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Radio Radio Radio Radio Radio Radio Radio Radio Radio Radio Radio Radio

Applicant:

Robert Bosch Power Tools GmbH

Max-Lang-Strasse 40-46

70771 Leinfelden-Echterdingen

Tel.: +49 711 758 0

Test report no.:

240001-AU01+W01

for:

Robert Bosch Power Tools GmbH

BTLE smart tag

GCT 30-42

Location of Testing:

Element Materials Technology Straubing GmbH
Tel.: +49 9421 56868-0
Fax: +49 9421 56868-100
Email: info.straubing@element.com
Gustav-Hertz-Straße 35
94315 Straubing, Germany

The technical accuracy is guaranteed through the quality management of
Element Materials Technology Straubing GmbH.
However, testing referred to in this test report is out of the scope of accreditation.

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1 Summary of test results

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Table 1: Test result

Straubing, January 26, 2024

Tested by
Konrad Graßl
Department Manager Radio

Approved by
Christian Kiermeier
Reviewer

2 Equipment under test (EUT)

All information in this clause is declared by manufacturer.

2.1 General information

Product type:	BTLE smart tag
Model name:	GCT 30-42
Part number:	1600A02GH1 (EU)
Serial number:	n/a
Manufacturer:	Robert Bosch Power Tools GmbH
Short description:	The EUT is a BTLE smart tag (GCT 30-42) mounted on portable electric power tools. It sends a start signal in the 2.4 GHz range to a BTLE smart plug (GCA 30-42) in a worksite vacuum cleaner for activating the dust extrusion.

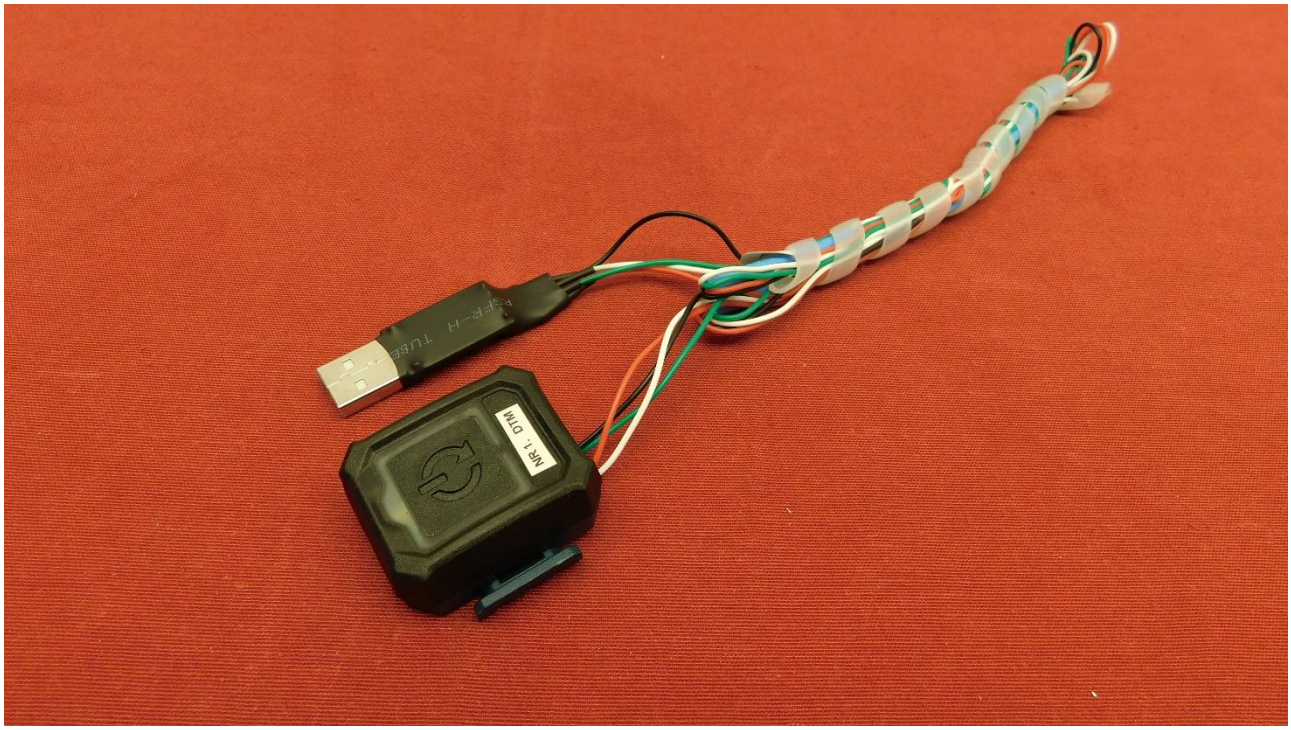
Note:
1. According to customer's declaration, all models (part numbers) mentioned below are identical with the tested EUT and only differ in the printing label.
2. All tests documented in this test report were performed with GCT 30-42.

Model name	*Part number*
GCT 30-42	1600A02GH1 (EU)
GCT 30-42	1600A02GH2 (AUS/JP/KR)
GCT30-42	1600A02GH3 (RNA)
GCT 30-42	1600A02GH4

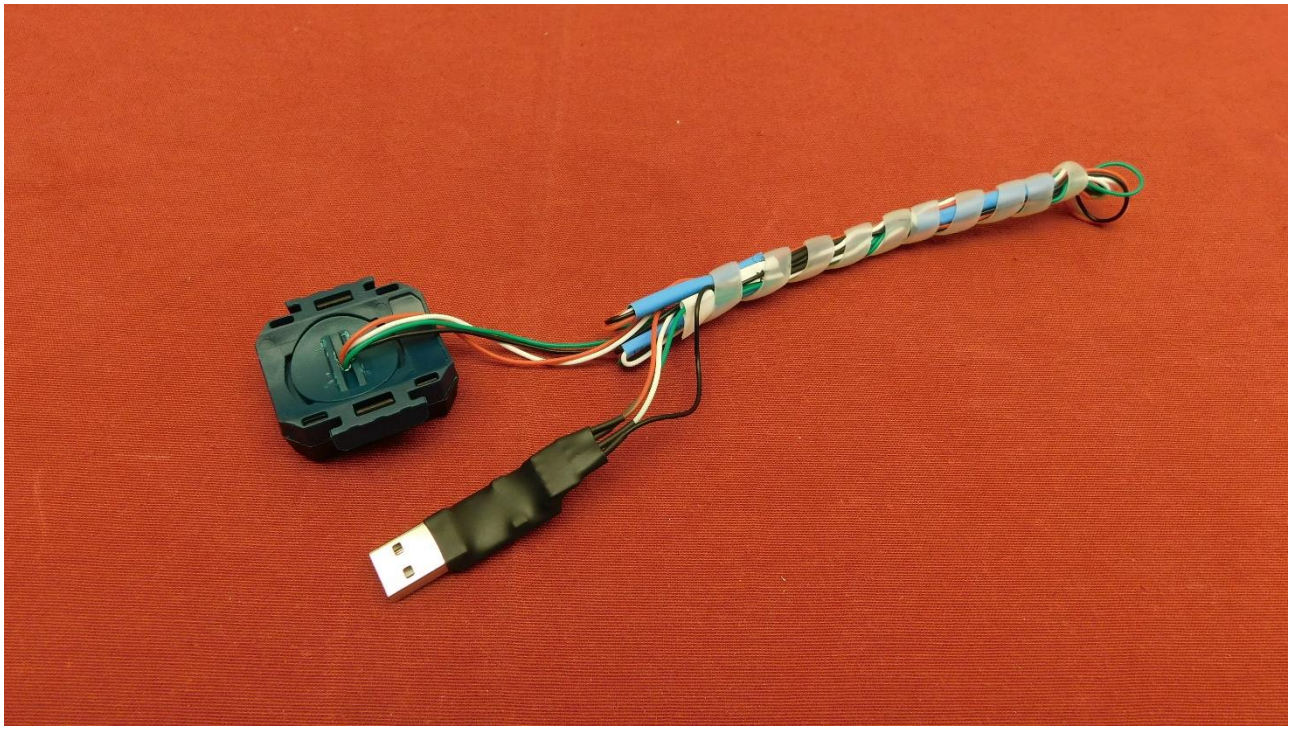
2.2 Radio specifications

Application(s):	Wideband data transmission system		
Operational frequency band(s):	2.4 GHz		
Tested frequencies:	2402 MHz, 2440 MHz, 2480 MHz		
Number of transmit chains:	1		
Antenna:	Type:	PCB antenna	
	Connector:	☐ external	☐ internal
		☐ temporary	☒ none (integral antenna)

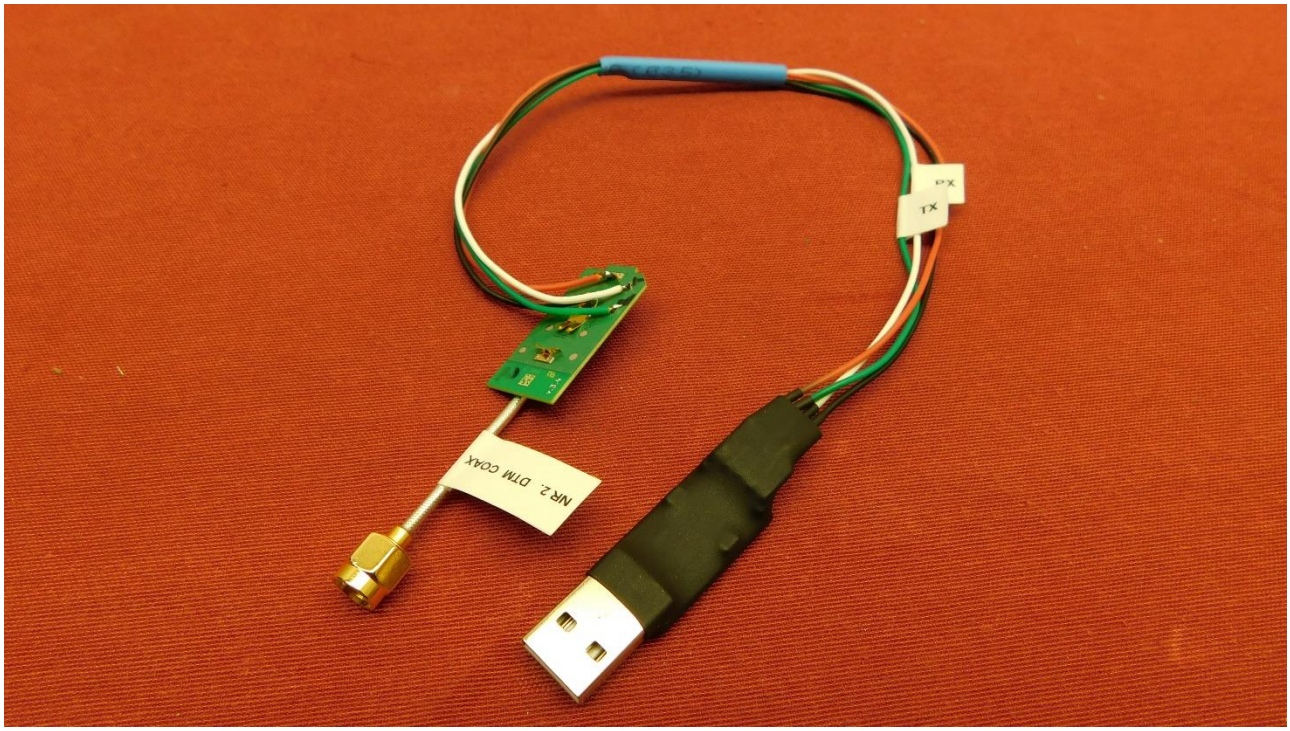
3 Photographs of EUT



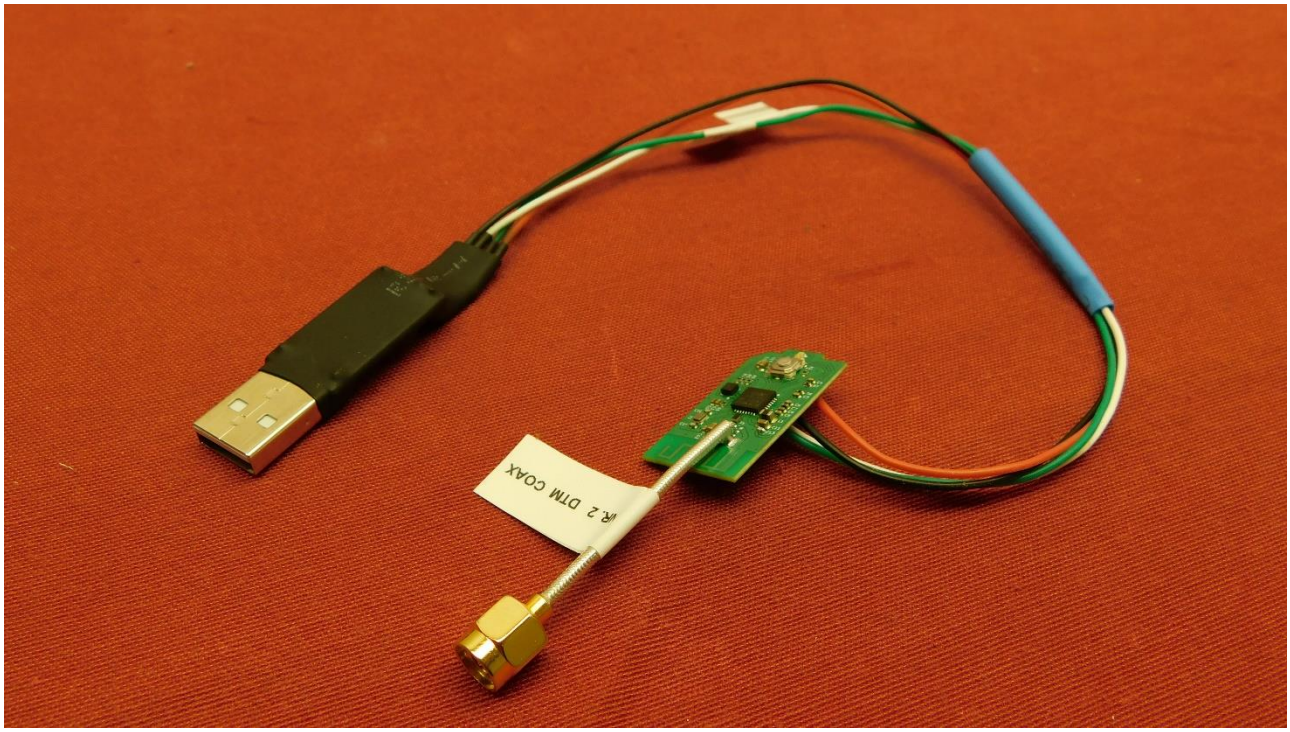
Picture 1: Top view of EUT for radiated tests



Picture 2: Back view of EUT for radiated tests



Picture 3: Top view of EUT for conducted tests



Picture 4: Back view of EUT for conducted tests

Picture 5: Front view of final device

Picture 6: Back view of final device

Picture 7: Name plate of EUT

4 Test configuration and mode of operation

4.1 Test configuration

Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
BTLE smart tag	GCT 30-42 (sample for radiated tests)	n/a	Robert Bosch Power Tools GmbH
BTLE smart tag	GCT 30-42 (sample for conducted tests)	n/a	Robert Bosch Power Tools GmbH

