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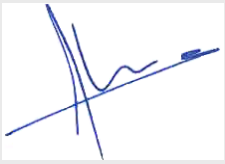
C.I.F. A29 507 456

Test report No:
NIE: 62133RAN.001

Test report

LoRa Alliance End-Device Certification Radiated RF Performance for EU 868 MHz ISM Band Devices

(*) Identification of item tested	LORA – RS485 interface
(*) Trademark	CARLO GAVAZZI
(*) Model and /or type reference	UWPAM1US1L1X
Other identification of the product	S/N: BT212000201 1M (Wireless Endpoint Gateway)
(*) Features	RS485 to Carlo Gavazzi meters and analysers
Manufacturer	Company name: CARLO GAVAZZI CONTROLS SPA Postal address: Via Safforze 8 – 32100 Belluno - Italy
Test method requested, standard	[1] LoRa Alliance End-Device Certification Radiated RF Performance for EU 868 MHz ISM Band Devices
Test Operator	Manuel Garcia Fuertes
Approved by (name / position & signature)	Miguel Lacave Antennas Lab Manager  MIGUEL LACAVE GARCÍA 2019.09.13 14:37:39 +02'00'
Date of issue	2019-09-13
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.

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4. This test report cannot be used partially or in full for publicity and/or promotional purposes without previous written permission of DEKRA 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 related 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.

Instrumentation

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

Equipment
1. Anechoic chamber ETS LINDGREN AMS-8700
2. Positioning system controller and RF switch ETS LINDGREN EMCENTER 7000-001
3. OTA measurement software ETS LINDGREN EMQuest v1.12
4. Spectrum analyzer Keysight Technologies PSA E4445A
5. LoRa Gateway Semtech IOT868TKLM1 HAL v3.2.0
6. Step attenuator Vaunix Technology Corporation Lab BrickDigital Attenuator
7. RF Circulator Channel Microwave Corporation, Model BUL330
8. RF Isolator Channel Microwave Corporation, Model AUL330
9. Temperature and Humidity probe, model HWg-STE

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
62133/001	AC/DC Switching Power Supply	SPM4-241	803297392405	2019-08-06
62133/002	Wireless Endpoint Gateway	UWPAM1US1L1X	BT212000201 1M	2019-08-06
62133/003	Power Supply	EM210-72D.AV6.3.H.OS.P/FBD	BP3030003001F	2019-08-06
62133/009	Antenna	LTE FIX MOUNT DIPOLE ANTENNA	BT212000201 1M (same as the endpoint)	2019-08-06

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

Test sample description

The test sample is a Carlo Gavazzi’s endpoint adapter that provides LoRaWAN communication to RS485 Carlo Gavazzi meters and analysers.

Identification of the client

Company name: CARLO GAVAZZI CONTROLS SPA

Postal Address: Via Safforze 8 – 32100 Belluno - Italy

Contact Person: FABIO SOGNE

Telephone/e-mail: +390437355811/fabio.sogne@gavazziacbu.it

Testing period and place

Test Location	DEKRA Testing and Certification S.A.U.
Date (start)	2019-09-03
Date (finish)	2019-09-11

Document history

Report number	Date	Description
62133RAN.001	2019-09-13	First release

Environmental conditions

Date	Max. Temp. ºC	Min. Temp. ºC	Max. Hum. %	Min. Hum. %
From 2019-09-03 to 2019-09-11	28.3	20.7	74.0	32.7

Remarks and comments

The Equipment Under Test (EUT) is composed of four elements (see “Usage of samples”) that are interconnected to each other as illustrated in Figure 28. The EUT antenna is connected to the LoRa endpoint with a 2-meters RF cable and therefore the element that was mounted on the positioner inside the chamber was the antenna (see Figure 29). The other three elements were hidden below RF absorbers to minimize their influence into the radiated measurements.

Testing has been performed by Manuel Garcia.

Testing verdicts

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

Transmitter Performance:

LoRa Alliance End-Device Certification Radiated RF Performance for EU 868 MHz ISM Band Devices, PARAGRAPH	Verdict				
	N/A	P	F	M	N/M
2 : End-device transmitter performance				X	

Receiver Performance:

LoRa Alliance End-Device Certification Radiated RF Performance for EU 868 MHz ISM Band Devices, PARAGRAPH	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 = 24 V_{DC} supplied by its own AC/DC adapter.

1.2 Test frequencies and output power

In all required operating bands the measurements for Total Radiated Power (TRP) measurements are to be performed on lowest, default and highest channels and Total Isotropic Sensitivity (TIS) measurements are to be performed on default and highest channels 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.

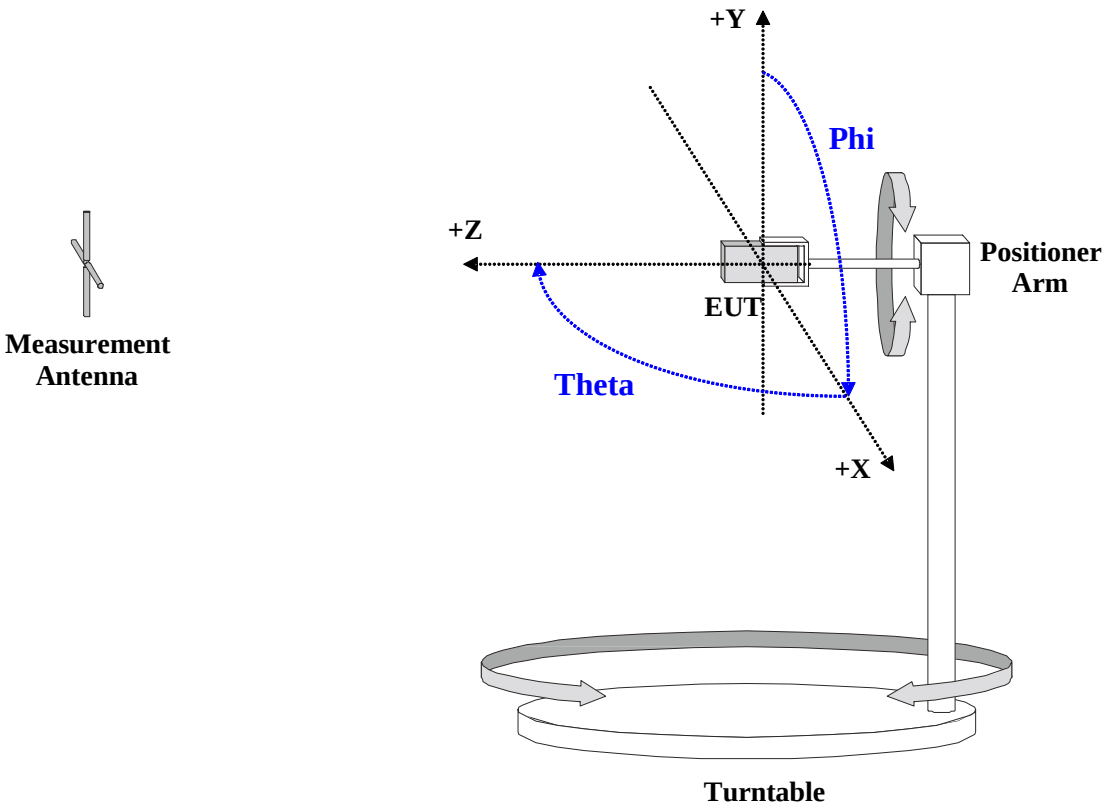

Fig. 1. Coordinate system.

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

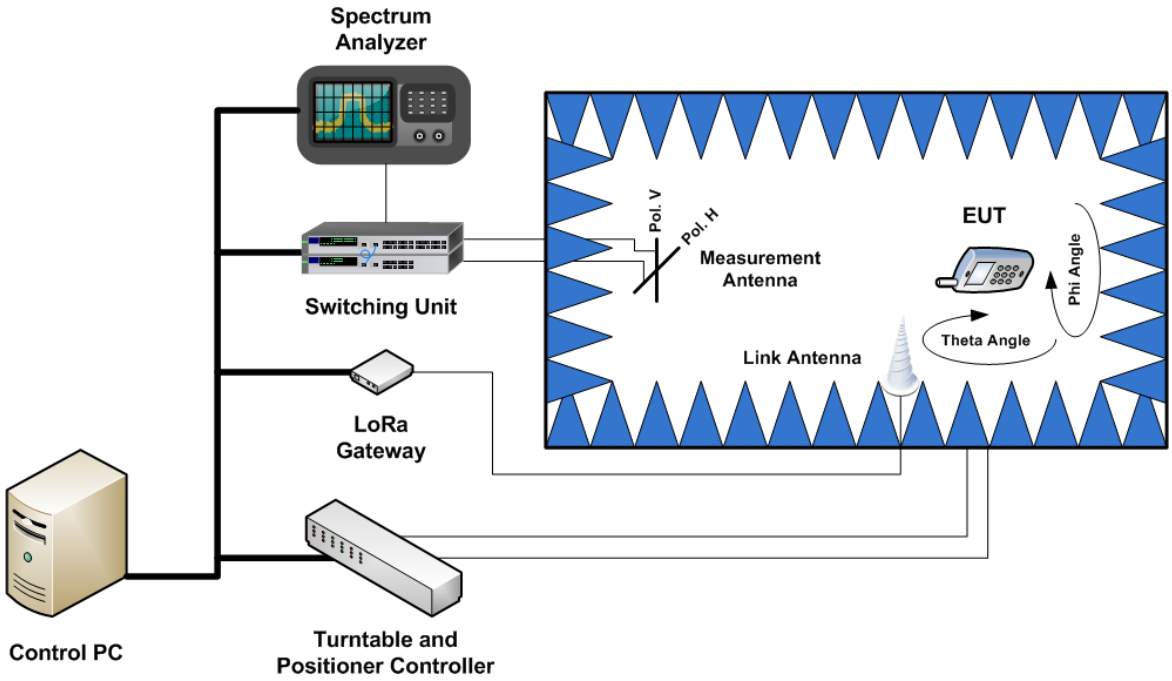

Fig. 2. Transmitter performance test connection diagram.

End-device receiver performance

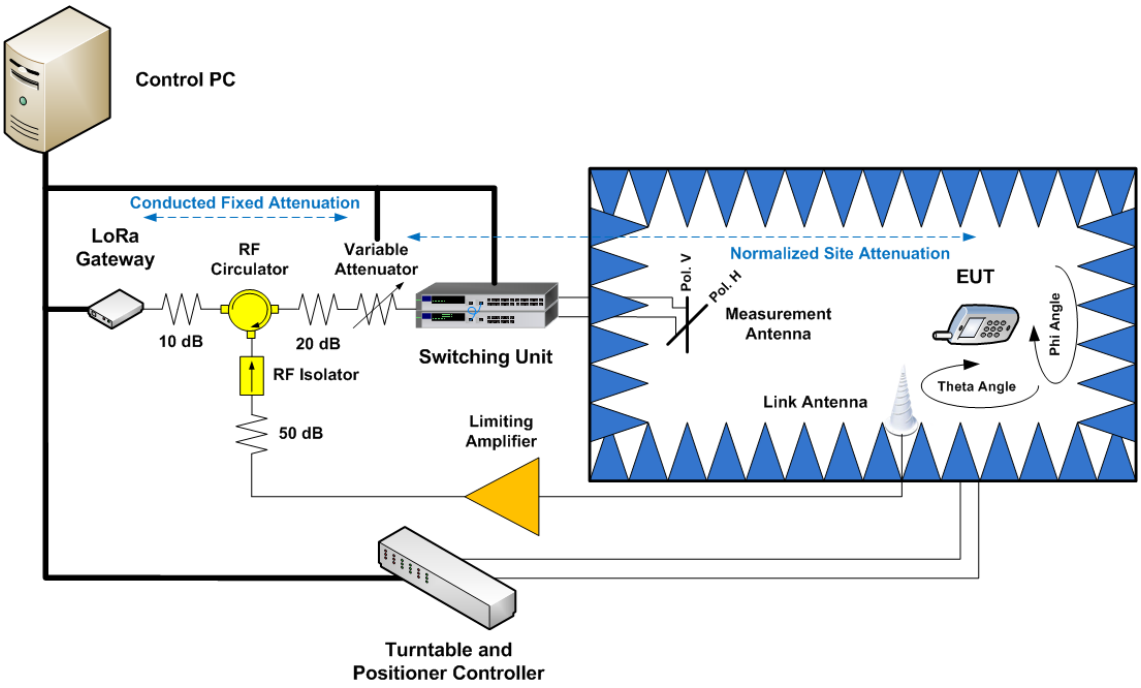

Fig. 3. Receiver performance test connection diagram.

