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Antenna Pattern TEST REPORT

Tests performed at:

Radio Test Site
Twentypence Road,
Cottenham,
Cambridge
U.K.
CB24 8PS

On

Sepura Limited

330-00016 (Pulse 403-470MHz Extended Helical) Antenna Gain Test Results

Document History

Version	Date	Affected page(s)	Description of modifications	Revised by	Approved by
00	12/07/2019		Initial release		
01	21/07/2019	7	CF equations corrected	DS	DS

Product:	330-00016 (Pulse 403-470MHz Extended Helical) Antenna Gain Test Results	
Company:	Sepura Limited	
Representative:	David Reeves	
Address:	9000 Cambridge Research Park Beach Drive Waterbeach Cambridgeshire CB25 9TL	
Start Date:	*18th June 2019*	
End Date:	*18th June 2019*	
Report Written By:	Peter Barlow	
Version V00 Authorised By:	Dave Smith	12th July 2019
Version V01 Authorised By:	Dave Smith	21st July 2019
Signature:	Dave Smith Digitally signed by Dave Smith DN: CN=Dave Smith, C=UK, O=dB Technology, E=mail@dbtechnology.co.uk Reason: I am approving this document Location: Cottenham Date: 2019-07-21 17:47:01	
Position:	Senior Engineer	

dB Technology can only report on the specific unit(s) tested at its site. The responsibility for extrapolating this data to a product line lies solely with the manufacturer.

Table of Contents

1 Introduction

This document describes testing performed by dB Technology (Cambridge) Ltd.

Sections 2 and 3 of this document contain information that has been supplied by /agreed with the customer commissioning this set of work (typically the representative named at the start of this report). Any inaccuracies are the responsibility of the customer and may have a bearing on the validity of this report.

2 General Information

2.1 Product Name and Contact Details

Product:	330-00016 (Pulse 403-470MHz Extended Helical) Antenna Gain Test Results
Company:	Sepura Limited
Representative:	David Reeves
Address:	9000 Cambridge Research Park Beach Drive Waterbeach Cambridgeshire CB25 9TL

2.2 Product Description

This report describes a series of tests performed on two types of antennae connected to a Sepura SC21 UV band radio.

The SC21 is a battery powered radio device. Its transmit output power of +15dBm to a 50R load is well defined and easily measured. However, it is the antenna radiation efficiency which ultimately determines the effective radiated power (e.r.p.) of the unit and hence the range over which the unit can communicate.

The purpose of the tests described in this report was to obtain a clear picture of radiation efficiency of the SC21 with a second source antenna (P/N: 330-00016). Two sets of tests were performed ('Free-Space Gain' and 'Belt-Worn with B-RSM Cable Parallel to Antenna') using the already tested (first source) antenna (P/N: 310-00014) and the new second source antenna (P/N: 330-00016) for comparison/reference.

The Antenna (P/N: 310-00014) was used to cover the TW part of the band (from 403 to 430MHz) while the new Antenna (P/N: 330-00016) covered the UV range (420-470MHz).

2.2.1 UUT Details

Test were performed on the following product:

- Sepura SC21 UV band (403-470MHz) Radio - P/N SC2120

Antennae fitted were:

- SC21 Extended Helical Antenna 420-470MHz - P/N 330-00016
- SC21 Extended Helical Antenna 380-430MHz - P/N 310-00014

Accessories connected were:

- Basic RSM (Remote Speaker Microphone) - P/N 300-00389
- RAC Two-Wire Kit Acoustic Tube - P/N 300-01628

2.2.2 Body Positions

All measurements, apart from the free space measurement, were made with the UUTs held by, or close to, a real human being. The same person was used for all tests. Photographs at the end of this document show the position of the UUT for all options tested.

2.3 Gain Correction Factors

2.3.1 Method

Measurements were made on a 10m open area test site conforming to the requirements of CISPR 16. A broadband receiving antenna was positioned 10m from the UUT. The receiving antenna was connected to an RF receiver. The receiver was tuned to the appropriate frequency. The receiver mode was set to quasi-peak with a 120kHz bandwidth and a 1sec dwell time.

2.3.2 Substitution measurements

Measurements were made using a mini-biconical as the transmitting antenna in order to be able to make comparisons between the actual antennae and the mini-bicon.

The mini-bicon was positioned at the centre of the turntable at approximately shoulder height.

The height of the receiving antenna was adjusted over the range 1m to 4m until a maximum reading was recorded on the RF receiver.

The gain of the mini-dipole was (dBi) was taken from a calibration report and used to compare the gain of the mini-bicon with that of an ideal dipole. This information was used to calculate the level expected on the RF receiver when using an "ideal" dipole.

2.3.3 Derivation of Correction Factors

The gain of the antenna under test was established by measuring the e.i.r.p. and comparing the results with the measured output power at the EUT antenna port.

Gain[EUT_ant] (dB) =

Measured e.i.r.p[from EUT] (dBm) - Level at Connector Output[EUT] (dBm) (equation 1)

The first stage of measuring the e.i.r.p. from the EUT was to measure the radiated level from a calibrated antenna fed with a known signal. The e.i.r.p from the calibrated antenna is given by:

e.i.r.p.[cal_ant] (dBm) = Sig Applied[cal_ant] (dBm) + Gain[cal_ant] (dBi) (equation 2)

The result of the radiated measurement from the calibrated antenna (Rx Reading [cal_ant]) is a voltage on the measuring receiver. Relating this measured voltage to the predicted e.i.r.p. from the calibrated reference (equation 2) results in a correction factor to convert reading on measuring receiver to e.i.r.p.

Correction Factor: Receiver Reading (dBuV) to e.i.r.p. (dBm) =

Sig Applied[cal_ant] (dBm) + Gain[cal_ant] (dBi) - Rx Reading [cal_ant] (dBuV)

Taking this a step further, the correction factor can be adjusted to convert the measured receiver reading to the Gain of the EUT antenna by incorporating equation 1.

Correction Factor: Receiver Reading (dBuV) to EUT Antenna Gain. (dBi) =

Sig Applied[cal_ant] (dBm) + Gain[cal_ant] (dBi) - Rx Reading [cal_ant] (dBuV)
- Level at Connector Output[EUT] (dBm)

2.3.4 Results

Radiated Emissions Results (Substitution Method)											*#Ref00*
Date: 18/06/2019	*Test Engineer: Peter Barlow*										
Notes	**Freq. MHz**	**Fact Set**	**Sub'n Ant Gain dBi**	**Dist-ance (m)**	**Ant. *Pol.***	**Output Level of EUT (dBm)**	**Sig Gen Level Sub'n Ant dBm**	**Rec'vr Level Sub'n Ant dBuV**		**Gain CF dB**	
	403	1	-0.5	10	V	15.0	-22.6	45.5		**-83.6**	
	420	1	-0.1	10	V	15.0	-22.6	45.5		**-83.1**	
	430	1	0.0	10	V	15.0	-22.6	45.5		**-83.1**	
	445	1	-0.2	10	V	15.0	-22.6	45.9		**-83.7**	
	470	1	-0.2	10	V	15.0	-22.7	44.9		**-82.8**	
Notes:											
	120kHz quasi-peak detector used for all measurements. Gain Correction factors. Based on EIRP substitution measurement - antenna gain figures provided by Sepura PLC.										

2.3.5 Test Equipment

Test Equipment			
Ref:	**Type:**	**Description:**	**S/N:**
A30	Antenna	Schwarzbeck MiniBicon (30MHz to 1GHz)	9115-180
A39	Antenna	Schwarzbeck VULP 9118A Log Periodic	581
CBL107	Cable	RG214 - 10m N-N	CBL107
CBL134	Cable	RG214 - 25m N-N	CBL134
PM3	Power meters / sensors	Marconi 6960B RF Power Meter	236952/008
PS7	Power meters / sensors	Marconi 6920 RF Power Sensor (-70dBm / -20dBm) 10MHz to 20GHz	898
SG22	Signal generators	SRS SG386 DC to 6GHz Signal Generator	002752
R4	Receiver	R&S ESVS10	843744/002
Correction Factors			
CF1:A30_dBi_18A.txt			

2.4 Radiation Patterns

2.4.1 Method

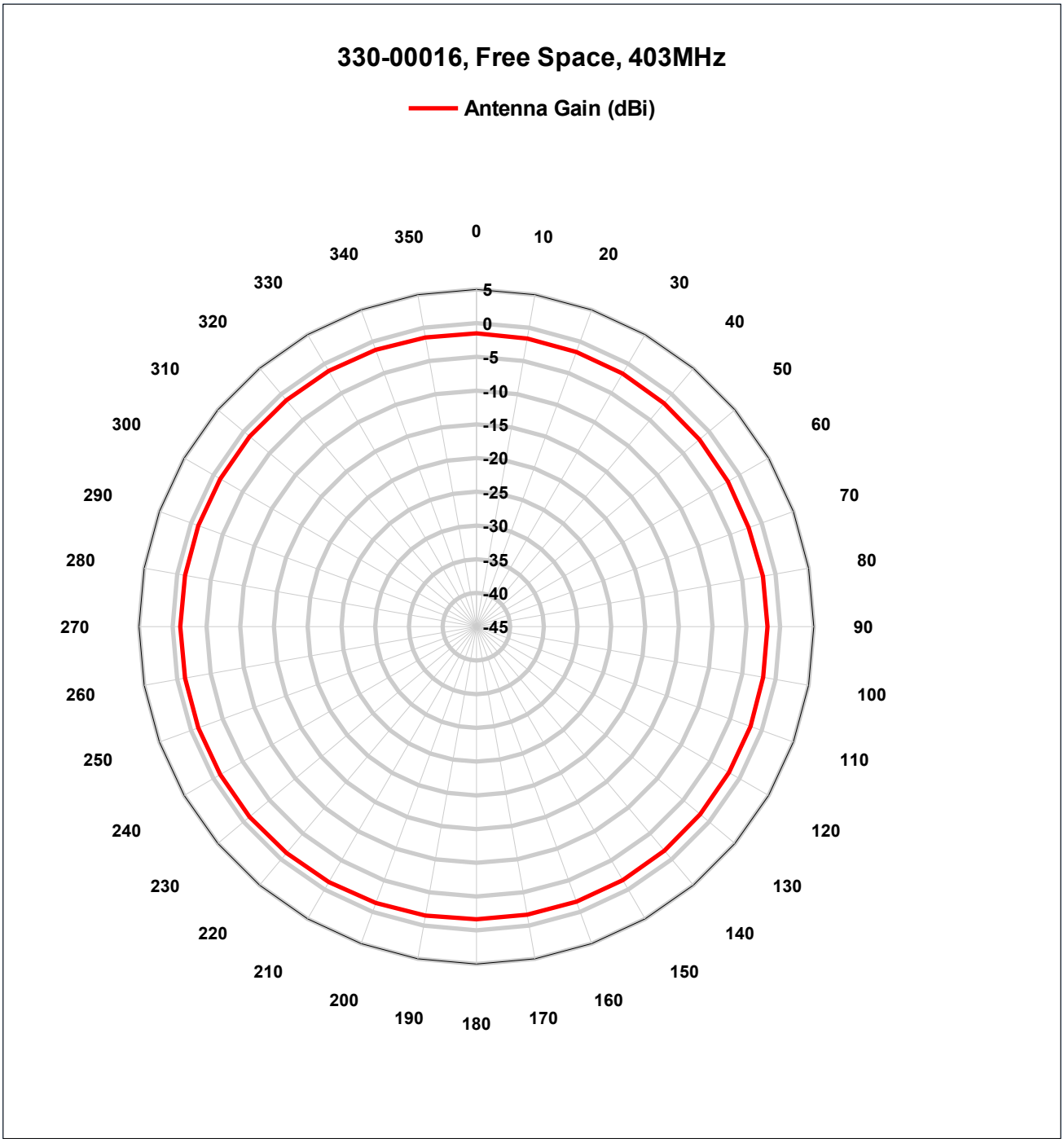
The radiation pattern was established as follows. The person holding/wearing the UUT stood at the centre of the turntable and faced the receive antenna (i.e. angle of 0°). The height of the receiving antenna was adjusted to produce a maximum level on the RF receiver. This level was recorded. The person holding the UUT then rotated clockwise by 10° (i.e. angle of 10°). The receiver reading was recorded (without adjusting the height of the receiving antenna). This process was repeated at 10° steps until the person returned to the starting position (facing the receive antenna). The resulting polar plots are shown in the following sections with the correction factors derived in the previous section applied to each recorded reading.

2.4.2 Test Equipment

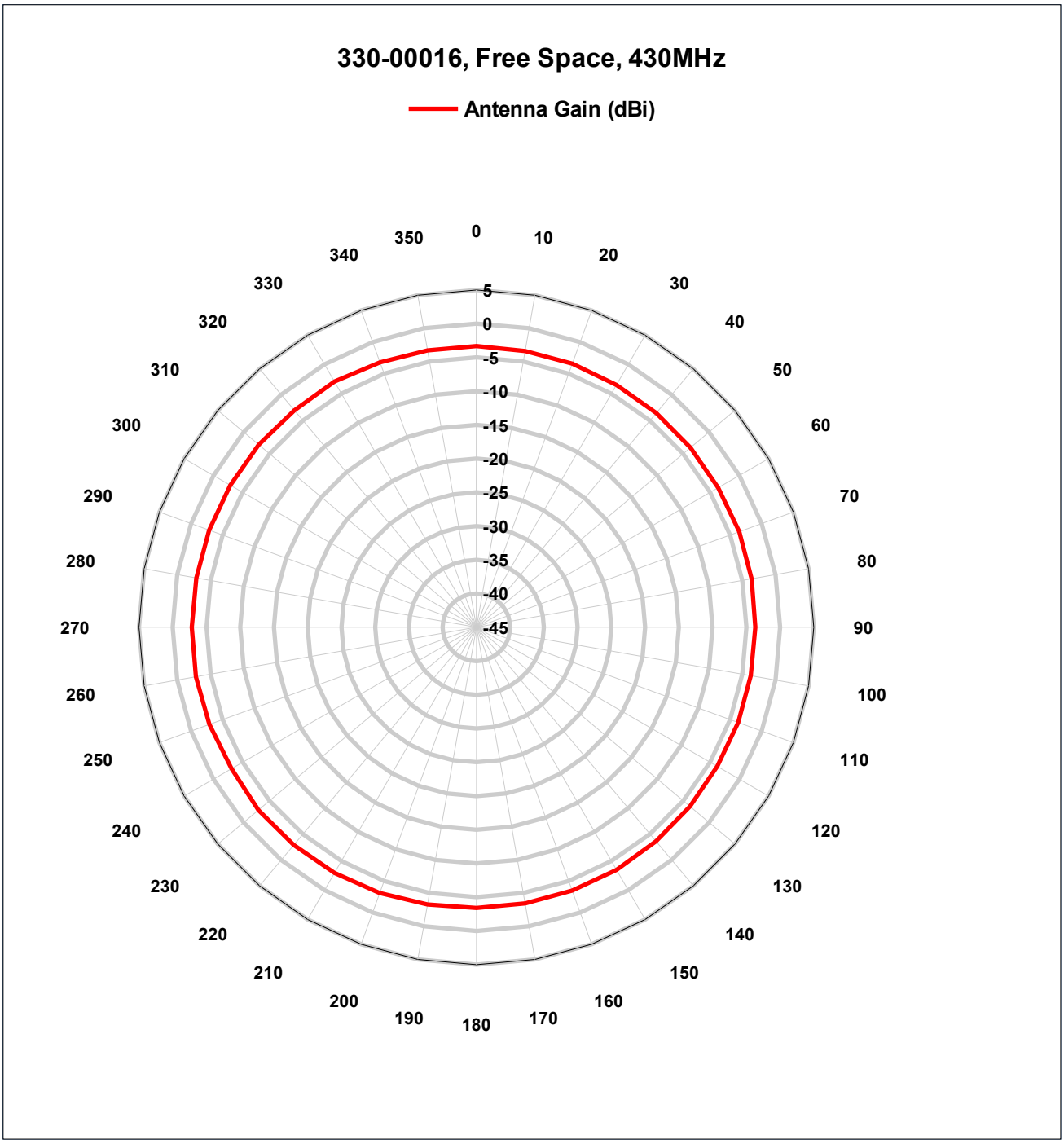
Test Equipment			
Ref:	**Type:**	**Description:**	**S/N:**
R4	Receiver	R&S ESVS10	843744/002
A39	Antenna	Schwarzbeck VULP 9118A Log Periodic	581
CBL134	Cable	RG214 - 25m N-N	CBL134
OATS5	Test site	OATS - 3m NSA compliant	005
OATS6	Test site	OATS - 10m NSA compliant	006
SW001	Software	dB Emissions v3_180321	
SW002	Software	PMM Emissions_2_25	
Correction Factors			
CF1:A39_18A.txt CBL134_19A.txt			

Measurement Uncertainty		
Radiated Emissions:	3m	10m
30MHz to 200MHz: Horizontal	±4.84 dB	±5.38 dB
30MHz to 200MHz: Vertical	±4.95 dB	±5.36 dB
200MHz to 1GHz: Horizontal	±5.24 dB	±5.43 dB
200MHz to 1GHz: Vertical	±6.30 dB	±5.45 dB

