Japan Test Report

Equipment	:	**Sterling-LWB5 Module**
Model No.	:	**450-0168, 450-0169** **(Refer to item 1.1.1 for more details)**
Brand Name	:	**Laird**
Applicant	:	**Laird Technologies**
Address	:	**W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA**
Standard	:	**Article 2 Paragraph 1 Item 19**
Received Date	:	**May 23, 2018**
Tested Date	:	**May 26 ~ Oct. 04, 2018**

Measurement was conducted by the following test method:
the test method of Ordinance Concerning Technical Regulations Conformity Certification etc. of Specified Radio Equipment in Annex 1, the Ministry of Internal Affairs and Communication notification in Annex "43" of Article 88, Paragraph 1 and ARIB STD-T66.

We, International Certification Corp., would like to declare that the tested sample has been evaluated and in compliance with the requirement of the above standards. The test results contained in this report refer exclusively to the product. It may be duplicated completely for legal use with the approval of the applicant. It shall not be reproduced except in full without the written approval of our laboratory.

Reviewed by:	**Approved by:**
James Fan / Assistant Manager	**Gary Chang / Manager**

Testing Laboratory
2732

Table of Contents

Release Record

Report No.	Version	Description	Issued Date
JR770305-01AE	Rev. 01	Initial issue	Oct. 08, 2018

Summary of Test Results

Ref. Std. Clause	Description	Result
3.2(2)(3)	Antenna Power	Pass
3.2(4)	Frequency Tolerance	Pass
3.2(6)	Transmitter Spurious Emission	Pass
3.2(7)	Occupied Bandwidth	Pass
3.3(1)	Receiver Emission	Pass
3.4.1	Interference prevention function	Pass

1 General Description

1.1 Information

1.1.1 Product Details

The following models are provided to this EUT.

Brand Name	Model Name	Product Name	Description
Laird	450-0168	Sterling-LWB5 Module	U.FL Module
	450-0169		Chip Antenna Module

1.1.2 Specification of the Equipment under Test (EUT)

Power Type	3.3Vdc from host
Type(s) of Modulation / Technology	GFSK = 1Mbps
Frequency Range (MHz)	2402 ~ 2480 MHz
Total Channel Number	40
HW Version	1.0
SW Version	6.37.39.77

1.1.3 Accessories

N/A

1.1.4 Antenna Details

Ant. No.	Model	Type	Connector	Gain (dBi)	Remarks
1	LSR/001-0009	Dipole	IPEX U.FL	2	---
2	LSR/FlexPIFA 001-0016	PIFA	IPEX U.FL	2.5	---
3	LSR/001-0012	Dipole	IPEX U.FL	2	---
4	Johanson P/N: 2450AD14A5500#	Chip	IPEX U.FL	1	---

Note: Please refer to Appendix G for more details about antenna pattern and other information.

1.1.5 Antenna Power

Operating Mode	Rated Power (mW)	Measured Conducted Power (mW)	Radiated Power (mW)
LE	4.00	4.00867	7.129

1.1.6 Channel List

Frequency band (MHz)				2400~2483.5			
Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)	Channel	Frequency (MHz)
37	2402	9	2422	18	2442	28	2462
0	2404	10	2424	19	2444	29	2464
1	2406	38	2426	20	2446	30	2466
2	2408	11	2428	21	2448	31	2468
3	2410	12	2430	22	2450	32	2470
4	2412	13	2432	23	2452	33	2472
5	2414	14	2434	24	2454	34	2474
6	2416	15	2436	25	2456	35	2476
7	2418	16	2438	26	2458	36	2478
8	2420	17	2440	27	2460	39	2480

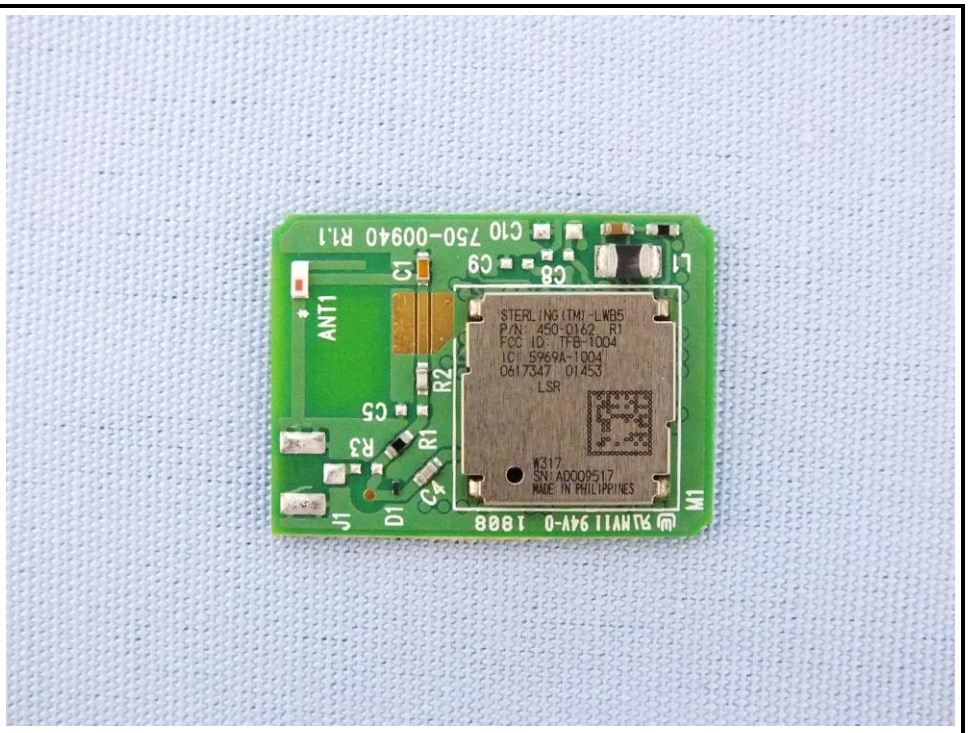
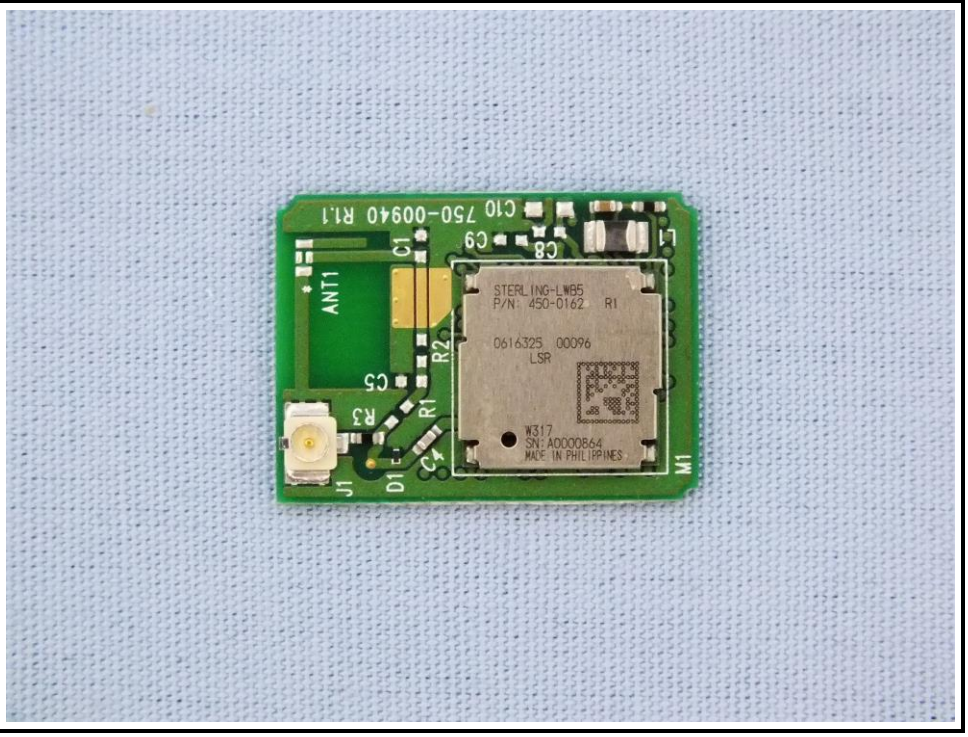
1.1.7 Test Tool and Power Setting

Test Tool
BT RF Eval Tool v. 2.10.0.0

Modulation Mode	Test Frequency (MHz)		
	2402	2440	2480
GFSK/1Mbps	Default	Default	Default

1.1.8 Protection Method for High Frequency and Modulation Section

Protected Method	Description
Shielding Case	RF and Modulation components are covered with shielding case and this shielding case is soldered

Photo (Chip Antenna Module)	
Photo| (U.FL Module)	

1.2 Test Equipment and Calibration Data

Test Item	RF Conducted				
Test Site	(TH01-WS)				
Instrument	**Manufacturer**	**Model No.**	**Serial No.**	**Calibration Date**	**Calibration Until**
Spectrum Analyzer	R&S	FSV40	101063	Apr. 16, 2018	Apr. 15, 2019
Power Meter	Anritsu	ML2495A	1241002	Oct. 16, 2017	Oct. 15, 2018
Power Sensor	Anritsu	MA2411B	1207366	Oct. 16, 2017	Oct. 15, 2018
DC POWER SOURCE	GW INSTEK	GPC-6030D	EM892433	Oct. 26, 2017	Oct. 25, 2018
Measurement Software	Sporton	Sporton_1	1.3.30	NA	NA
Note 1: Calibration Interval of instruments listed above is one year. Note 2: Above instruments are calibrated by Electronics Testing Center					

1.3 Testing Applied Standards

According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

Article 2 Paragraph 1 Item 19

1.4 Measurement Uncertainty

ISO/IEC 17025 requires that an estimate of the measurement uncertainties associated with the emissions test results be included in the report. The measurement uncertainties given below are based on a 95% confidence level (based on a coverage factor (k=2)

Measurement Uncertainty	
Parameters	**Uncertainty**
Frequency error	±33.988 Hz
Bandwidth	±33.988 Hz
Conducted power	±0.537 dB
TX Conducted emission	±2.308 dB
RX Conducted emission	±2.525 dB

2 Test Configuration

2.1 Testing Location and Conditions

Test Site	Site Category	Ambient Condition	Tested By
TH01-WS	OVEN Room	25℃ / 65%	Chris Zeng

2.2 Supporting Units

Support Unit	Brand	Model	FCC ID
---	---	---	---

2.3 The Worst Test Modes and Channel Details

Test item	Mode	Test Frequency (MHz)
Antenna Power Frequency Tolerance Transmitter Spurious Emission Occupied Bandwidth Spreading Bandwidth Collateral Emission of Receiver Spreading Factor Interference prevention function	BT LE	2402 / 2440 / 2480

3 Transmitter Test Results

3.1 Antenna Power

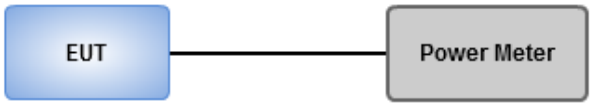
3.1.1 Limit of Antenna Power

Mode	Limit	Tolerance
1) FH, FH+DS, FH+OFDM	3 mW / MHz	+20 % , -80 %
2) OFDM(Narrow- bandwidht), DS	10 mW / MHz	
3) Other than 1) & 2)	10mW	
4) OFDM (Wide-band)	5 mW / MHz	

3.1.2 Test Procedures

Measure the total power by Power Meter

3.1.3 Test Setup



3.1.4 Test Result of Maximum Transmit Power

Reference Documents	Test Mode
Appendix A1, A2	BT-LE

3.2 Frequency Tolerance

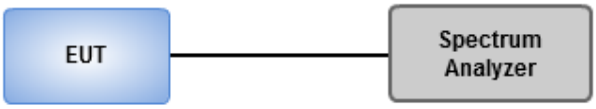
3.2.1 Limit of Frequency Tolerance

Frequency tolerance shall be +/- 50ppm.

3.2.2 Test Procedures

1. Set Span = 150kHz, RBW = 1kHz, VBW = 30kHz, Sweep time = Auto, detector = Peak.
2. Use Peak search function to find the max peak value and record this value (RF).
3. Calculate frequency tolerance by below formula
   FT(ppm) = { (RF) – (MF) / (MF) } × 1000000
   (FT: Frequency Tolerance, RF: Reading Frequency, MF: Measurement Frequency.)

3.2.3 Test Setup



3.2.4 Test Result of Frequency Tolerance

Reference Documents	Test Mode
Appendix B	BT-LE

3.3 Occupied Bandwidth

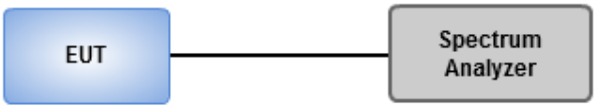
3.3.1 Limit of Occupied Bandwidth

Mode	Limit (MHz)
FH	83.5
FH+DS	83.5
FH+OFDM	83.5
OFDM(Narrow- bandwidht), DS	26
Others	26
OFDM (Wide-band)	38

3.3.2 Test Procedures

1. Set Span = 40MHz, RBW = VBW = 300kHz, detector = Peak, Sweep time = Auto.
2. Enable OBW function of spectrum analyzer to measure OBW and capture test plot.

3.3.3 Test Setup



3.3.4 Test Result of Occupied Bandwidth

Reference Documents	Test Mode
Appendix C	BT-LE

3.4 Transmitter Spurious Emissions

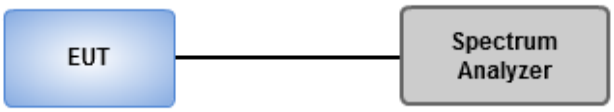
3.4.1 Limit of Transmitter Spurious Emissions

Item	Limits
Tx Spurious Emission	≤ 2.5 μW (2387MHz > f ; 2496.5MHz < f).
	≤ 25 μW. (2387MHz ≤ f < 2400MHz) and (2483.5MHz < f ≤ 2496.5MHz).

3.4.2 Test Procedures

1. Set EUT to transmit at rated power and channel to perform test.
2. Set RBW = VBW = 1MHz, Detector type = Peak, Sweep time = Auto.
3. Following above setting of spectrum analyzer to measure spurious emission of 30~12500 MHz.

3.4.3 Test Setup



3.4.4 Test Result of Transmitter Spurious Emissions

Reference Documents	Test Mode
Appendix D	BT-LE

3.5 Interference Prevention Function

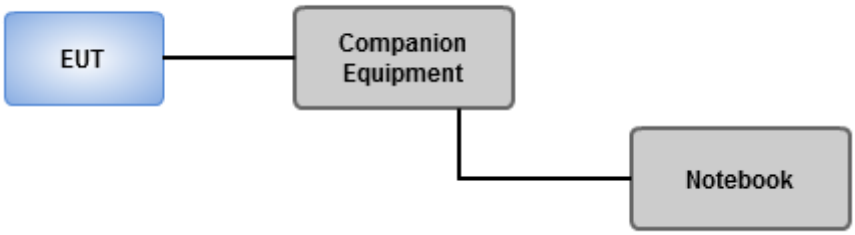
3.5.1 Limit of Interference Prevention Function

Limits
The identification code shall be 48 bits long

3.5.2 Test Procedures

1. Set EUT under operating mode and link up with companion equipment
2. Check communication status between EUT and companion equipment is normal
3. Confirm the MAC address of EUT

3.5.3 Test Setup



3.5.4 Test Result of Interference Prevention Function

Reference Documents	Test Mode
Appendix E	BT-LE

4 Receiver Test Results

4.1 Receiver Spurious Emissions

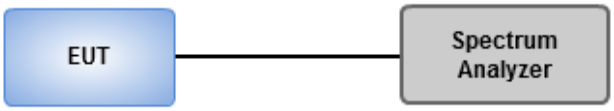
4.1.1 Limit of Receiver Spurious Emissions

Item	Limits
Rx Spurious Emission	≤ 4nW (f < 1GHz).
	≤ 20nW (1GHz ≤ f).

4.1.2 Test Procedures

1. Set EUT under receiving condition to perform test
2. Set RBW = VBW = 100kHz, detector = Peak, Sweep time = Auto for emission measurement below 1GHz.
3. Set RBW = VBW=1MHz, detector = Peak, Sweep time = Auto for emission measurement above 1GHz.

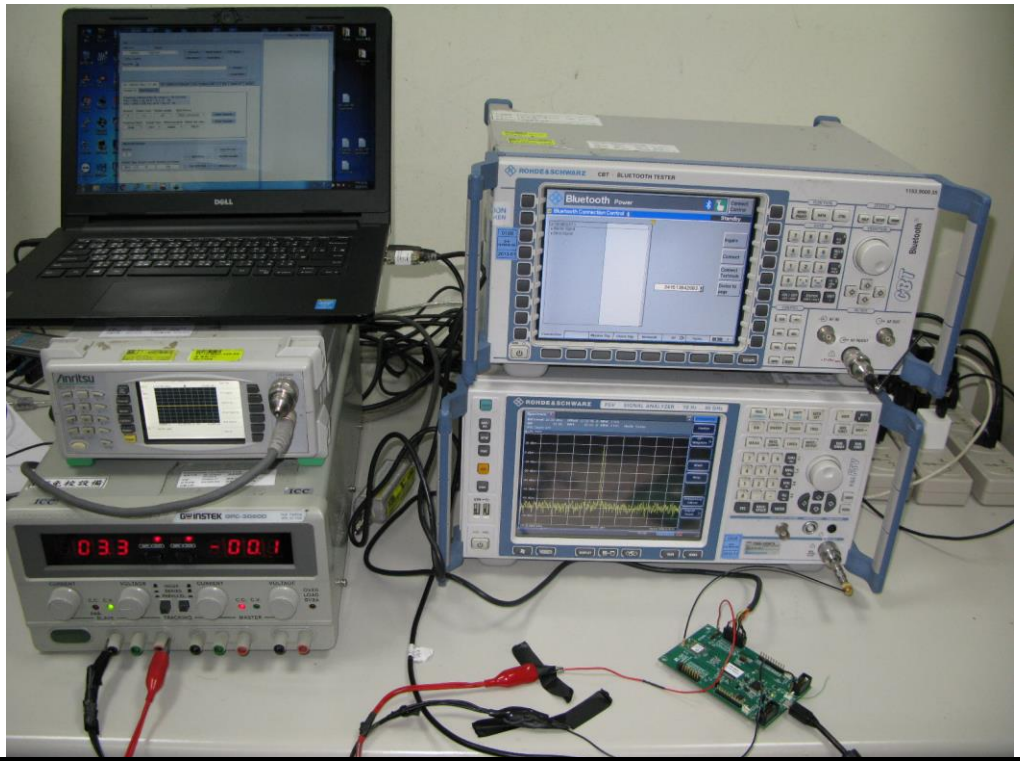
4.1.3 Test Setup



4.1.4 Test Result of Receiver Spurious Emissions

Reference Documents	Test Mode
Appendix F	BT-LE

5 Photographs of the Test Configuration



6 Test laboratory information

Established in 2012, ICC provides foremost EMC & RF Testing and advisory consultation services by our skilled engineers and technicians. Our services employ a wide variety of advanced edge test equipment and one of the widest certification extents in the business.

