dB Technology
(Cambridge Ltd.)
EMC Testing
EMC Consultancy
EMC Training

23, Headington Drive,
Cambridge.
CB1 9HE
Tel : 01954 251974 (test site)
or : 01223 241140 (accounts)
Fax : 01954 251907
web : www.dbtechnology.co.uk
email: mail@dbtechnology.co.uk

Antenna Pattern TEST REPORT

Tests performed at:

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

On

Sepura PLC

SC21 Quarter-Wave Whip Antenna 380-470MHz (PN 310-00015) Gain Test Results

Document History

Version	Date	Affected page(s)	Description of modifications	Revised by	Approved by
00	26/11/2018		Initial release		
01	25/07/2023	1,2,4,5,10-41	Customer has noticed an error with the PN associated with the antenna. This has been corrected. It was initially recorded as '300-00015' it has been updated to '310-00015'.	CA	DS

Product:	SC21 Quarter-Wave Whip Antenna 380-470MHz (PN 310-00015)	
Company:	Sepura PLC	
Representative:	Ruben Selva	
Address:	9000 Cambridge Research Park Beach Drive Waterbeach Cambridgeshire CB25 9TL	
Start Date:	*6th November 2018*	
End Date:	*6th November 2018*	
Report Written By:	Peter Barlow	
Report Authorised By:	Derek Barlow	26th November 2018
V01 Report Authorised By:	David Smith	25th July 2023
Signature:	Dave Smith Digitally signed by Dave Smith DN: C=UK, O=dB Technology, CN=Dave Smith, E=mail@dbtechnology.co.uk Reason: I am approving this document Location: Cottenham Date: 2023-07-25 12:22:48 Foxit Reader Version: 9.2.0	
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.

2 General Information

2.1 Product Name and Contact Details

Product:	SC21 Quarter-Wave Whip Antenna 380-470MHz (PN 310-00015)
Company:	Sepura PLC
Representative:	Ruben Selva
Address:	9000 Cambridge Research Park Beach Drive Waterbeach Cambridgeshire CB25 9TL

2.2 Product Description

This report describes a series of tests performed on an SC21 Quarter-wave whip antenna connected to Sepura SC21 TW and UW Band radios.

The SC21 radios are battery powered radio devices. The transmit output power 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 radios with the Quarter-wave whip antenna and with and without accessories and with the antenna positioned on different parts of the body.

2.2.1 UUT Details

Test were performed on the following products:

- SC21 TW Band (380-430MHz) Radio; Sepura P/N: SC2120
- SC21 UW Band (403-470MHz) Radio; Sepura P/N: SC2124

Antenna fitted was:

- SC21 Quarter-Wave Whip Antenna 380-470MHz; Sepura P/N: 310-00015

Accessories fitted were:

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

2.2.2 Body Positions

All measurements were made with the UUTs held by or close to a real human being. The same person was used for all tests. The photographs at the end of this report 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 100msec 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 1m 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.

Correction factor figures provided by the manufacturer (dBi) of the mini-bicon were 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

Gain Correction Factors (Substitution Method) *#Ref00*

Date: 06/11/2018 *Test Engineer: Russell McDonnell*

Notes	Freq. MHz	Fact Set	Sub'n Ant Gain dBi	Dist-ance (m)	Ant. *Pol.*	Rec'vr Level EUT dBuV	Sig Gen Level Sub'n Ant dBm	Rec'vr Level Sub'n Ant dBuV	ERP dBm	Gain CF dB	
	380	1	-1.0	10	V	0.0	-26.3	41.5	-68.8	**-83.9**	
	403	1	-0.5	10	V	0.0	-26.4	42.0	-68.9	**-83.9**	
	405	1	-0.5	10	V	0.0	-26.3	42.0	-68.8	**-83.5**	
	430	1	0.0	10	V	0.0	-26.4	41.4	-67.8	**-82.2**	
	437	1	-0.2	10	V	0.0	-26.4	41.7	-68.3	**-83.0**	
	460	1	-0.1	10	V	0.0	-26.5	40.9	-67.4	**-82.0**	
	470	1	-0.2	10	V	0.0	-26.5	40.4	-67.1	**-81.7**	

Notes:

120kHz quasi-peak detector used for all measurements.

Gain Correction factors. Based on EIRP substitution measurement.
Output levels at EUT connector supplied by Sepura.

2.3.5 Test Equipment

Test Equipment

Ref:	Type:	Description:	S/N:
R4	Receiver	R&S ESVS10	843744/002
PM1	Power meters / sensors	Marconi 6960A RF Power Meter	2785
PS2	Power meters / sensors	Marconi 6920 RF Power Sensor (-70dBm / -20dBm) 10MHz to 20GHz	112
SG19	Signal generators	SRS SG386 DC to 6GHz Signal Generator	002670
A39	Antenna	Schwarzbeck VULP 9118A Log Periodic	581
A30	Antenna	Schwarzbeck MiniBicon (30MHz to 1GHz)	9115-180
CBL107	Cable	RG214 - 10m N-N	CBL107
CBL134	Cable	RG214 - 25m N-N	CBL134

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
A38	Antenna	Schwarzbeck VULP 9118A Log Periodic	580
CBL134	Cable	RG214 - 25m N-N	CBL134

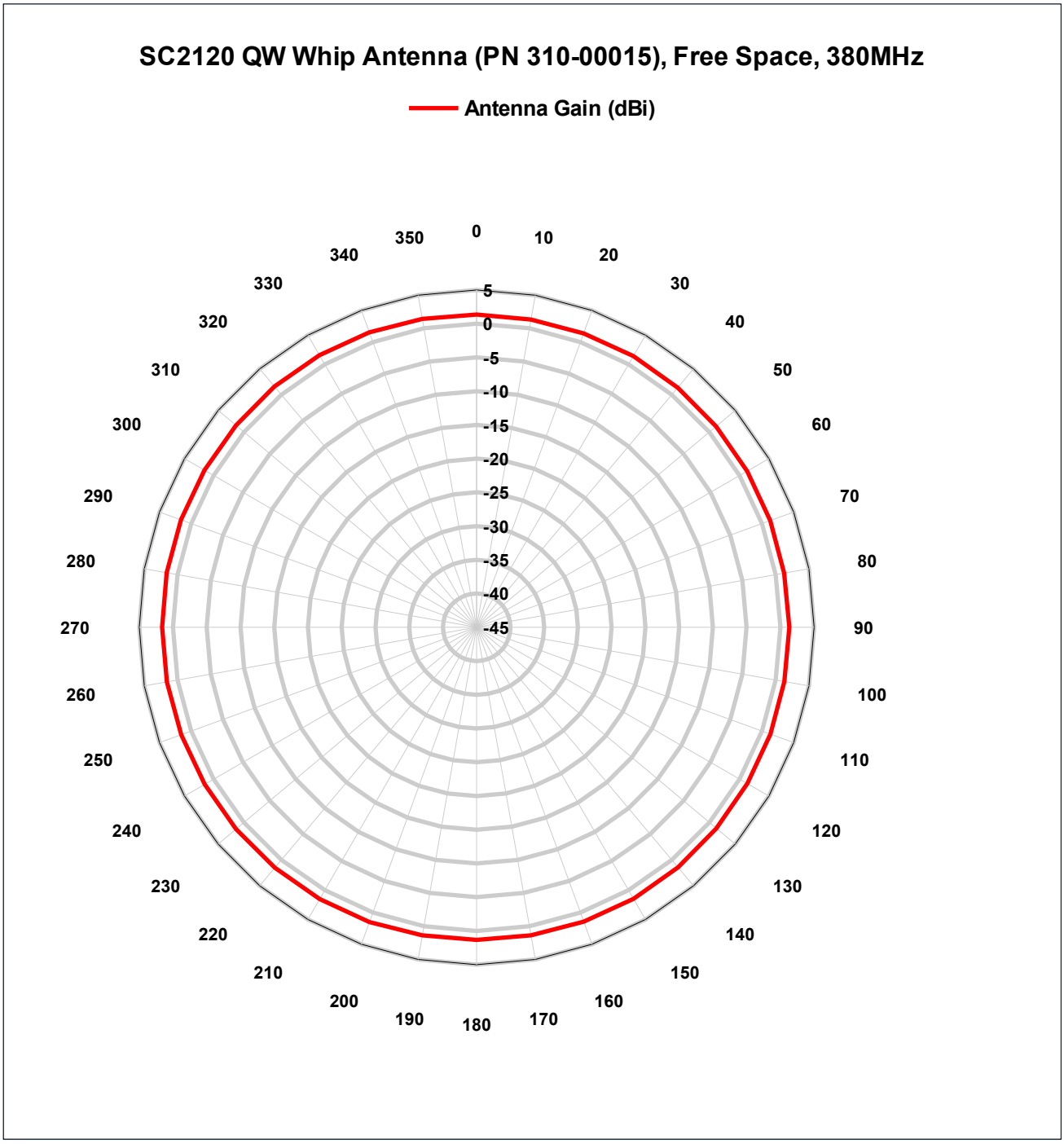
Measurement Uncertainty

Radiated Emissions:	3m	10m
30MHz to 200MHz: Horizontal	±4.83 dB	±5.37 dB
30MHz to 200MHz: Vertical	±4.94 dB	±5.36 dB
200MHz to 1GHz: Horizontal	±5.24 dB	±5.43 dB
200MHz to 1GHz: Vertical	±6.30 dB	±5.45 dB

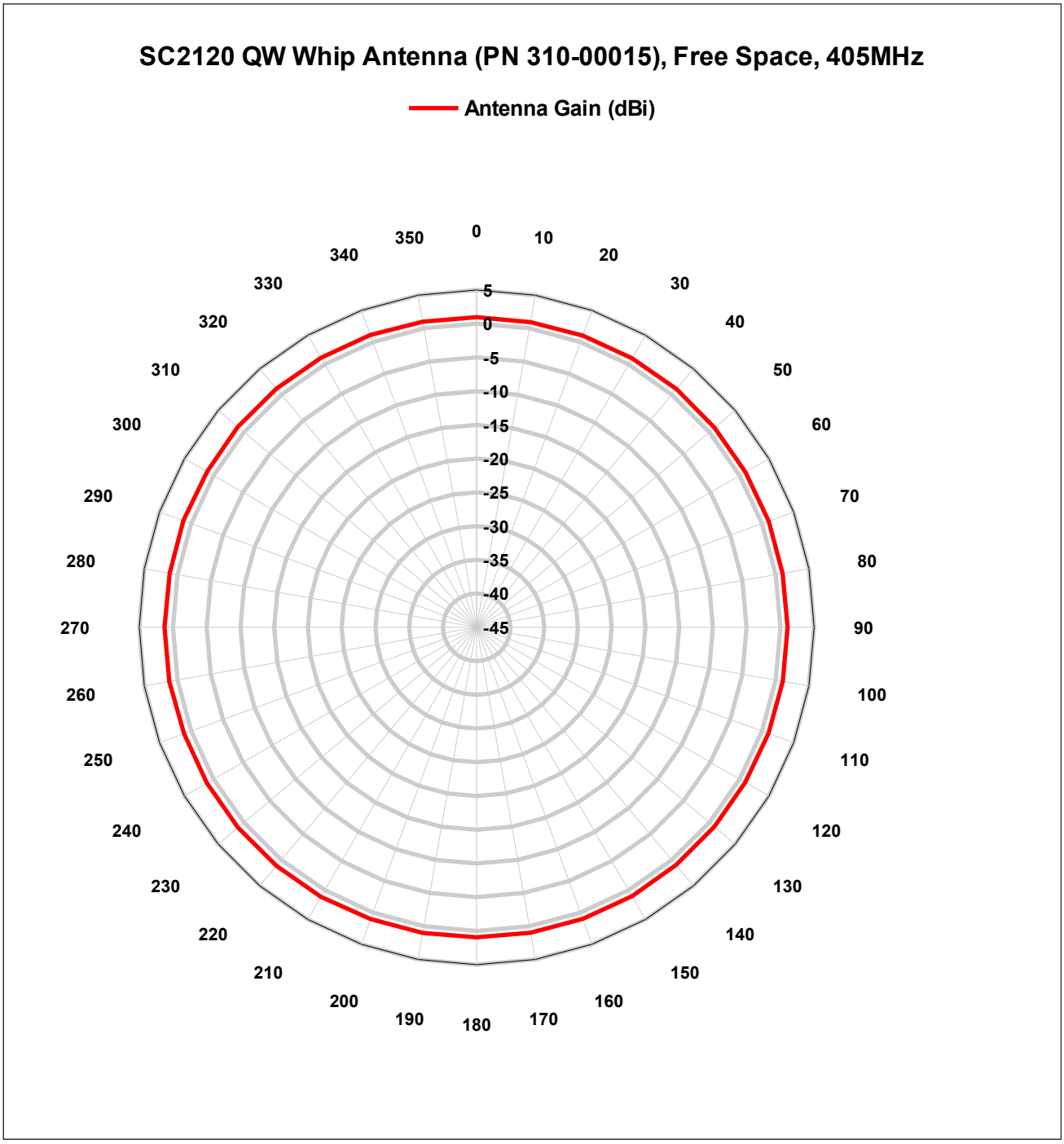
The reported uncertainty is based on a standard uncertainty multiplied by the coverage factor k=2, providing a level of confidence of approximately 95%

2.4.3 Plots

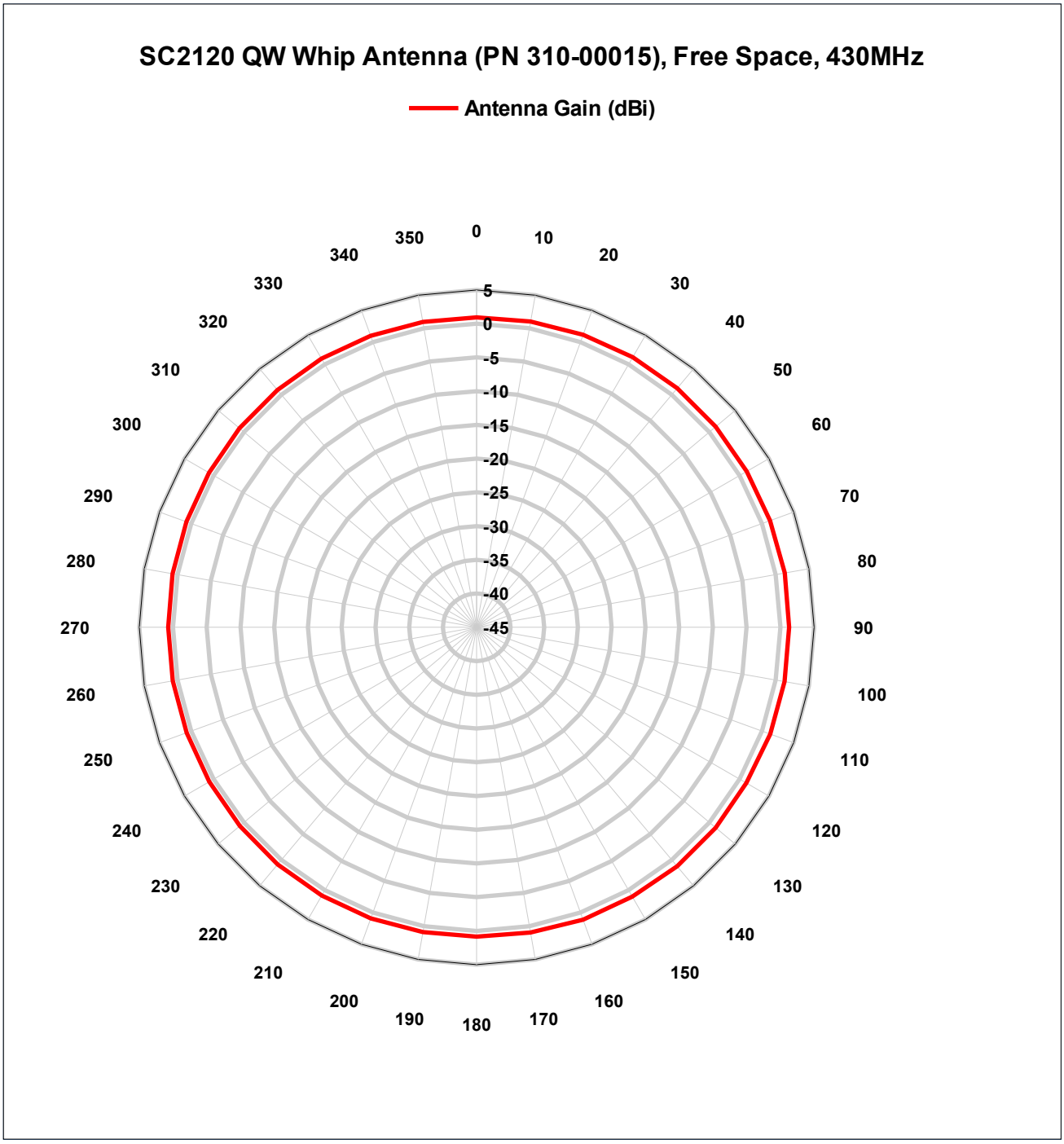
The following pages show plot results for the various antenna configurations.