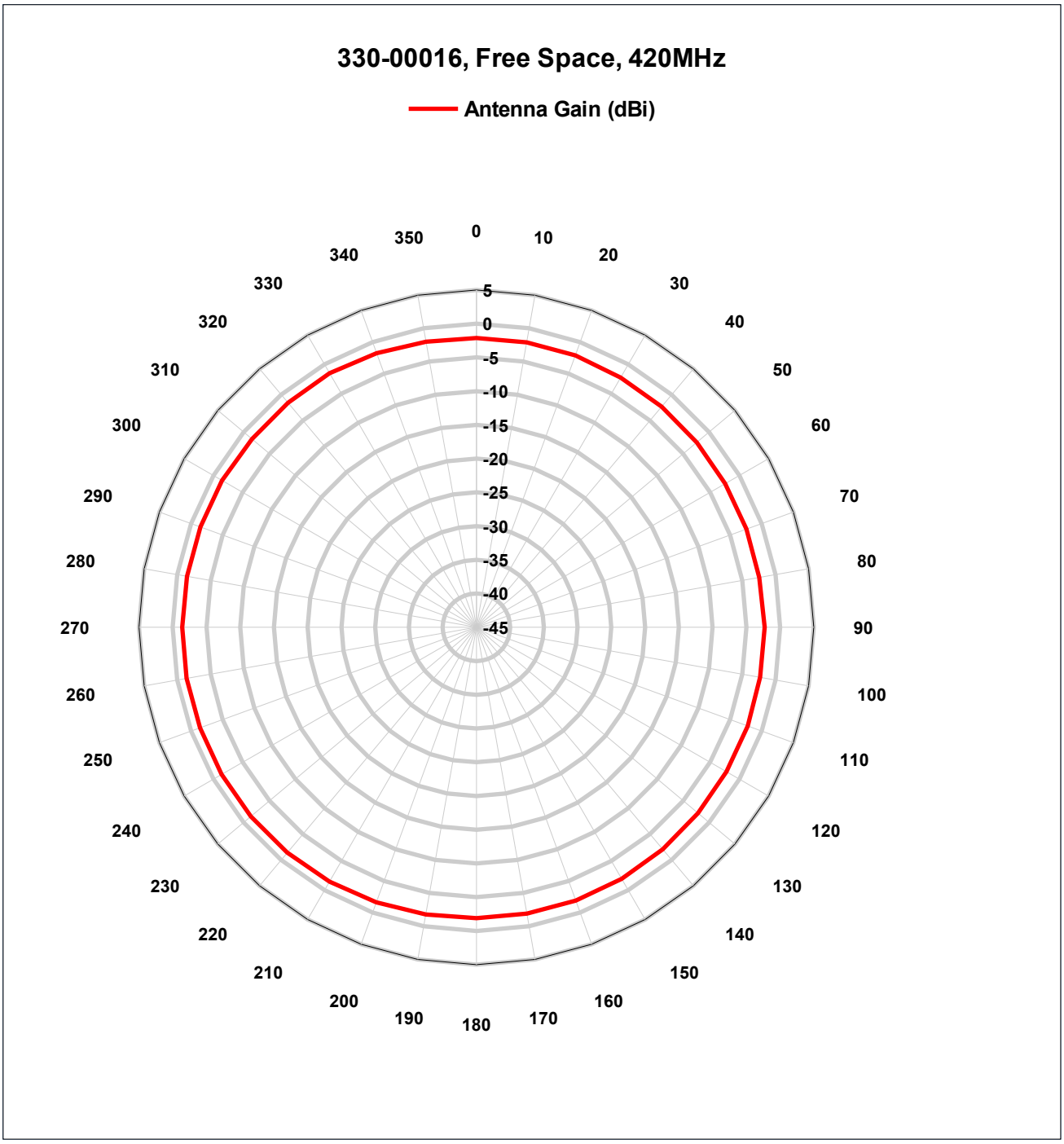
The reported uncertainty is based on a standard uncertainty multiplied by the coverage factor k=2, providing a level of confidence of approximately 95%



	MAX	MIN	AVG
Antenna Gain (dBi)	-1.12	-2.06	-1.49



	MAX	MIN	AVG
Antenna Gain (dBi)	-2.81	-3.78	-3.27



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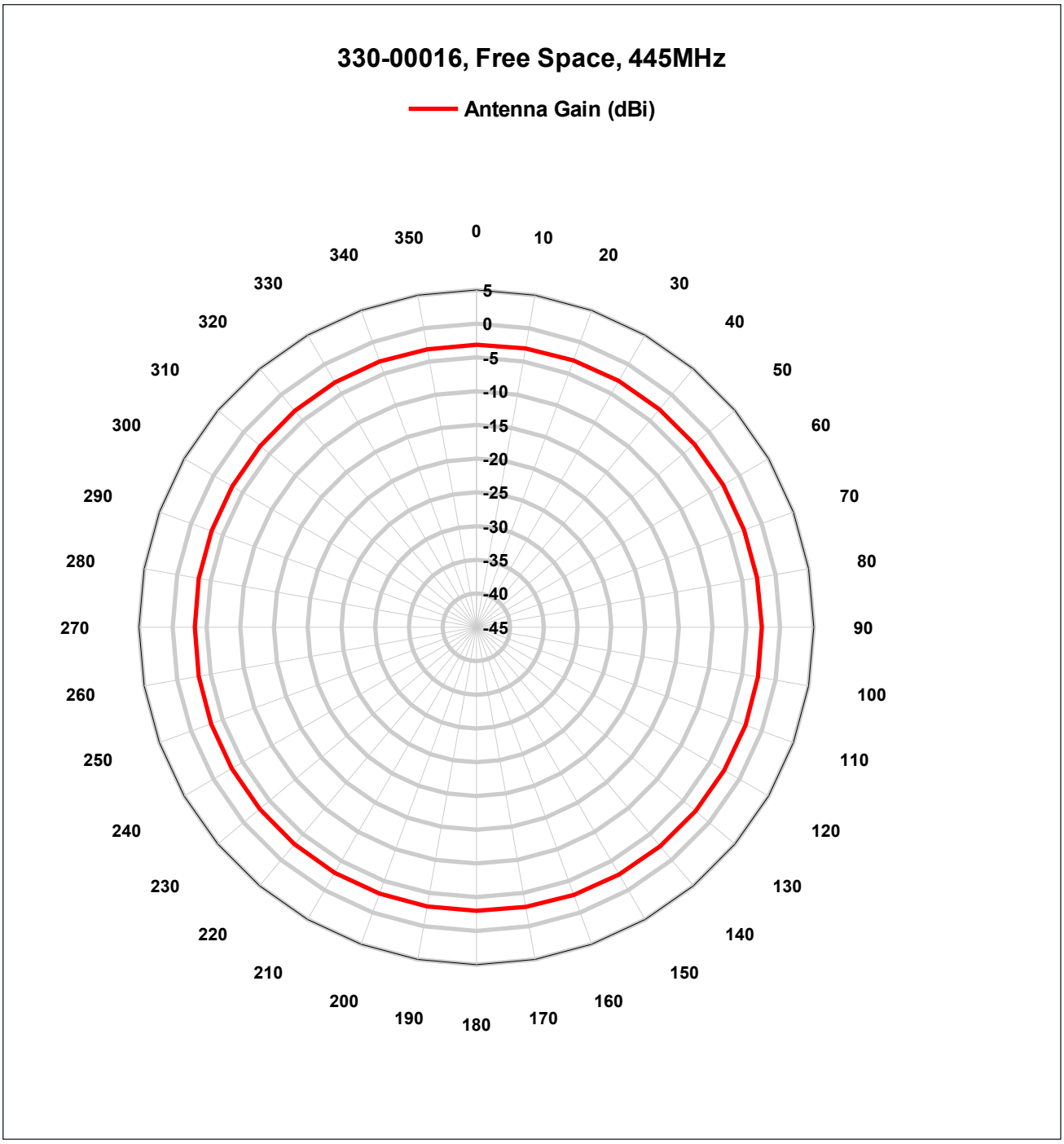
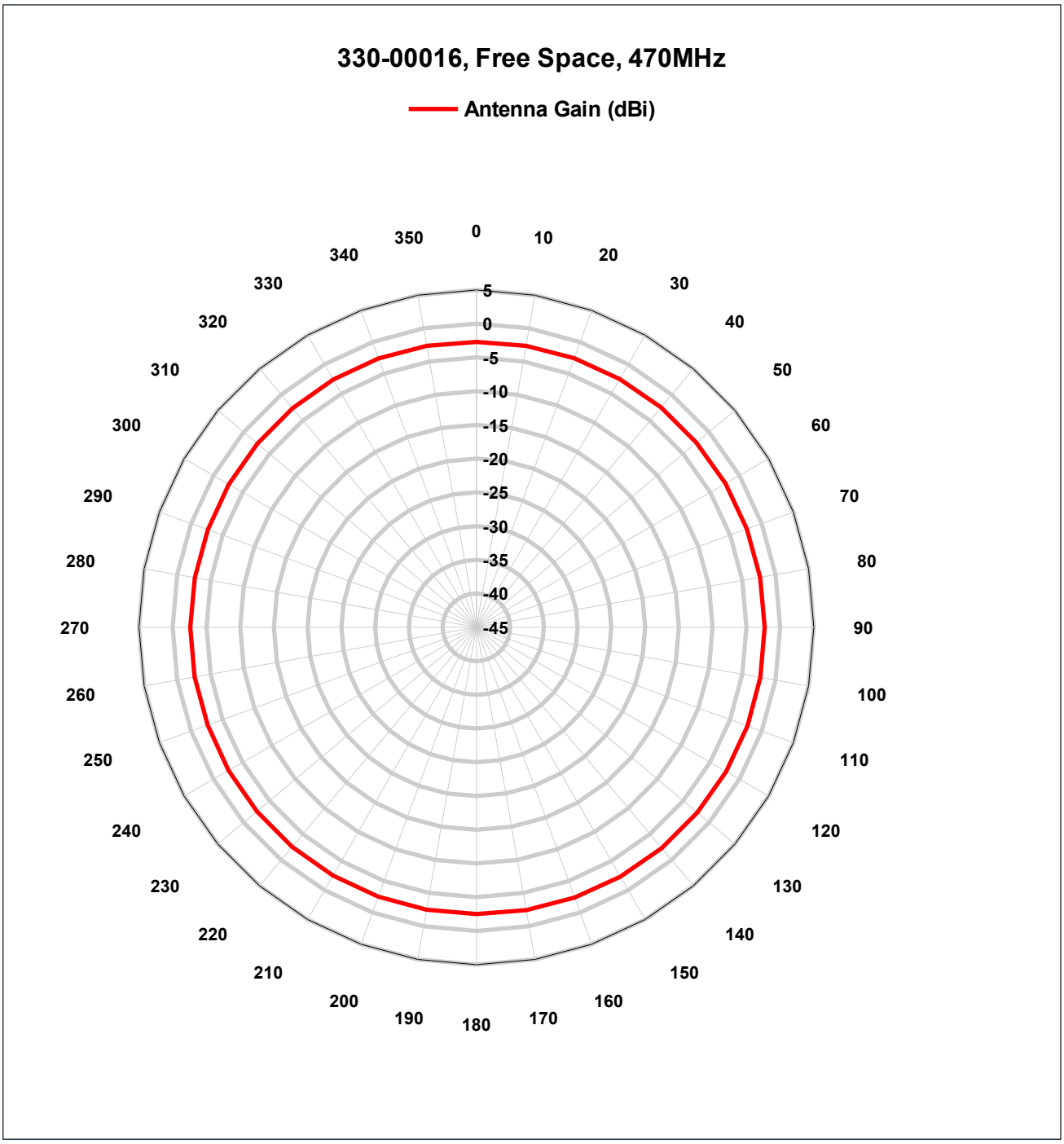
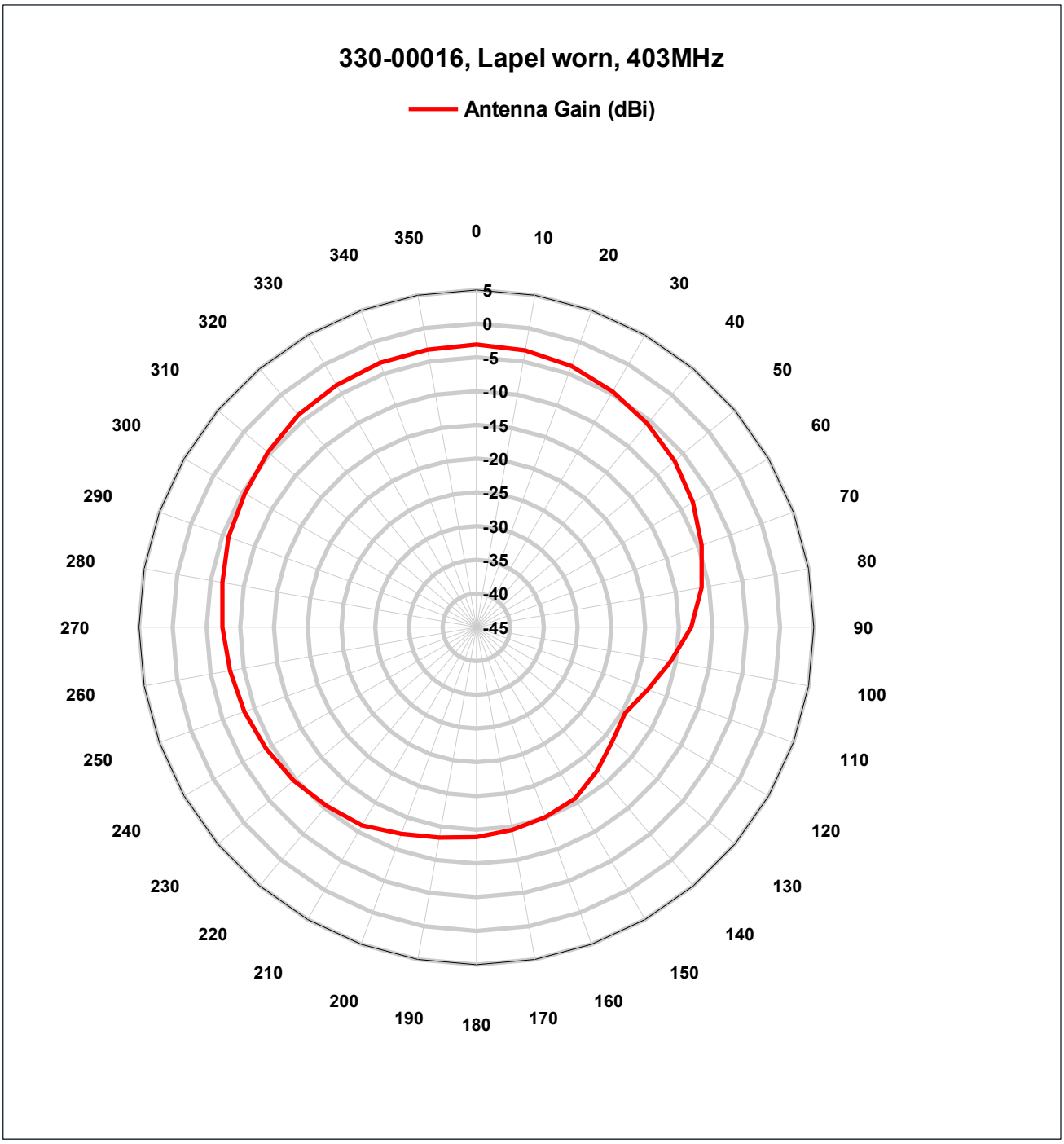
Antenna Gain (dBi)	-1.38	-2.43	-1.86



	MAX	MIN	AVG
Antenna Gain (dBi)	-2.57	-3.27	-2.95



	MAX	MIN	AVG
Antenna Gain (dBi)	-2.25	-2.69	-2.48



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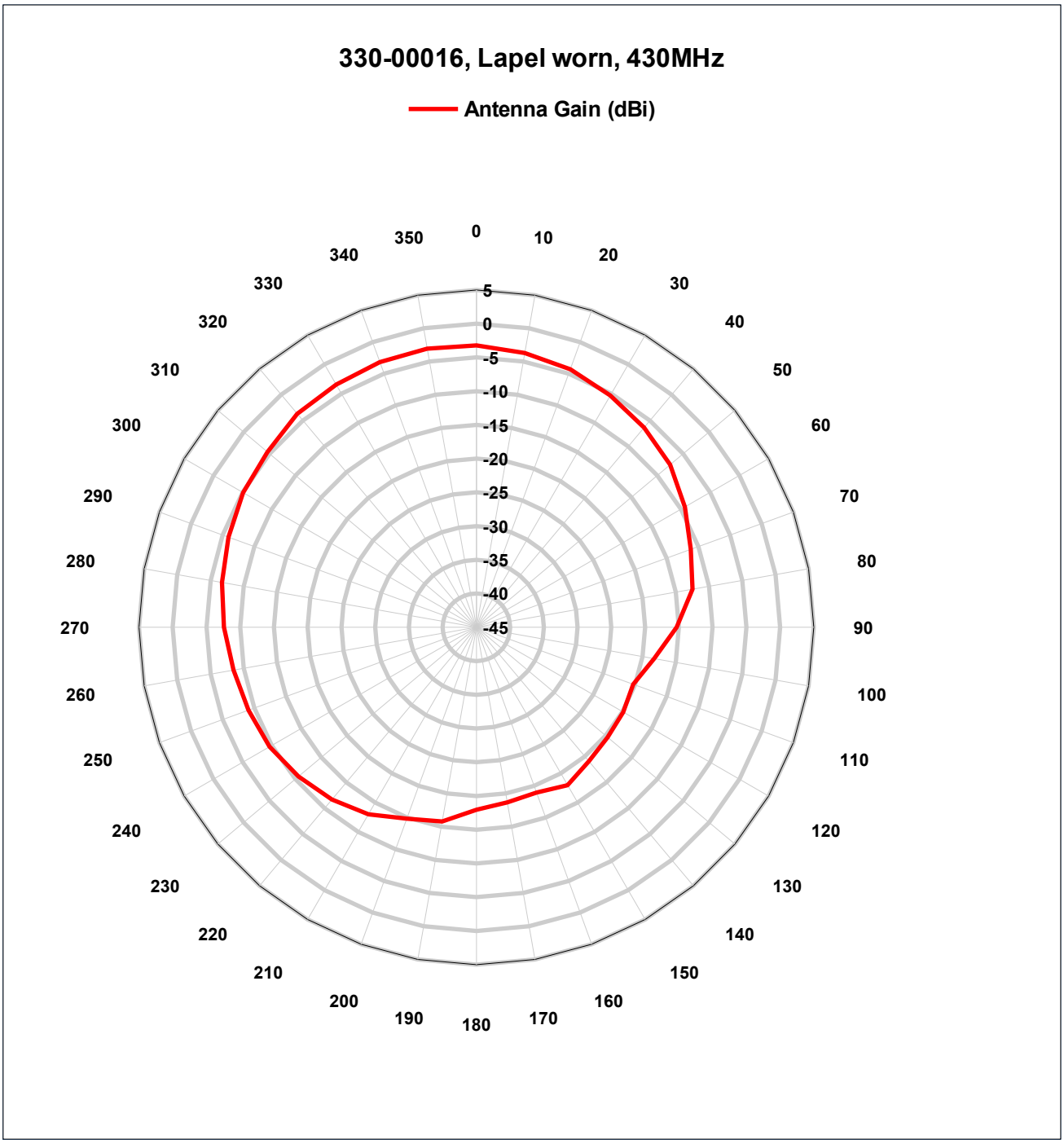
Antenna Gain (dBi)	-3.09	-19.56	-7.29



