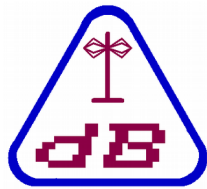


	File:	R000573_V01	
		Test Report	Page 1 of 47



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

	File:	R000573_V01	
		Test Report	Page 2 of 47

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:

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.....	4
2 General Information.....	4
2.1 Product Name and Contact Details.....	4
2.2 Product Description.....	4
2.2.1 UUT Details.....	5
2.2.2 Body Positions.....	5
2.3 Gain Correction Factors.....	6
2.3.1 Method.....	6
2.3.2 Substitution Measurements.....	6
2.3.3 Derivation of Correction Factors.....	6
2.3.4 Results.....	7
2.3.5 Test Equipment.....	7
2.4 Radiation Patterns.....	8
2.4.1 Method.....	8
2.4.2 Test Equipment.....	8
2.4.3 Plots.....	9
Photos.....	42
Photo 1: SC2120 Free space.....	43
Photo 2: SC2120 Free space : position of table.....	43
Photo 3: SC2120 Free space : OATS 10m site.....	44
Photo 4: SC2120 Lapel-worn.....	44
Photo 5: SC2120 Belt worn.....	45
Photo 6: SC2120 Belt-worn with B-RSM cable parallel to antenna.....	45
Photo 7: SC2124 Belt-worn with B-RSM cable parallel to antenna.....	46
Photo 8: SC2120 Lapel-worn with 2-WK cable parallel to antenna.....	46
Photo 9: SC2120 Belt-worn with B-RSM cable free hanging.....	47

	File:	R000573_V01	
		Test Report	Page 4 of 47

1 Introduction

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

2 General Information

2.1 Product Name and Contact Details

<i>Product:</i>	SC21 Quarter-Wave Whip Antenna 380-470MHz (PN 310-00015)
<i>Company:</i>	Sepura PLC
<i>Representative:</i>	Ruben Selva
<i>Address:</i>	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.

	File:	R000573_V01	
		Test Report	Page 5 of 47

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.

	File:	R000573_V01	
		Test Report	Page 6 of 47

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) =

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

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:

$$\text{e.i.r.p. [cal_ant] (dBm) = Sig Applied[cal_ant] (dBm) + Gain[cal_ant] (dBi) (equation 2)}$$

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) =

$$\text{Sig Applied[cal_ant] (dBm) + Gain[cal_ant] (dBi) - Rx Reading [cal_ant] (dBuV)}$$

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) =

$$\begin{aligned} &\text{Sig Applied[cal_ant] (dBm) + Gain[cal_ant] (dBi) - Rx Reading [cal_ant] (dBuV)} \\ &\text{- Level at Connector Output[EUT] (dBm)} \end{aligned}$$

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 /	Marconi 6960A RF Power Meter	2785
PS2	sensors Power meters /	Marconi 6920 RF Power Sensor (-70dBm / -20dBm) 10MHz	112
	sensors	to 20GHz	
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

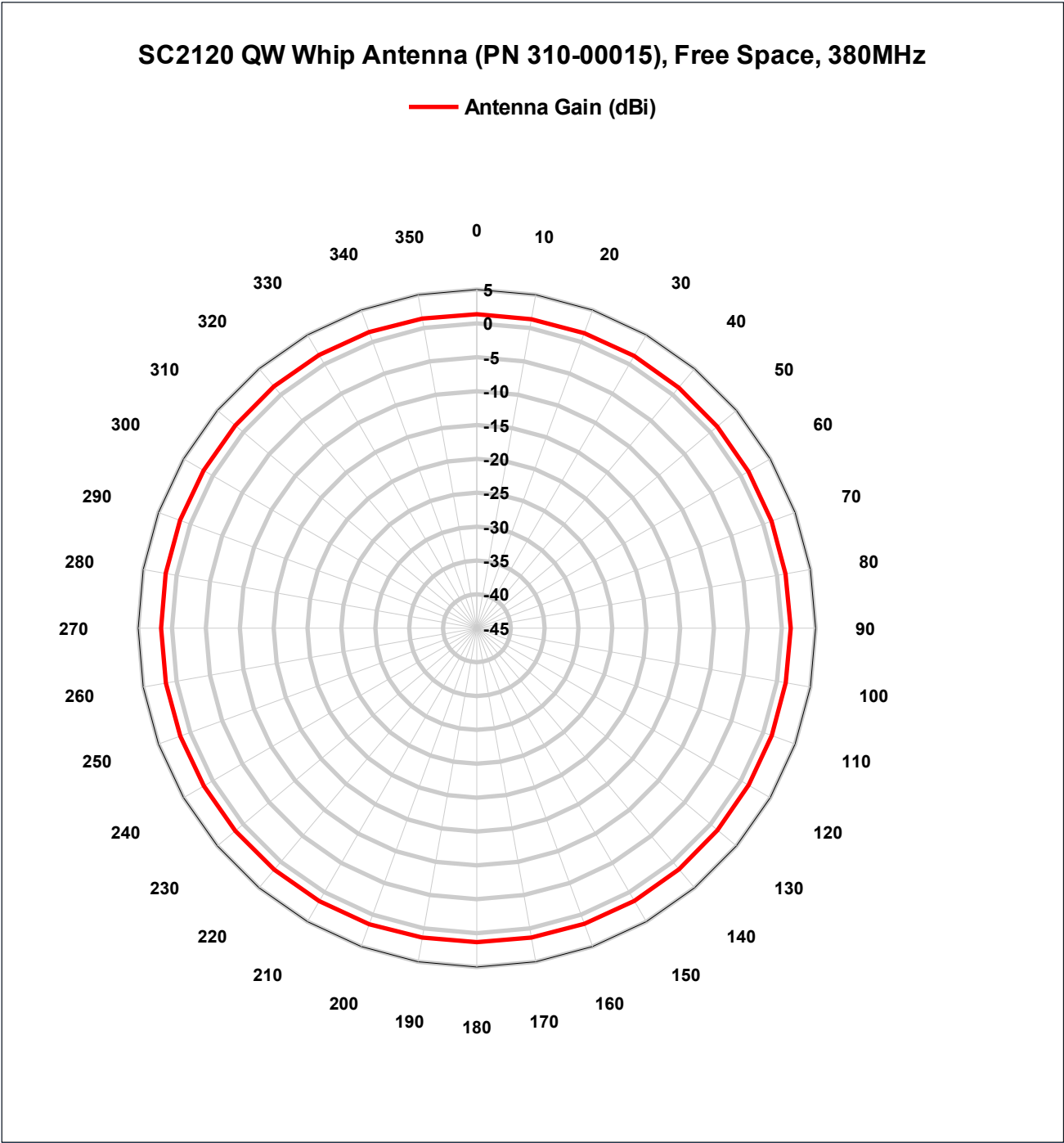
Test Equipment			
Ref:	Type:	Description:	S/N:
R4	Receiver	R&S ESVS10	843744/002
A38	Antenna	Schwarzbeck VULP 9118A Log Periodic	580
CBL134	Cable	RG214 - 25m N-N	CBL134

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

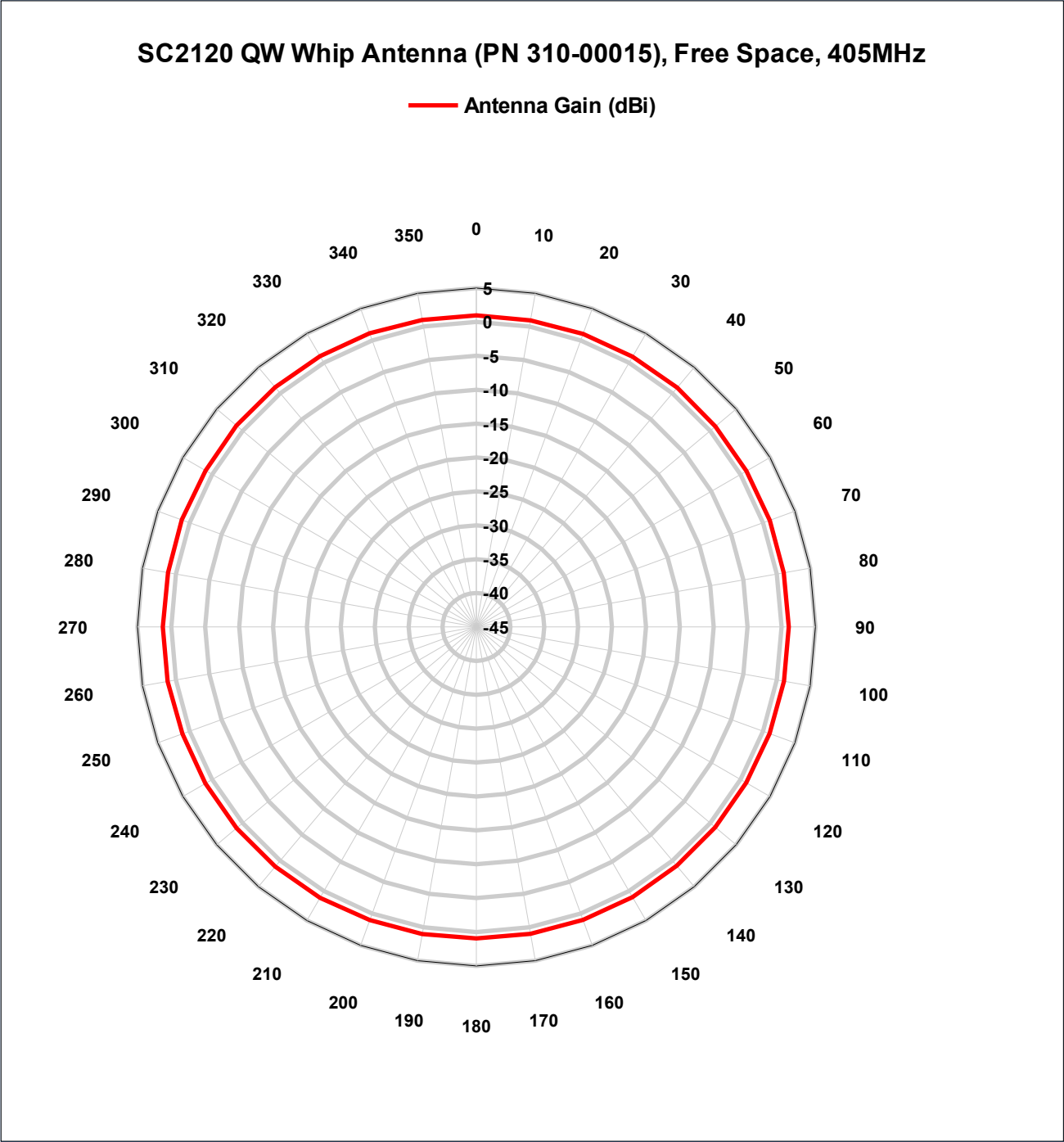
	File:	R000573_V01	
		Test Report	Page 9 of 47

2.4.3 Plots

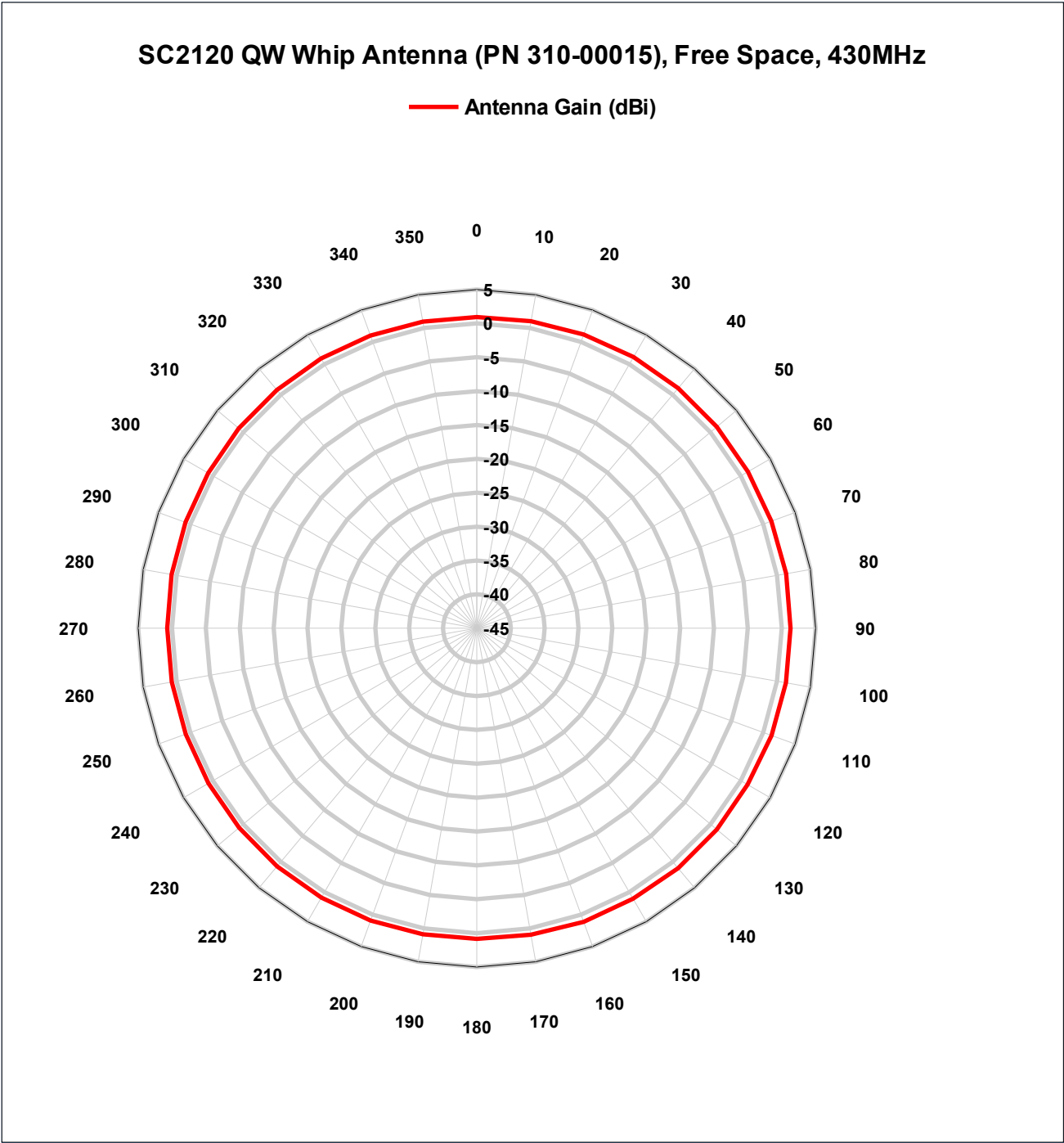
The following pages show plot results for the various antenna configurations.



