in the CTIA Test plan for mobile station over the air performance. Method of measurement for radiated RF power and receiver performance. April 2019. Revision 3.8.2.

Table 1. ***TRP and TIS Measurement Uncertainty results***

Test	**Test Configuration**	**Expanded Uncertainty** (k=2, 95 % confidence level) [dB]	
		Value (dB)	**LoRaWAN End-Device RF Performance measurements for All Regions Uncertainty Limit (dB)**
TRP	**FREE SPACE**	1.60	3.0
TIS	**FREE SPACE**	1.77	3.5

4. RF TEST RESULT ON 2D

4.1 EIRP Pattern 863.1 MHz – Free Space

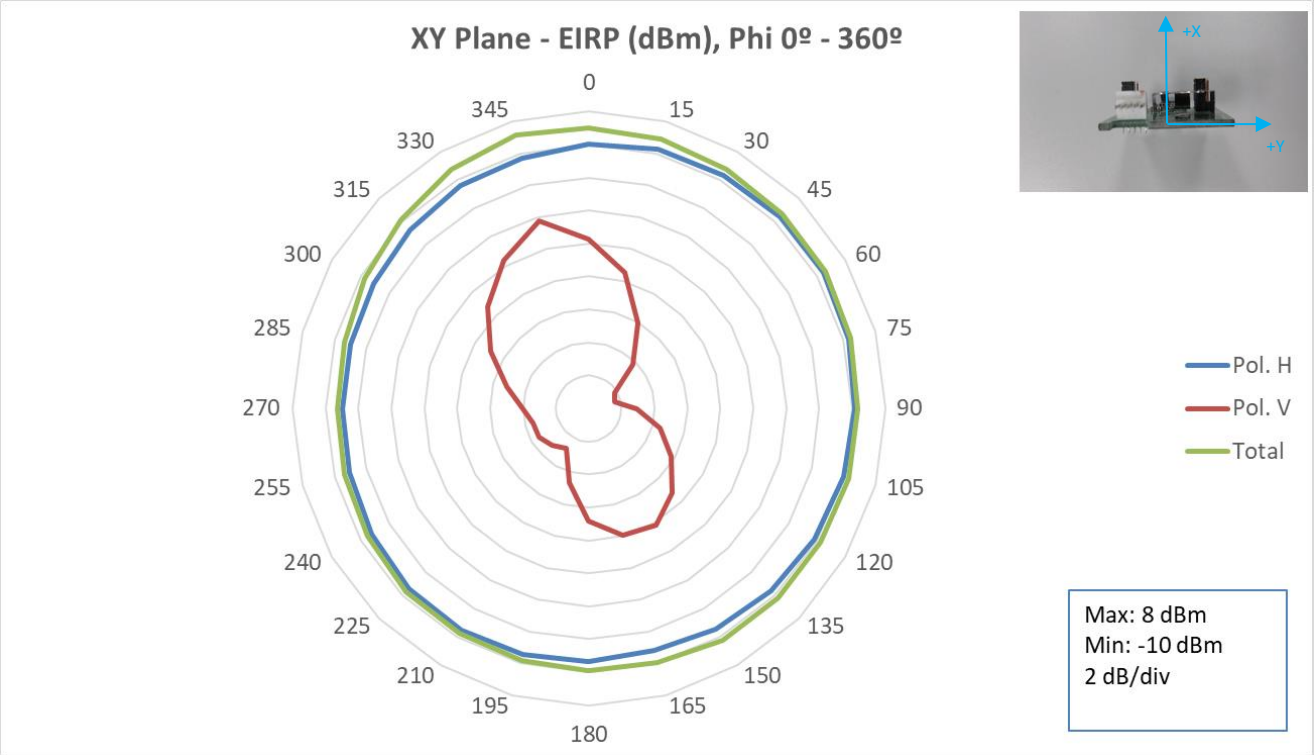

Fig. 4. XY Plane EIRP, Free Space, 863.1 MHz.

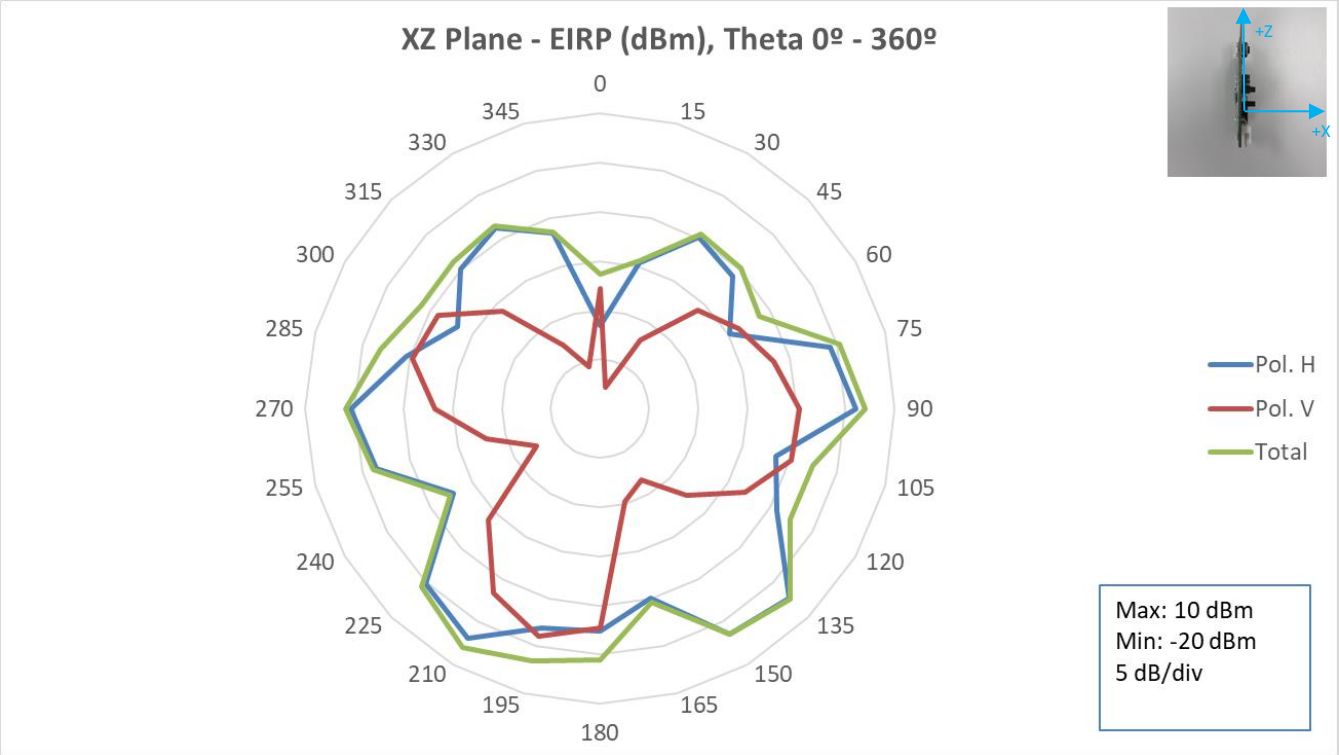

Fig. 5. XZ Plane EIRP, Free Space, 863.1 MHz.

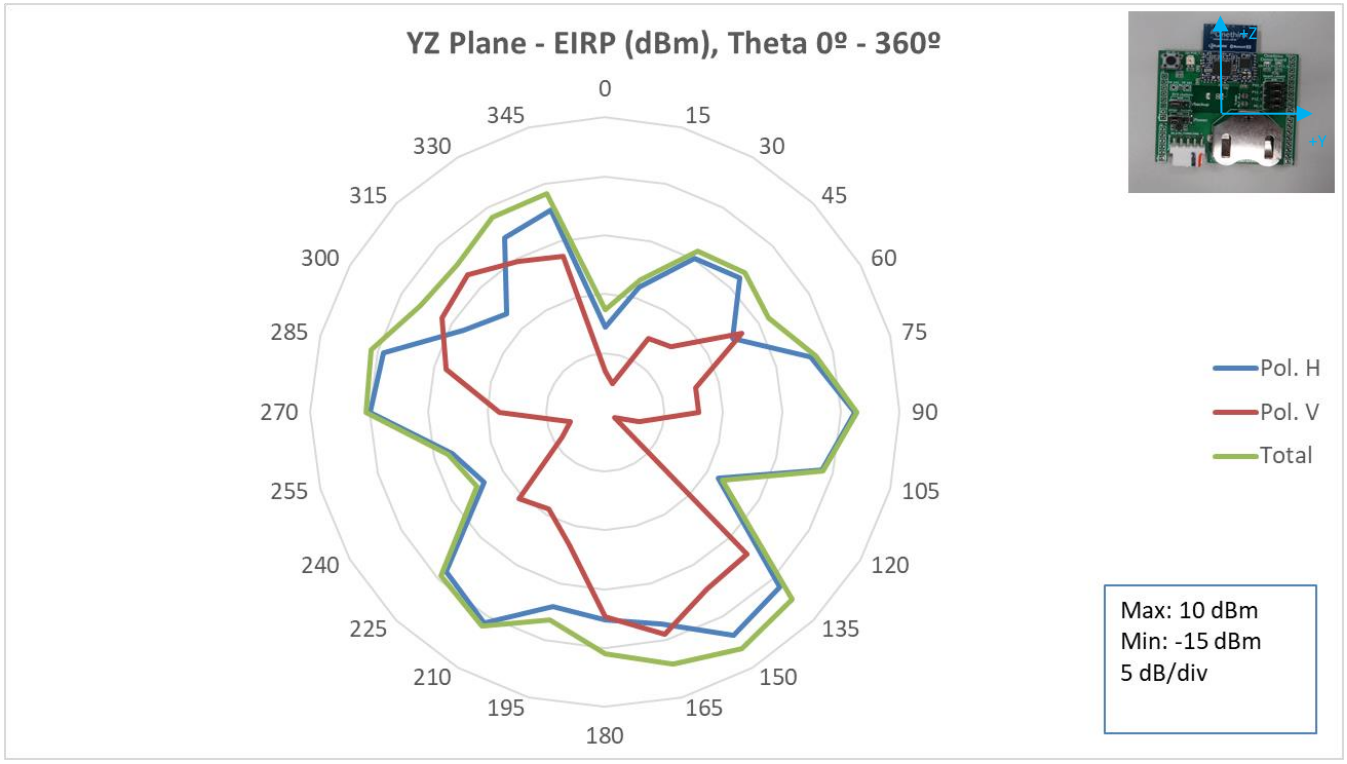

Fig. 6. YZ Plane EIRP, Free Space, 863.1 MHz.