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	13.51	16.59	-9.65	16.60	90	0
	3	N/A	11.42	-12.66	11.41	90	0
	6	N/A	4.41	-19.39	4.42	90	0
865.1	0	13.05	16.15	-20.96	16.15	70	190
	3	N/A	11.32	-9.52	11.35	70	190
	6	N/A	4.27	-16.39	4.31	70	190
868.3	0	12.95	16.09	-21.11	16.09	70	190
	3	N/A	11.28	-9.89	11.31	70	190
	6	N/A	4.11	-16.95	4.14	70	190
869.525	0	13.01	16.14	-22.55	16.14	70	190

2.2 Receiver performance

Frequency (MHz)		863.1	865.1	868.3	869.525	
Spreading Factor		SF12 (DR0)	SF12 (DR0)	SF12 (DR0)	SF12 (DR0)	SF7 (DR5)
TIS (dBm)		-132.37	-132.91	-131.13	-128.37	-114.10
Measured EIS	EIS (dBm)	-135.68	-136.24	-134.50	-131.73	-117.46
	PER (%)	3.33[1]	6.67[1]	6.67[1]	6.67[1]	3.33[1]
	Polarization	Theta	Theta	Theta	Theta	Theta
	Theta (º)	90	70	70	70	70
	Phi (º)	0	190	190	190	190
GW Tx Power (dBm)		9.16	11.61	12.80	13.20	13.20
Forward path attenuation (dB)		-147.26	-147.85	-147.30	-144.93	-130.66
Normalized Site Attenuation (NSA) (dB)[2]		-48.99	-49.04	-49.02	-49.07	-49.07
Conducted fixed attenuation (dB)[2]		-98.26	-98.80	-98.27	-95.86	-81.59
RF Path attenuation step size (dB)		0.50	0.50	0.50	0.50	0.50

[1] PER reported in the table is the one obtained at the reported EIS. Please note EIS is defined as the minimum downlink signal level received at the device that guarantees PER better than 10%. In other words, a downlink signal level lower than the reported EIS would result in a PER equal to or higher than 10%.
[2] 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)	**LoRa Alliance End-Device Certification Radiated RF Performance for EU 868 MHz ISM Band Devices 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

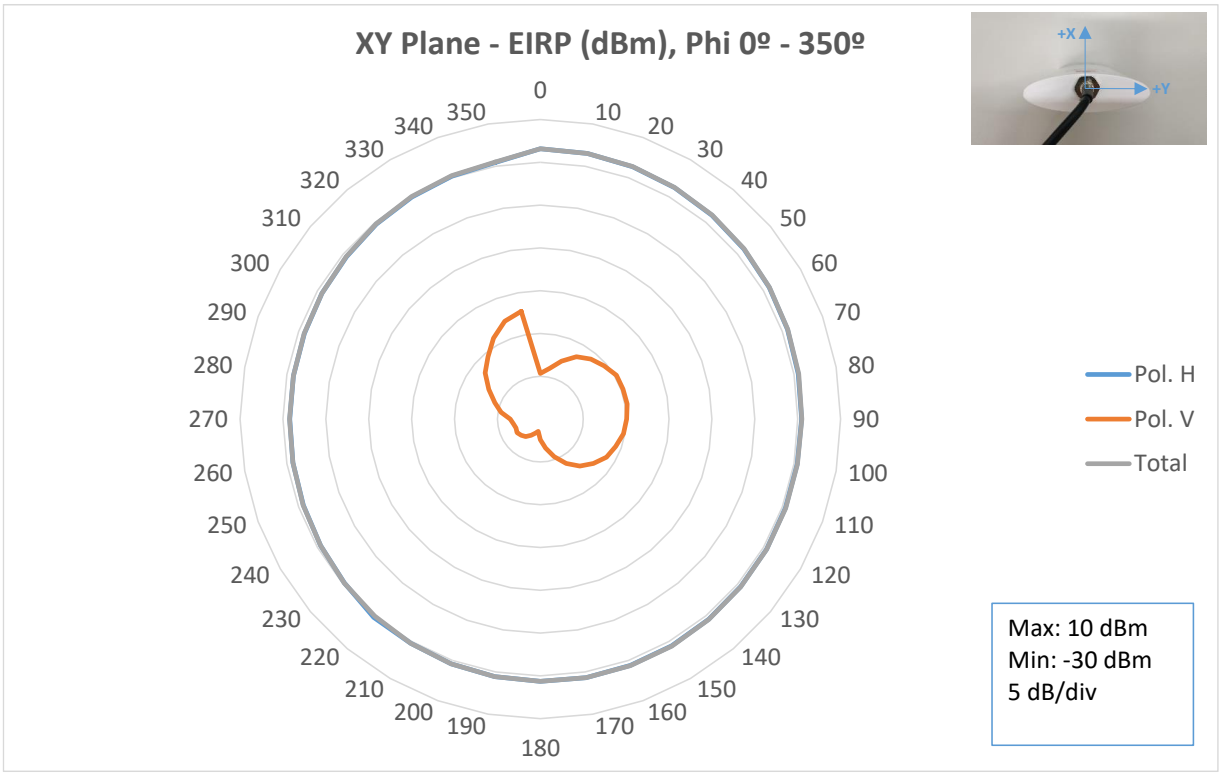

Fig. 4. XY Plane EIRP, Free Space, 863.1 MHz.

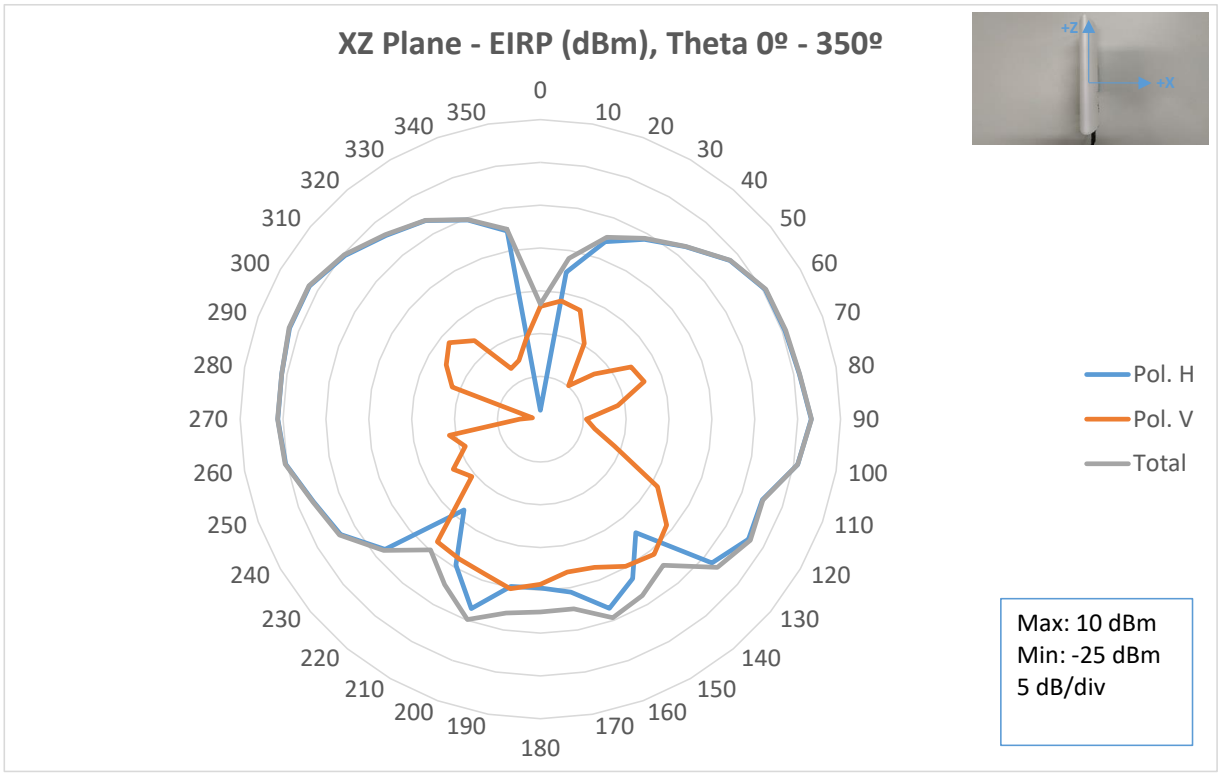

Fig. 5. XZ Plane EIRP, Free Space, 863.1 MHz.

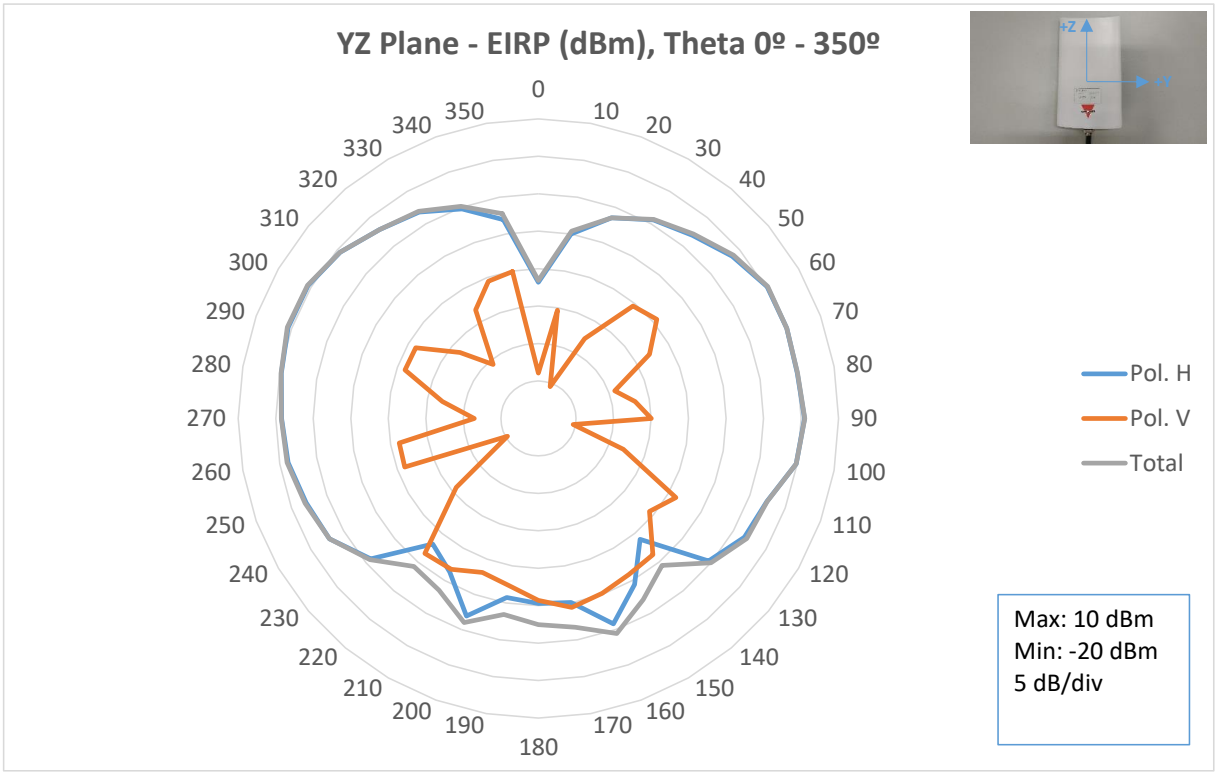

Fig. 6. YZ Plane EIRP, Free Space, 863.1 MHz.

4.2 EIRP Pattern 865.1 MHz – Free Space

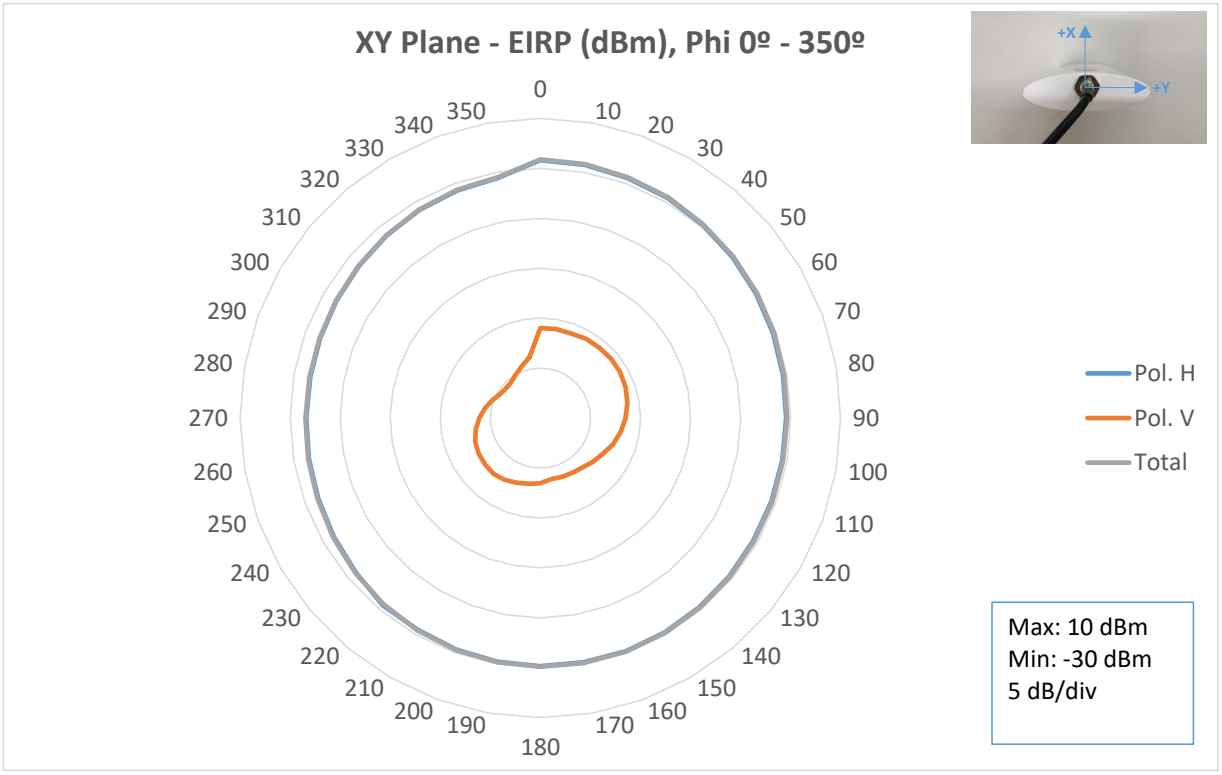

Fig. 7. XY Plane EIRP, Free Space, 865.1 MHz.