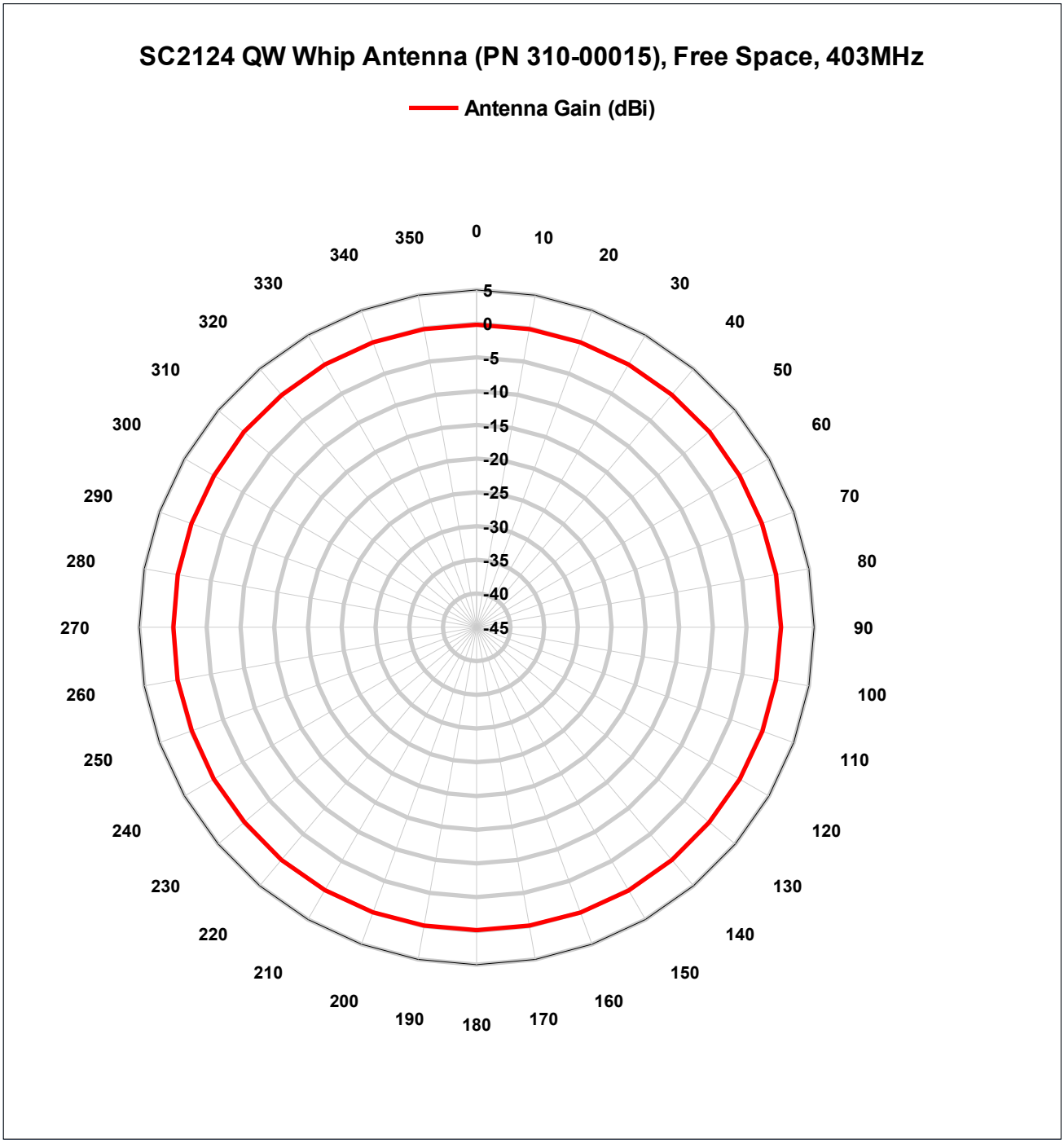
	MAX	MIN	AVG
Antenna Gain (dBi)	1.63	1.27	1.45



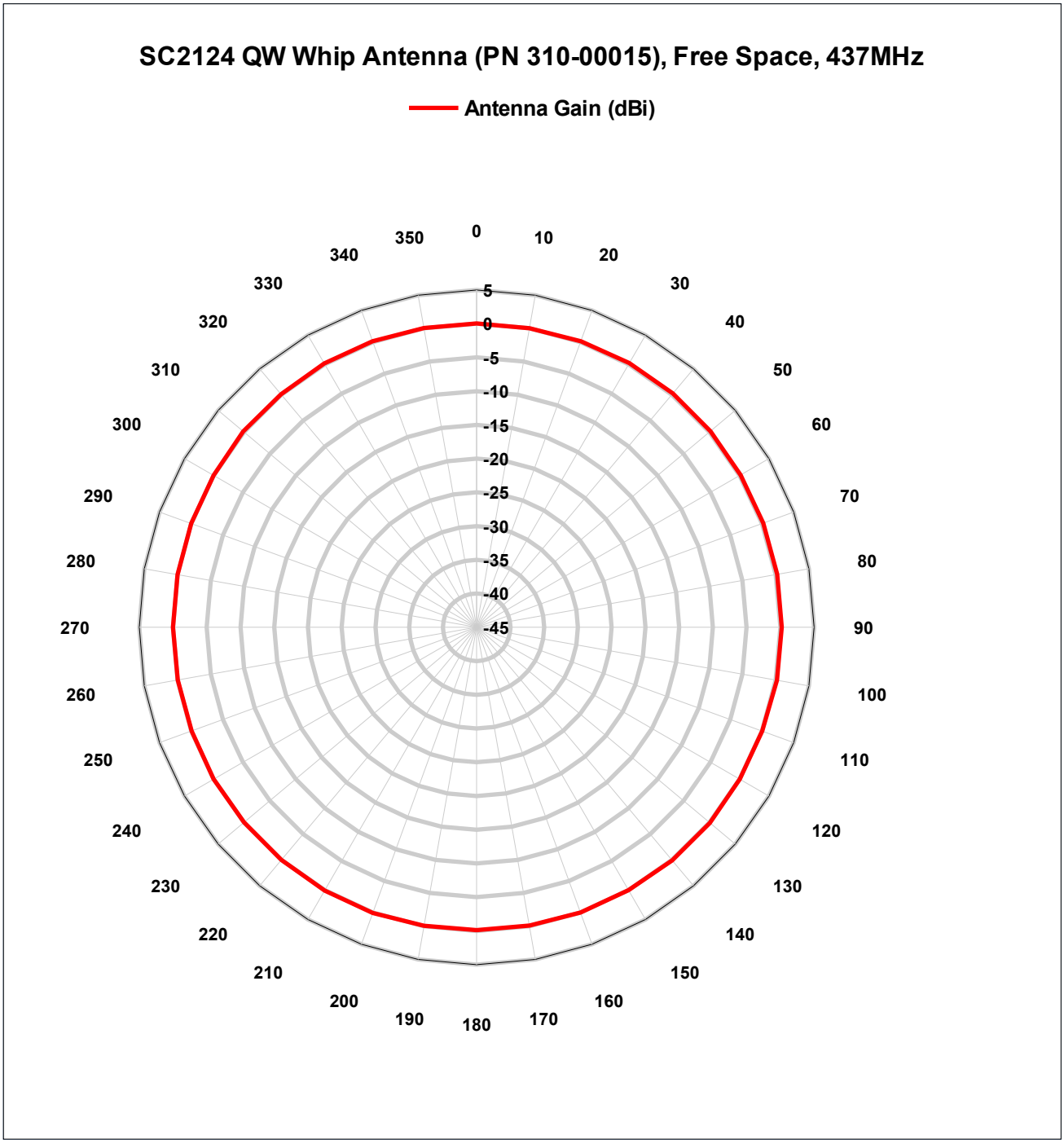
	MAX	MIN	AVG
Antenna Gain (dBi)	1.24	0.94	1.07



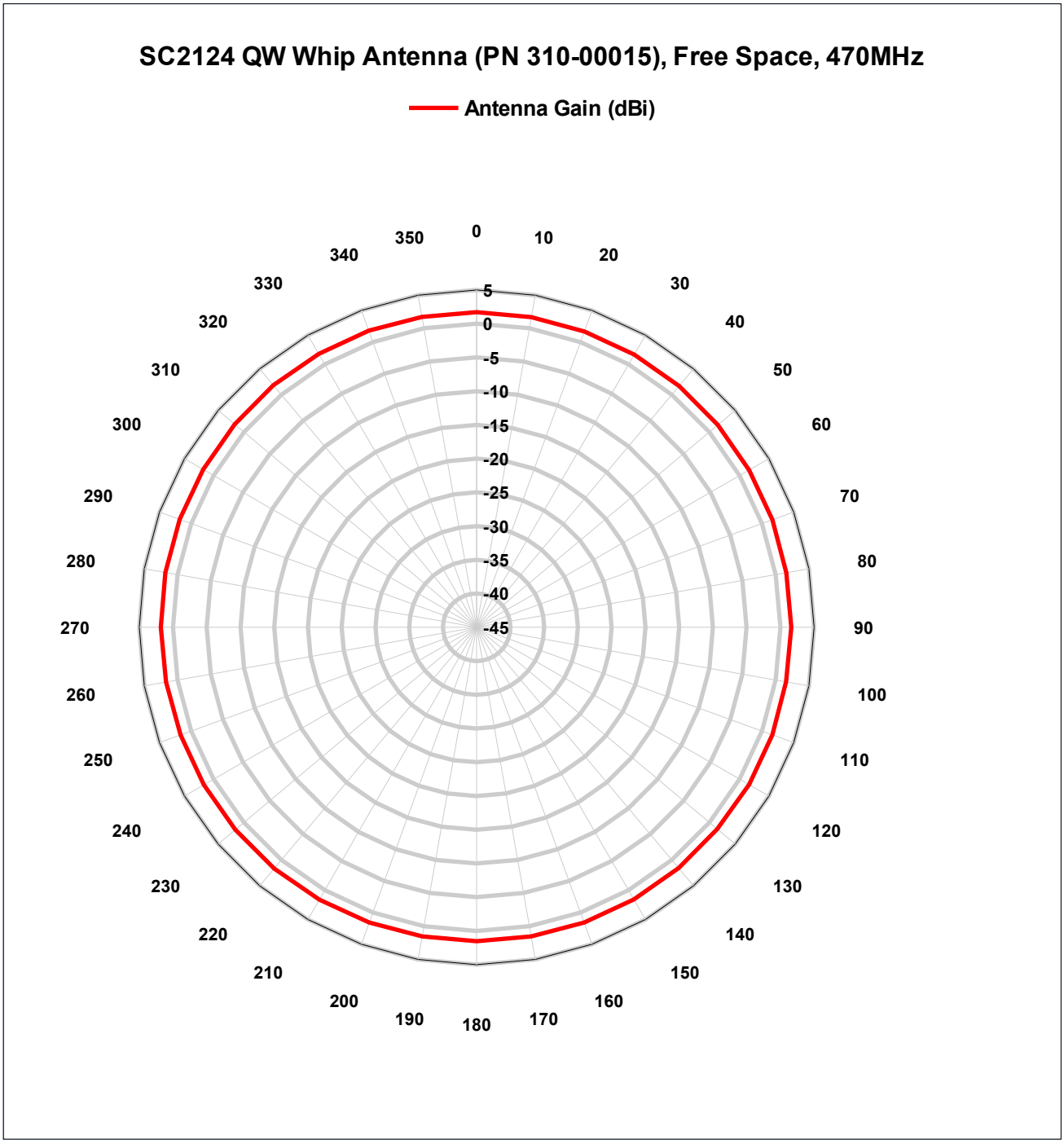
	MAX	MIN	AVG
Antenna Gain (dBi)	1.35	0.72	1.02



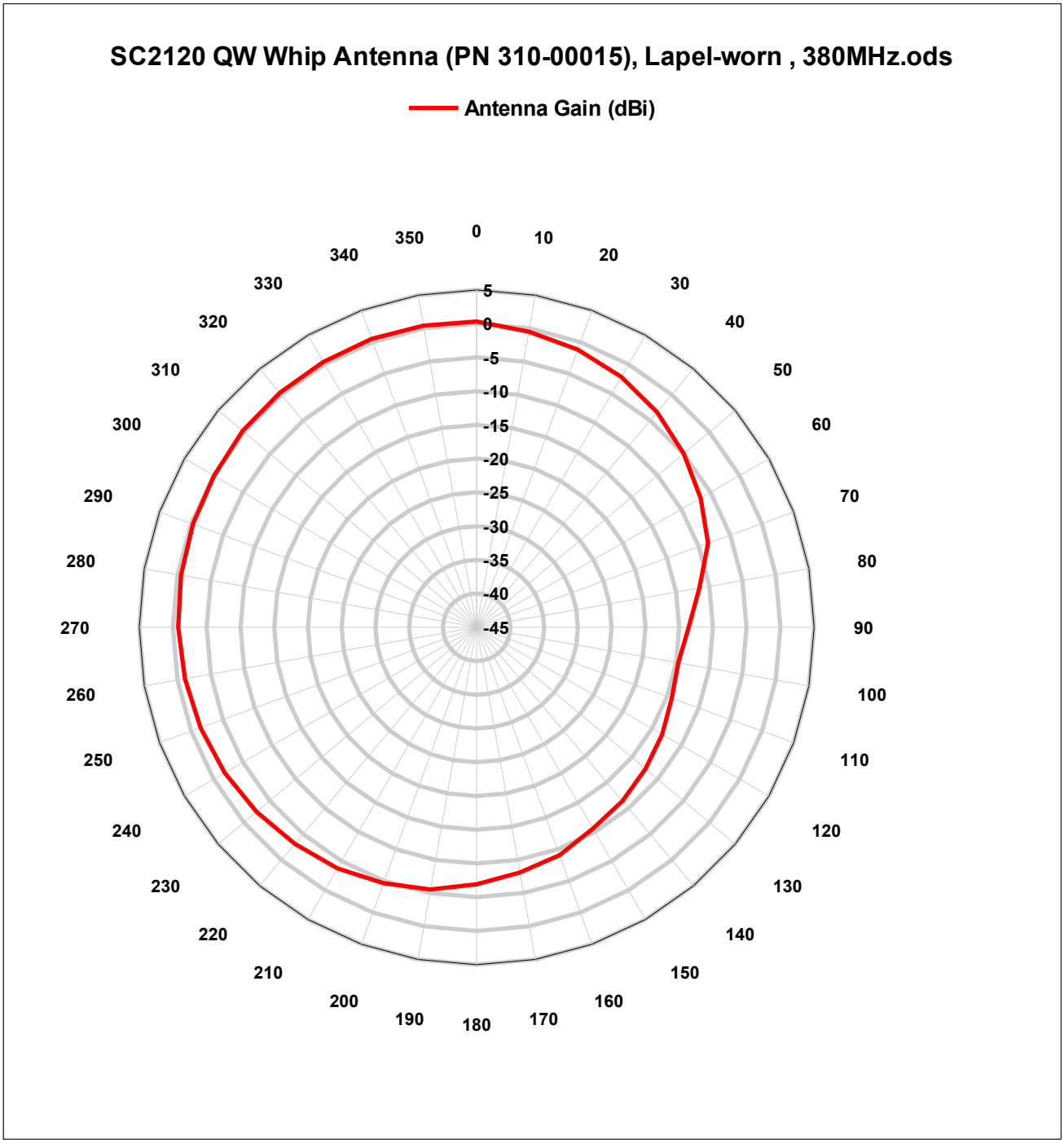
	MAX	MIN	AVG
Antenna Gain (dBi)	0.12	-0.15	-0.03