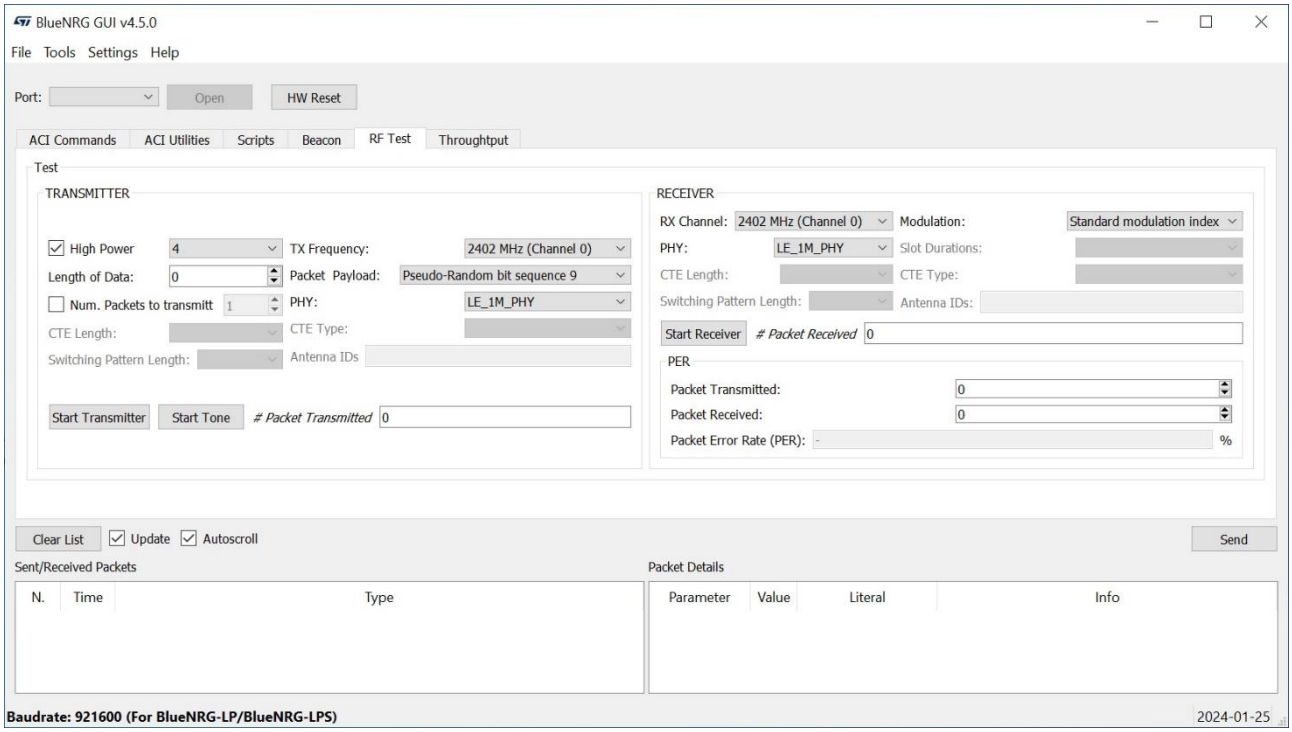
Table 2: EUT used for testing

Device	*Type designation*	*Serial or inventory no.*	*Manufacturer*
Laptop	ProBook 440 G6	5CD941CVQY	HP
Power supply for laptop	AC adapter	L25296-002	HP

Table 3: Support equipment used for testing

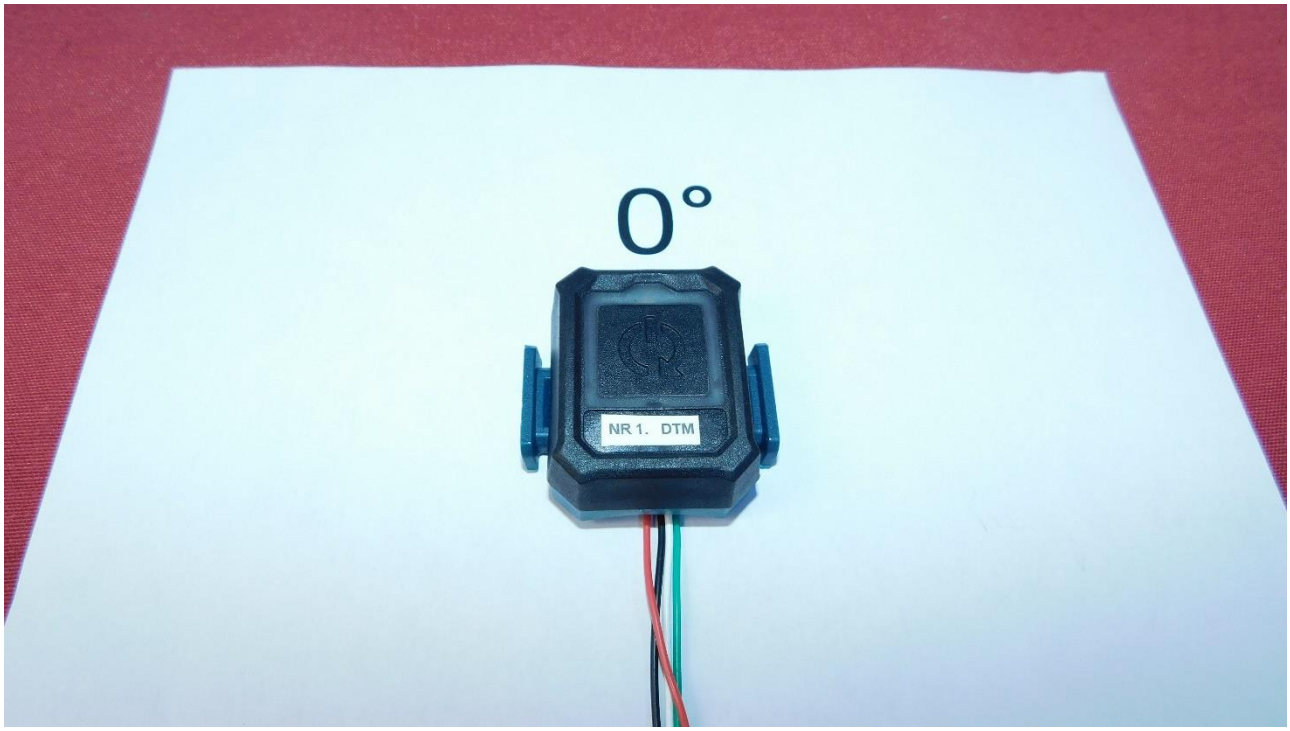
4.2 Mode of operation

- The EUT was continuously transmitting an unmodulated signal at 2402 MHz, 2440 MHz or 2480 MHz.
- The EUT was connected to a laptop and powered via USB.
- The test software BlueNRG GUI was used to set the EUT in the appropriate test modes.
- Power setting in the test software: enable High Power option with value 4

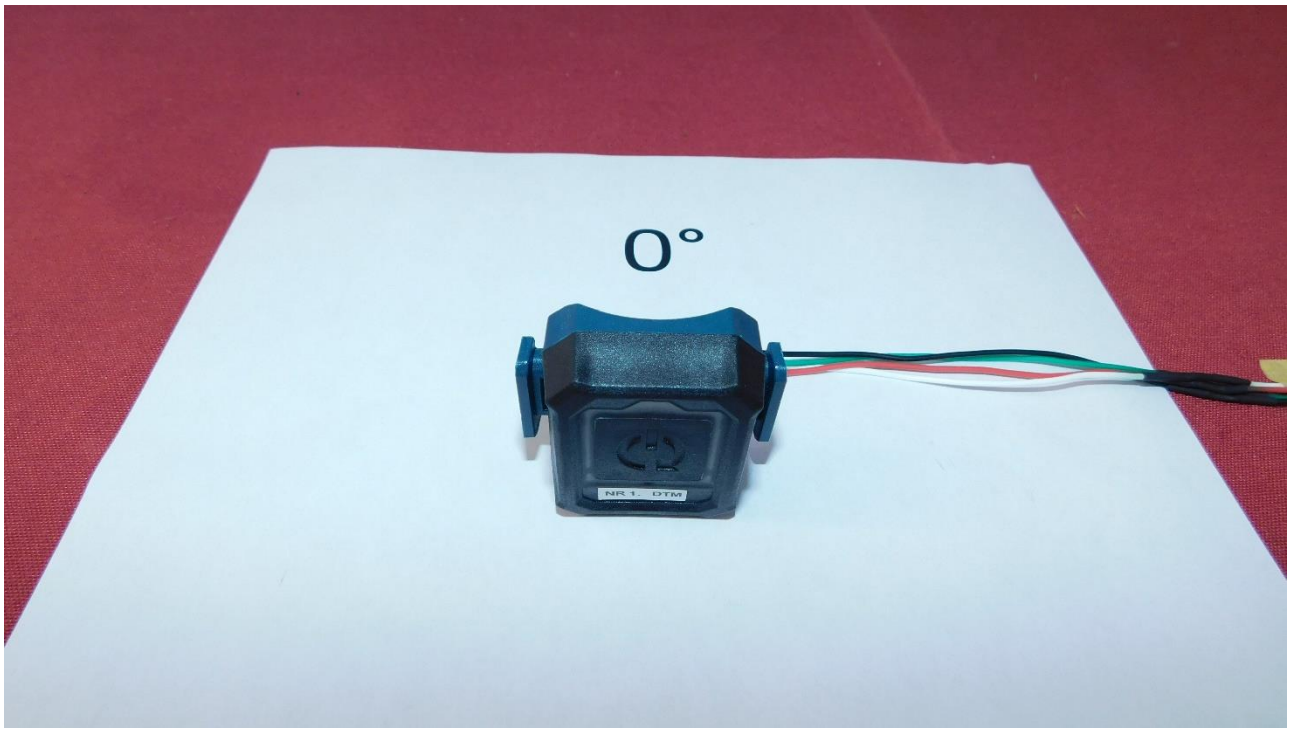


Picture 8: Screenshot of the test software settings

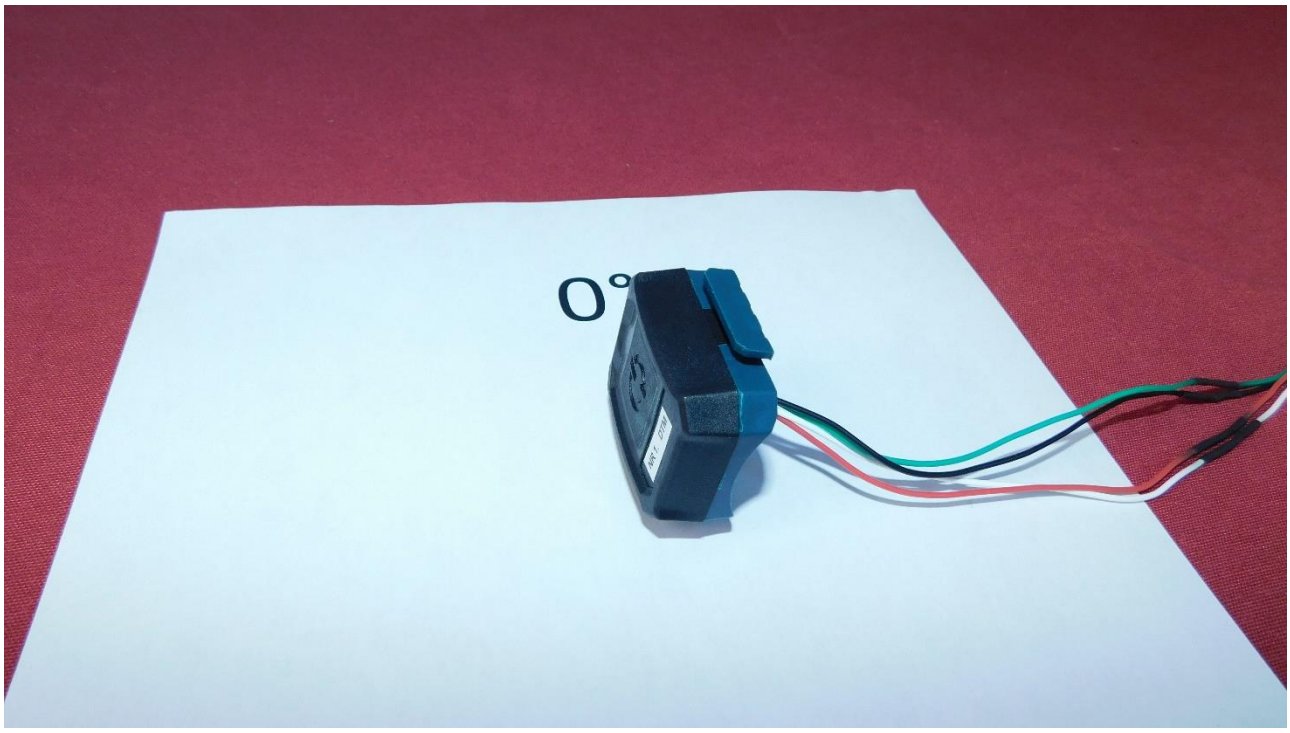
4.3 EUT positions



Picture 9: Setup for EUT position X



Picture 10: Setup for EUT position Y



Picture 11: Setup for EUT position Z

5 Measurement procedures

5.1 Conducted measurements at antenna connector

The RF signal of the EUT is measured at the external or internal antenna connector. In case of no permanent antenna connector, a temporary antenna connector needs to be supplied by the manufacturer. The specific insertion loss of the signal path, which is matched to 50 Ohm, is evaluated within a calibration. The test receiver is set to analyser mode with pre-selector activated. All measurement readings are corrected by the signal path loss.
The power of the carrier frequency is measured.

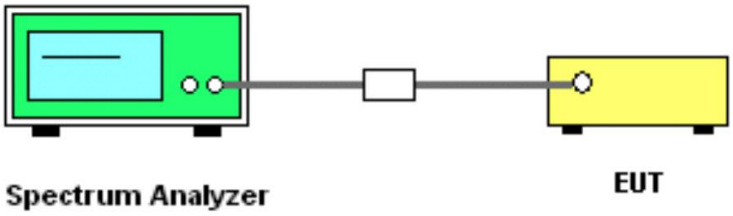


Figure 1: Setup for conducted measurements at antenna connector

5.2 Antenna gain above 1 GHz

Radiated measurement of the antenna gain is performed in an anechoic room with floor absorbers. The measurement distance is 1.5 metres.
A turntable capable of rotation through 360° in the horizontal plane is used to support the EUT at as close as possible to a height of 1.5 m above the ground plane. The measurement antenna is mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization and in the same height as the EUT.
The measurement antenna is a horn antenna.