4.2 EIRP Pattern 865.1 MHz – Free Space

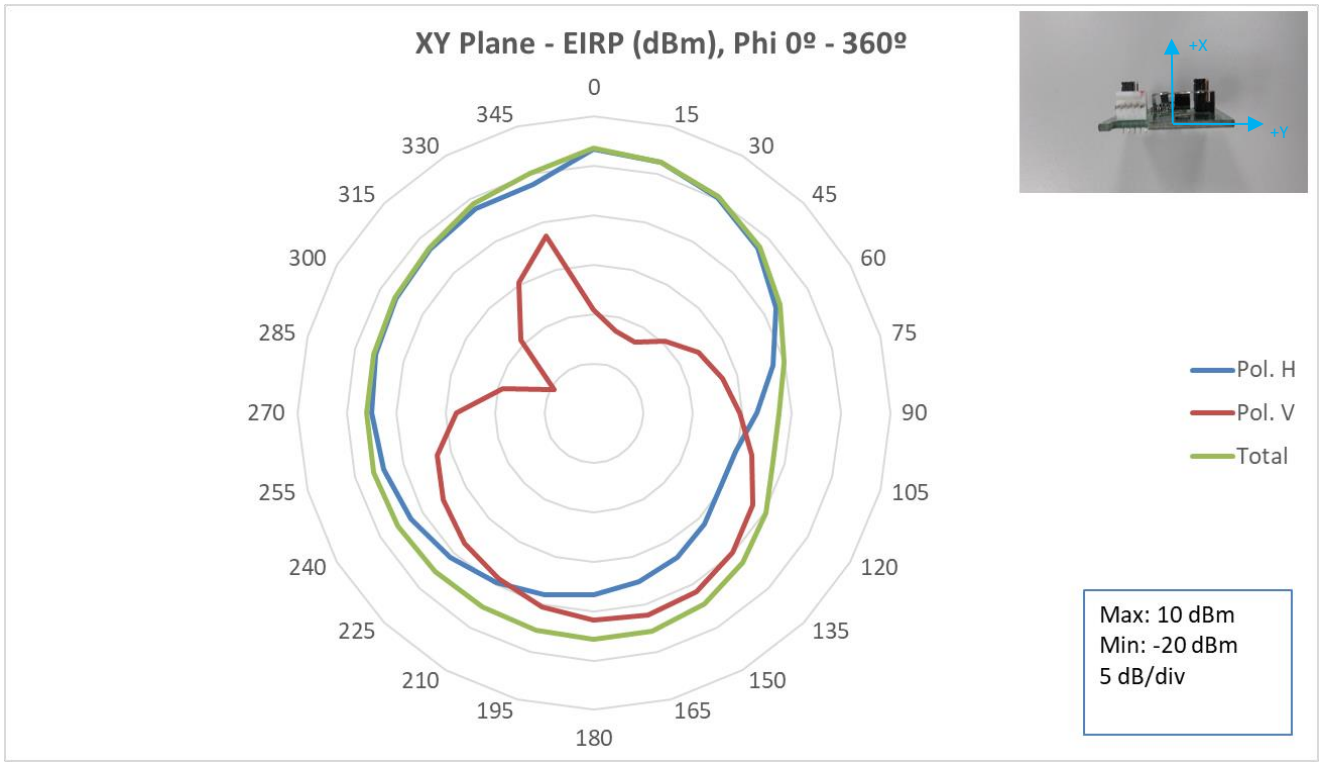

Fig. 7. XY Plane EIRP, Free Space, 865.1 MHz.

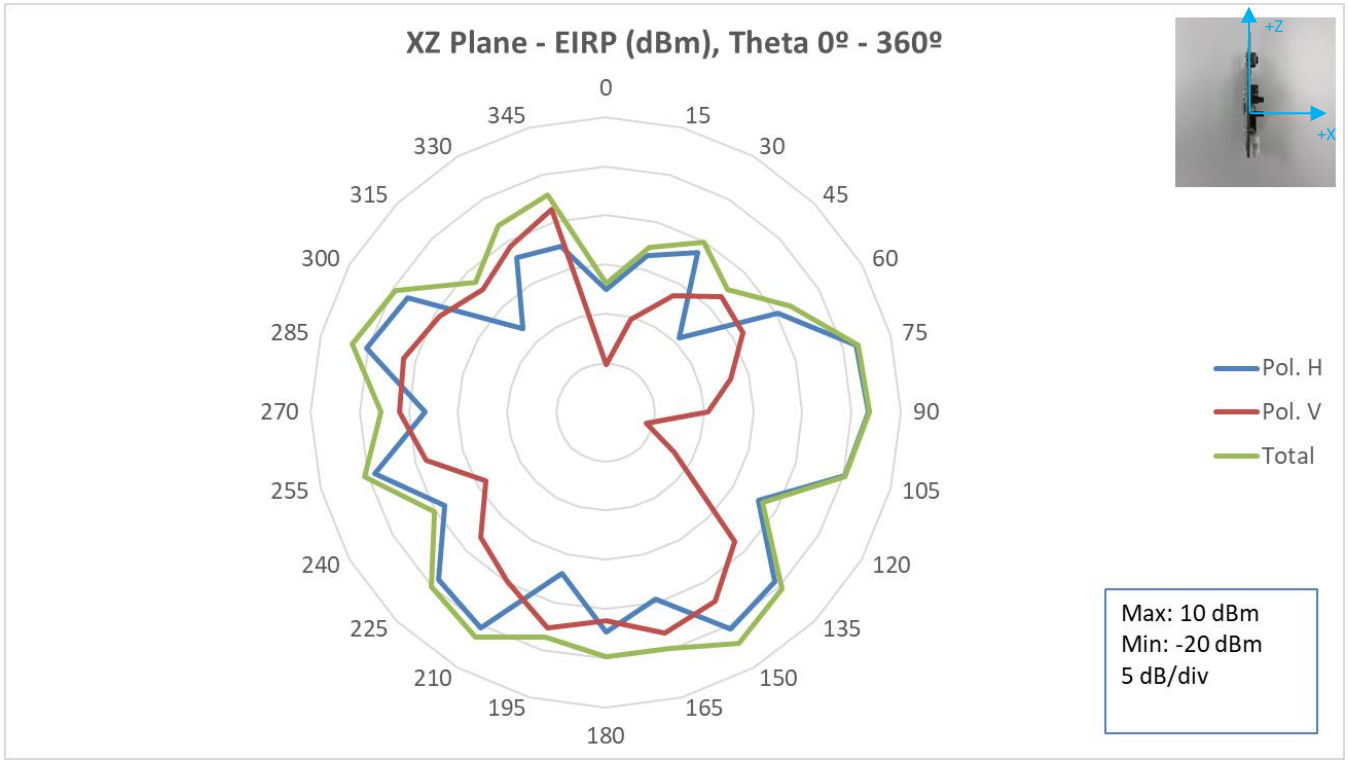

Fig. 8. XZ Plane EIRP, Free Space, 865.1 MHz.

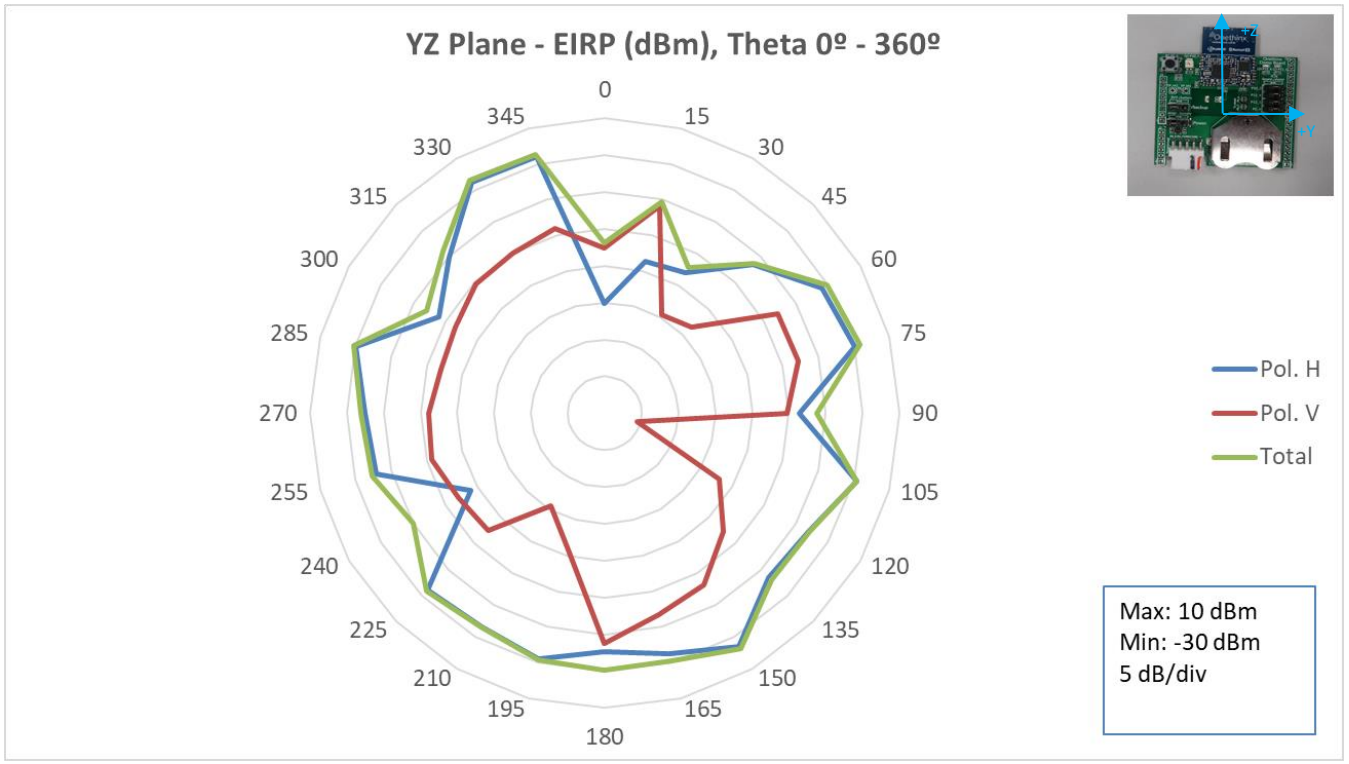

Fig. 9. YZ Plane EIRP, Free Space, 865.1 MHz.

4.3 EIRP Pattern 868.3 MHz – Free Space

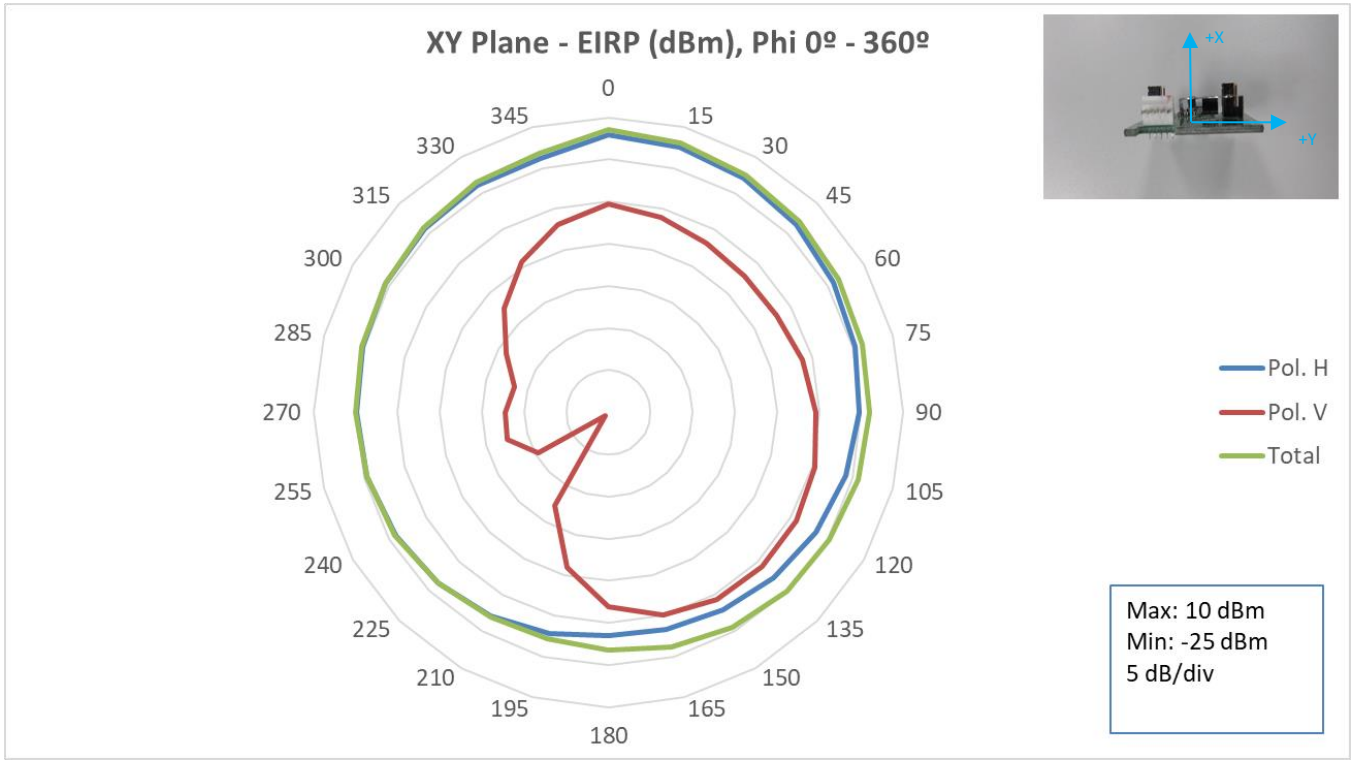

Fig. 10. XY Plane EIRP, Free Space, 868.3 MHz.