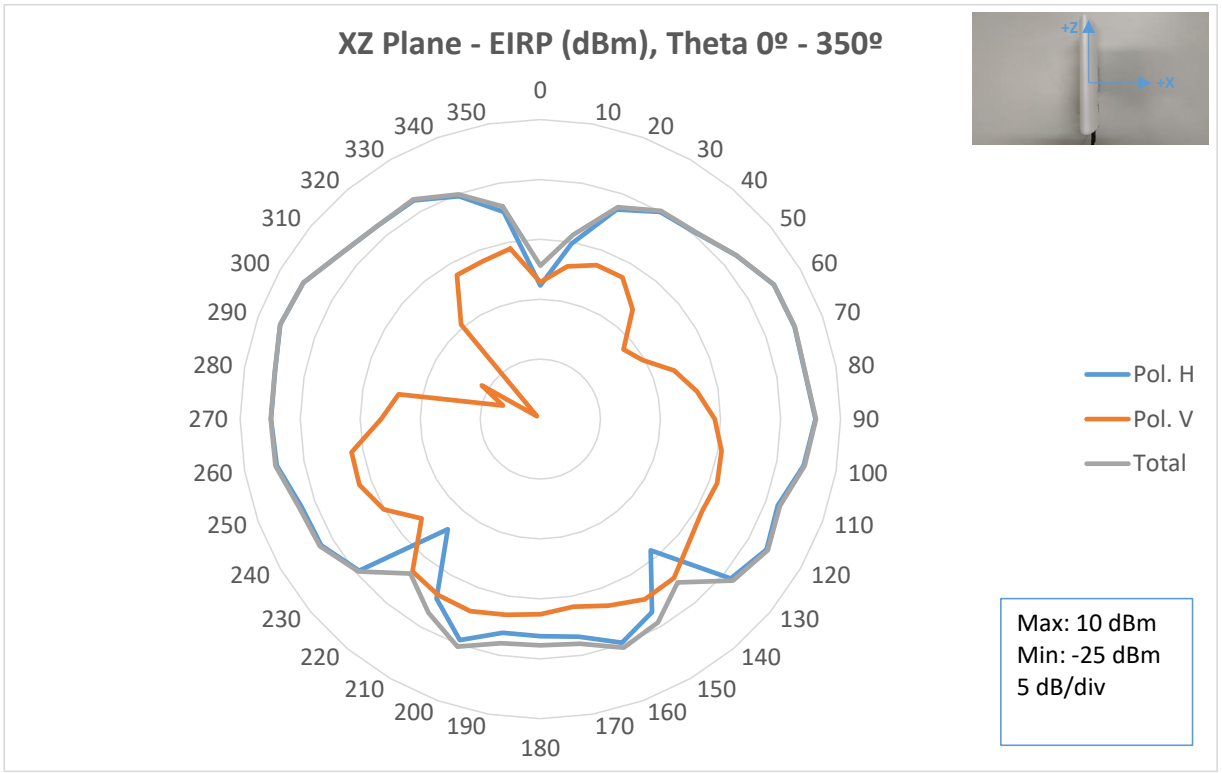

Fig. 8. XZ Plane EIRP, Free Space, 865.1 MHz.

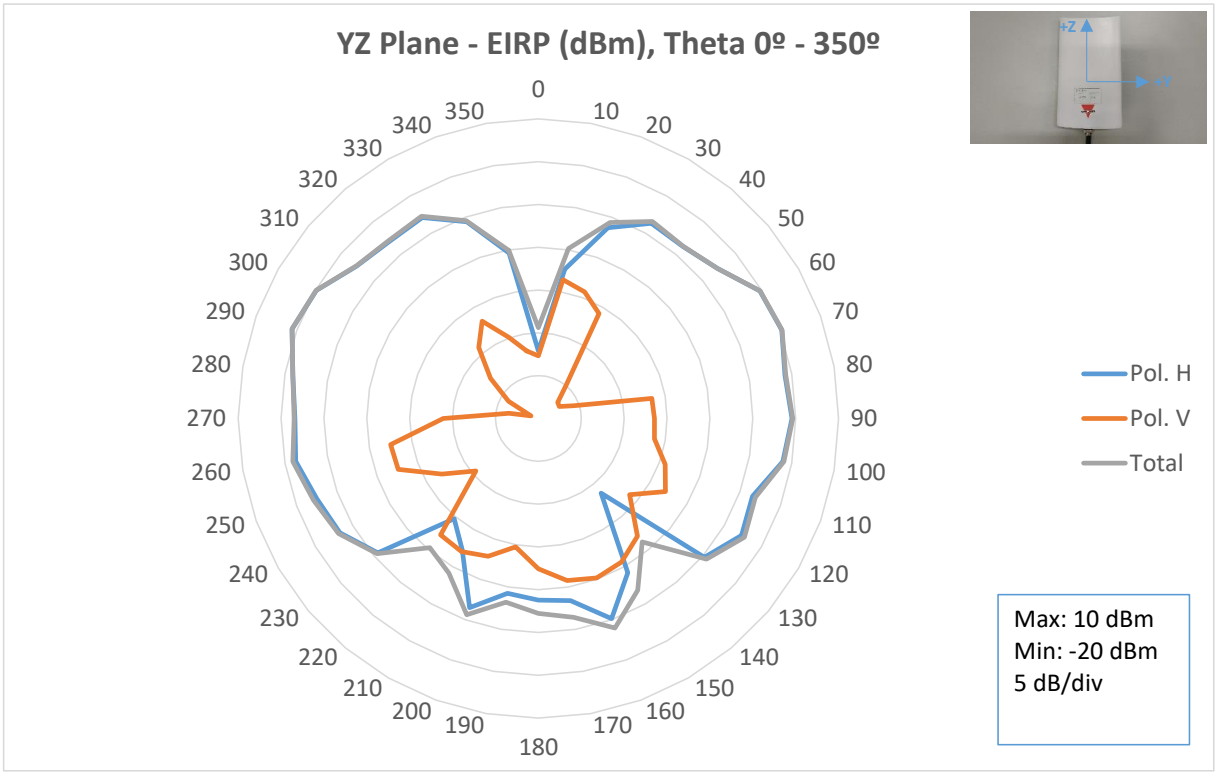

Fig. 9. YZ Plane EIRP, Free Space, 865.1 MHz.

4.3 EIRP Pattern 868.3 MHz – Free Space

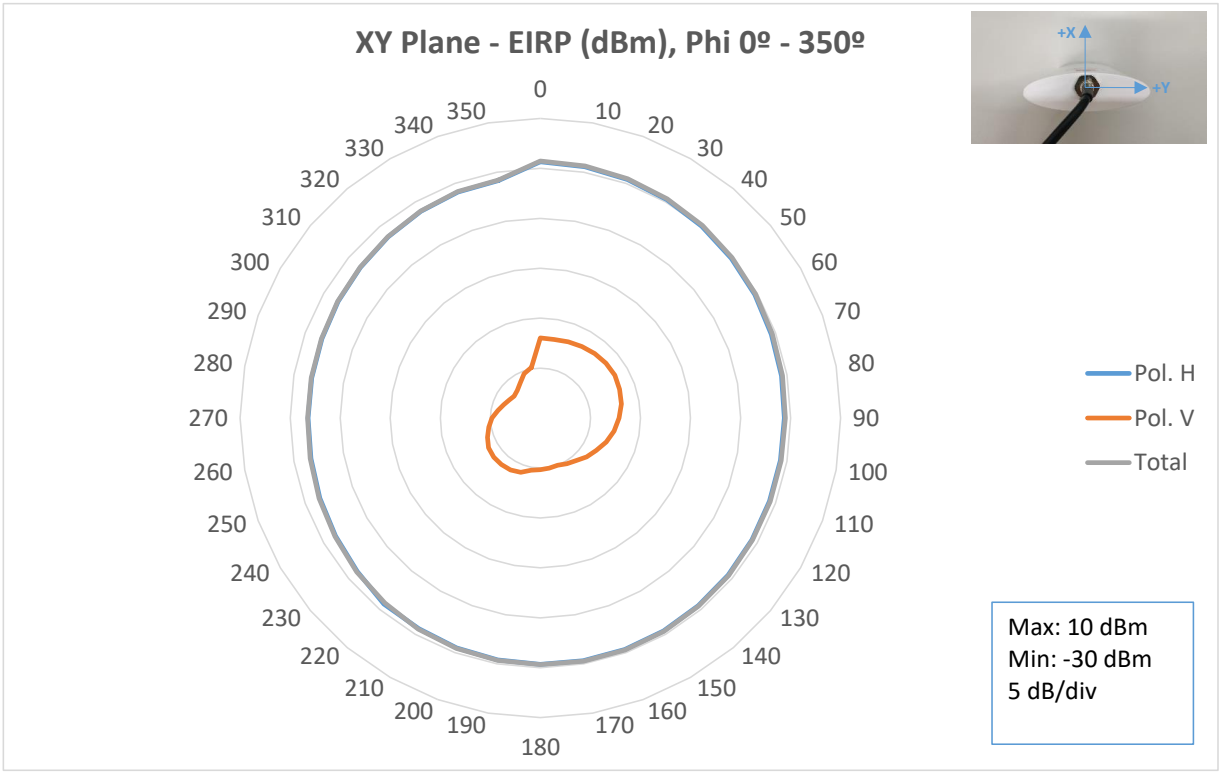

Fig. 10. XY Plane EIRP, Free Space, 868.3 MHz.

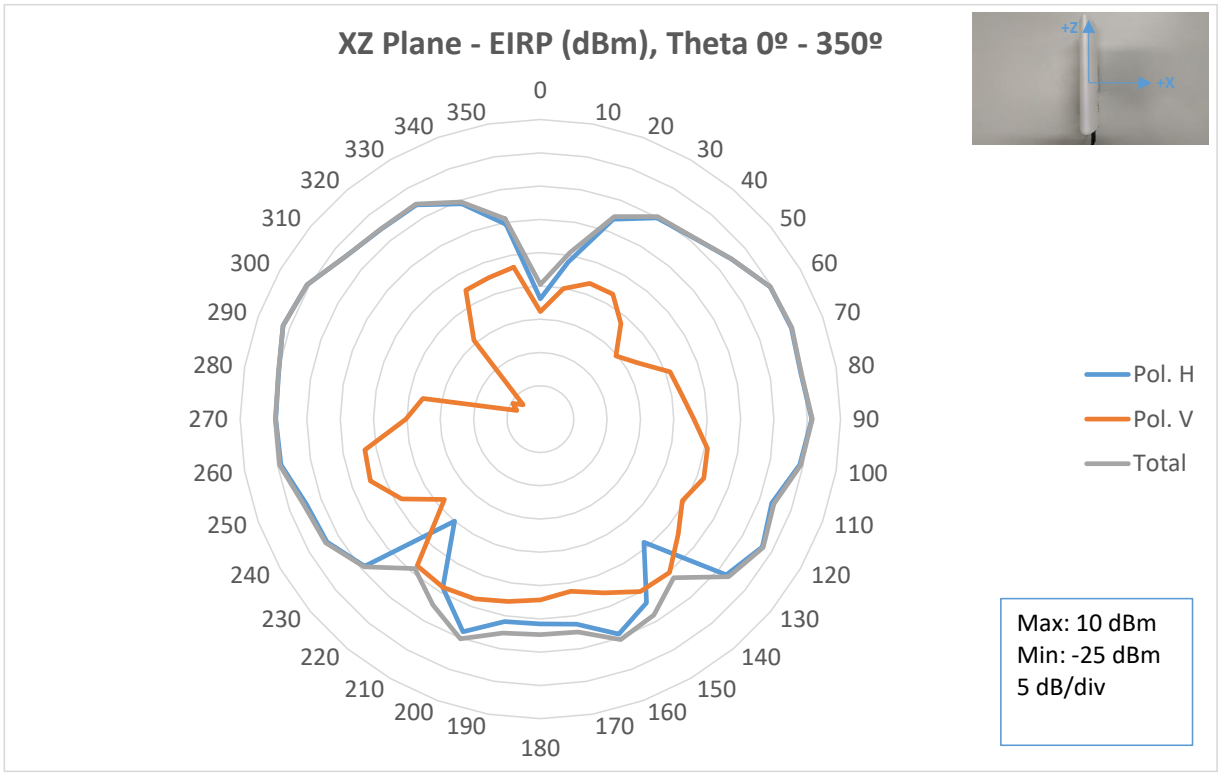

Fig. 11. XZ Plane EIRP, Free Space, 868.3 MHz.