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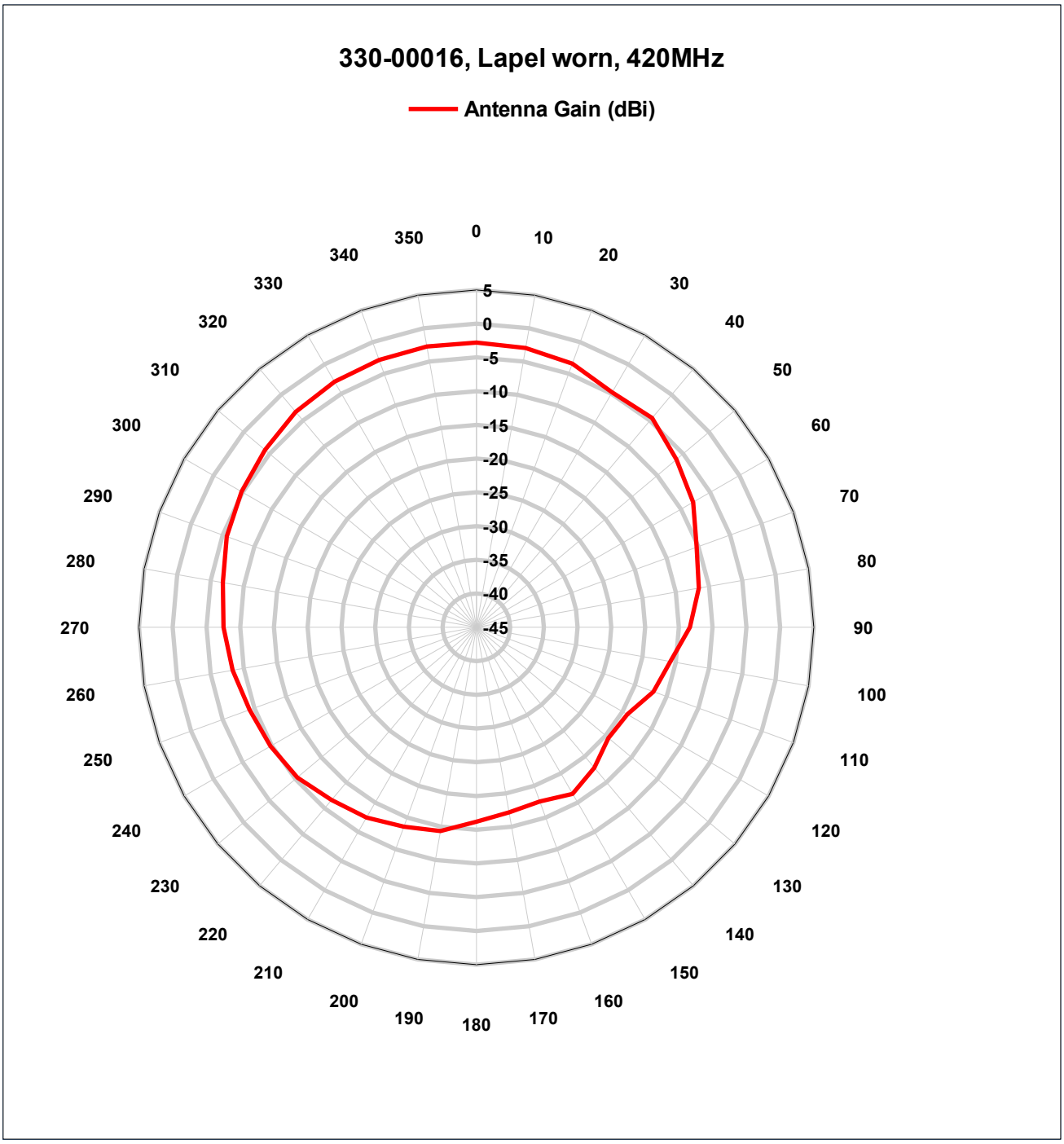
Antenna Gain (dBi)	-3.06	-20.26	-7.66



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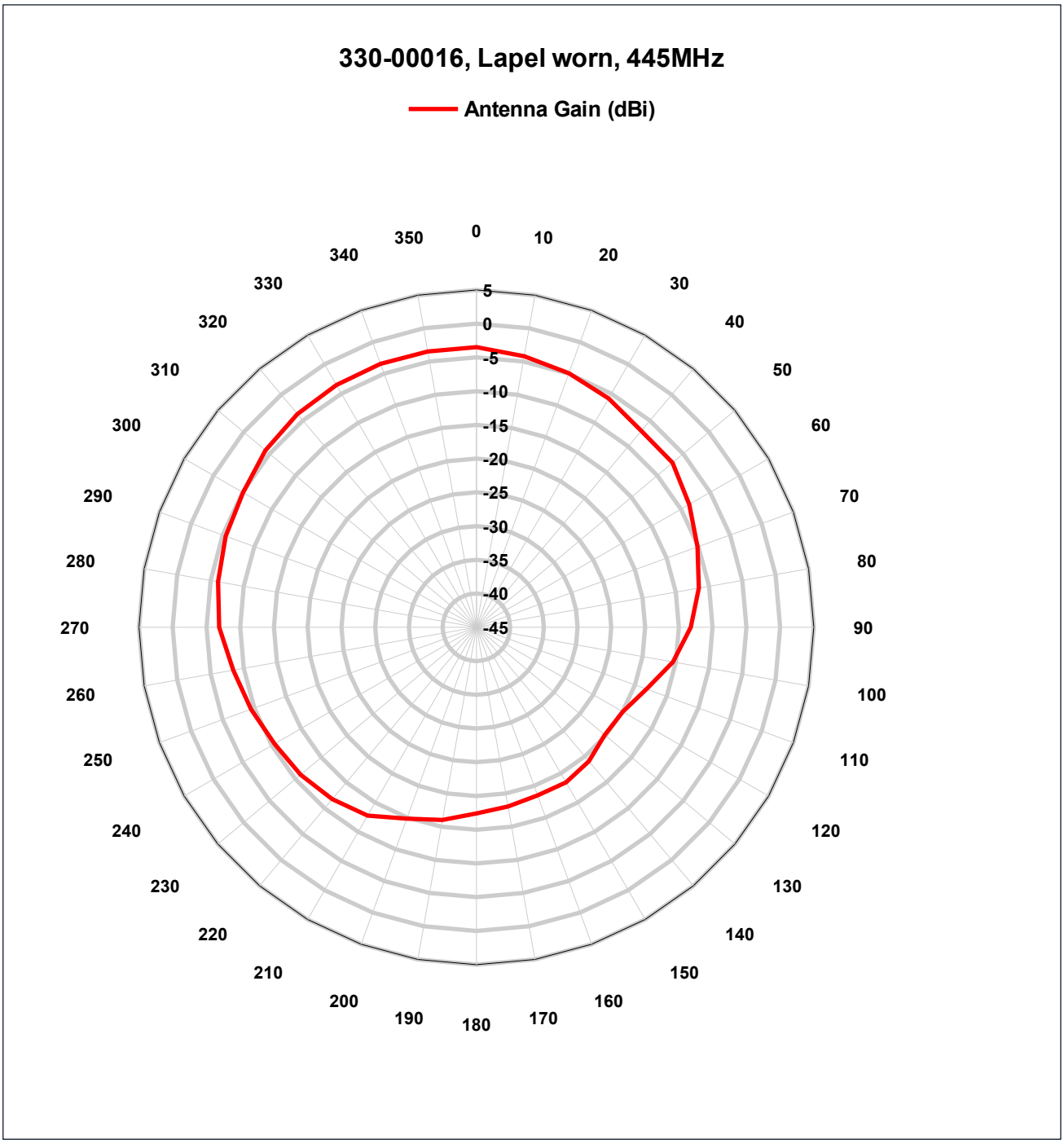
Antenna Gain (dBi)	-2.73	-19.46	-7.09



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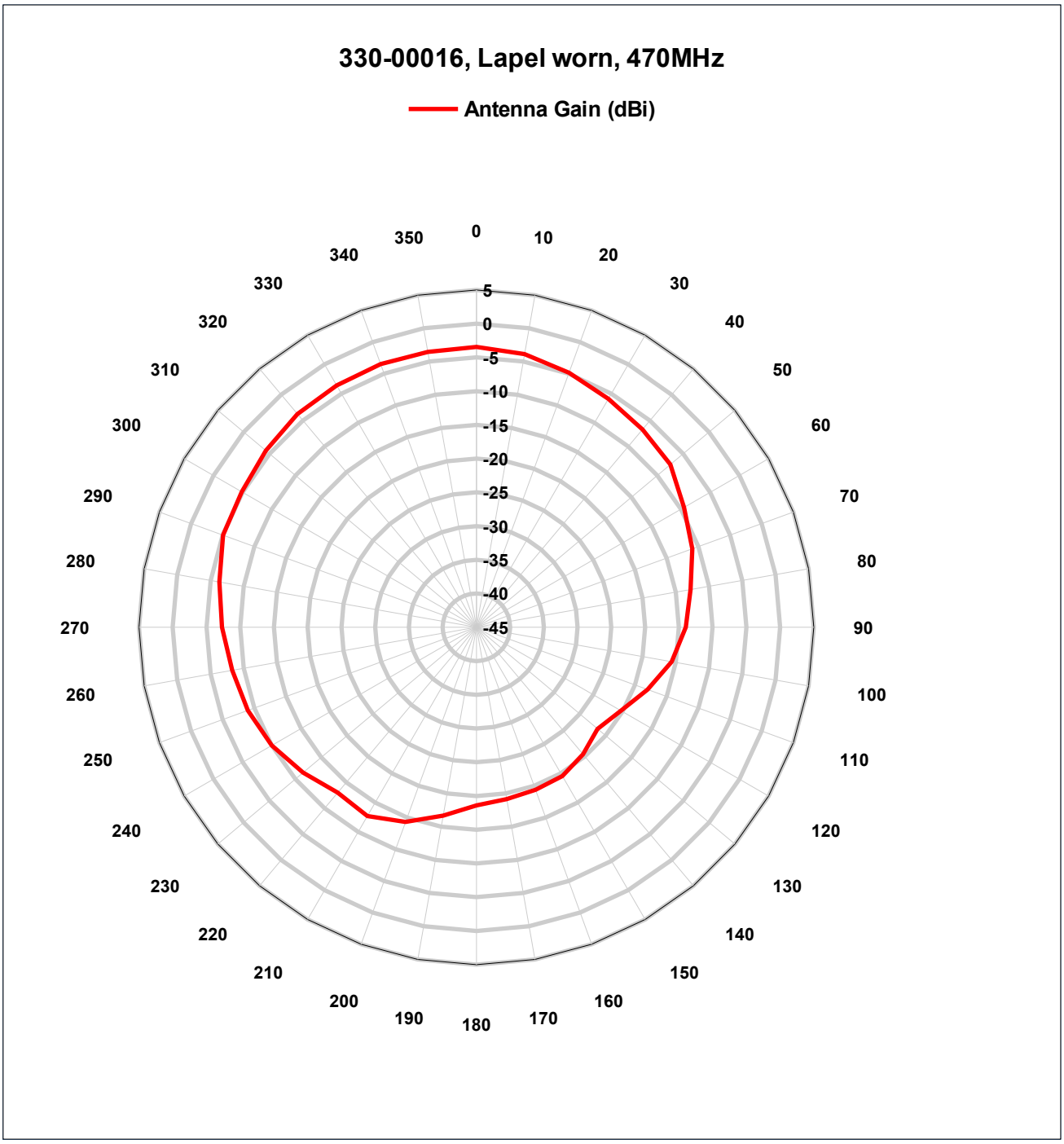
Antenna Gain (dBi)	-3.45	-20.18	-7.71



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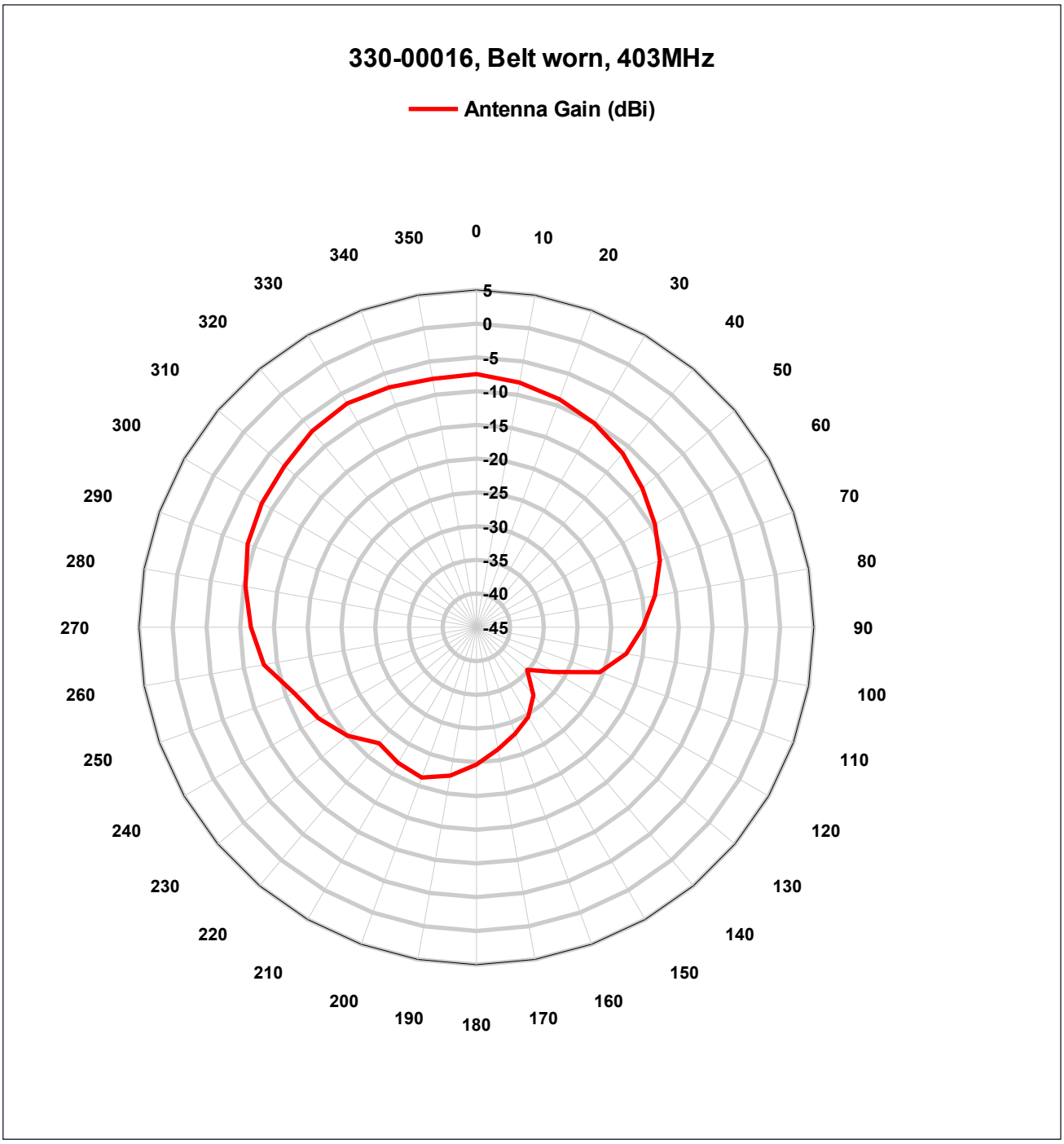
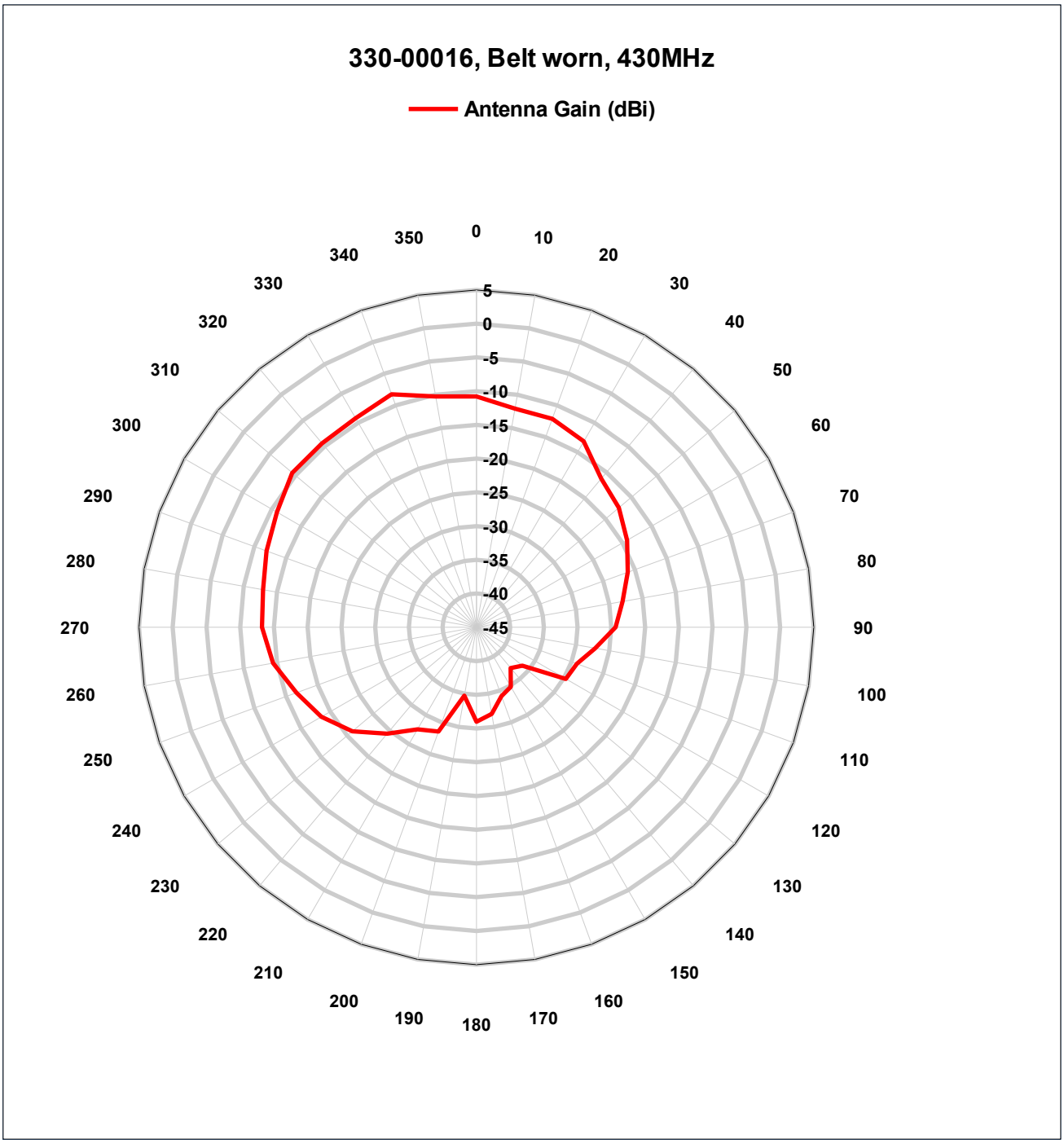
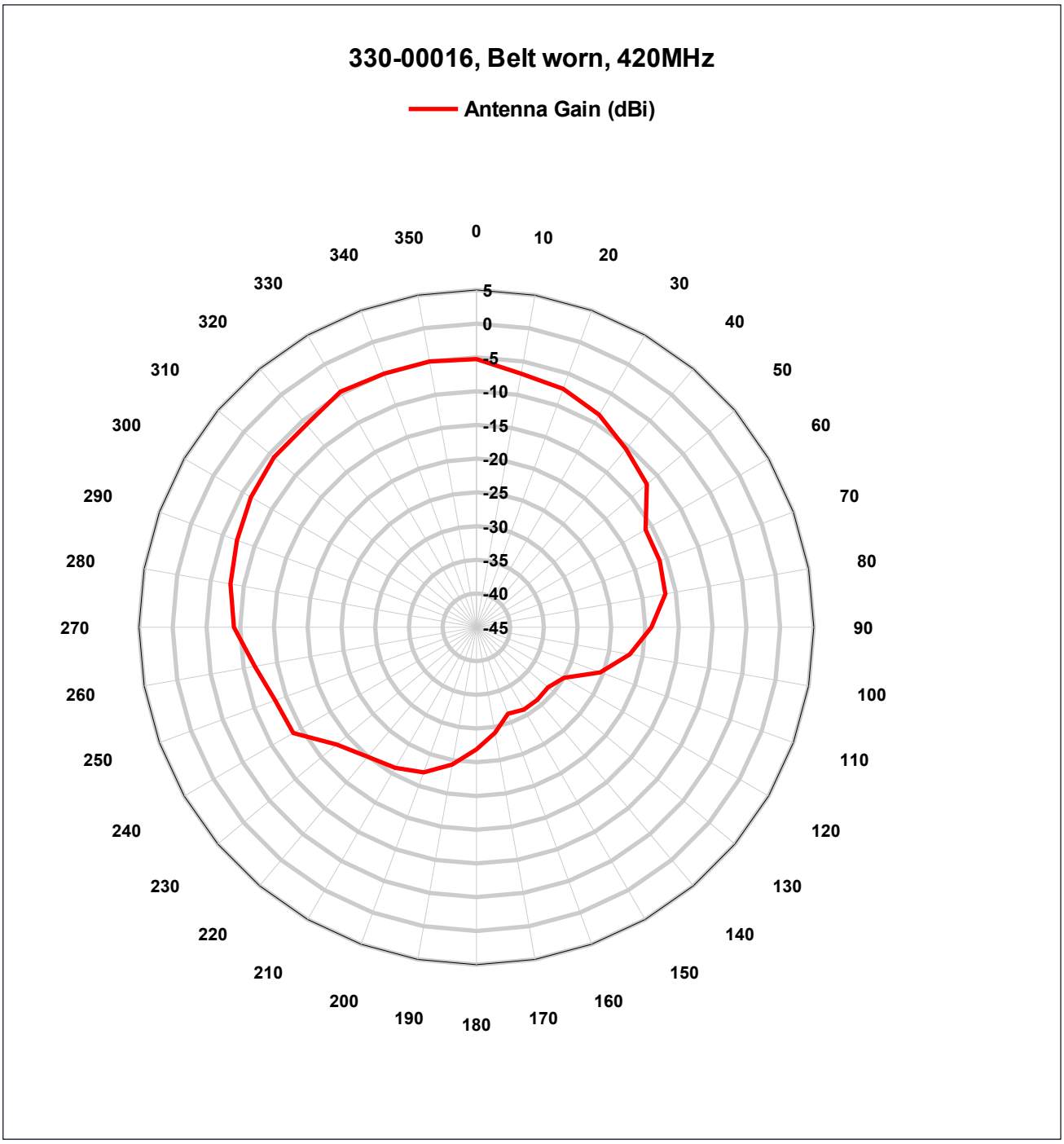
Antenna Gain (dBi)	-3.44	-21.56	-7.75