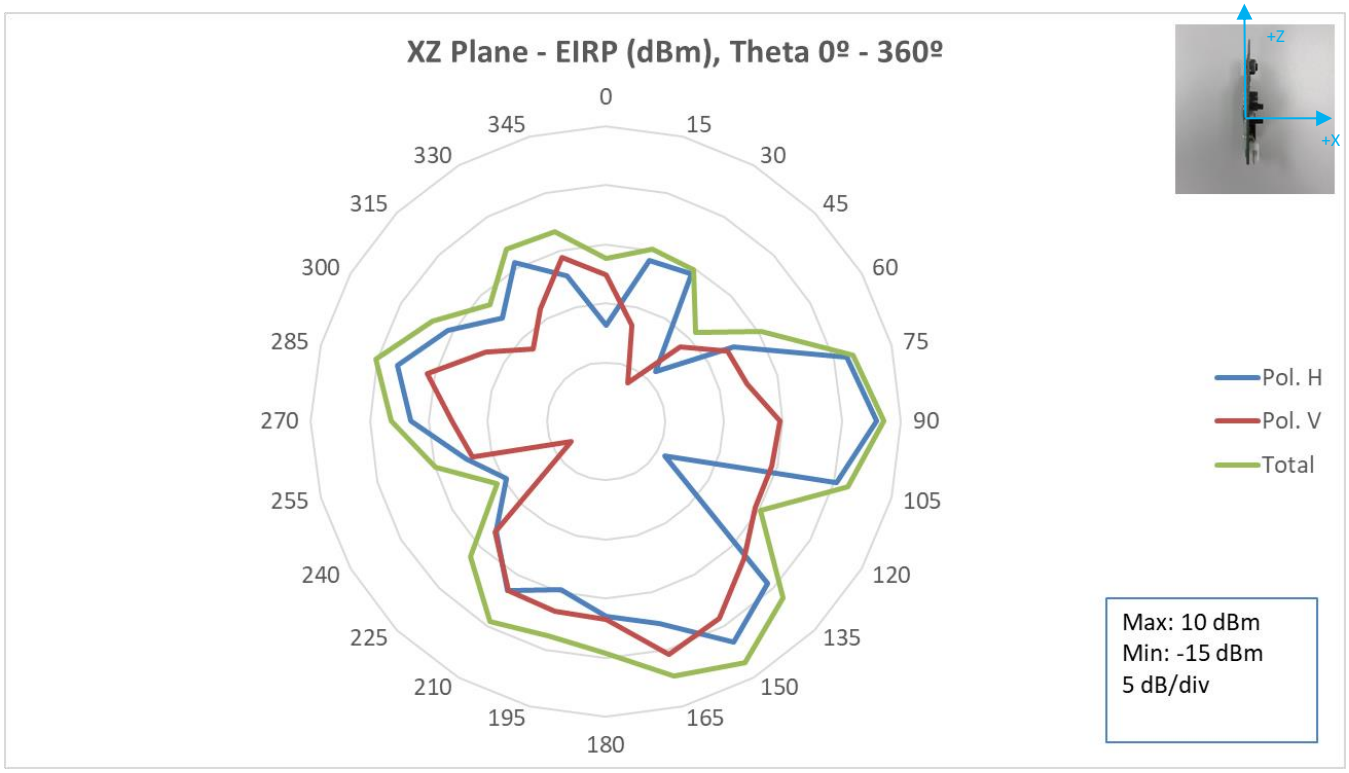

Fig. 11. XZ Plane EIRP, Free Space, 868.3 MHz.

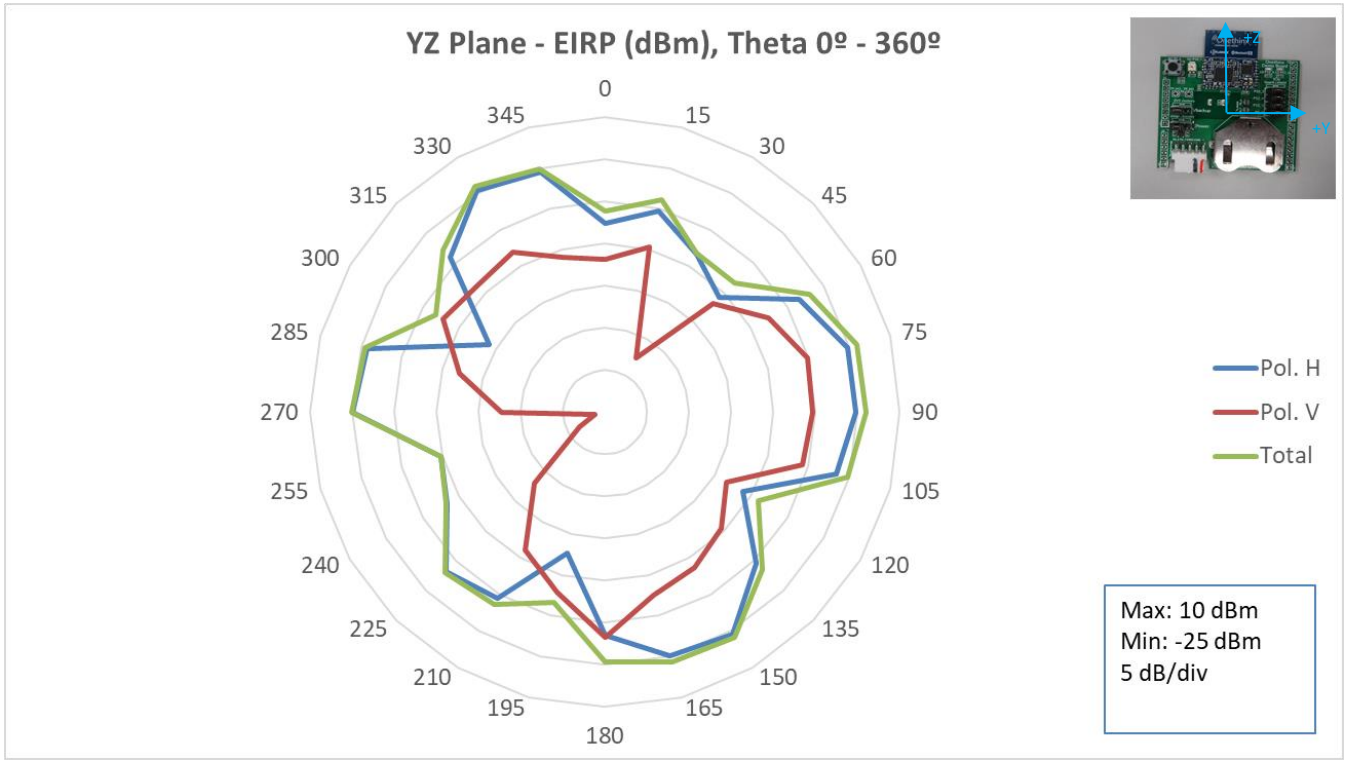

Fig. 12. YZ Plane EIRP, Free Space, 868.3 MHz.

4.4 EIRP Pattern 869.525 MHz – Free Space

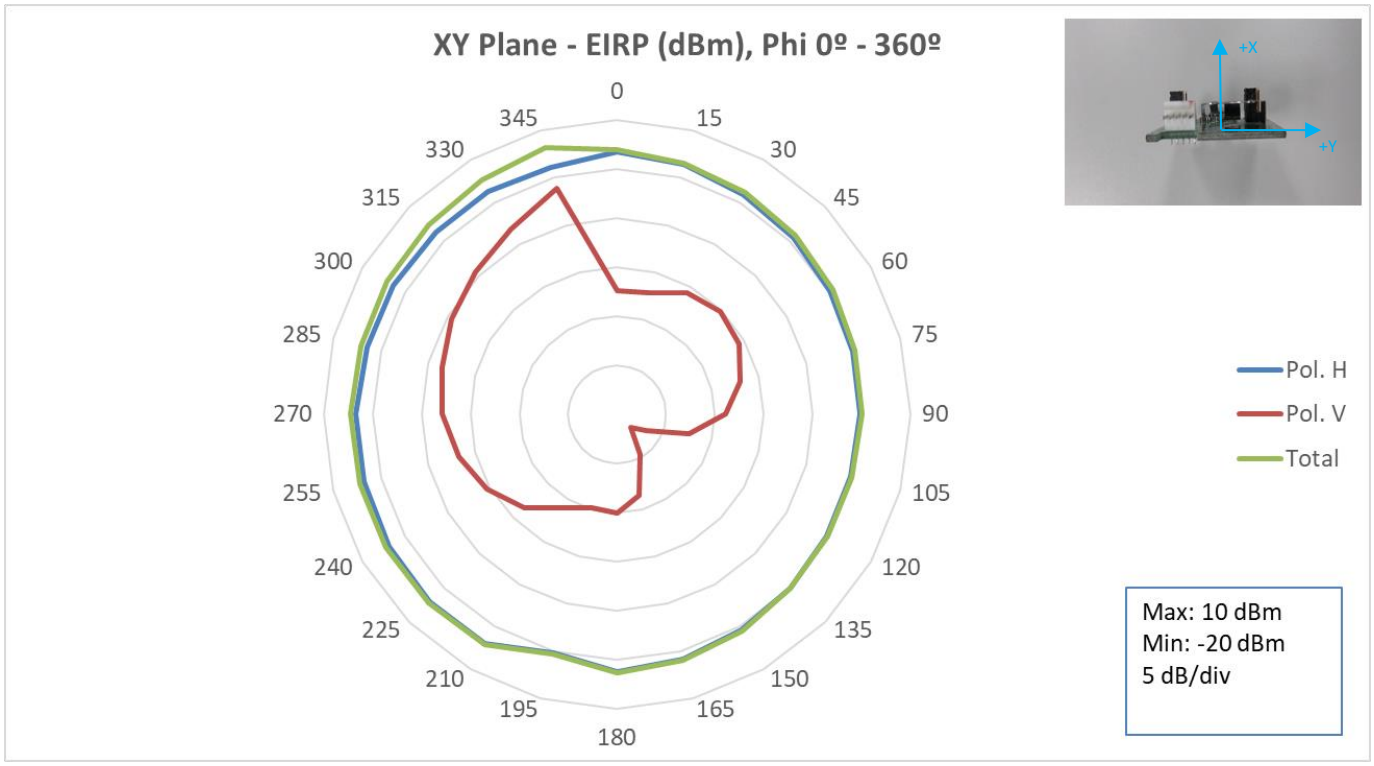

Fig. 13. XY Plane EIRP, Free Space, 869.525 MHz.

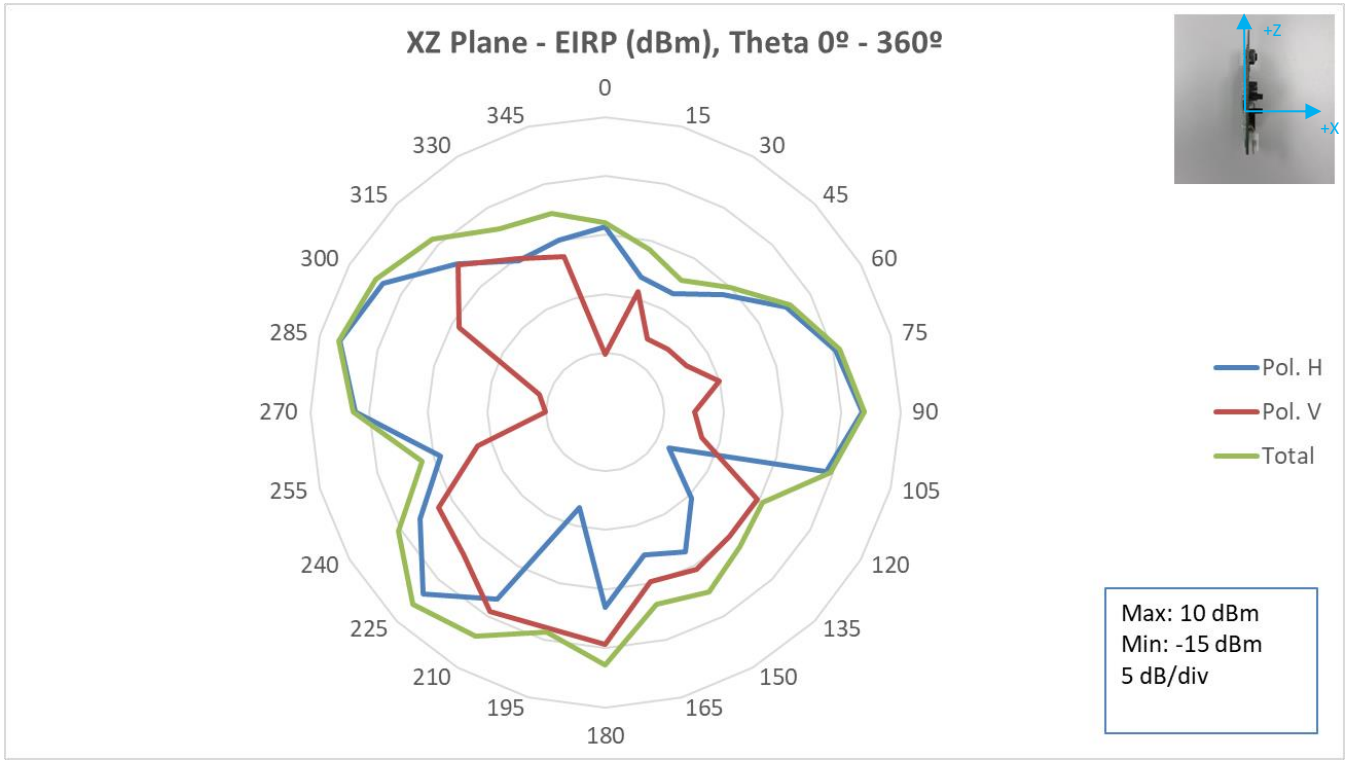

Fig. 14. XZ Plane EIRP, Free Space, 869.525 MHz.