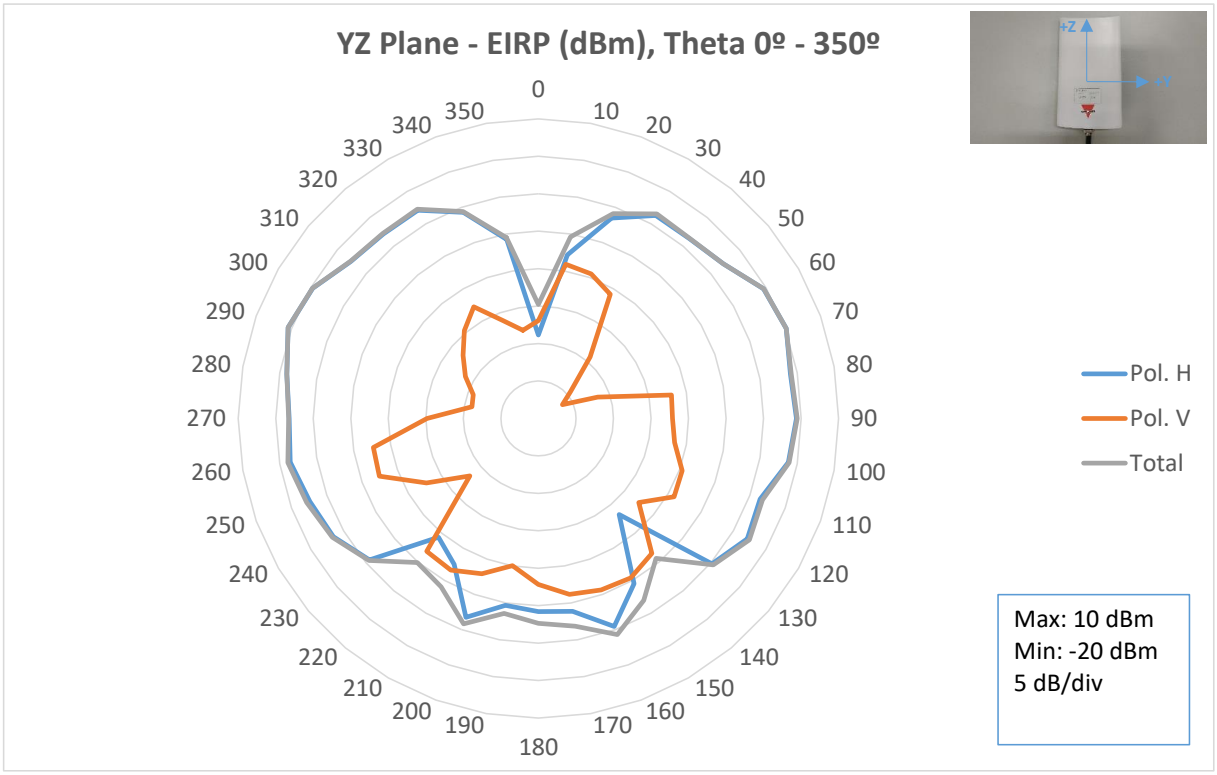

Fig. 12. YZ Plane EIRP, Free Space, 868.3 MHz.

4.4 EIRP Pattern 869.525 MHz – Free Space

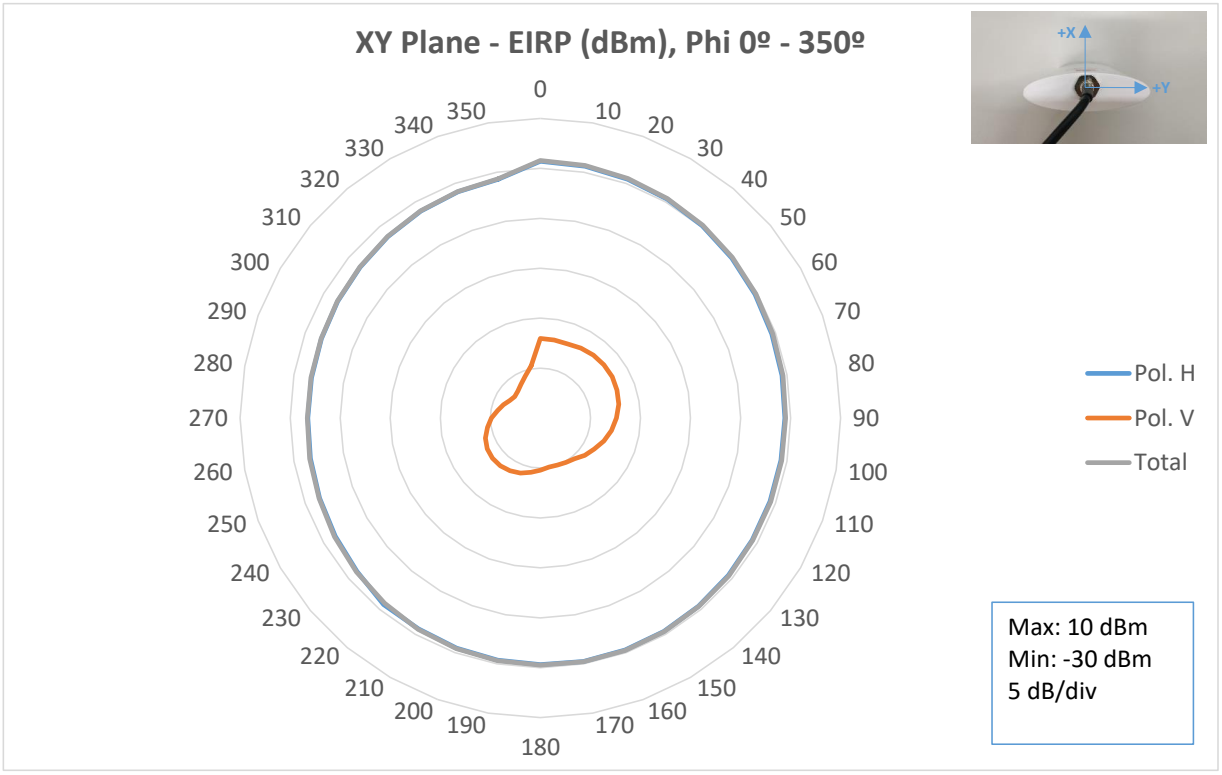

Fig. 13. XY Plane EIRP, Free Space, 869.525 MHz.

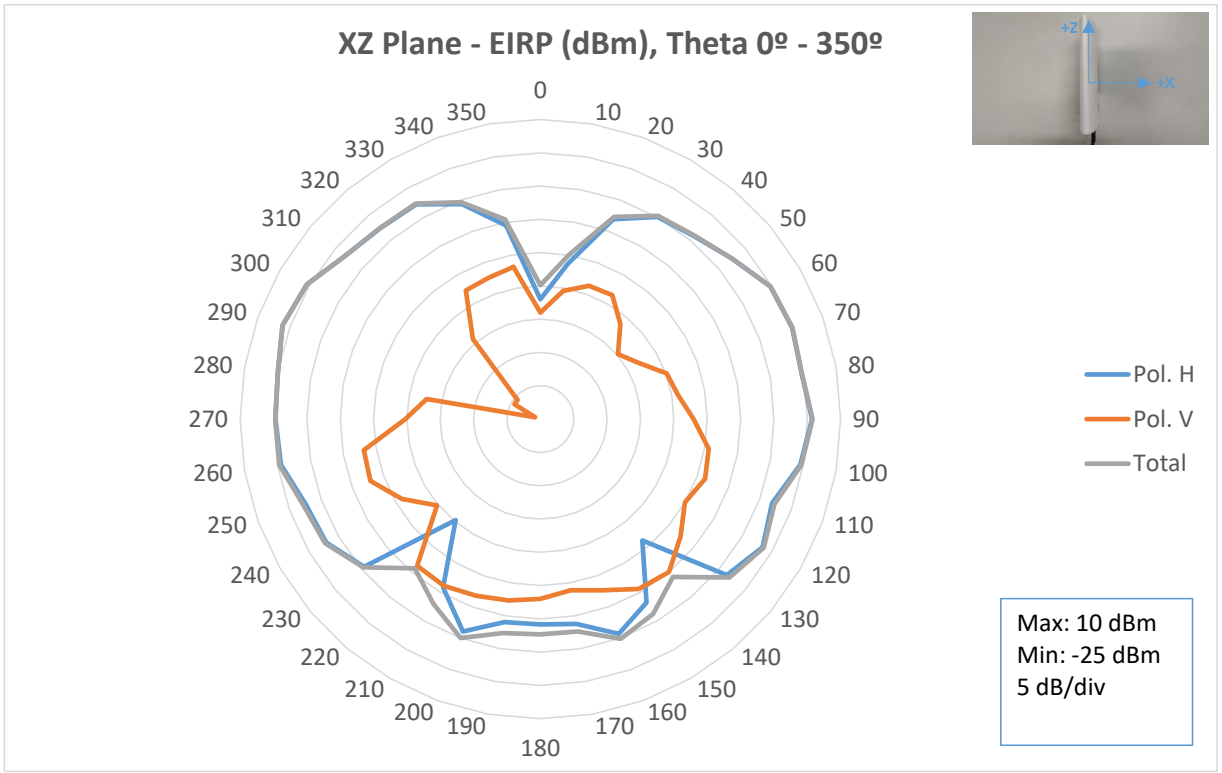

Fig. 14. XZ Plane EIRP, Free Space, 869.525 MHz.

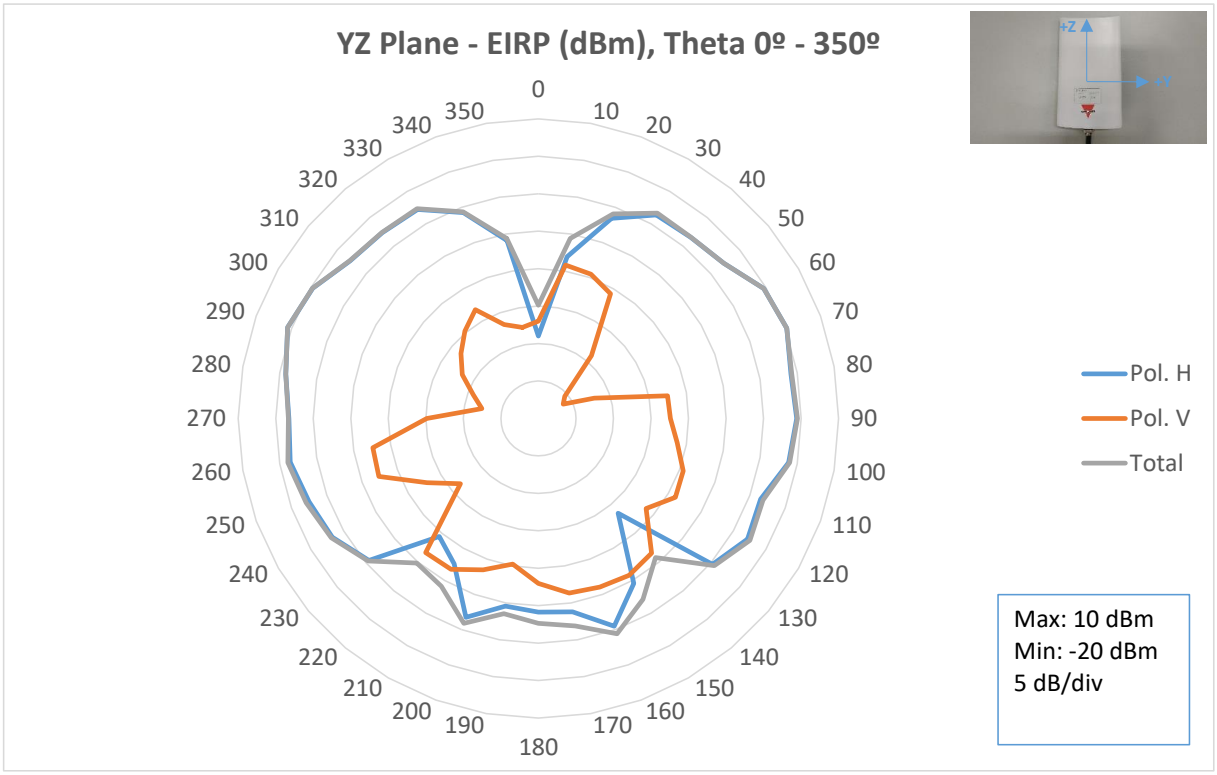

Fig. 15. YZ Plane EIRP, Free Space, 869.525 MHz.