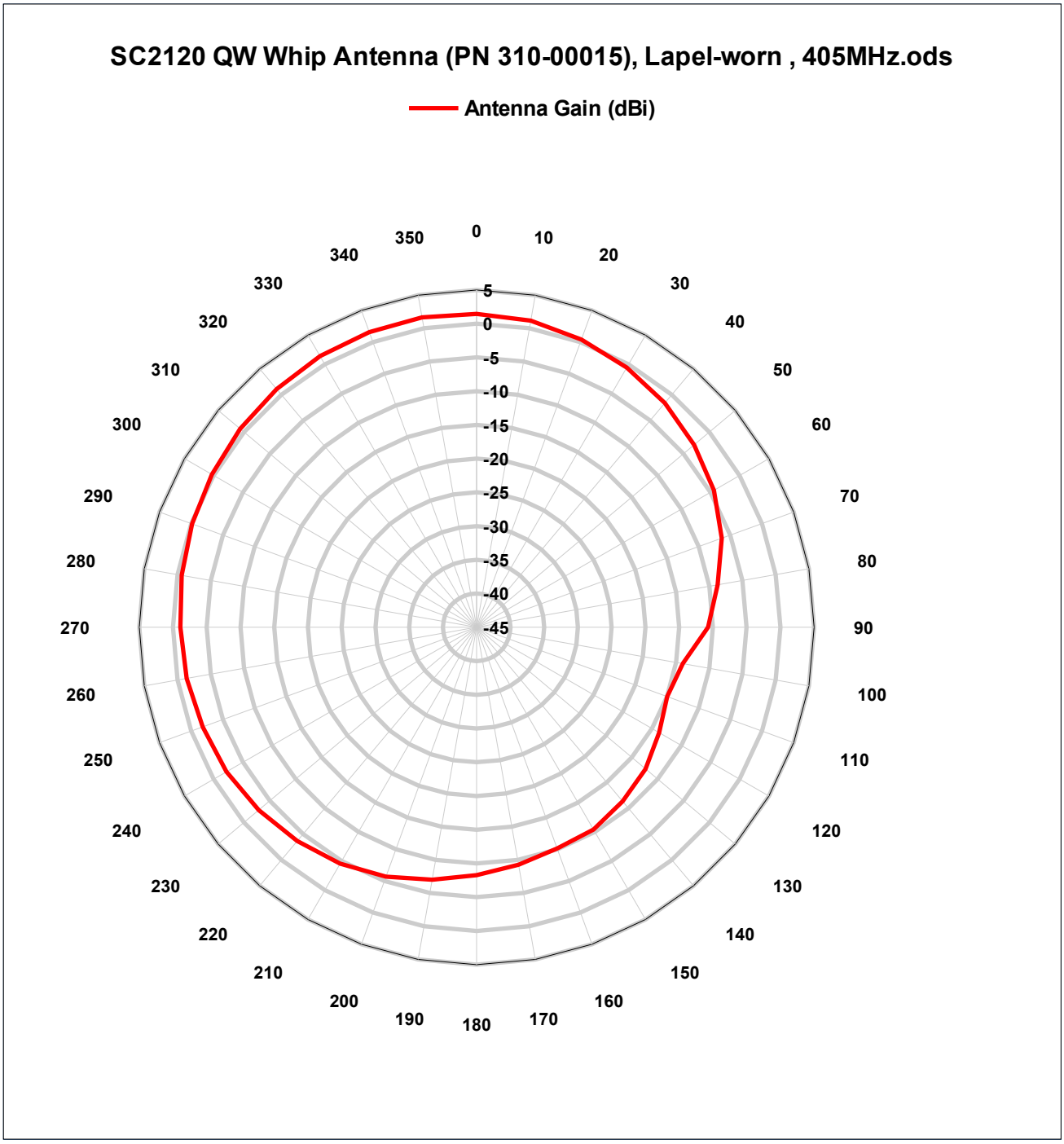
	MAX	MIN	AVG
Antenna Gain (dBi)	0.23	-0.12	0.07



	MAX	MIN	AVG
Antenna Gain (dBi)	1.85	1.51	1.67



	MAX	MIN	AVG
Antenna Gain (dBi)	0.48	-14.67	-2.82



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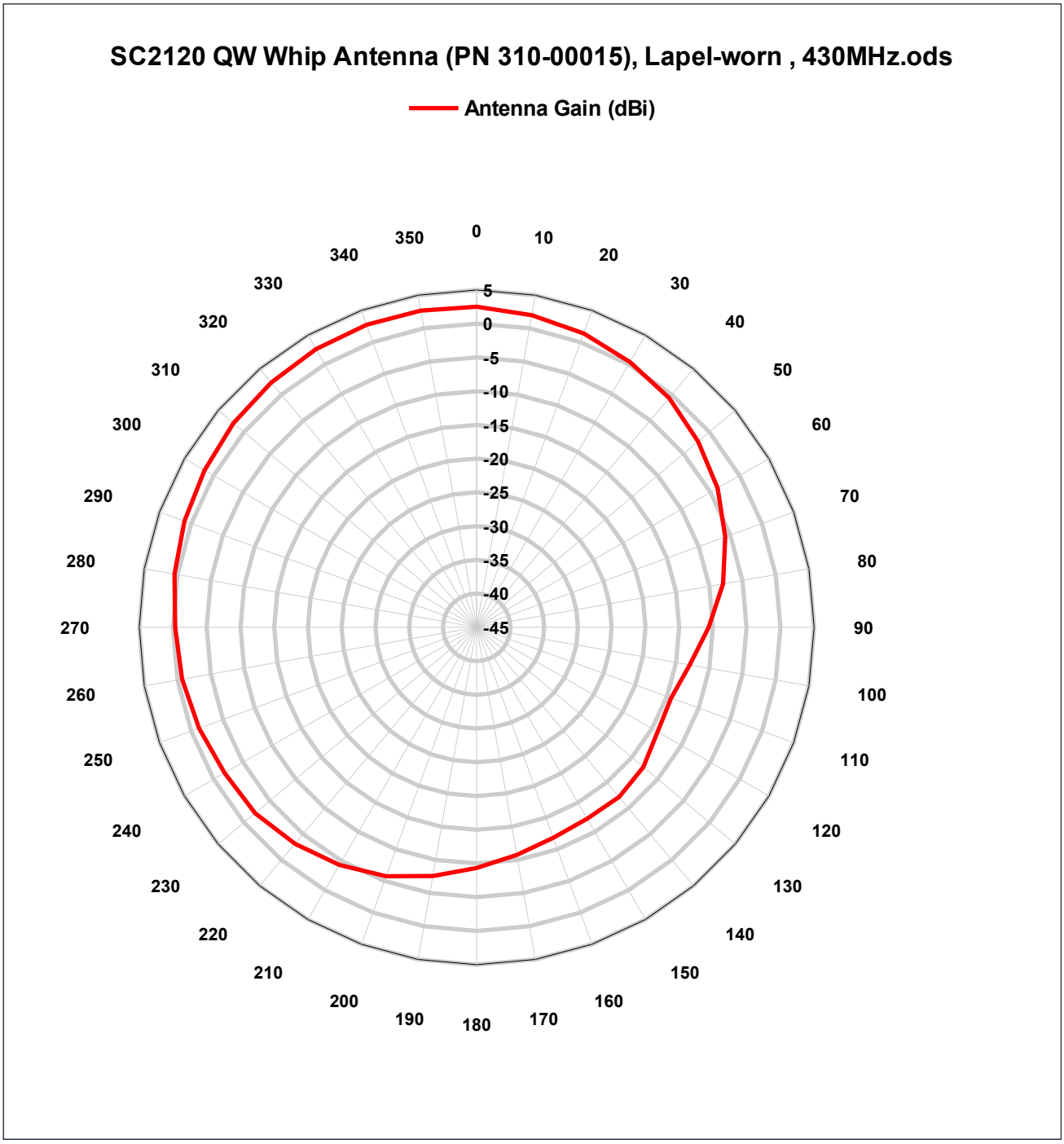
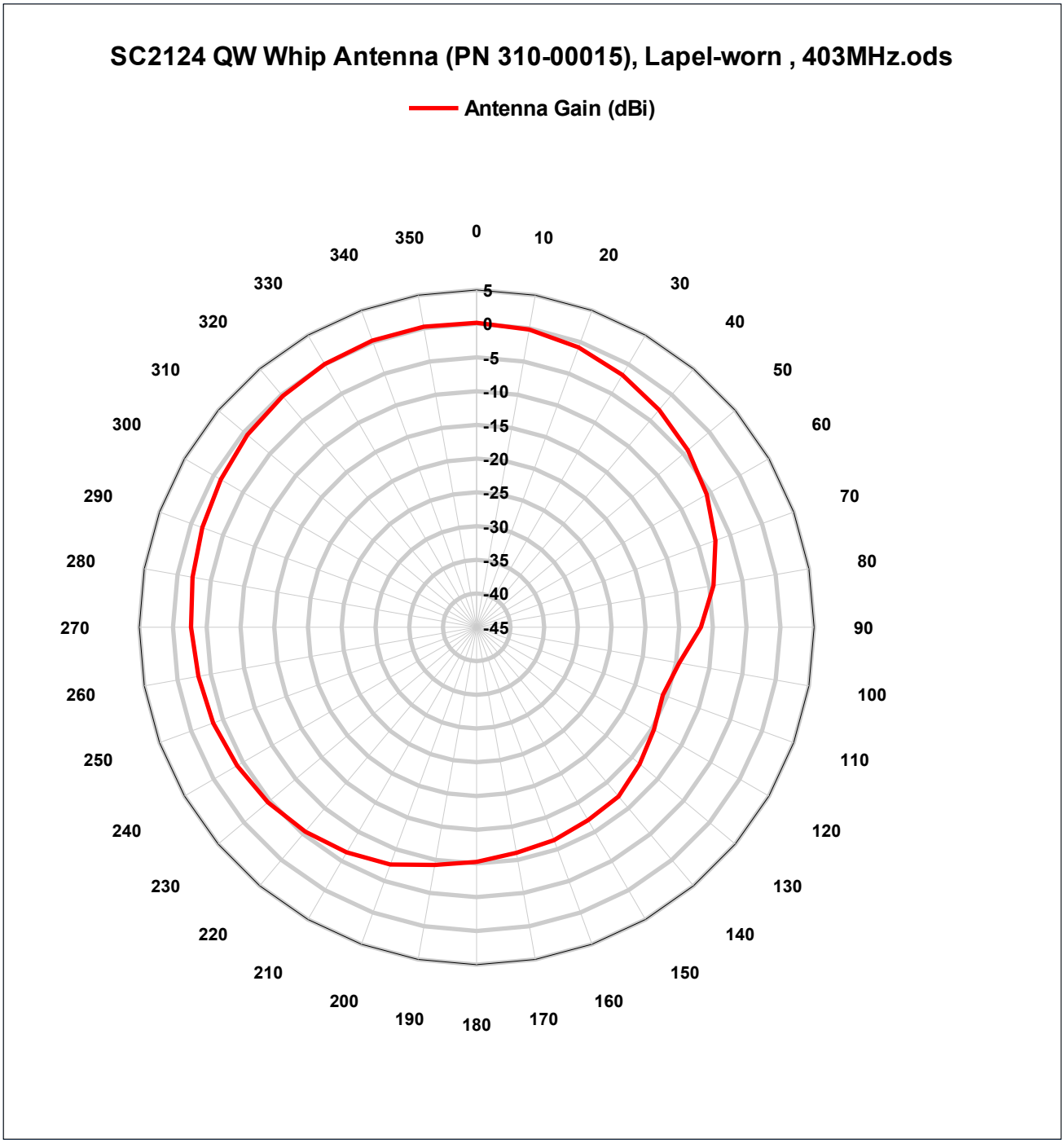
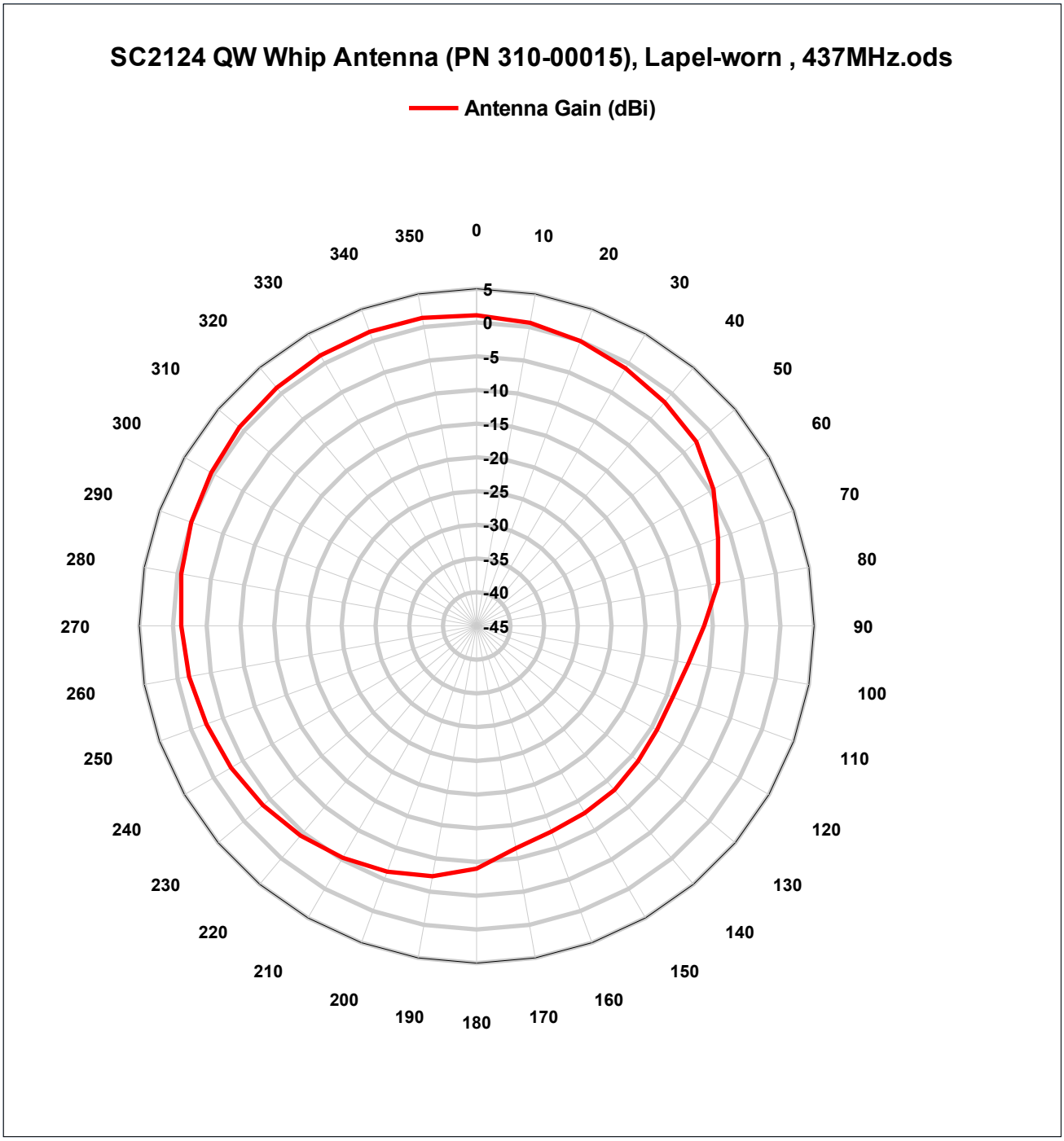
Antenna Gain (dBi)	1.63	-14.95	-2.22