The radiated measurement of the antenna gain is performed in several steps:

a) The EUT is placed on the support in its standard position and set to the mode of operation (see clause 4.2).
b) The measurement antenna is oriented initially for vertical polarization unless otherwise stated.
c) The measurement equipment is connected to the measurement antenna and set-up according to the specifications of the test.
d) The EUT is rotated in a horizontal plane through 360°. Continuously the power of the used frequency is measured and recorded.
e) Steps a) to d) are repeated for horizontal polarization.

If the EUT may be used in various positions, steps a) to e) are repeated in other three orthogonal positions.

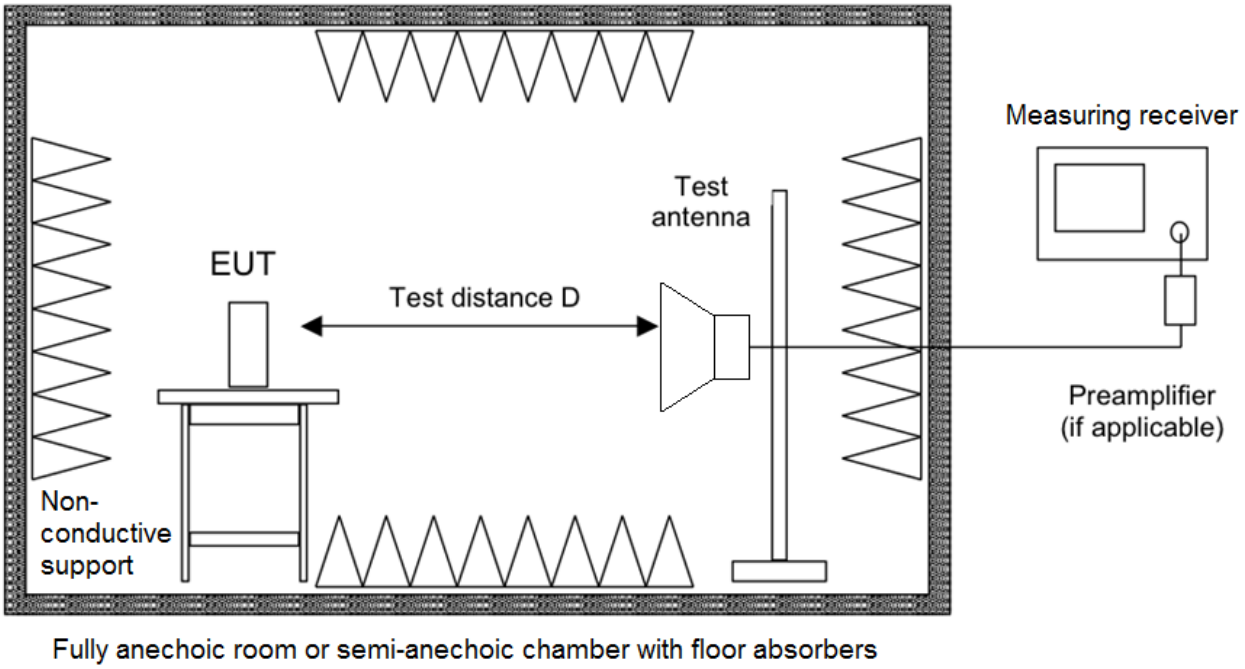


Figure 2: Setup for radiated measurement of antenna gain above 1 GHz

5.3 Antenna pattern above 1 GHz

Radiated measurement of the antenna pattern is performed in an anechoic room with floor absorbers. The measurement distance is 1.5 metres.
A turntable capable of rotation through 360° in the horizontal plane is used to support the EUT at as close as possible to a height of 1.5 m above the ground plane. The measurement antenna is mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization and in the same height as the EUT.
The measurement antenna is a horn antenna.

The radiated measurement of the antenna pattern is performed in several steps:

a) The EUT is placed on the support in its standard position and set to the mode of operation (see clause 4.2).
b) The measurement antenna is oriented initially for vertical polarization unless otherwise stated and the EUT is placed on the support in its standard position and switched on.
c) The measurement equipment is connected to the measurement antenna and set-up according to the specifications of the test.
d) The EUT is rotated in a horizontal plane through 360° in steps of 6°. At each step the power of the used frequency is measured and recorded.
e) Steps a) to d) are repeated for horizontal polarization.

If the EUT may be used in various positions, steps a) to e) are repeated in other three orthogonal positions.

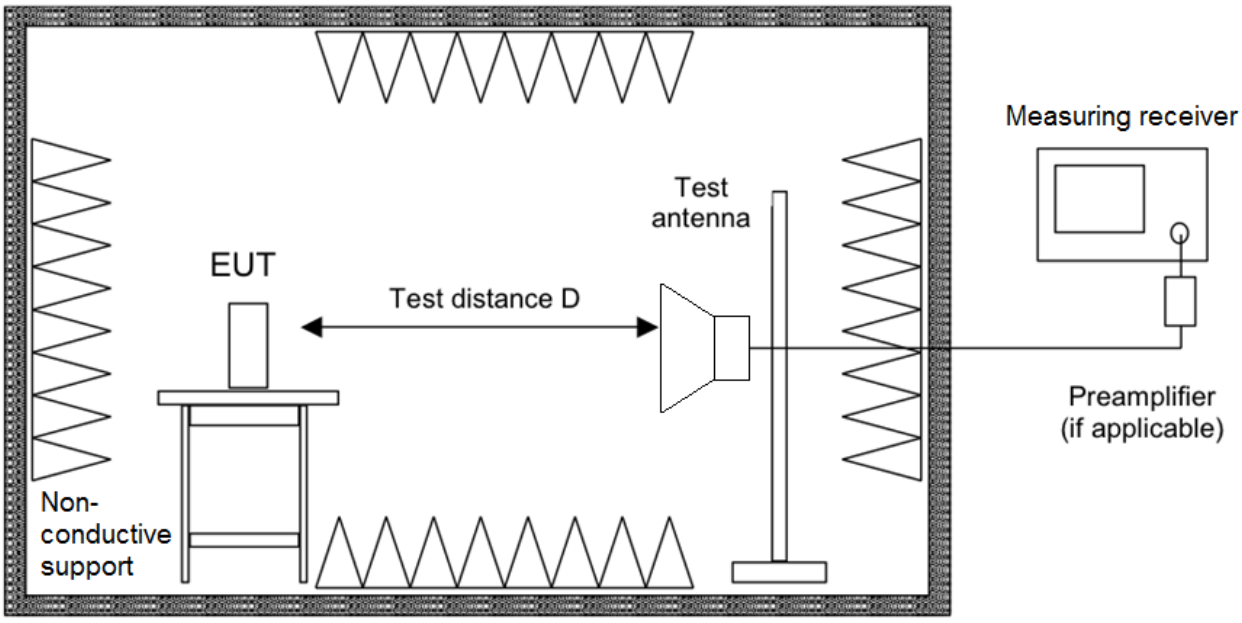


Figure 3: Setup for radiated measurement of antenna pattern above 1 GHz

6 Test results

This clause gives details about the test results as collected in the Summary of test results starting on page 5.

For information about measurement uncertainties see page **Fehler! Textmarke nicht definiert.**.

The climatic conditions are recorded during the tests. It is ensured that the climatic conditions are within the following ranges:

Ambient temperature	*Ambient humidity*	*Ambient pressure*
15°C to 35°C	30 % to 75 %	86 kPa to 106 kPa

6.1 Antenna gain above 1 GHz

Performed by:	Konrad Graßl	Date(s) of test:	January 24, 2024

6.1.1 Test equipment

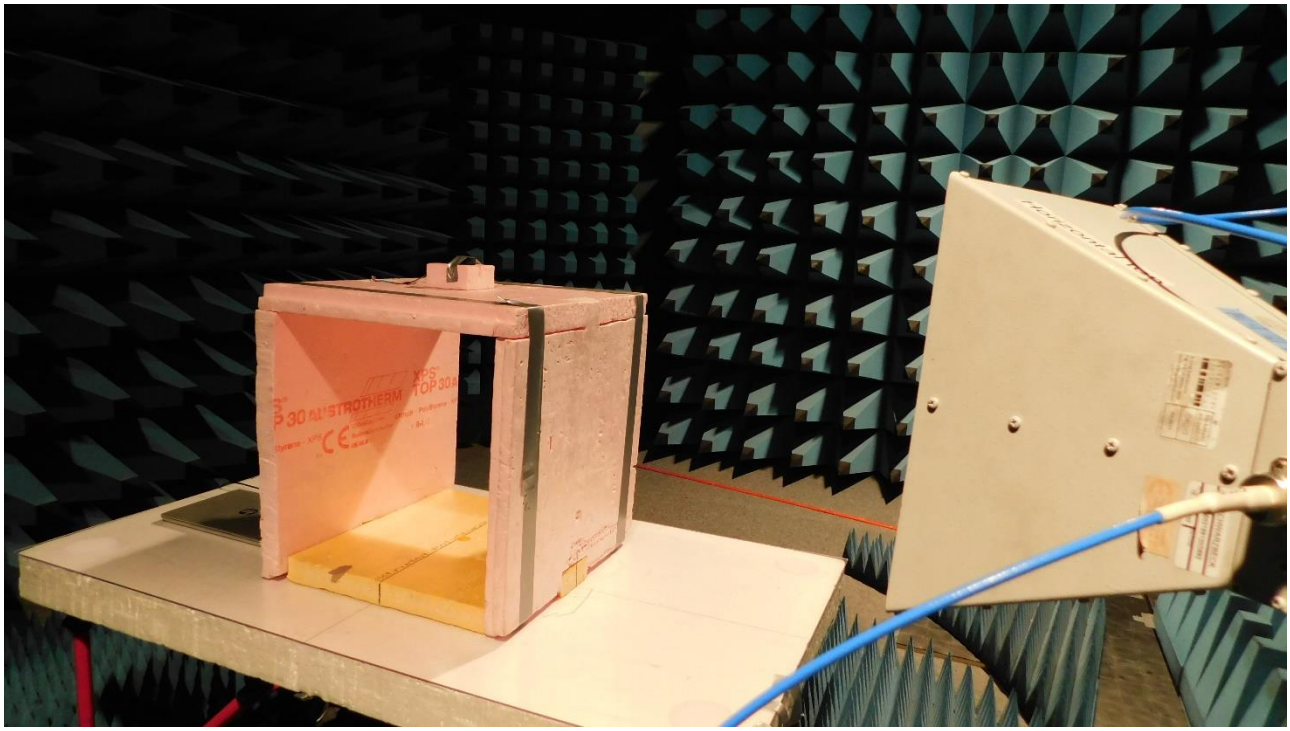
Type	*Designation*	*Manufacturer*	*Inventory no.*
Free space semi-anechoic chamber (FS-SAC)	FS-SAC	ELEMENT STRAUBING	E00100
EMI test receiver	ESU 26	Rohde & Schwarz	W00002
Attenuator (20 dB)	R411.820.121	RADIALL	W00708
Preamplifier (0.5 GHz - 18 GHz)	BBV 9718 B	Schwarzbeck	W01325
Horn antenna	BBHA 9120D	Schwarzbeck	W00053
Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433

6.1.2 Measurement procedure

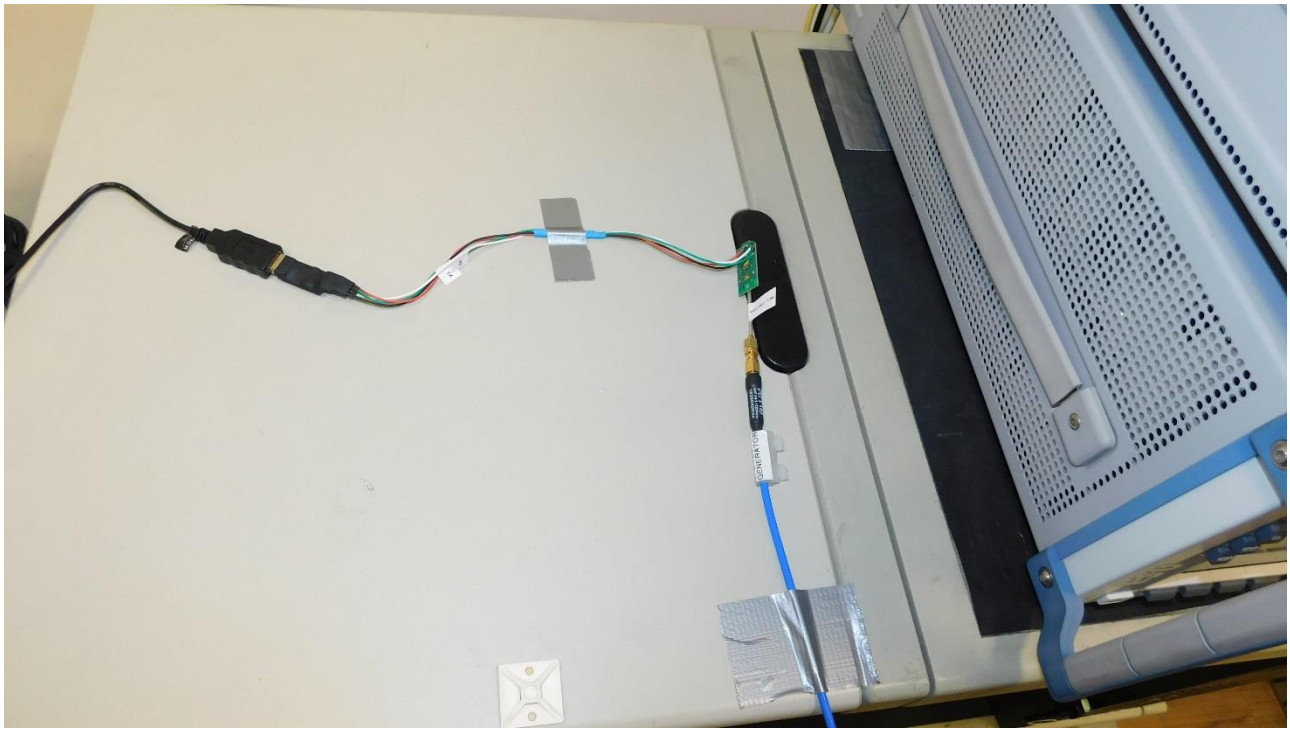
Antenna gain is measured using the
☒ conducted measurement procedure as described in clause 5.1 and
☒ radiated measurement procedure as described in clause 5.2.

Note(s):
1. The field strength was measured at a measurement distance of 1.5 m.
2. EIRP was calculated as defined in clause 9.5 of ANSI C63.10-2013.
3. Conducted output power is calculated by subtracting the gain of the EIRP.