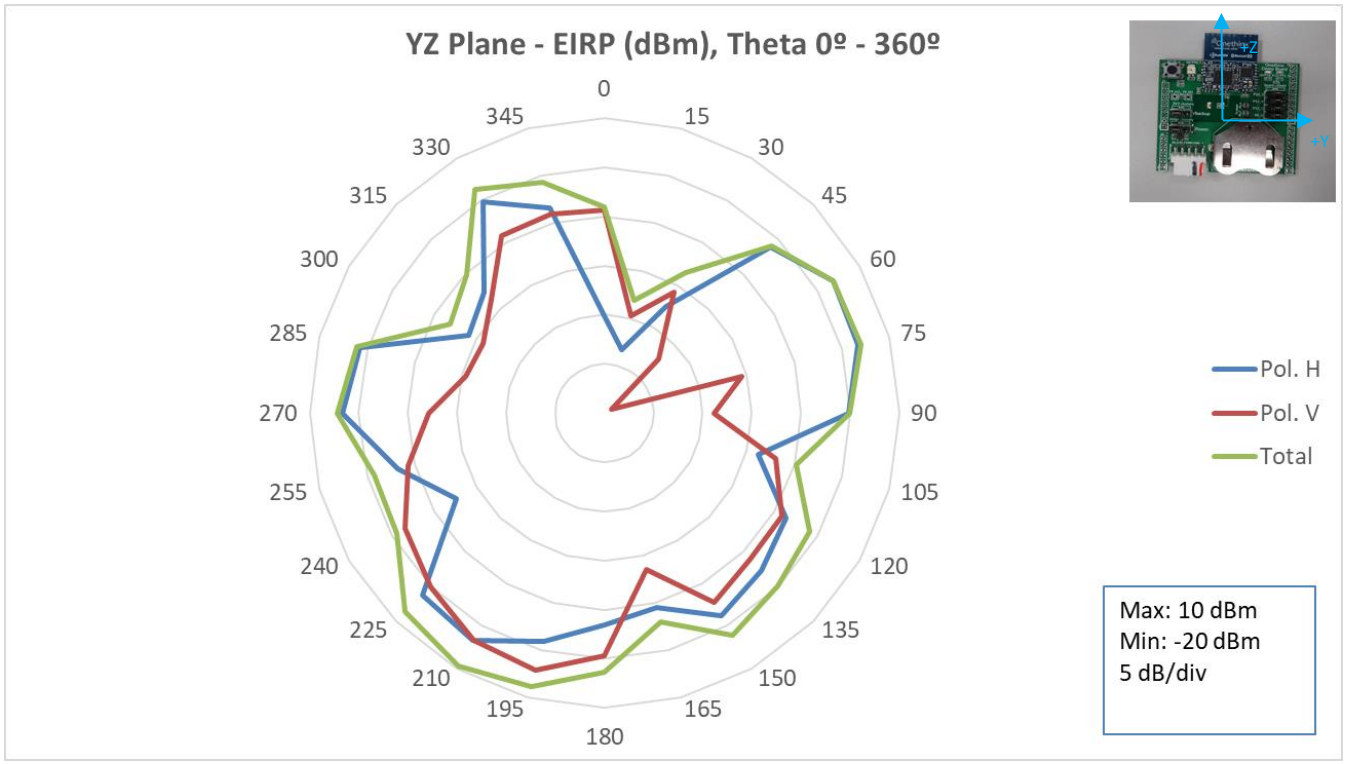

Fig. 15. YZ Plane EIRP, Free Space, 869.525 MHz.

5. RF TEST RESULT ON 3D

5.1 TRP 863.1 MHz – Free Space

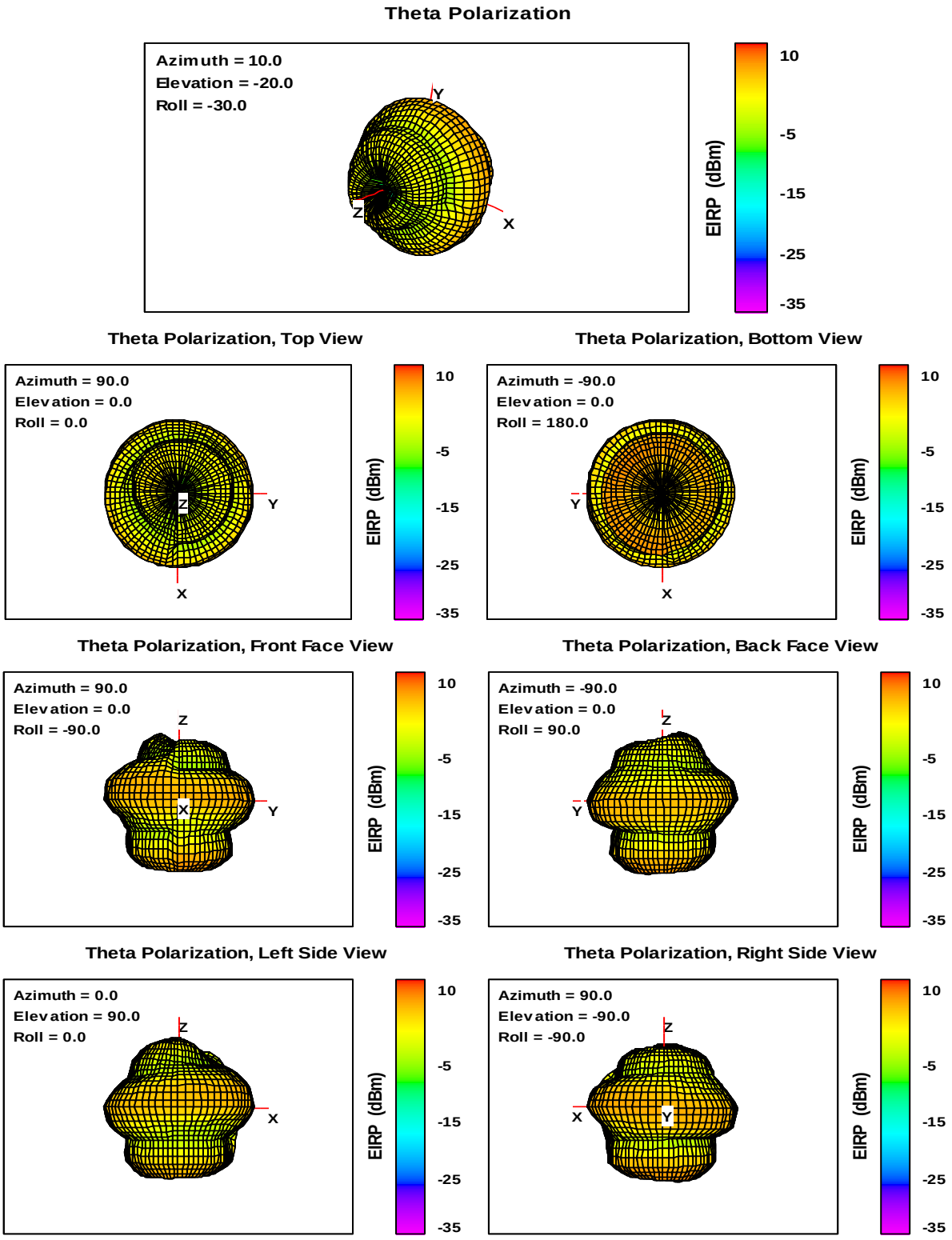

Fig. 16. Theta Polarization (Horizontal) EIRP, Free Space, 863.1 MHz.

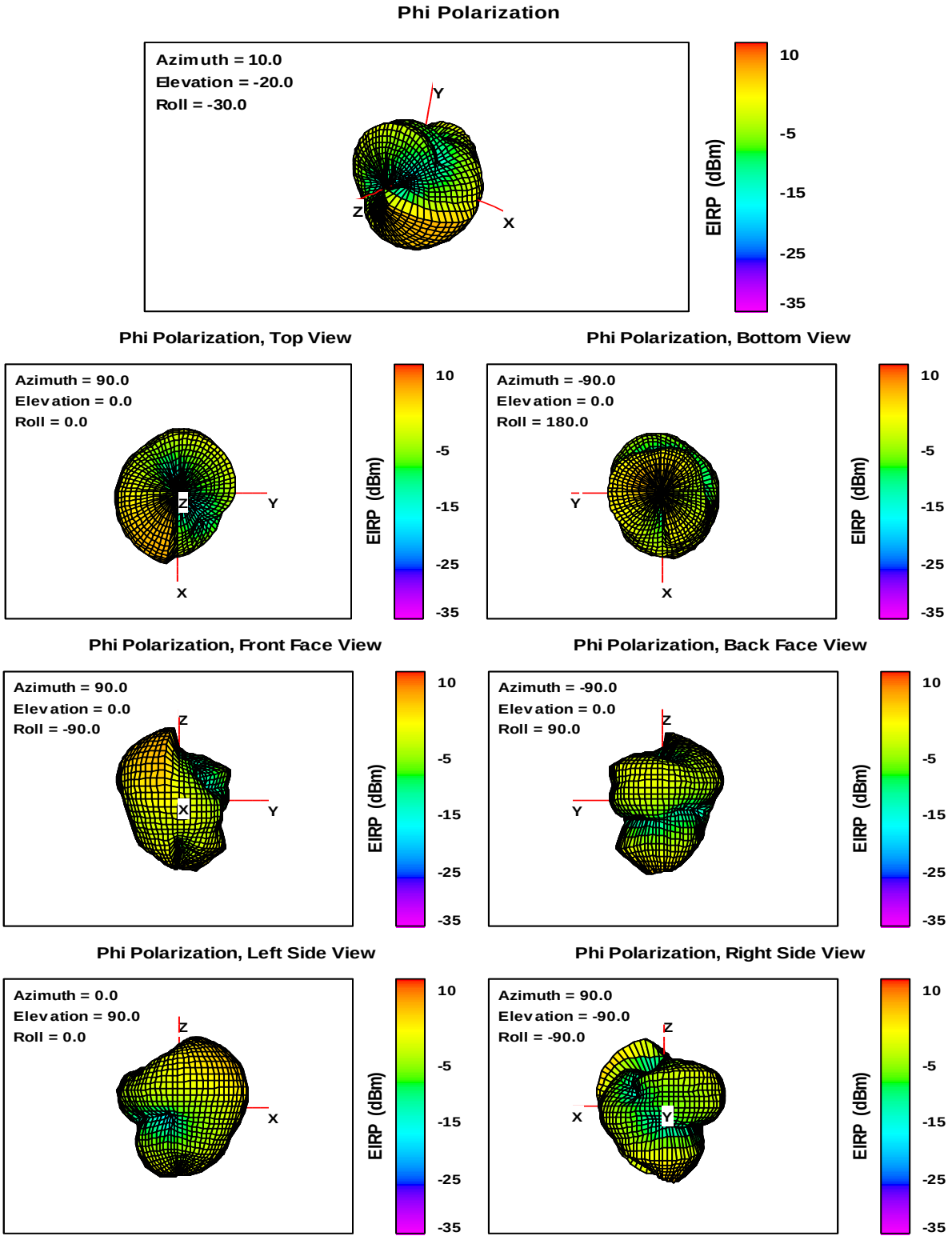

Fig. 17. Phi Polarization (Vertical) EIRP, Free Space, 863.1 MHz.