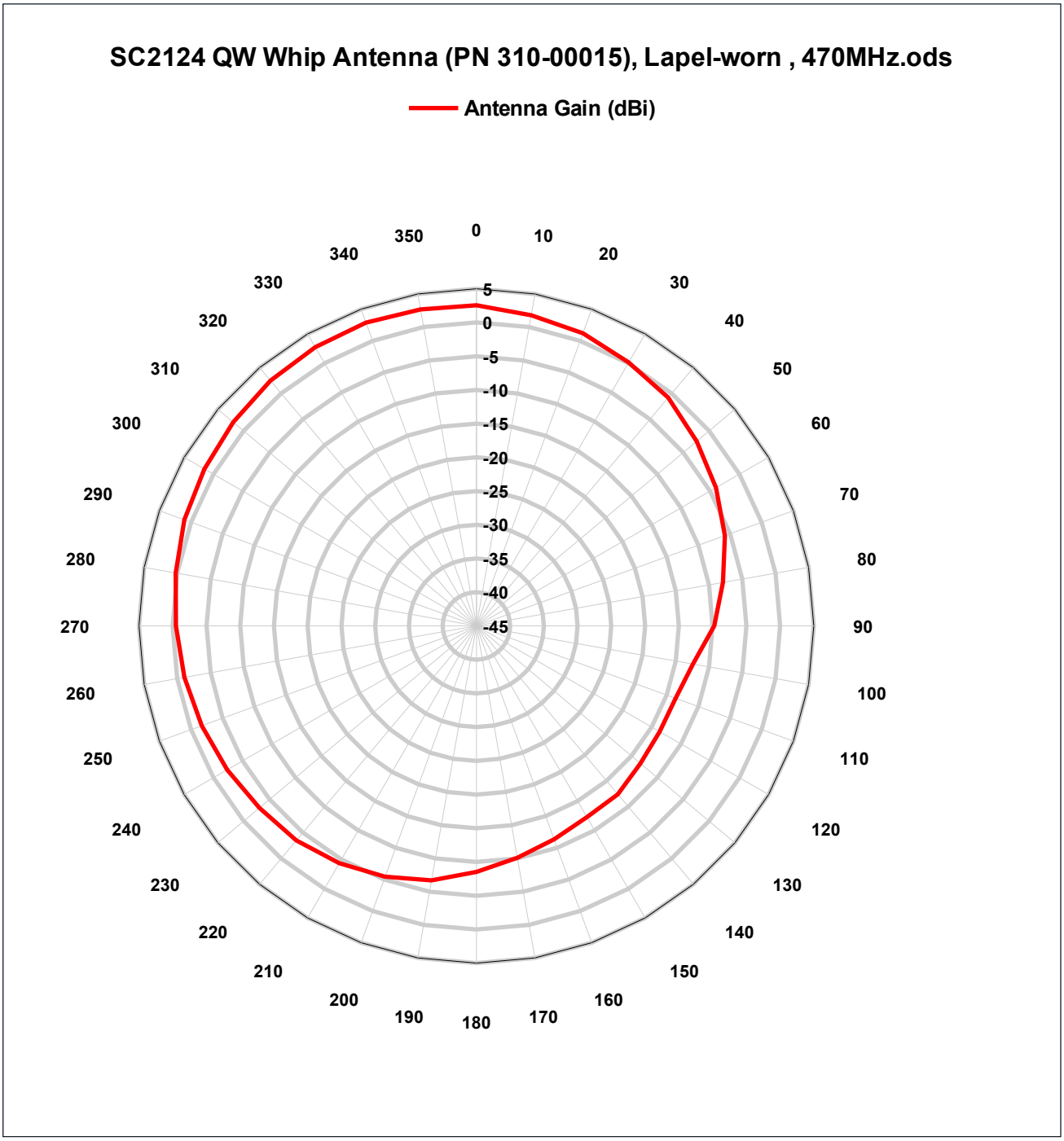
	MAX	MIN	AVG
Antenna Gain (dBi)	2.71	-14.32	-1.31



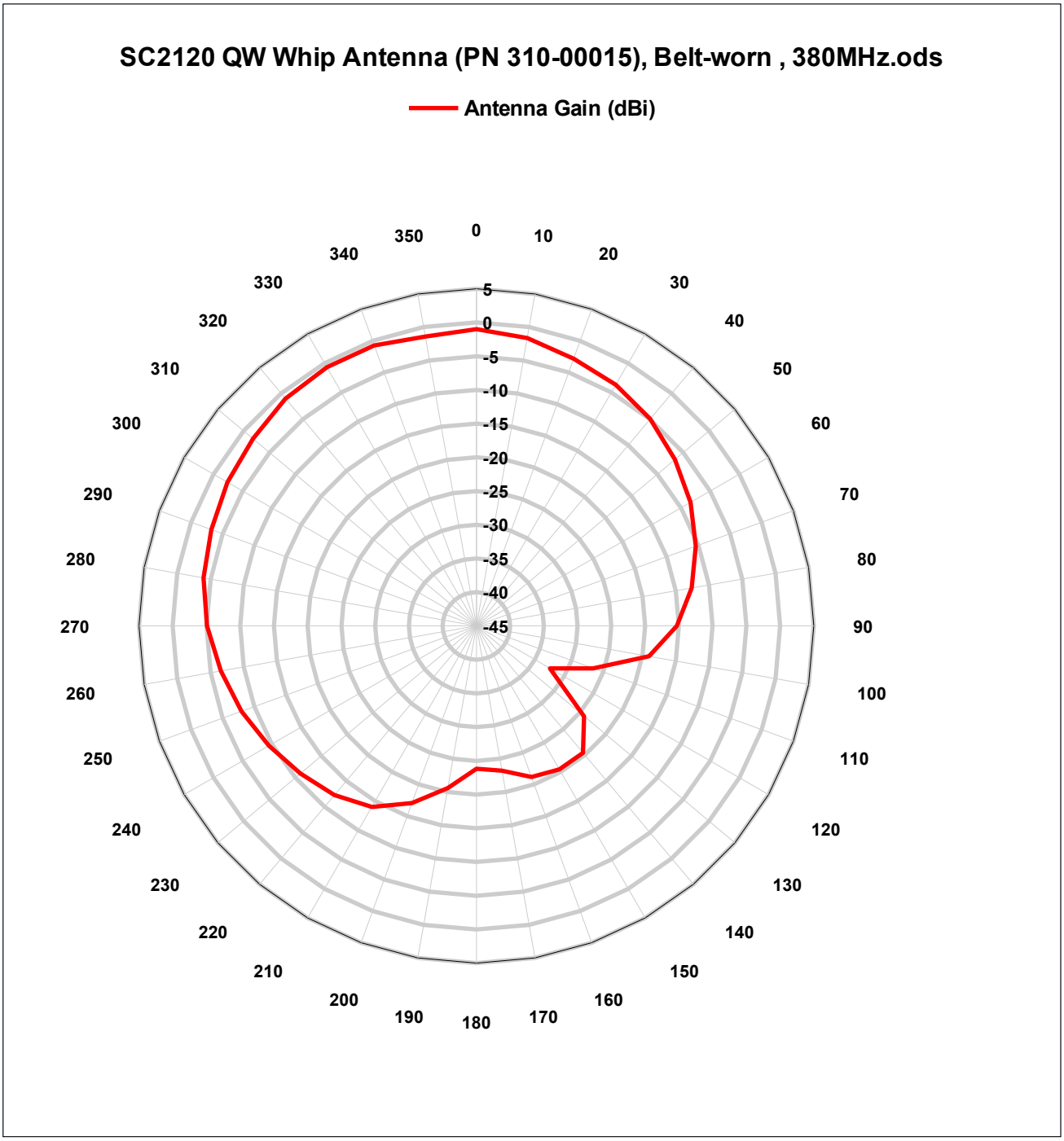
	MAX	MIN	AVG
Antenna Gain (dBi)	0.22	-15.64	-3.67



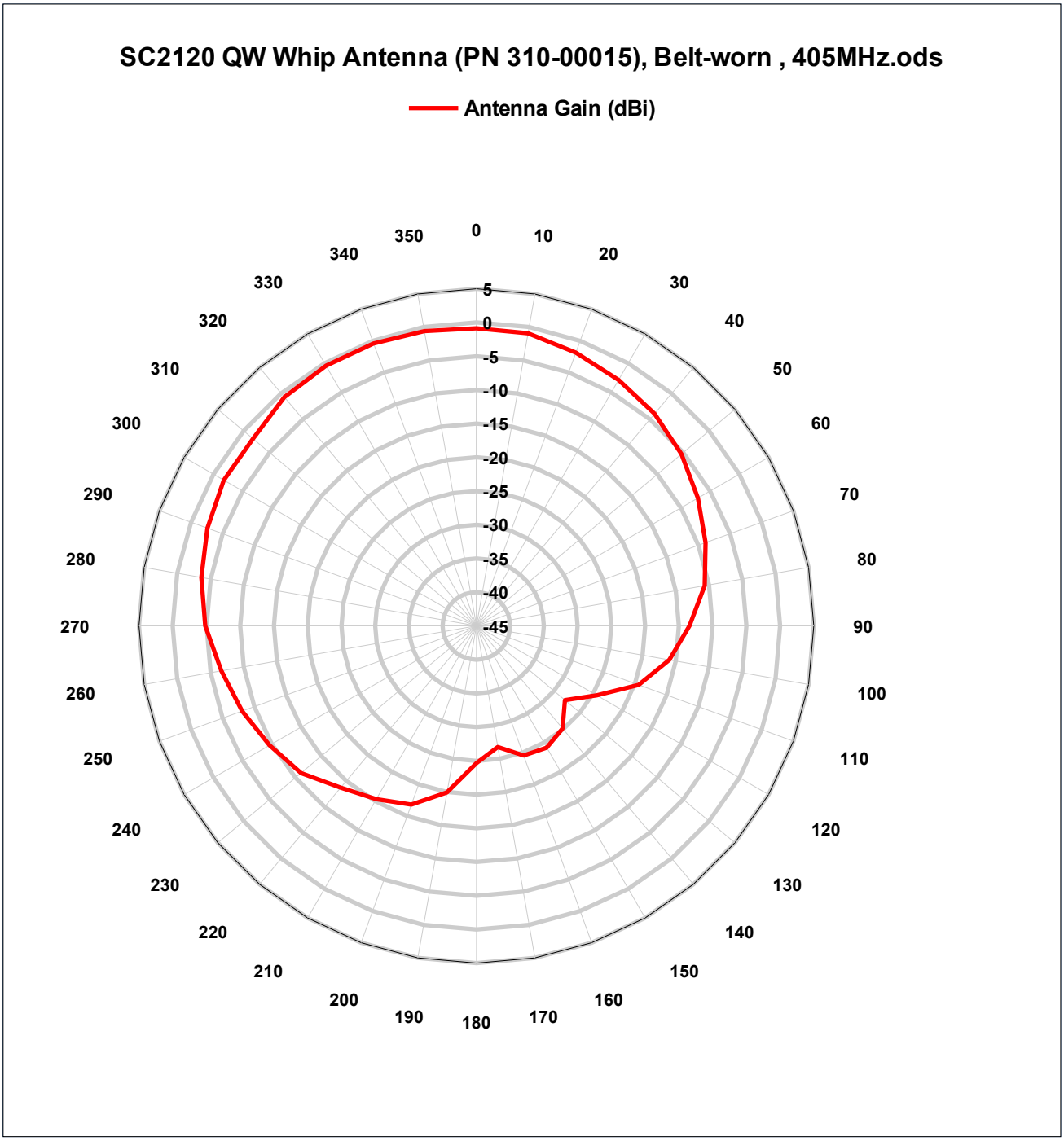
	MAX	MIN	AVG
Antenna Gain (dBi)	1.41	-14.16	-2.47



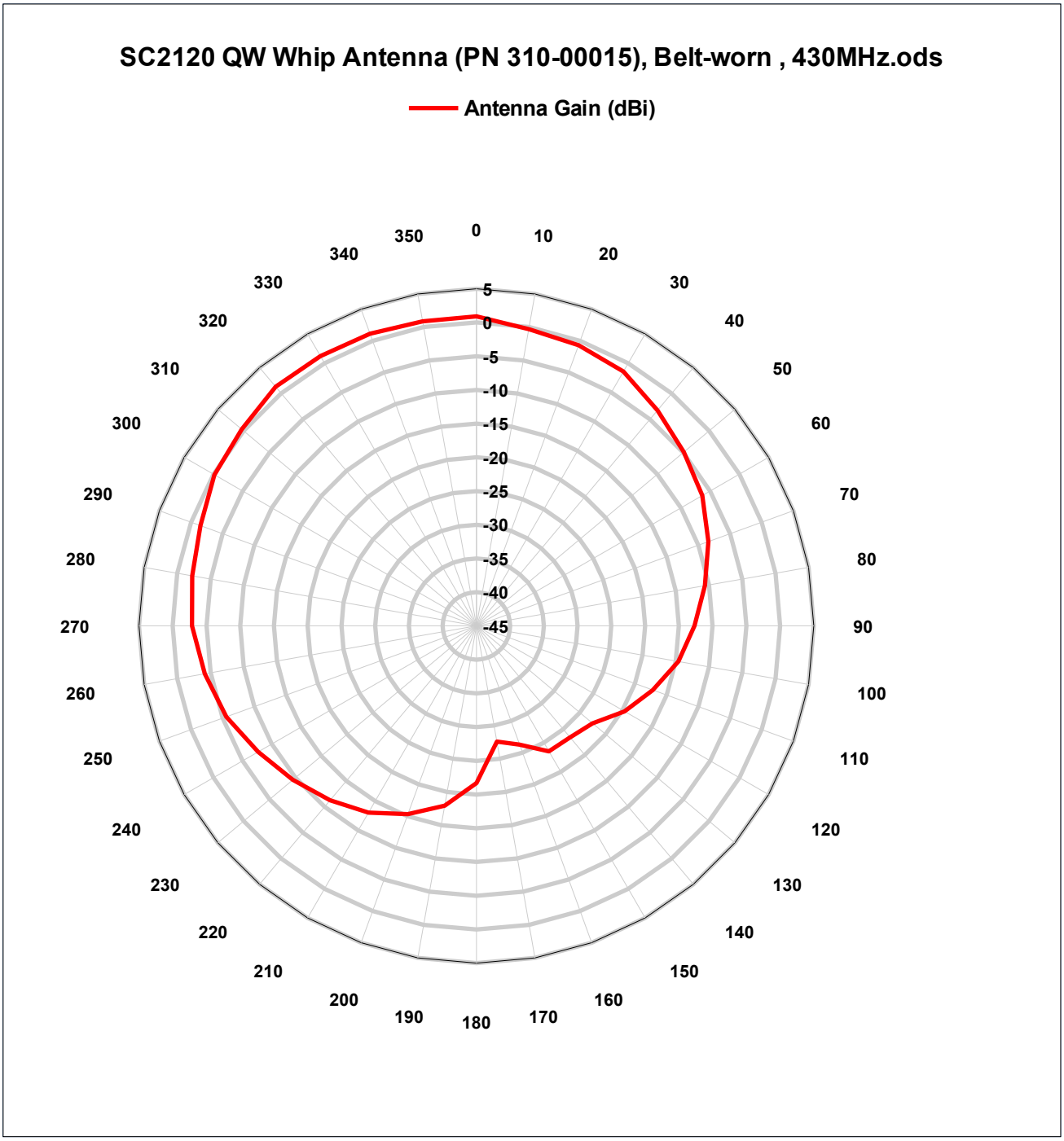
	MAX	MIN	AVG
Antenna Gain (dBi)	2.87	-13.64	-1.39