6.1.3 Test setup



Picture 12: Setup for radiated measurement



Picture 13: Setup for conducted measurement

6.1.4 Test results

Note(s):
1 Premeasurements were performed to declare the worst case which is documented below.
2 The highest EIRP was measured in position Y with the antenna in vertical polarization.
3 The gain is calculated with the following formula:

$$Calculated\ antenna\ gain\ = E.I.R.P. - conducted\ power$$

Frequency (MHz)	*EIRP (dBm)*	*Conducted power (dBm)*	*Calculated antenna gain (dBi)*
2402	-2.6	-1.9	-0.7
2440	-2.5	-1.9	-0.6
2480	-3.2	-2.0	-1.2

Table 4: Final result of antenna gain

6.2 Antenna pattern above 1 GHz

Performed by:	Konrad Graßl	Date(s) of test:	January 16, 2024

6.2.1 Test equipment

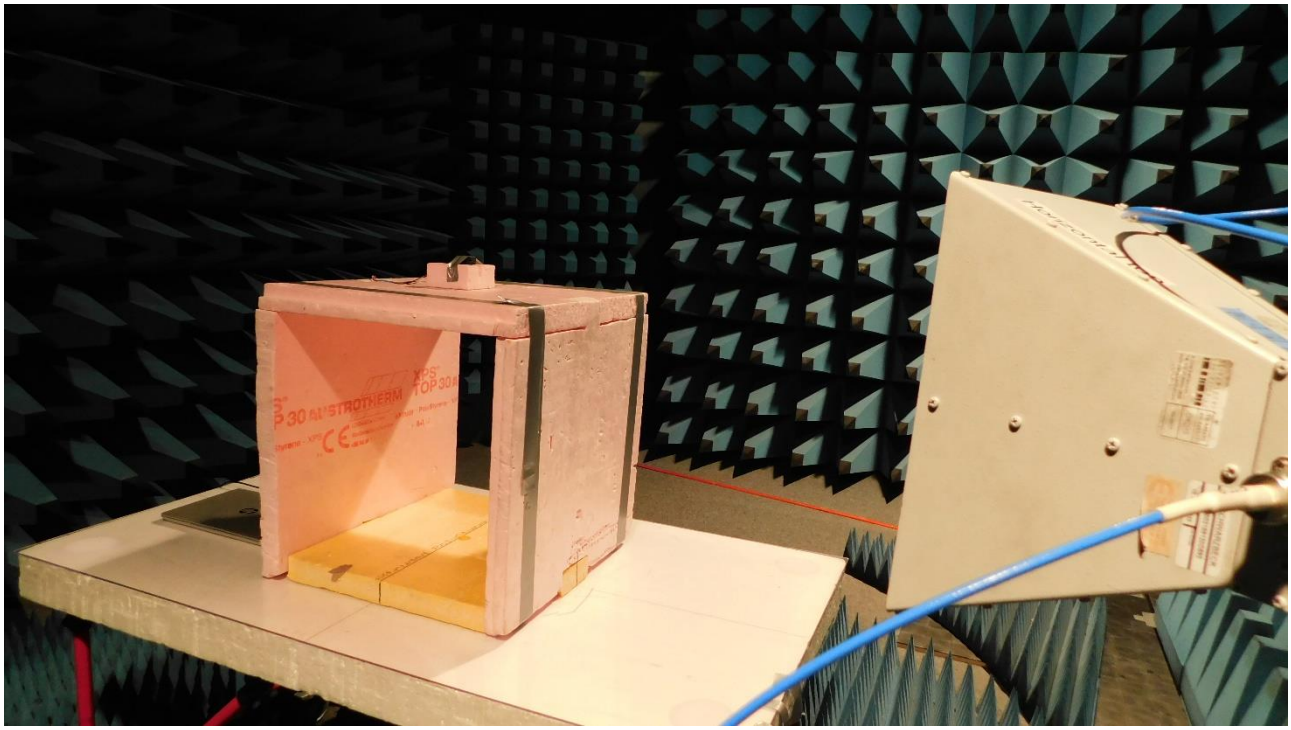
Type	*Designation*	*Manufacturer*	*Inventory no.*
Free space semi-anechoic chamber (FS-SAC)	FS-SAC	ELEMENT STRAUBING	E00100
EMI test receiver	ESU 26	Rohde & Schwarz	W00002
Attenuator (20 dB)	R411.820.121	RADIALL	W00708
Preamplifier (0.5 GHz - 18 GHz)	BBV 9718 B	Schwarzbeck	W01325
Horn antenna	BBHA 9120D	Schwarzbeck	W00053
Cable set FS-SAC	RF cable(s)	Teledyne Reynolds Huber + Suhner Teledyne Reynolds	E00435 E00307 E00433

6.2.2 Measurement procedure

Antenna pattern is measured using the
☒ radiated measurement procedure as described in clause 5.3.

Note(s):
1. The field strength was measured at a measurement distance of 1.5 m.
2. EIRP was calculated as defined in clause 9.5 of ANSI C63.10-2013.
3. Conducted output power is calculated by subtracting the gain of the EIRP.

6.2.3 Test setup



Picture 14: Setup for measuring the antenna pattern

6.2.4 Test results

General note(s):
1 The black line shows the EIRP.
2 The red line shows the value which is 3 dB lower than the highest EIRP.

Note(s):
1 The highest EIRP of the EUT in this pattern is -3.1 dBm.

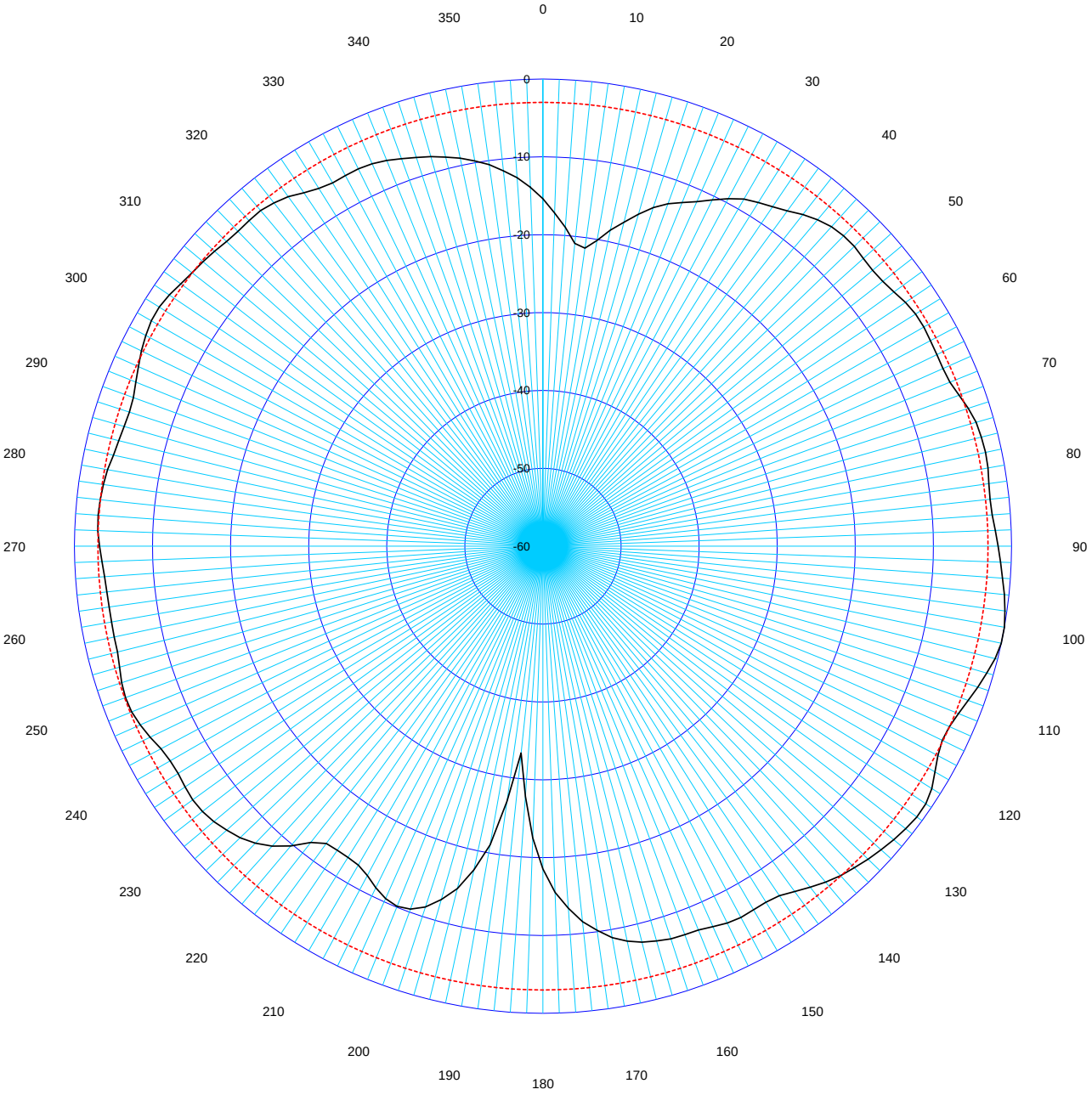


Figure 4: Antenna pattern of 2402 MHz in EUT position X and horizontal polarization

Note(s):

1 The highest EIRP of the EUT in this pattern is -8.4 dBm.

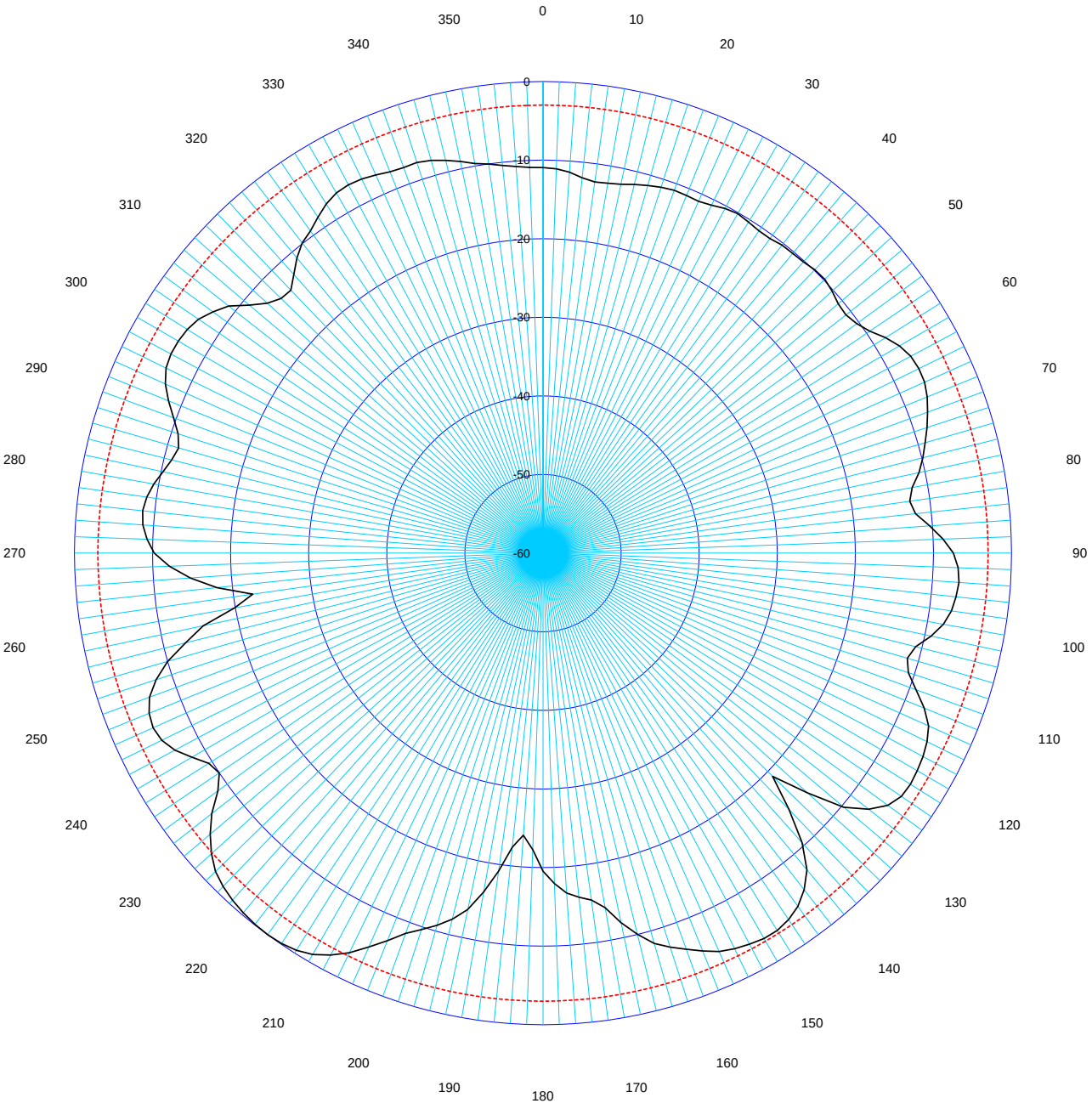


Figure 5: Antenna pattern of 2402 MHz in EUT position X and vertical polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -10.3 dBm.

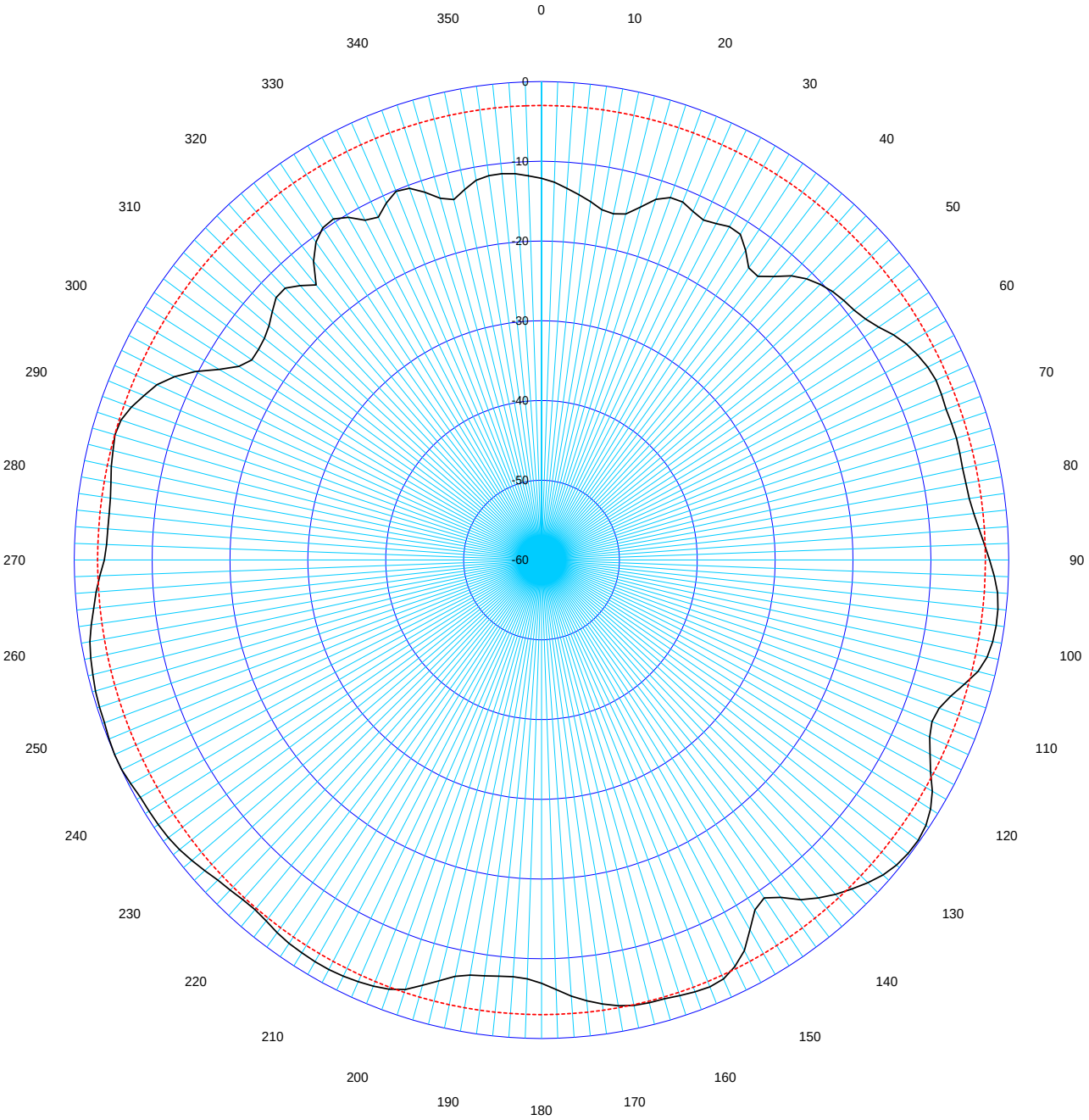


Figure 6: Antenna pattern of 2402 MHz in EUT position Y and horizontal polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -2.6 dBm.