International Certification Corp (EMC and Wireless Communication Laboratory), it is our definitive objective is to institute long term, trust-based associations with our clients. The expectation we set up with our clients is based on outstanding service, practical expertise and devotion to a certified value structure. Our passion is to grant our clients with best EMC / RF services by oriented knowledgeable and accommodating staff.

Our Test sites are located at Linkou District and Kwei Shan District. Location map can be found on our website http://www.icertifi.com.tw.

Linkou	**Kwei Shan**	**Kwei Shan Site II**
Tel: 886-2-2601-1640	Tel: 886-3-271-8666	Tel: 886-3-271-8640
No. 30-2, Ding Fwu Tsuen, Lin Kou District, New Taipei City, Taiwan, R.O.C.	No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.	No. 14-1, Lane 19, Wen San 3rd St., Kwei Shan District, Tao Yuan City 333, Taiwan, R.O.C.

If you have any suggestion, please feel free to contact us as below information

Tel: 886-3-271-8666
Fax: 886-3-318-0155
Email: ICC_Service@icertifi.com.tw

==END==

Summary

Mode	Power (dBm)	Power (mW)	EIRP (dBm)	EIRP (mW)
2.4-2.4835GHz	-	-	-	-
BT-LE(1Mbps)	6.03	4.00867	8.53	7.129

P1 = Port 1 output power; **Power** = Total power sum by **P1**;

Result

Mode	Result	Gain (dBi)	Power (dBm)	Power (mW)	Power Lim. (mW)	EIRP (dBm)	EIRP (mW)	EIRP Lim. (mW)
BT-LE(1Mbps)	-	-	-	-	-	-	-	-
2402MHz_TnomVnom	Pass	2.50	5.89	3.88150	10	8.39	6.902	16.368
2402MHz_TnomVmin	Pass	2.50	5.88	3.87258	10	8.38	6.887	16.368
2402MHz_TnomVmax	Pass	2.50	5.90	3.89045	10	8.40	6.918	16.368
2440MHz_TnomVnom	Pass	2.50	6.03	4.00867	10	8.53	7.129	16.368
2440MHz_TnomVmin	Pass	2.50	6.01	3.99025	10	8.51	7.096	16.368
2440MHz_TnomVmax	Pass	2.50	6.01	3.99025	10	8.51	7.096	16.368
2480MHz_TnomVnom	Pass	2.50	4.70	2.95121	10	7.20	5.248	16.368
2480MHz_TnomVmin	Pass	2.50	4.71	2.95801	10	7.21	5.260	16.368
2480MHz_TnomVmax	Pass	2.50	4.75	2.98538	10	7.25	5.309	16.368

P1 = Port 1 output power; **Power** = Total power sum by **P1**;

Summary

Mode	Result	Power (dBm)	Power (mW)	Declare (mW)	Tolerance (%)	Limit+ (%)	Limit- (%)
2.4-2.4835GHz	-	-	-	-	-	-	-
BT-LE(1Mbps)	Pass	6.03	4.00867	4.00	0.22	20	-80

Result

Mode	Result	Power (dBm)	Power (mW)	Declare (mW)	Tolerance (%)	Limit+ (%)	Limit- (%)
BT-LE(1Mbps)	-	-	-	-	-	-	-
2402MHz_TnomVnom	Pass	5.89	3.88150	4.00	-2.96	20	-80
2402MHz_TnomVmin	Pass	5.88	3.87258	4.00	-3.19	20	-80
2402MHz_TnomVmax	Pass	5.90	3.89045	4.00	-2.74	20	-80
2440MHz_TnomVnom	Pass	6.03	4.00867	4.00	0.22	20	-80
2440MHz_TnomVmin	Pass	6.01	3.99025	4.00	-0.24	20	-80
2440MHz_TnomVmax	Pass	6.01	3.99025	4.00	-0.24	20	-80
2480MHz_TnomVnom	Pass	4.70	2.95121	4.00	-26.22	20	-80
2480MHz_TnomVmin	Pass	4.71	2.95801	4.00	-26.05	20	-80
2480MHz_TnomVmax	Pass	4.75	2.98538	4.00	-25.37	20	-80

Summary

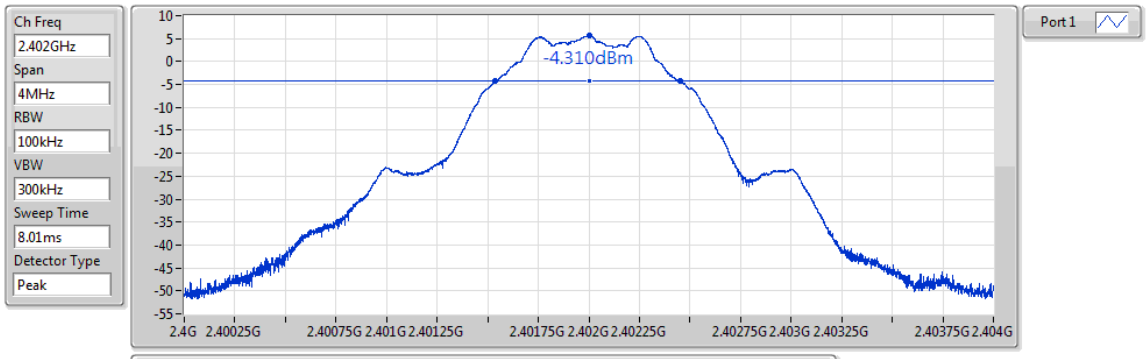
Mode	Result	Ch (Hz)	Center (Hz)	ppm	Limit (ppm)	Port	Remark
2.4-2.4835GHz	-	-	-	-	-	-	-
BT-LE(1Mbps)	Pass	2.48G	2.479979G	-8.468	±50	1	-

Result

Mode	Result	Ch (Hz)	Center (Hz)	ppm	Limit (ppm)	Port	Remark
BT-LE(1Mbps)	-	-	-	-	-	-	-
2402MHz_TnomVnom	Pass	2.402G	2.401994G	-2.394	±50	1	-
2402MHz_TnomVmin	Pass	2.402G	2.401996G	-1.769	±50	1	-
2402MHz_TnomVmax	Pass	2.402G	2.401995G	-2.082	±50	1	-
2440MHz_TnomVnom	Pass	2.44G	2.439988G	-4.816	±50	1	-
2440MHz_TnomVmin	Pass	2.44G	2.439988G	-4.816	±50	1	-
2440MHz_TnomVmax	Pass	2.44G	2.439986G	-5.84	±50	1	-
2480MHz_TnomVnom	Pass	2.48G	2.47998G	-7.964	±50	1	-
2480MHz_TnomVmin	Pass	2.48G	2.47998G	-8.165	±50	1	-
2480MHz_TnomVmax	Pass	2.48G	2.479979G	-8.468	±50	1	-

BT-LE(1Mbps) **Freq. Stability**

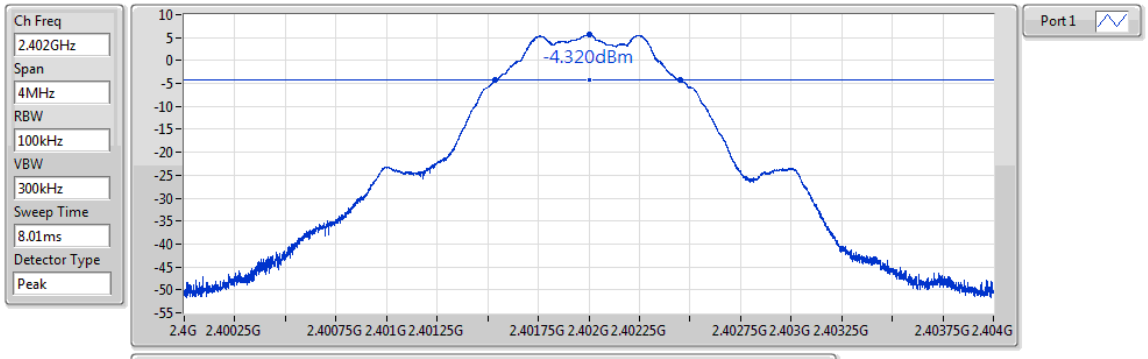
2402MHz_TnomVnom



Ch(Hz)	Center(Hz)	Fl(Hz)	Fh(Hz)	ppm	Limit(ppm)	Port	Remark
2.402G	2.401994G	2.401536G	2.402453G	-2.394	±50	1	-

BT-LE(1Mbps) **Freq. Stability**

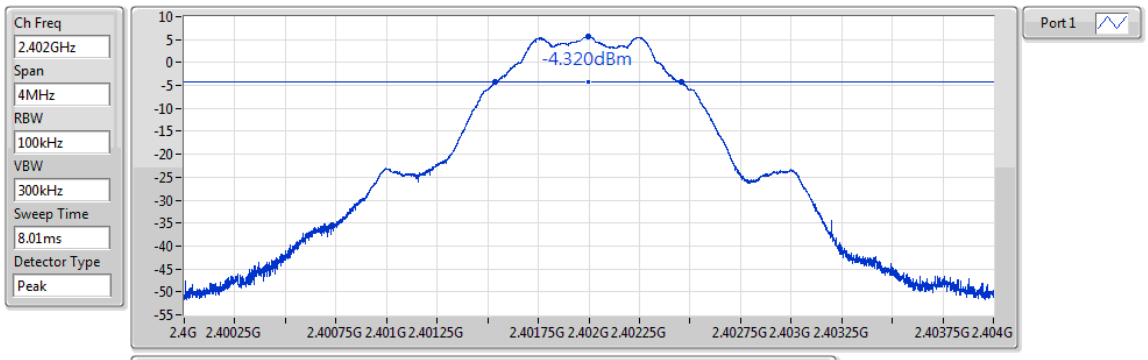
2402MHz_TnomVmin



Ch(Hz)	Center(Hz)	Fl(Hz)	Fh(Hz)	ppm	Limit(ppm)	Port	Remark
2.402G	2.401996G	2.401538G	2.402454G	-1.769	±50	1	-

BT-LE(1Mbps) **Freq. Stability**

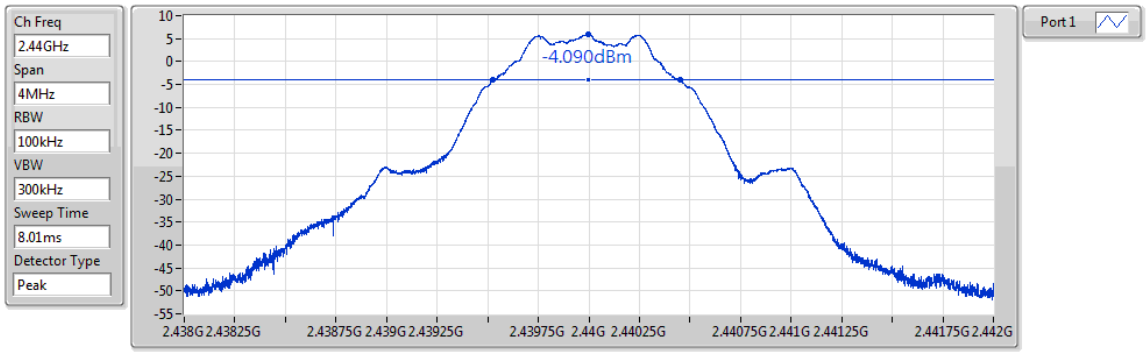
2402MHz_TnomVmax



Ch(Hz)	Center(Hz)	Fl(Hz)	Fh(Hz)	ppm	Limit(ppm)	Port	Remark
2.402G	2.401995G	2.401535G	2.402455G	-2.082	±50	1	-

BT-LE(1Mbps) **Freq. Stability**

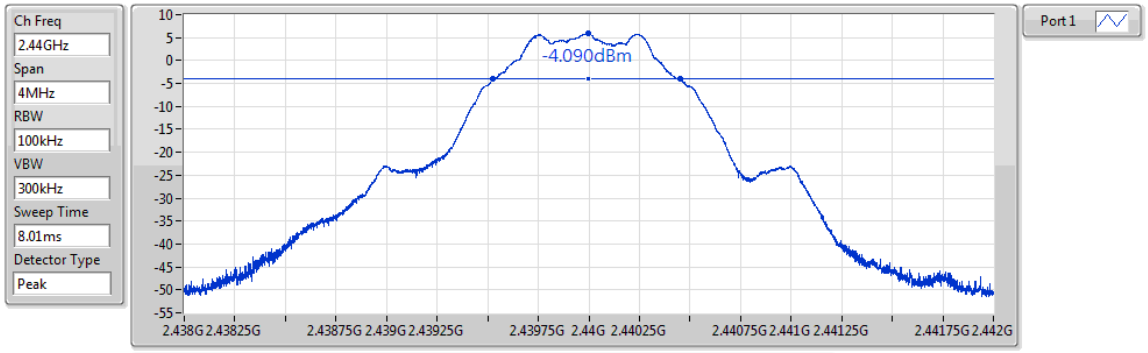
2440MHz_TnomVnom



Ch(Hz)	Center(Hz)	Fl(Hz)	Fh(Hz)	ppm	Limit(ppm)	Port	Remark
2.44G	2.439988G	2.439527G	2.44045G	-4.816	±50	1	-

BT-LE(1Mbps) **Freq. Stability**

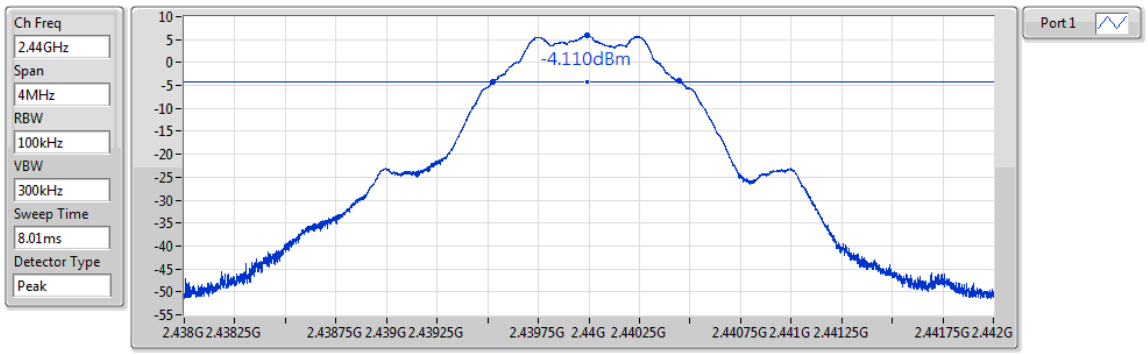
2440MHz_TnomVmin



Ch(Hz)	Center(Hz)	Fl(Hz)	Fh(Hz)	ppm	Limit(ppm)	Port	Remark
2.44G	2.439988G	2.439528G	2.440449G	-4.816	±50	1	-

BT-LE(1Mbps) **Freq. Stability**

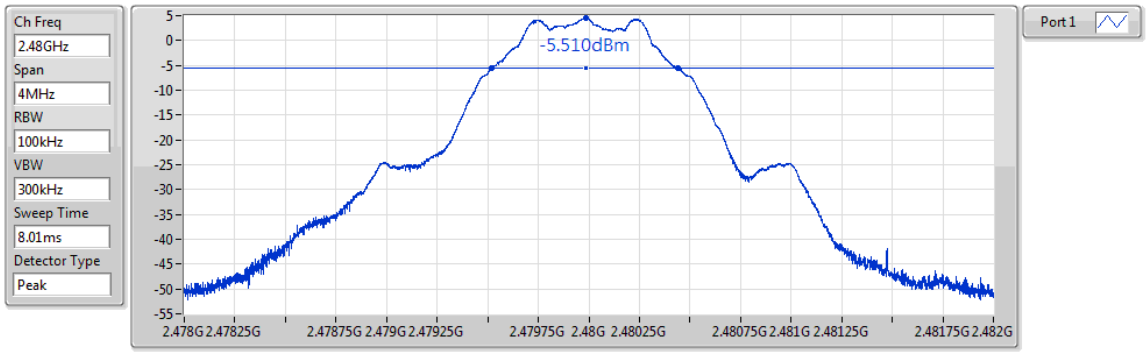
2440MHz_TnomVmax



Ch(Hz)	Center(Hz)	Fl(Hz)	Fh(Hz)	ppm	Limit(ppm)	Port	Remark
2.44G	2.439986G	2.439527G	2.440445G	-5.84	±50	1	-

BT-LE(1Mbps) **Freq. Stability**

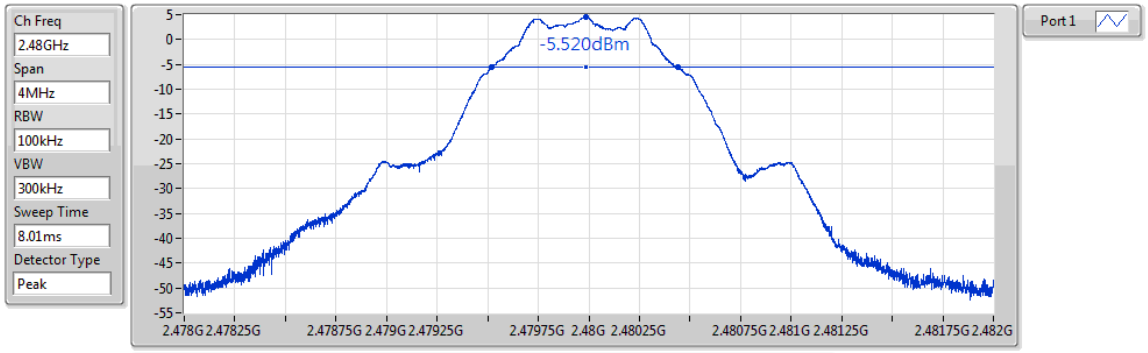
2480MHz_TnomVnom



Ch(Hz)	Center(Hz)	Fl(Hz)	Fh(Hz)	ppm	Limit(ppm)	Port	Remark
2.48G	2.47998G	2.479521G	2.48044G	-7.964	±50	1	-

BT-LE(1Mbps) **Freq. Stability**

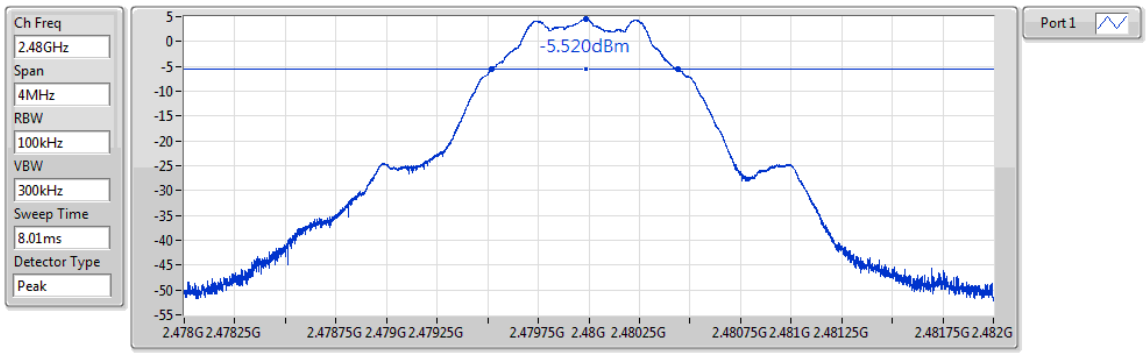
2480MHz_TnomVmin



Ch(Hz)	Center(Hz)	Fl(Hz)	Fh(Hz)	ppm	Limit(ppm)	Port	Remark
2.48G	2.47998G	2.479521G	2.480439G	-8.165	±50	1	-