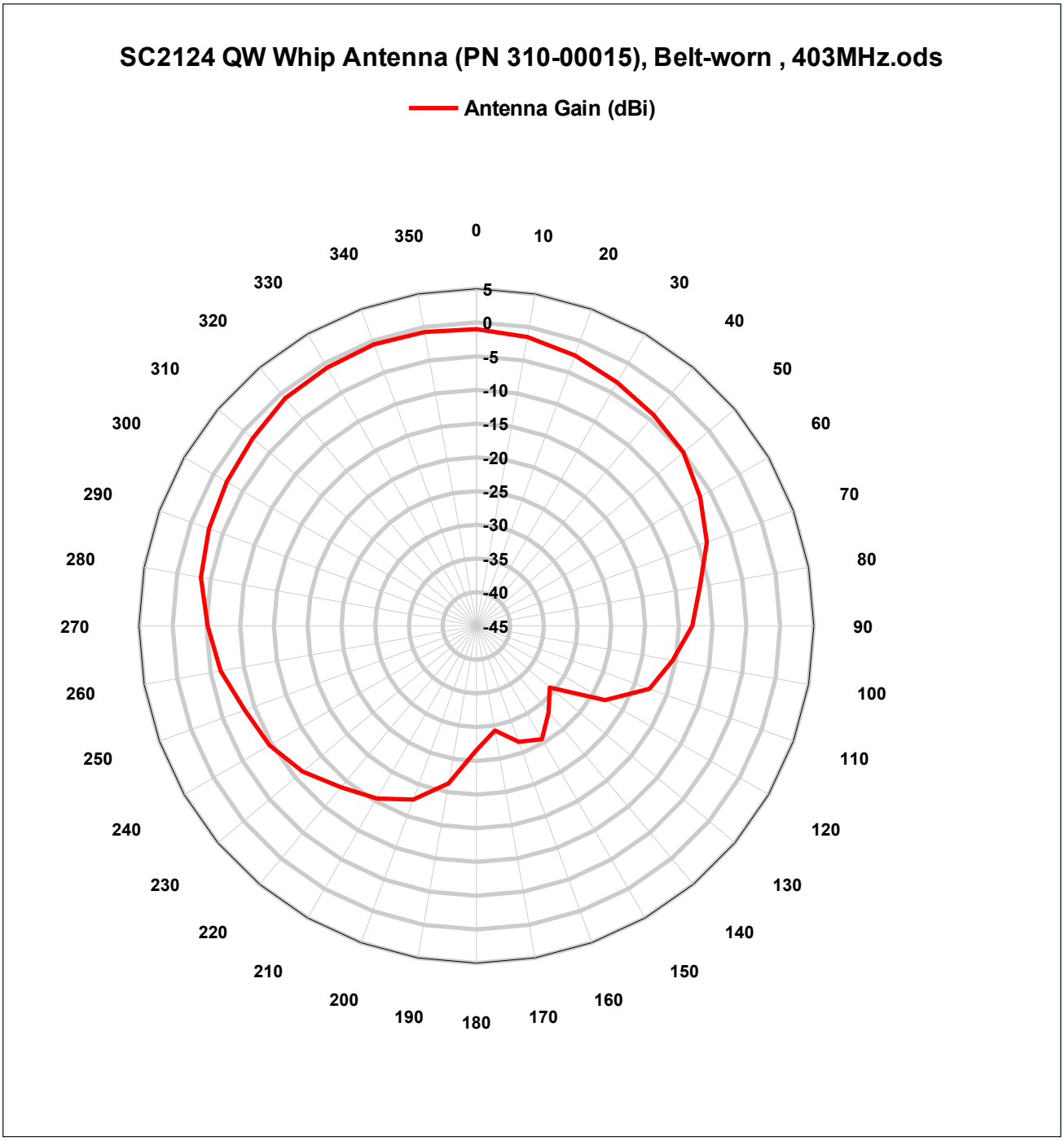
	MAX	MIN	AVG
Antenna Gain (dBi)	-0.70	-32.43	-5.70



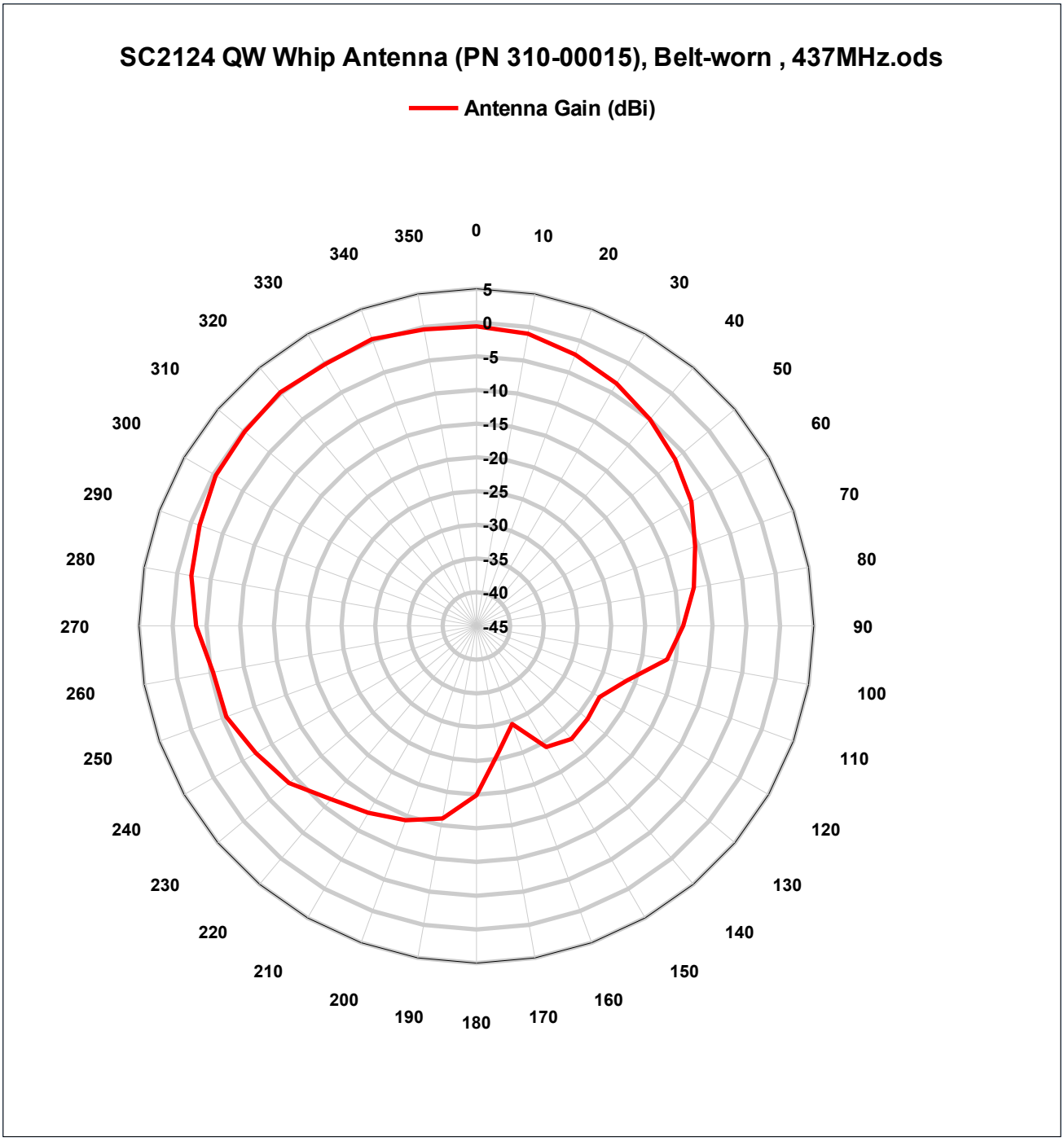
	MAX	MIN	AVG
Antenna Gain (dBi)	-0.41	-27.87	-5.21



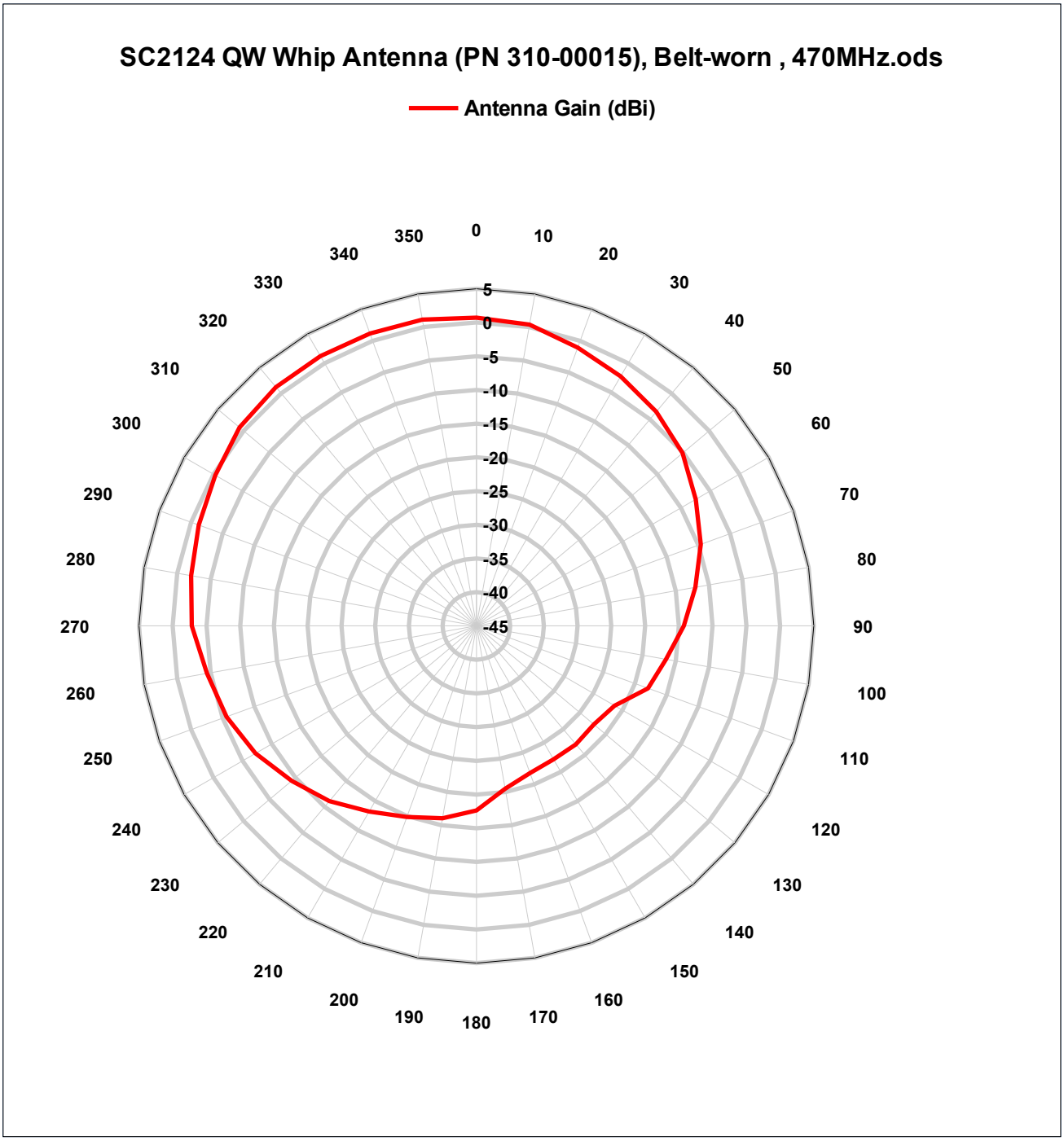
	MAX	MIN	AVG
Antenna Gain (dBi)	1.29	-27.57	-3.71



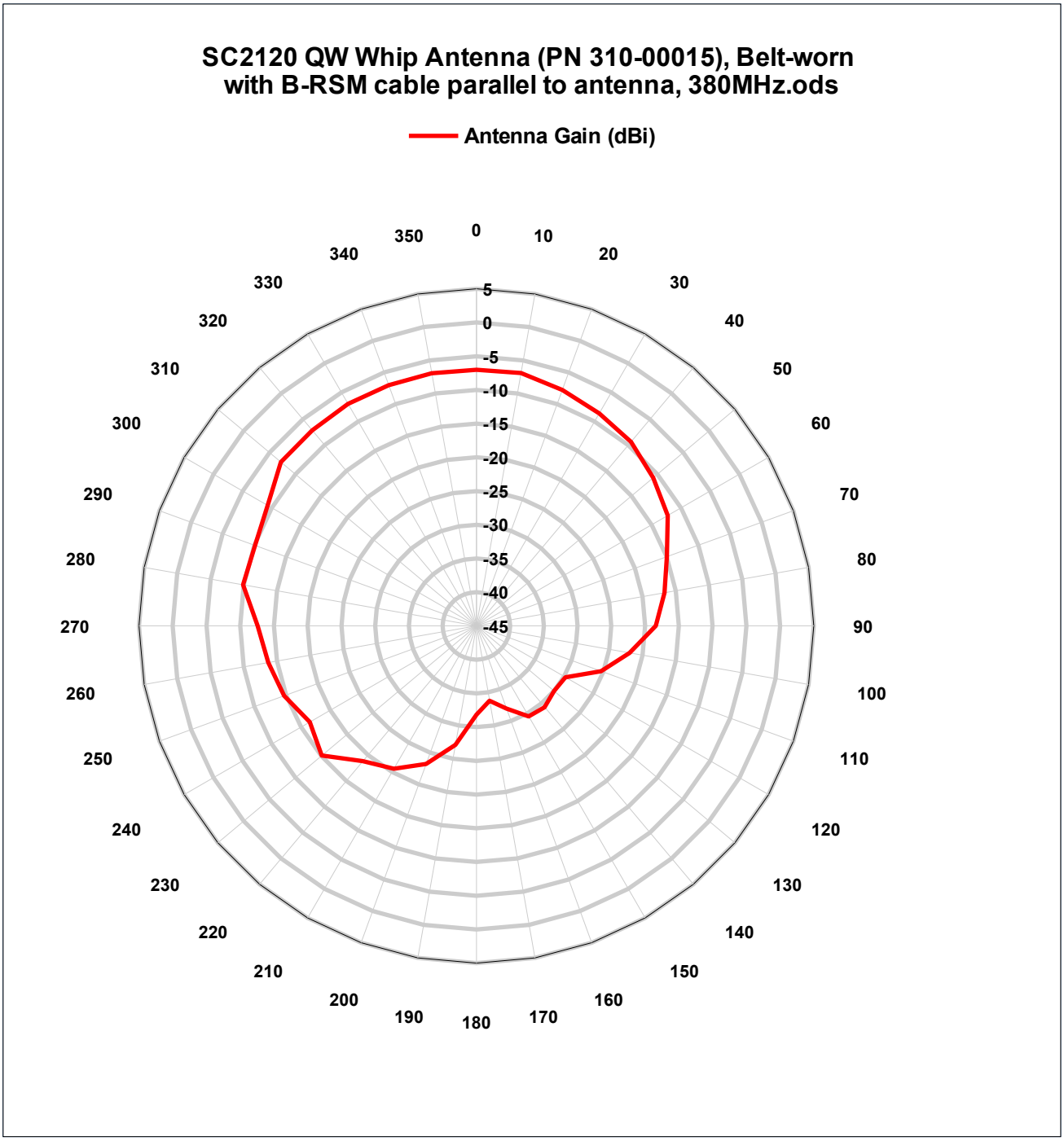
	MAX	MIN	AVG
Antenna Gain (dBi)	-0.57	-30.81	-5.41



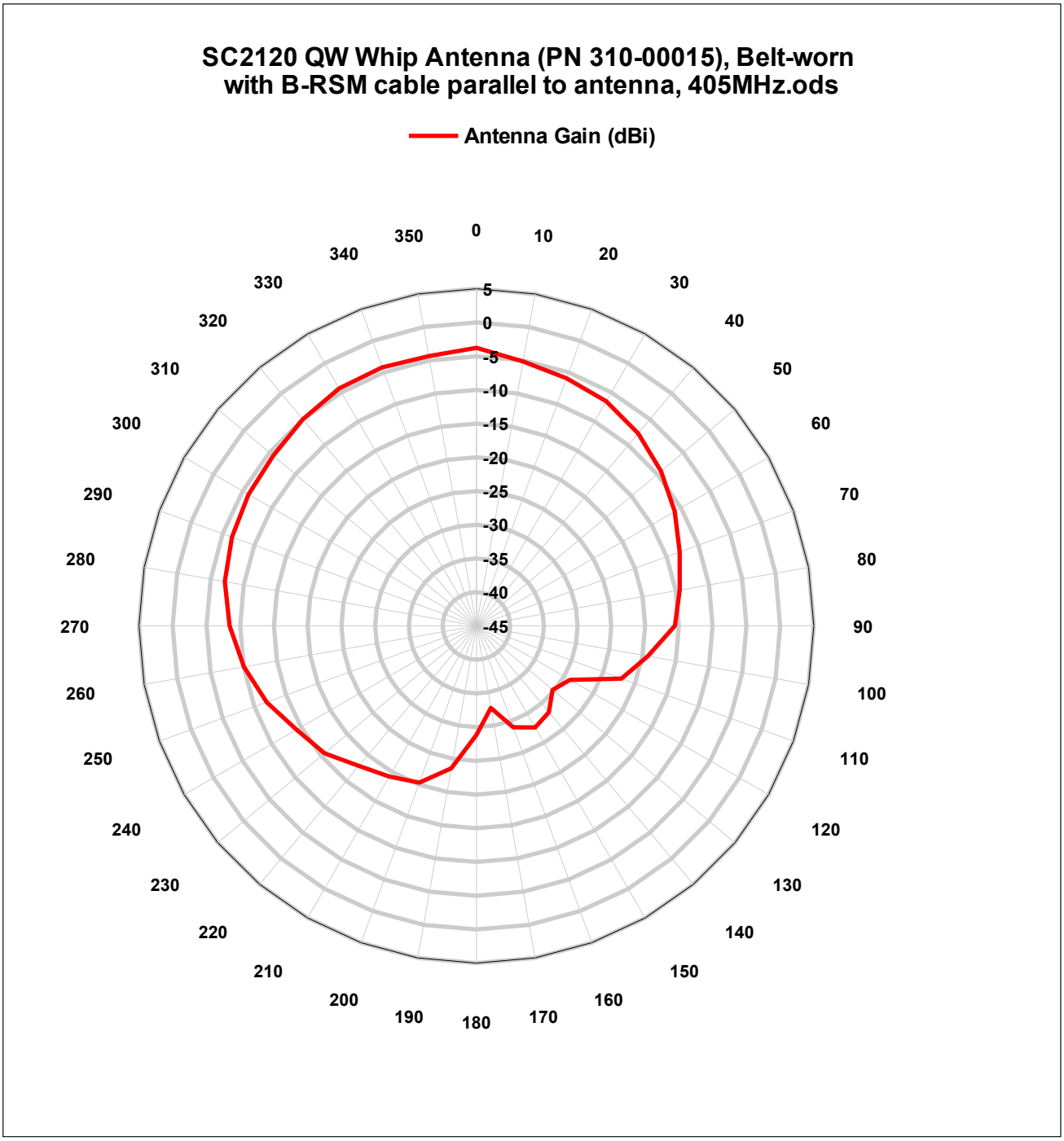
	MAX	MIN	AVG
Antenna Gain (dBi)	0.25	-29.53	-4.62