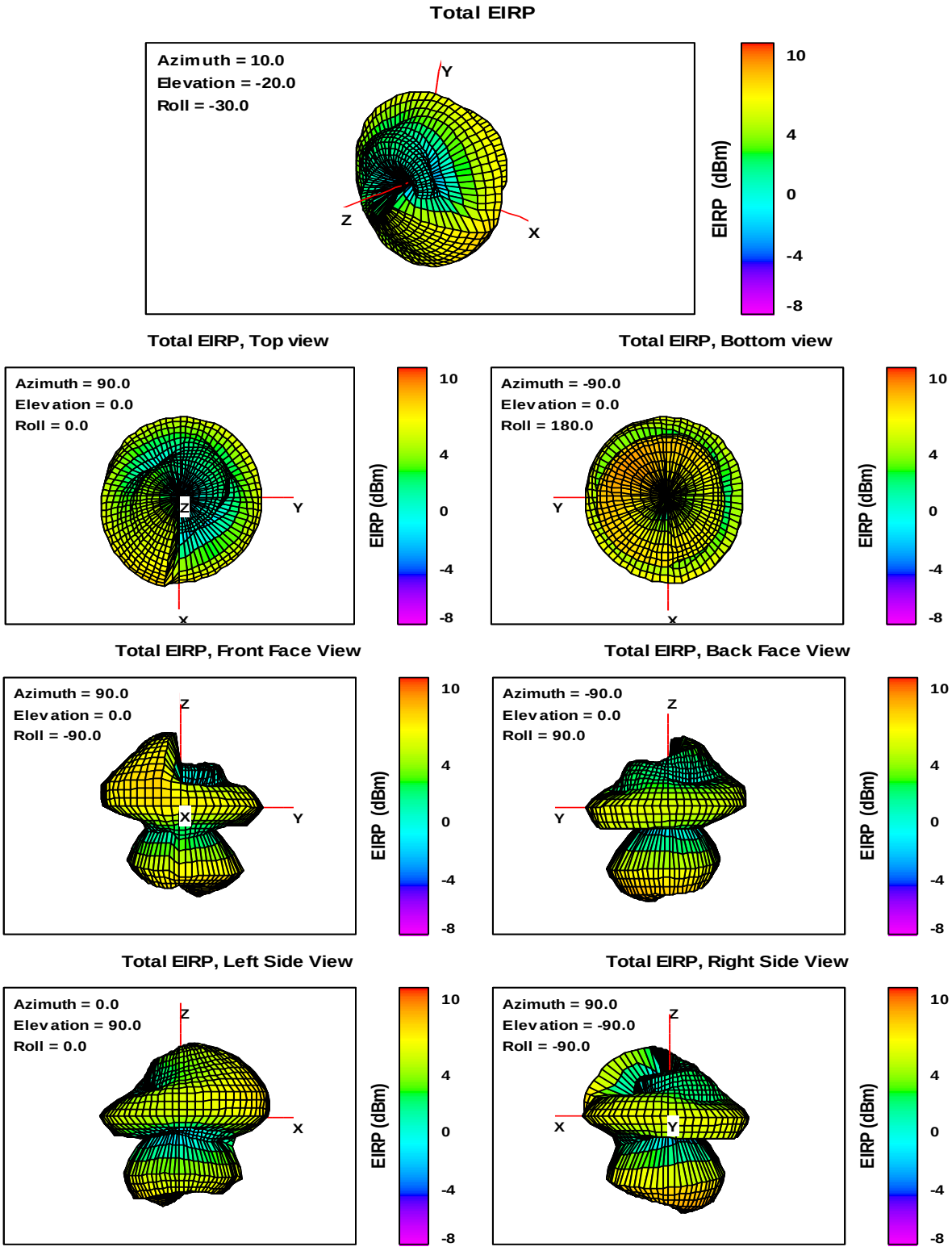

Fig. 18. Total EIRP, Free Space, 863.1 MHz.

5.2 TRP 865.1 MHz – Free Space

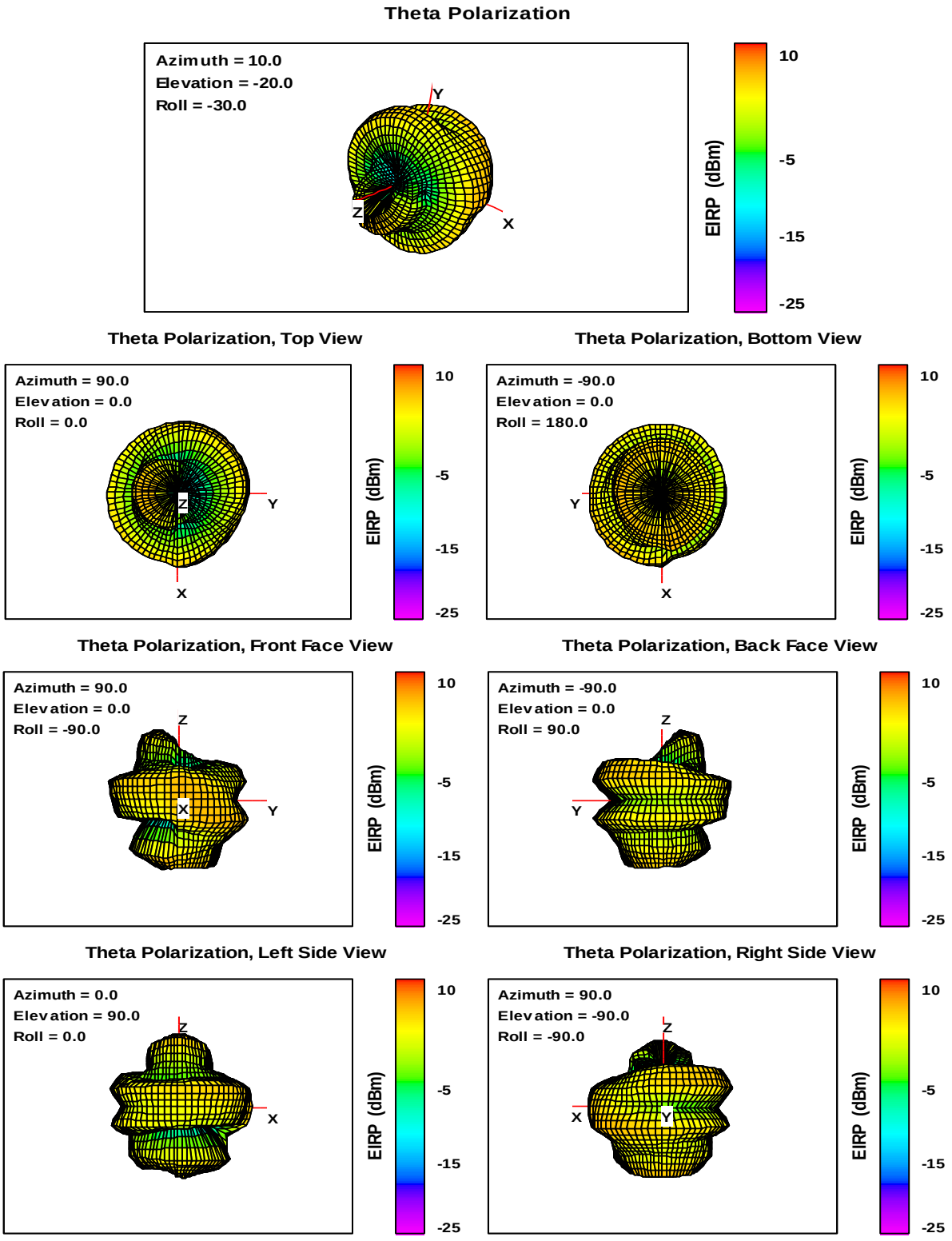

Fig. 19. Theta Polarization (Horizontal) EIRP, Free Space, 865.1 MHz.

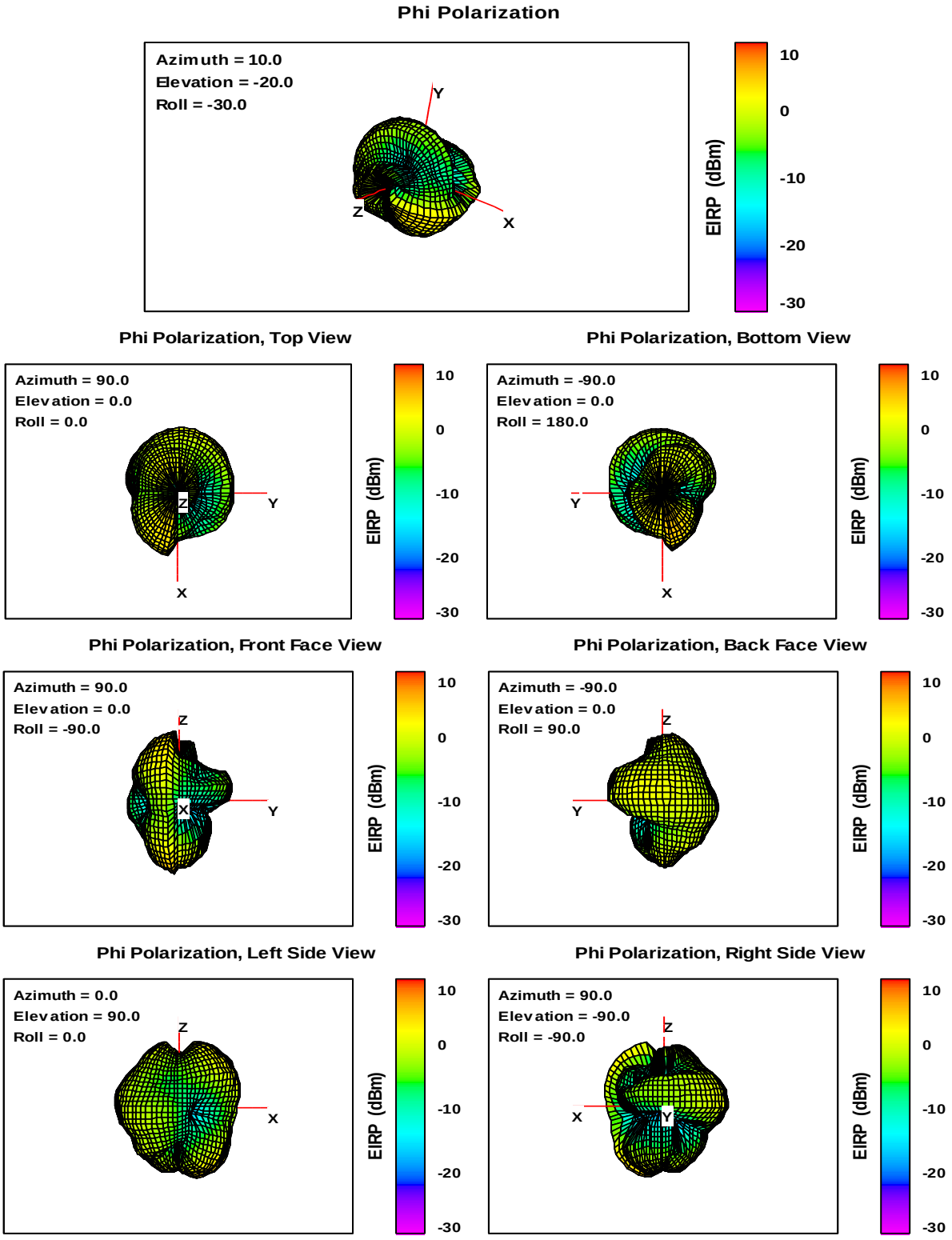

Fig. 20. Phi Polarization (Vertical) EIRP, Free Space, 865.1 MHz.