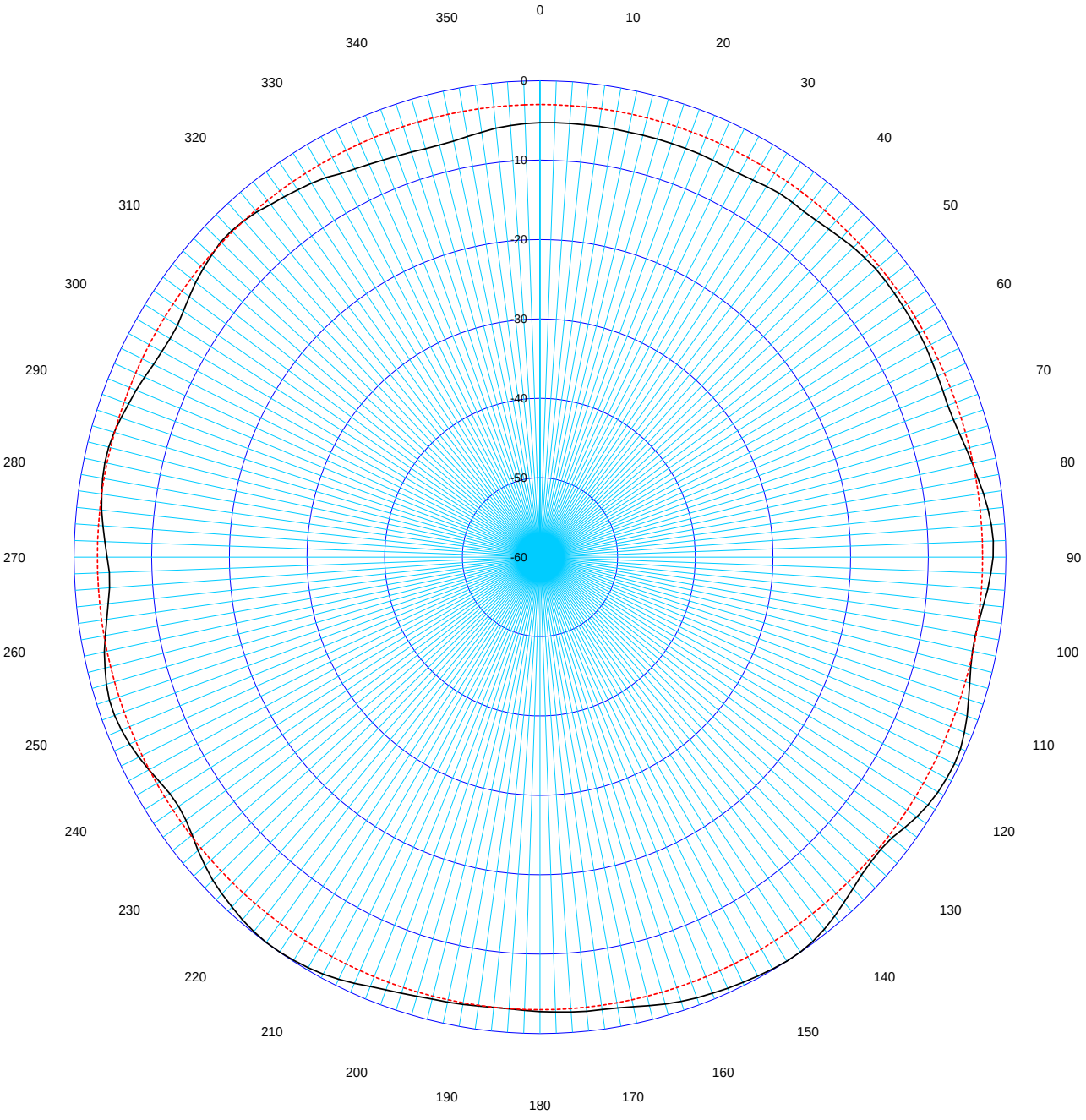


Figure 7: Antenna pattern of 2402 MHz in EUT position Y and vertical polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -3.4 dBm.

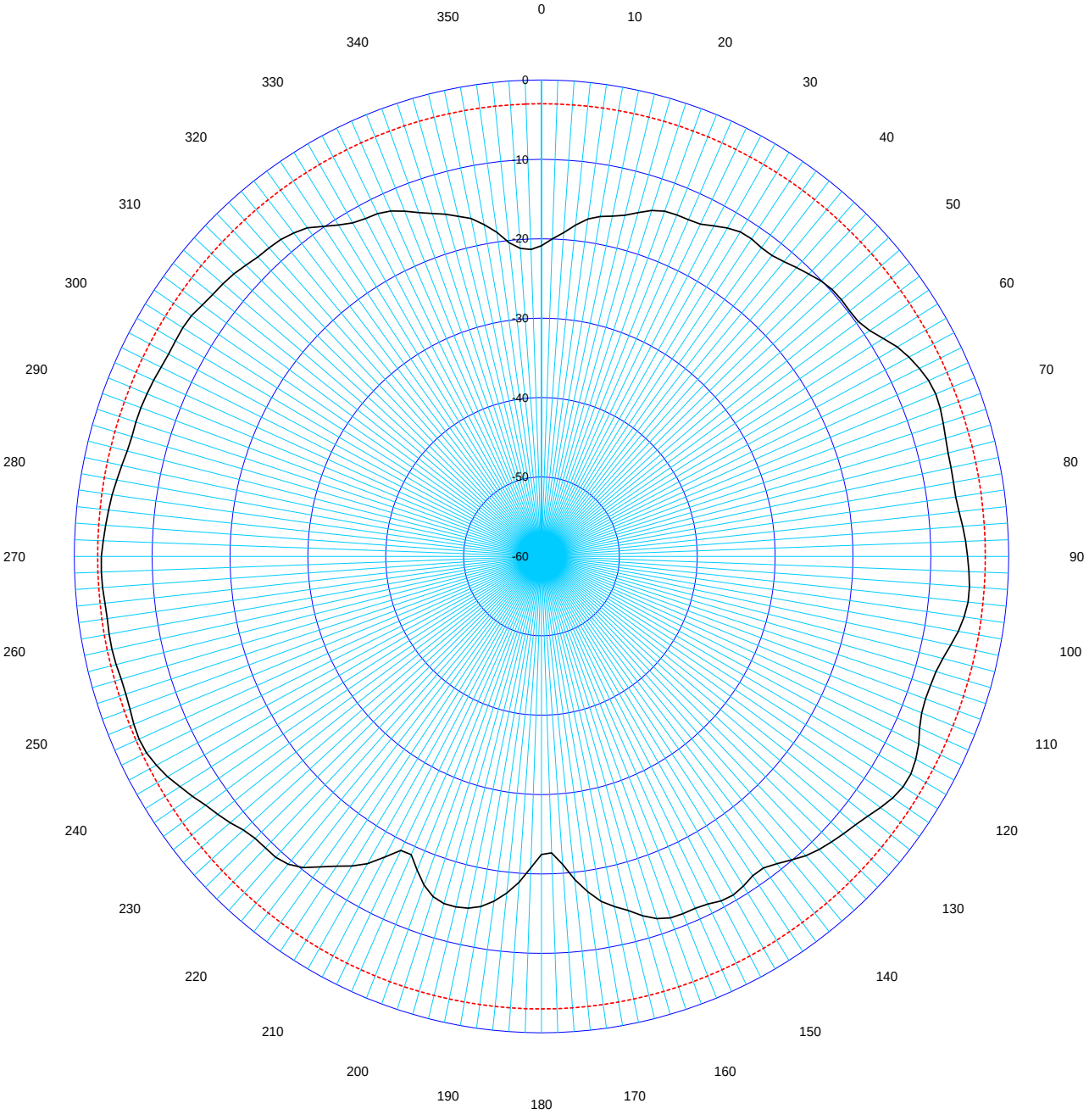


Figure 8: Antenna pattern of 2402 MHz in EUT position Z and horizontal polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -9.5 dBm.

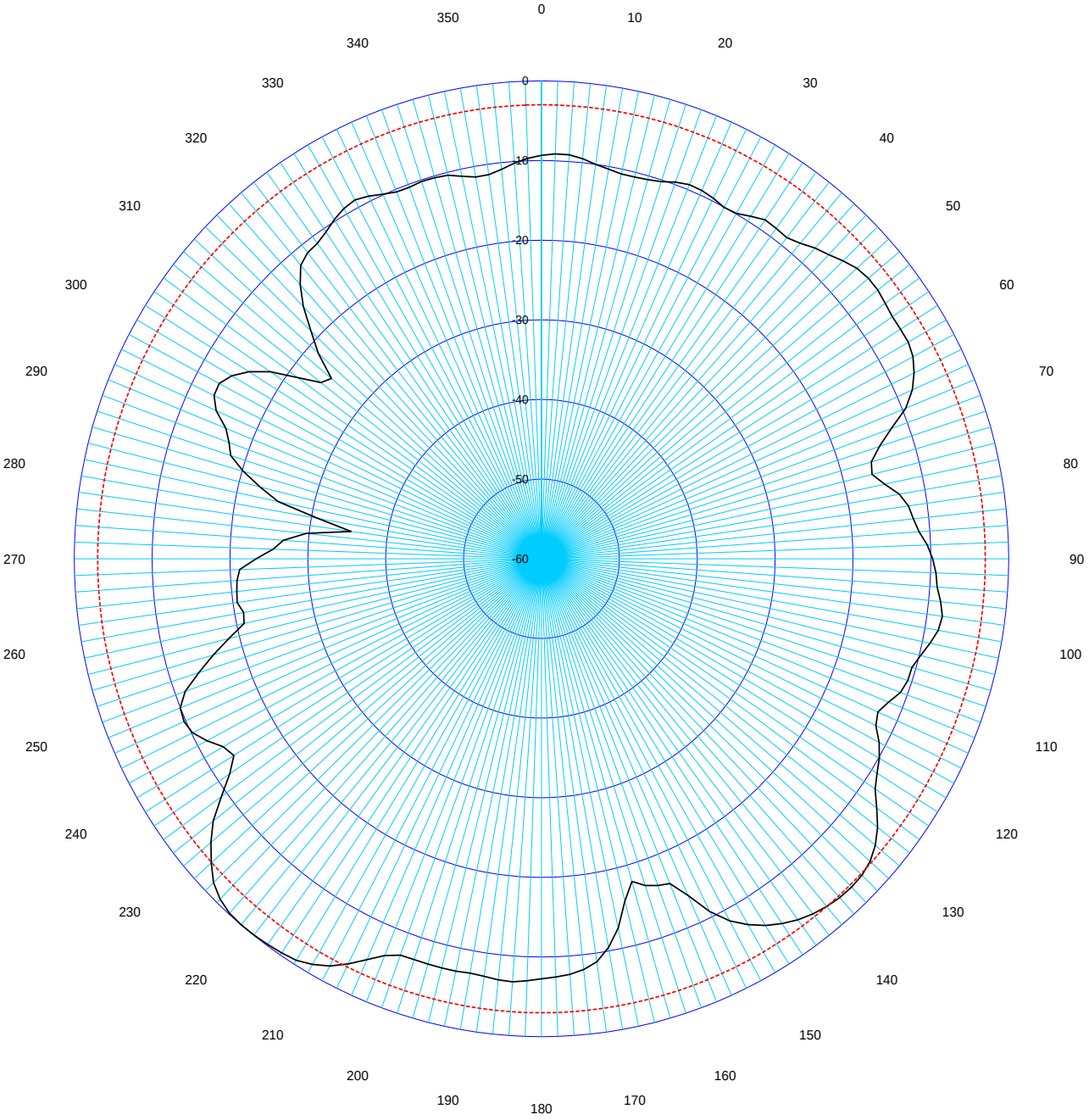


Figure 9: Antenna pattern of 2402 MHz in EUT position Z and vertical polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -3.8 dBm.

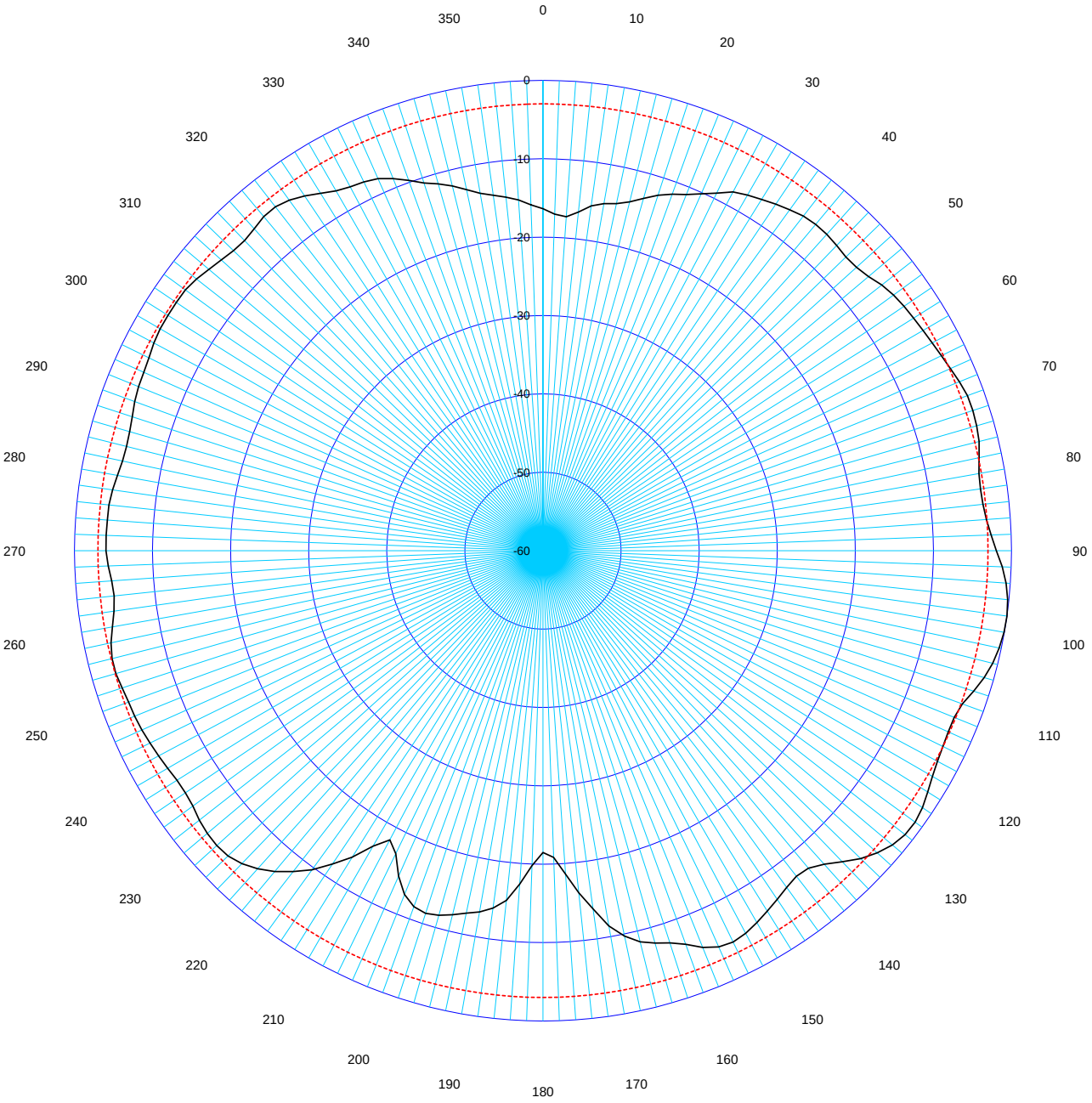


Figure 10: Antenna pattern of 2440 MHz in EUT position X and horizontal polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -8.4 dBm.