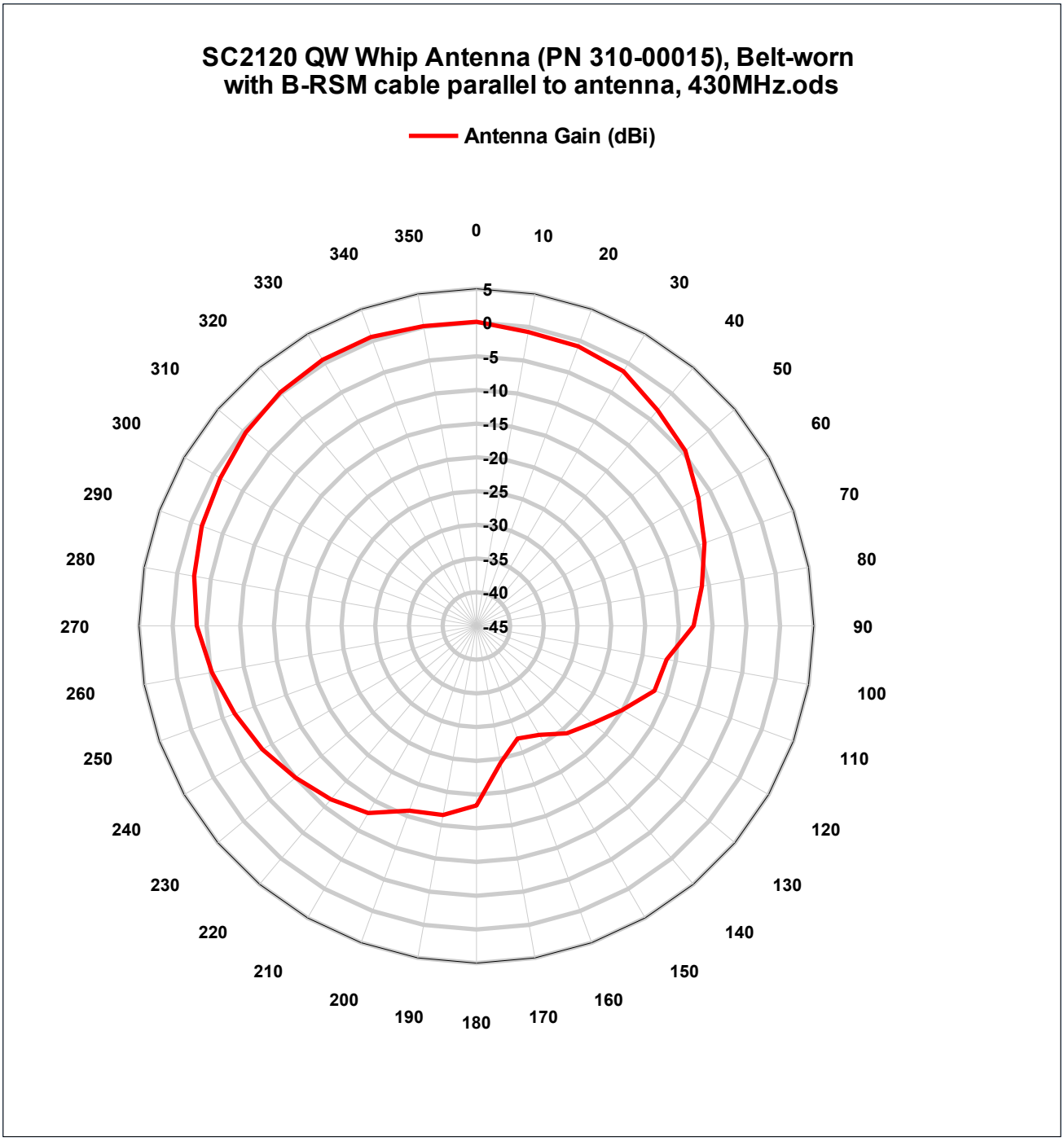
	MAX	MIN	AVG
Antenna Gain (dBi)	1.24	-22.29	-3.71



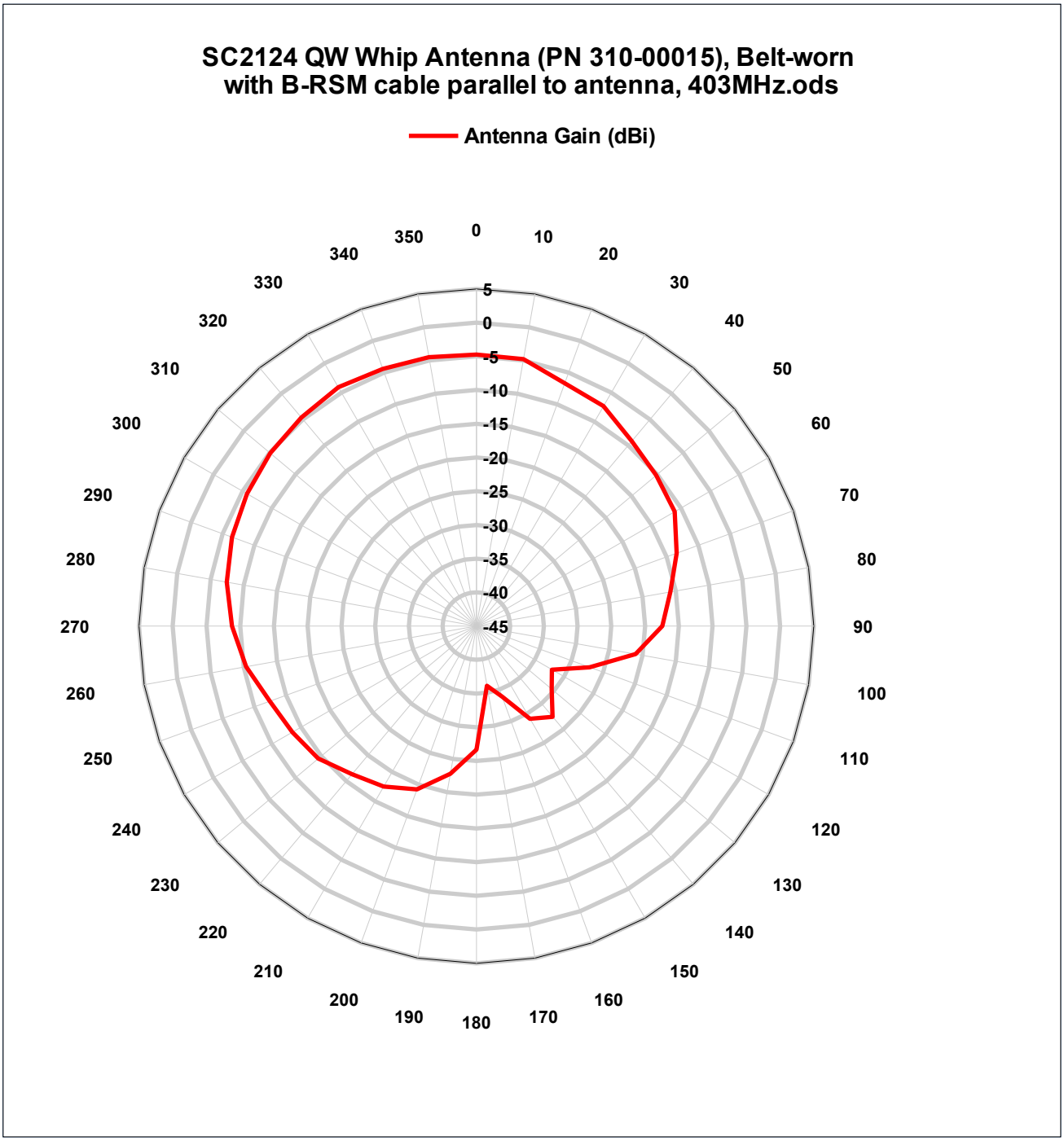
	MAX	MIN	AVG
Antenna Gain (dBi)	-6.92	-33.75	-11.47



	MAX	MIN	AVG
Antenna Gain (dBi)	-3.75	-32.66	-9.03



	MAX	MIN	AVG
Antenna Gain (dBi)	0.62	-27.21	-4.28



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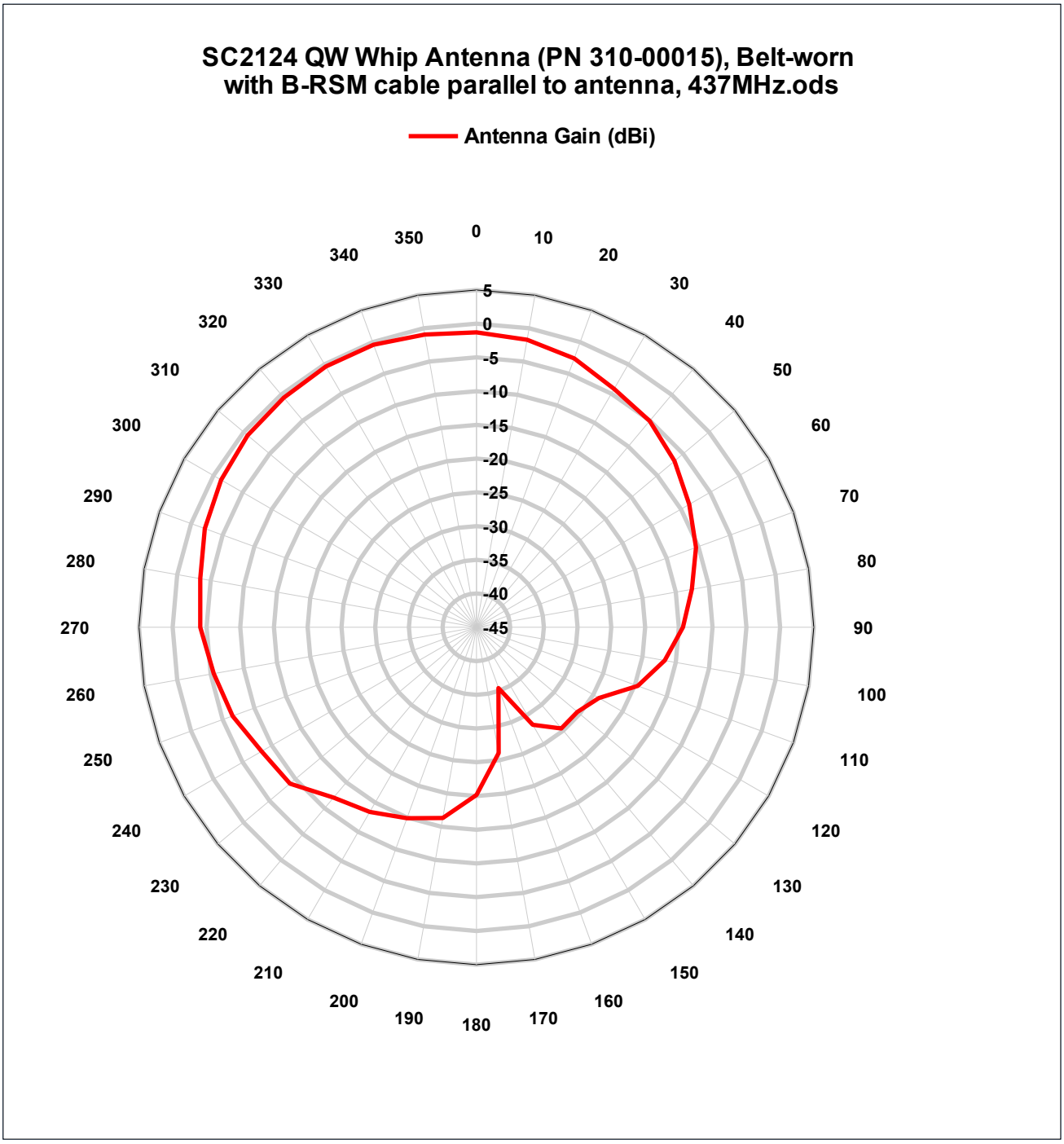
Antenna Gain (dBi)	-4.10	-36.00	-9.21



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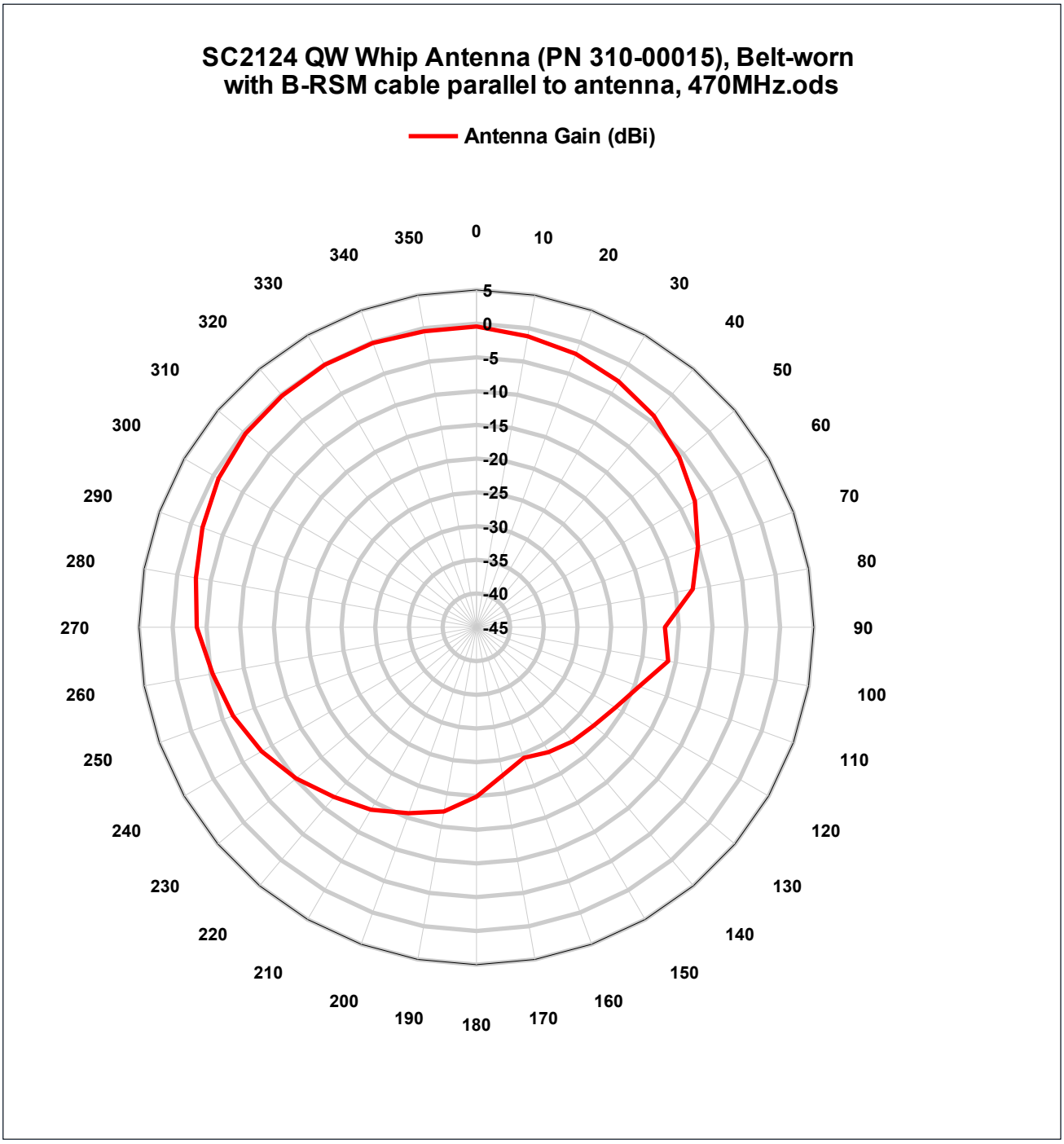
Antenna Gain (dBi)	-0.36	-35.42	-5.26