BT-LE(1Mbps) **Freq. Stability**

2480MHz_TnomVmax



Ch(Hz)	Center(Hz)	Fl(Hz)	Fh(Hz)	ppm	Limit(ppm)	Port	Remark
2.48G	2.479979G	2.47952G	2.480438G	-8.468	±50	1	-

Summary

Mode	Max-OBW (MHz)	ITU-Code	Min-OBW (MHz)
2.4-2.4835GHz	-	-	-
BT-LE(1Mbps)	1.31	1M31F1D	1.305

Max-OBW = Maximum 99% occupied bandwidth; **Min-OBW** = Minimum 99% occupied bandwidth;

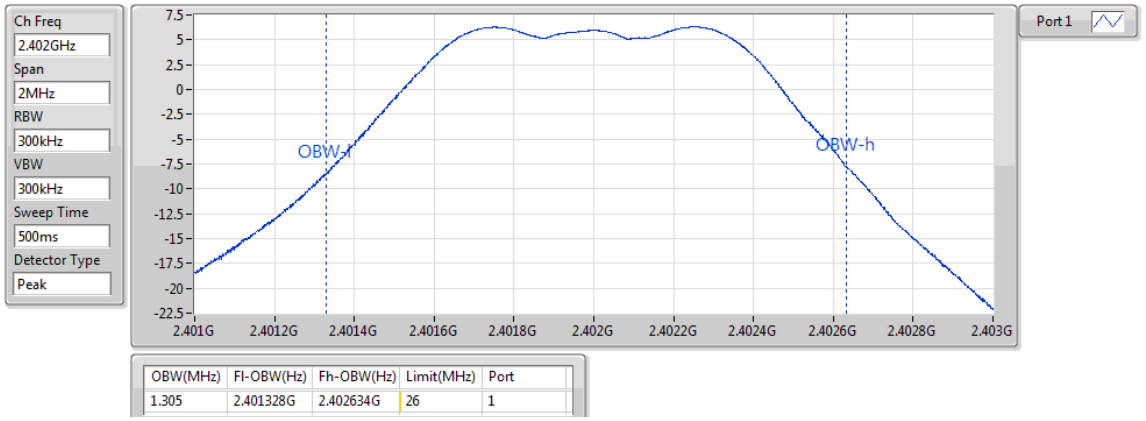
Result

Mode	Result	Limit (MHz)	P1-OBW (MHz)
BT-LE(1Mbps)	-	-	-
2402MHz_TnomVnom	Pass	26	1.305
2402MHz_TnomVmin	Pass	26	1.305
2402MHz_TnomVmax	Pass	26	1.305
2440MHz_TnomVnom	Pass	26	1.31
2440MHz_TnomVmin	Pass	26	1.309
2440MHz_TnomVmax	Pass	26	1.31
2480MHz_TnomVnom	Pass	26	1.31
2480MHz_TnomVmin	Pass	26	1.31
2480MHz_TnomVmax	Pass	26	1.31

P1-OBW = Port 1 99% occupied bandwidth;

BT-LE(1Mbps) **OBW**

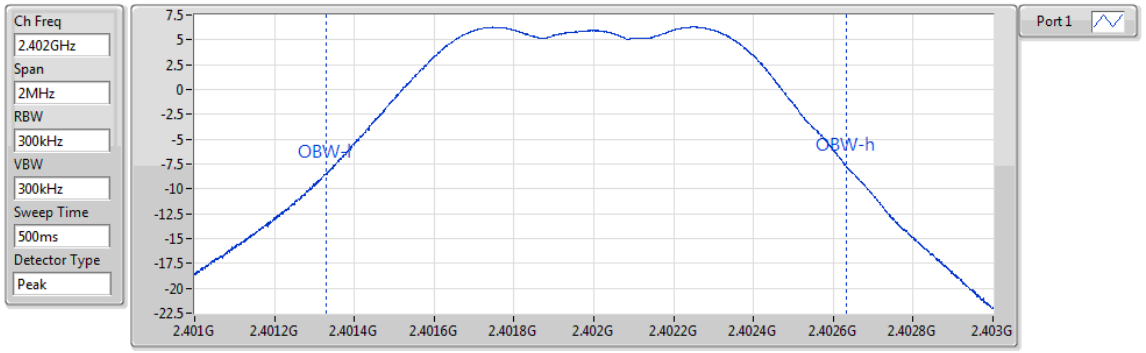
2402MHz_TnomVnom



OBW(MHz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(MHz)	Port
1.305	2.401328G	2.402634G	26	1

BT-LE(1Mbps) **OBW**

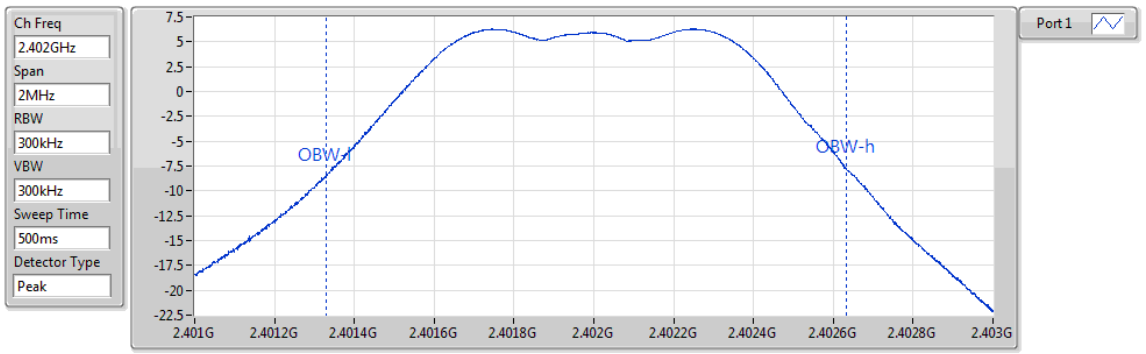
2402MHz_TnomVmin



OBW(MHz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(MHz)	Port
1.305	2.401328G	2.402634G	26	1

BT-LE(1Mbps) **OBW**

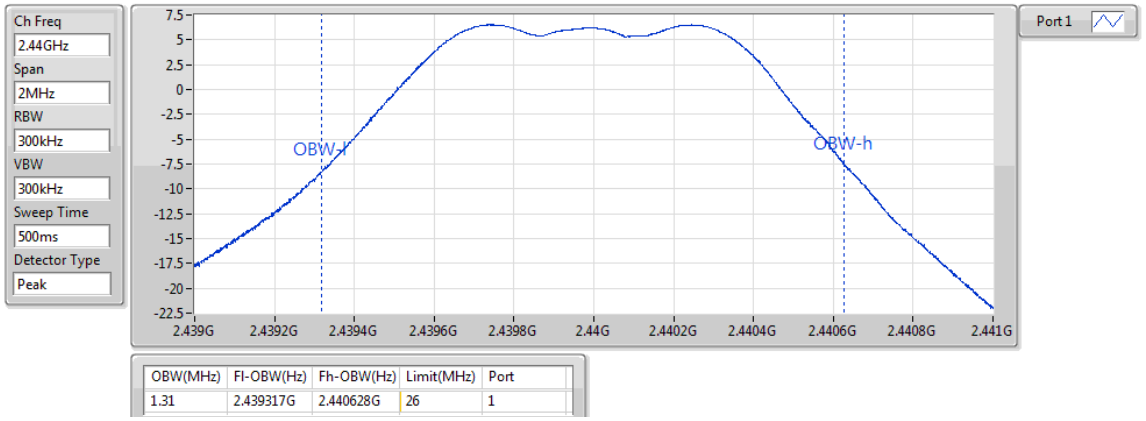
2402MHz_TnomVmax



OBW(MHz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(MHz)	Port
1.305	2.401328G	2.402634G	26	1

BT-LE(1Mbps) **OBW**

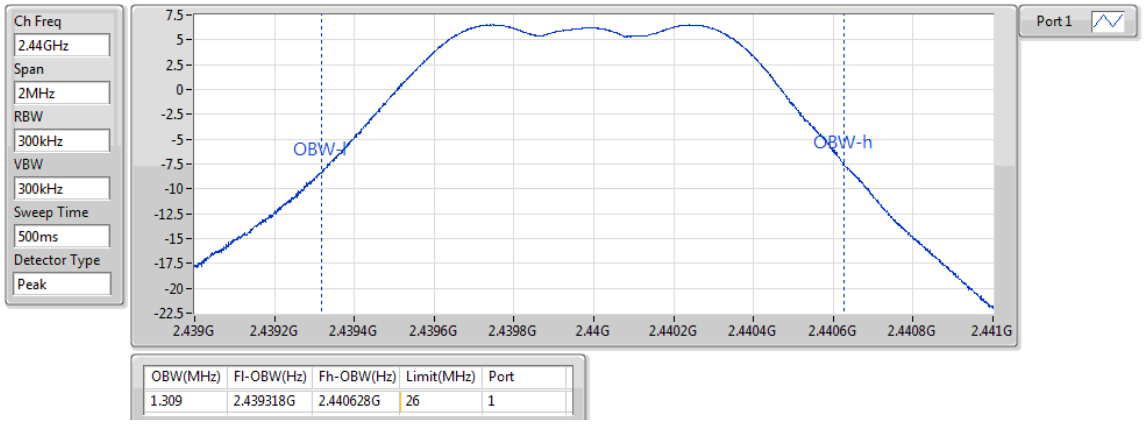
2440MHz_TnomVnom



OBW(MHz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(MHz)	Port
1.31	2.439317G	2.440628G	26	1

BT-LE(1Mbps) **OBW**

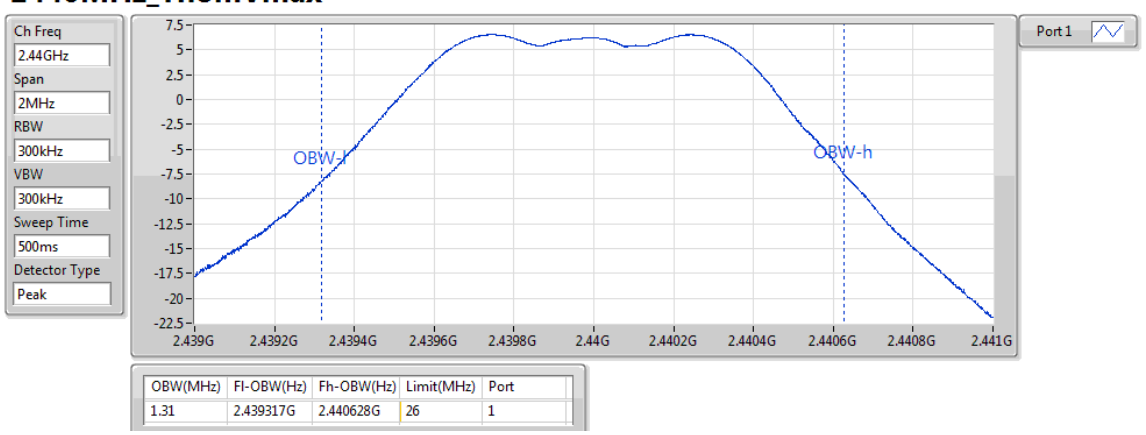
2440MHz_TnomVmin



OBW(MHz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(MHz)	Port
1.309	2.439318G	2.440628G	26	1

BT-LE(1Mbps) **OBW**

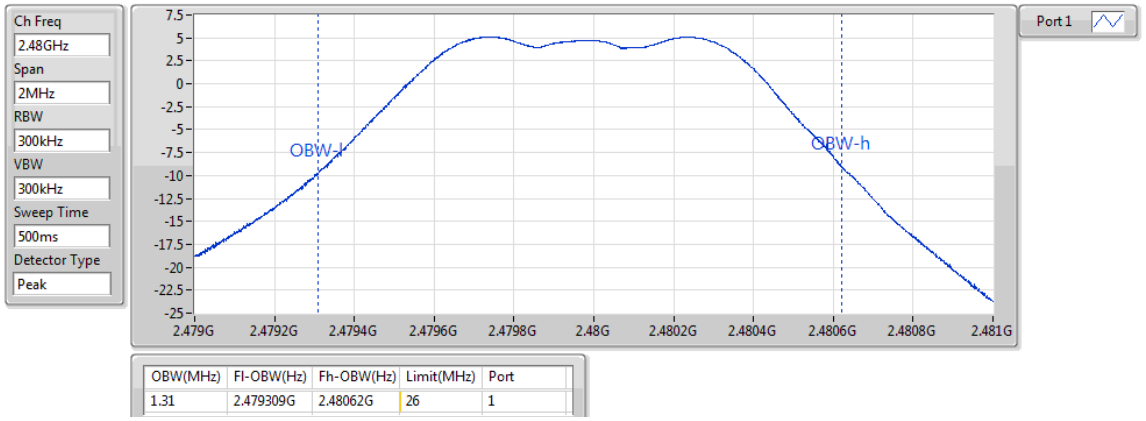
2440MHz_TnomVmax



OBW(MHz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(MHz)	Port
1.31	2.439317G	2.440628G	26	1

BT-LE(1Mbps) **OBW**

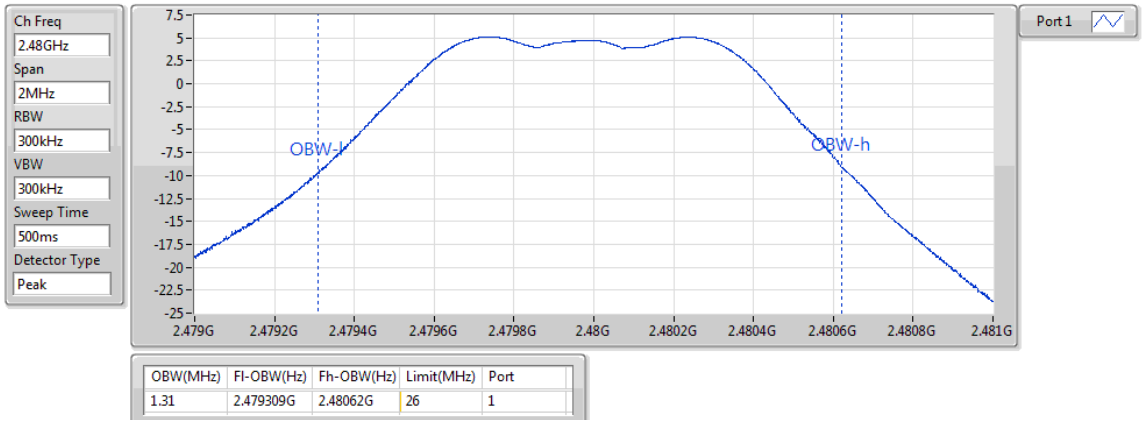
2480MHz_TnomVnom



OBW(MHz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(MHz)	Port
1.31	2.479309G	2.48062G	26	1

BT-LE(1Mbps) **OBW**

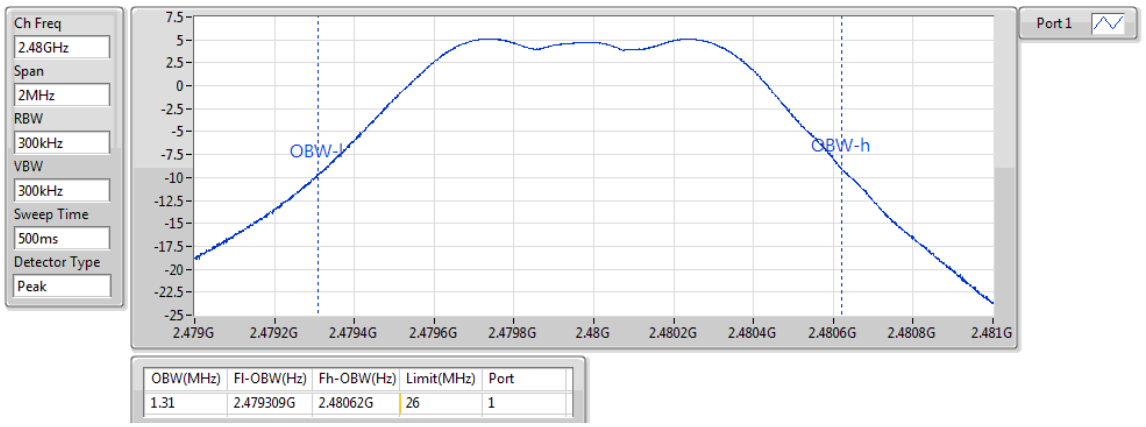
2480MHz_TnomVmin



OBW(MHz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(MHz)	Port
1.31	2.479309G	2.48062G	26	1

BT-LE(1Mbps) **OBW**

2480MHz_TnomVmax



OBW(MHz)	Fl-OBW(Hz)	Fh-OBW(Hz)	Limit(MHz)	Port
1.31	2.479309G	2.48062G	26	1

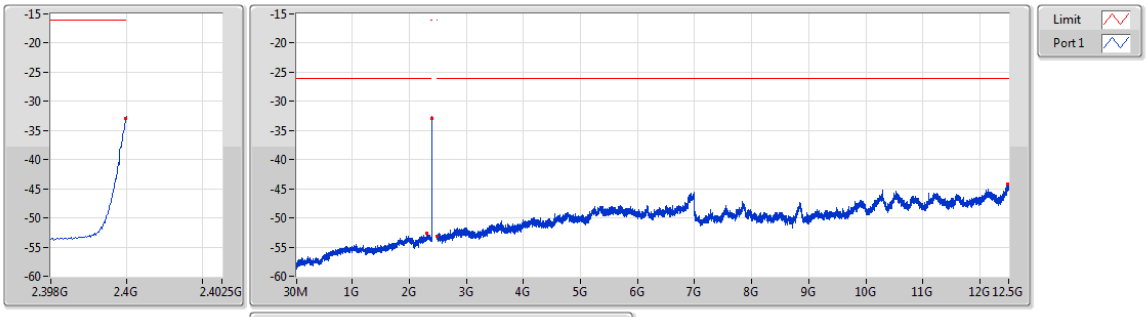
Summary

Mode	Result	F-Start (Hz)	F-Stop (Hz)	RBW (Hz)	Freq (MHz)	Psum (dBm)	Psum (uW/MHz)	Limit (dBm)	Limit (uW/MHz)	Margin (dB)
2.4-2.4835GHz	-	-	-	-	-	-	-	-	-	-
BT-LE(1Mbps)	Pass	2.387G	2.4G	1M	2399.974	-32.88	0.51523	-16.02	25	-16.86