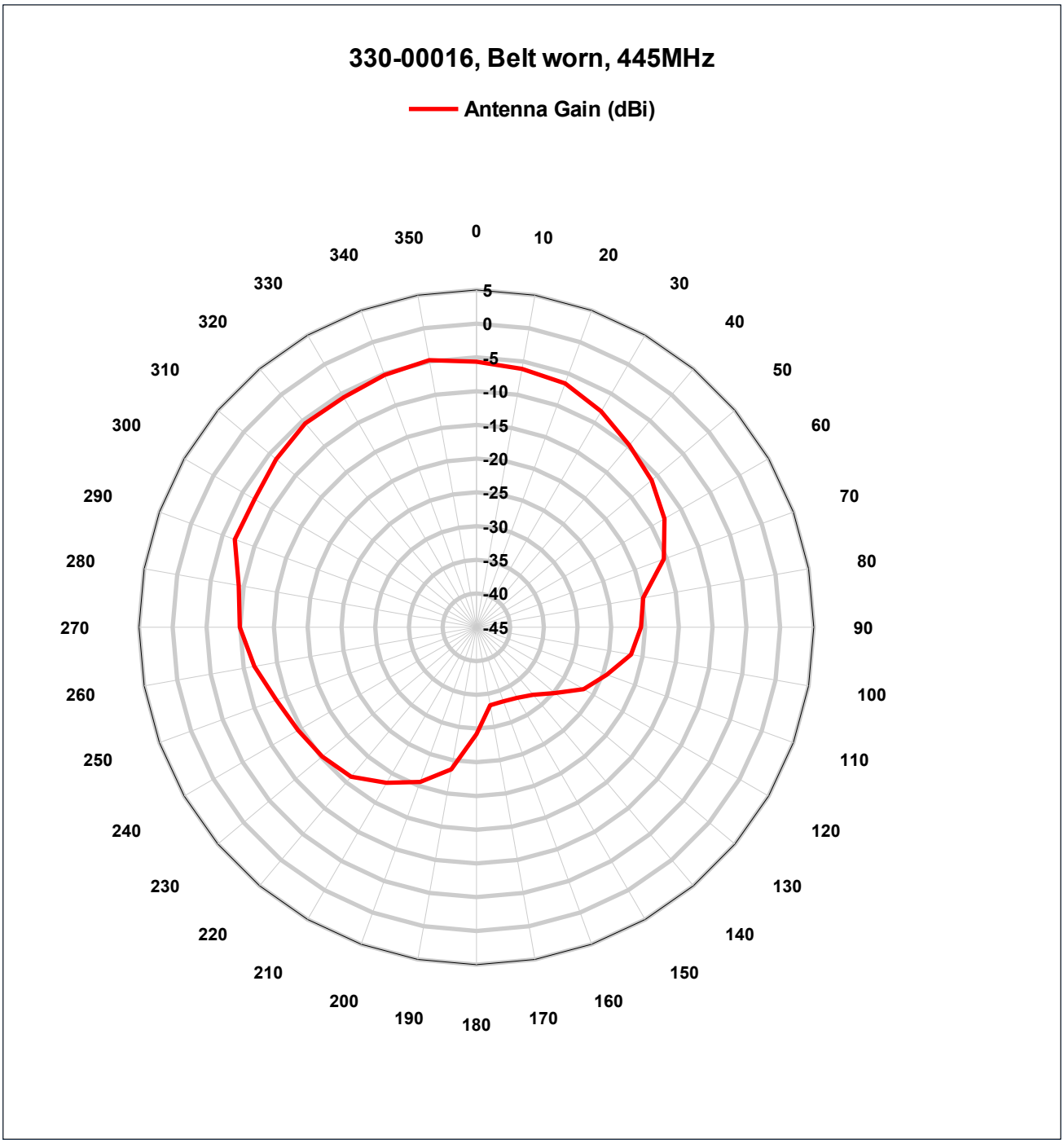
	MAX	MIN	AVG
Antenna Gain (dBi)	-6.70	-35.18	-11.97



	MAX	MIN	AVG
Antenna Gain (dBi)	-8.25	-37.10	-14.57



	MAX	MIN	AVG
Antenna Gain (dBi)	-4.68	-31.36	-10.15



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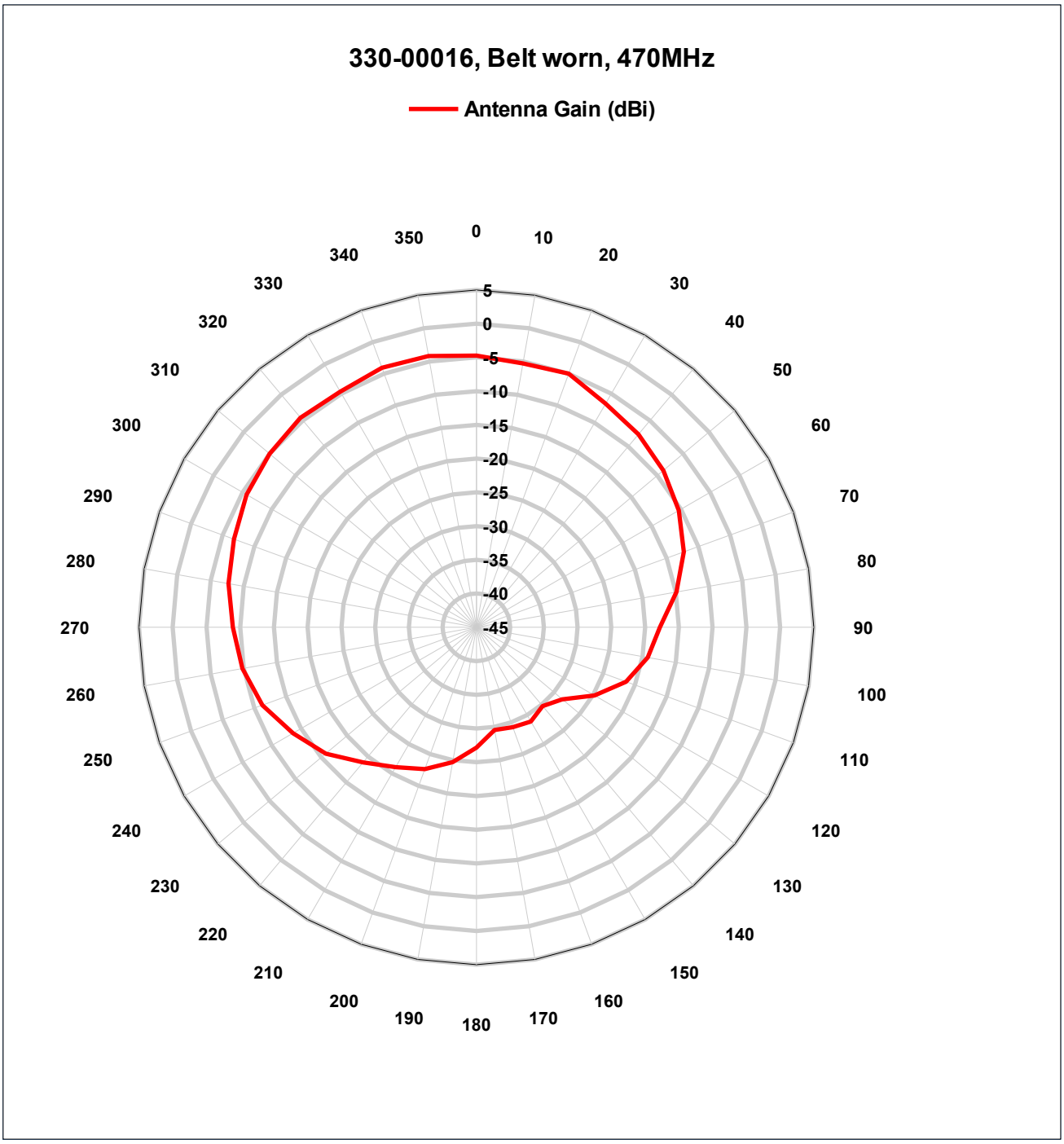
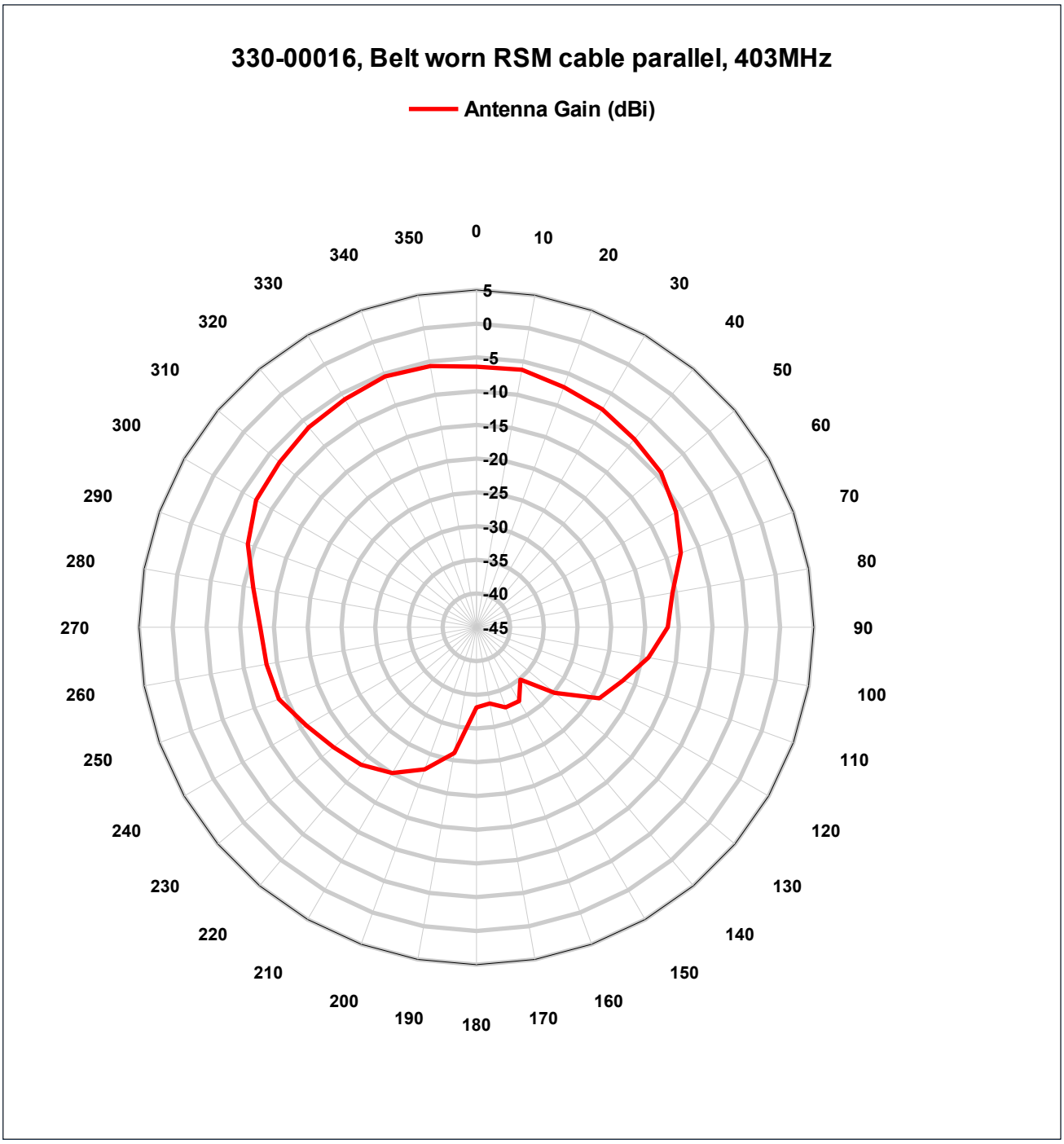
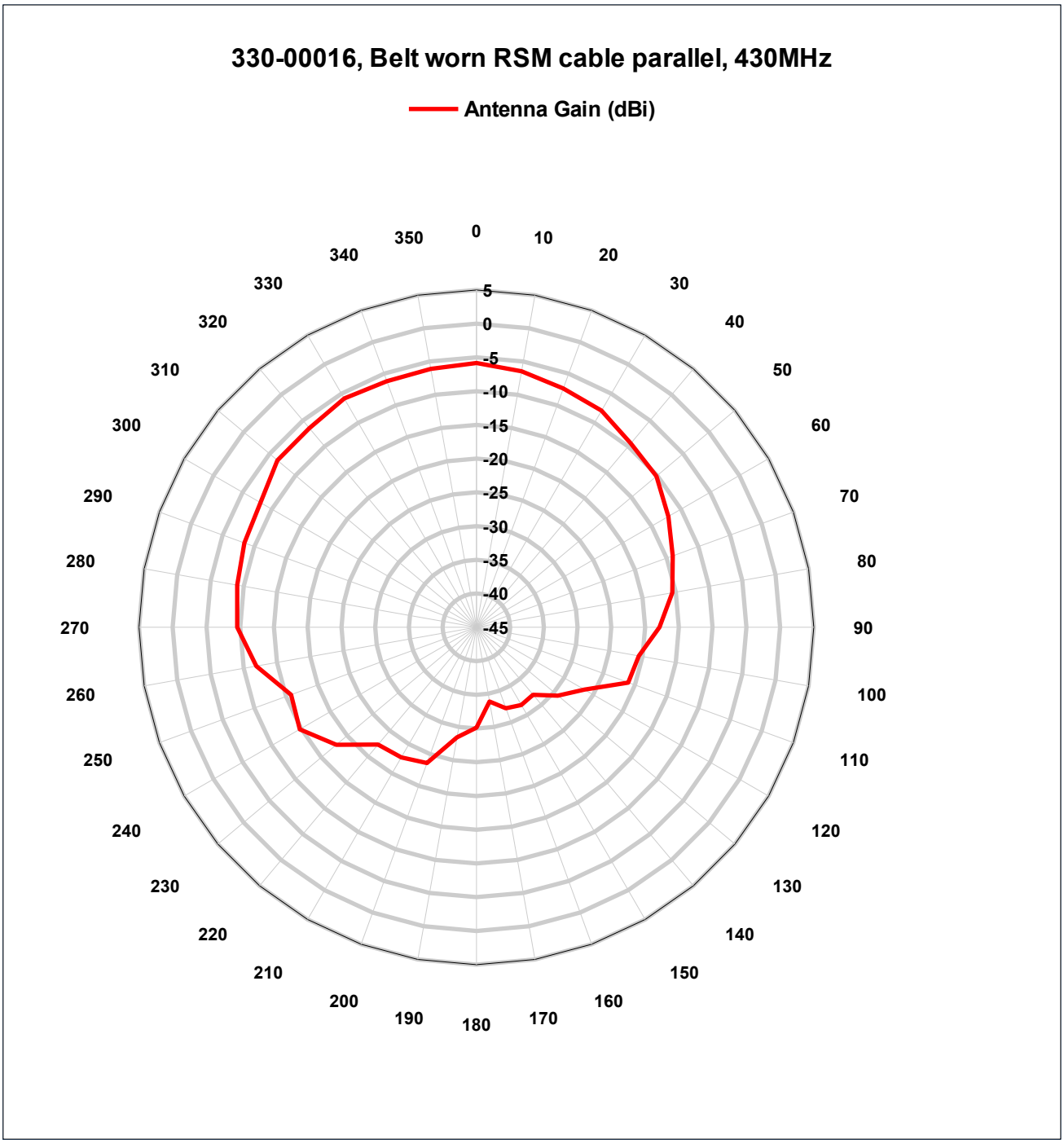
Antenna Gain (dBi)	-4.80	-33.31	-10.15