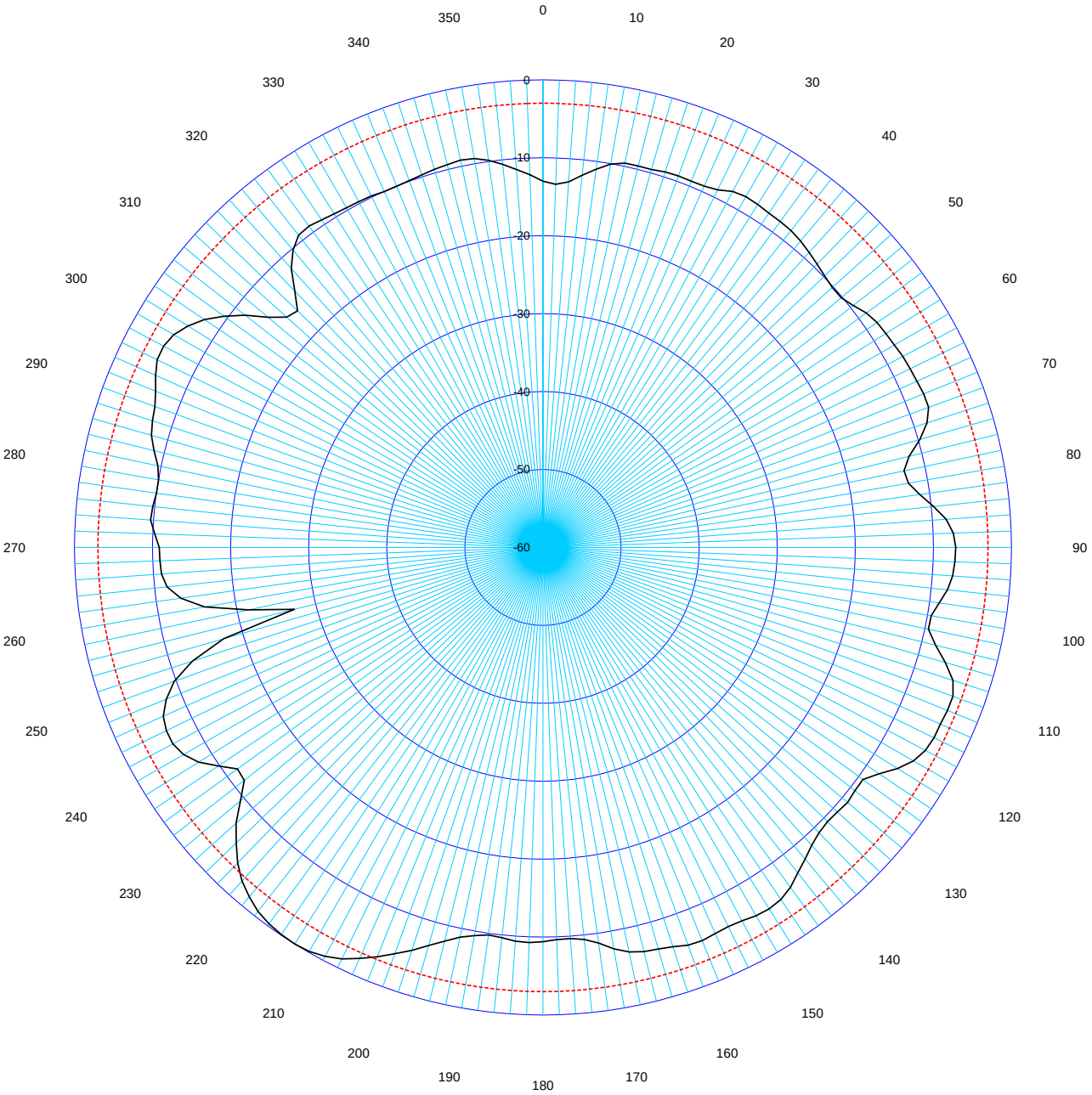


Figure 11: Antenna pattern of 2440 MHz in EUT position X and vertical polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -10.4 dBm.

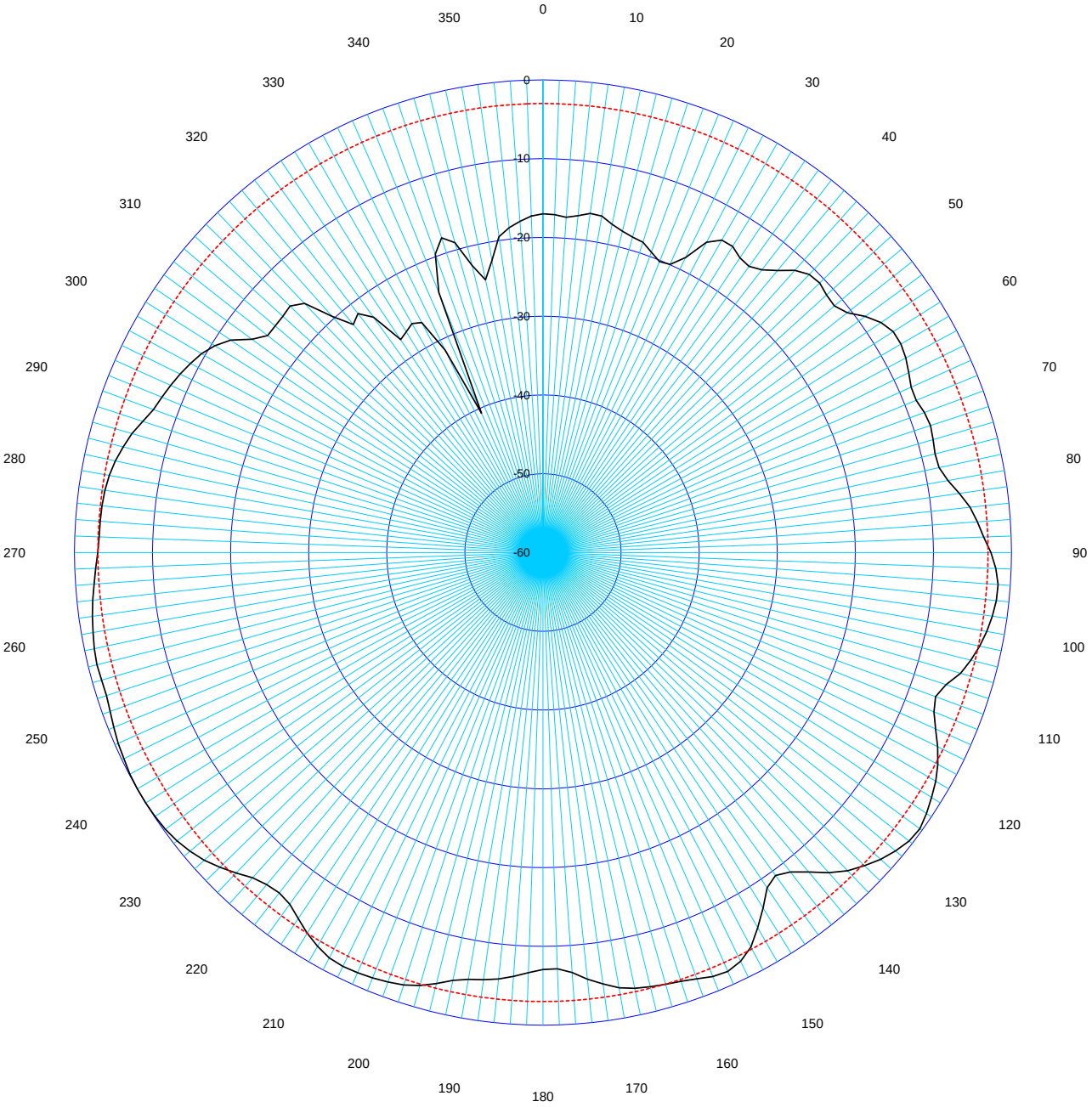


Figure 12: Antenna pattern of 2440 MHz in EUT position Y and horizontal polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -2.5 dBm.

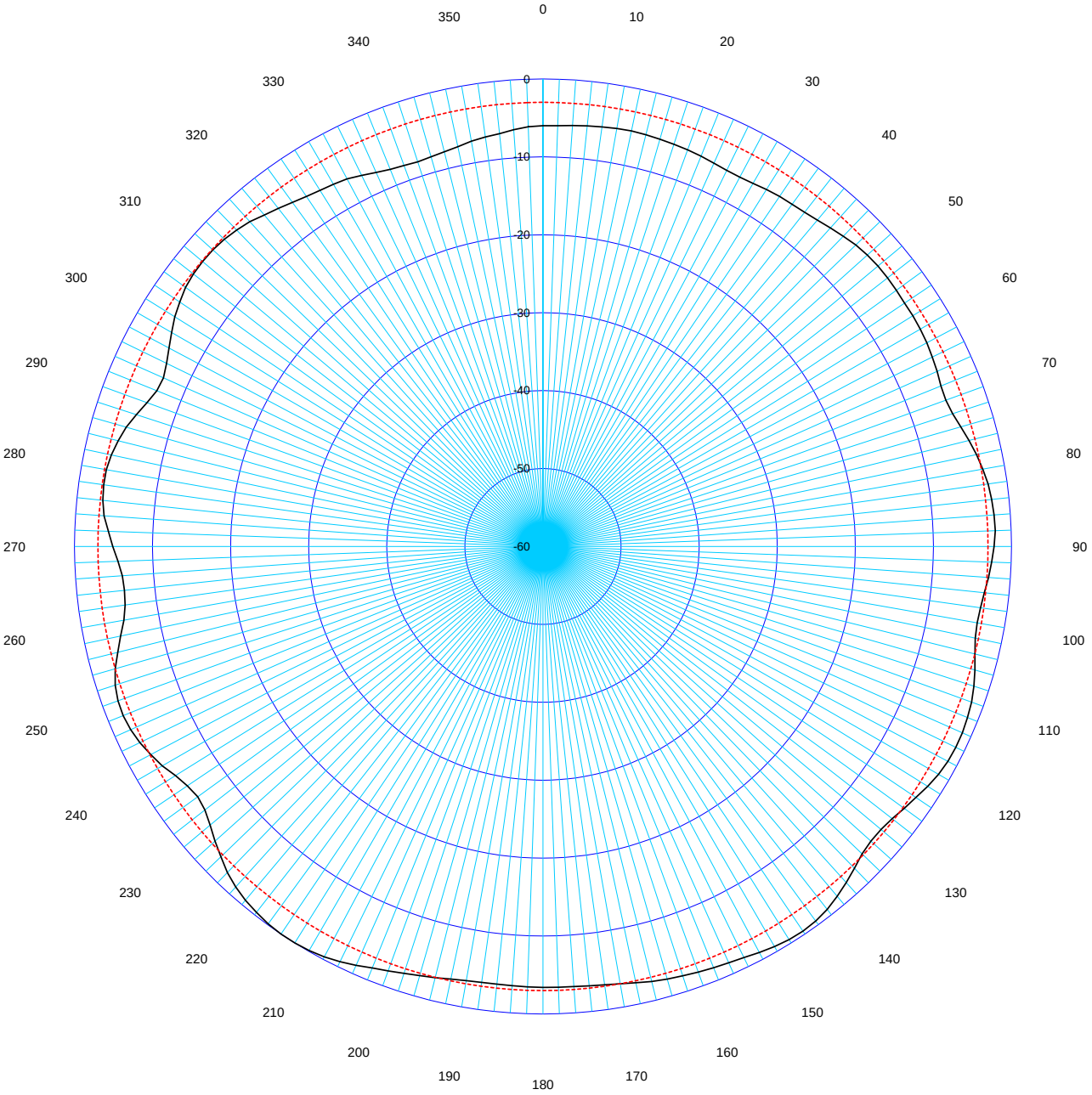


Figure 13: Antenna pattern of 2440 MHz in EUT position Y and vertical polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -4.1 dBm.