Result

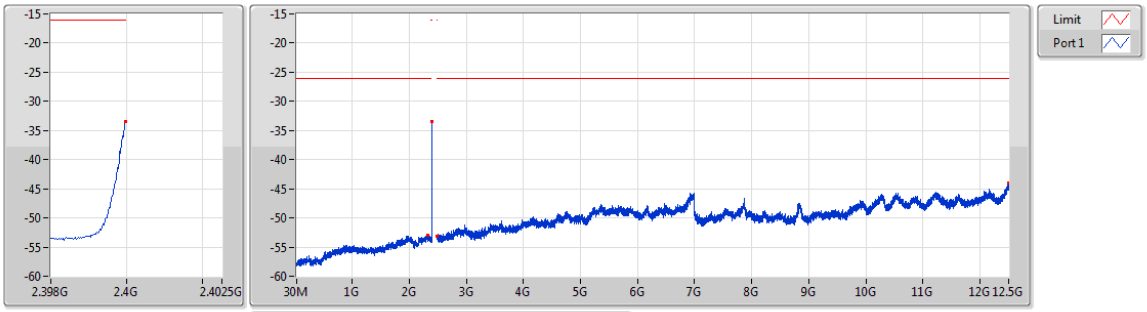
Mode	Result	F-Start (Hz)	F-Stop (Hz)	RBW (Hz)	Freq (MHz)	Psum (dBm)	Psum (uW/MHz)	Limit (dBm)	Limit (uW/MHz)	Margin (dB)
BT-LE(1Mbps)	-	-	-	-	-	-	-	-	-	-
2402MHz_TnomVnom	Pass	30M	2.387G	1M	2312.755	-52.61	0.00548	-26.02	2.5	-26.59
2402MHz_TnomVnom	Pass	2.387G	2.4G	1M	2399.974	-32.88	0.51523	-16.02	25	-16.86
2402MHz_TnomVnom	Pass	2.4835G	2.4965G	1M	2484.54	-53.20	0.00479	-16.02	25	-37.18
2402MHz_TnomVnom	Pass	2.4965G	12.5G	1M	12486.245	-44.16	0.03837	-26.02	2.5	-18.14
2402MHz_TnomVmin	Pass	30M	2.387G	1M	2325.718	-52.98	0.00504	-26.02	2.5	-26.96
2402MHz_TnomVmin	Pass	2.387G	2.4G	1M	2399.974	-33.37	0.46026	-16.02	25	-17.35
2402MHz_TnomVmin	Pass	2.4835G	2.4965G	1M	2493.38	-53.20	0.00479	-16.02	25	-37.18
2402MHz_TnomVmin	Pass	2.4965G	12.5G	1M	12498.75	-44.09	0.03899	-26.02	2.5	-18.07
2402MHz_TnomVmax	Pass	30M	2.387G	1M	2357.537	-52.84	0.0052	-26.02	2.5	-26.82
2402MHz_TnomVmax	Pass	2.387G	2.4G	1M	2399.974	-32.98	0.5035	-16.02	25	-16.96
2402MHz_TnomVmax	Pass	2.4835G	2.4965G	1M	2490.312	-53.23	0.00475	-16.02	25	-37.21
2402MHz_TnomVmax	Pass	2.4965G	12.5G	1M	12491.247	-44.32	0.03698	-26.02	2.5	-18.30
2440MHz_TnomVnom	Pass	30M	2.387G	1M	2330.432	-52.78	0.00527	-26.02	2.5	-26.76
2440MHz_TnomVnom	Pass	2.387G	2.4G	1M	2396.256	-53.65	0.00432	-16.02	25	-37.63
2440MHz_TnomVnom	Pass	2.4835G	2.4965G	1M	2484.514	-53.22	0.00476	-16.02	25	-37.20
2440MHz_TnomVnom	Pass	2.4965G	12.5G	1M	12496.249	-44.08	0.03908	-26.02	2.5	-18.06
2440MHz_TnomVmin	Pass	30M	2.387G	1M	1982.774	-52.85	0.00519	-26.02	2.5	-26.83
2440MHz_TnomVmin	Pass	2.387G	2.4G	1M	2394.852	-53.59	0.00438	-16.02	25	-37.57
2440MHz_TnomVmin	Pass	2.4835G	2.4965G	1M	2488.544	-53.25	0.00473	-16.02	25	-37.23
2440MHz_TnomVmin	Pass	2.4965G	12.5G	1M	12487.496	-44.28	0.03733	-26.02	2.5	-18.26
2440MHz_TnomVmax	Pass	30M	2.387G	1M	2346.931	-52.75	0.00531	-26.02	2.5	-26.73
2440MHz_TnomVmax	Pass	2.387G	2.4G	1M	2387.208	-53.68	0.00429	-16.02	25	-37.66
2440MHz_TnomVmax	Pass	2.4835G	2.4965G	1M	2488.804	-53.22	0.00476	-16.02	25	-37.20
2440MHz_TnomVmax	Pass	2.4965G	12.5G	1M	12498.75	-43.73	0.04236	-26.02	2.5	-17.71
2480MHz_TnomVnom	Pass	30M	2.387G	1M	2311.576	-52.91	0.00512	-26.02	2.5	-26.89
2480MHz_TnomVnom	Pass	2.387G	2.4G	1M	2398.284	-53.61	0.00436	-16.02	25	-37.59
2480MHz_TnomVnom	Pass	2.4835G	2.4965G	1M	2484.124	-53.00	0.00501	-16.02	25	-36.98
2480MHz_TnomVnom	Pass	2.4965G	12.5G	1M	12452.483	-44.47	0.03573	-26.02	2.5	-18.45
2480MHz_TnomVmin	Pass	30M	2.387G	1M	2318.647	-52.90	0.00513	-26.02	2.5	-26.88
2480MHz_TnomVmin	Pass	2.387G	2.4G	1M	2399.454	-53.55	0.00442	-16.02	25	-37.53
2480MHz_TnomVmin	Pass	2.4835G	2.4965G	1M	2483.526	-53.05	0.00495	-16.02	25	-37.03
2480MHz_TnomVmin	Pass	2.4965G	12.5G	1M	12498.75	-44.10	0.0389	-26.02	2.5	-18.08
2480MHz_TnomVmax	Pass	30M	2.387G	1M	2345.753	-52.85	0.00519	-26.02	2.5	-26.83
2480MHz_TnomVmax	Pass	2.387G	2.4G	1M	2391.576	-53.64	0.00433	-16.02	25	-37.62
2480MHz_TnomVmax	Pass	2.4835G	2.4965G	1M	2483.89	-53.04	0.00497	-16.02	25	-37.02
2480MHz_TnomVmax	Pass	2.4965G	12.5G	1M	12498.75	-44.34	0.03681	-26.02	2.5	-18.32

BT-LE(1Mbps) CSE-TX-2402MHz_TnomVnom



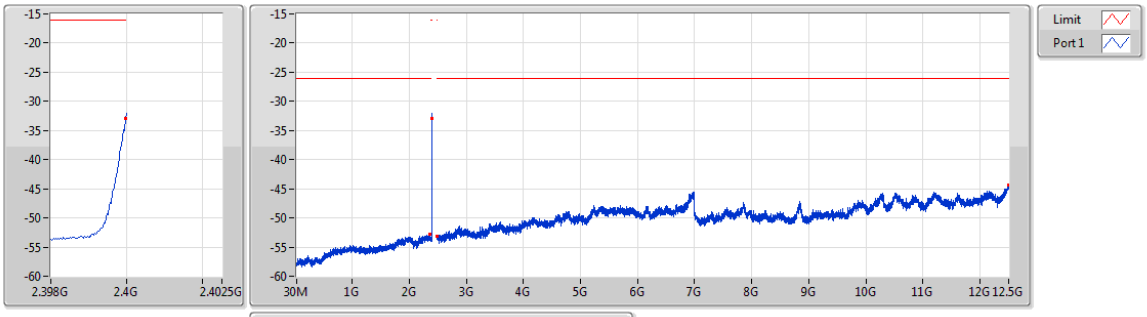
Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
2312.755	-52.61	-26.02	-26.59	-52.61
2399.974	-32.88	-16.02	-16.86	-32.88
2484.54	-53.20	-16.02	-37.18	-53.20
12486.245	-44.16	-26.02	-18.14	-44.16

BT-LE(1Mbps) CSE-TX-2402MHz_TnomVmin



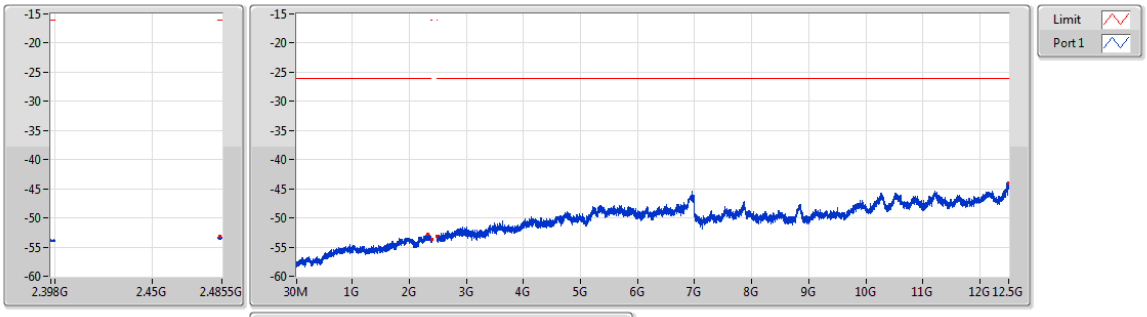
Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
2325.718	-52.98	-26.02	-26.96	-52.98
2399.974	-33.37	-16.02	-17.35	-33.37
2493.38	-53.20	-16.02	-37.18	-53.20
12498.75	-44.09	-26.02	-18.07	-44.09

BT-LE(1Mbps) CSE-TX-2402MHz_TnomVmax



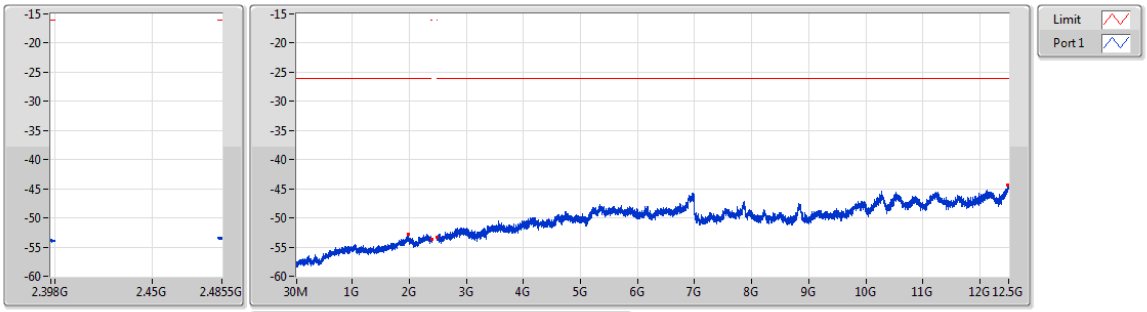
Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
2357.537	-52.84	-26.02	-26.82	-52.84
2399.974	-32.98	-16.02	-16.96	-32.98
2490.312	-53.23	-16.02	-37.21	-53.23
12491.247	-44.32	-26.02	-18.30	-44.32

BT-LE(1Mbps) CSE-TX-2440MHz_TnomVnom



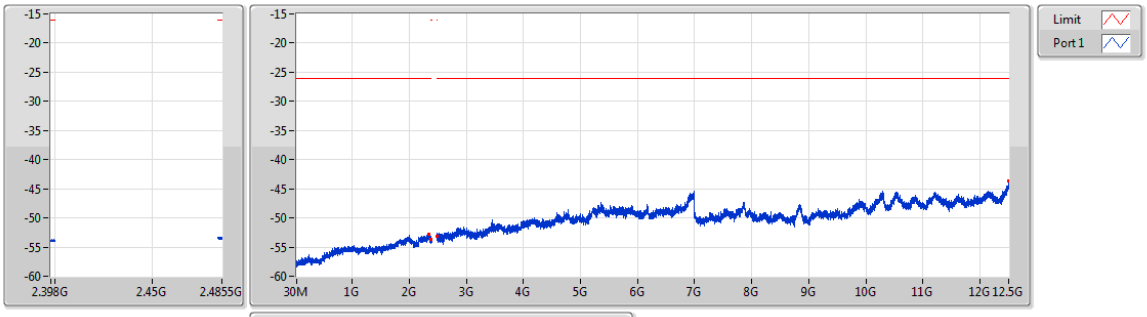
Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
2330.432	-52.78	-26.02	-26.76	-52.78
2396.256	-53.65	-16.02	-37.63	-53.65
2484.514	-53.22	-16.02	-37.20	-53.22
12496.249	-44.08	-26.02	-18.06	-44.08

BT-LE(1Mbps) CSE-TX-2440MHz_TnomVmin



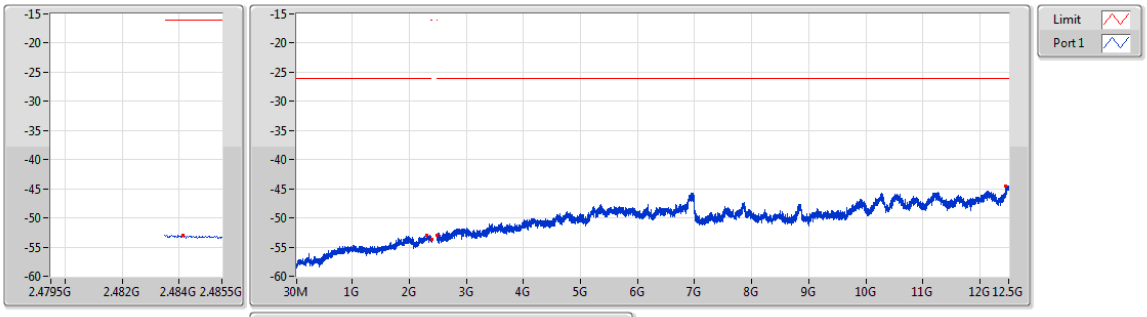
Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
1982.774	-52.85	-26.02	-26.83	-52.85
2394.852	-53.59	-16.02	-37.57	-53.59
2488.544	-53.25	-16.02	-37.23	-53.25
12487.496	-44.28	-26.02	-18.26	-44.28

BT-LE(1Mbps) CSE-TX-2440MHz_TnomVmax



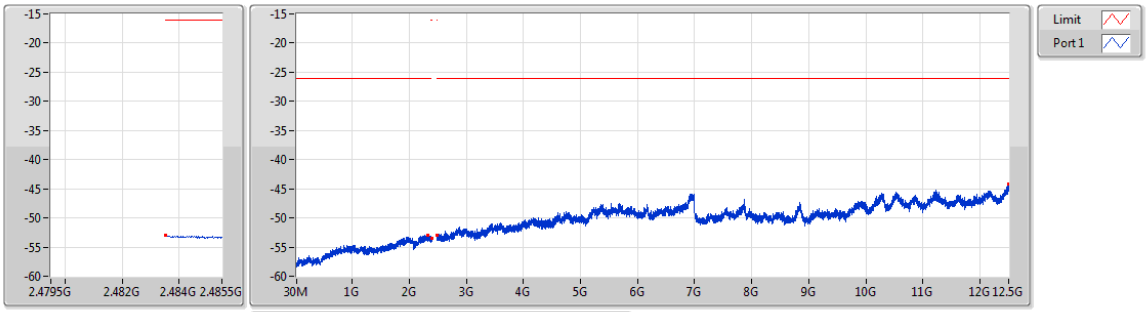
Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
2346.931	-52.75	-26.02	-26.73	-52.75
2387.208	-53.68	-16.02	-37.66	-53.68
2488.804	-53.22	-16.02	-37.20	-53.22
12498.75	-43.73	-26.02	-17.71	-43.73

BT-LE(1Mbps) CSE-TX-2480MHz_TnomVnom



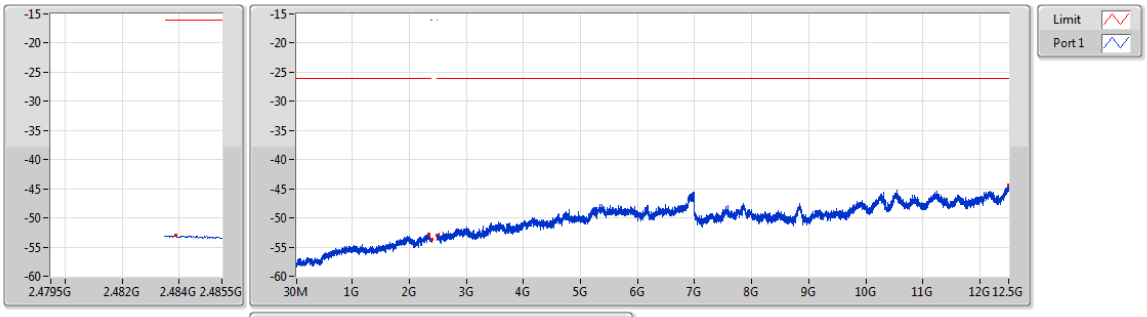
Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
2311.576	-52.91	-26.02	-26.89	-52.91
2398.284	-53.61	-16.02	-37.59	-53.61
2484.124	-53.00	-16.02	-36.98	-53.00
12452.483	-44.47	-26.02	-18.45	-44.47

BT-LE(1Mbps) CSE-TX-2480MHz_TnomVmin



Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
2318.647	-52.90	-26.02	-26.88	-52.90
2399.454	-53.55	-16.02	-37.53	-53.55
2483.526	-53.05	-16.02	-37.03	-53.05
12498.75	-44.10	-26.02	-18.08	-44.10

BT-LE(1Mbps) CSE-TX-2480MHz_TnomVmax



Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
2345.753	-52.85	-26.02	-26.83	-52.85
2391.576	-53.64	-16.02	-37.62	-53.64
2483.89	-53.04	-16.02	-37.02	-53.04
12498.75	-44.34	-26.02	-18.32	-44.34

Summary

Mode	Result	ID Length	ID Limit	Function
2.4-2.4835GHz	-	-	-	-
BT-LE(1Mbps)	Pass	43:39:00:07:1F:AC	48 bits	Good

Result

Mode	Result	ID Length	ID Limit	Function
BT-LE(1Mbps)	-	-	-	-
2402MHz_TnomVnom	Pass	43:39:00:07:1F:AC	48 bits	Good
2402MHz_TnomVmin	Pass	43:39:00:07:1F:AC	48 bits	Good
2402MHz_TnomVmax	Pass	43:39:00:07:1F:AC	48 bits	Good
2440MHz_TnomVnom	Pass	43:39:00:07:1F:AC	48 bits	Good
2440MHz_TnomVmin	Pass	43:39:00:07:1F:AC	48 bits	Good
2440MHz_TnomVmax	Pass	43:39:00:07:1F:AC	48 bits	Good
2480MHz_TnomVnom	Pass	43:39:00:07:1F:AC	48 bits	Good
2480MHz_TnomVmin	Pass	43:39:00:07:1F:AC	48 bits	Good
2480MHz_TnomVmax	Pass	43:39:00:07:1F:AC	48 bits	Good