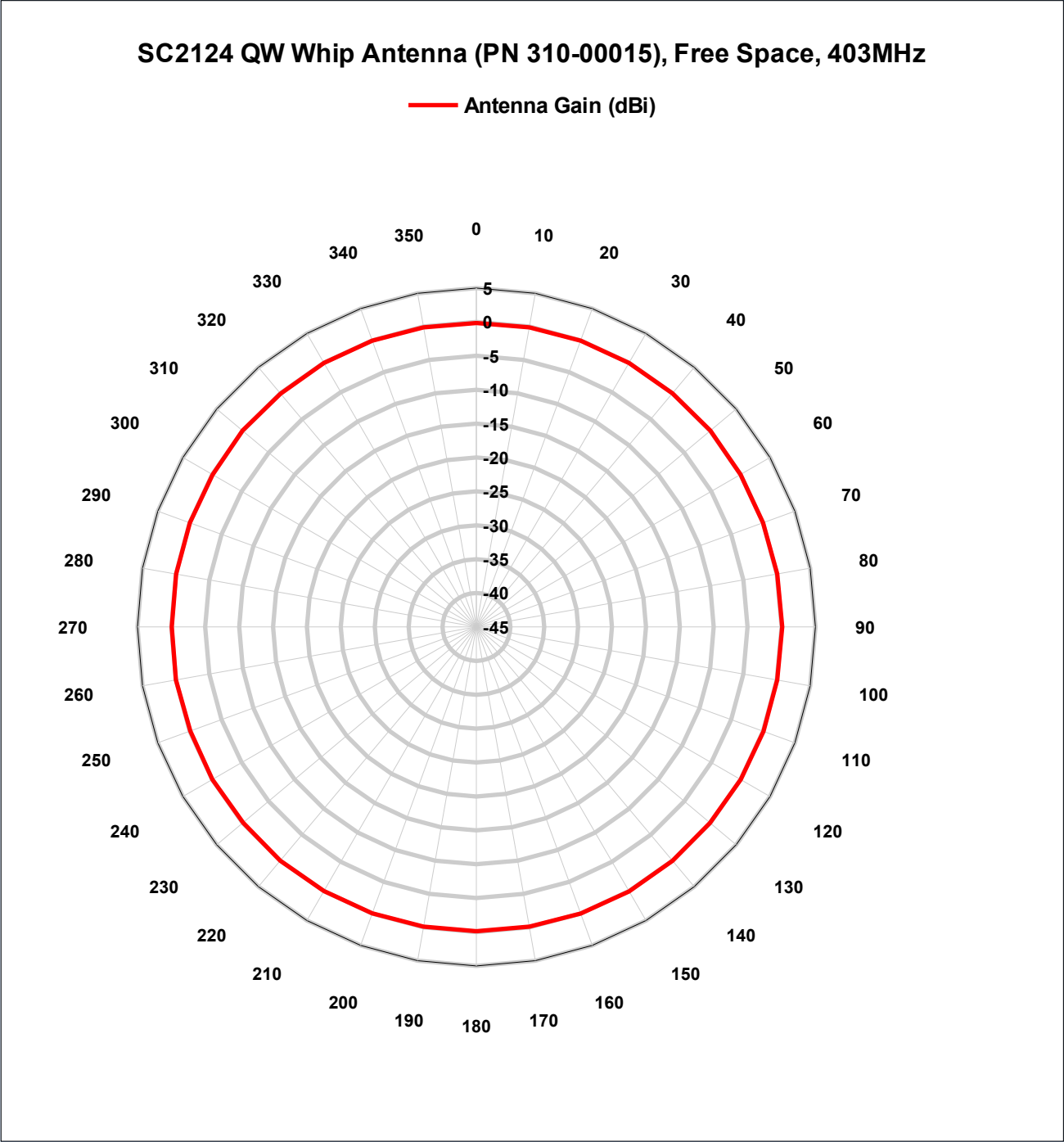
	MAX	MIN	AVG
Antenna Gain (dBi)	1.63	1.27	1.45



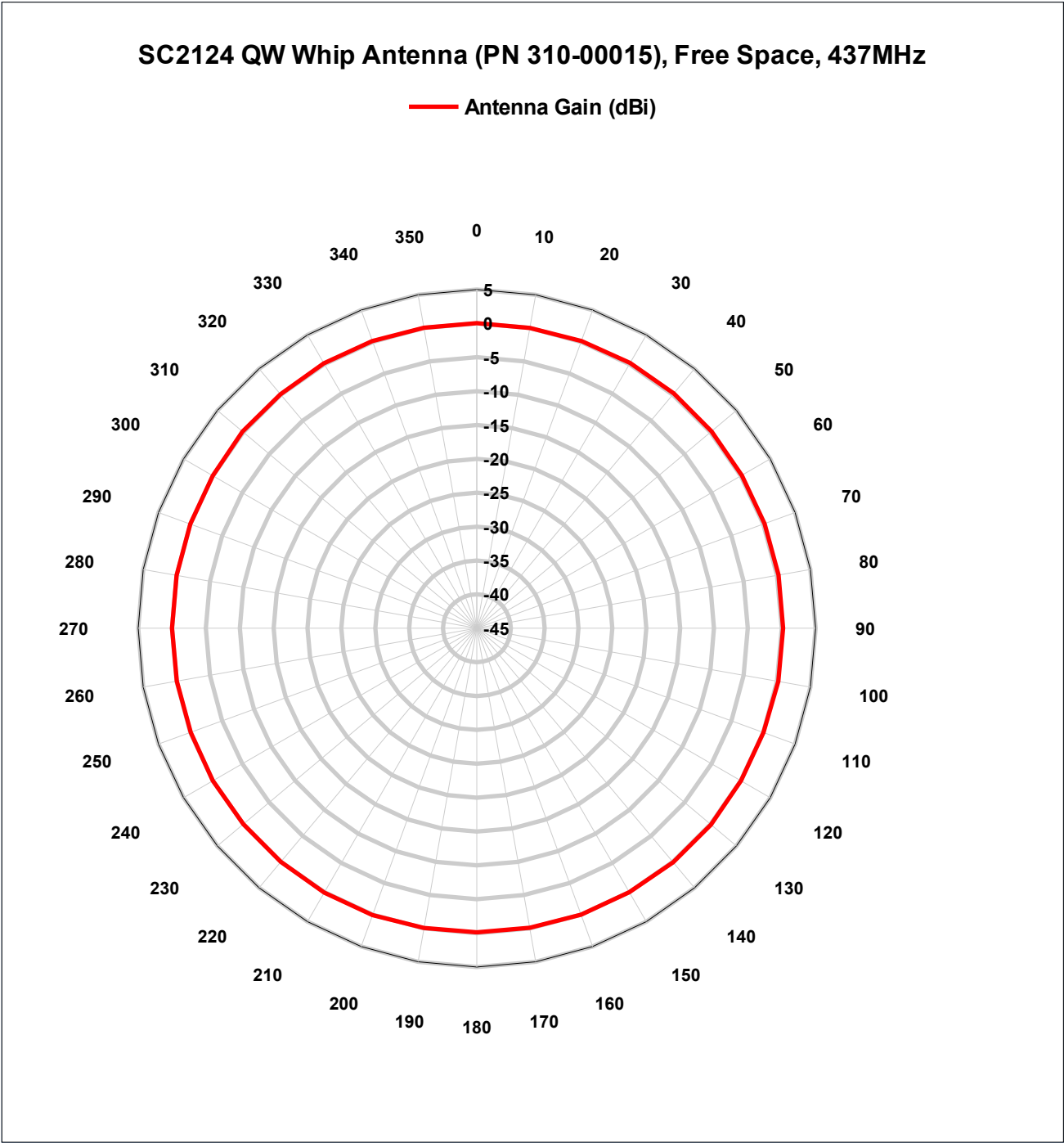
	MAX	MIN	AVG
Antenna Gain (dBi)	1.24	0.94	1.07



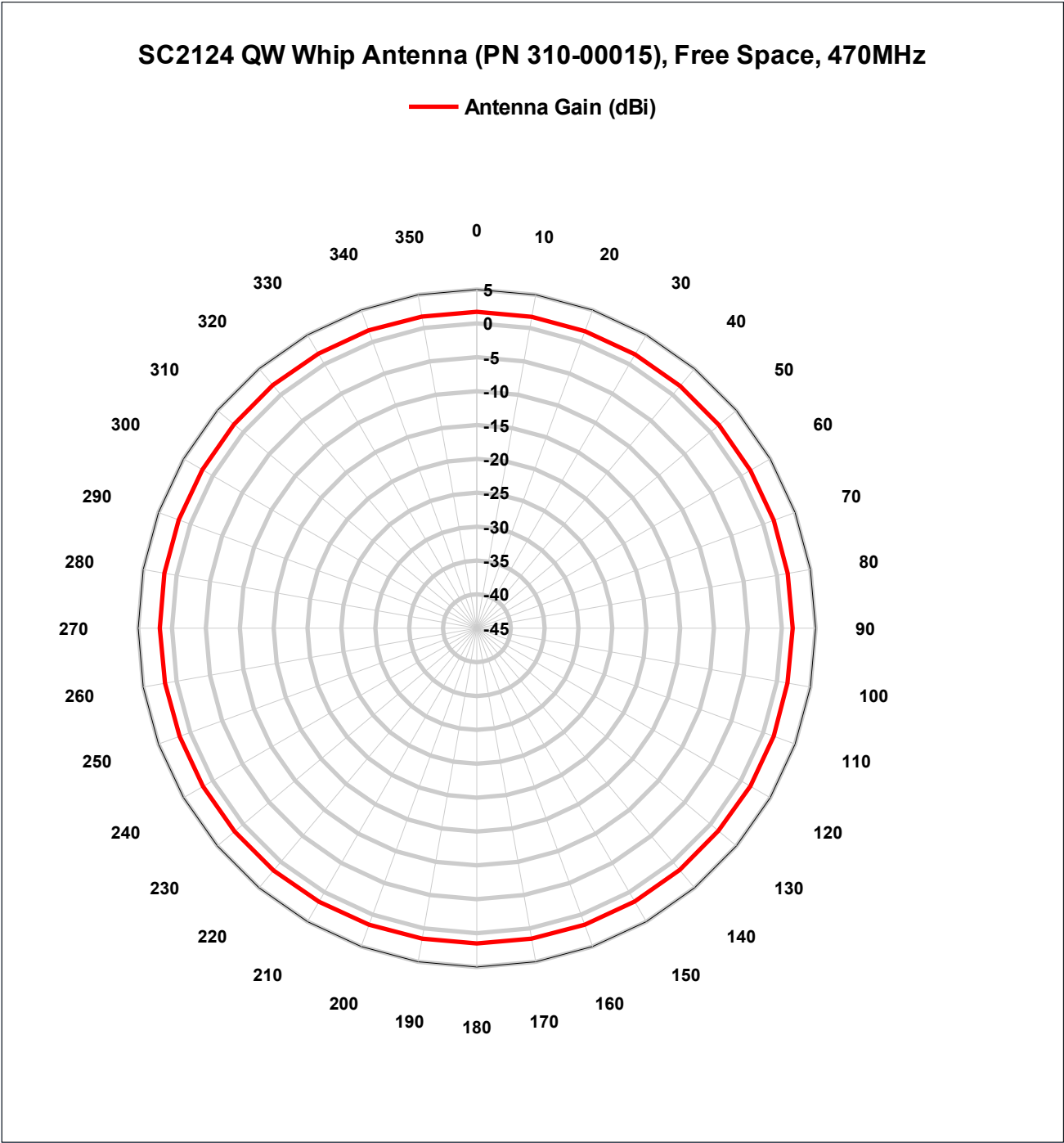
	MAX	MIN	AVG
Antenna Gain (dBi)	1.35	0.72	1.02



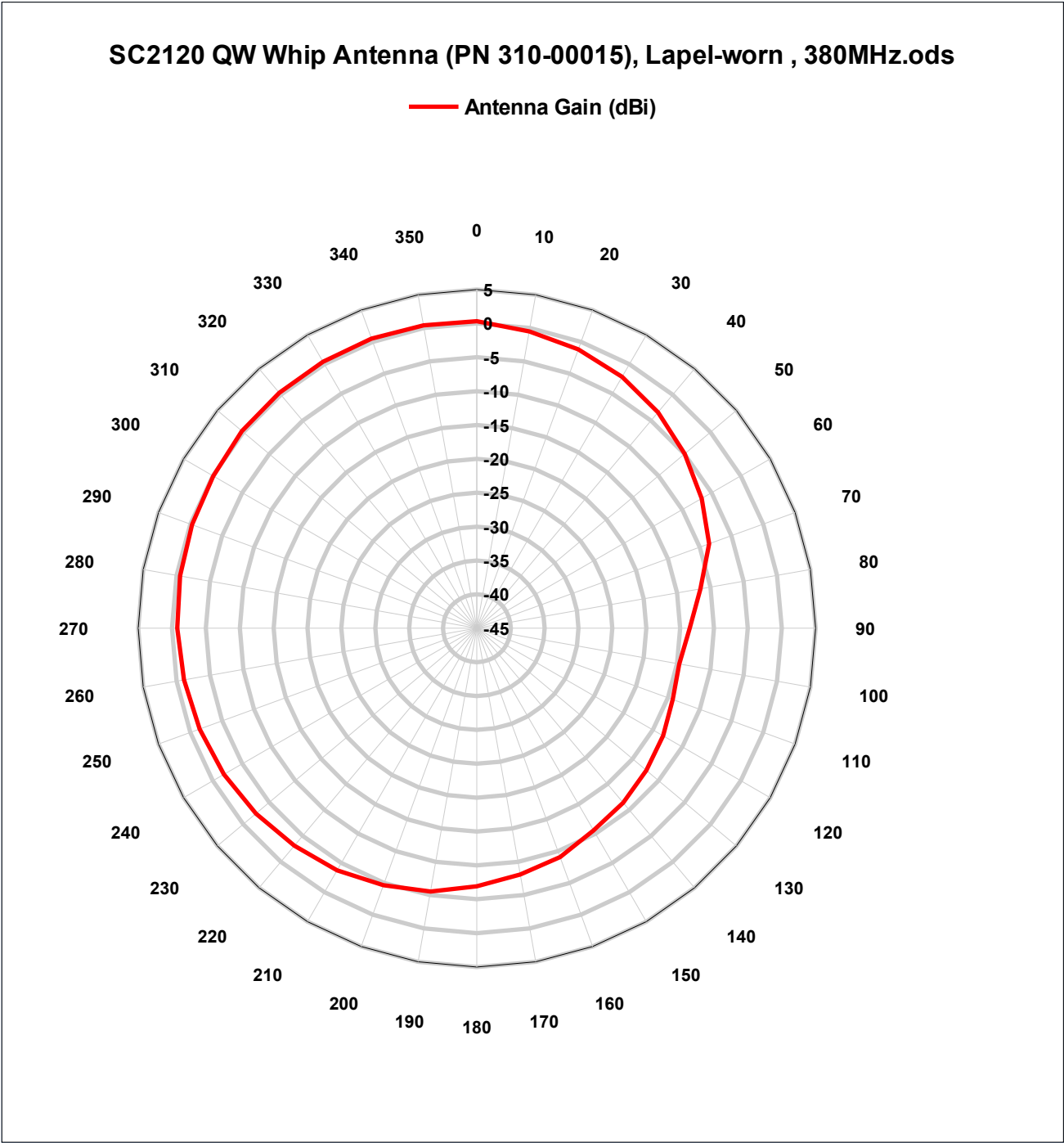
	MAX	MIN	AVG
Antenna Gain (dBi)	0.12	-0.15	-0.03