5. RF TEST RESULT ON 3D

5.1 TRP 863.1 MHz – Free Space

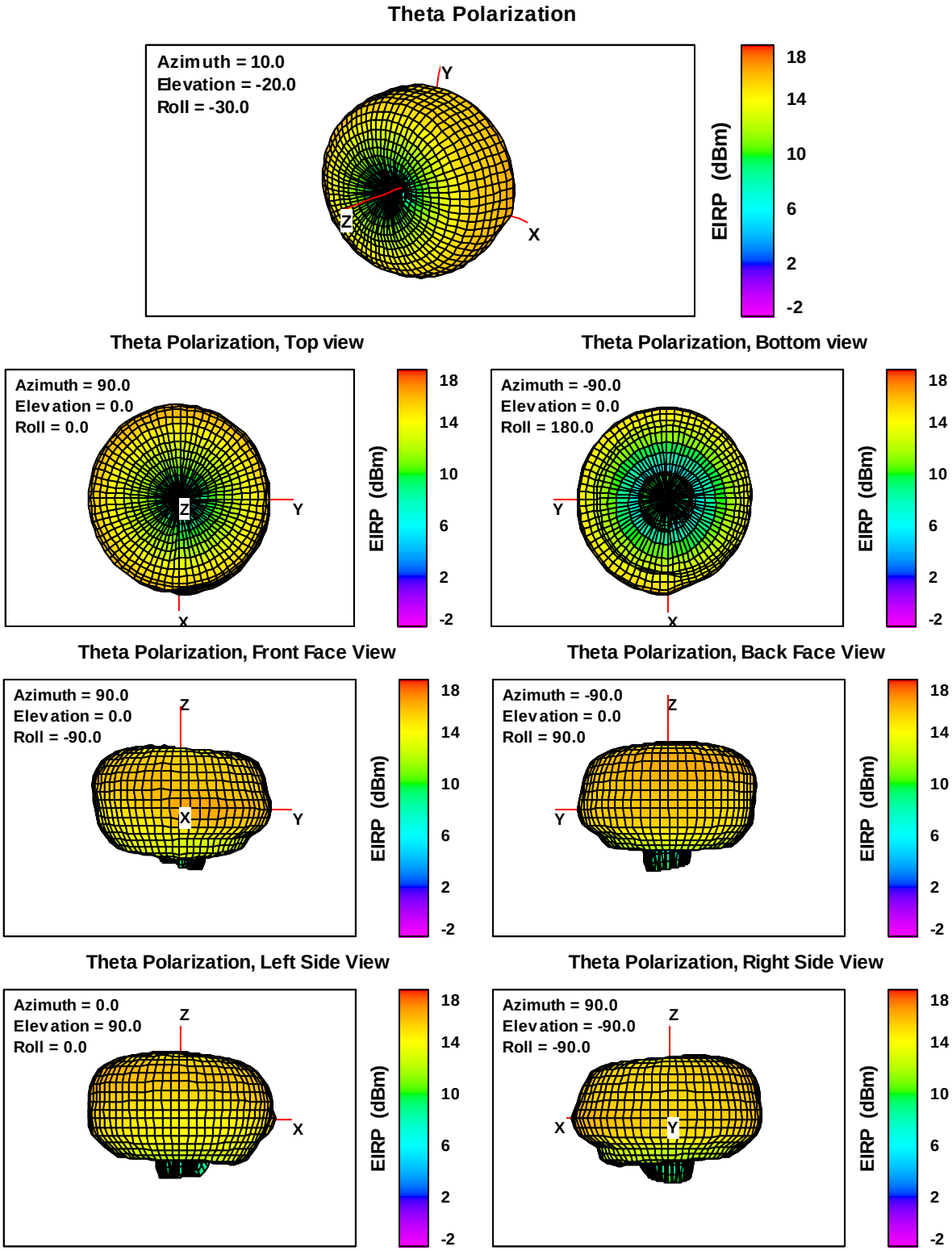

Fig. 16. Theta Polarization (Horizontal) EIRP, Free Space, 863.1 MHz.

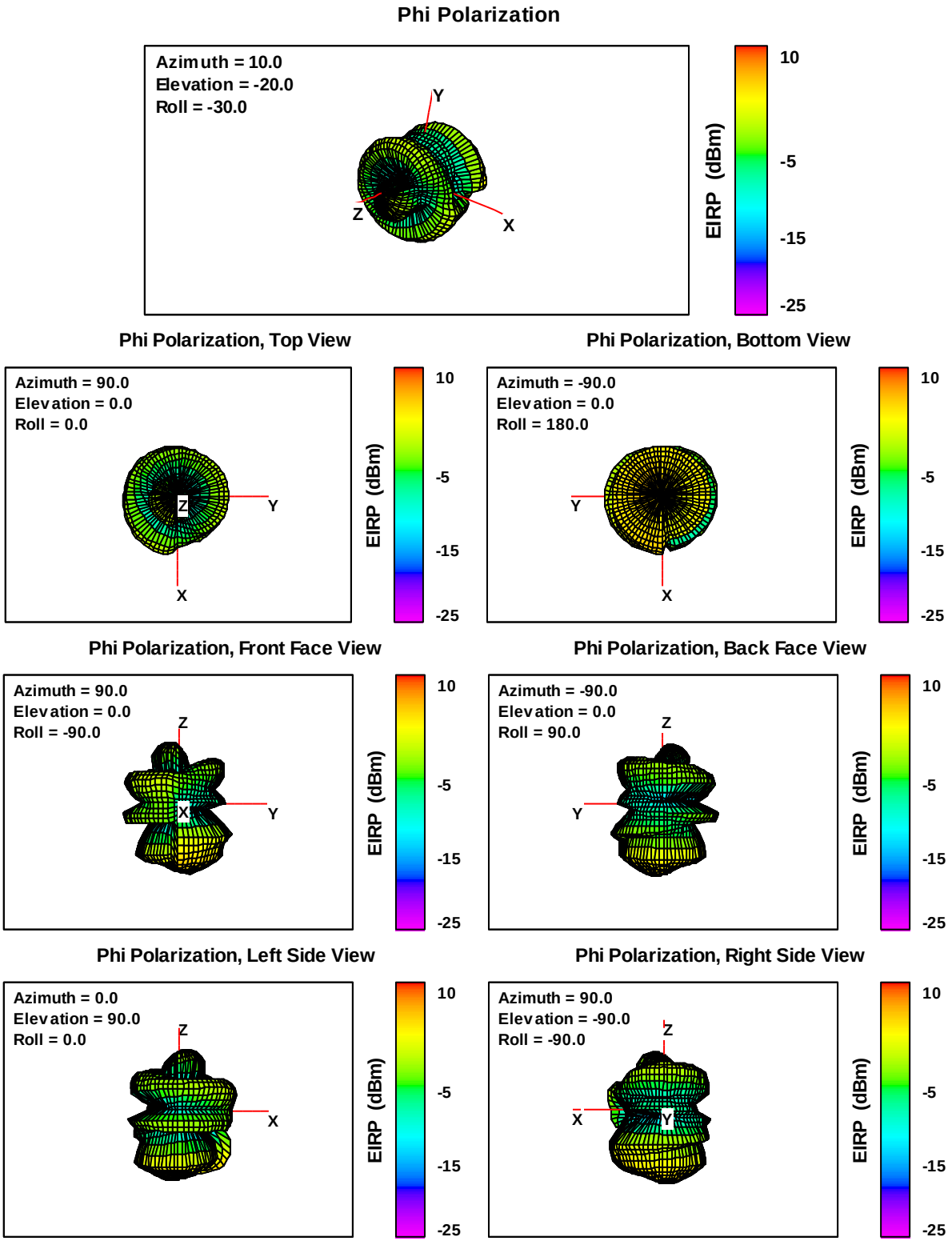

Fig. 17. Phi Polarization (Vertical) EIRP, Free Space, 863.1 MHz.

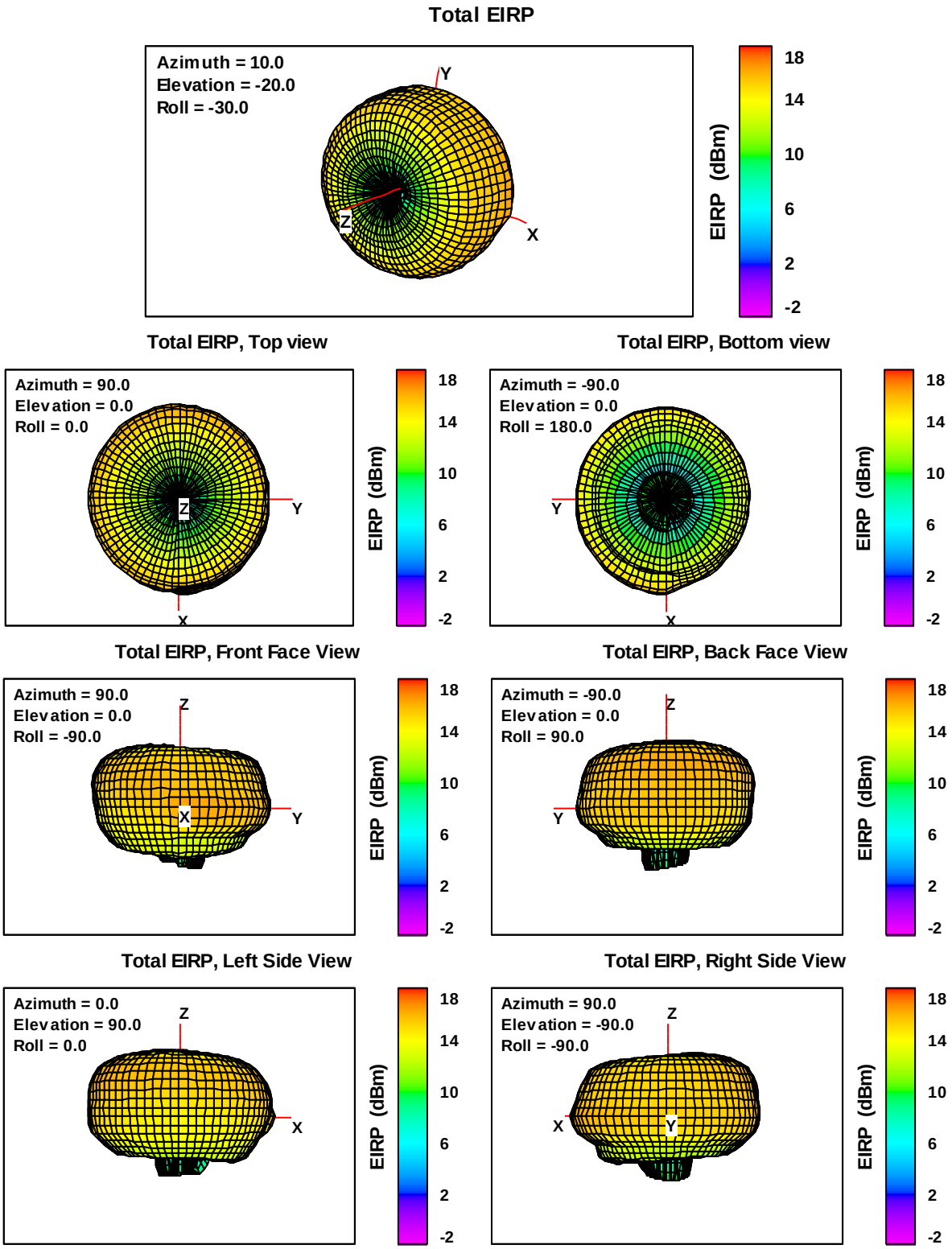

Fig. 18. Total EIRP, Free Space, 863.1 MHz.

5.2 TRP 865.1 MHz – Free Space

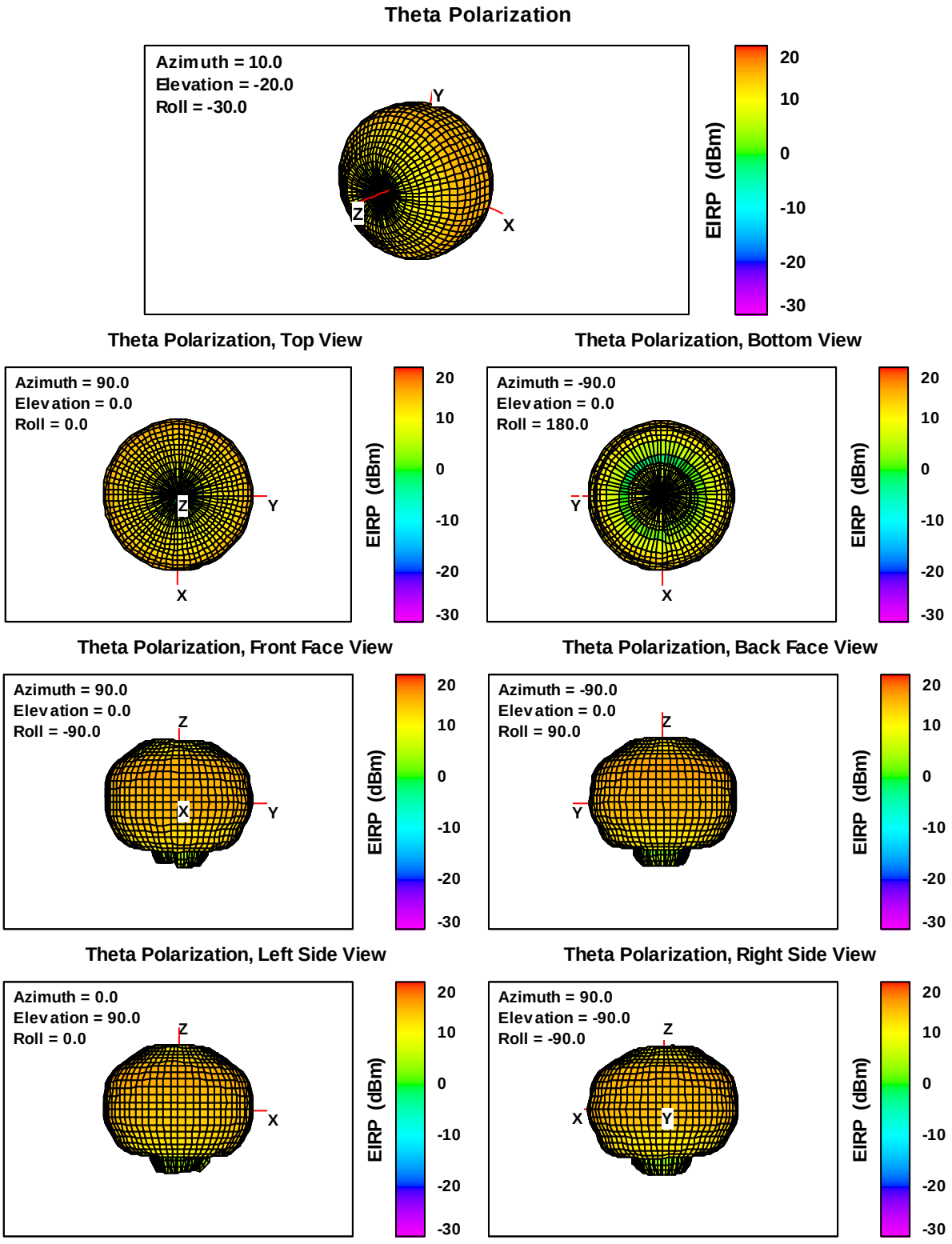

Fig. 19. Theta Polarization (Horizontal) EIRP, Free Space, 865.1 MHz.