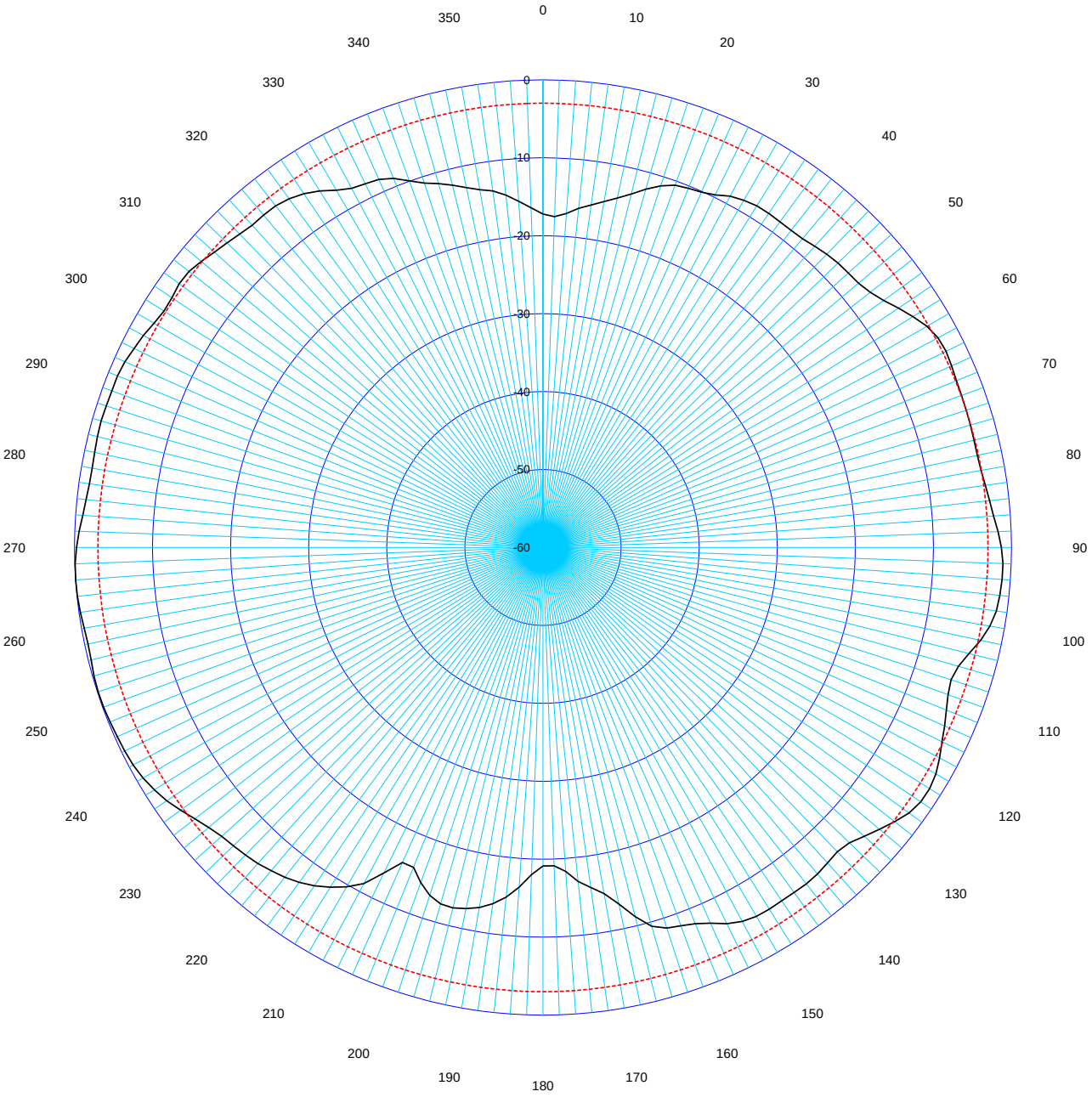


Figure 14: Antenna pattern of 2440 MHz in EUT position Z and horizontal polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -9.7 dBm.

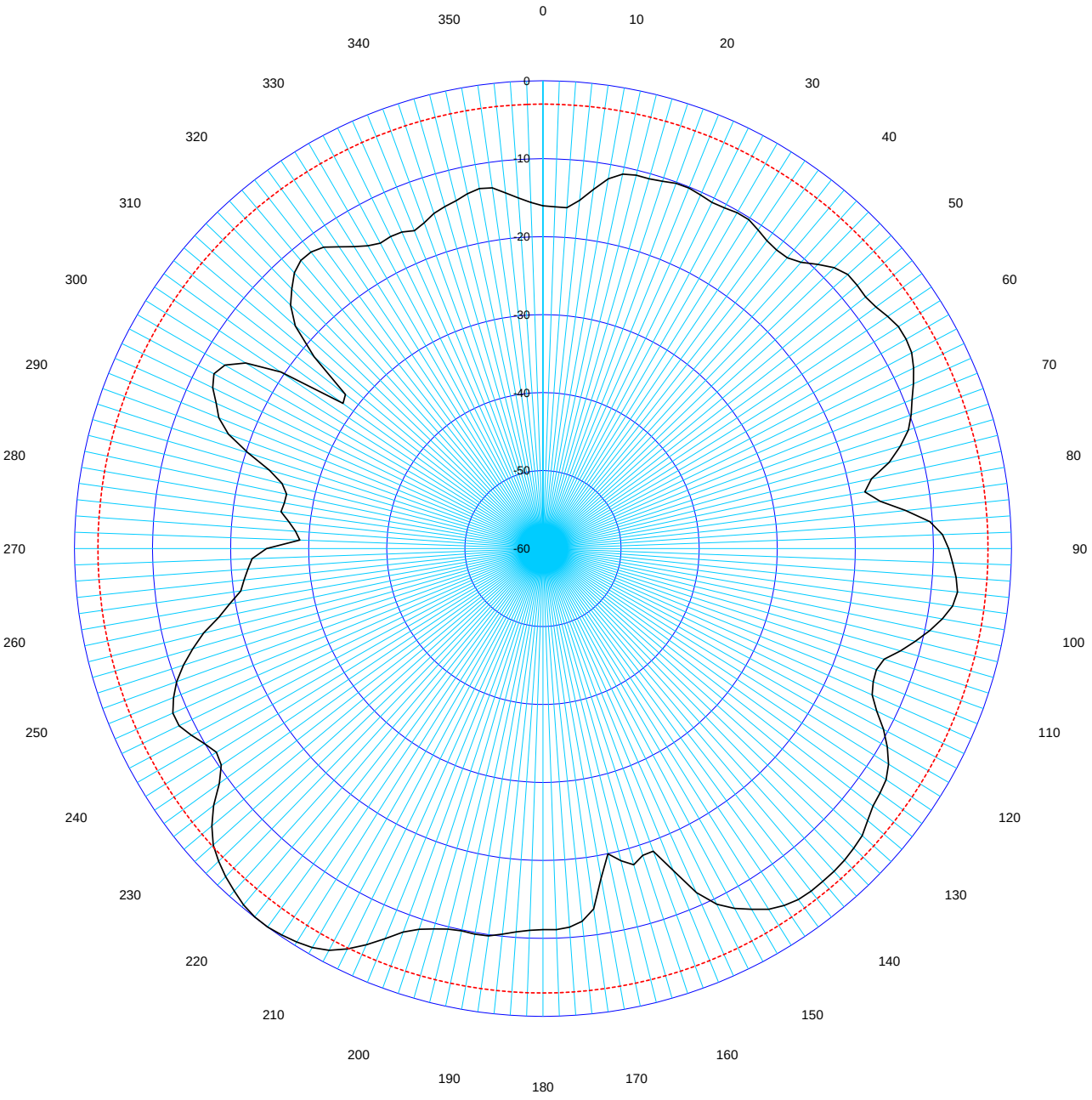


Figure 15: Antenna pattern of 2440 MHz in EUT position Z and vertical polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -4.2 dBm.

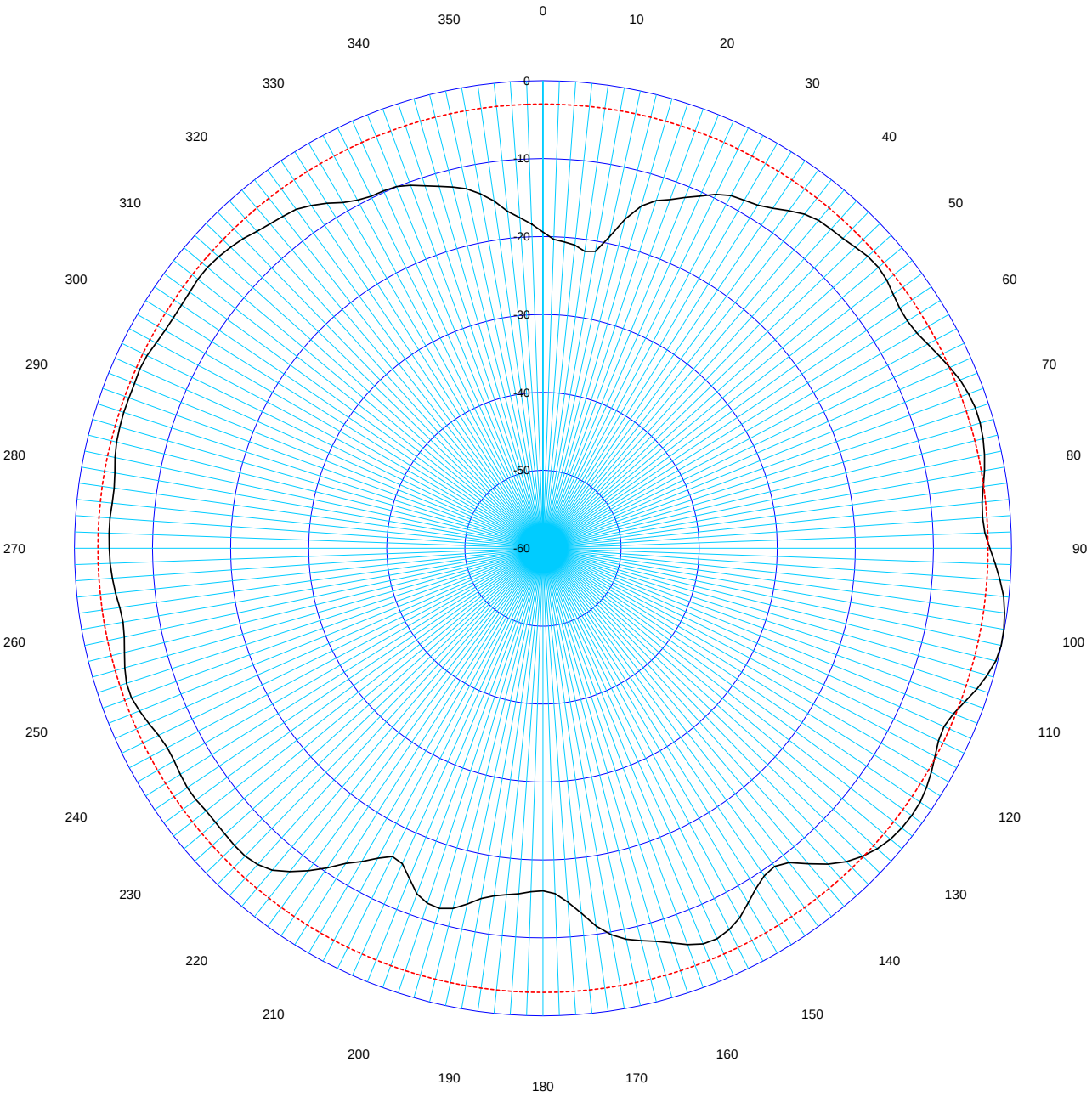


Figure 16: Antenna pattern of 2480 MHz in EUT position X and horizontal polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -9.2 dBm.

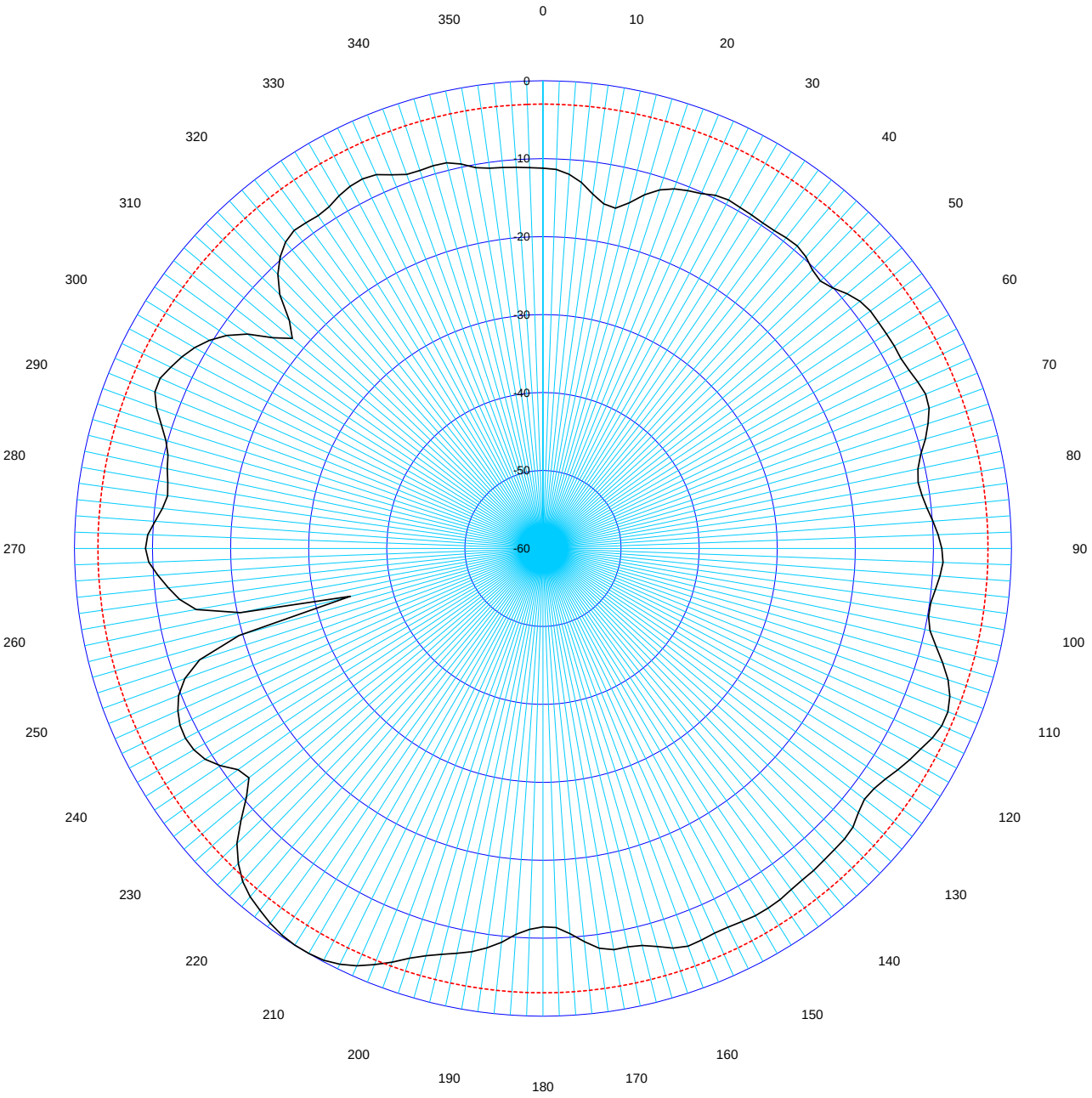


Figure 17: Antenna pattern of 2480 MHz in EUT position X and vertical polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -8.6 dBm.