	MAX	MIN	AVG
Antenna Gain (dBi)	-4.06	-29.73	-8.98



	MAX	MIN	AVG
Antenna Gain (dBi)	-5.42	-34.86	-10.59



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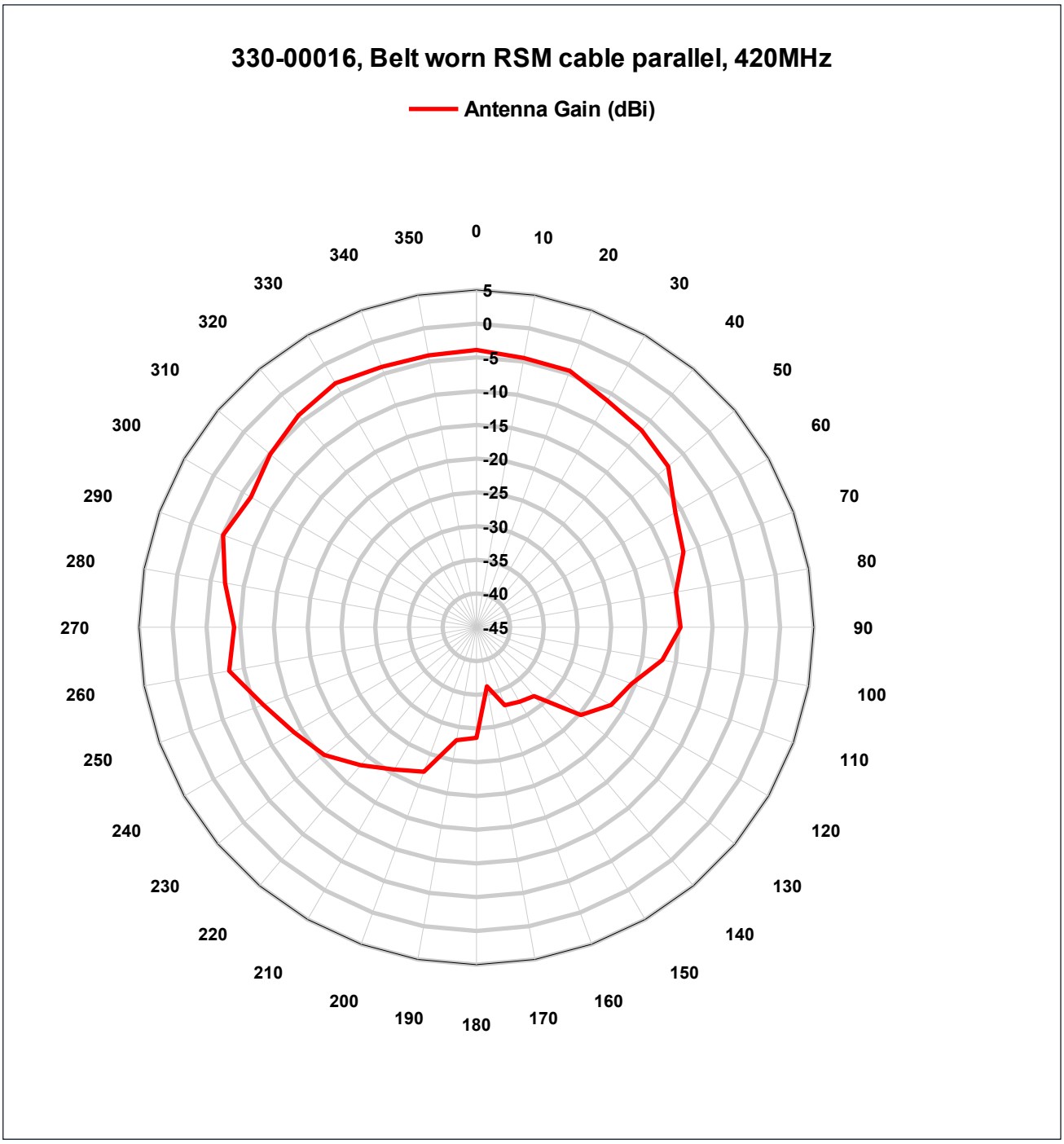
Antenna Gain (dBi)	-5.82	-33.81	-10.64



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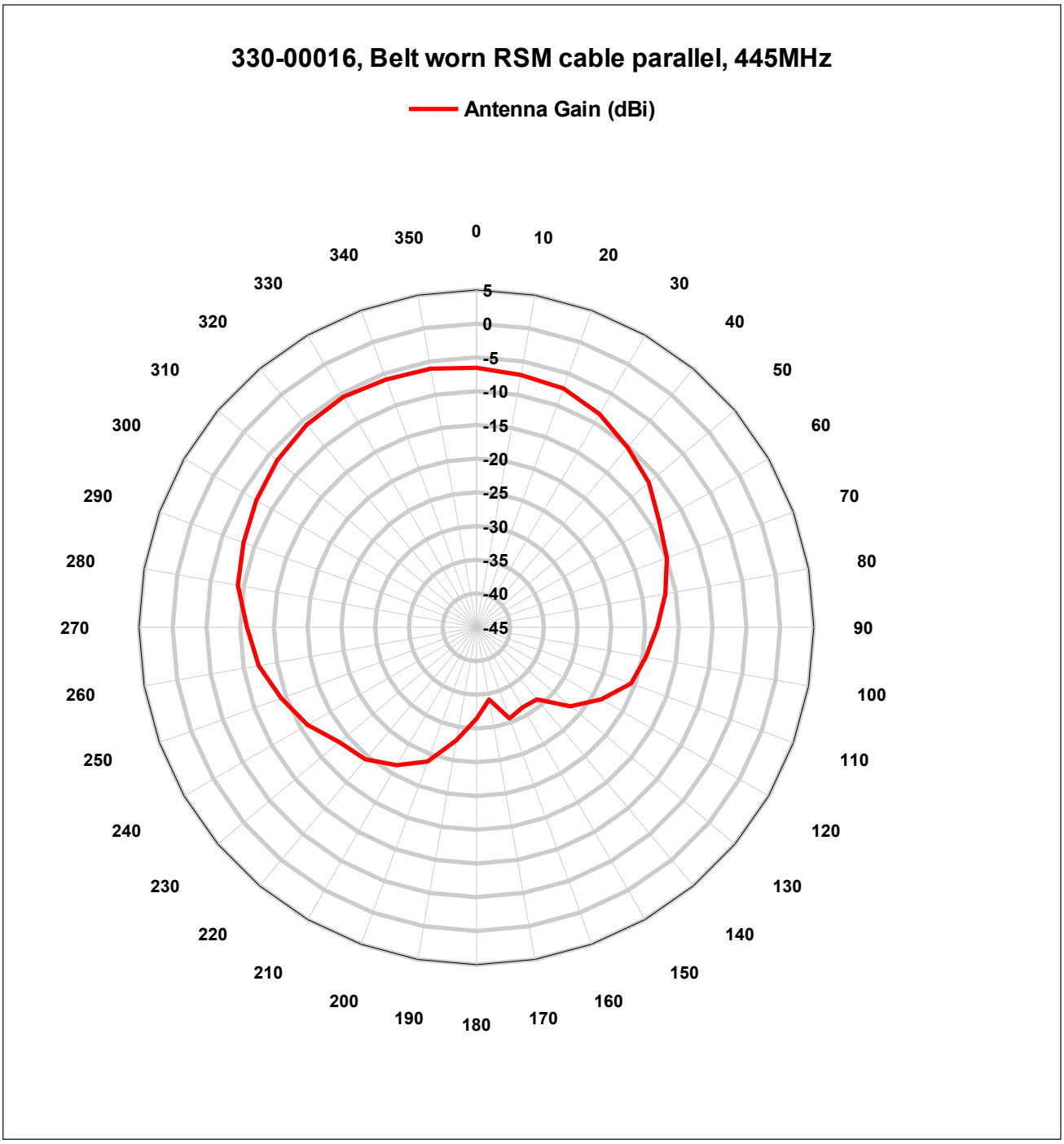
Antenna Gain (dBi)	-3.22	-36.12	-8.45



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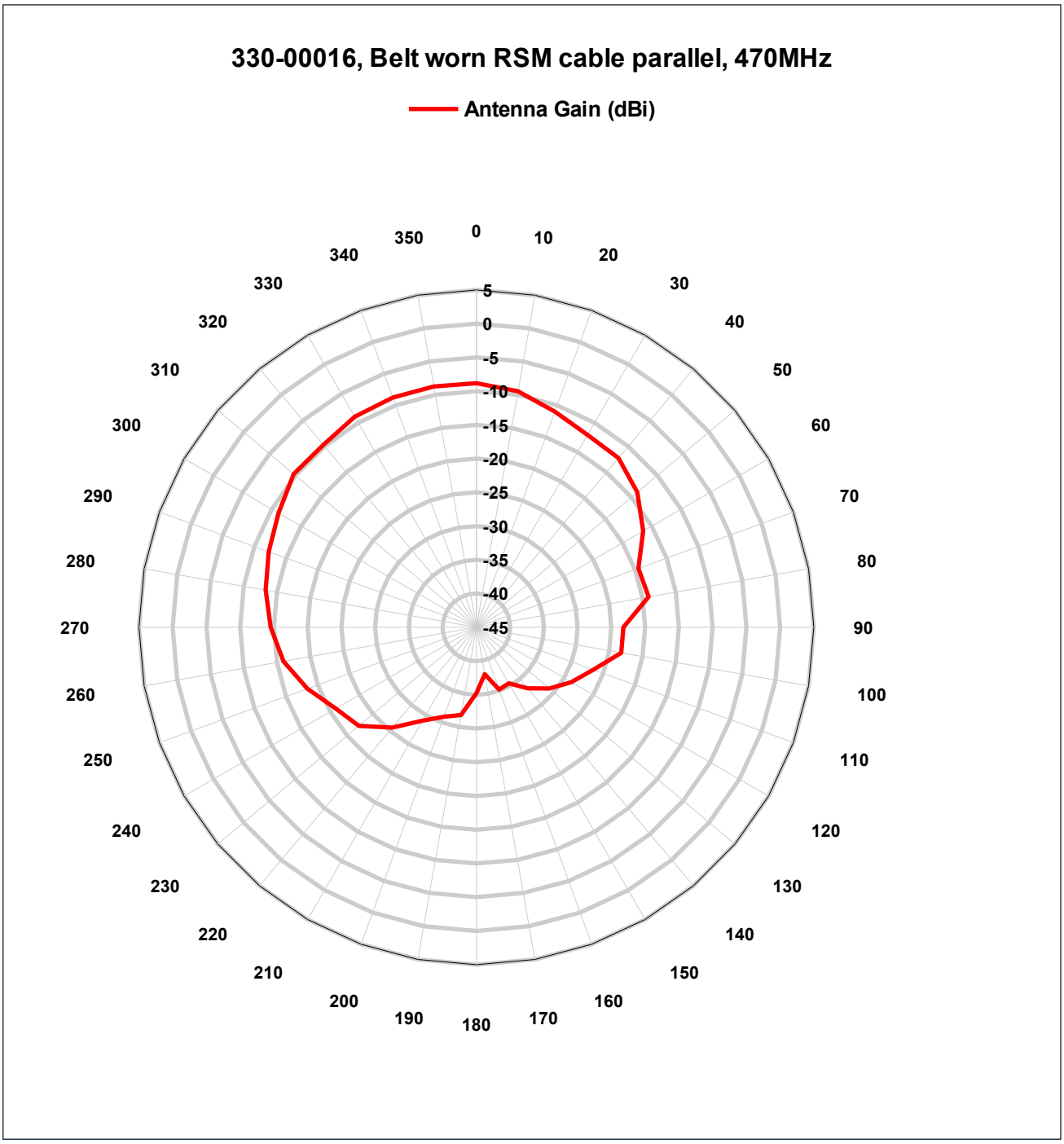
Antenna Gain (dBi)	-5.56	-34.12	-10.77



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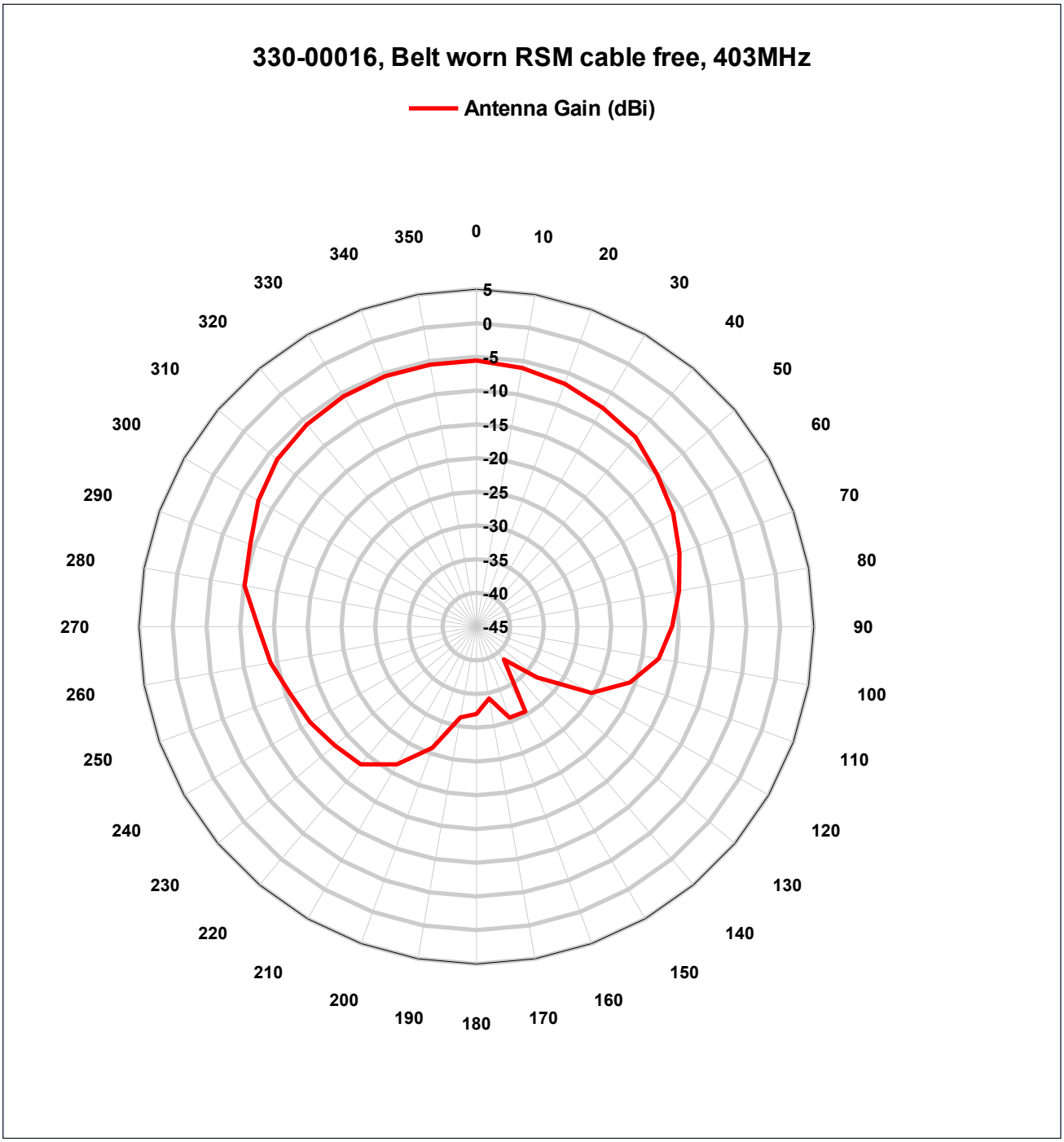
Antenna Gain (dBi)	-8.77	-37.94	-13.99