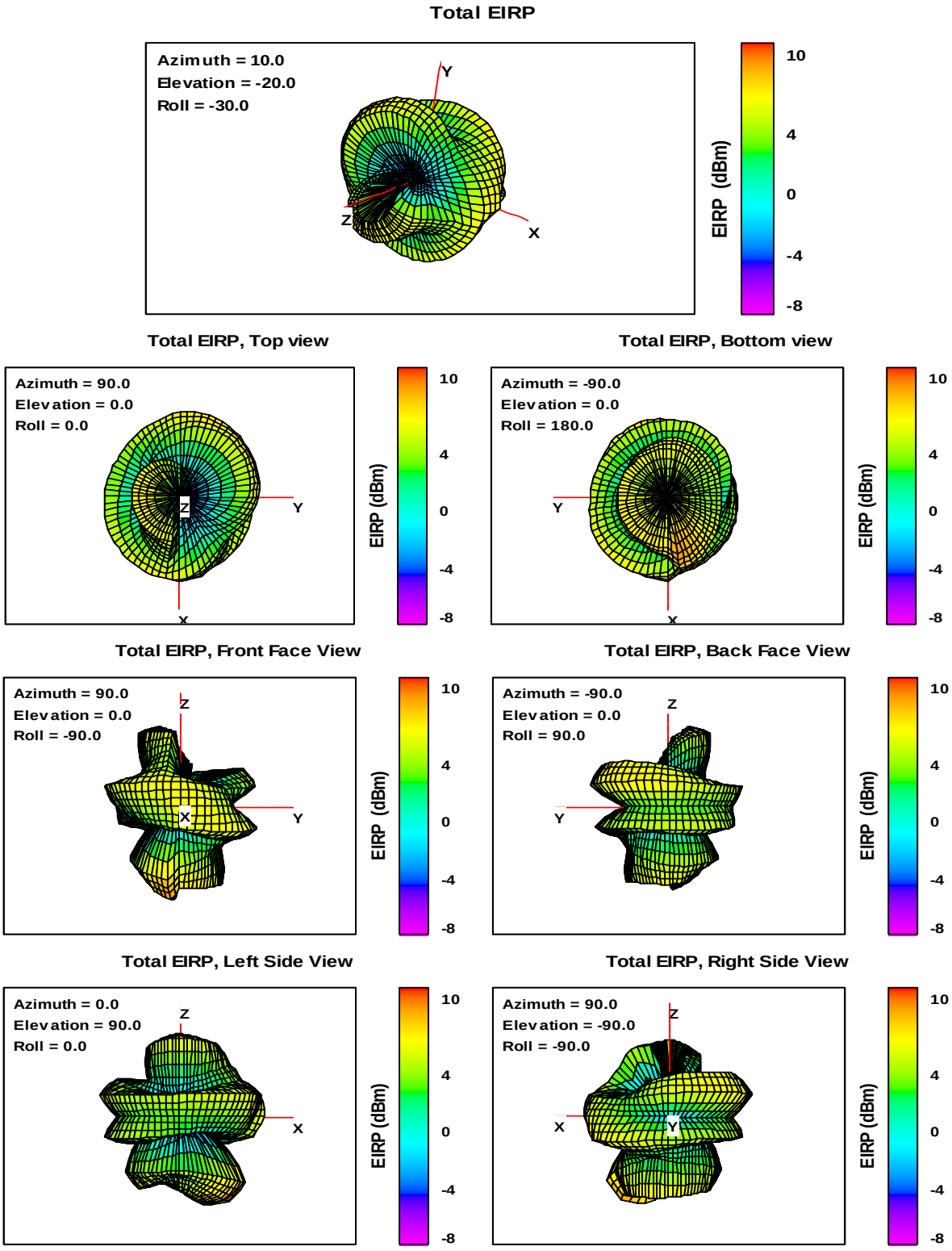

Fig. 21. Total EIRP, Free Space, 865.1 MHz.

5.3 TRP 868.3 MHz – Free Space

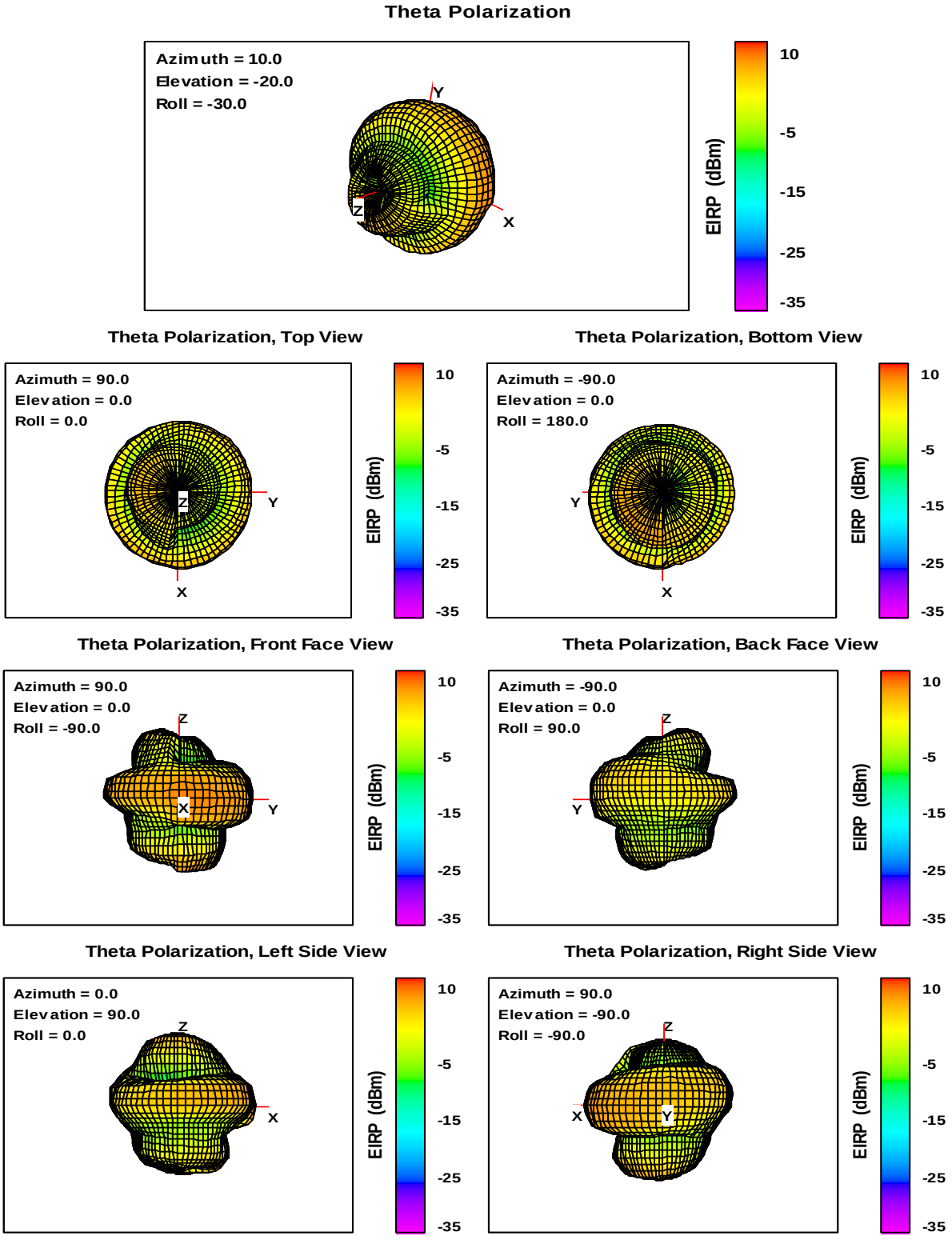

Fig. 22. Theta Polarization (Horizontal) EIRP, Free Space, 868.3 MHz.

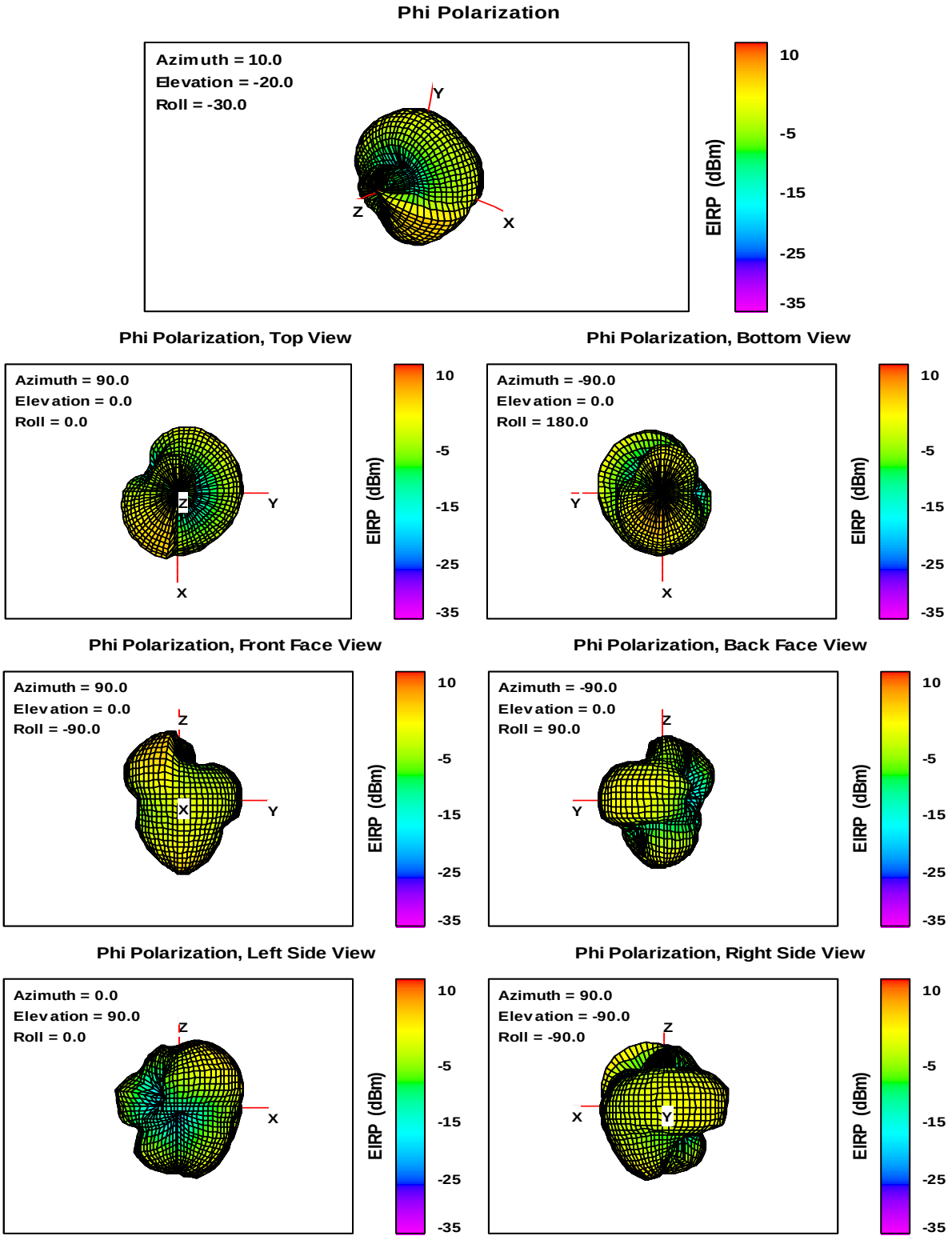

Fig. 23. Phi Polarization (Vertical) EIRP, Free Space, 868.3 MHz.