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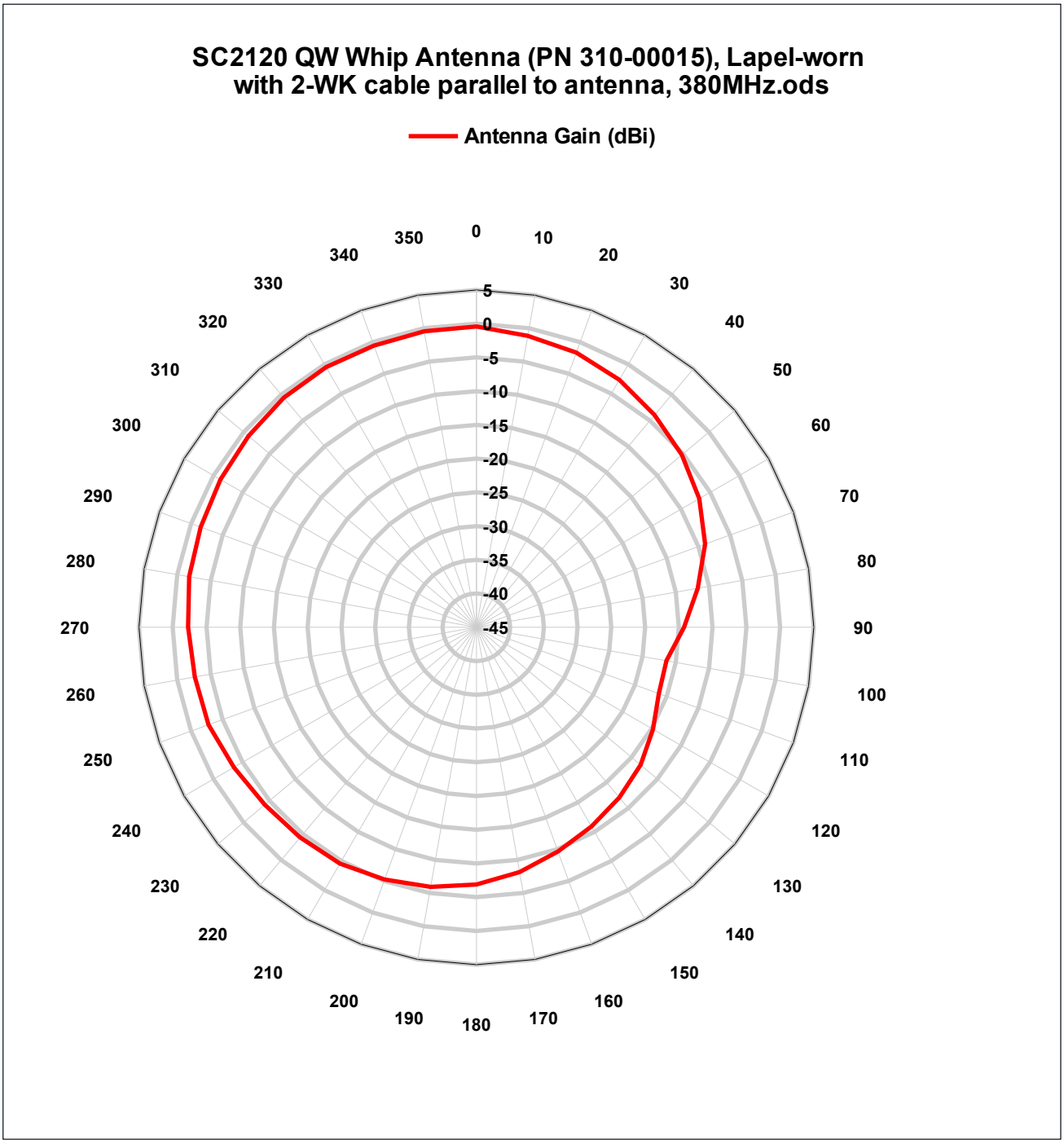
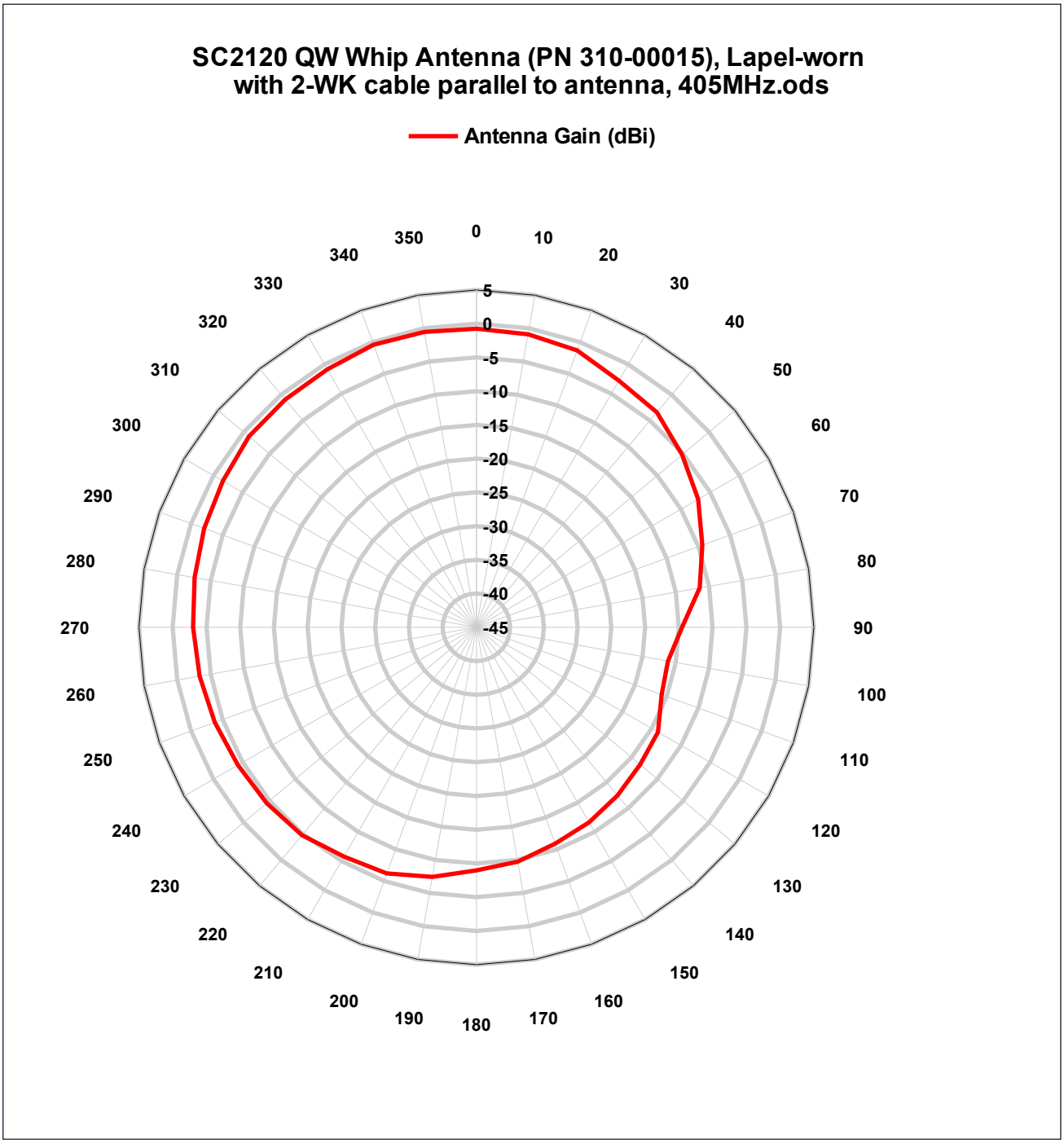
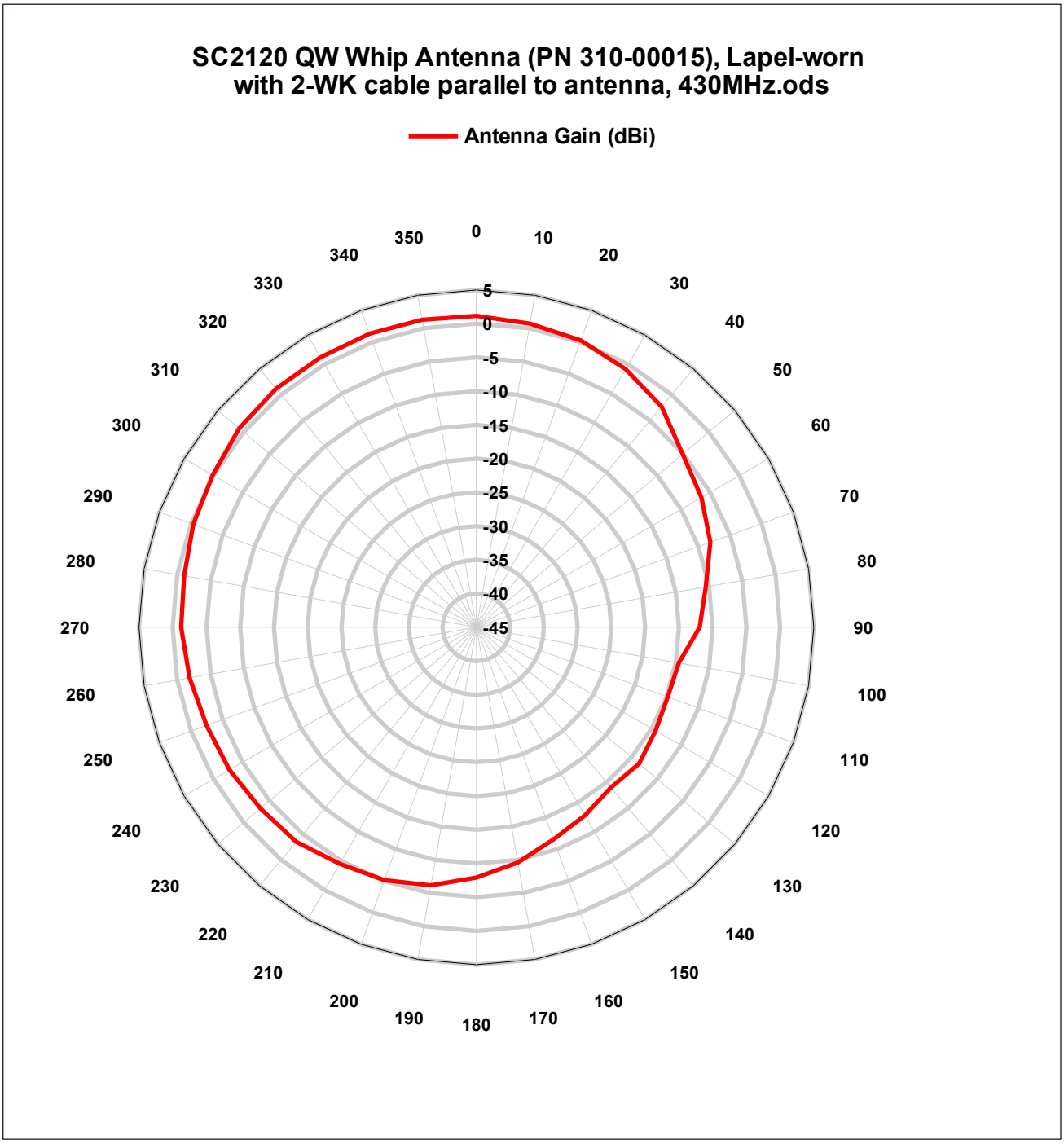
Antenna Gain (dBi)	-0.07	-24.41	-4.77



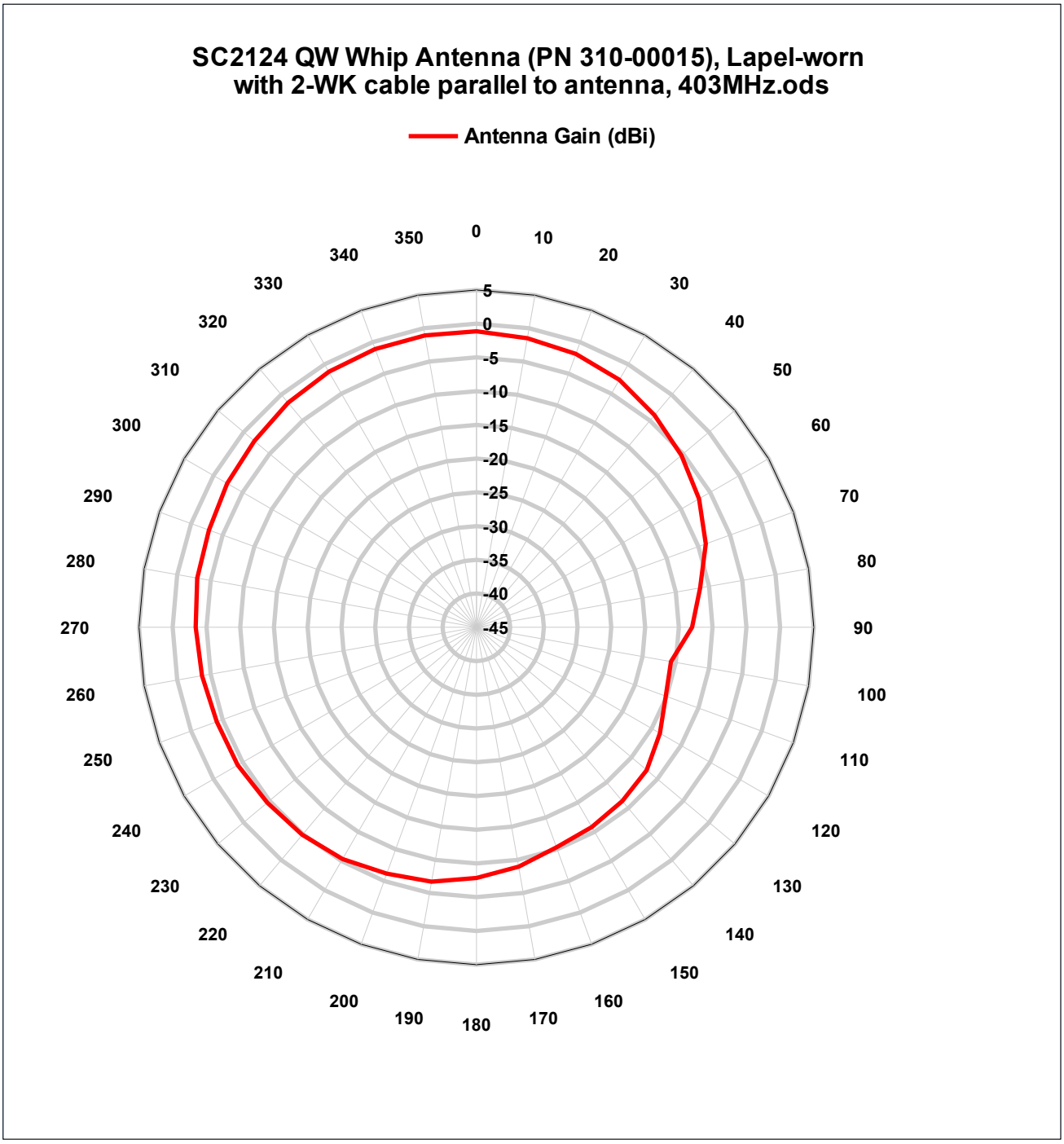
	MAX	MIN	AVG
Antenna Gain (dBi)	-0.42	-16.40	-3.79