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

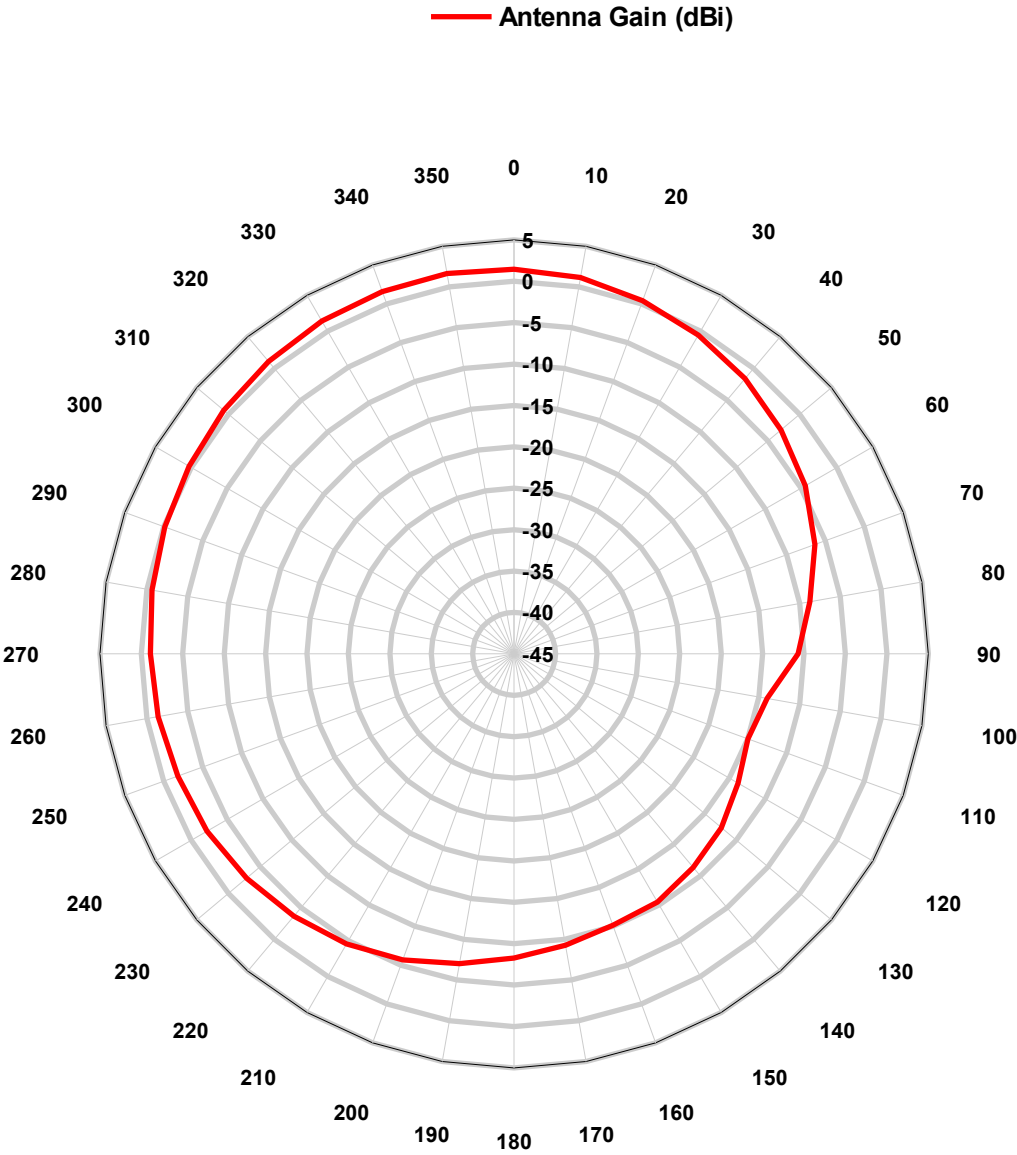


	MAX	MIN	AVG
Antenna Gain (dBi)	1.85	1.51	1.67



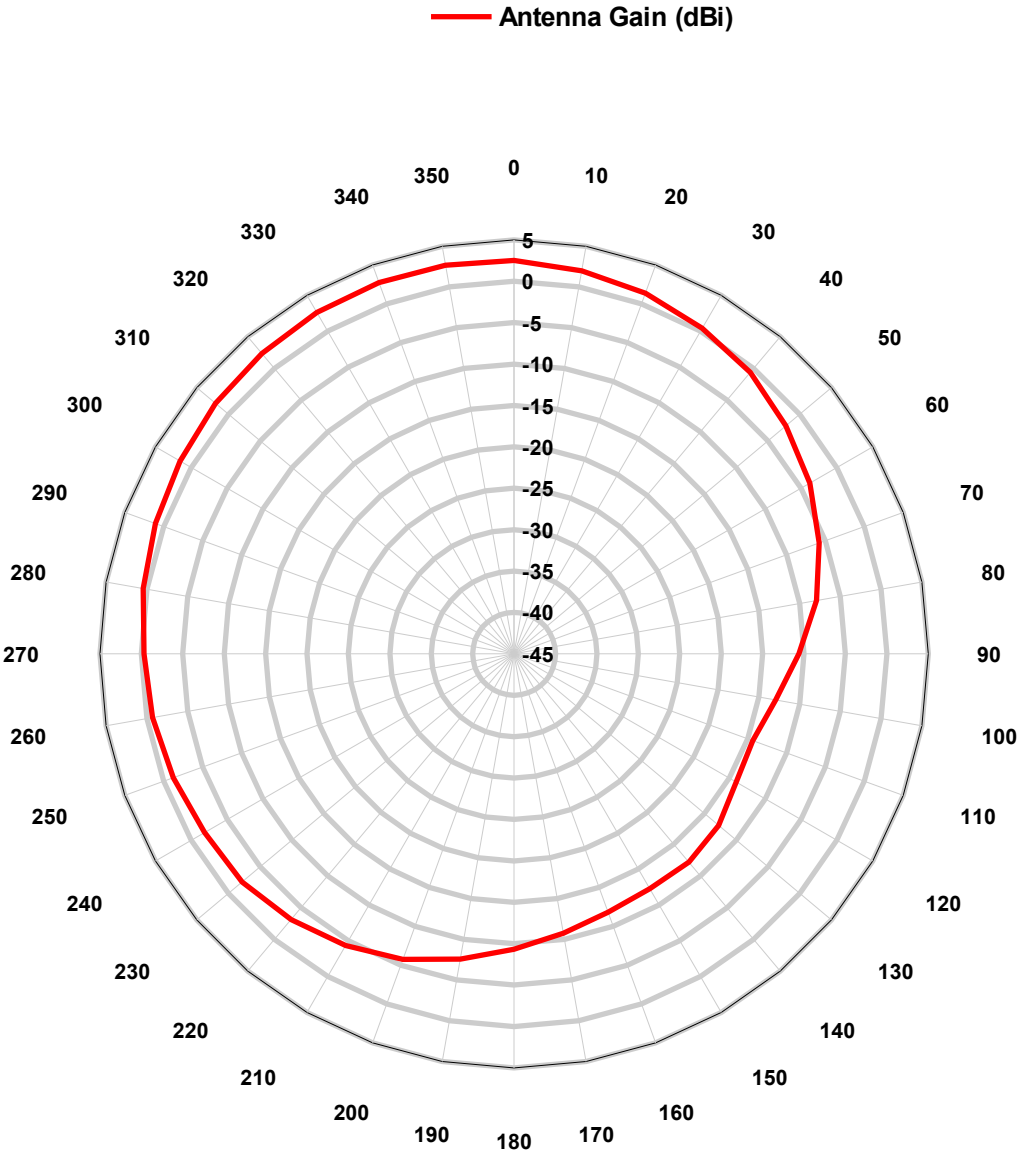
	MAX	MIN	AVG
Antenna Gain (dBi)	0.48	-14.67	-2.82

SC2120 QW Whip Antenna (PN 310-00015), Lapel-worn , 405MHz.ods



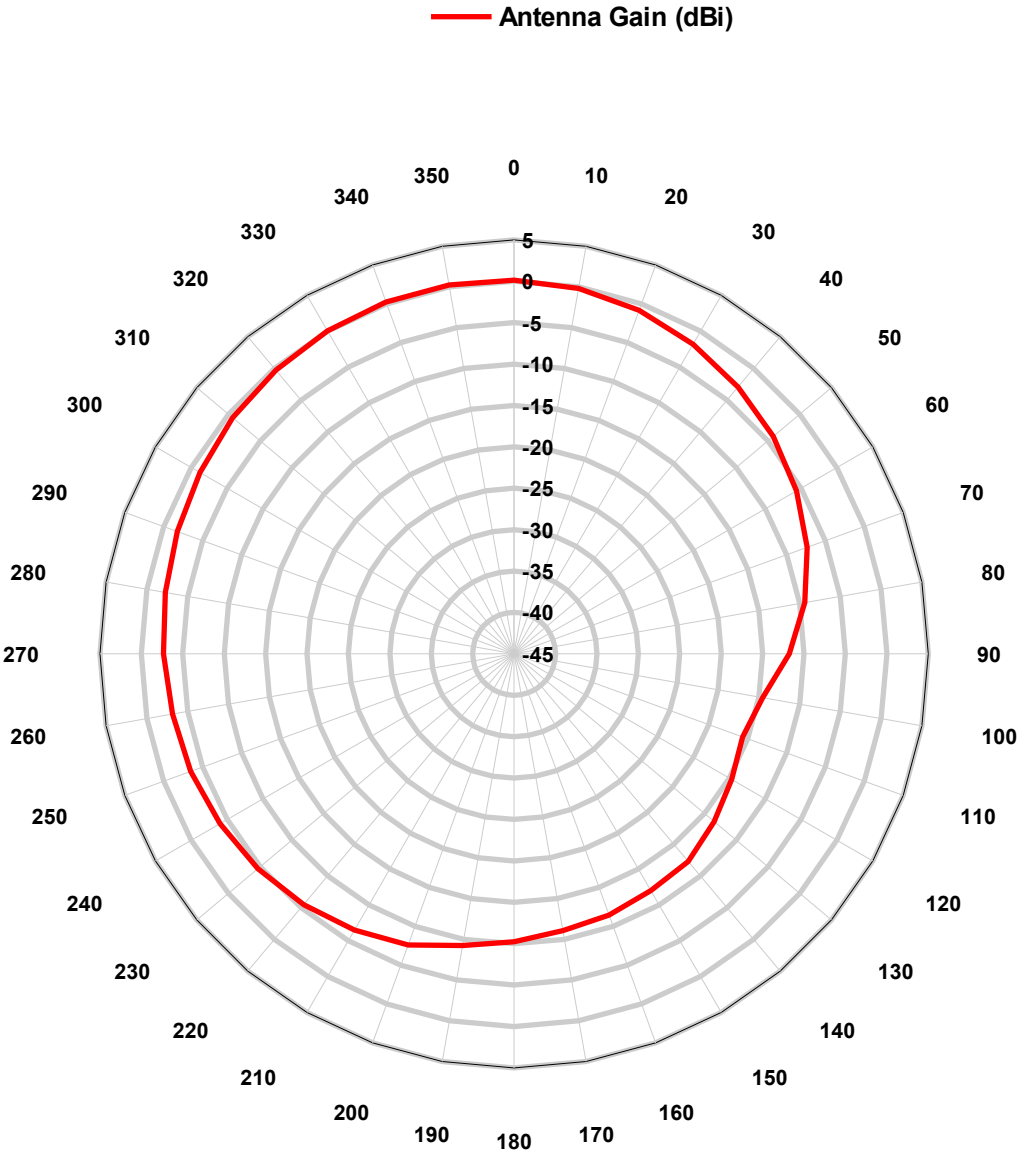
	MAX	MIN	AVG
Antenna Gain (dBi)	1.63	-14.95	-2.22

SC2120 QW Whip Antenna (PN 310-00015), Lapel-worn , 430MHz.ods



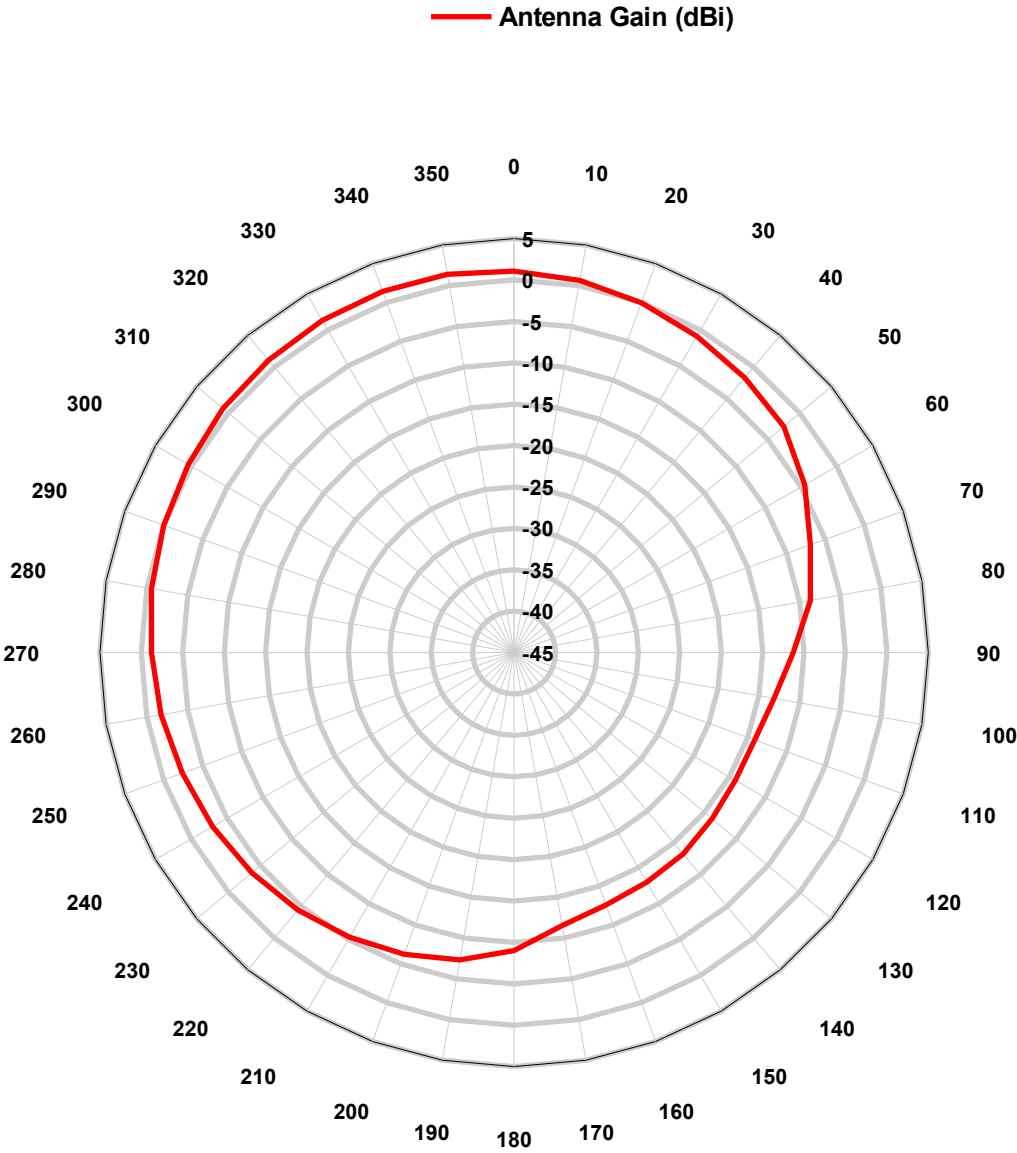
	MAX	MIN	AVG
Antenna Gain (dBi)	2.71	-14.32	-1.31

SC2124 QW Whip Antenna (PN 310-00015), Lapel-worn , 403MHz.ods



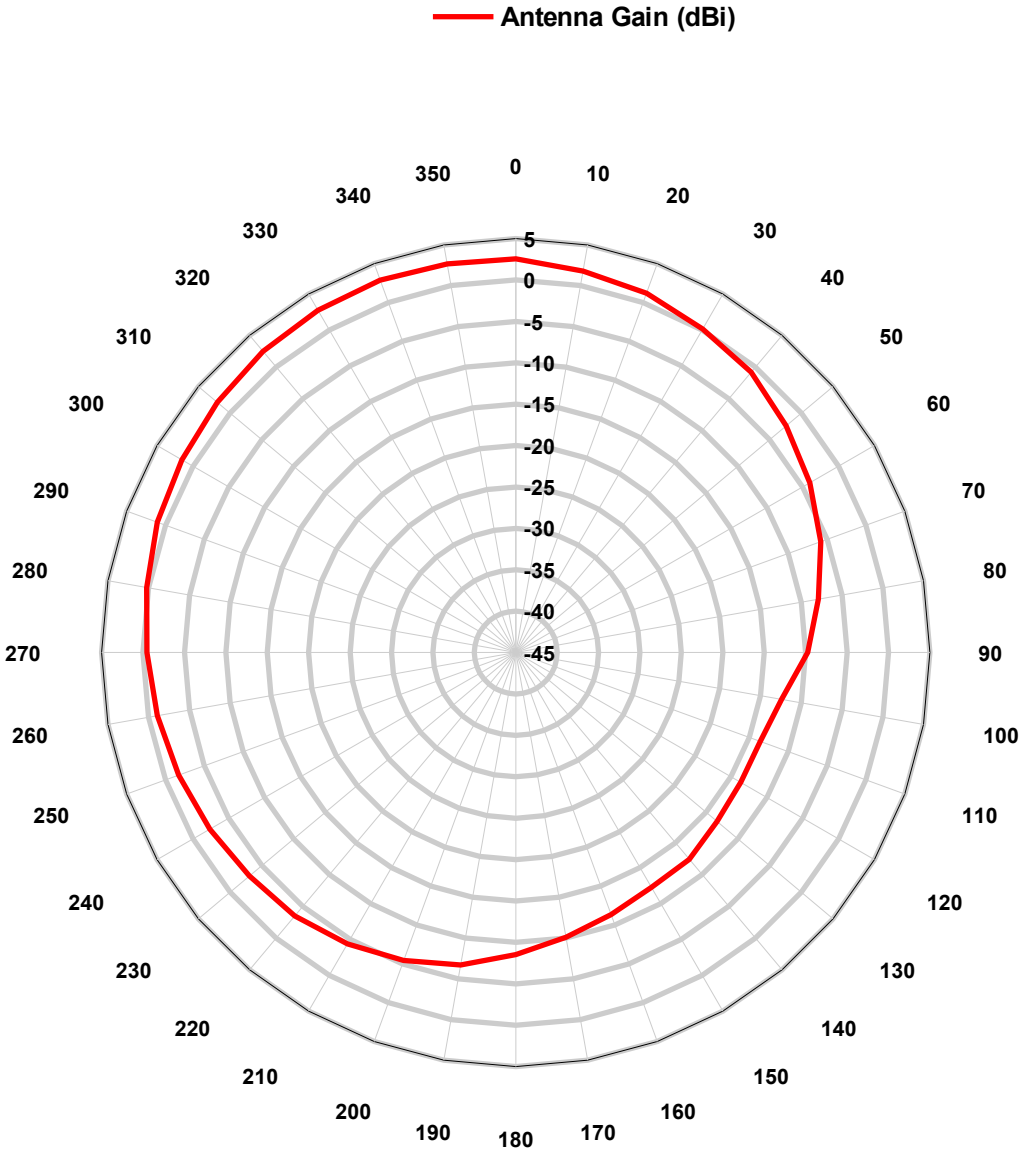
	MAX	MIN	AVG
Antenna Gain (dBi)	0.22	-15.64	-3.67