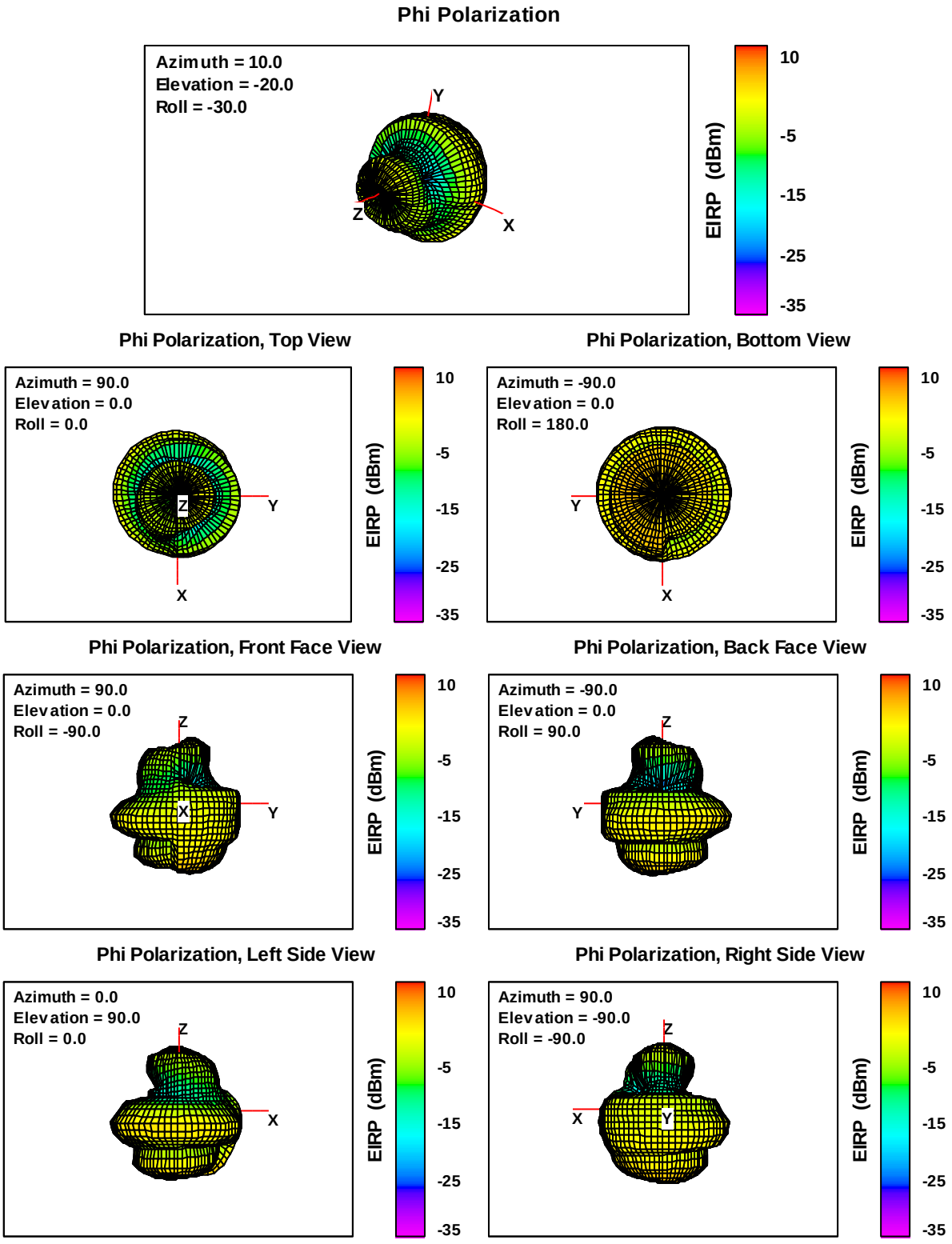

Fig. 20. Phi Polarization (Vertical) EIRP, Free Space, 865.1 MHz.

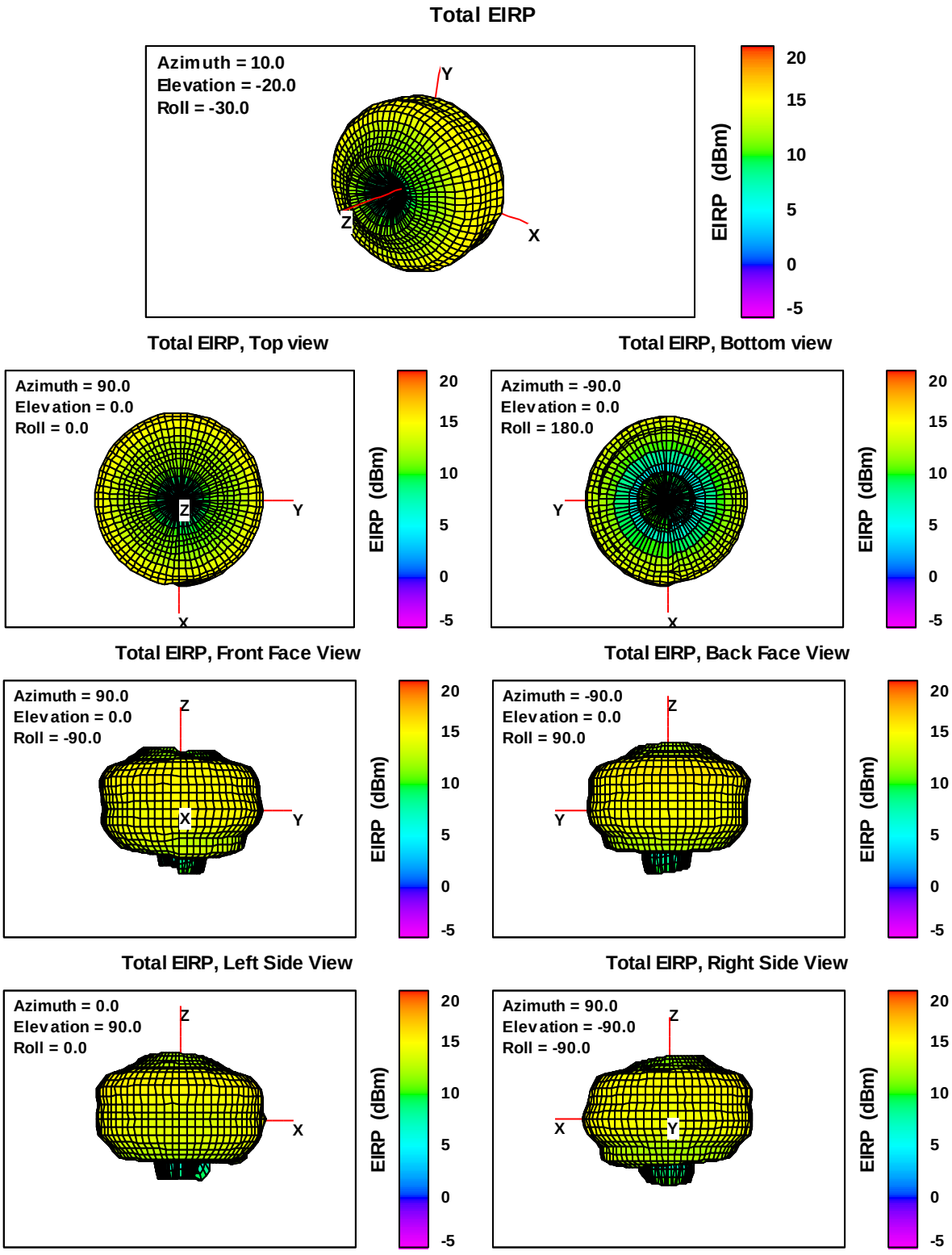

Fig. 21. Total EIRP, Free Space, 865.1 MHz.

5.3 TRP 868.3 MHz – Free Space

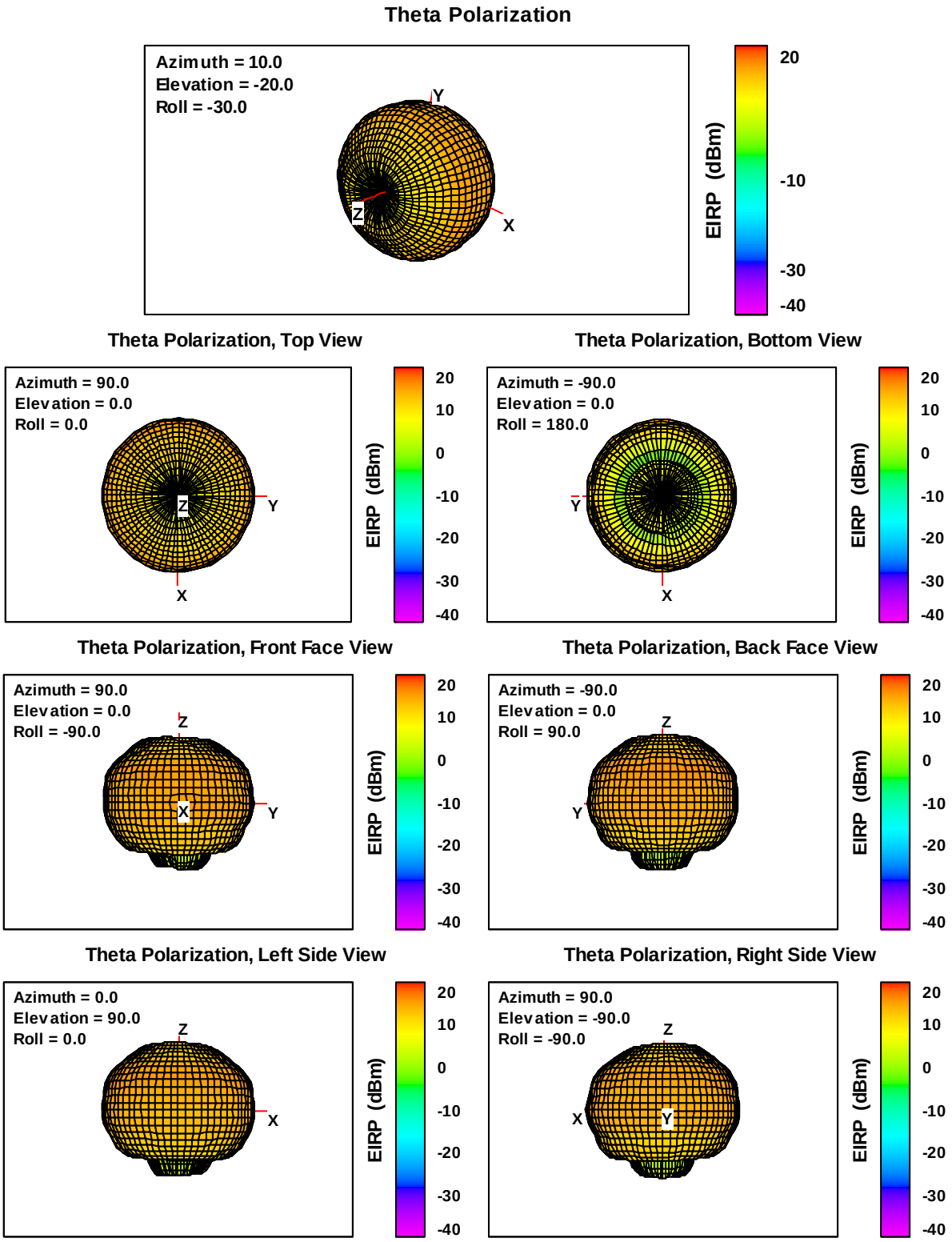

Fig. 22. Theta Polarization (Horizontal) EIRP, Free Space, 868.3 MHz.