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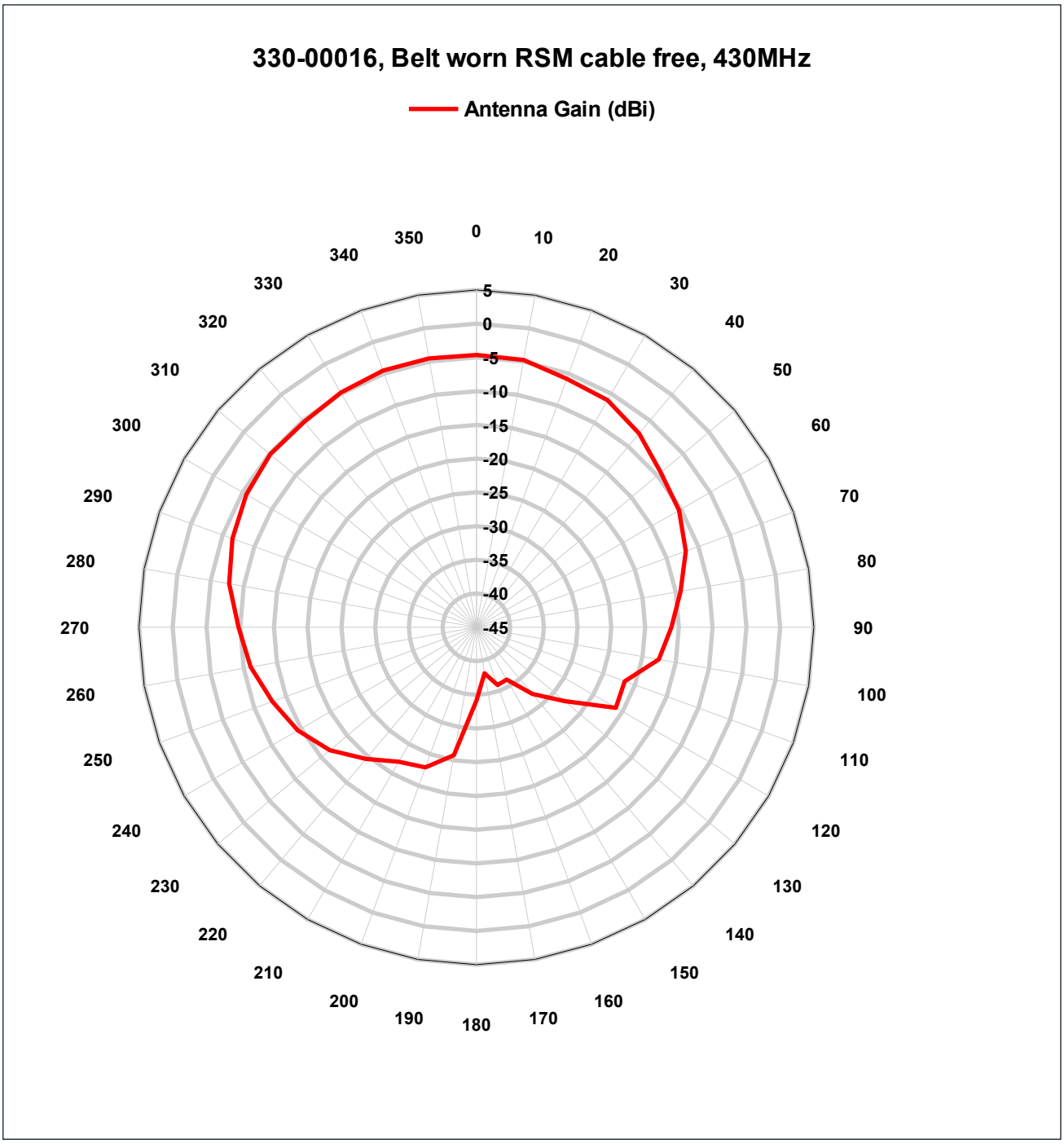
Antenna Gain (dBi)	-5.47	-38.66	-10.42



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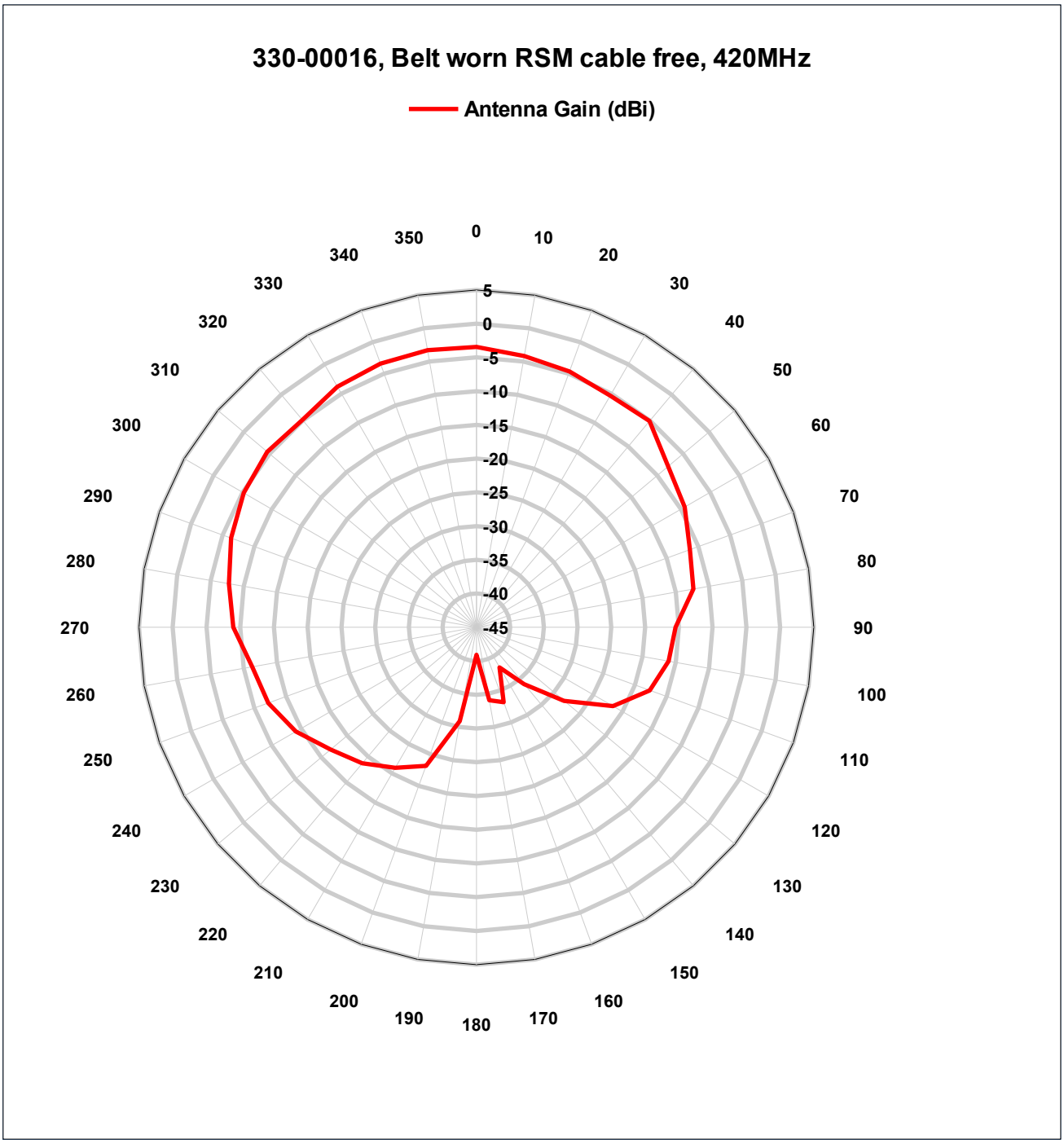
Antenna Gain (dBi)	-4.52	-38.07	-9.17



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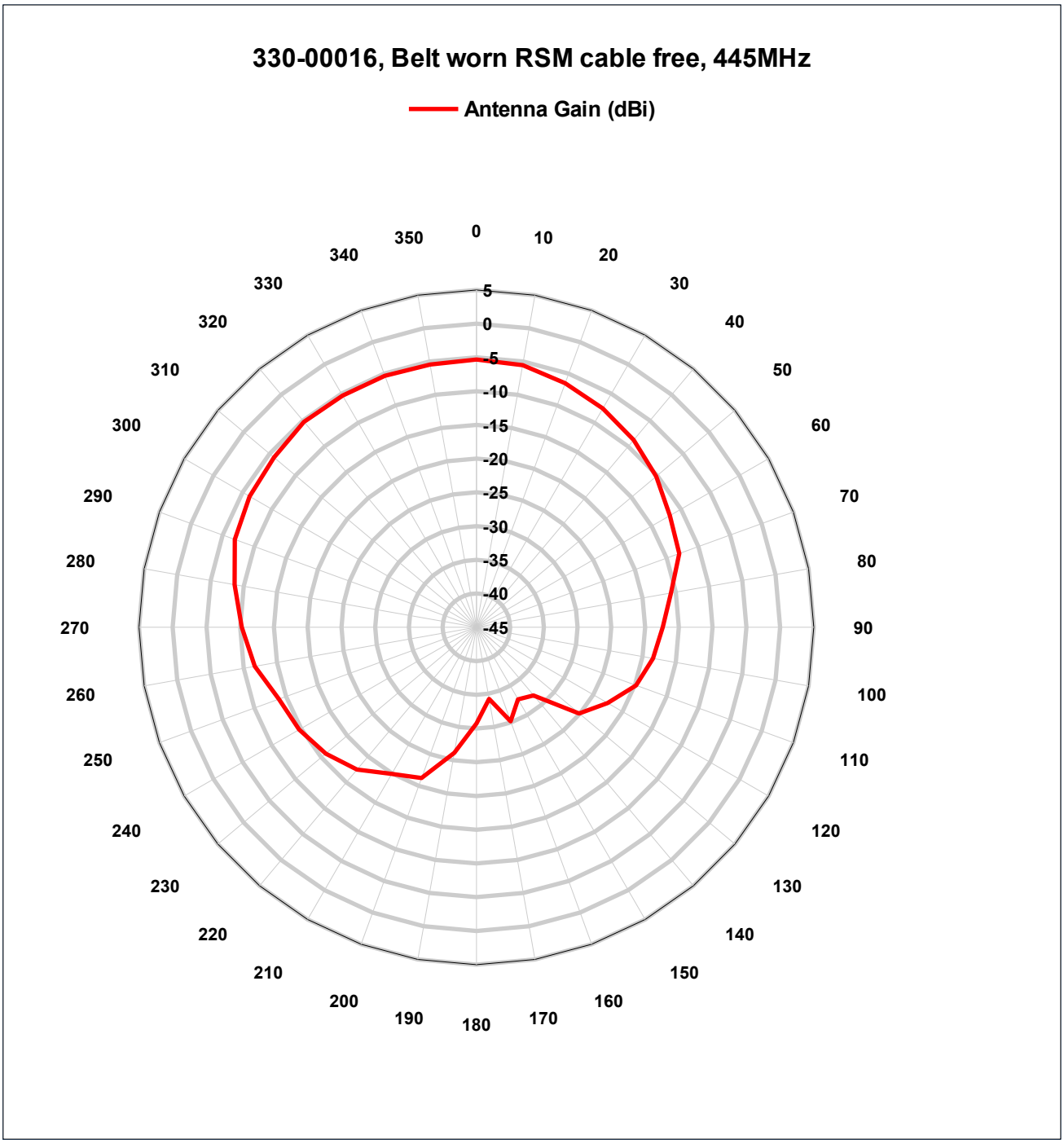
Antenna Gain (dBi)	-3.28	-40.92	-8.29



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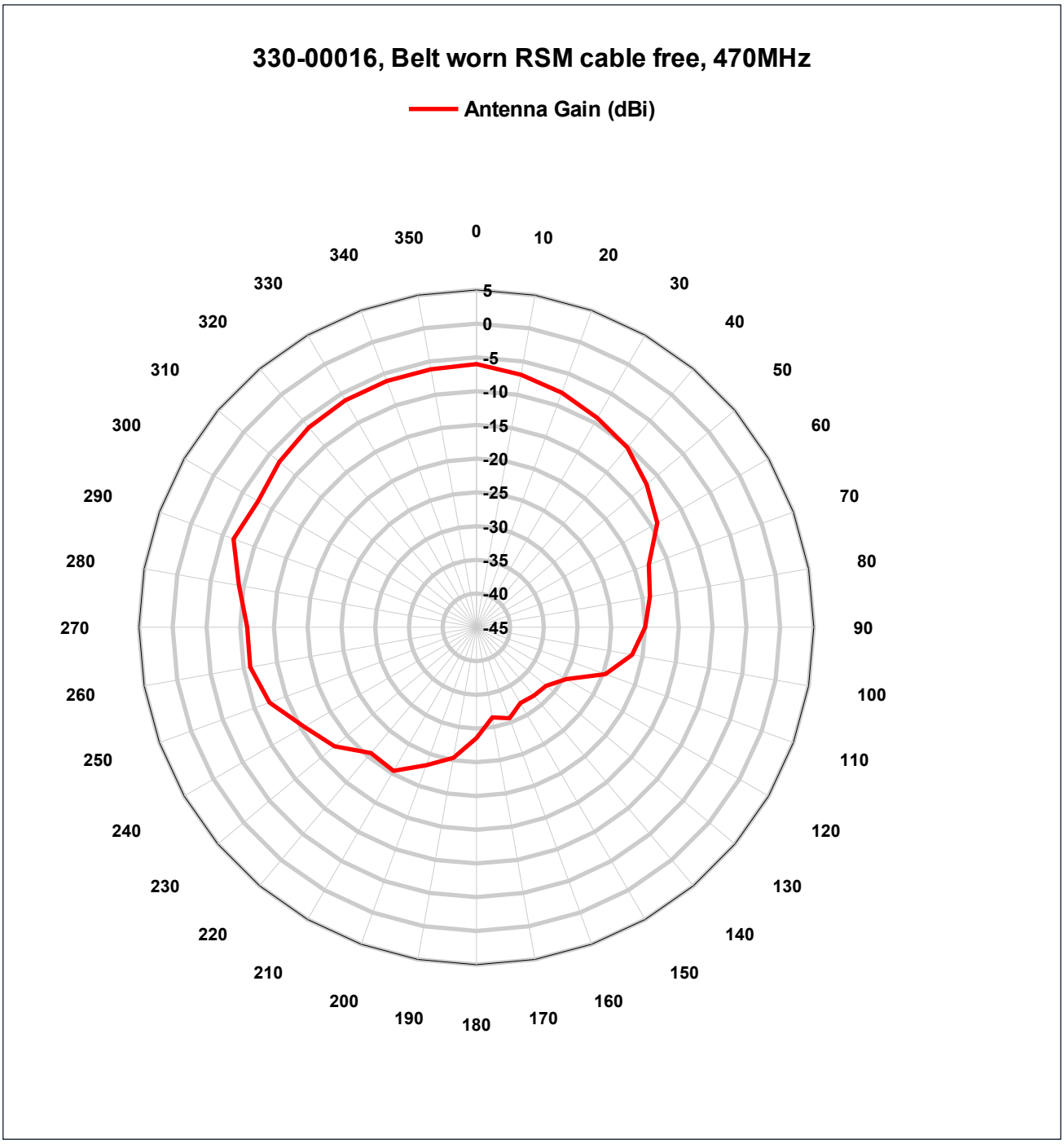
Antenna Gain (dBi)	-5.24	-34.20	-9.86



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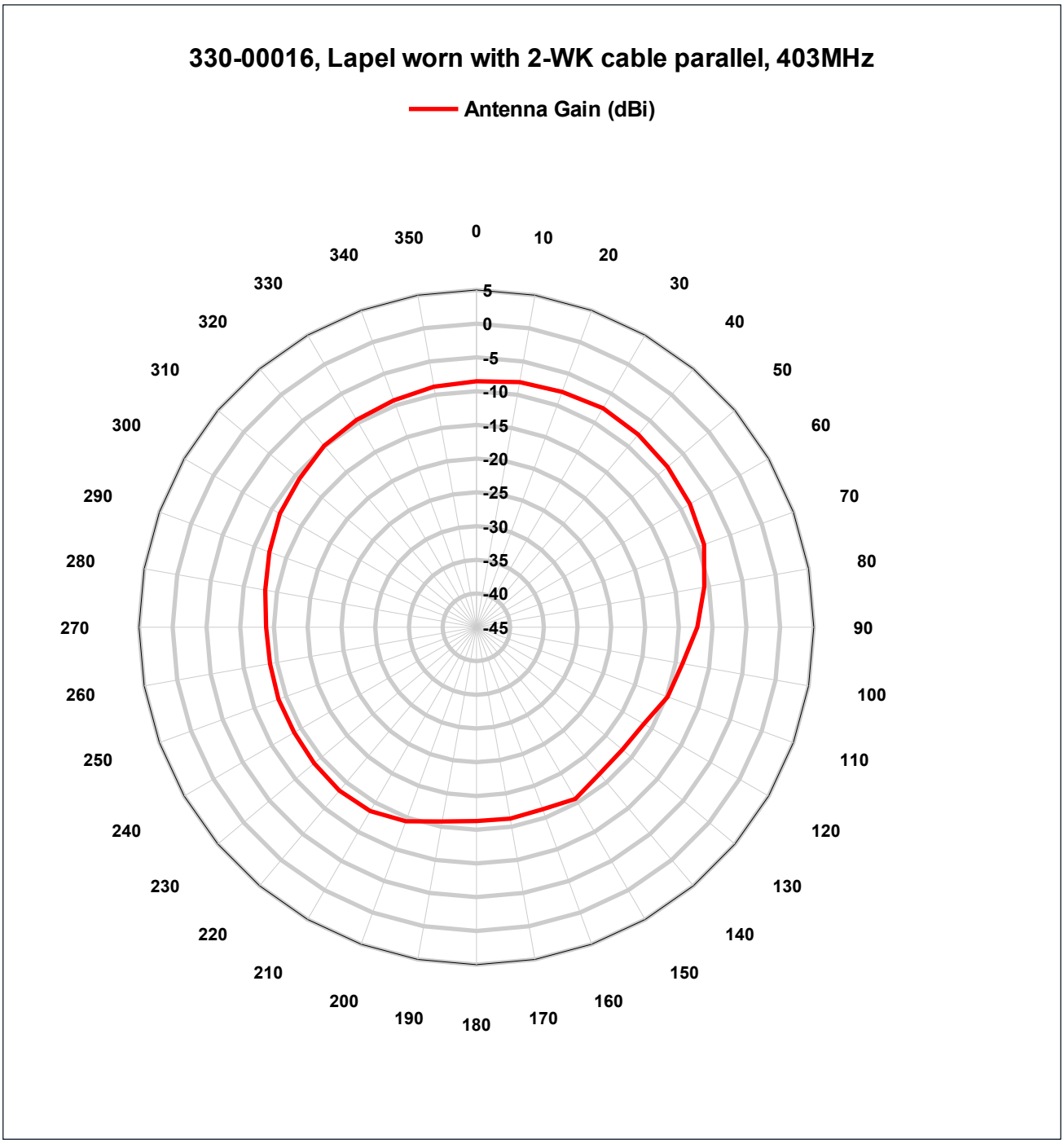
Antenna Gain (dBi)	-5.99	-32.01	-10.88