SC2124 QW Whip Antenna (PN 310-00015), Lapel-worn , 437MHz.ods



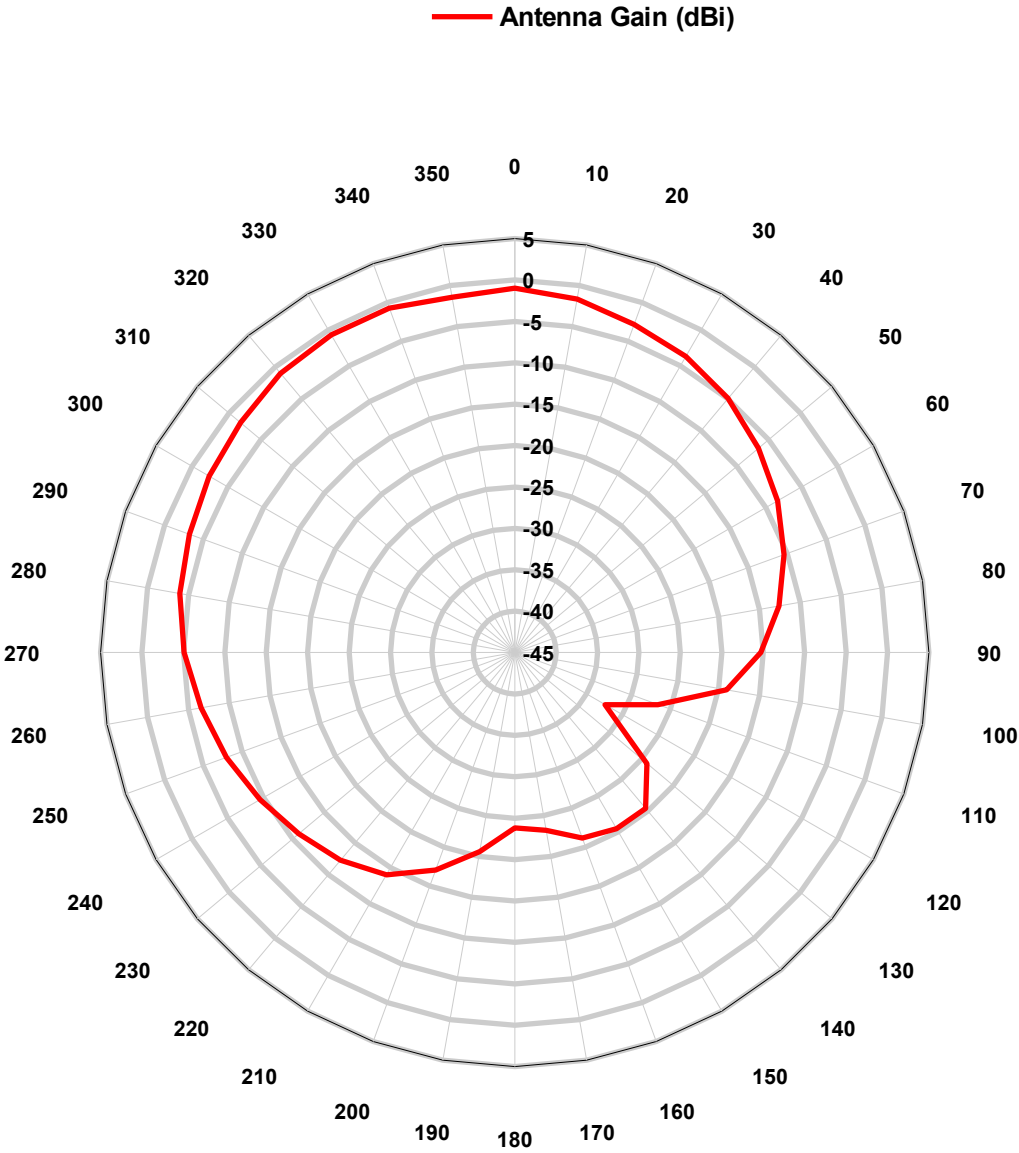
	MAX	MIN	AVG
Antenna Gain (dBi)	1.41	-14.16	-2.47

SC2124 QW Whip Antenna (PN 310-00015), Lapel-worn , 470MHz.ods



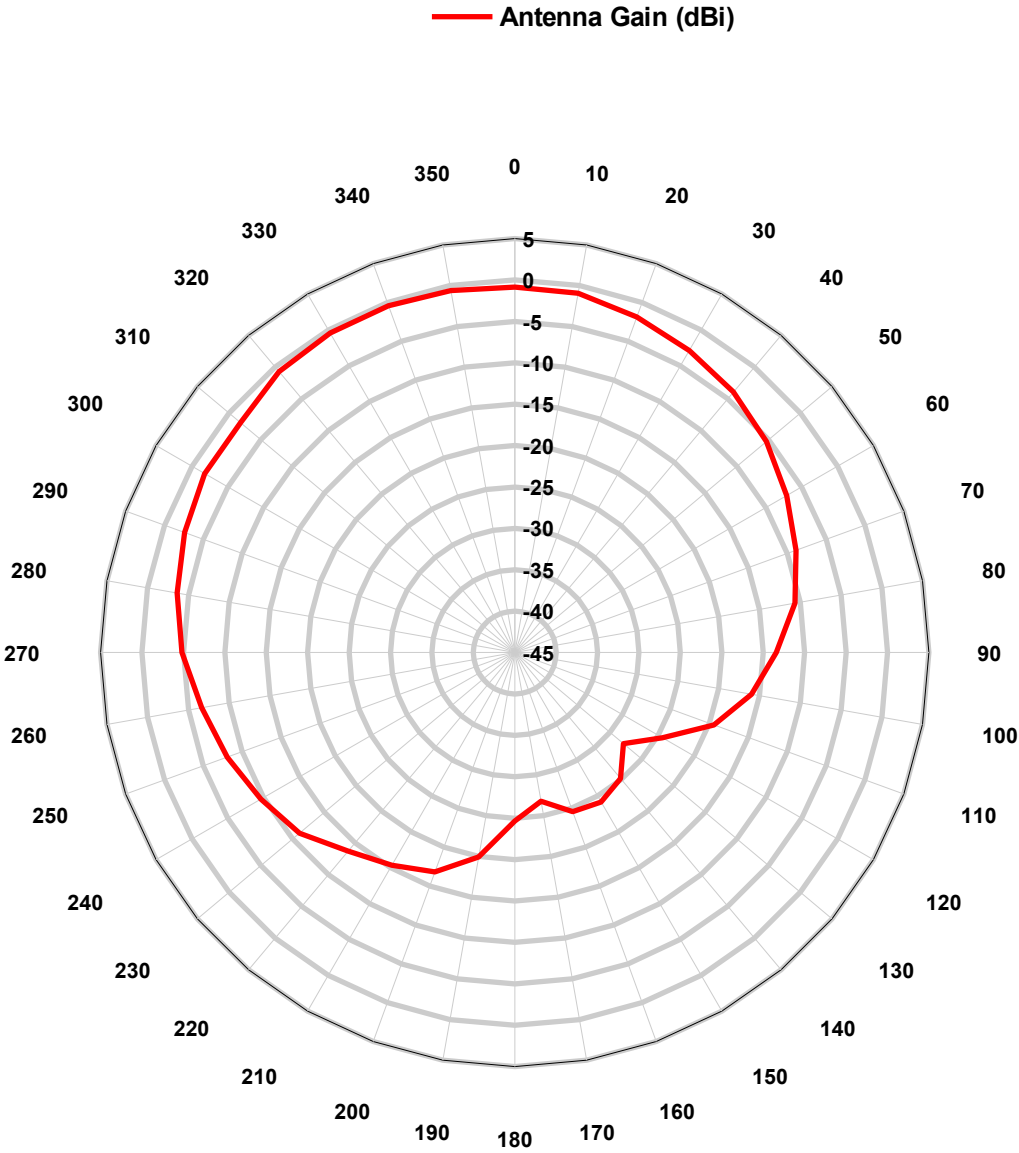
	MAX	MIN	AVG
Antenna Gain (dBi)	2.87	-13.64	-1.39

SC2120 QW Whip Antenna (PN 310-00015), Belt-worn , 380MHz.ods



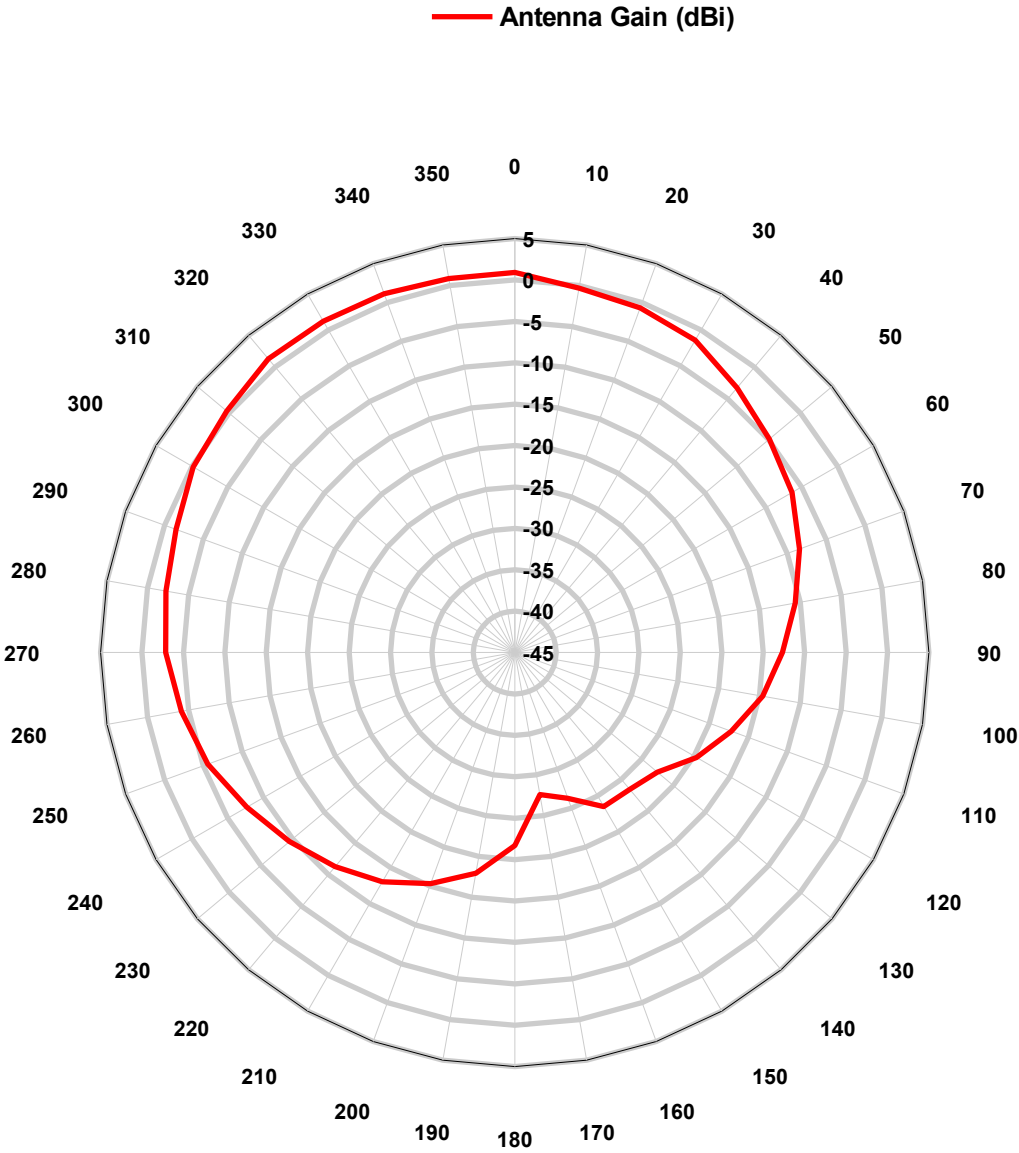
	MAX	MIN	AVG
Antenna Gain (dBi)	-0.70	-32.43	-5.70

SC2120 QW Whip Antenna (PN 310-00015), Belt-worn , 405MHz.ods



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

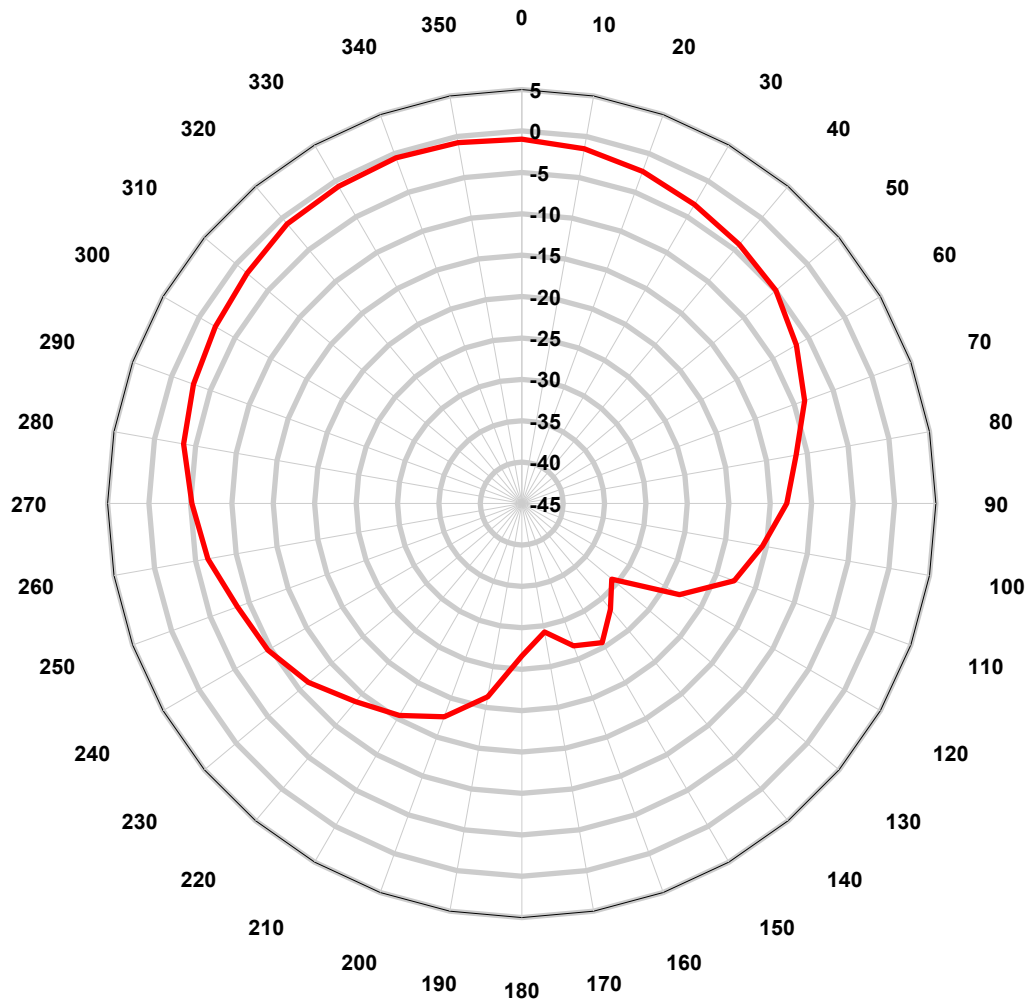
SC2120 QW Whip Antenna (PN 310-00015), Belt-worn , 430MHz.ods