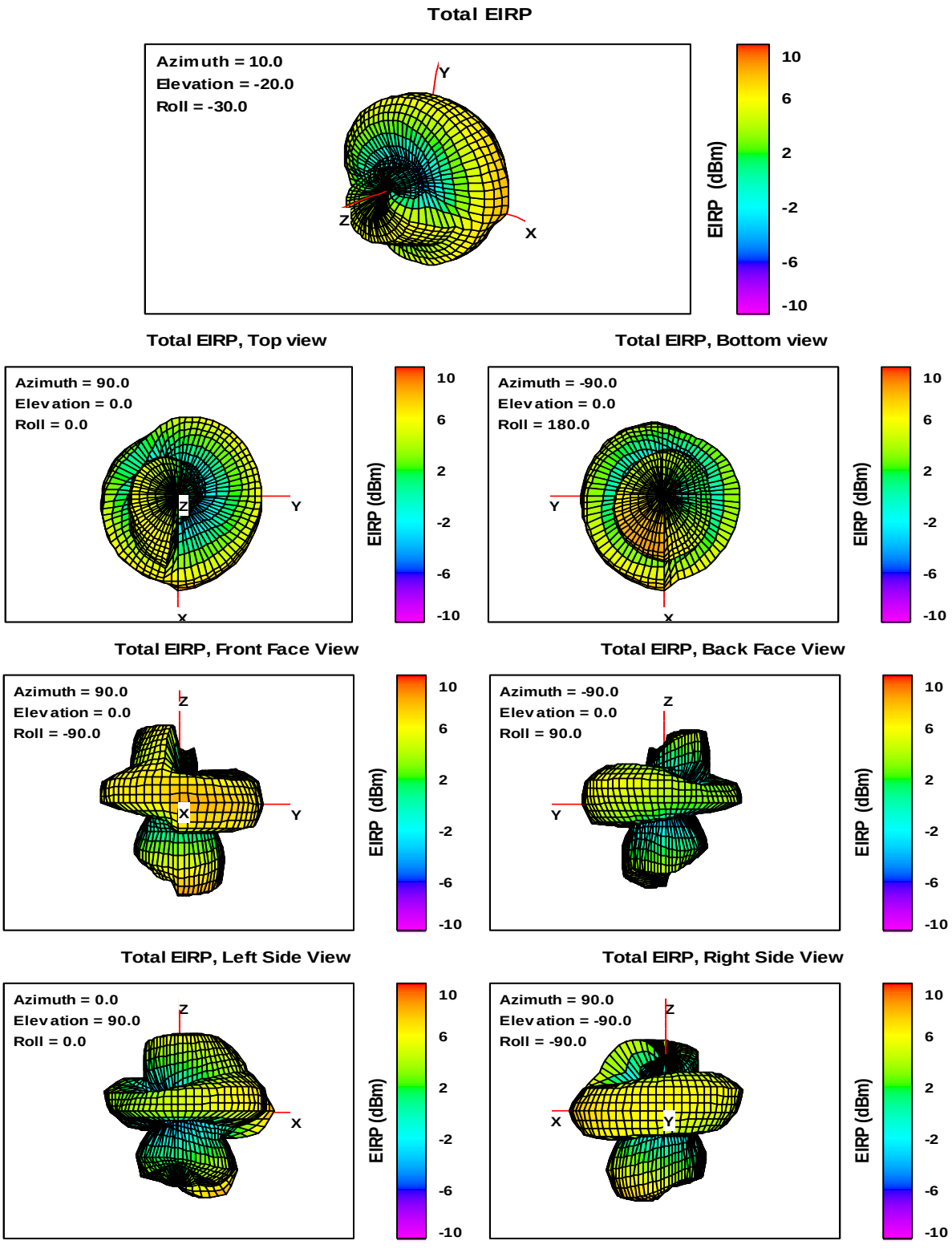

Fig. 24. Total EIRP, Free Space, 868.3 MHz.

5.4 TRP 869.525 MHz – Free Space

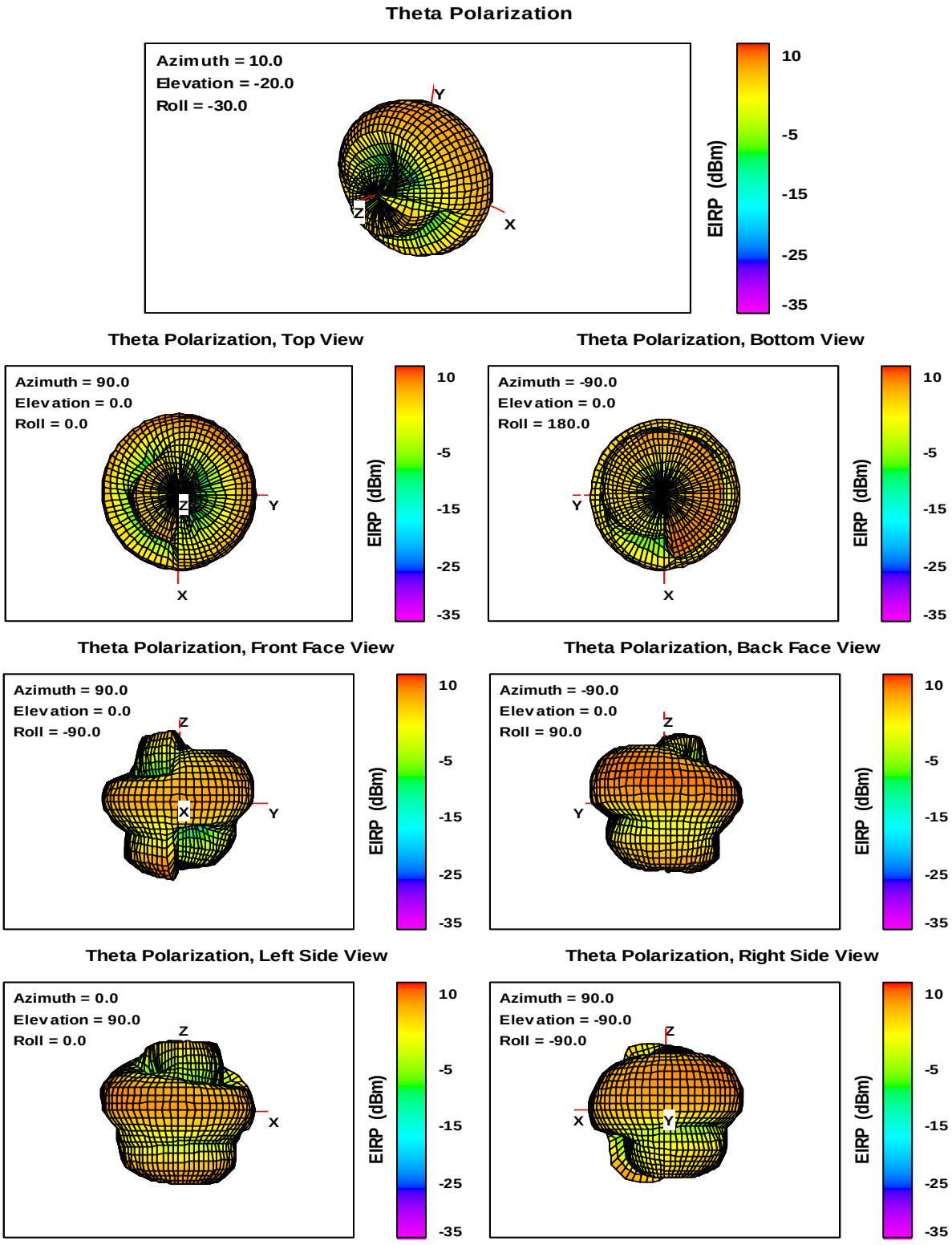

Fig. 25. Theta Polarization (Horizontal) EIRP, Free Space, 869.525 MHz.

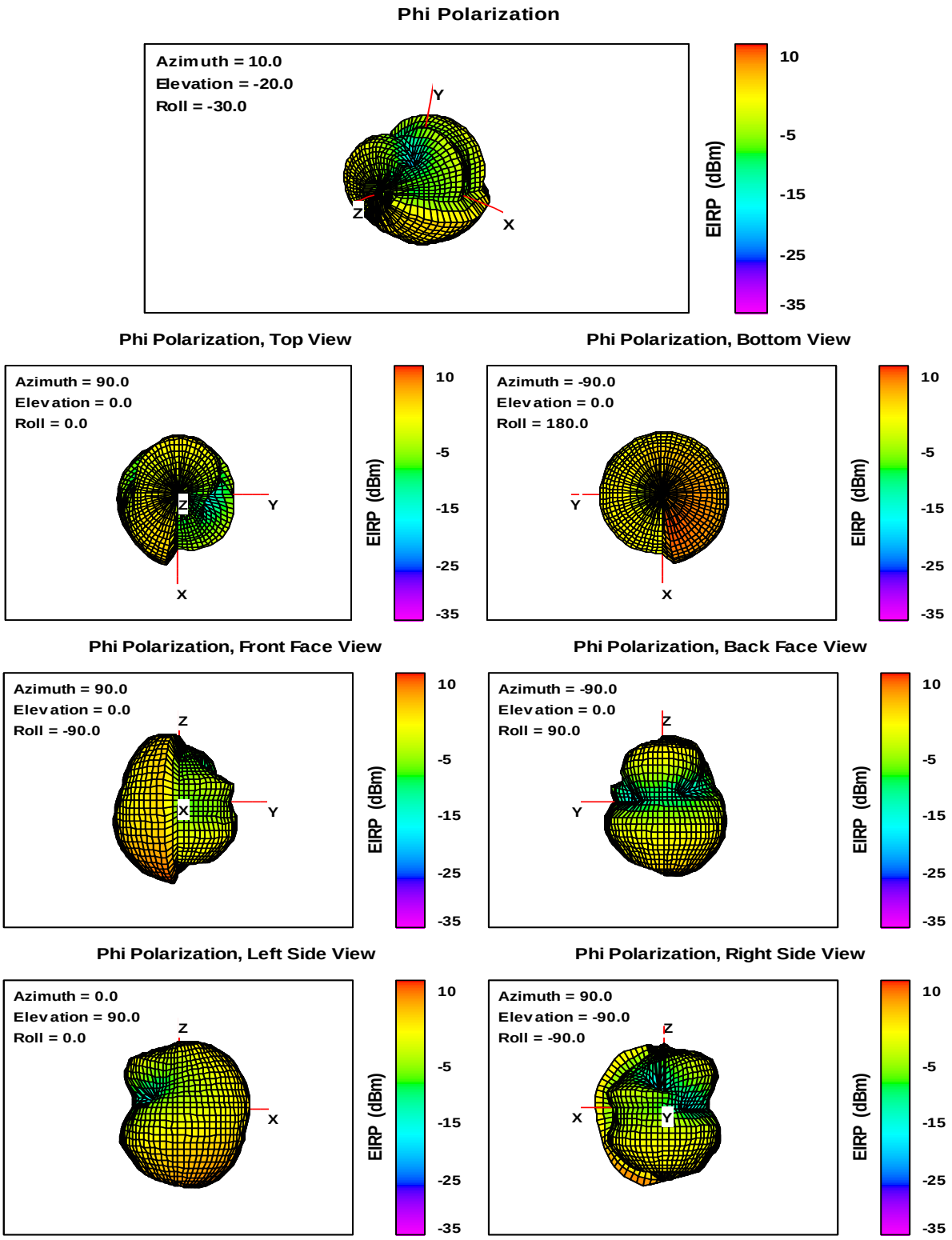

Fig. 26. Phi Polarization (Vertical) EIRP, Free Space, 869.525 MHz.