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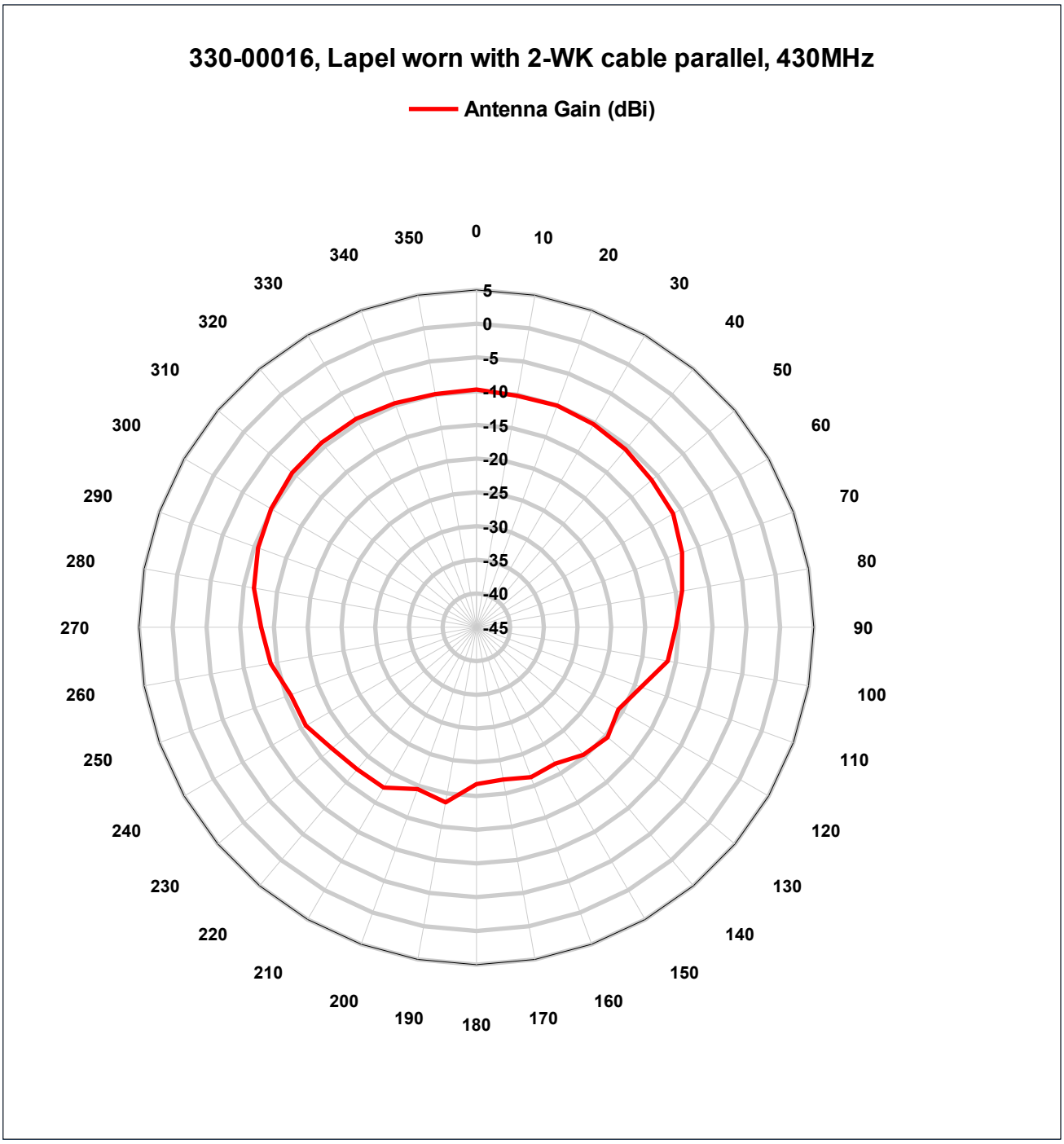
Antenna Gain (dBi)	-7.49	-16.77	-11.25



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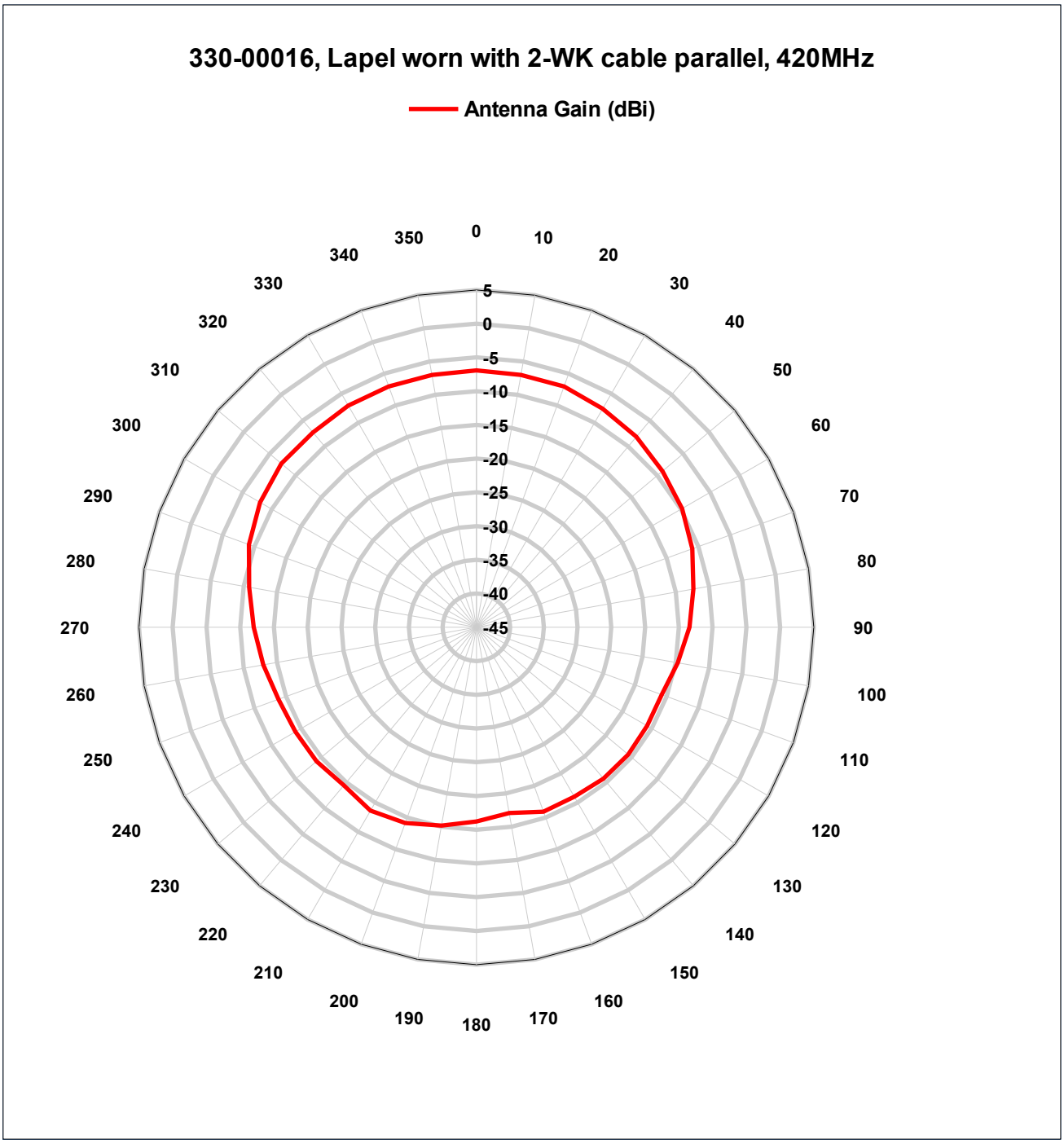
Antenna Gain (dBi)	-9.29	-22.08	-12.79



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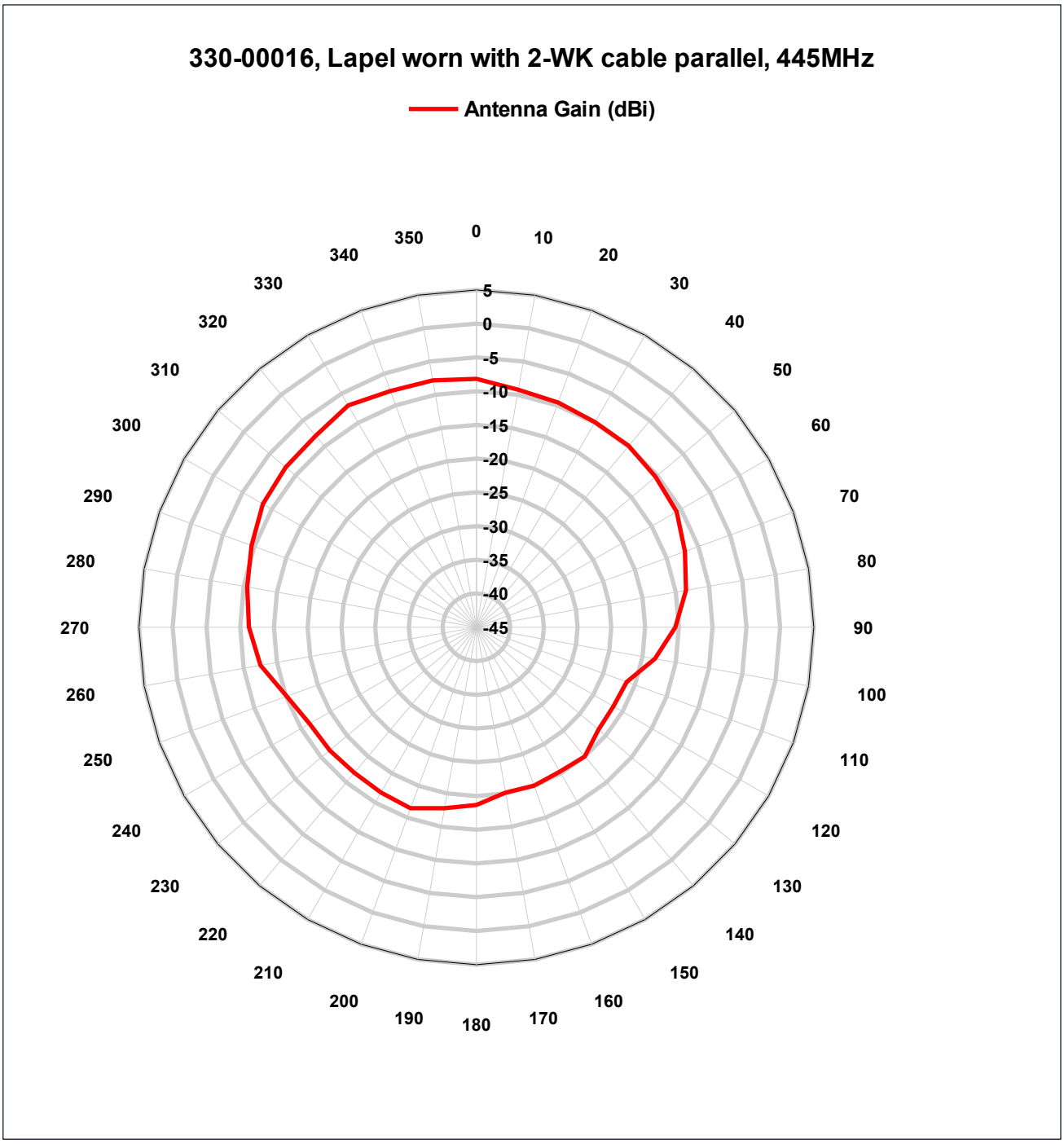
Antenna Gain (dBi)	-6.93	-17.05	-10.39



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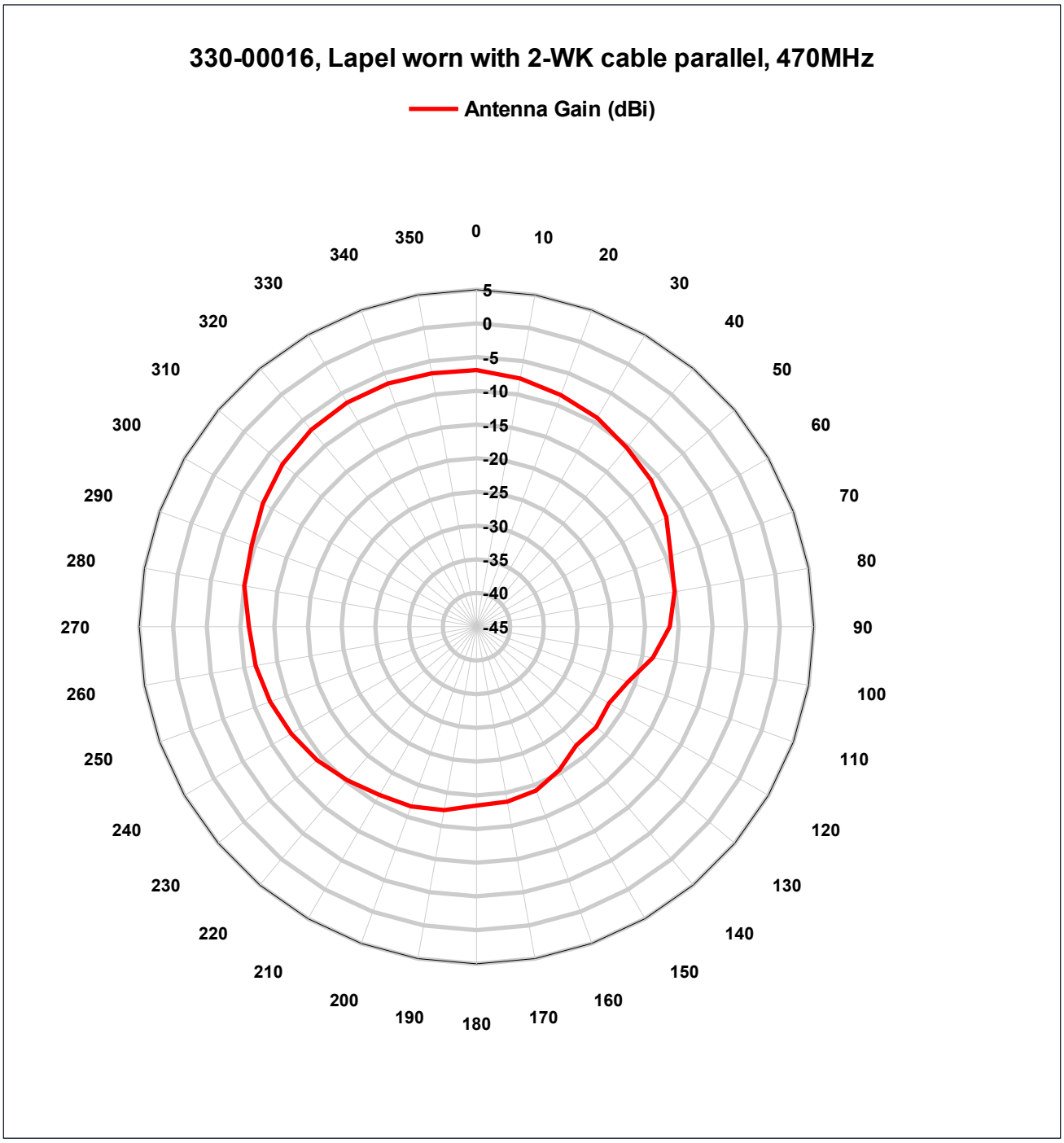
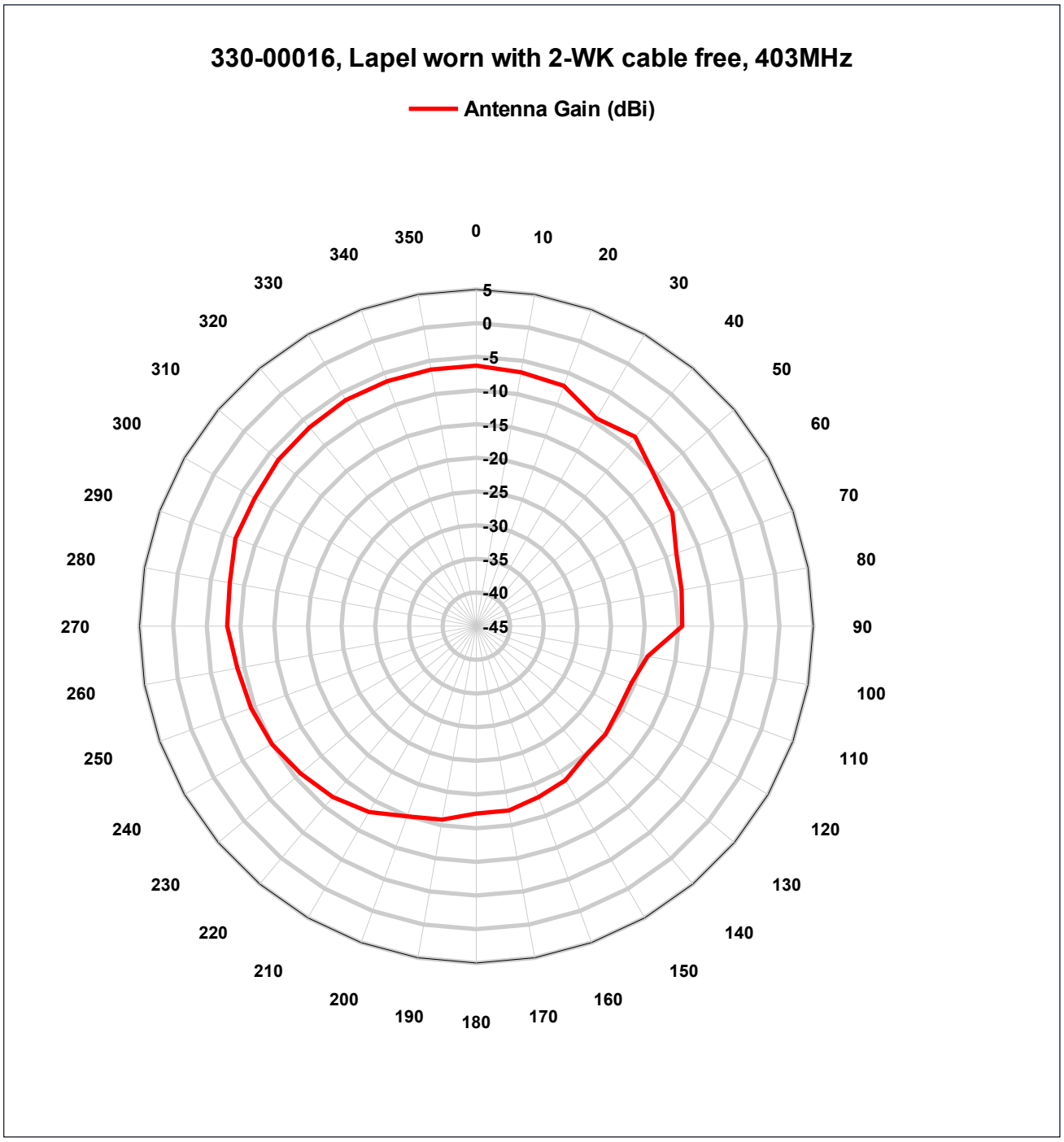
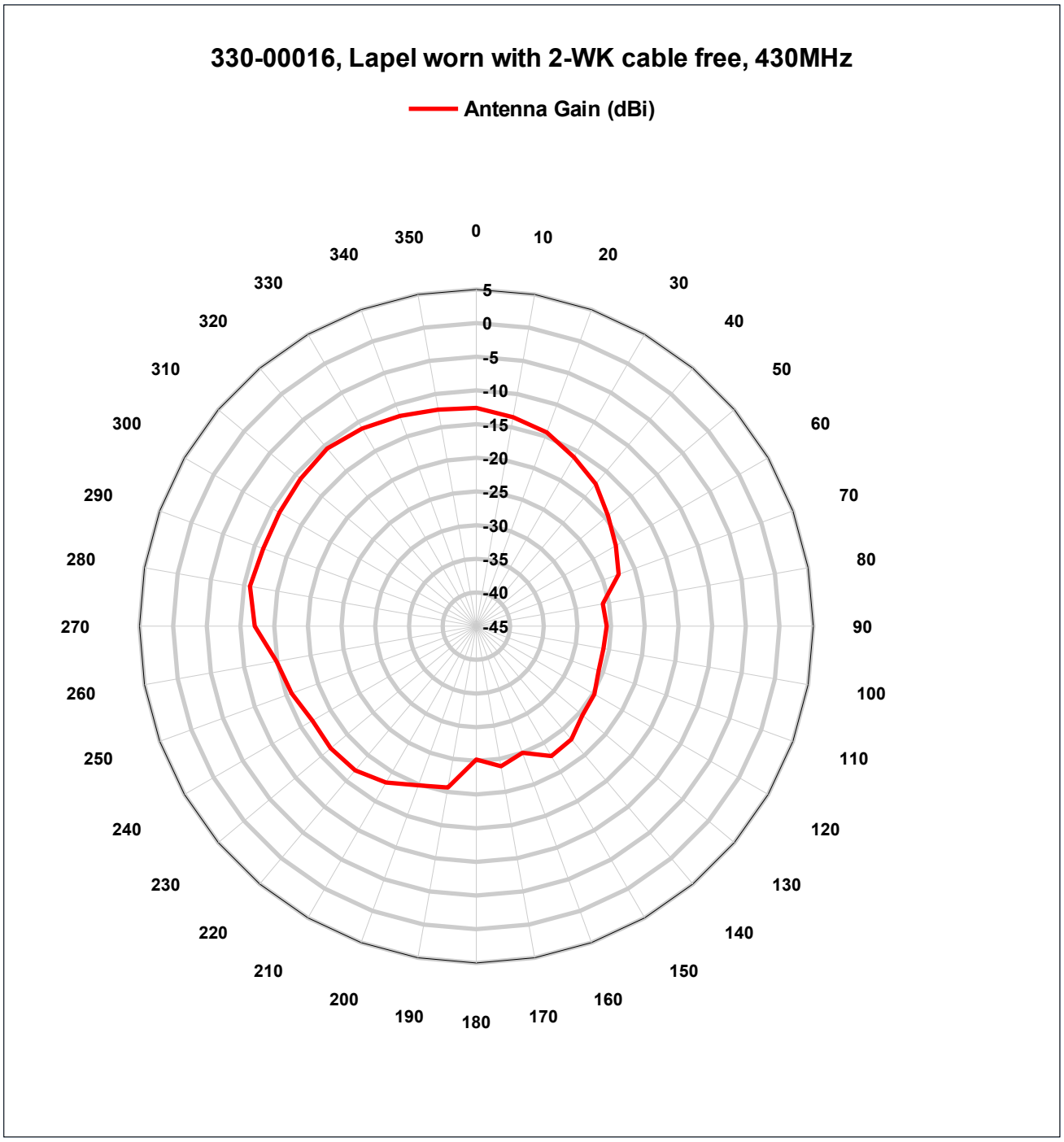
Antenna Gain (dBi)	-7.01	-21.56	-11.65