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

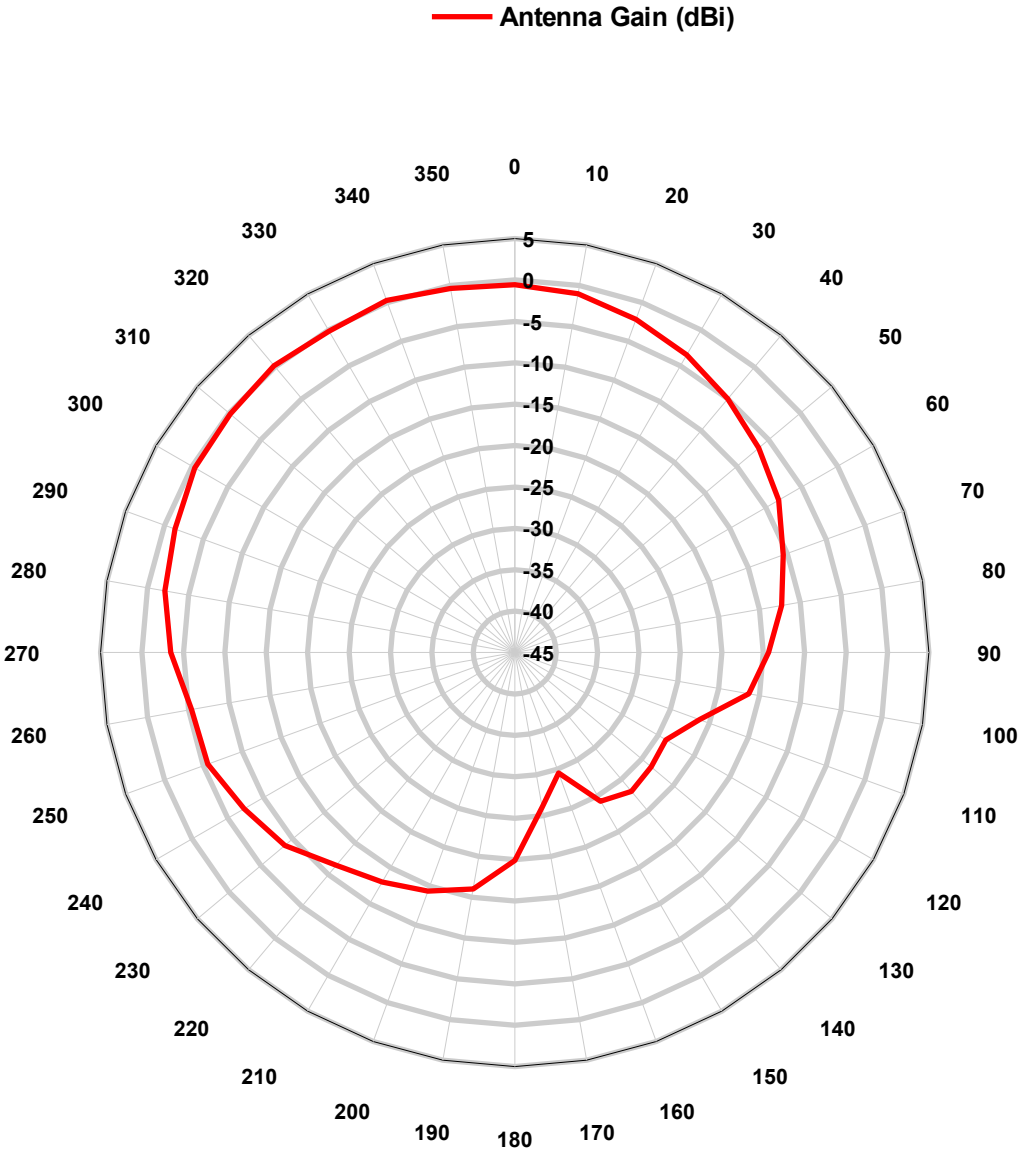
**SC2124 QW Whip Antenna (PN 310-00015), Belt-worn , 403MHz.ods**

— Antenna Gain (dBi)



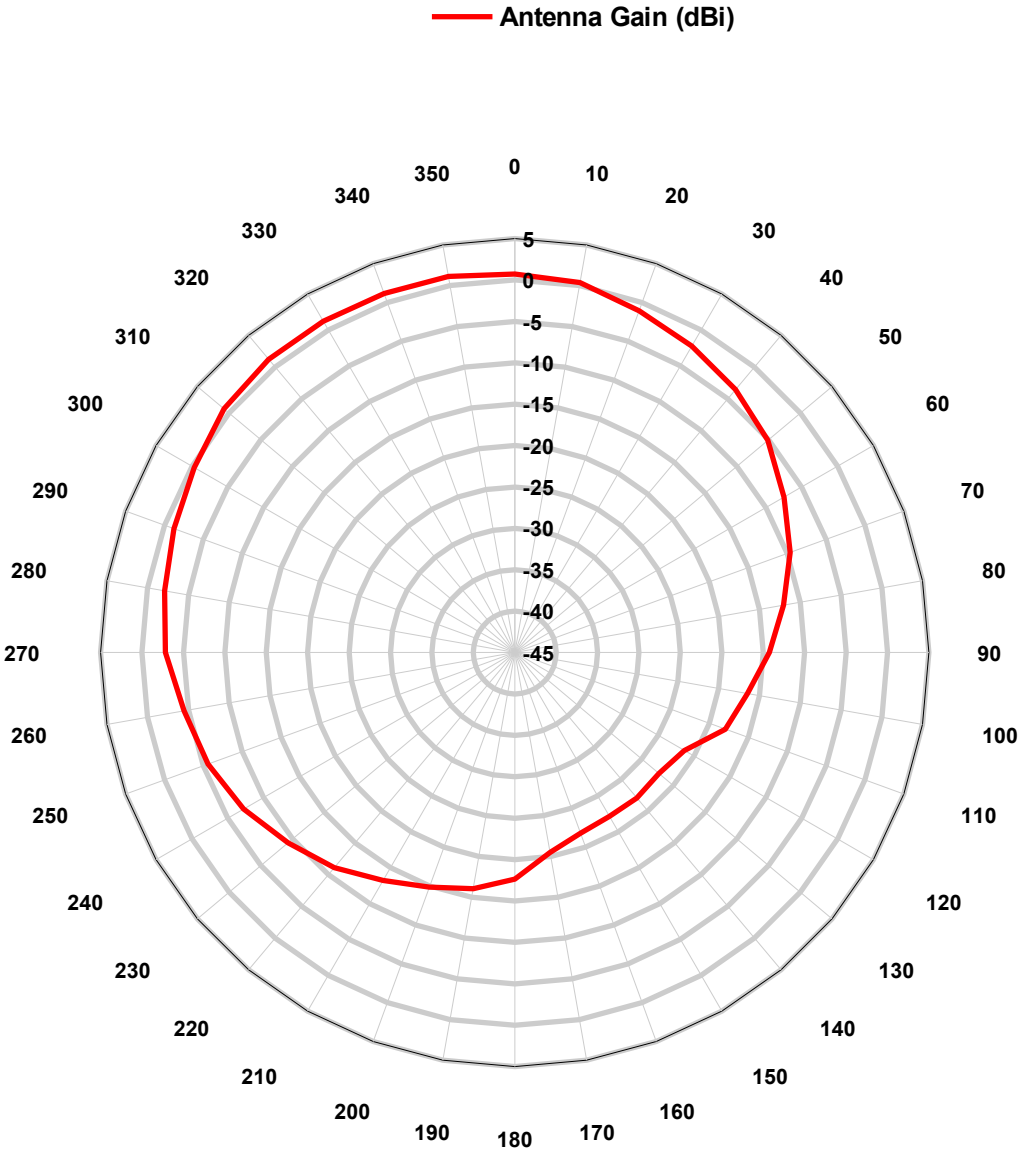
	MAX	MIN	AVG
Antenna Gain (dBi)	-0.57	-30.81	-5.41

SC2124 QW Whip Antenna (PN 310-00015), Belt-worn , 437MHz.ods

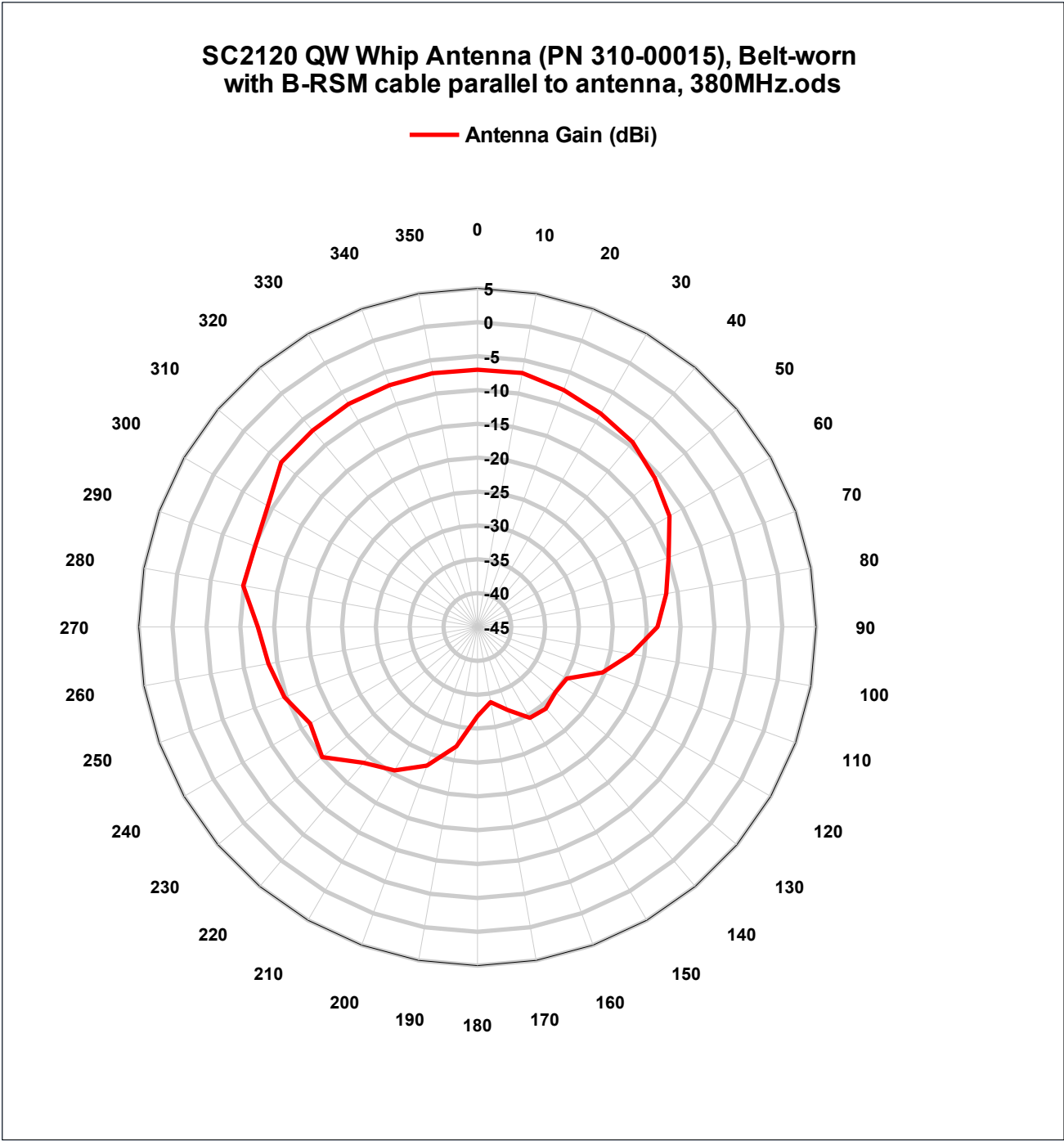


	MAX	MIN	AVG
Antenna Gain (dBi)	0.25	-29.53	-4.62

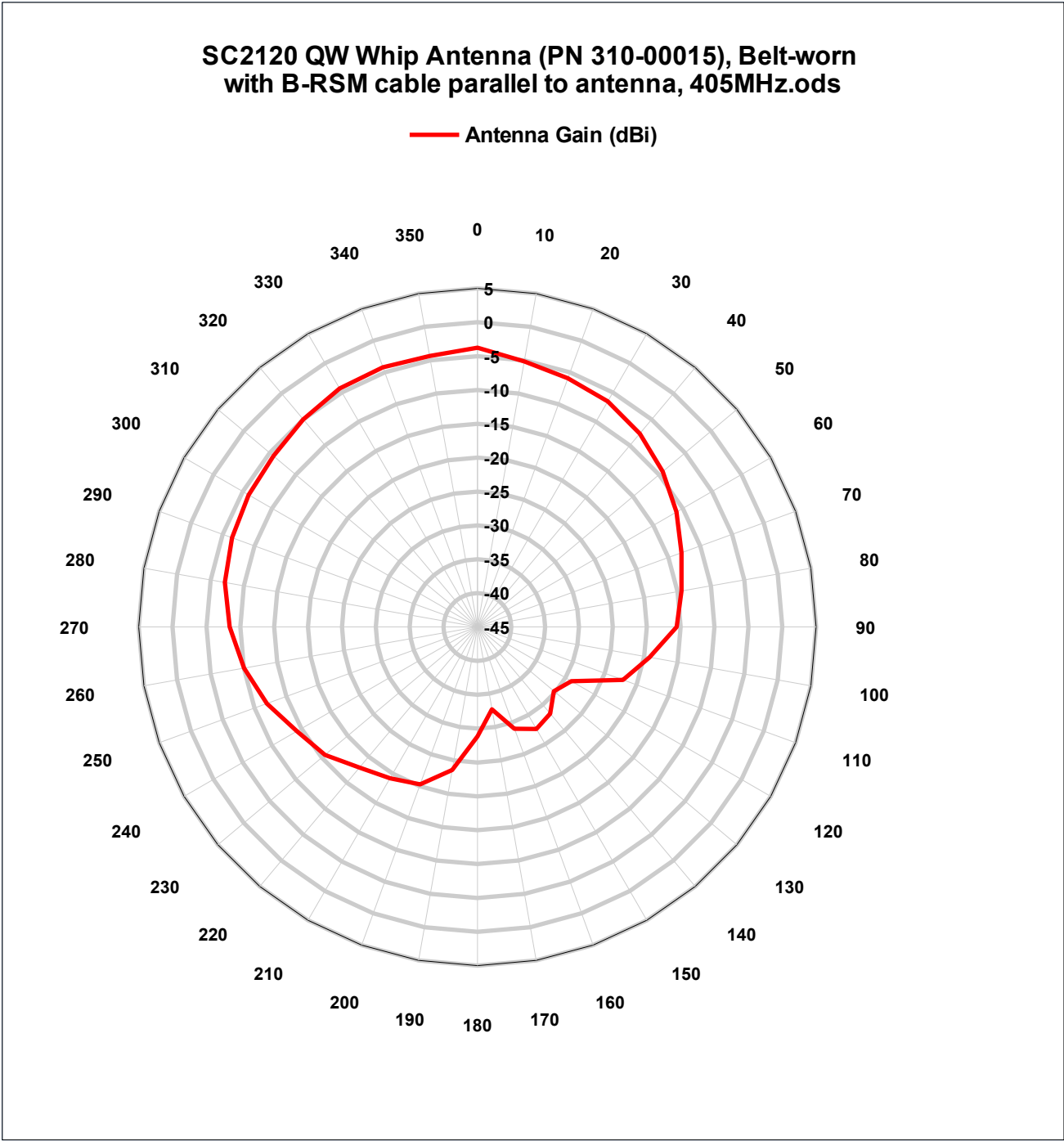
SC2124 QW Whip Antenna (PN 310-00015), Belt-worn , 470MHz.ods