Summary

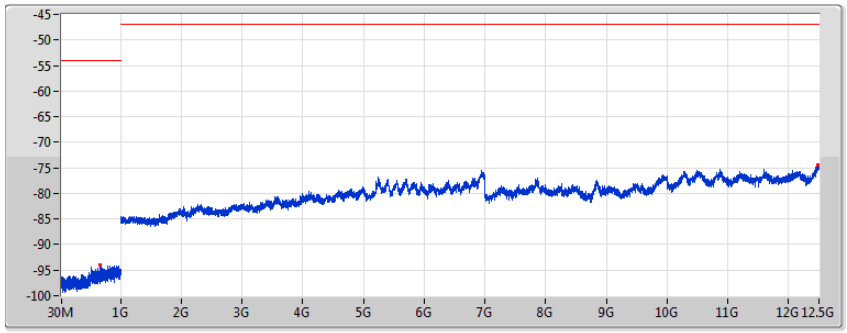
Mode	Result	F-Start (Hz)	F-Stop (Hz)	RBW (Hz)	Freq (MHz)	Psum (dBm)	Psum (nW/MHz)	Limit (dBm)	Limit (nW/MHz)	Margin (dB)
2.4-2.4835GHz	-	-	-	-	-	-	-	-	-	-
BT-LE(1Mbps)	Pass	1G	12.5G	1M	12498.562	-74.15	0.03846	-46.99	20	-27.16

Result

Mode	Result	F-Start (Hz)	F-Stop (Hz)	RBW (Hz)	Freq (MHz)	Psum (dBm)	Psum (nW/MHz)	Limit (dBm)	Limit (nW/MHz)	Margin (dB)
BT-LE(1Mbps)	-	-	-	-	-	-	-	-	-	-
2402MHz_TnomVnom	Pass	30M	1G	100k	664.38	-94.00	0.0004	-53.98	4	-40.02
2402MHz_TnomVnom	Pass	1G	12.5G	1M	12484.187	-74.47	0.03573	-46.99	20	-27.48
2402MHz_TnomVmin	Pass	30M	1G	100k	869.535	-94.06	0.00039	-53.98	4	-40.08
2402MHz_TnomVmin	Pass	1G	12.5G	1M	12500	-74.47	0.03573	-46.99	20	-27.48
2402MHz_TnomVmax	Pass	30M	1G	100k	948.105	-93.41	0.00046	-53.98	4	-39.43
2402MHz_TnomVmax	Pass	1G	12.5G	1M	12500	-74.57	0.03491	-46.99	20	-27.58
2440MHz_TnomVnom	Pass	30M	1G	100k	954.895	-93.20	0.00048	-53.98	4	-39.22
2440MHz_TnomVnom	Pass	1G	12.5G	1M	12498.562	-74.26	0.0375	-46.99	20	-27.27
2440MHz_TnomVmin	Pass	30M	1G	100k	986.905	-93.83	0.00041	-53.98	4	-39.85
2440MHz_TnomVmin	Pass	1G	12.5G	1M	12500	-74.63	0.03443	-46.99	20	-27.64
2440MHz_TnomVmax	Pass	30M	1G	100k	921.915	-93.59	0.00044	-53.98	4	-39.61
2440MHz_TnomVmax	Pass	1G	12.5G	1M	12484.187	-74.63	0.03443	-46.99	20	-27.64
2480MHz_TnomVnom	Pass	30M	1G	100k	909.305	-93.85	0.00041	-53.98	4	-39.87
2480MHz_TnomVnom	Pass	1G	12.5G	1M	12498.562	-74.15	0.03846	-46.99	20	-27.16
2480MHz_TnomVmin	Pass	30M	1G	100k	711.425	-93.86	0.00041	-53.98	4	-39.88
2480MHz_TnomVmin	Pass	1G	12.5G	1M	12492.812	-74.20	0.03802	-46.99	20	-27.21
2480MHz_TnomVmax	Pass	30M	1G	100k	992.725	-93.93	0.0004	-53.98	4	-39.95
2480MHz_TnomVmax	Pass	1G	12.5G	1M	12500	-74.16	0.03837	-46.99	20	-27.17

BT-LE(1Mbps) **CSE-RX-**

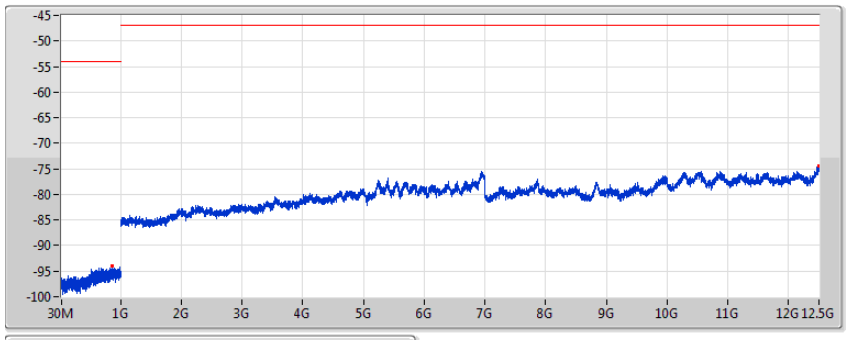
2402MHz_TnomVnom



Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
664.38	-94.00	-53.98	-40.02	-94.00
12484.187	-74.47	-46.99	-27.48	-74.47

BT-LE(1Mbps) **CSE-RX-**

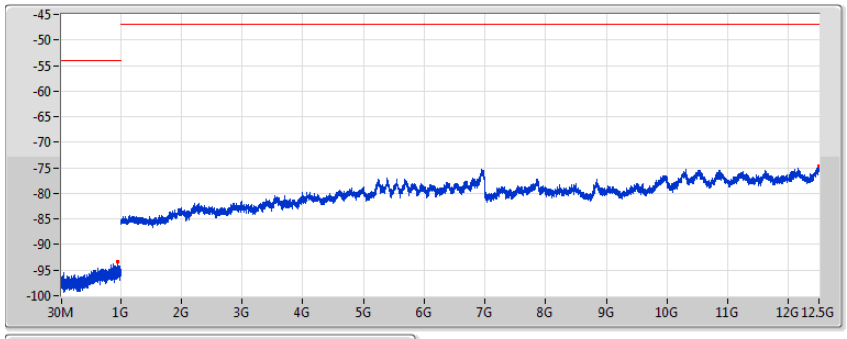
2402MHz_TnomVmin



Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
869.535	-94.06	-53.98	-40.08	-94.06
12500	-74.47	-46.99	-27.48	-74.47

BT-LE(1Mbps) **CSE-RX-**

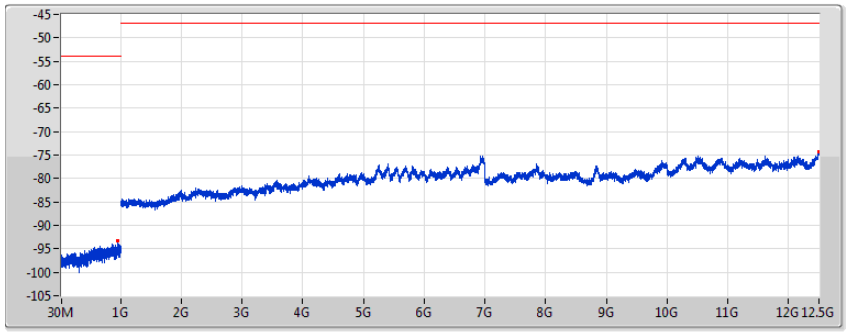
2402MHz_TnomVmax



Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
948.105	-93.41	-53.98	-39.43	-93.41
12500	-74.57	-46.99	-27.58	-74.57

BT-LE(1Mbps) **CSE-RX-**

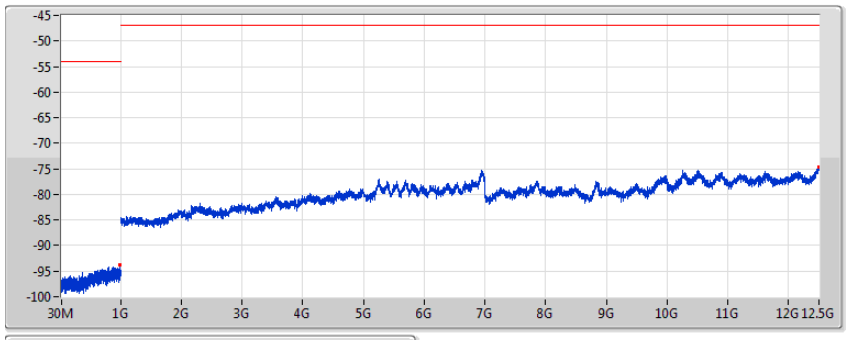
2440MHz_TnomVnom



Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
954.895	-93.20	-53.98	-39.22	-93.20
12498.562	-74.26	-46.99	-27.27	-74.26

BT-LE(1Mbps) **CSE-RX-**

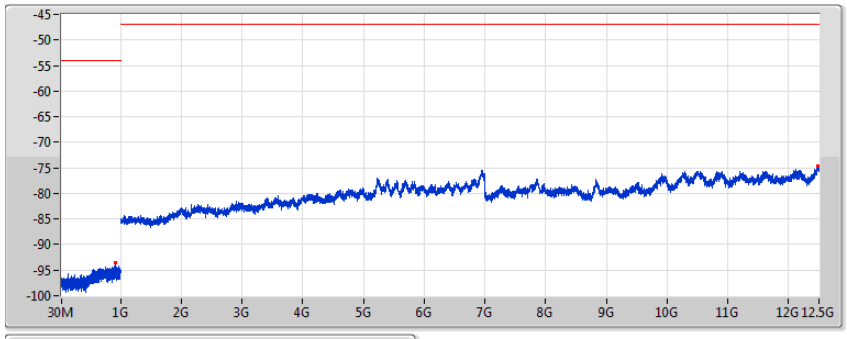
2440MHz_TnomVmin



Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
986.905	-93.83	-53.98	-39.85	-93.83
12500	-74.63	-46.99	-27.64	-74.63

BT-LE(1Mbps) **CSE-RX-**

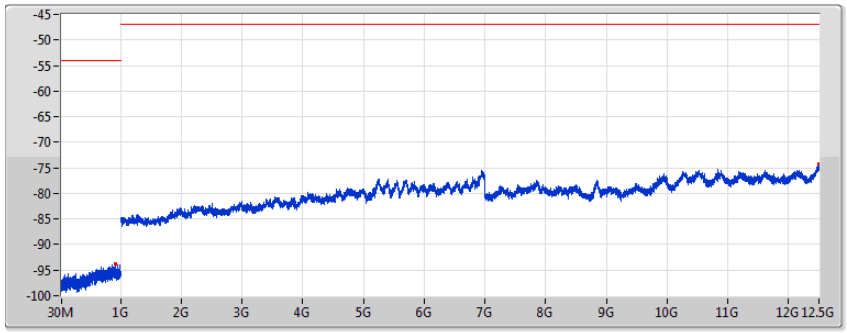
2440MHz_TnomVmax



Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
921.915	-93.59	-53.98	-39.61	-93.59
12484.187	-74.63	-46.99	-27.64	-74.63

BT-LE(1Mbps) **CSE-RX-**

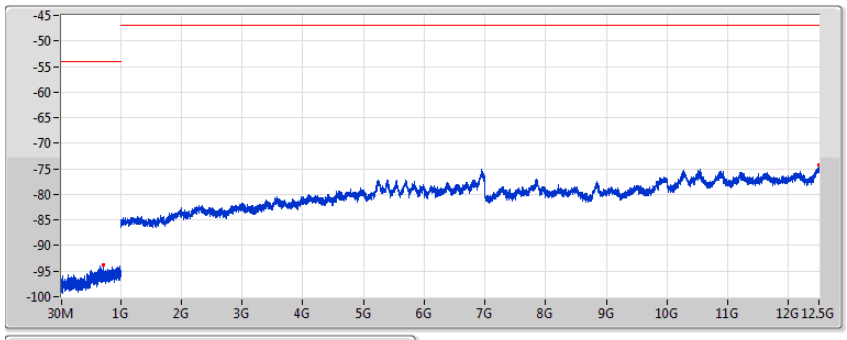
2480MHz_TnomVnom



Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
909.305	-93.85	-53.98	-39.87	-93.85
12498.562	-74.15	-46.99	-27.16	-74.15

BT-LE(1Mbps) **CSE-RX-**

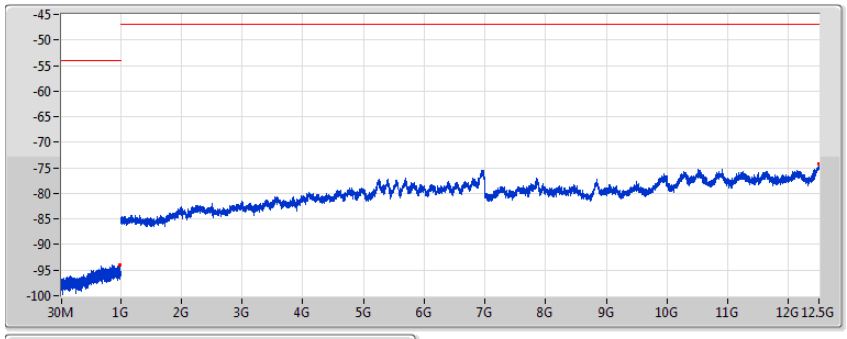
2480MHz_TnomVmin



Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
711.425	-93.86	-53.98	-39.88	-93.86
12492.812	-74.20	-46.99	-27.21	-74.20

BT-LE(1Mbps) **CSE-RX-**

2480MHz_TnomVmax



Freq(MHz)	Psum(dBm)	Limit(dBm)	Margin(dB)	P1(dBm)
992.725	-93.93	-53.98	-39.95	-93.93
12500	-74.16	-46.99	-27.17	-74.16

Appendix G. Antenna Information

2.4 GHz / 5.5 GHz Dipole 2 dBi Antenna for Reverse Polarity SMA

ORDERING INFORMATION

Order Number	Description
001-0009	2.4/5.5GHz Dipole Antenna for Reverse Polarity SMA Connector.
080-0001	U.FL to Reverse Polarity SMA Cable, 105mm

Table 1 Orderable Part Numbers

SPECIFICATIONS

Specification	Value
2.4Ghz Band Peak Gain	+2 dBi
5 GHz Band Peak Gain	+2 dBi
Impedance	50 ohms, Nominal
Type	Dipole
Polarization	Linear Vertical
VSWR	≤2.0：1, Maximum
Frequency	2400-2500MHz, 5150-5850MHz
Weight	22g
Size	137 × 13 mm
Antenna Color	Black
Operating Temp	－20°C＋65°C
UL Rating	UL 94HB

Table 2 Specifications

PHYSICAL DIMENSIONS (MM)