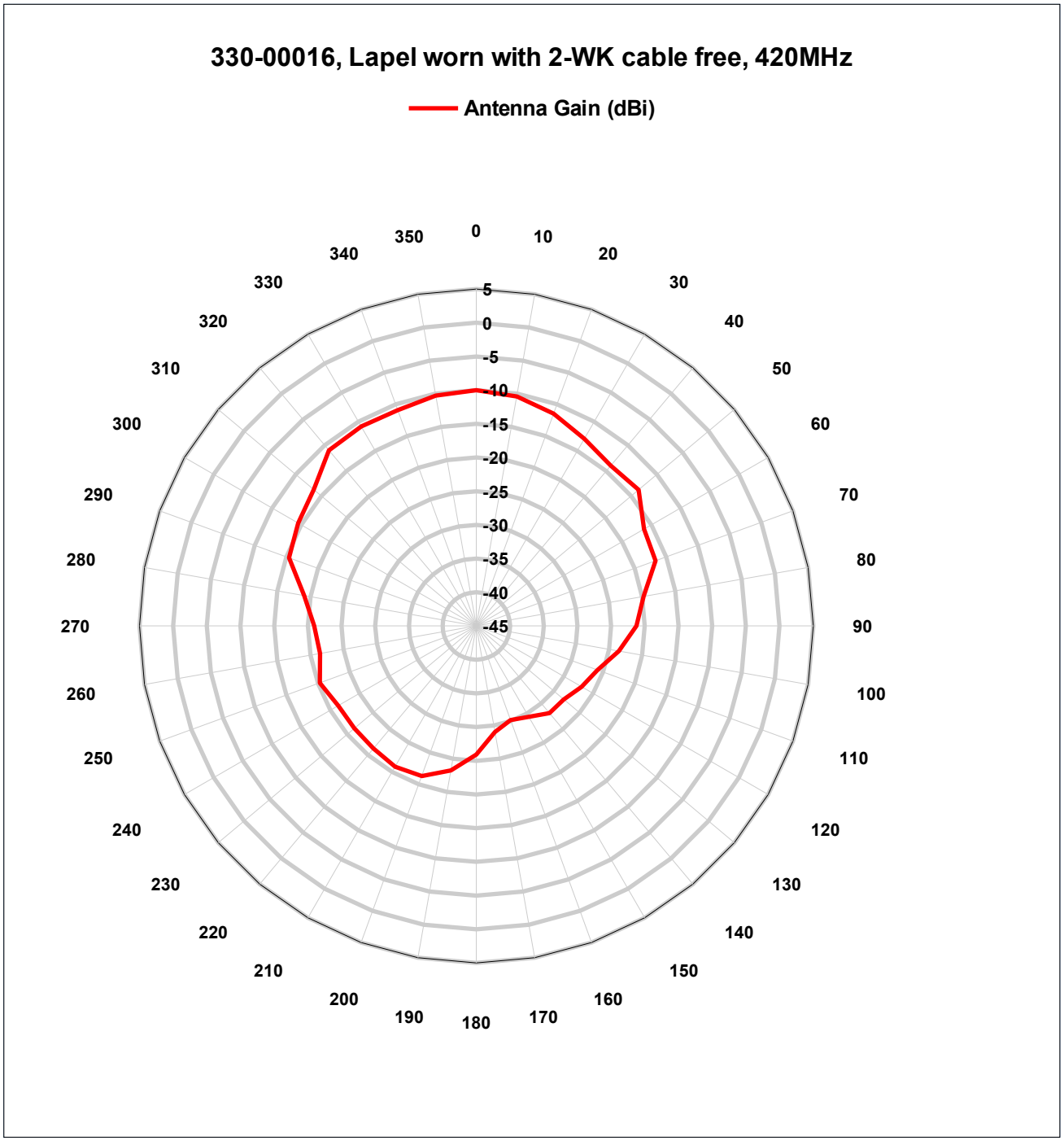
	MAX	MIN	AVG
Antenna Gain (dBi)	-6.59	-22.30	-11.08



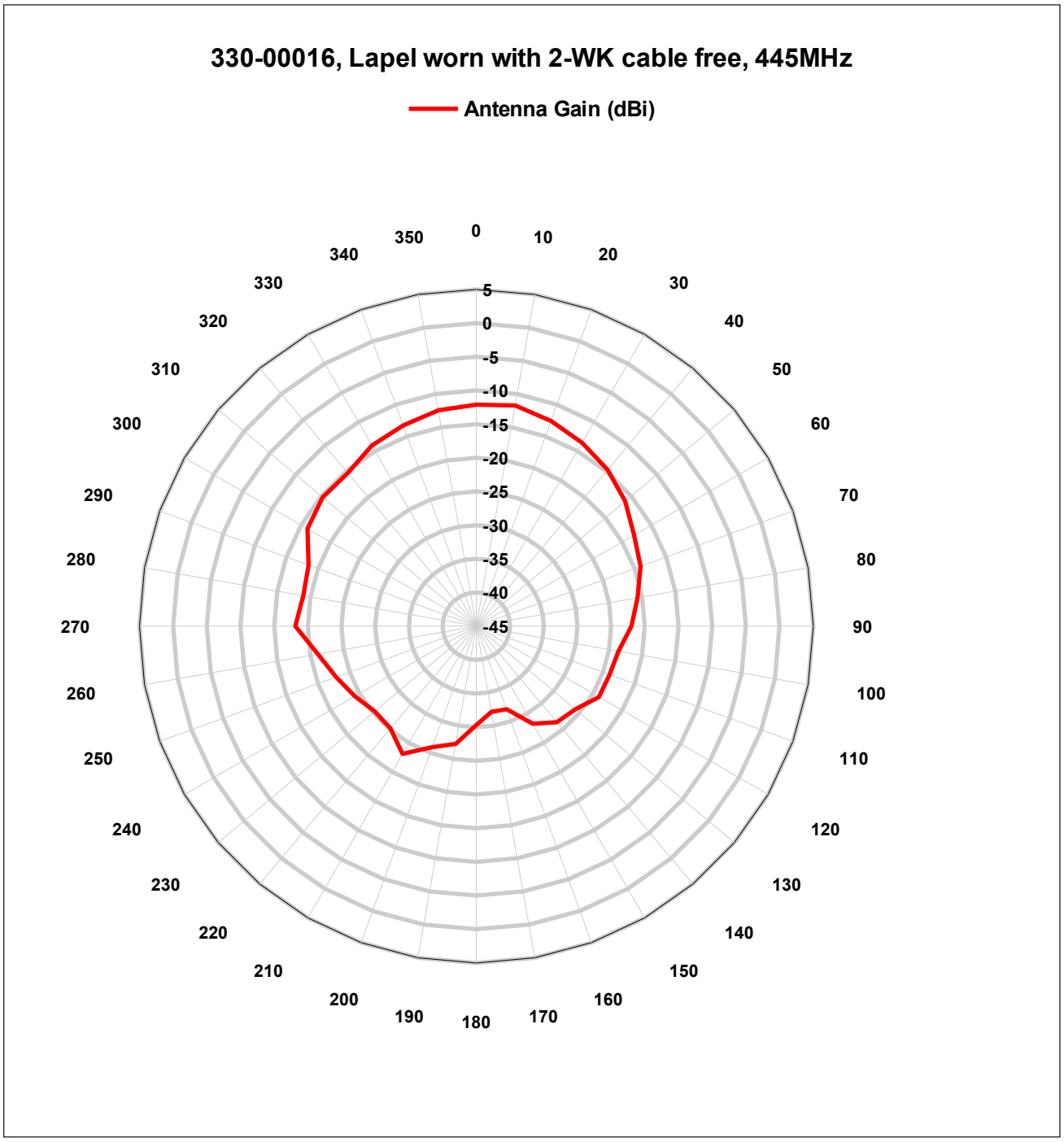
	MAX	MIN	AVG
Antenna Gain (dBi)	-6.24	-20.54	-9.79



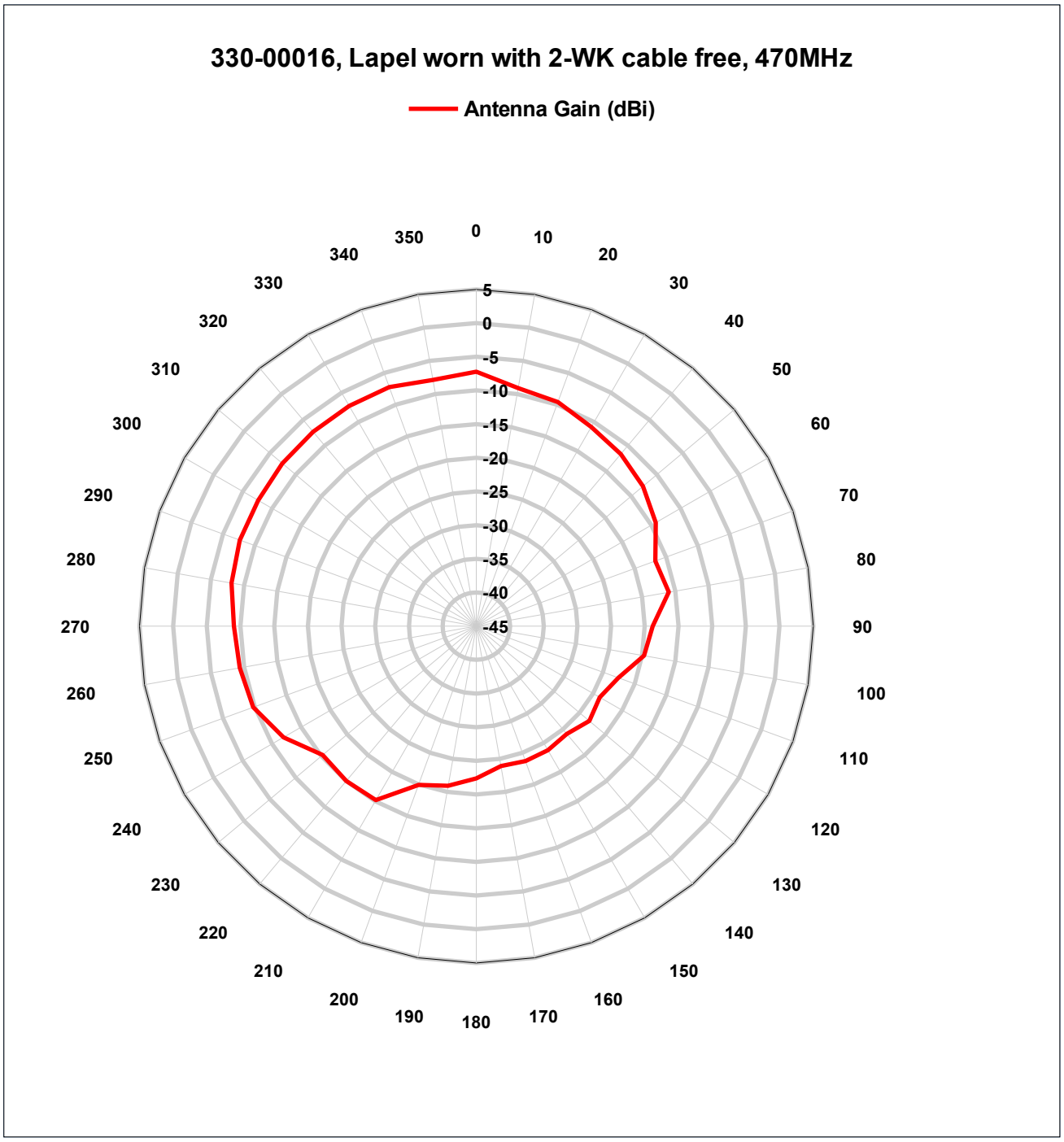
	MAX	MIN	AVG
Antenna Gain (dBi)	-10.58	-25.93	-15.33



	MAX	MIN	AVG
Antenna Gain (dBi)	-10.02	-30.15	-15.54



	MAX	MIN	AVG
Antenna Gain (dBi)	-11.74	-32.10	-17.42



	MAX	MIN	AVG
Antenna Gain (dBi)	-7.21	-24.12	-11.25

Photos

The following pages show various photographs taken during the testing.

Photo 1: Substitution Measurement - 10m OATS

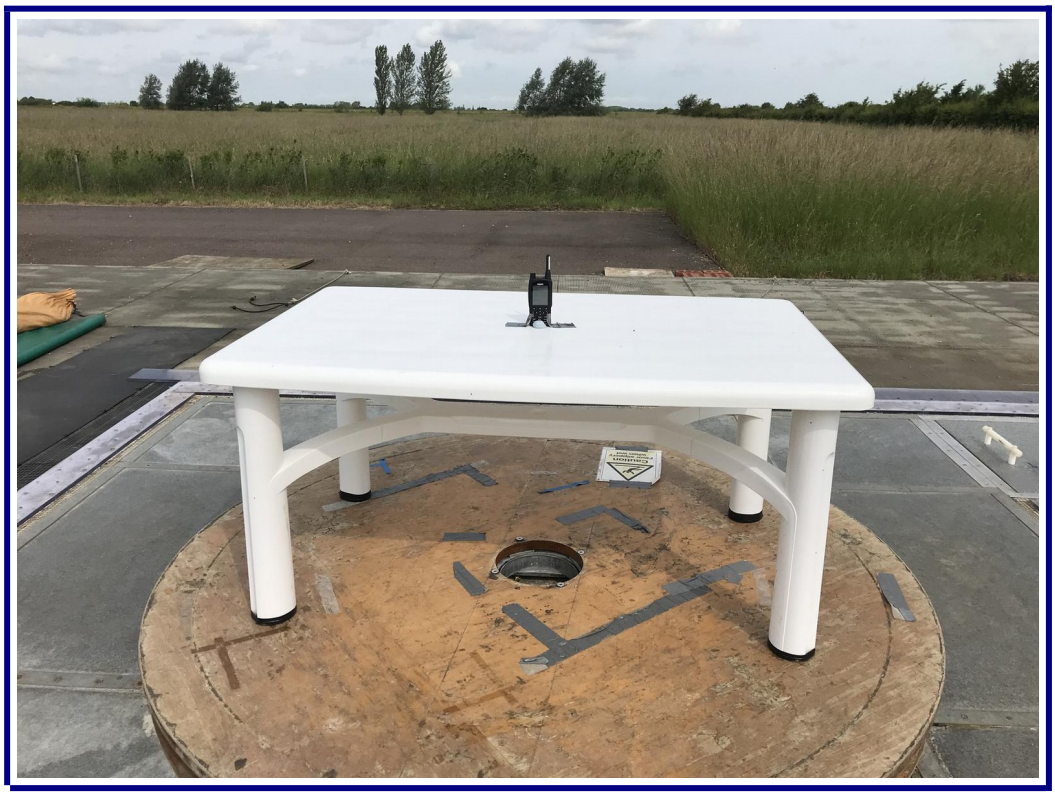


Photo 2: Free Space

Photo 3: Lapel Worn

Photo 4: Lapel Worn

Photo 5: Belt Worn

Photo 6: Belt worn RSM cable parallel

Photo 7: Belt worn RSM cable parallel

Photo 8: Belt worn RSM cable free

Photo 9: Lapel worn with 2-WK cable parallel

Photo 10: Lapel worn with 2-WK cable free