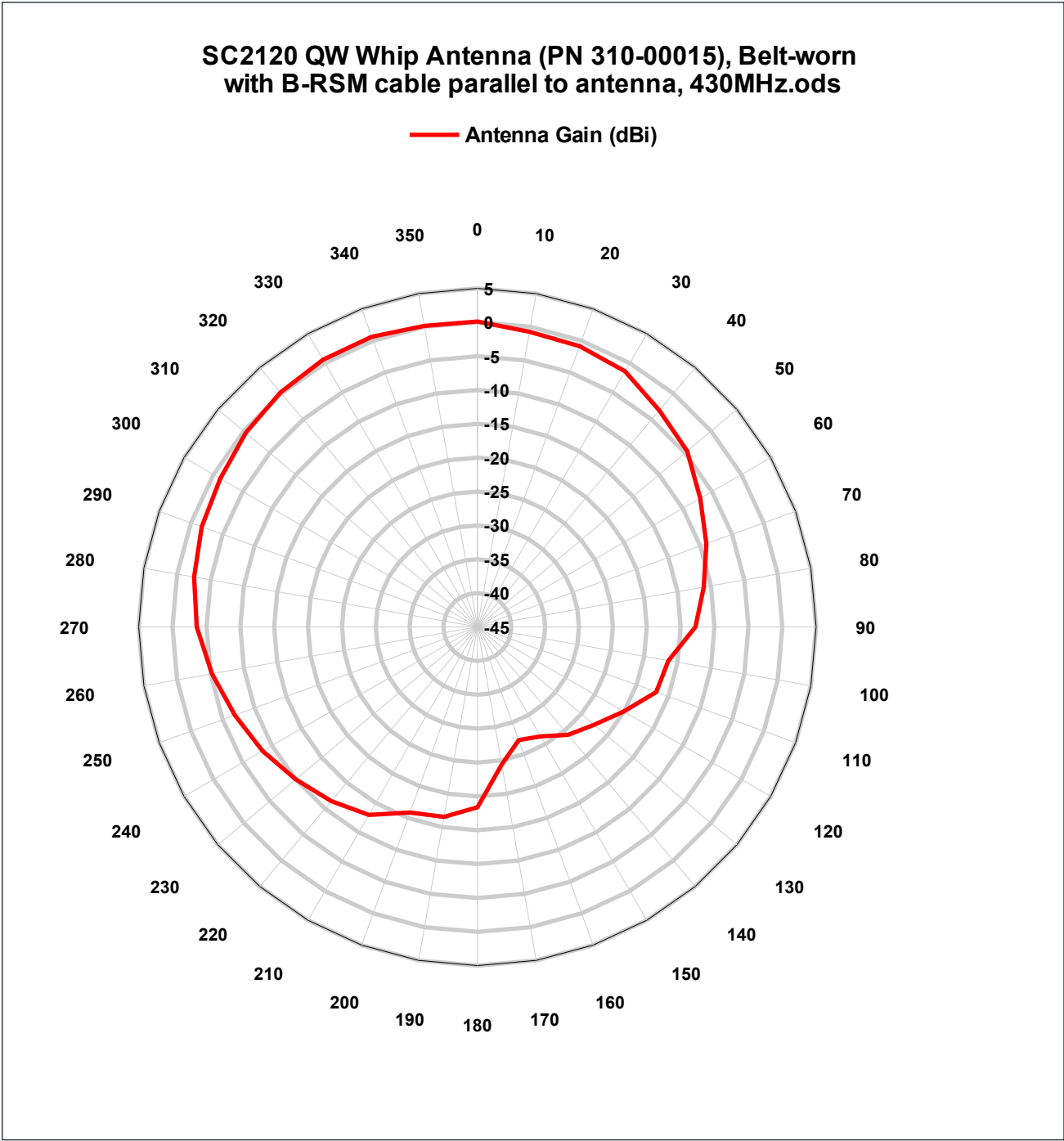
	MAX	MIN	AVG
Antenna Gain (dBi)	1.24	-22.29	-3.71



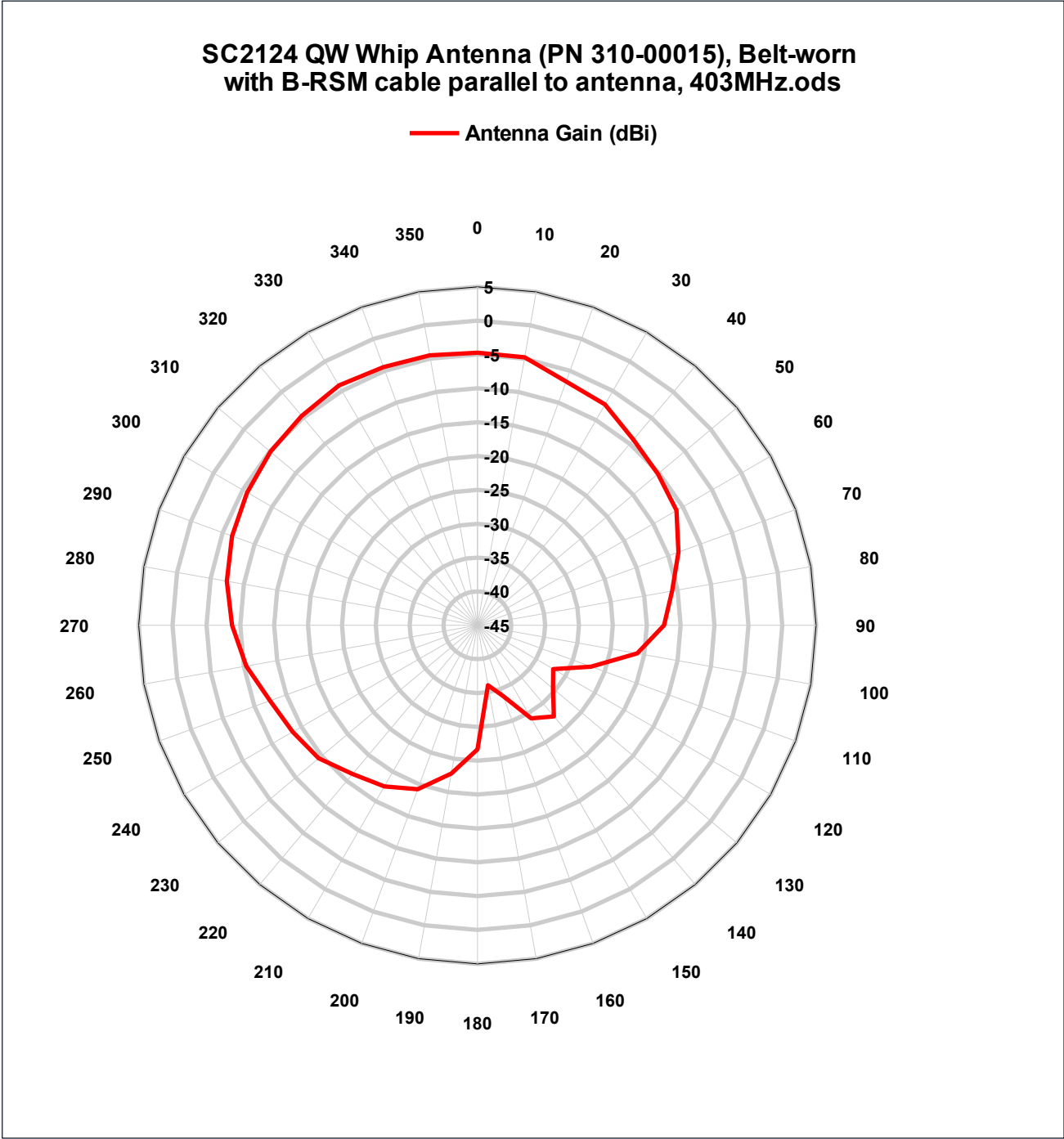
	MAX	MIN	AVG
Antenna Gain (dBi)	-6.92	-33.75	-11.47



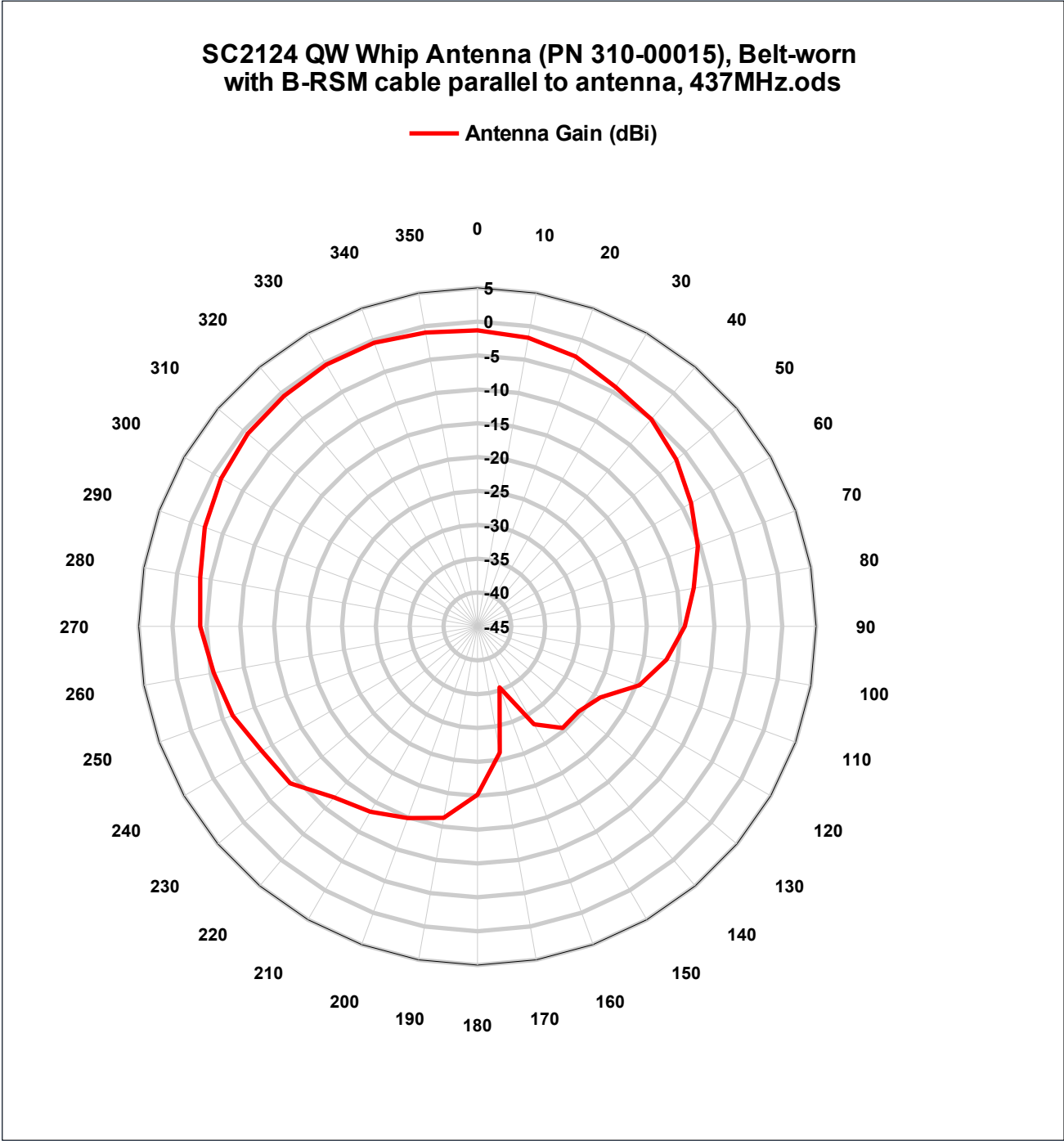
	MAX	MIN	AVG
Antenna Gain (dBi)	-3.75	-32.66	-9.03



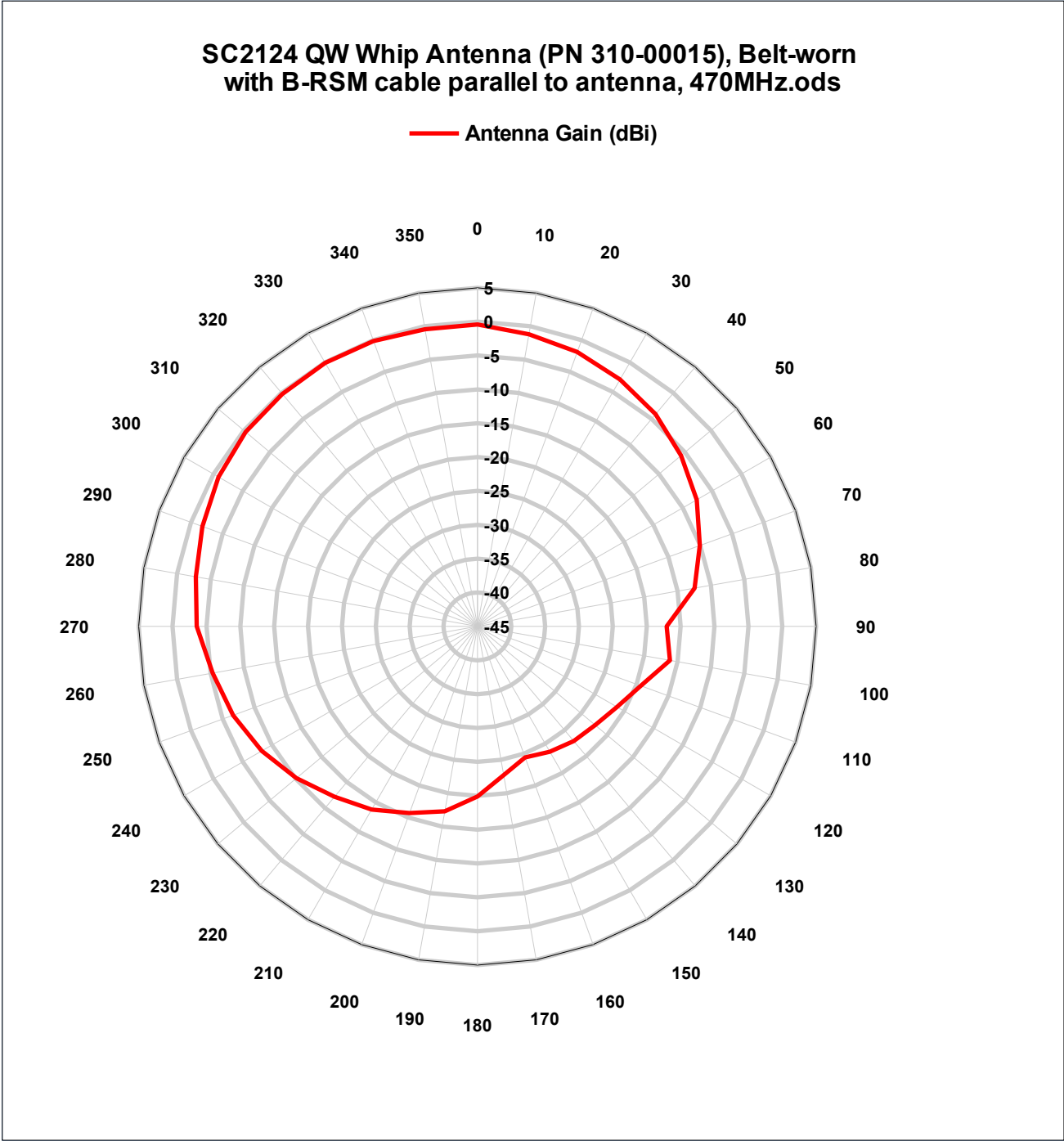
	MAX	MIN	AVG
Antenna Gain (dBi)	0.62	-27.21	-4.28