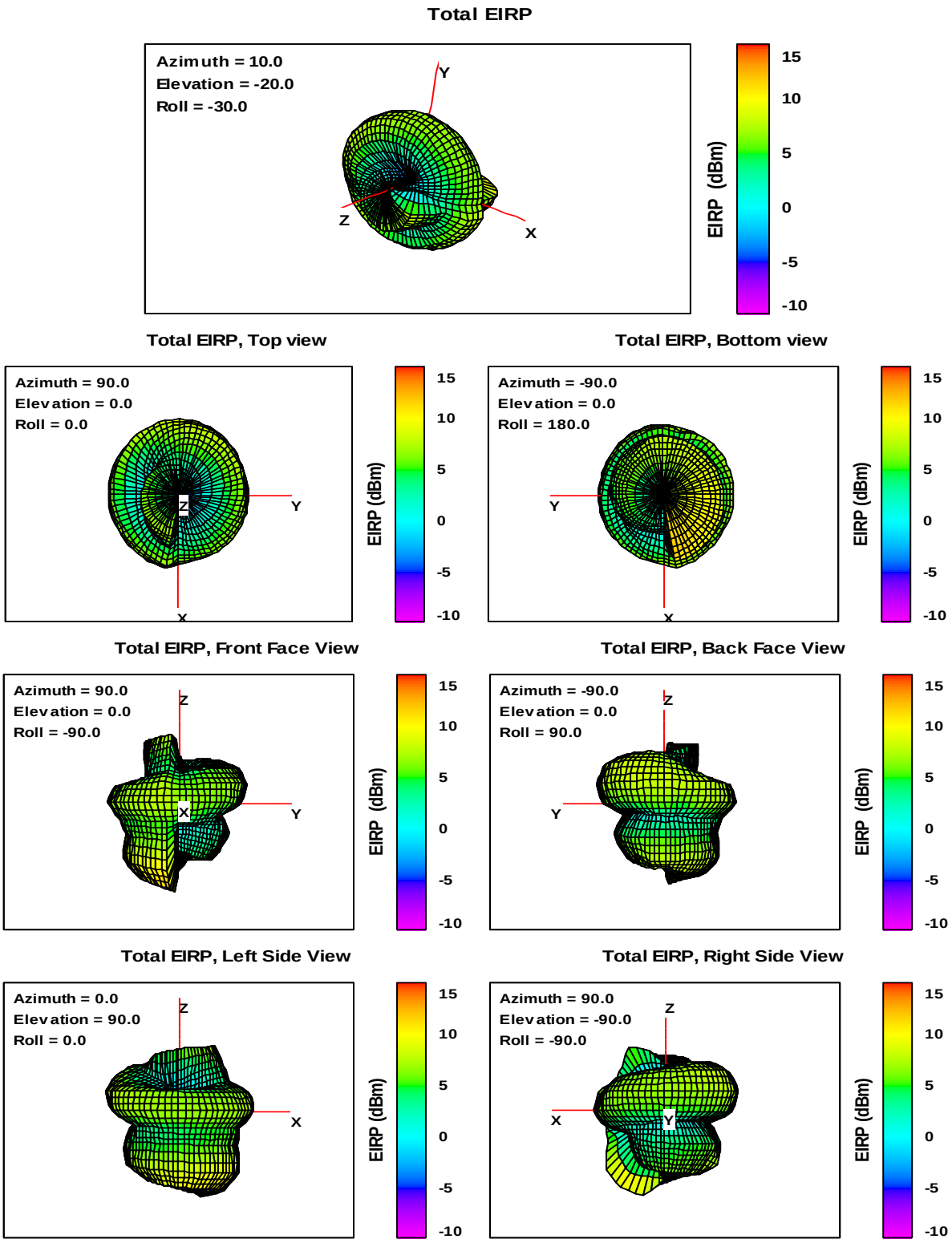

Fig. 27. Total EIRP, Free Space, 869.525 MHz.

6. RANGE REFERENCE MEASUREMENT DATA

Measurement Date:	2020-02-04
Reference Antenna(s):	ETS Lindgren Dipole antenna 880 MHz, model 3126-880 (Cellular Band)
Polarization:	Theta (Horizontal)
Signal Path:	Theta Polarization to Spectrum Analyzer (TRP)

Band	Freq. (MHz)	Cable Ref. (dBm)	Test Port (dBm)	Noise Floor (dBm)	Test Port - Cable (dB)	Test Port - Noise (dB)	Ref. Ant. Gain (dBi)	Path Loss (dB)
EU 868 MHz	863.1	-	-	-	48.46	-	1.68	50.14
EU 868 MHz	865.1	-	-	-	48.51	-	1.68	50.19
EU 868 MHz	868.3	-	-	-	48.48	-	1.68	50.16
EU 868 MHz	869.5	-	-	-	48.53	-	1.68	50.21

Measurement Date:	2020-02-04
Reference Antenna(s):	ETS Lindgren Dipole antenna 880 MHz, model 3126-880 (Cellular Band)
Polarization:	Phi (Vertical)
Signal Path:	Phi Polarization to Spectrum Analyzer (TRP)

Band	Freq. (MHz)	Cable Ref. (dBm)	Test Port (dBm)	Noise Floor (dBm)	Test Port - Cable (dB)	Test Port - Noise (dB)	Ref. Ant. Gain (dBi)	Path Loss (dB)
EU 868 MHz	863.1	-	-	-	51.11	-	1.68	52.79
EU 868 MHz	865.1	-	-	-	51.14	-	1.68	52.82
EU 868 MHz	868.3	-	-	-	51.24	-	1.68	52.92
EU 868 MHz	869.5	-	-	-	51.34	-	1.68	53.02

The path loss referenced in the following tables corresponds to the NSA value used in section 2 to determine the EIS level.

Measurement Date:	2020-02-04
Reference Antenna(s):	ETS Lindgren Dipole antenna 880 MHz, model 3126-880 (Cellular Band)
Polarization:	Theta (Horizontal)
Signal Path:	Theta Polarization to Variable Attenuator (TIS)

Band	**Freq. (MHz)**	**Cable Ref. (dBm)**	**Test Port (dBm)**	**Noise Floor (dBm)**	**Test Port - Cable (dB)**	**Test Port - Noise (dB)**	**Ref. Ant. Gain (dBi)**	**Path Loss (dB)**
EU 868 MHz	863.1	-	-	-	48.99	-	1.68	50.67
EU 868 MHz	865.1	-	-	-	49.04	-	1.68	50.72
EU 868 MHz	868.3	-	-	-	49.02	-	1.68	50.70
EU 868 MHz	869.525	-	-	-	49.07	-	1.68	50.75

Measurement Date:	2020-02-04
Reference Antenna(s):	ETS Lindgren Dipole antenna 880 MHz, model 3126-880 (Cellular Band)
Polarization:	Phi (Vertical)
Signal Path:	Phi Polarization to Variable Attenuator (TIS)

Band	**Freq. (MHz)**	**Cable Ref. (dBm)**	**Test Port (dBm)**	**Noise Floor (dBm)**	**Test Port - Cable (dB)**	**Test Port - Noise (dB)**	**Ref. Ant. Gain (dBi)**	**Path Loss (dB)**
EU 868 MHz	863.1	-	-	-	51.61	-	1.68	53.29
EU 868 MHz	865.1	-	-	-	51.69	-	1.68	53.37
EU 868 MHz	868.3	-	-	-	51.80	-	1.68	53.48
EU 868 MHz	869.525	-	-	-	51.87	-	1.68	53.55

Appendix B: Photographs

Equipment under test:

- **EUT front view:**

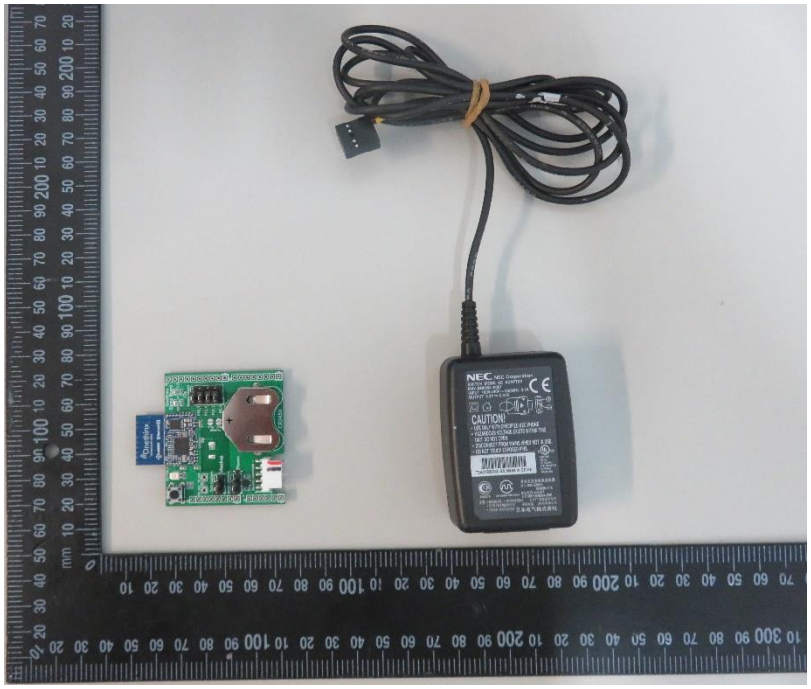

Fig 28. EUT front view.

- **EUT back view:**

Fig 29. EUT back view.

Test set:

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

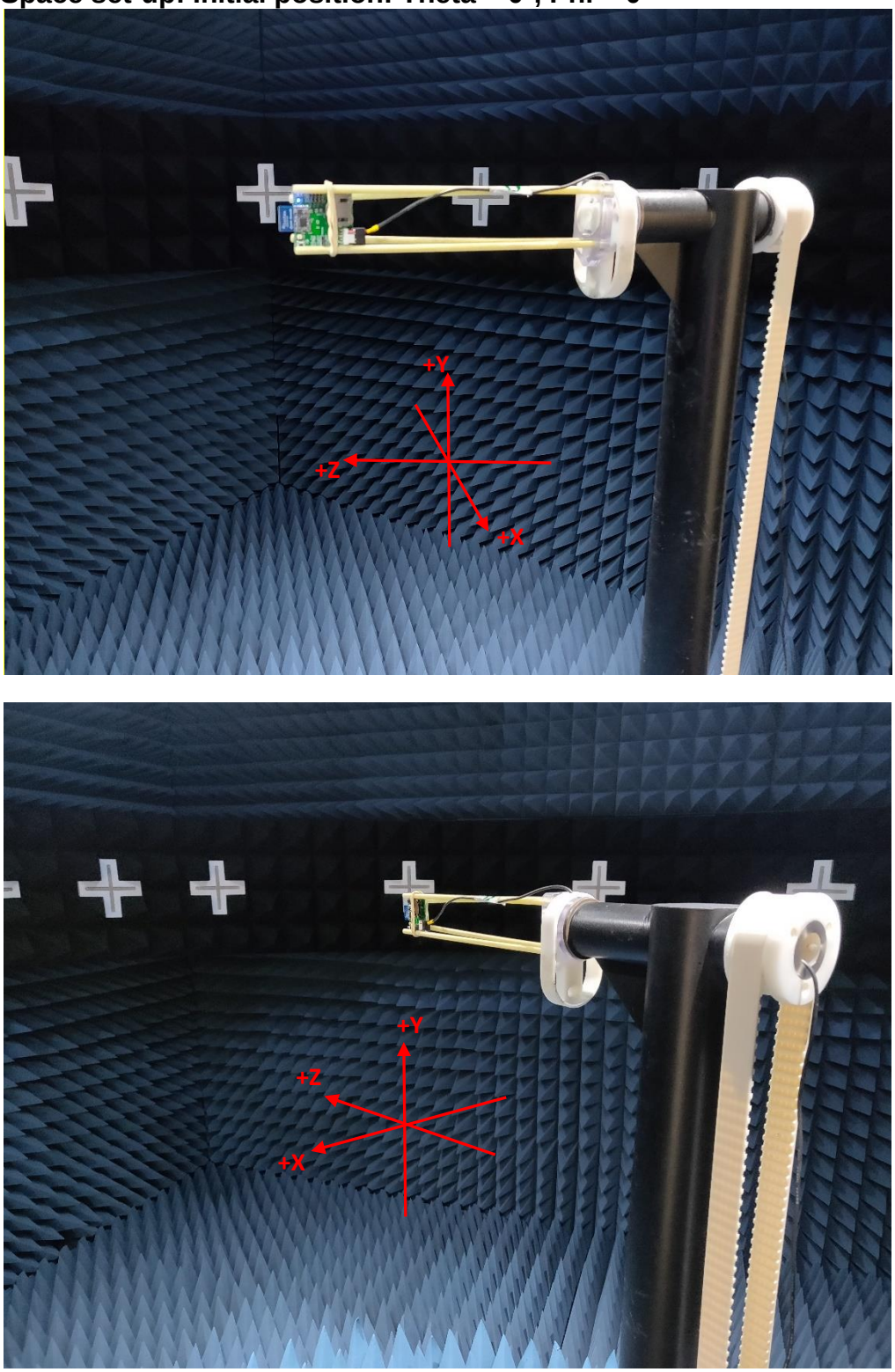

Fig 30. Free Space configuration set-up view.