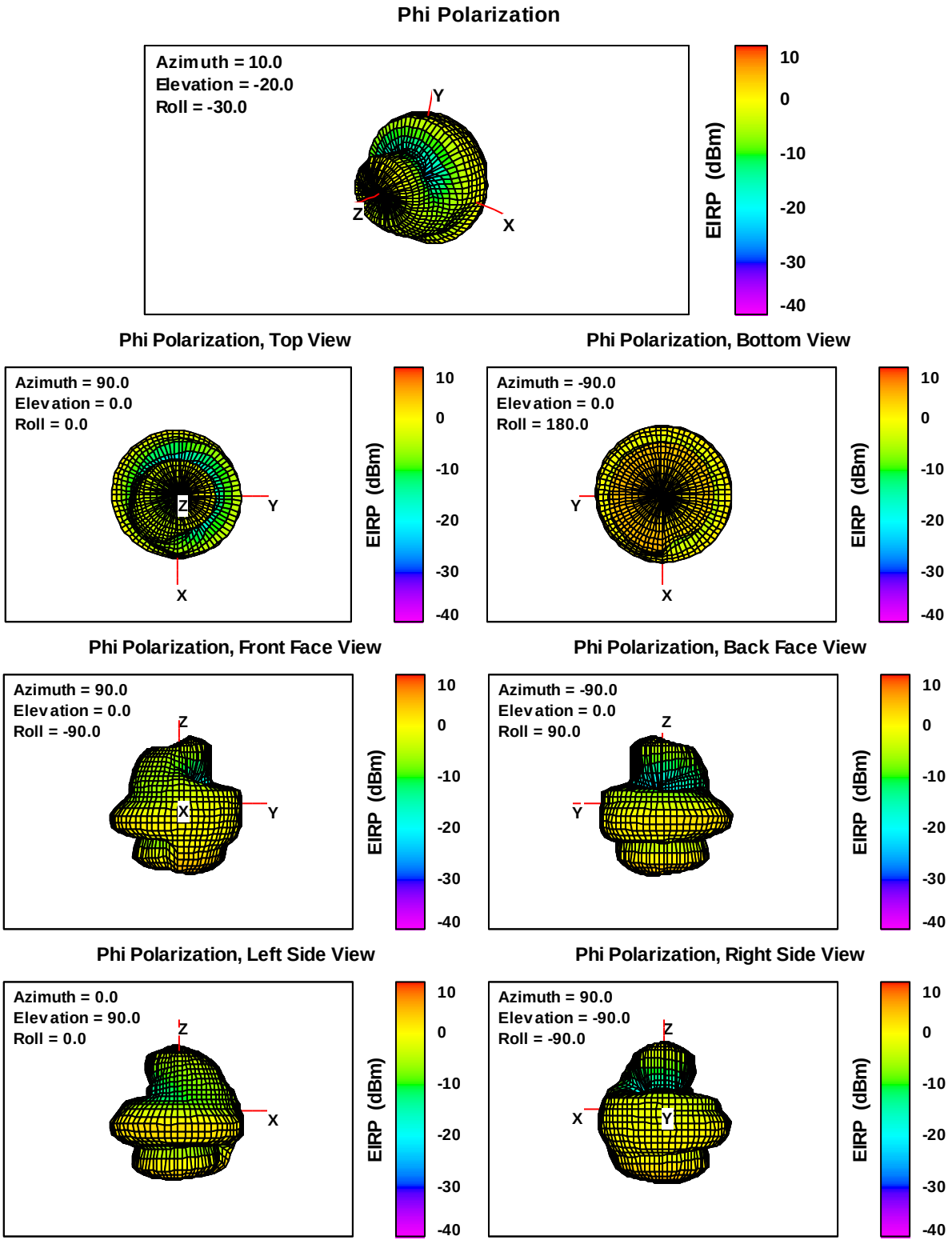

Fig. 23. Phi Polarization (Vertical) EIRP, Free Space, 868.3 MHz.

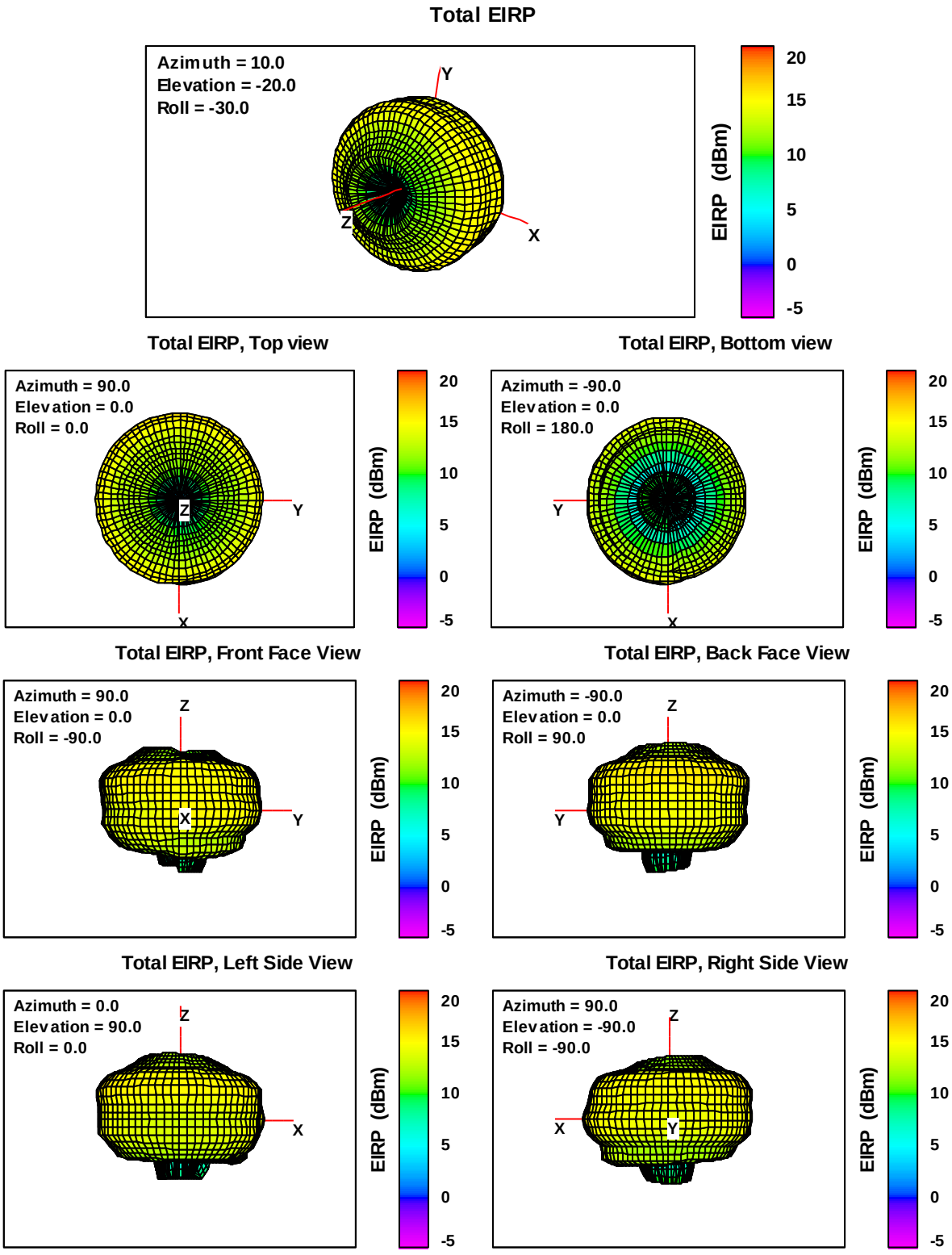

Fig. 24. Total EIRP, Free Space, 868.3 MHz.

5.4 TRP 869.525 MHz – Free Space

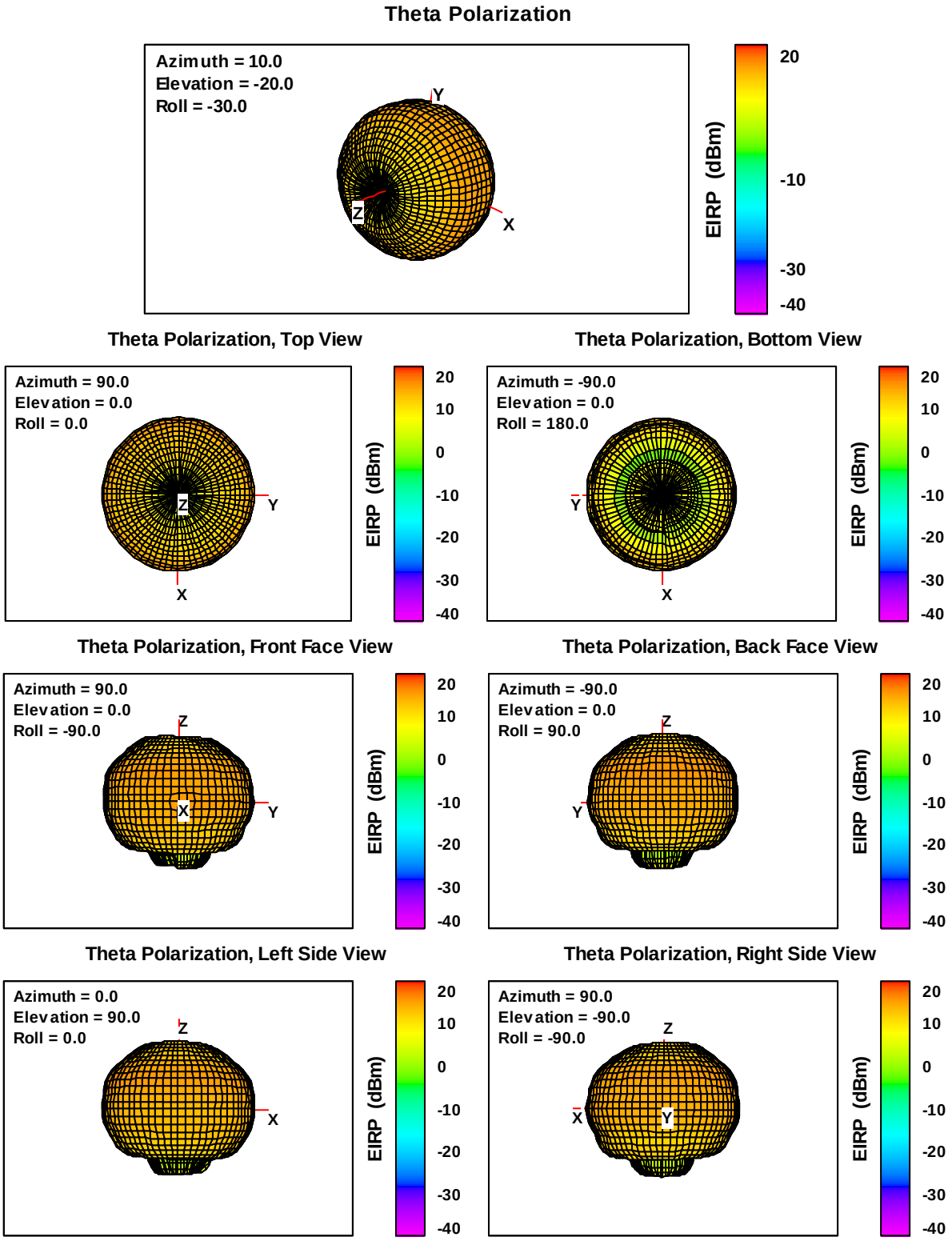

Fig. 25. Theta Polarization (Horizontal) EIRP, Free Space, 869.525 MHz.

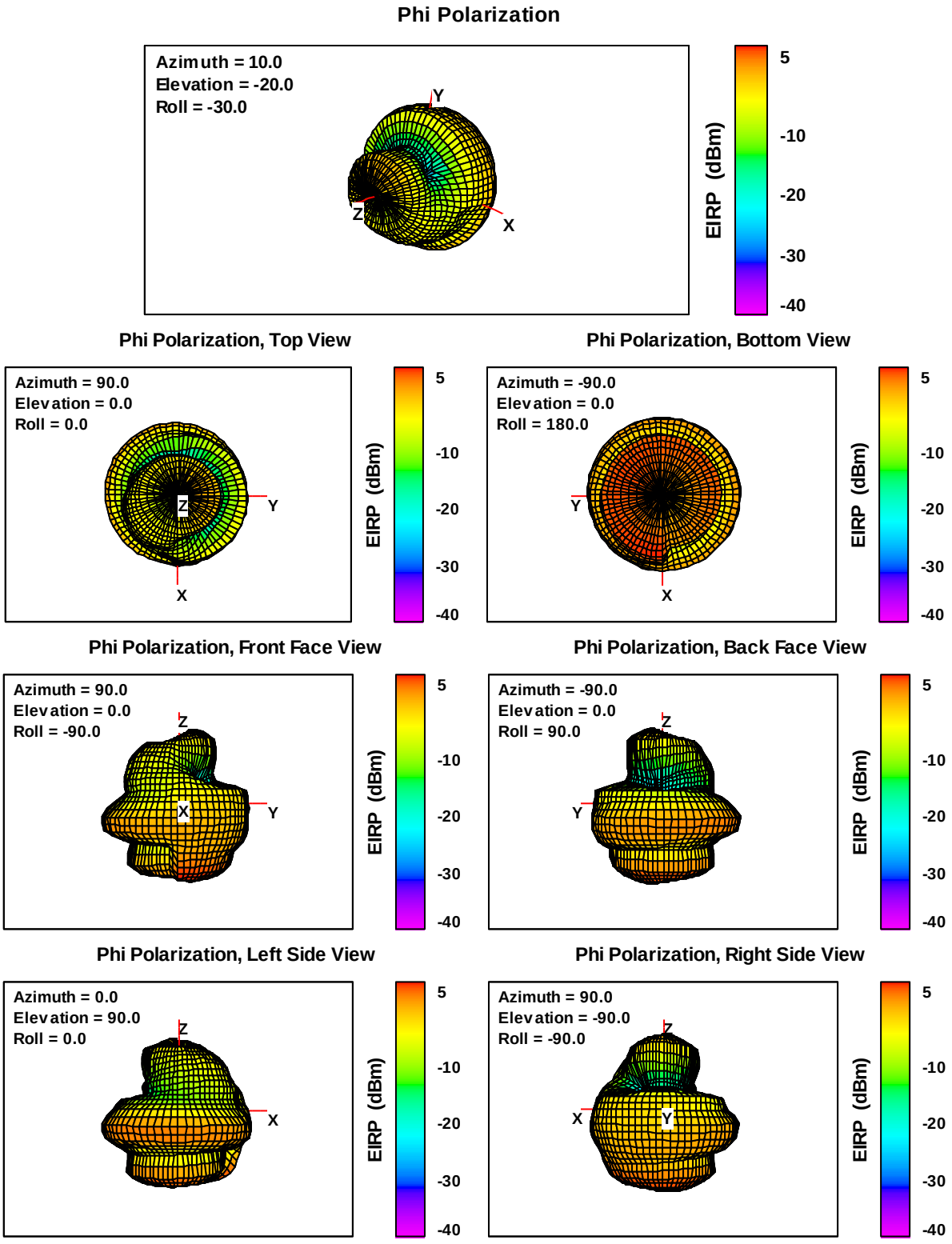

Fig. 26. Phi Polarization (Vertical) EIRP, Free Space, 869.525 MHz.