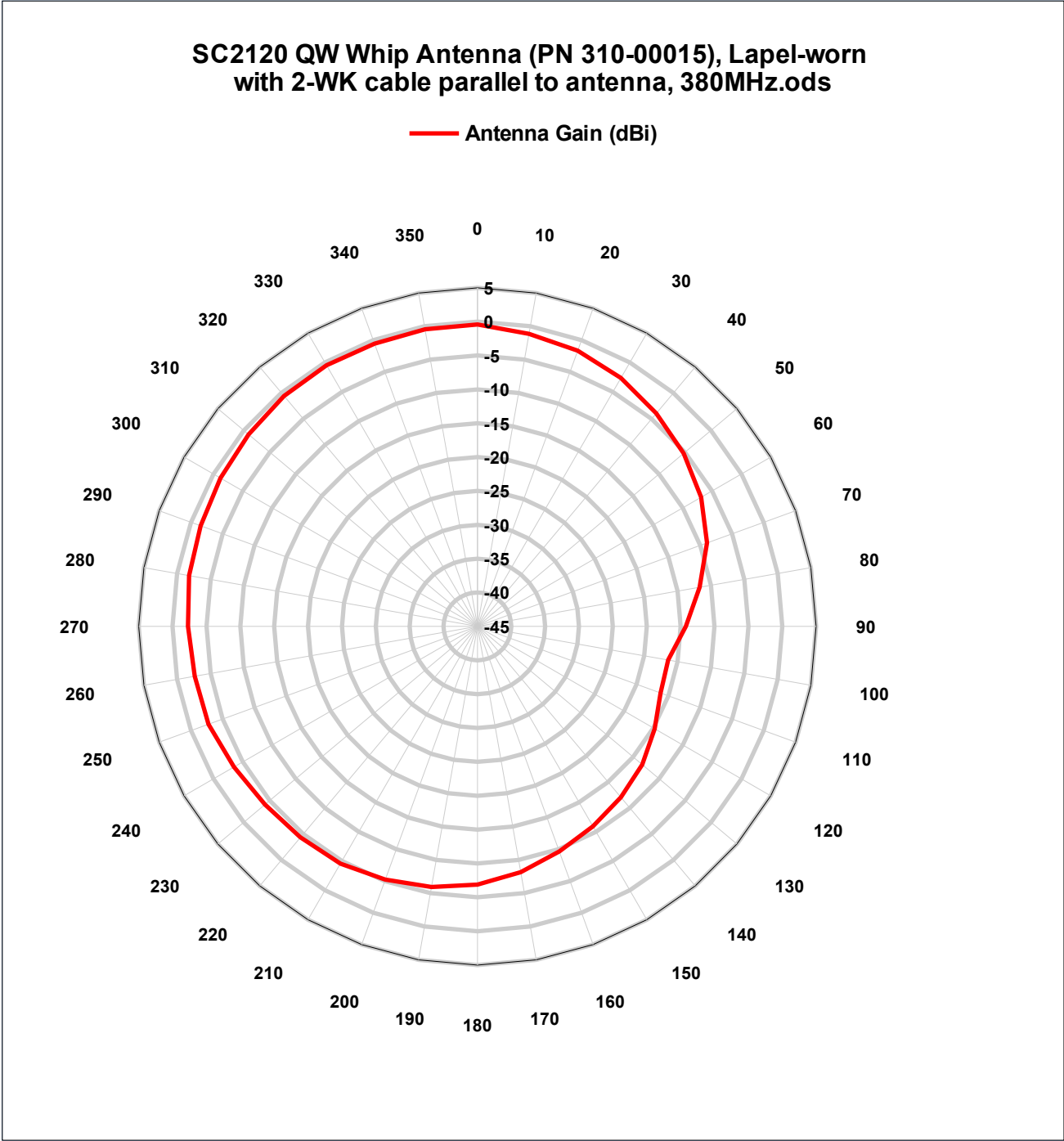
	MAX	MIN	AVG
Antenna Gain (dBi)	-4.10	-36.00	-9.21



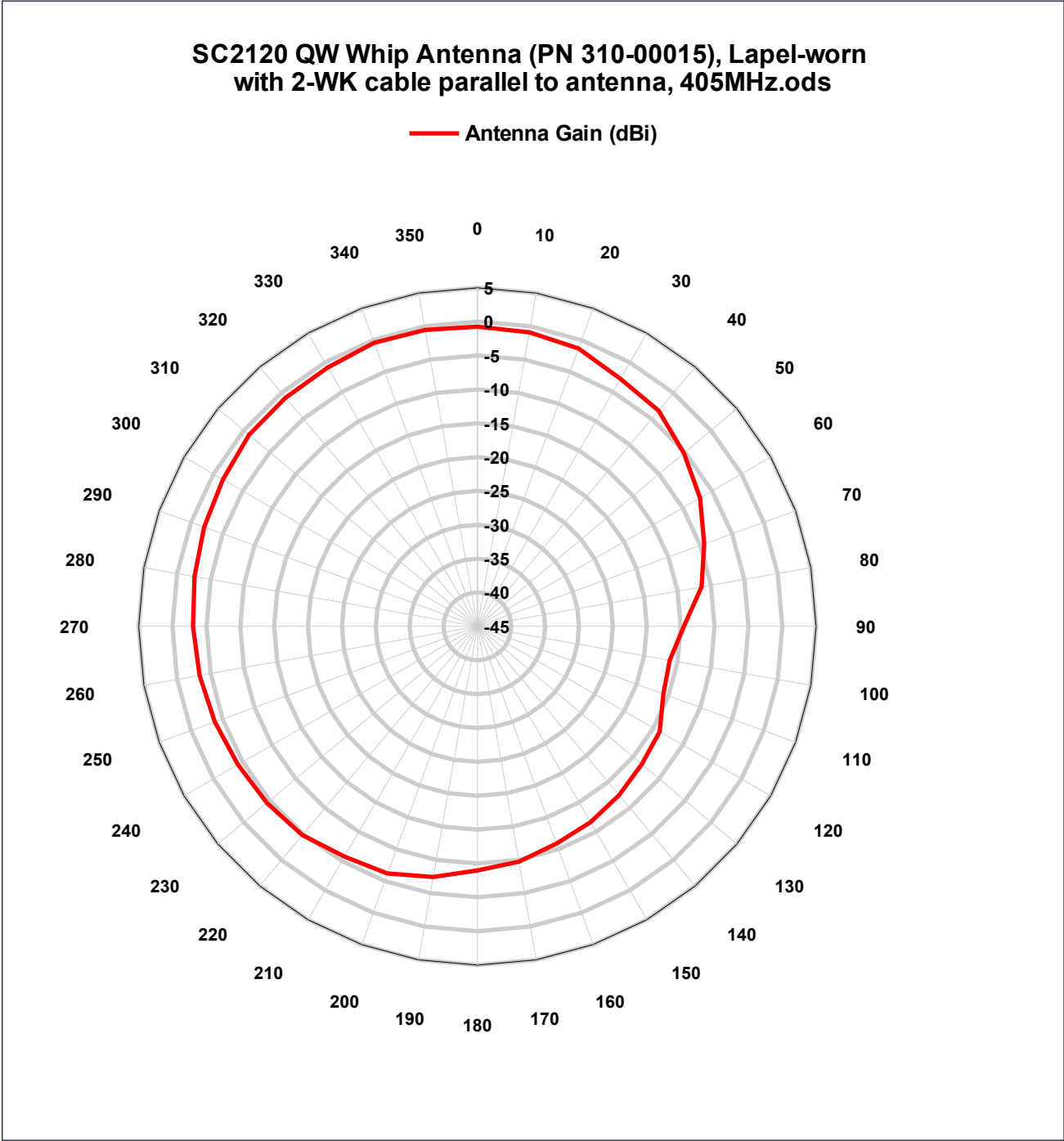
	MAX	MIN	AVG
Antenna Gain (dBi)	-0.36	-35.42	-5.26



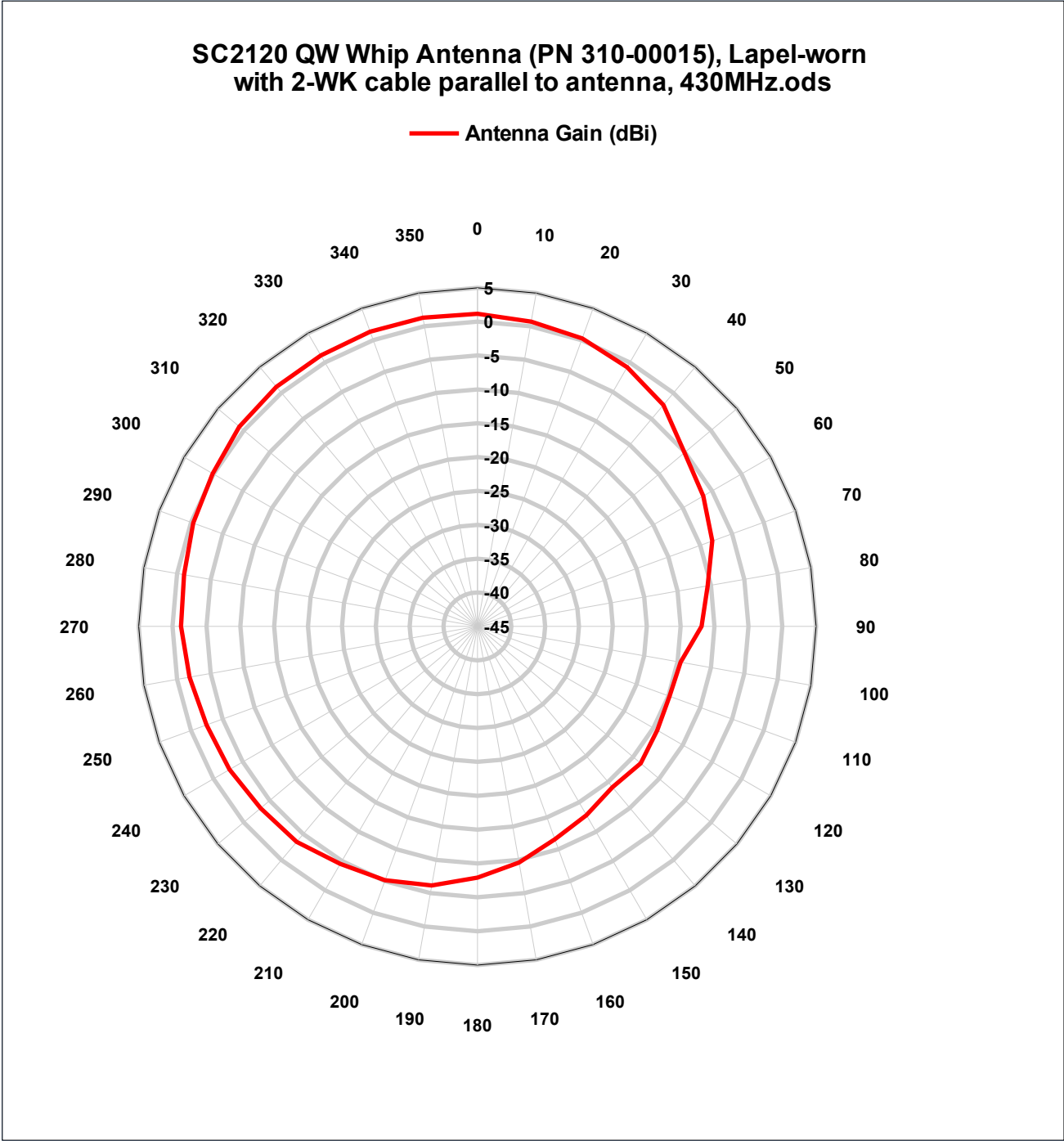
	MAX	MIN	AVG
Antenna Gain (dBi)	-0.07	-24.41	-4.77



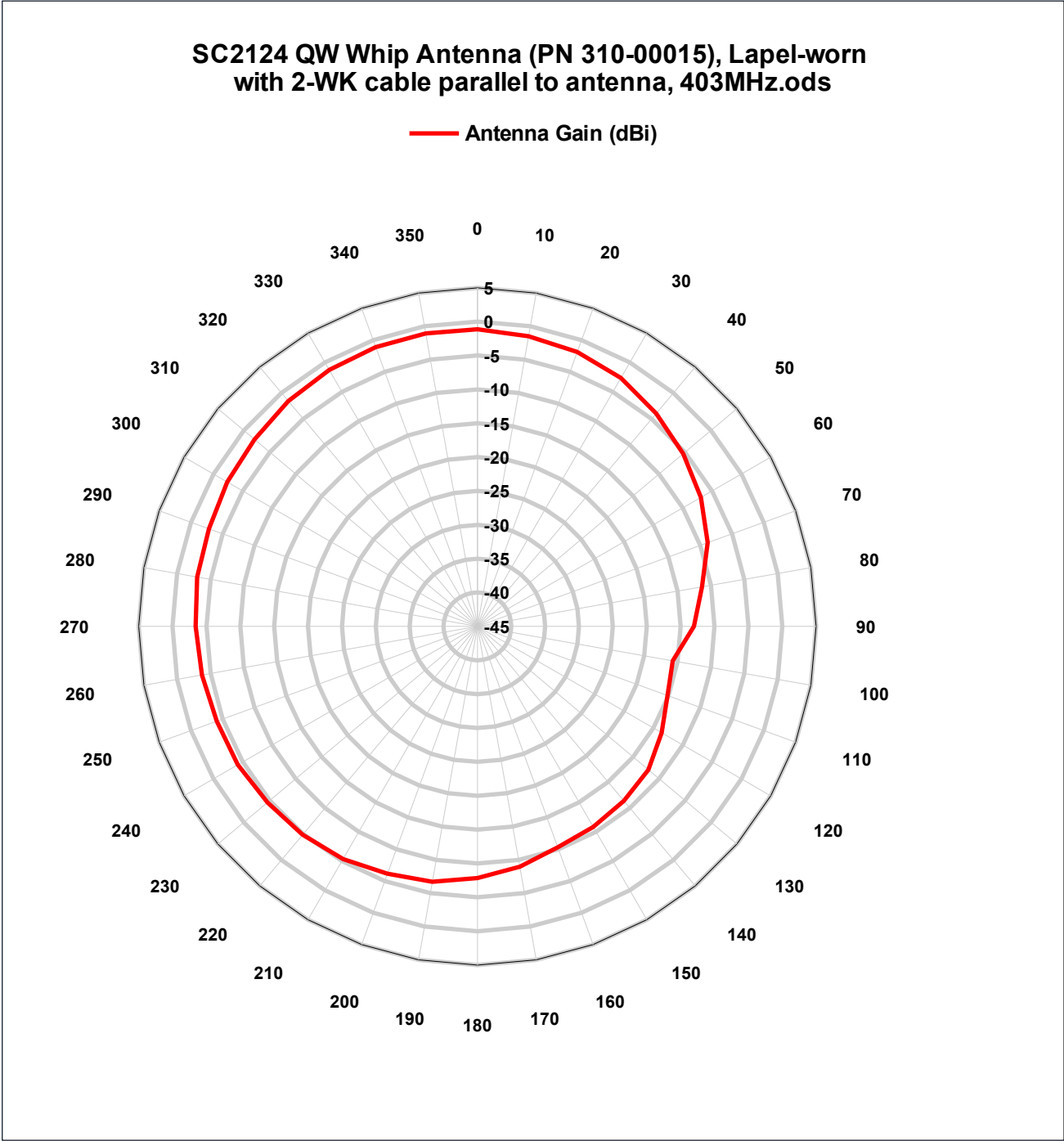
	MAX	MIN	AVG
Antenna Gain (dBi)	-0.42	-16.40	-3.79