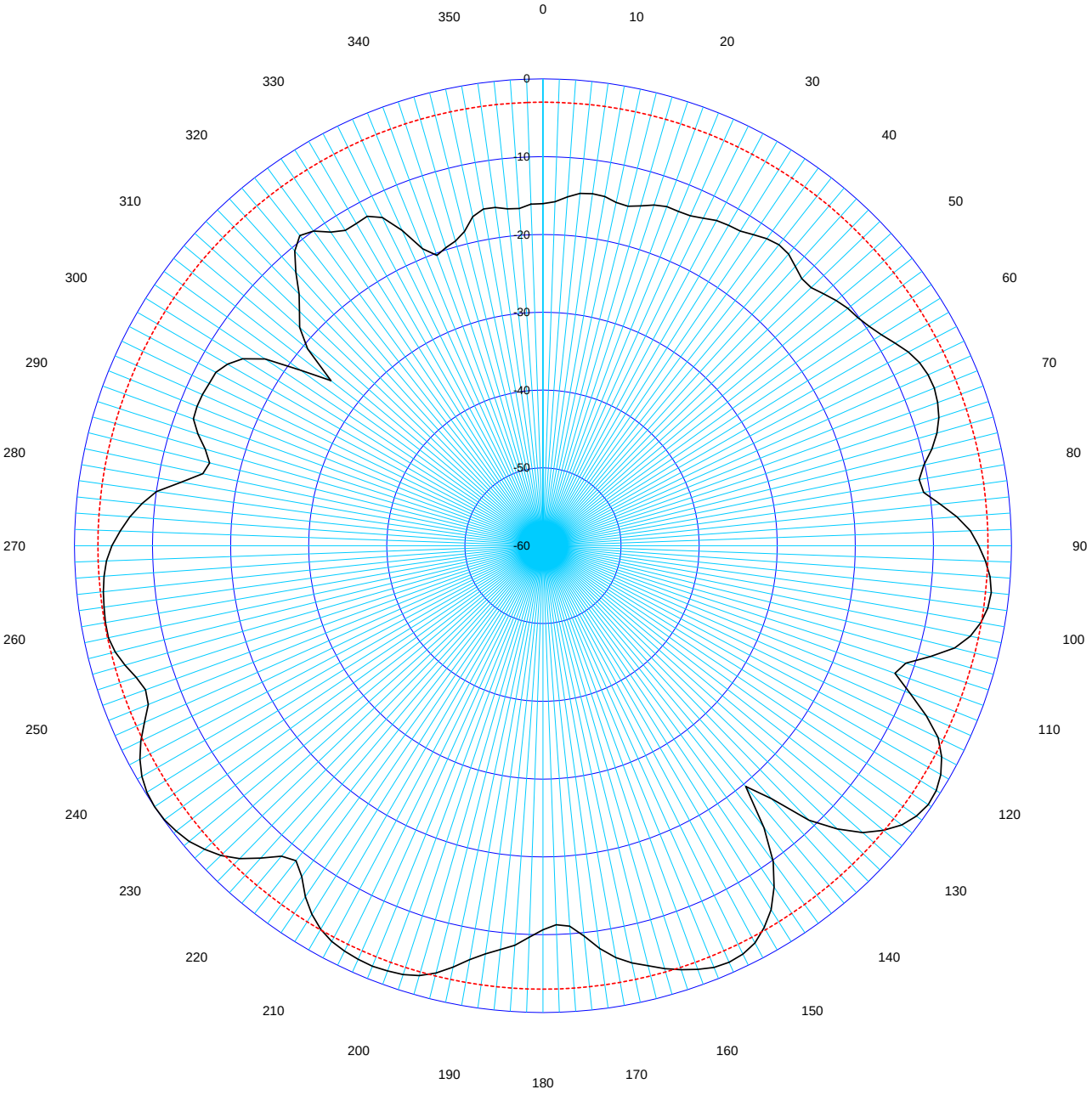


Figure 18: Antenna pattern of 2480 MHz in EUT position Y and horizontal polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -3.2 dBm.

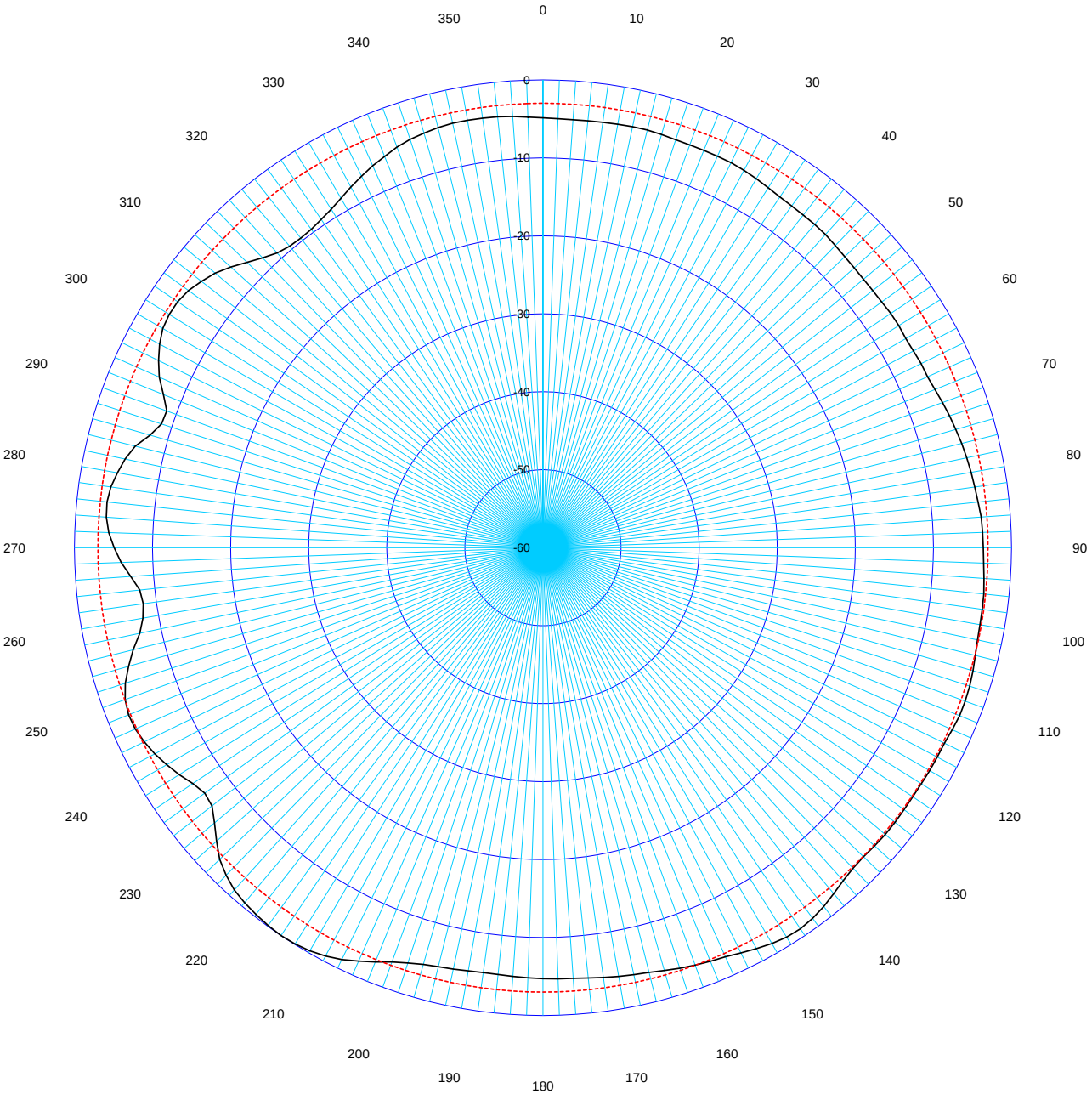


Figure 19: Antenna pattern of 2480 MHz in EUT position Y and vertical polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -5.1 dBm.

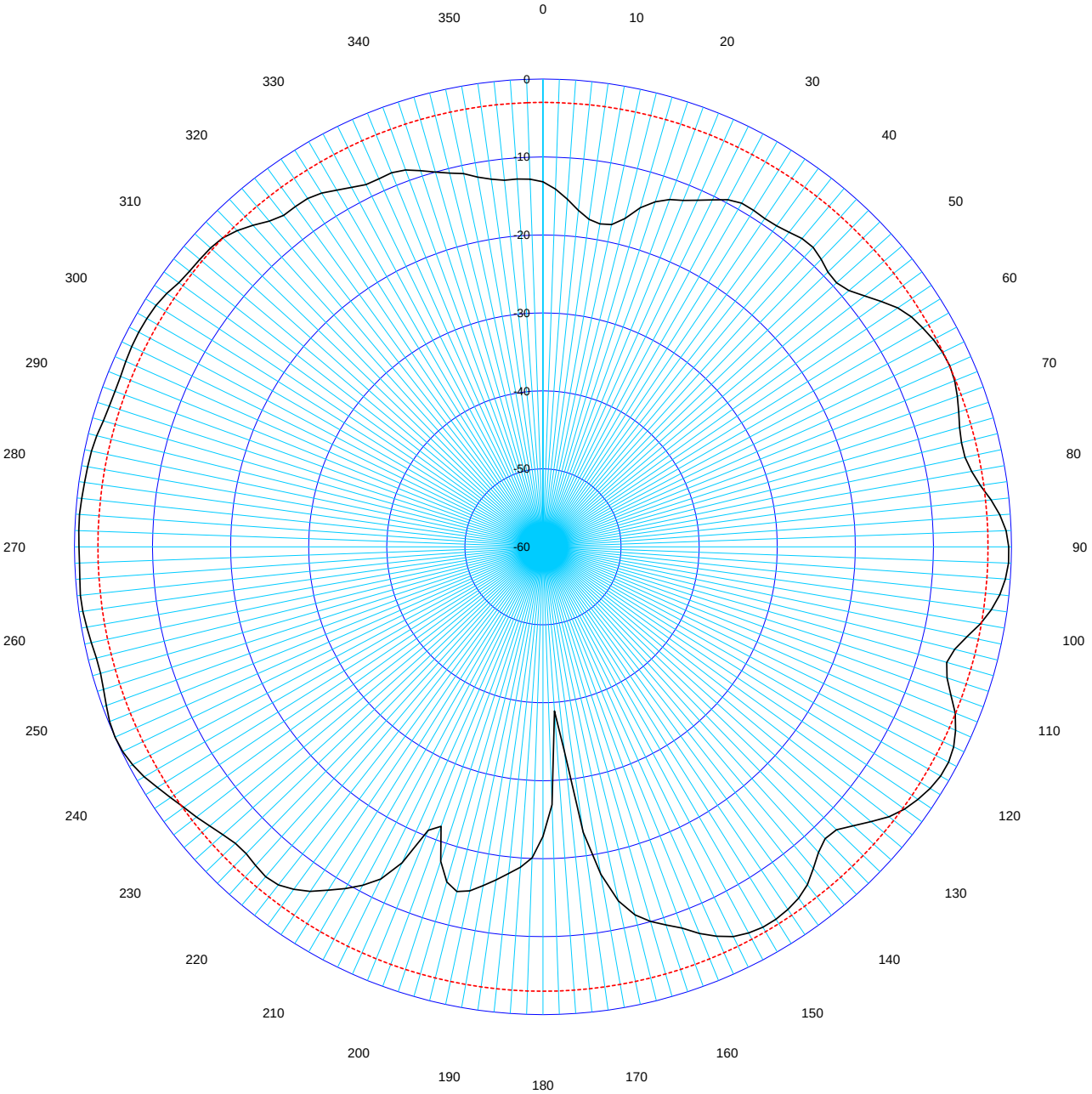


Figure 20: Antenna pattern of 2480 MHz in EUT position Z and horizontal polarization

Note(s):
1 The highest EIRP of the EUT in this pattern is -9.9 dBm.

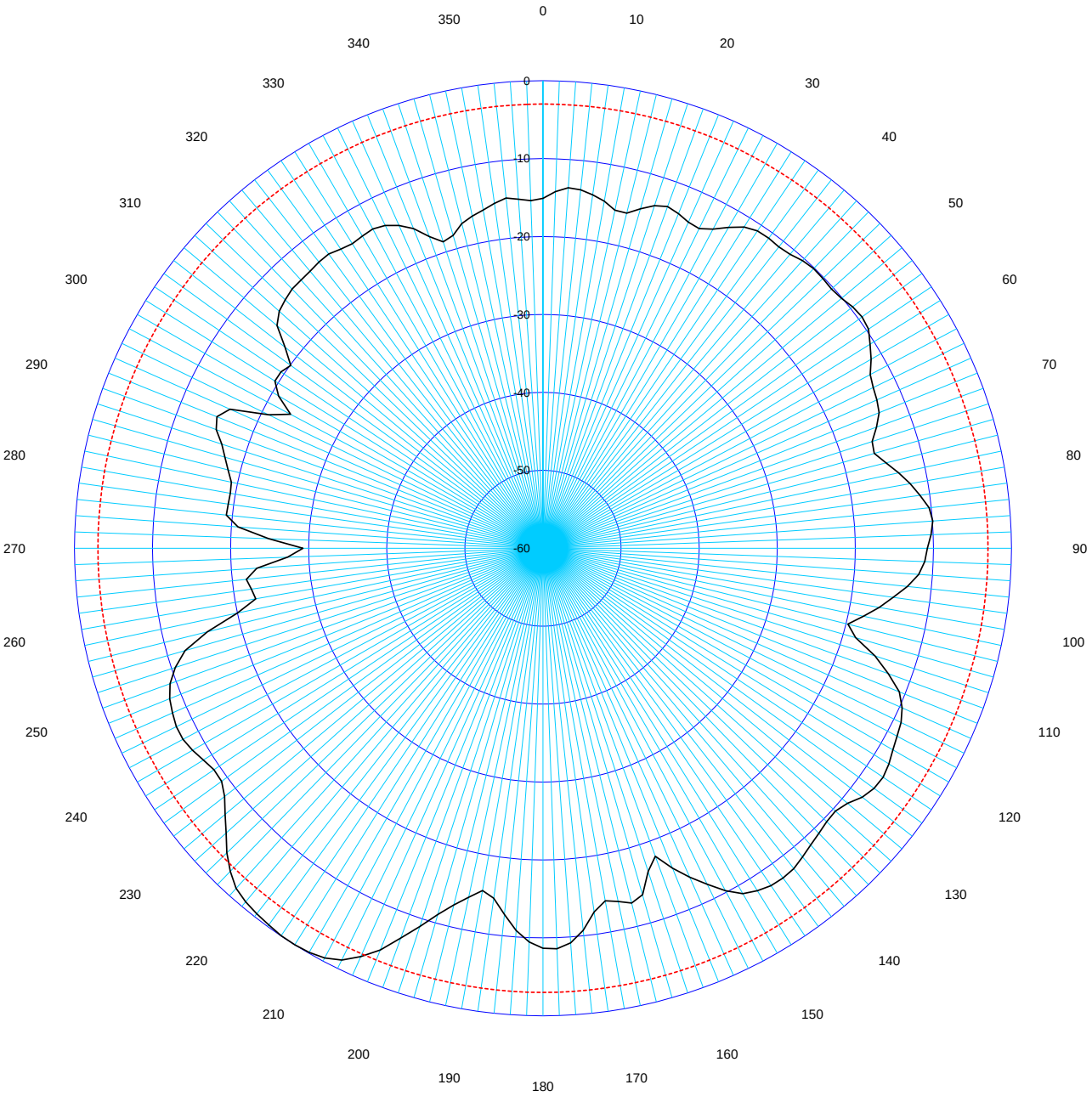


Figure 21: Antenna pattern of 2480 MHz in EUT position Z and vertical polarization

7 Revision history

Revision	*Date*	*Issued by*	*Description of modifications*
0	2024-01-26	Konrad Graßl	First edition

Template: RF_Antenna tests_V1.0