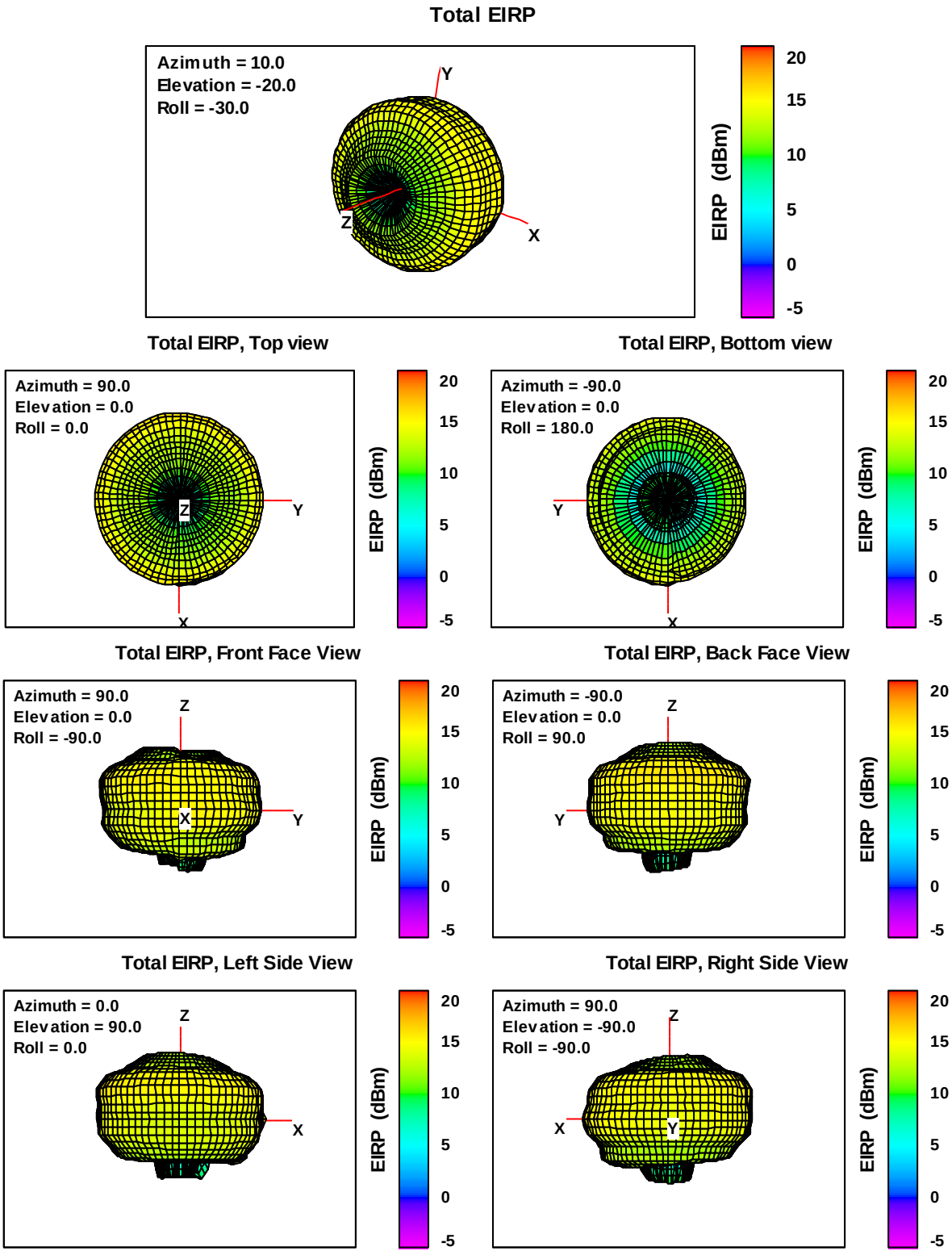

Fig. 27. Total EIRP, Free Space, 869.525 MHz.

6. RANGE REFERENCE MEASUREMENT DATA

Measurement Date:	2019-01-23
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	-	-	-	46.78	-	1.68	48.46
EU 868 MHz	865.1	-	-	-	46.83	-	1.68	48.51
EU 868 MHz	868.3	-	-	-	46.80	-	1.68	48.48
EU 868 MHz	869.5	-	-	-	46.85	-	1.68	48.53

Measurement Date:	2019-01-24
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	-	-	-	49.43	-	1.68	51.11
EU 868 MHz	865.1	-	-	-	49.46	-	1.68	51.14
EU 868 MHz	868.3	-	-	-	49.56	-	1.68	51.24
EU 868 MHz	869.5	-	-	-	49.66	-	1.68	51.34

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

Measurement Date:	2019-01-23
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	-	-	-	47.32	-	1.68	49.00
EU 868 MHz	865.1	-	-	-	47.36	-	1.68	49.04
EU 868 MHz	868.3	-	-	-	47.34	-	1.68	49.02
EU 868 MHz	869.525	-	-	-	47.39	-	1.68	49.07

Measurement Date:	2019-01-24
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	-	-	-	49.93	-	1.68	51.61
EU 868 MHz	865.1	-	-	-	50.01	-	1.68	51.69
EU 868 MHz	868.3	-	-	-	50.12	-	1.68	51.80
EU 868 MHz	869.525	-	-	-	50.19	-	1.68	51.87

Appendix B: Photographs

Equipment under test:

- **EUT front view:**

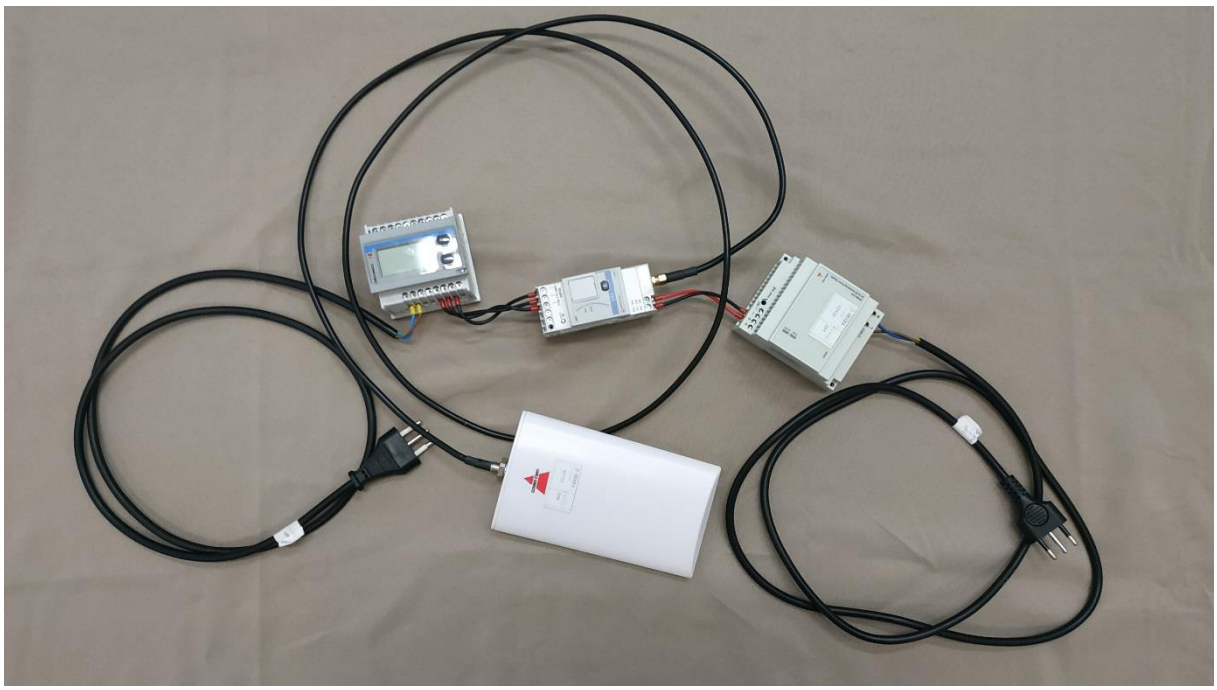

Fig 28. EUT front view.

Test set:

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

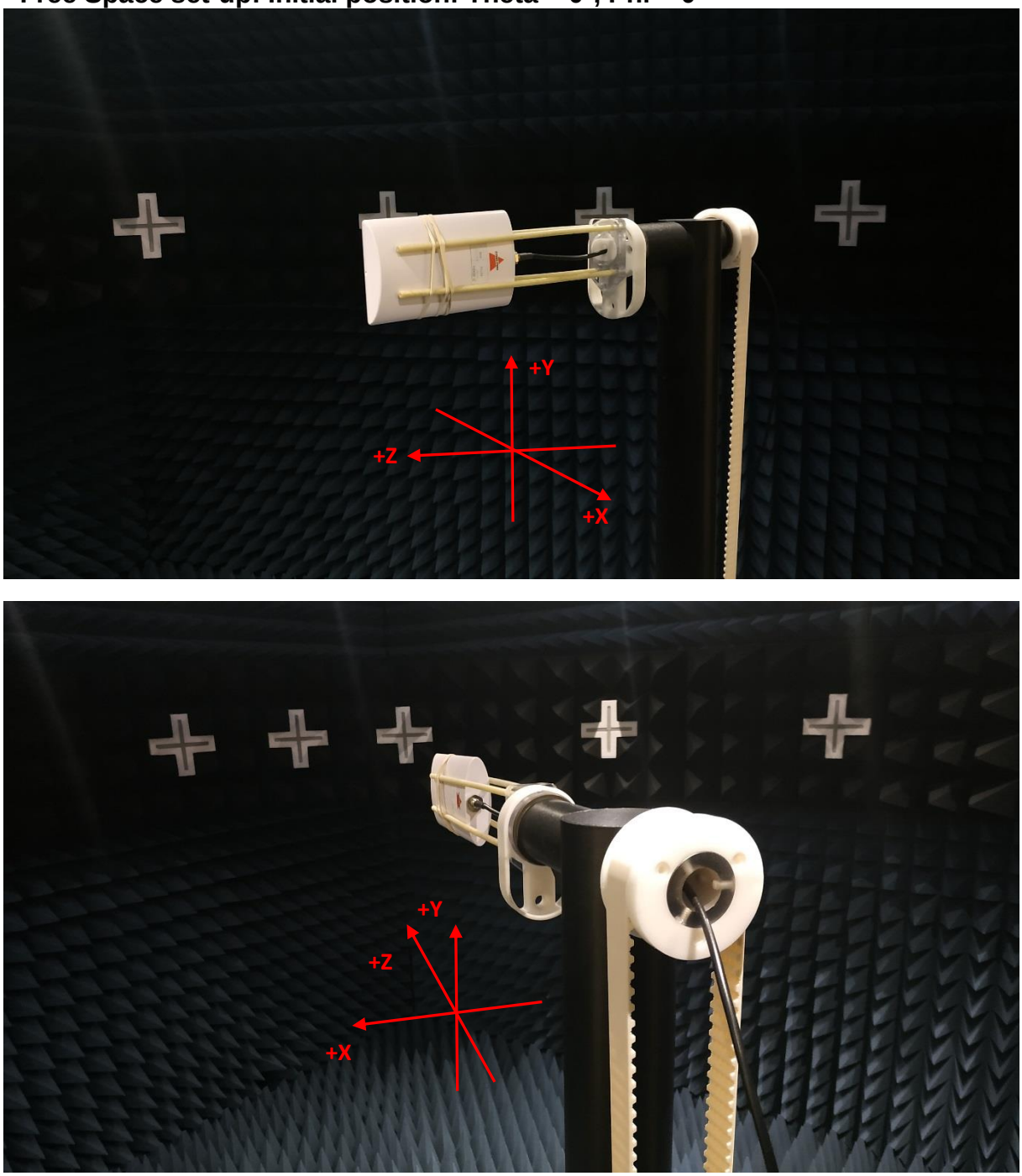

Fig 29. Free Space configuration set-up view.