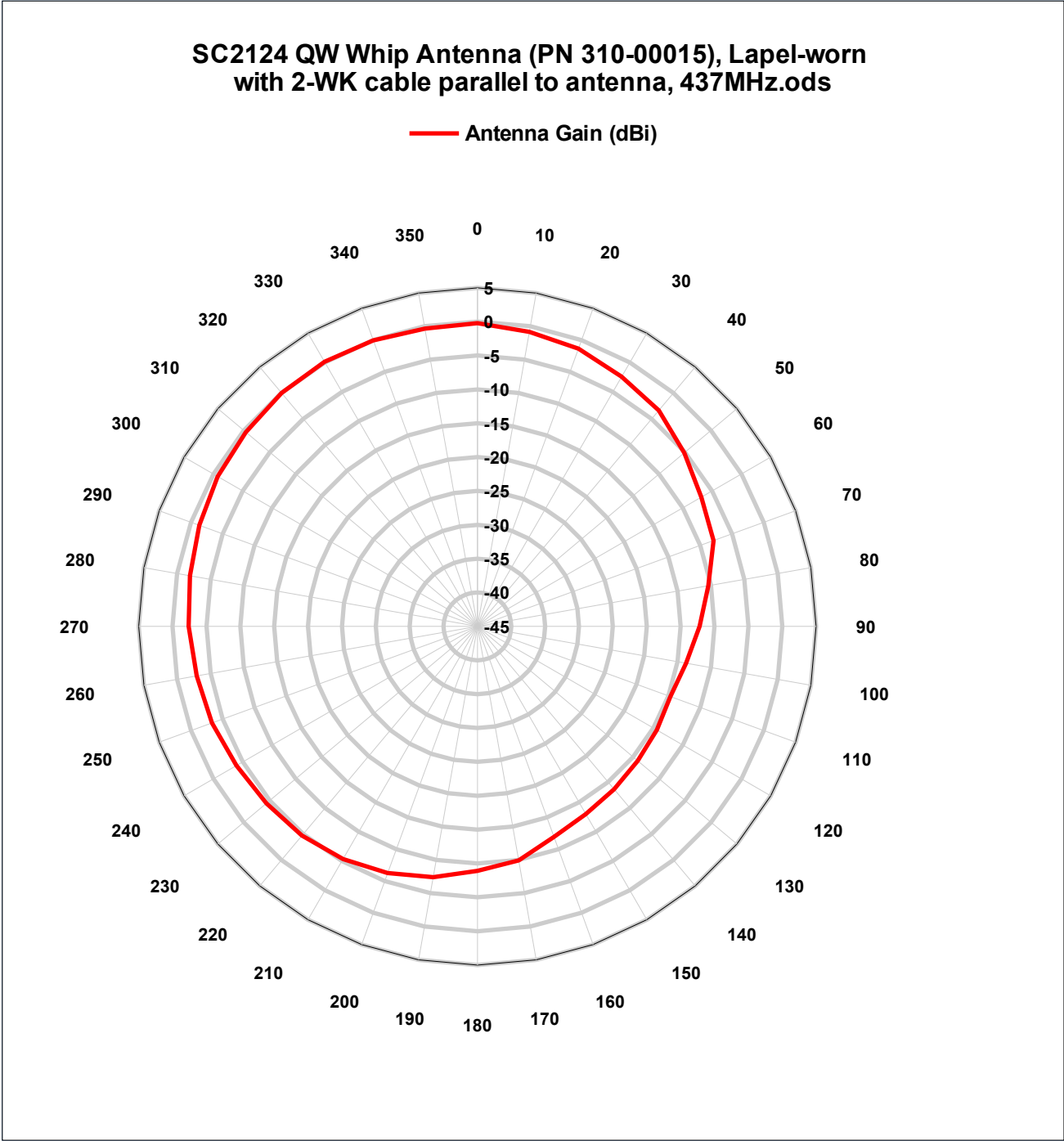
	MAX	MIN	AVG
Antenna Gain (dBi)	-0.43	-16.18	-4.13



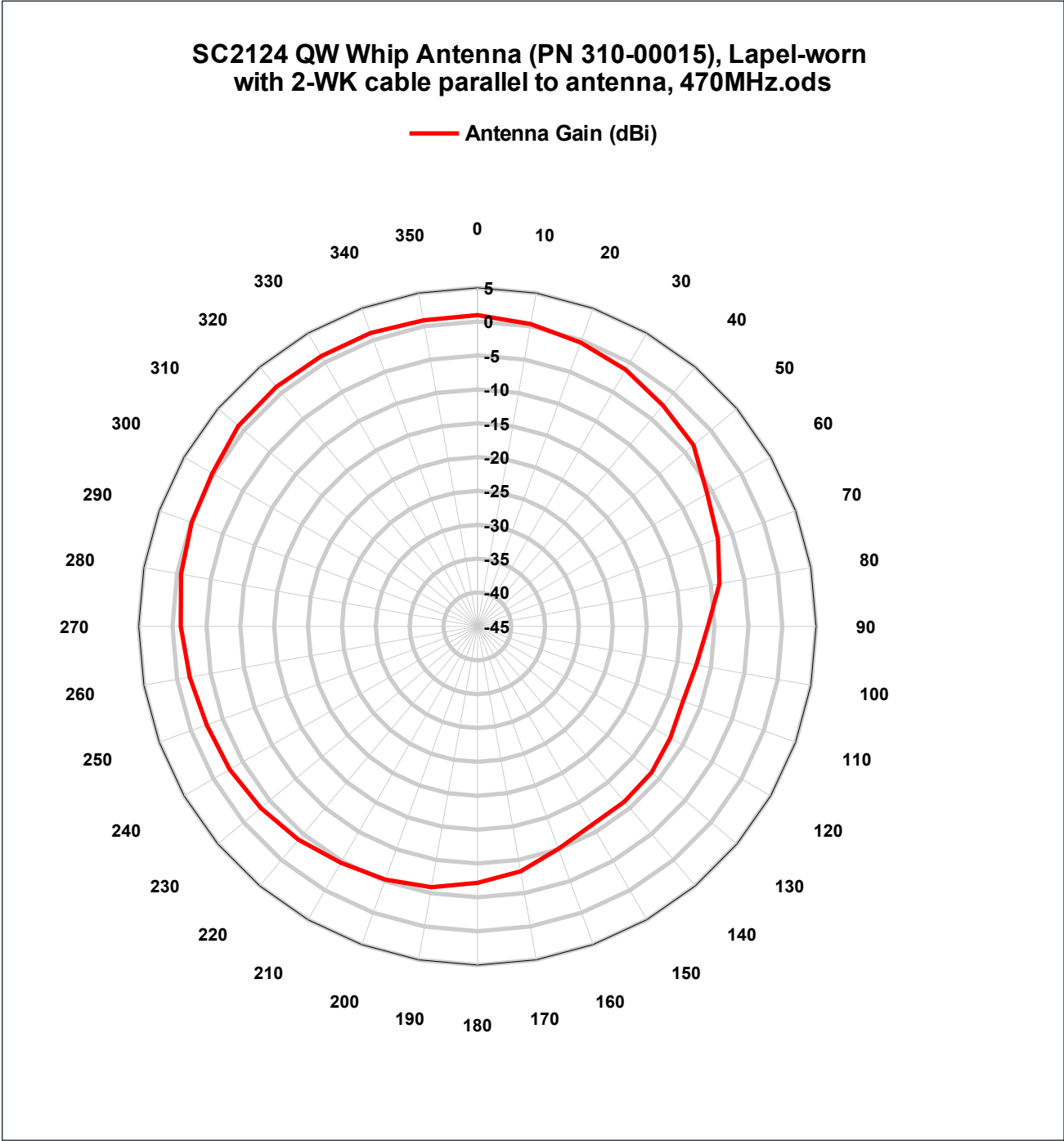
	MAX	MIN	AVG
Antenna Gain (dBi)	1.31	-14.81	-2.55



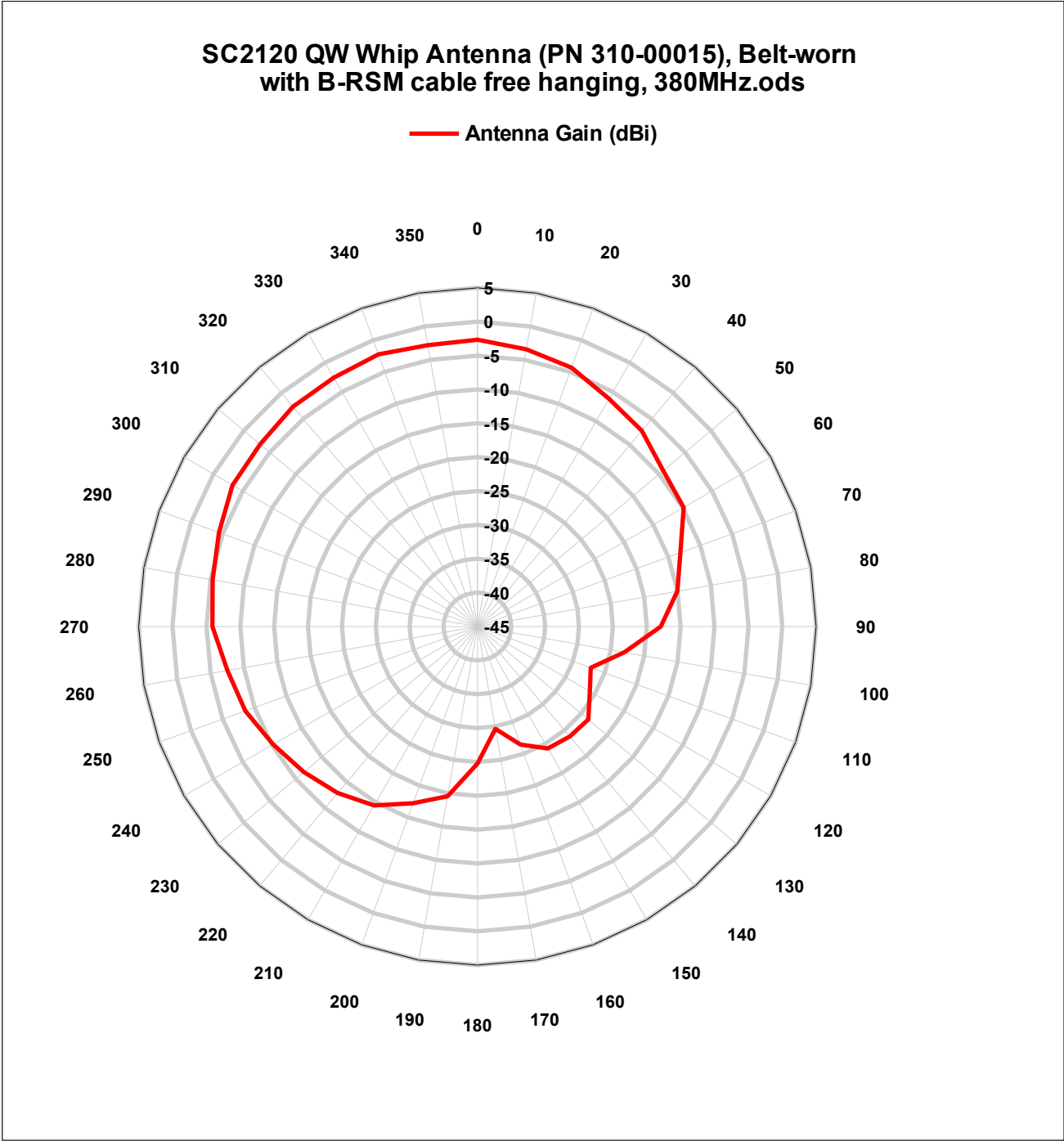
	MAX	MIN	AVG
Antenna Gain (dBi)	-1.08	-15.72	-4.48



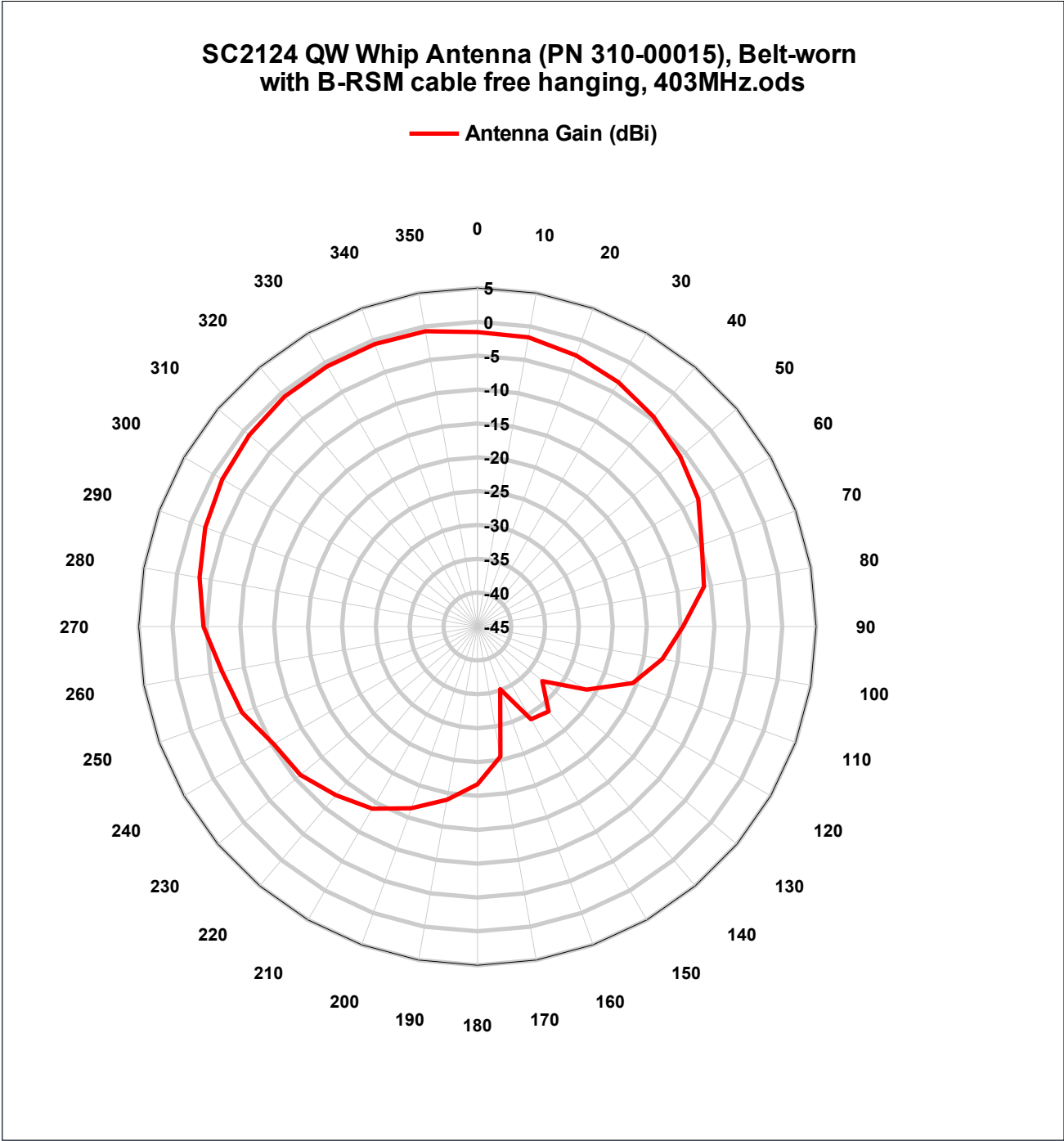
	MAX	MIN	AVG
Antenna Gain (dBi)	0.12	-14.70	-3.70



	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

	File:	R000573_V01	
		Test Report	Page 42 of 47

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

	File:	R000573_V01	
		Test Report	Page 47 of 47



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