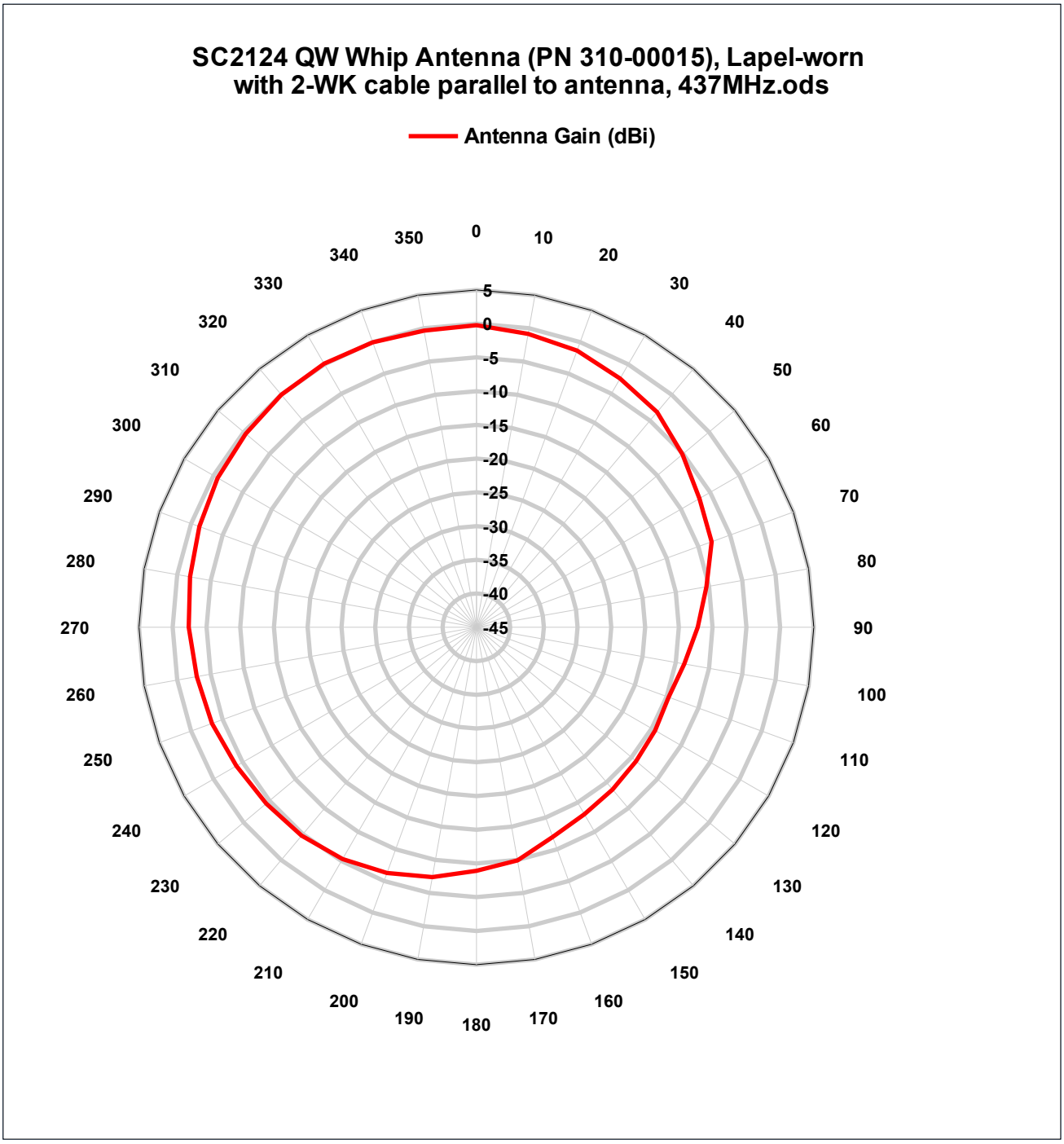
	MAX	MIN	AVG
Antenna Gain (dBi)	-0.43	-16.18	-4.13



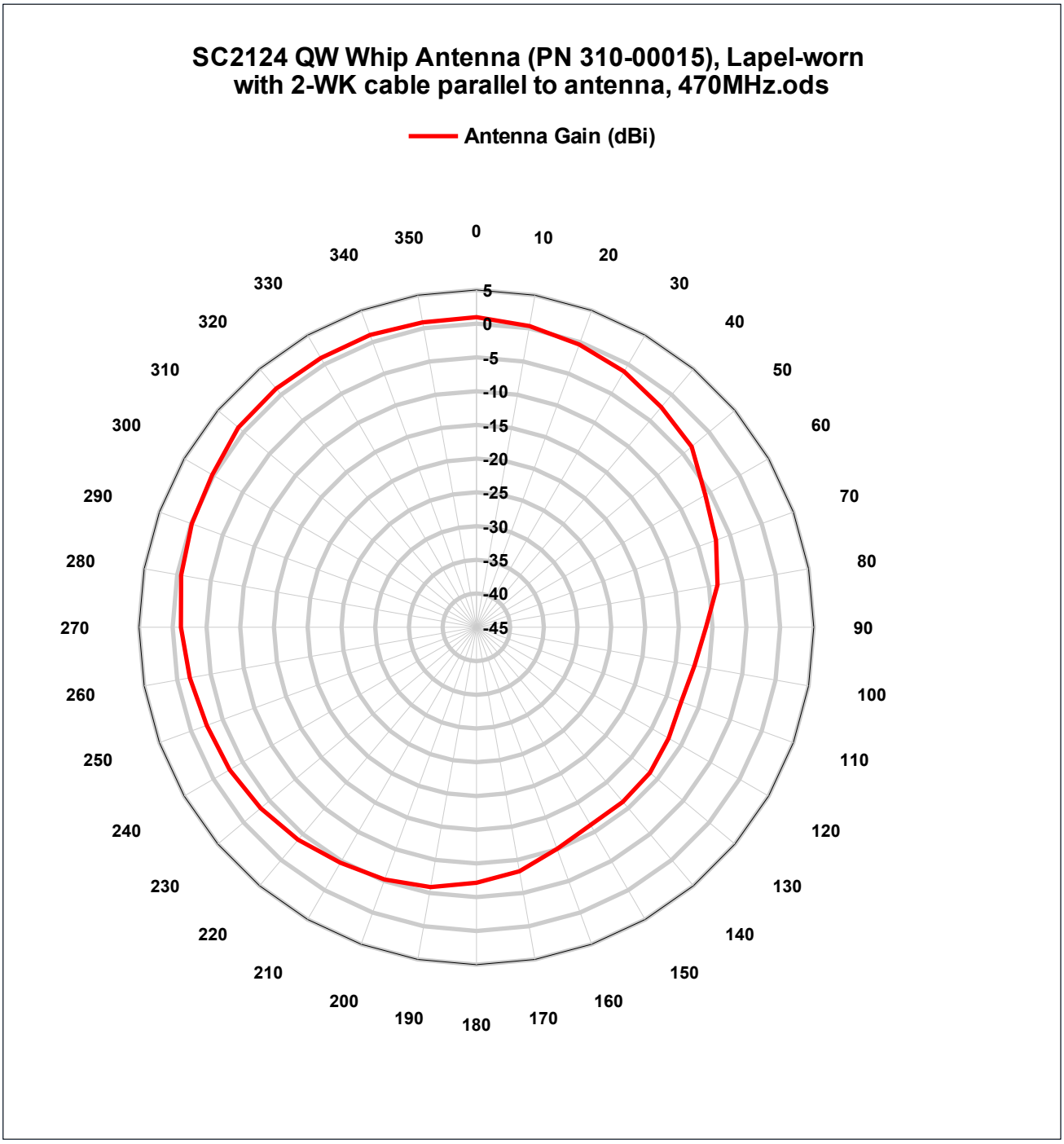
	MAX	MIN	AVG
Antenna Gain (dBi)	1.31	-14.81	-2.55



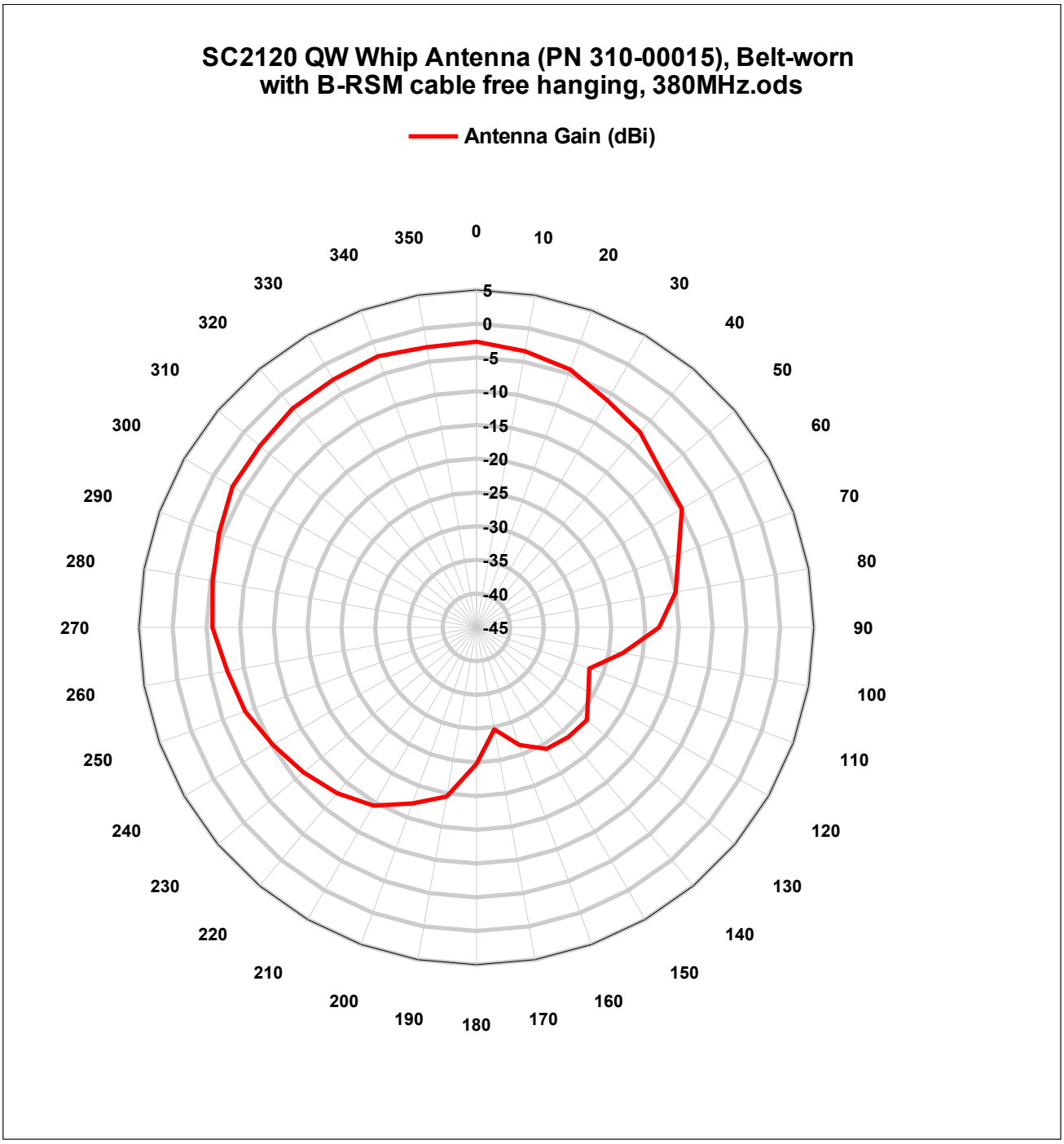
	MAX	MIN	AVG
Antenna Gain (dBi)	-1.08	-15.72	-4.48



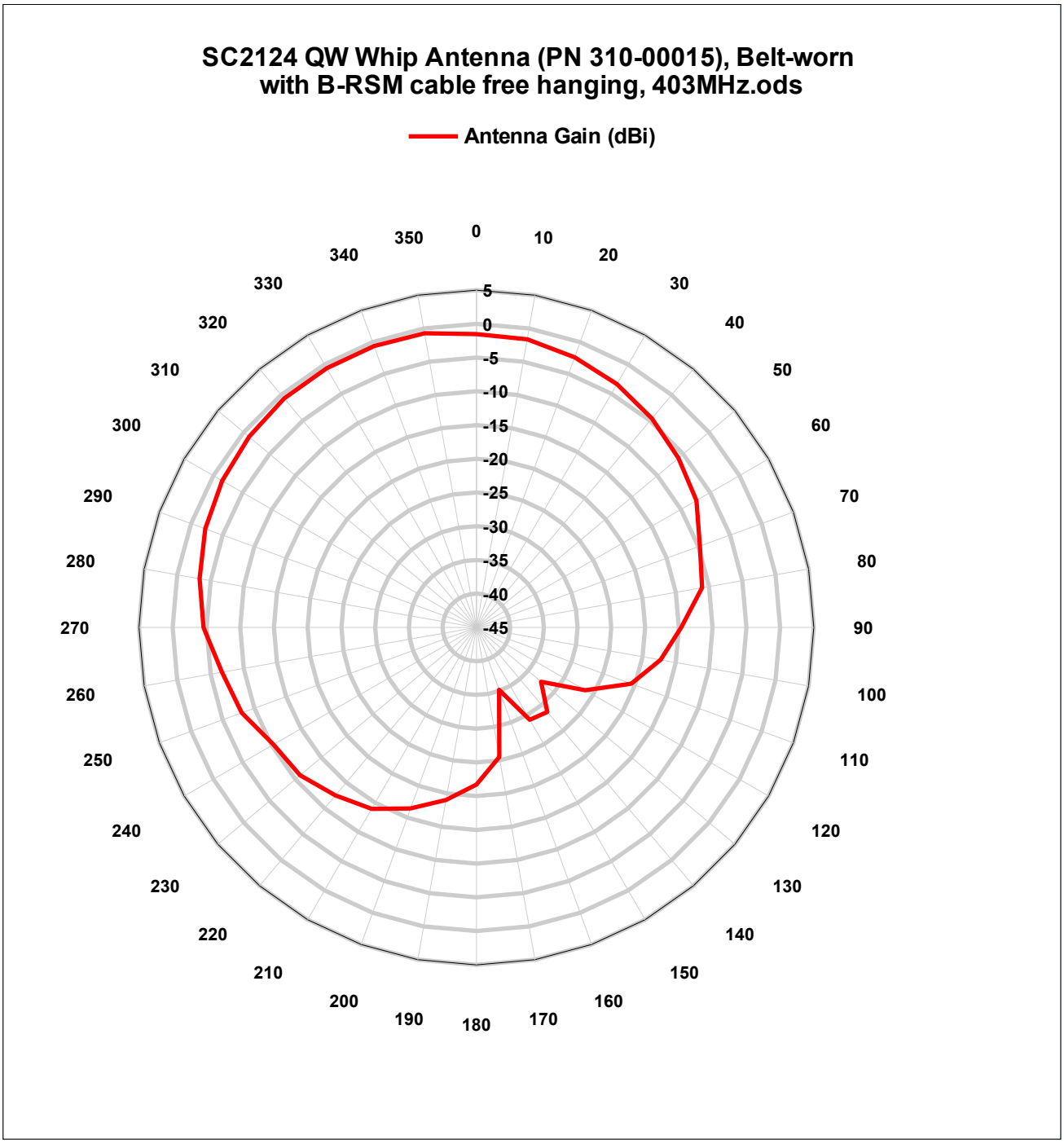
	MAX	MIN	AVG
Antenna Gain (dBi)	0.12	-14.70	-3.70



	MAX	MIN	AVG
Antenna Gain (dBi)	1.16	-12.70	-2.53



	MAX	MIN	AVG
Antenna Gain (dBi)	-2.24	-29.65	-7.22



	MAX	MIN	AVG
Antenna Gain (dBi)	-0.63	-35.17	-5.36

Photos

The following pages show various photographs taken during the testing.

Photo 1: SC2120 Free space

Photo 2: SC2120 Free space : position of table

Photo 3: SC2120 Free space : OATS 10m site

Photo 4: SC2120 Lapel-worn

Photo 5: SC2120 Belt worn

Photo 6: SC2120 Belt-worn with B-RSM cable parallel to antenna

Photo 7: SC2124 Belt-worn with B-RSM cable parallel to antenna

Photo 8: SC2120 Lapel-worn with 2-WK cable parallel to antenna

Photo 9: SC2120 Belt-worn with B-RSM cable free hanging