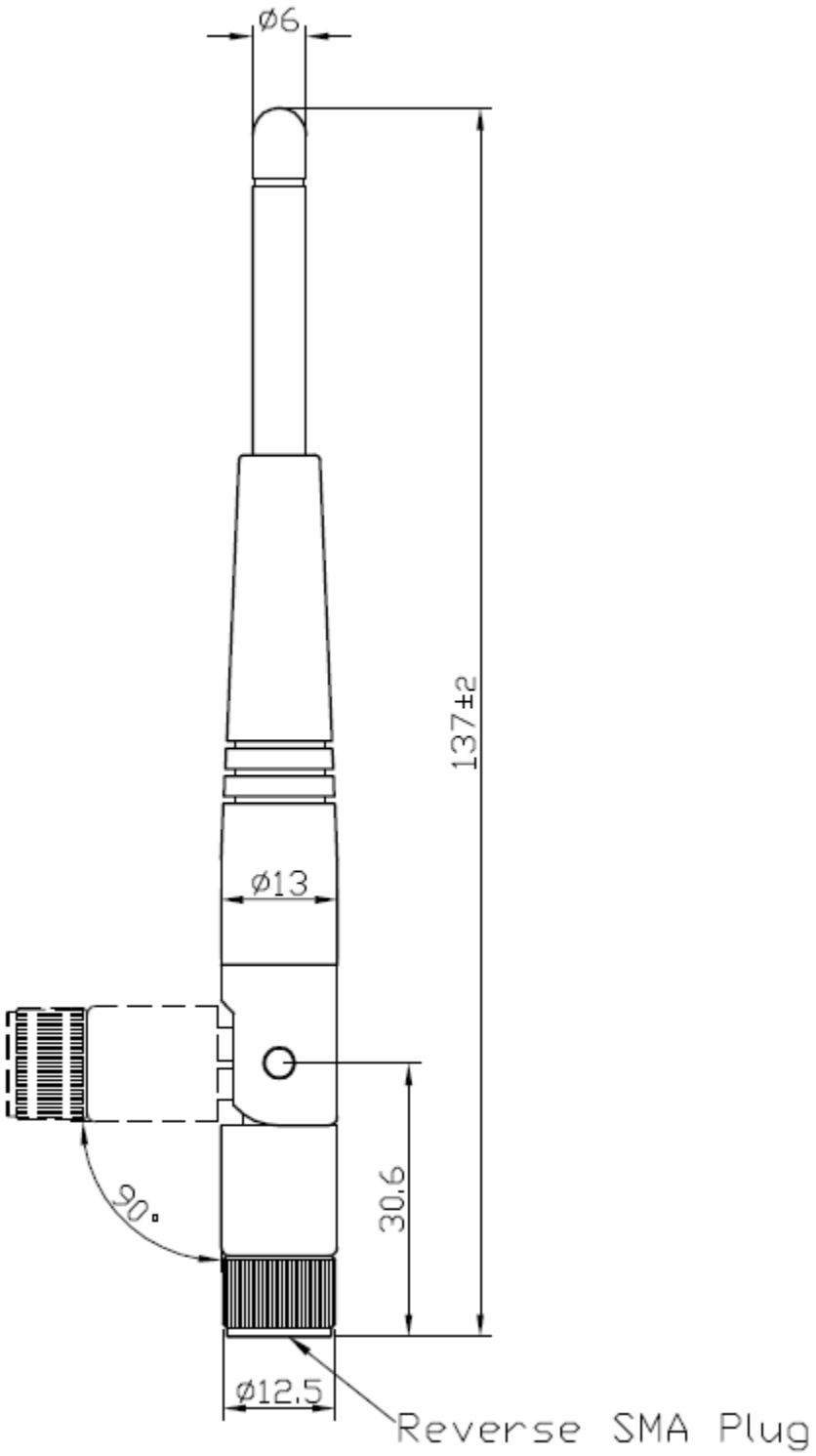


Figure 1 Physical Dimensions

TYPICAL ANTENNA REFLECTION PERFORMANCE

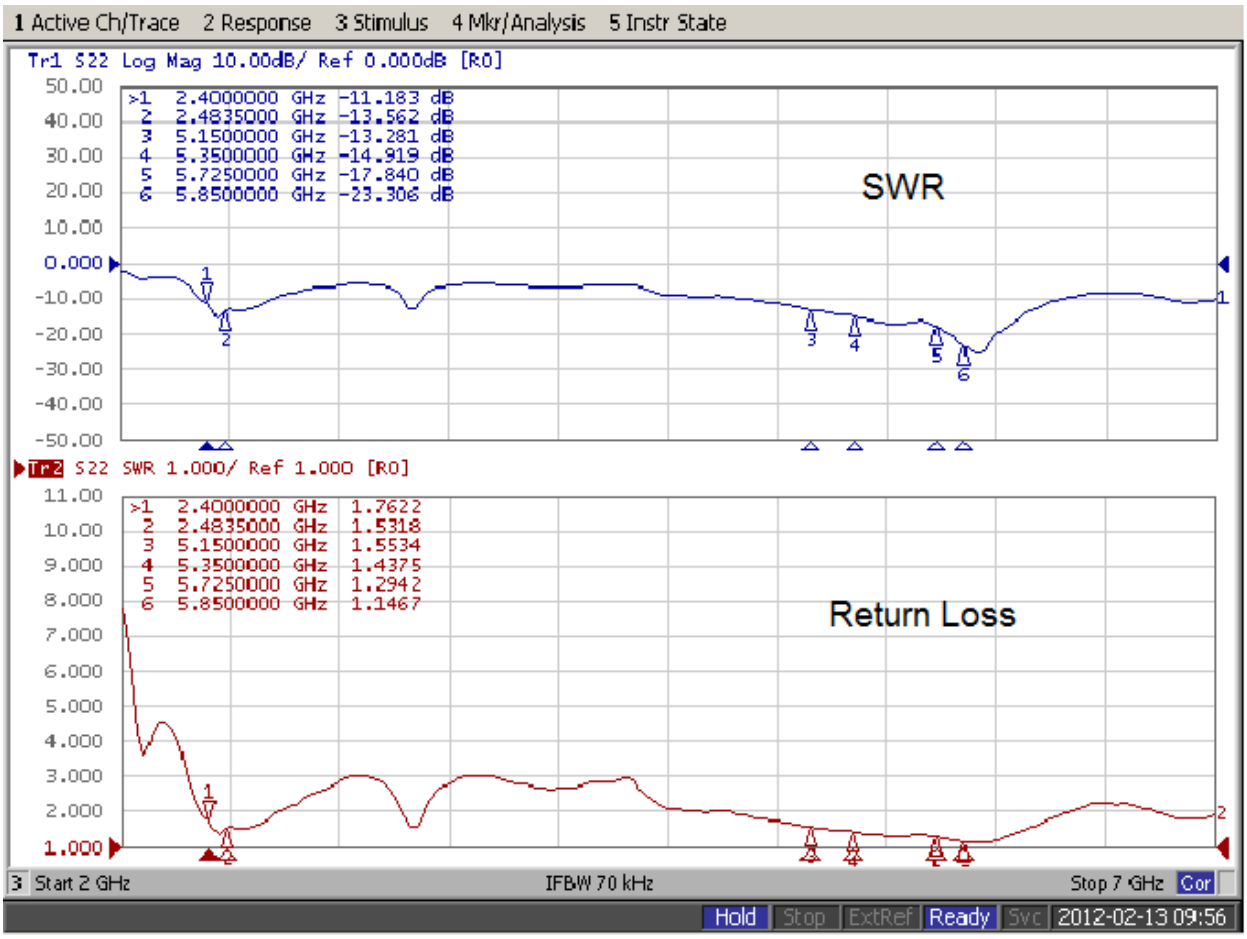


Figure 2 Typical Antenna Reflection Performance

TYPICAL ANTENNA RADIATION PERFORMANCE

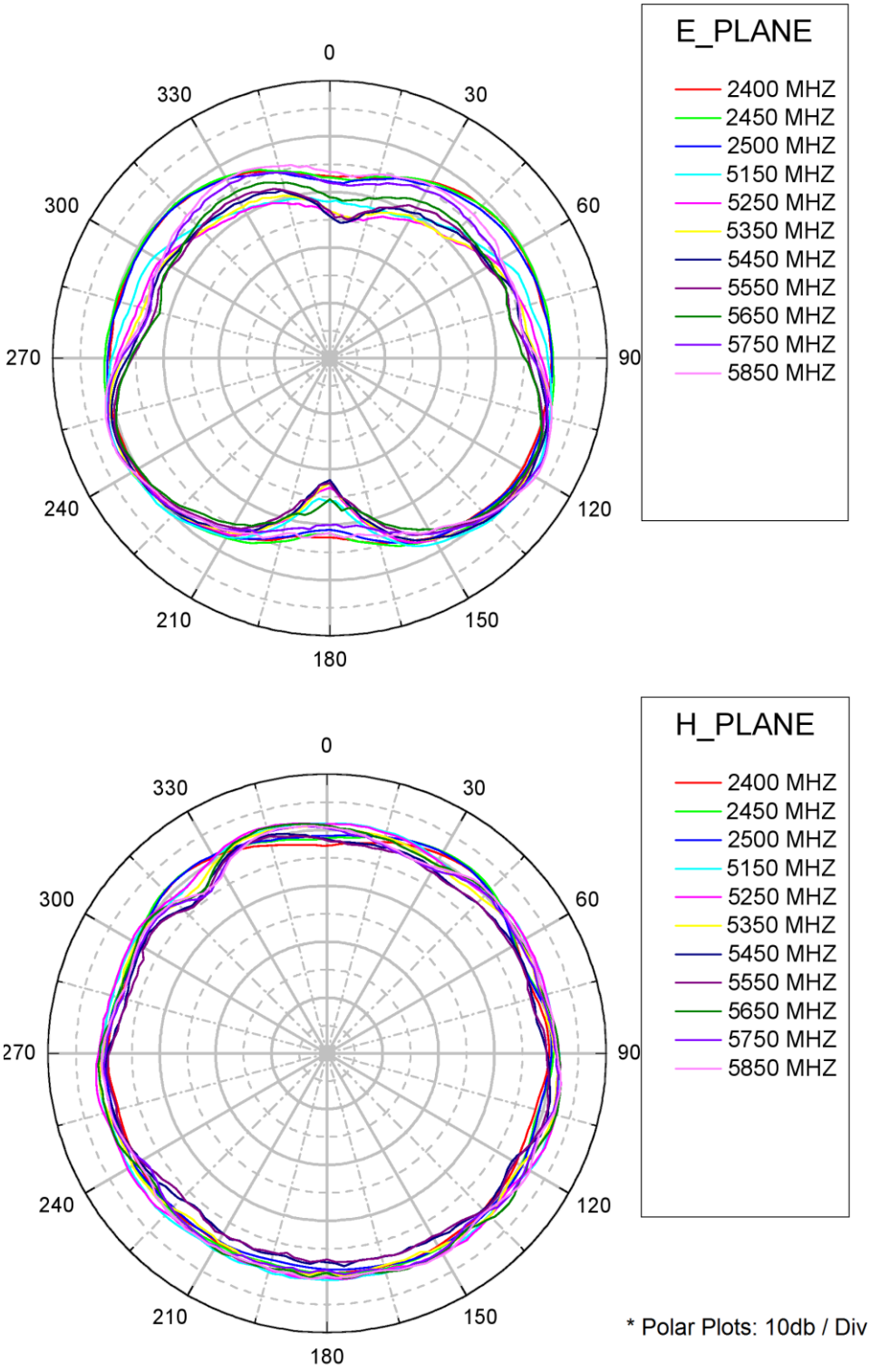


Figure 3 Typical Antenna Radiation Performance

CONTACTING LS RESEARCH

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Website	www.lsr.com
Wiki	wiki.lsr.com
Technical Support	forum.lsr.com
Sales Contact	sales@lsr.com

2.4 / 5.5 GHz FlexPIFA 3 dBi Antenna w/U.FL Cable, 100mm

ORDERING INFORMATION

Order Number	Description
001-0016	2.4 / 5.5 GHz FlexPIFA Antenna w/U.FL cable, 100mm
001-0021	2.4 / 5.5 GHz FlexPIFA Antenna w/MHF4L cable, 100mm

Table 1 Orderable Part Numbers

KEY FEATURES

- Can be installed on different non-conductive surfaces and thicknesses.
- Can be installed near metals or the human body.
- Dual Band Antenna: 2.4 GHz and 5 GHz
- Can be installed on flat or curved surfaces.
- Quick and easy Installation
- Adhesive holds to surface during humidity exposure and hot/cold cycles.
- RoHS Complaint

SPECIFICATIONS

Specification	Value
2.4 GHz Band Peak Gain	+2.5 dBi
5 GHz Band Peak Gain	+3 dBi
2.4 GHz Average Gain	> -1.9 dBi
5 GHz Average Gain	> -4.0 dBi
Impedance	50 ohms
Type	Flexible Planar Inverted F Antenna (FlexPIFA)
Polarization	Linear
VSWR	<3.0:1, 2400 – 2480 MHz
	<3.0:1, 4900 – 5900 MHz
Frequency	2400 - 2480 MHz, 4900 - 5900 MHz
Weight	1.13g
Size	38.6mm × 12.7mm × 2.5mm
Antenna Color	Clear Yellow
Adhesive	3M 100MP
Operating Temp	-40°C to +85°C
Connector Mating Height	U.FL: 2.5mm Max
	MHF4L: 1.4mm Max

Table 2 Specifications

PHYSICAL DIMENSIONS (MM)

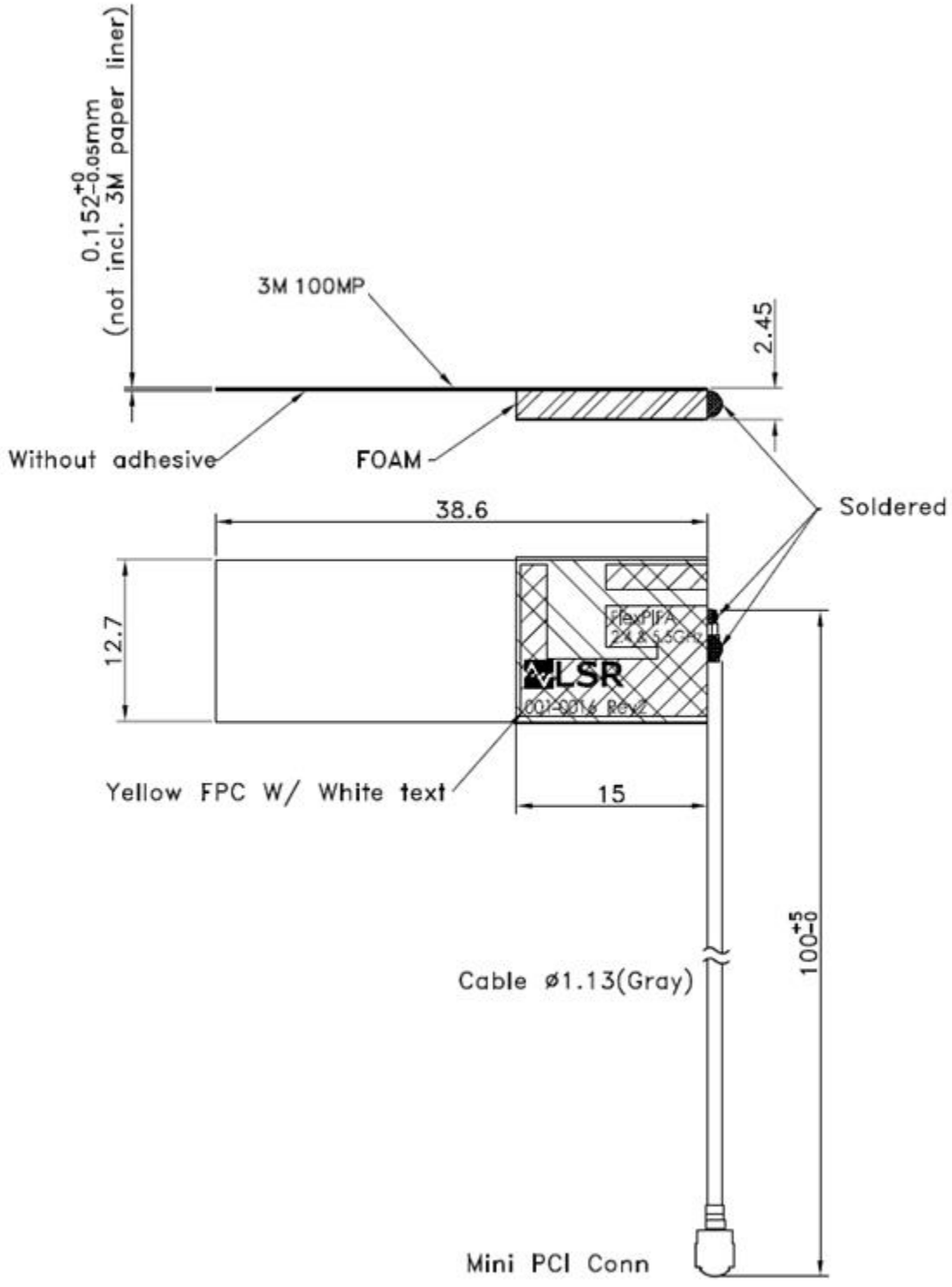


Figure 1 Physical Dimensions

TEST SETUP

Antenna measurements such as VSWR were measured with an Agilent E5071C Vector Network Analyzer. Radiation patterns were measured with an Agilent 5181A Signal Generator and Agilent E4445A Spectrum Analyzer in a 3 meter Anechoic Chamber.

Flat surface measurements were done with the antenna centered on a 1.5 mm thick plate of Polycarbonate. Curved surface measurements were taken by placing the antenna on the inside and outside of different diameter PVC tubing.

FLAT SURFACE ANTENNA MEASUREMENTS

VSWR

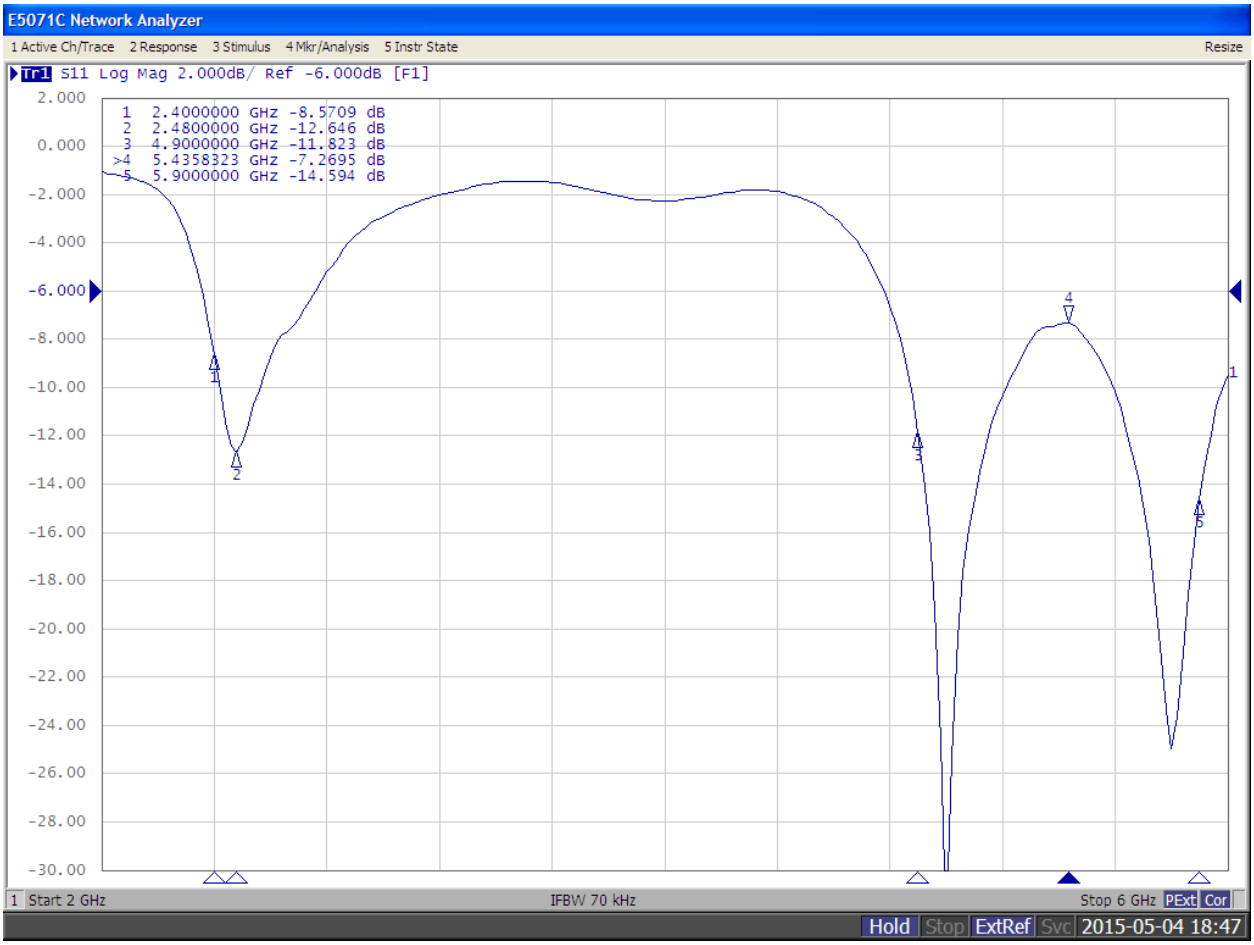


Figure 2 Antenna VSWR measured on a 1.5 mm thick plate of Polycarbonate

FLAT SURFACE ANTENNA RADIATION PERFORMANCE

FlexPIFA centered on a 1.5 mm thick plate of Polycarbonate

Antenna Measurement Set-Up:

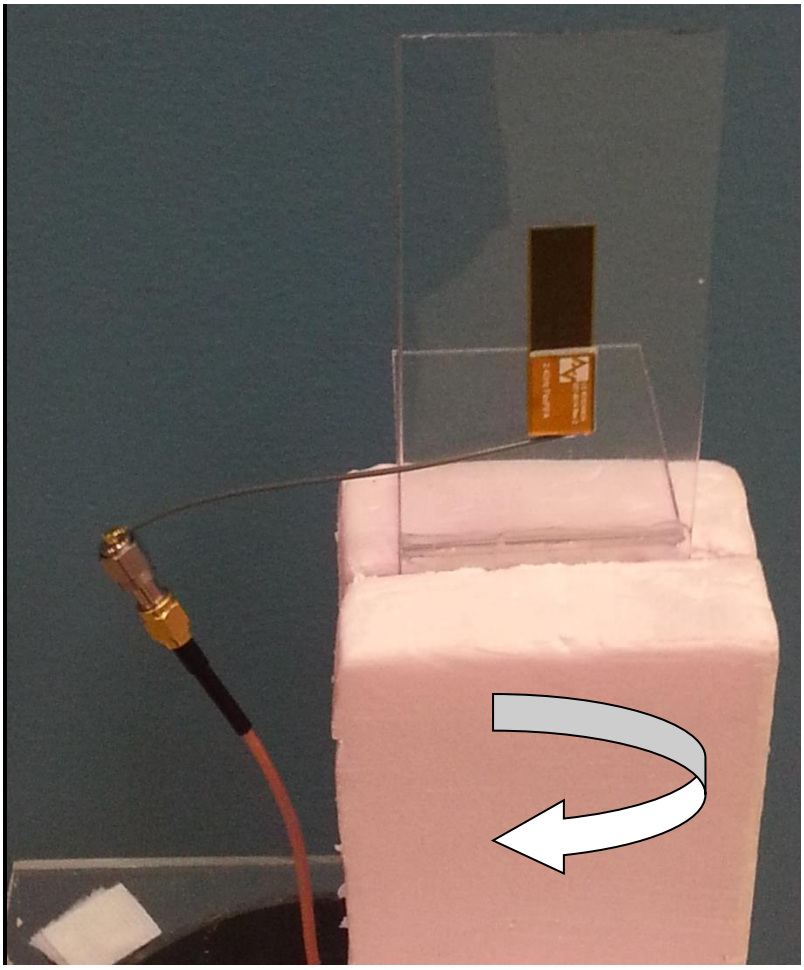


Figure 3 Vertical Orientation Set-Up

Vertical Orientation at 2440 MHz:

Figure 4 Vertical Orientation Pattern

Antenna Measurement Set-Up:

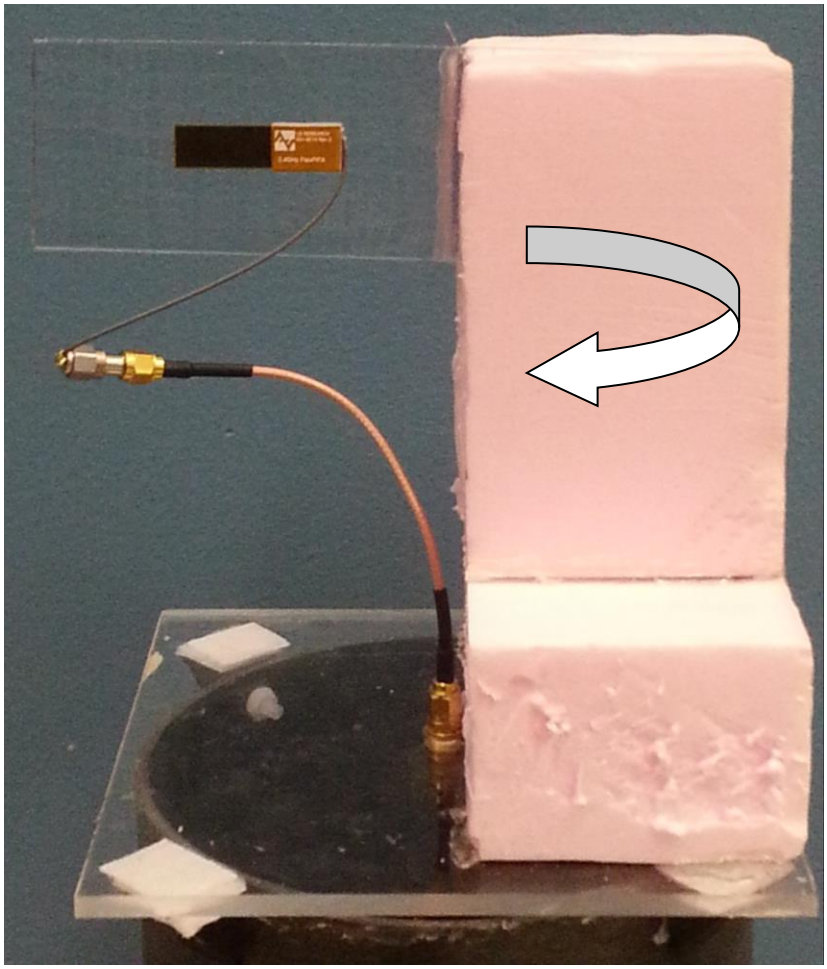


Figure 5 Horizontal Orientation Set-Up

Horizontal Orientation at 2440 MHz:

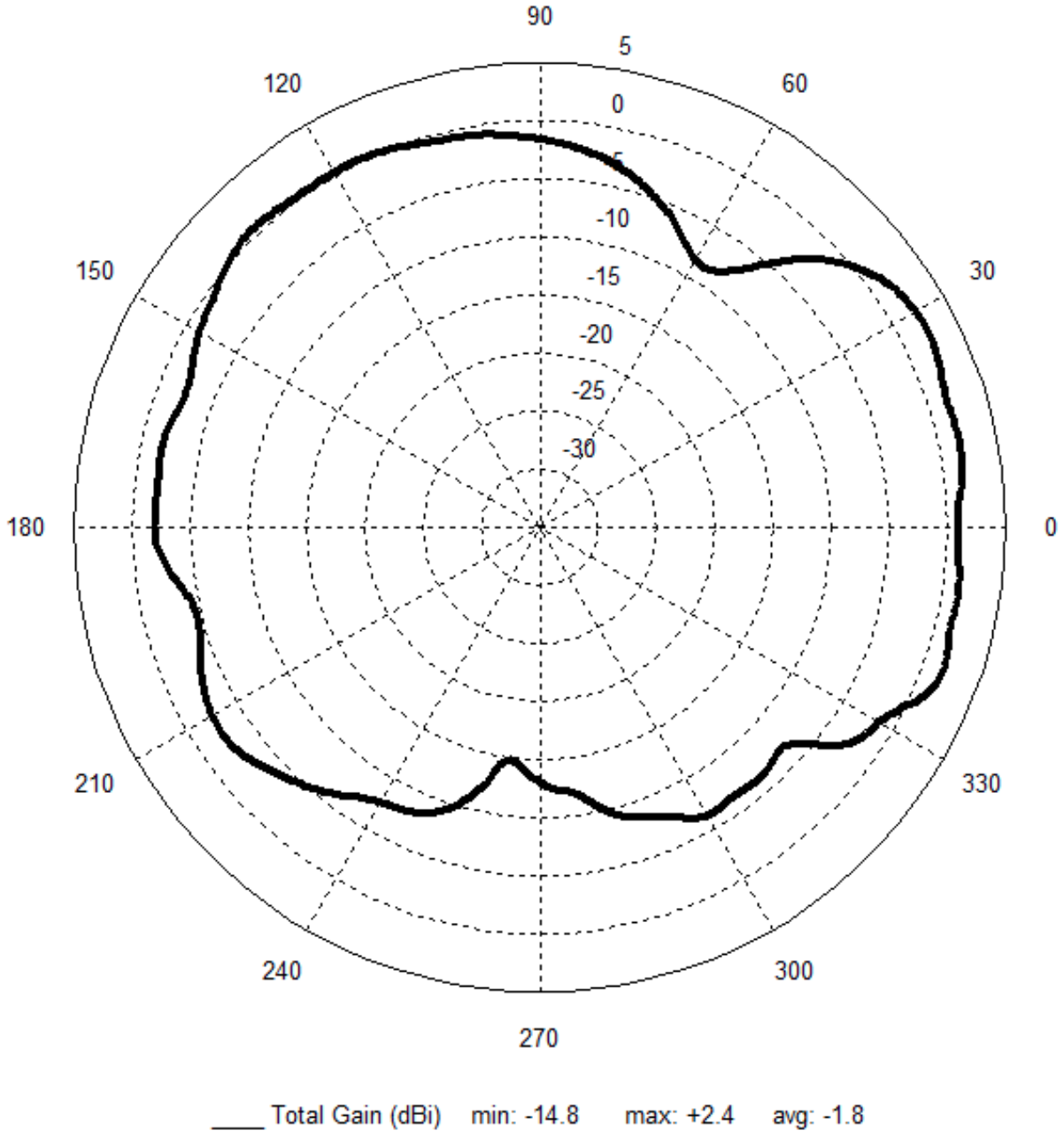


Figure 6 Horizontal Orientation Pattern

Antenna Measurement Set-Up:

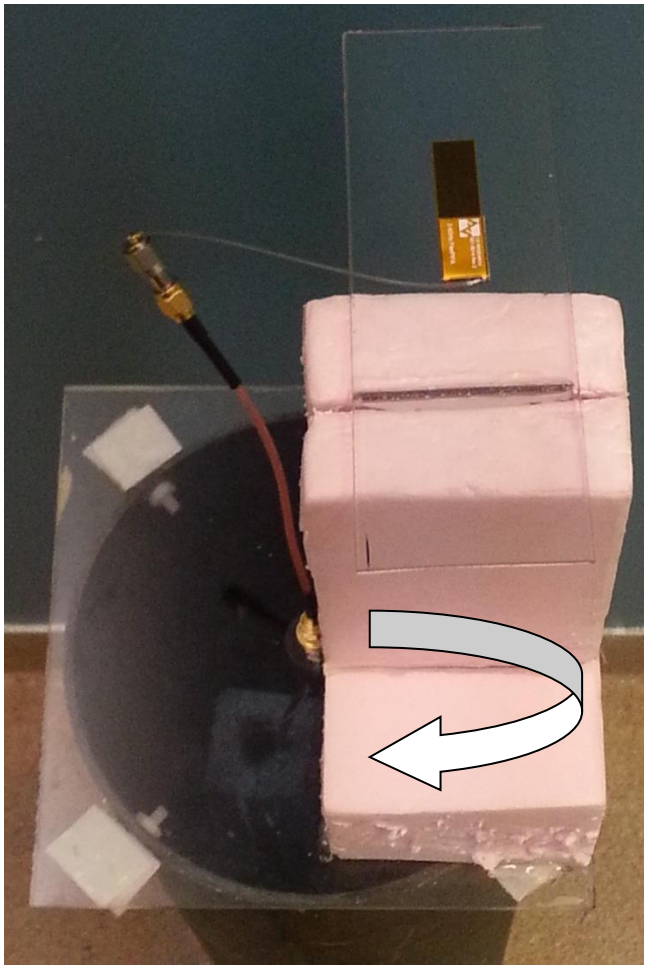


Figure 7 Flat Orientation Set-Up

Flat Orientation at 2440 MHz:

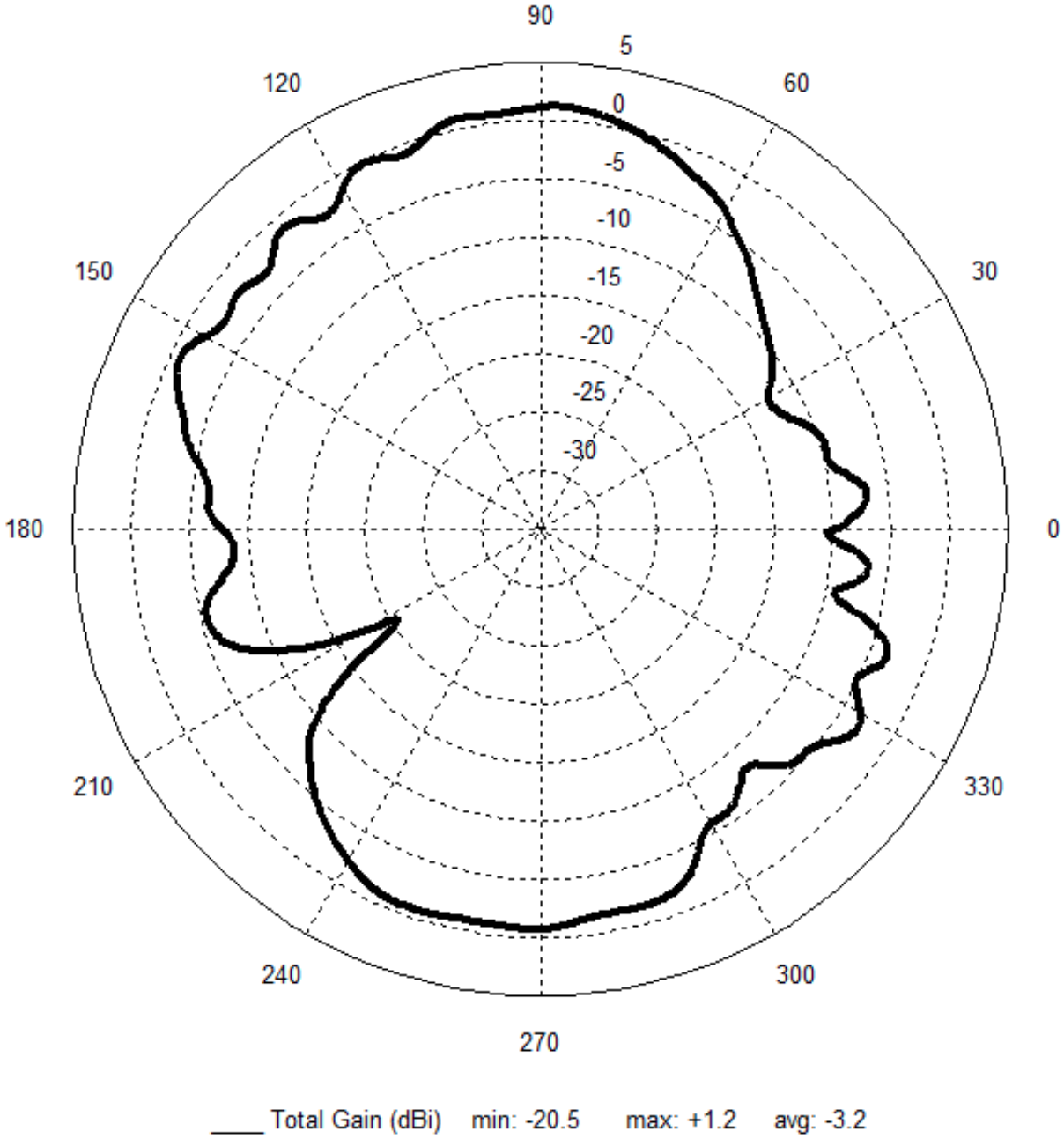


Figure 8 Flat Orientation Pattern

5 GHz Band

FlexPIFA centered on a 1.5 mm thick plate of Polycarbonate

Antenna Measurement Set-Up:

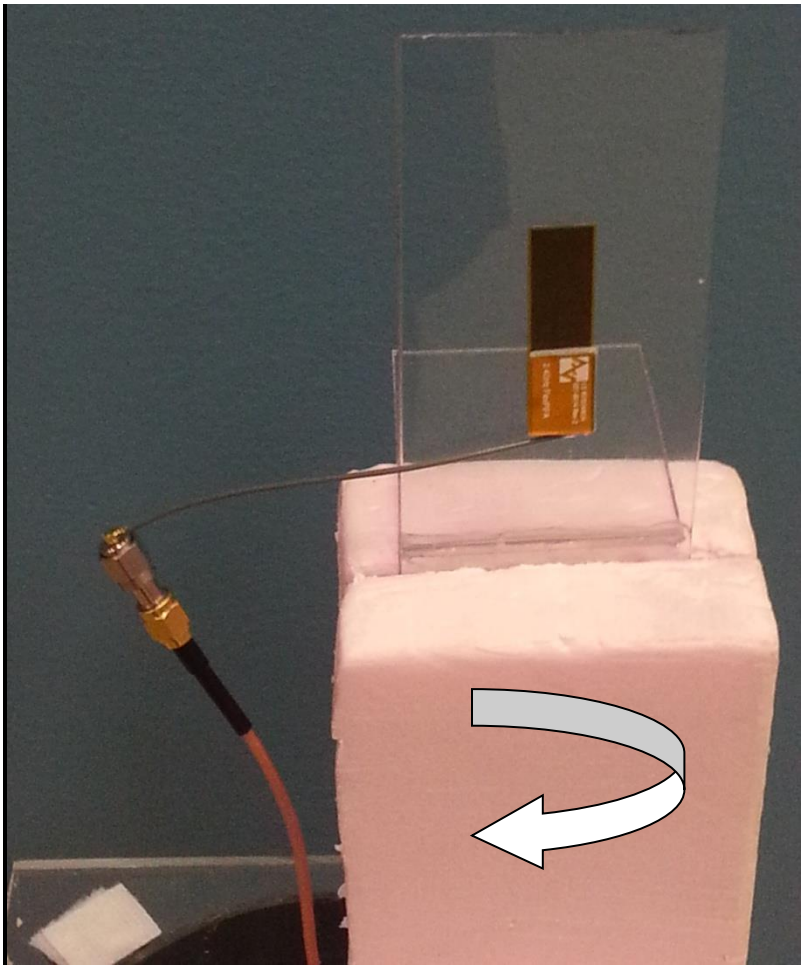


Figure 9 Vertical Orientation Set-Up

Vertical Orientation at 4900 MHz:

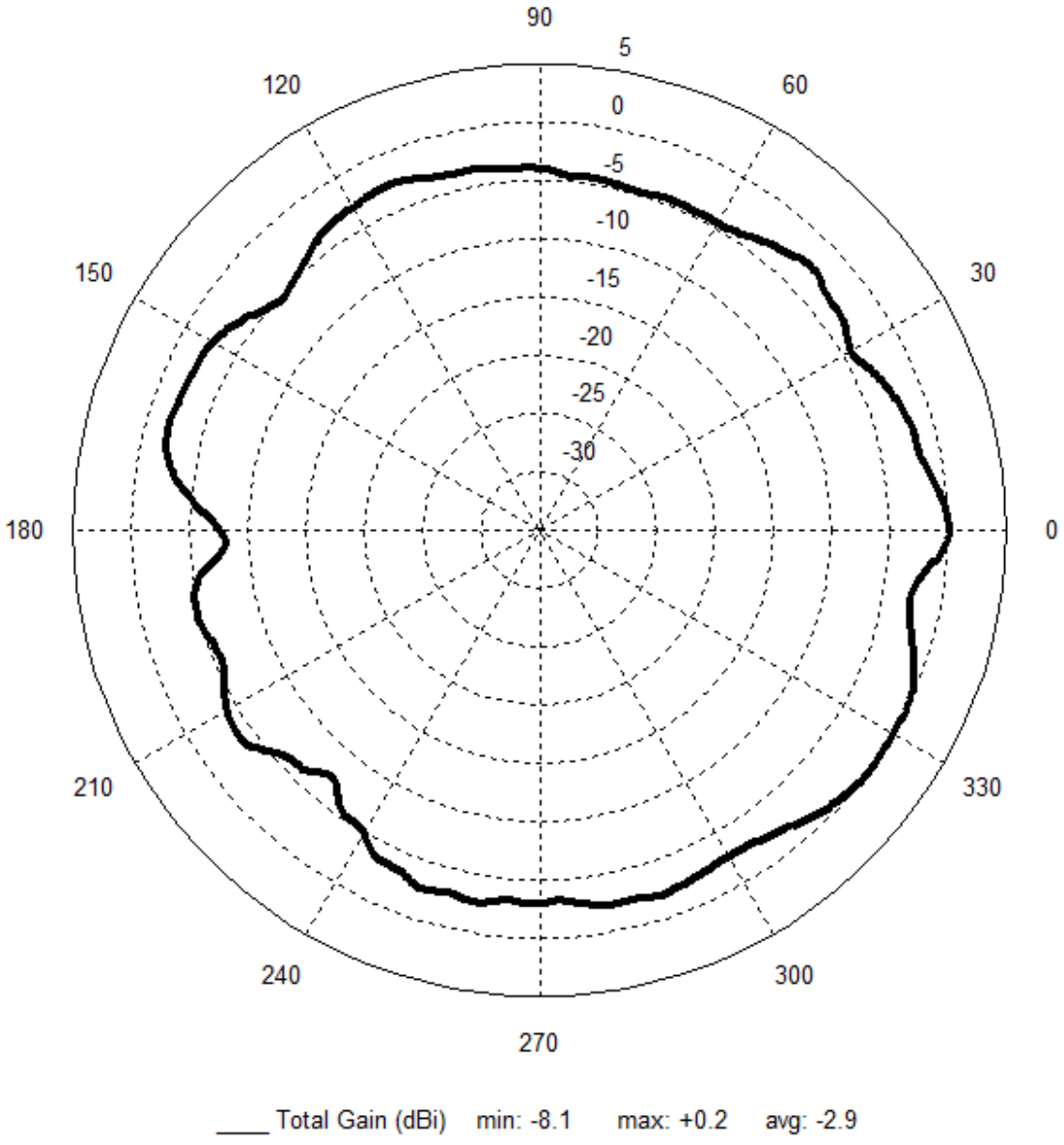


Figure 10 Vertical Orientation Pattern

Vertical Orientation at 5400 MHz:

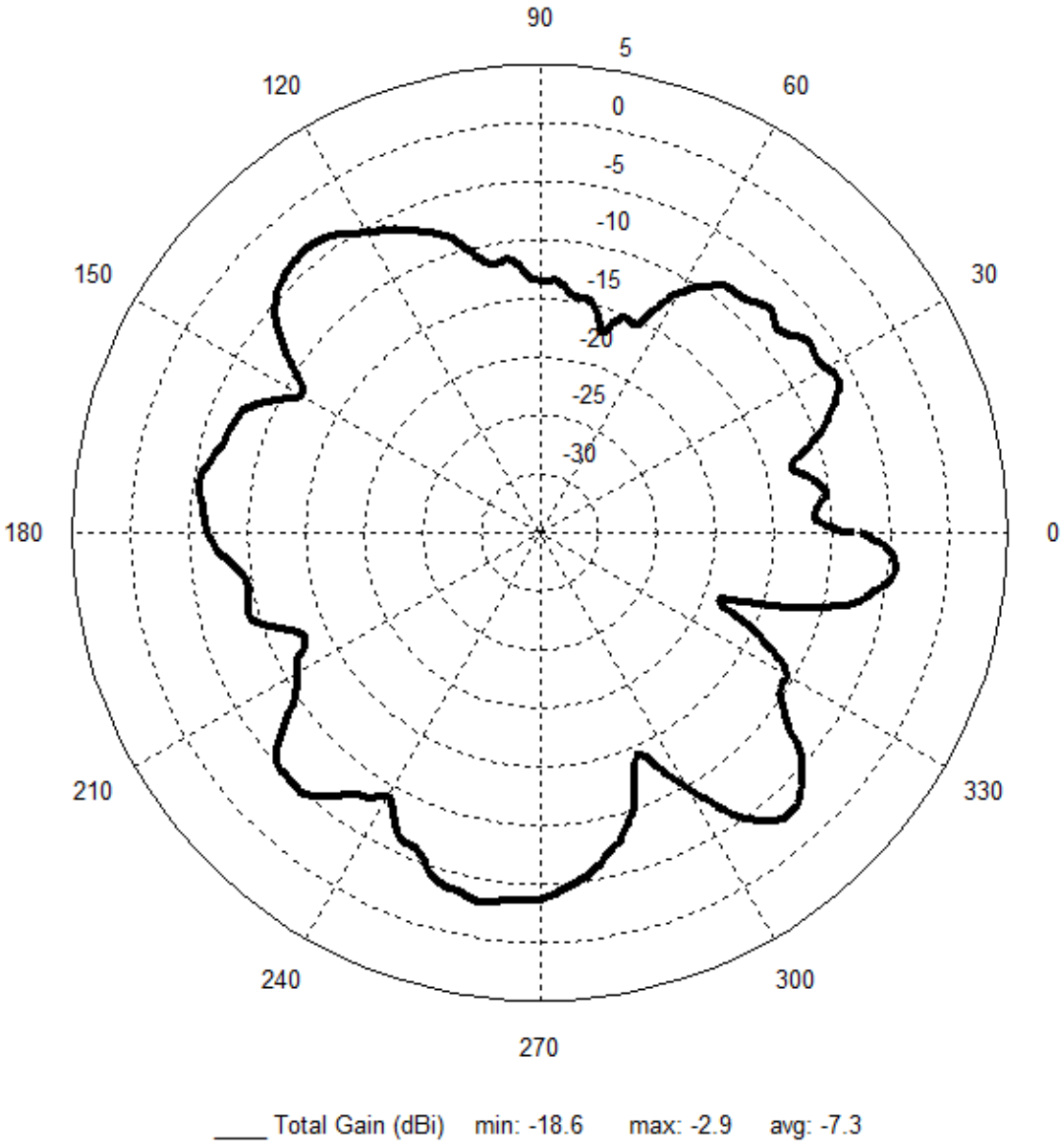


Figure 11 Vertical Orientation Pattern

Vertical Orientation at 5900 MHz:

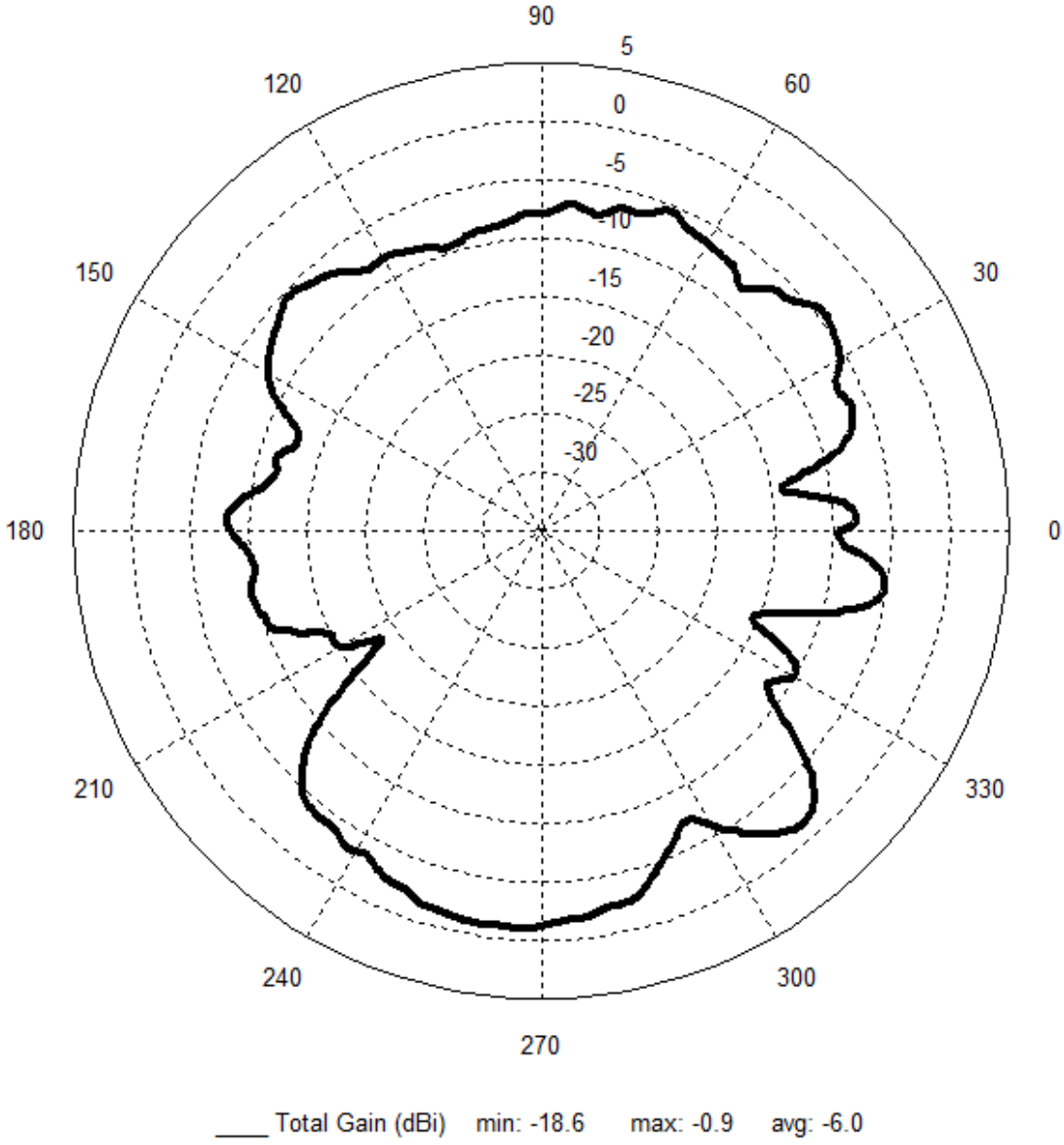


Figure 12 Vertical Orientation Pattern

Antenna Measurement Set-Up:

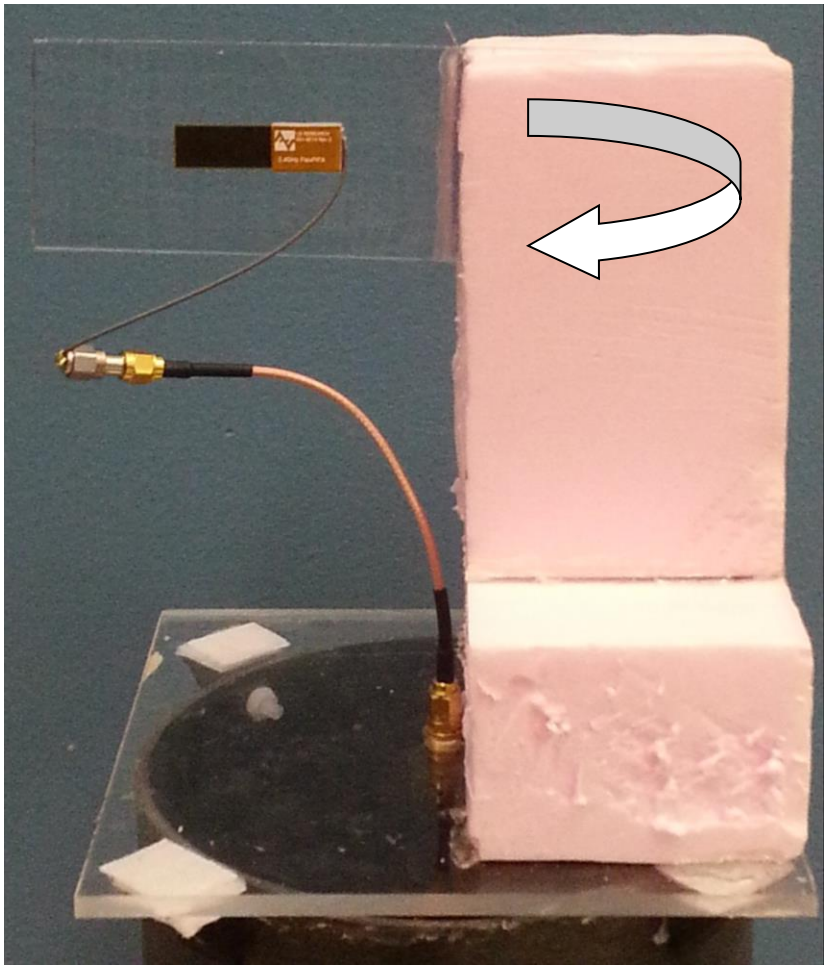


Figure 13 Horizontal Orientation Set-Up

Horizontal Orientation at 4900 MHz:

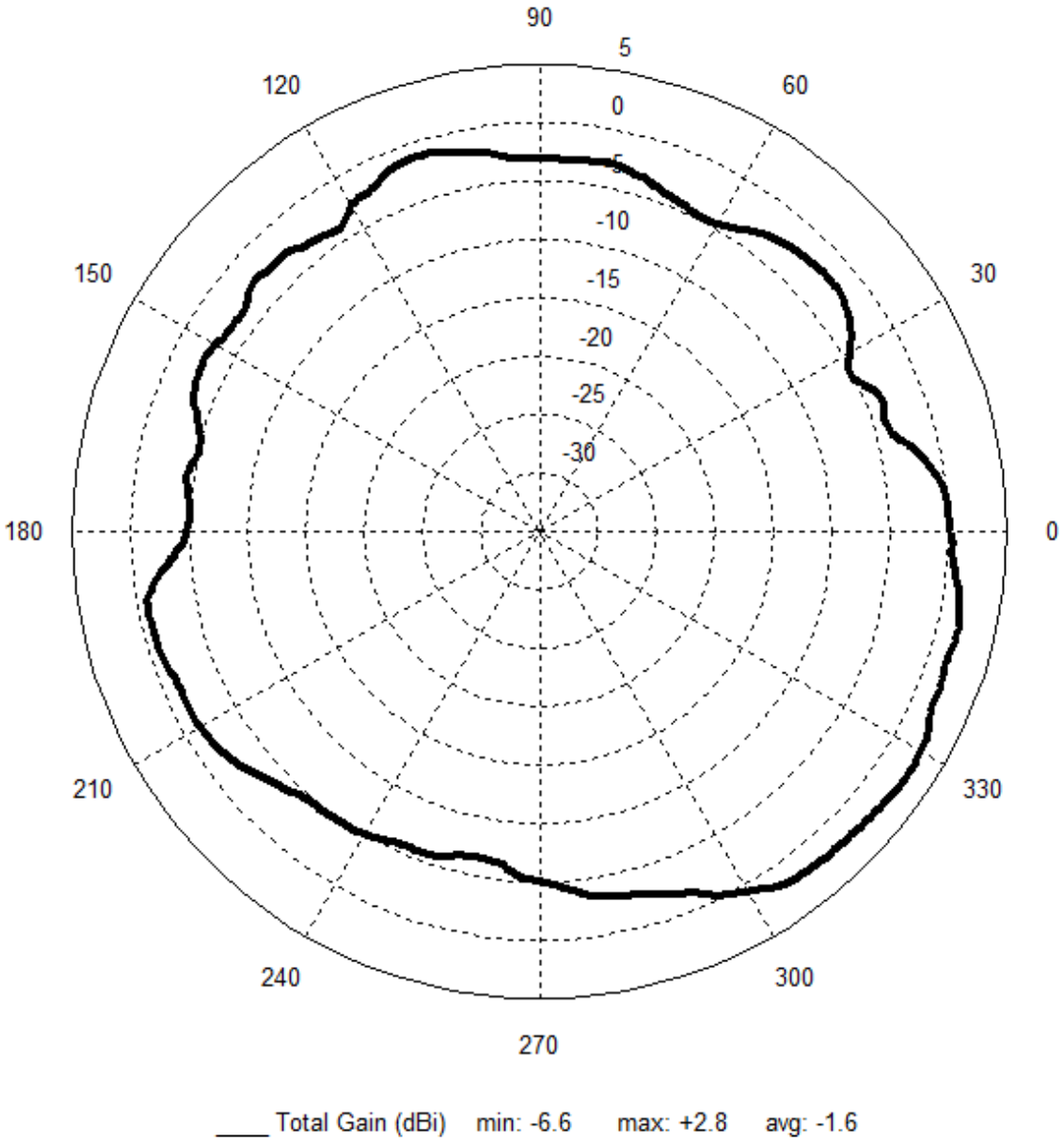


Figure 14 Horizontal Orientation Pattern

Horizontal Orientation at 5400 MHz:

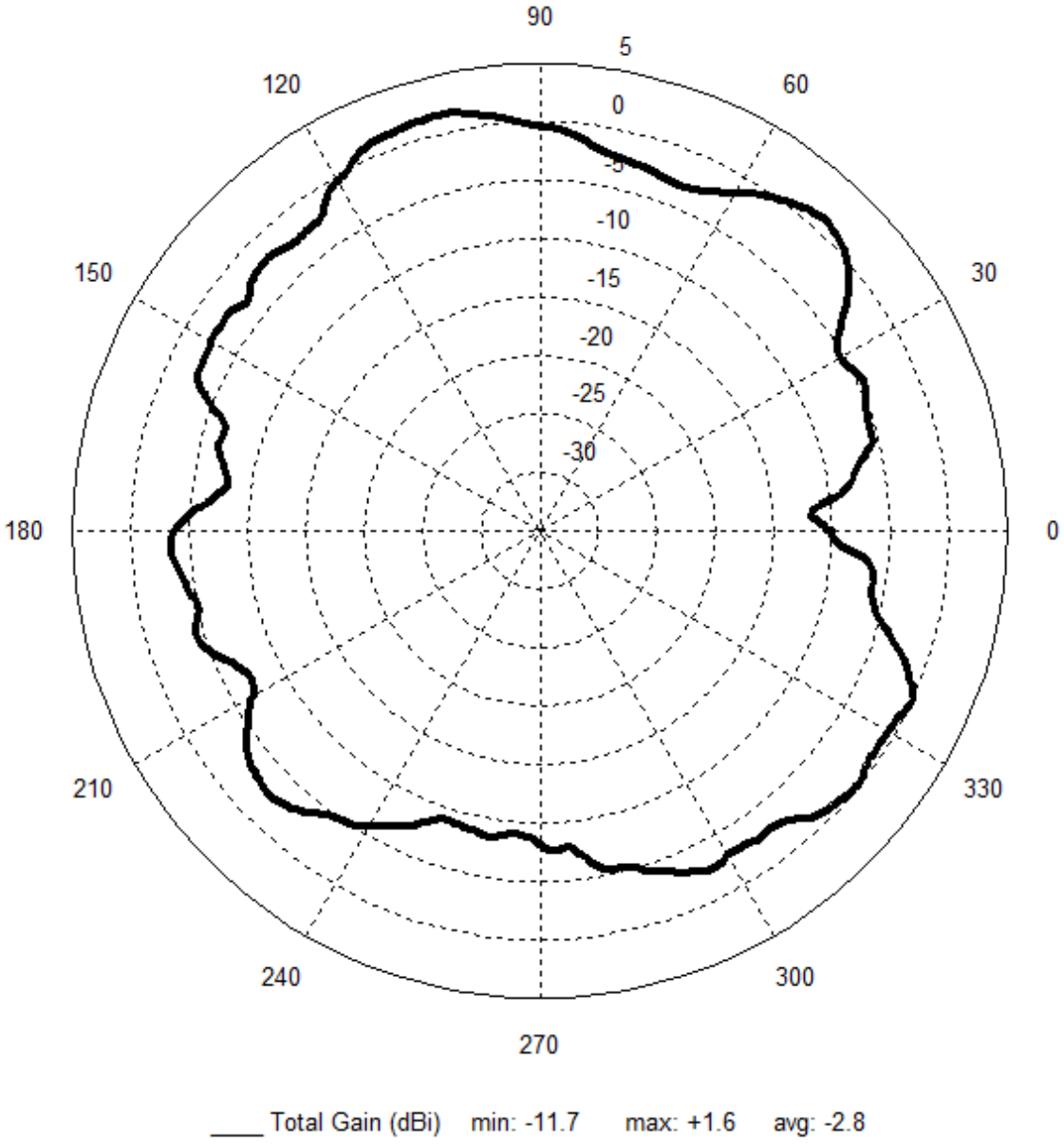


Figure 15 Horizontal Orientation Pattern

Horizontal Orientation at 5900 MHz:

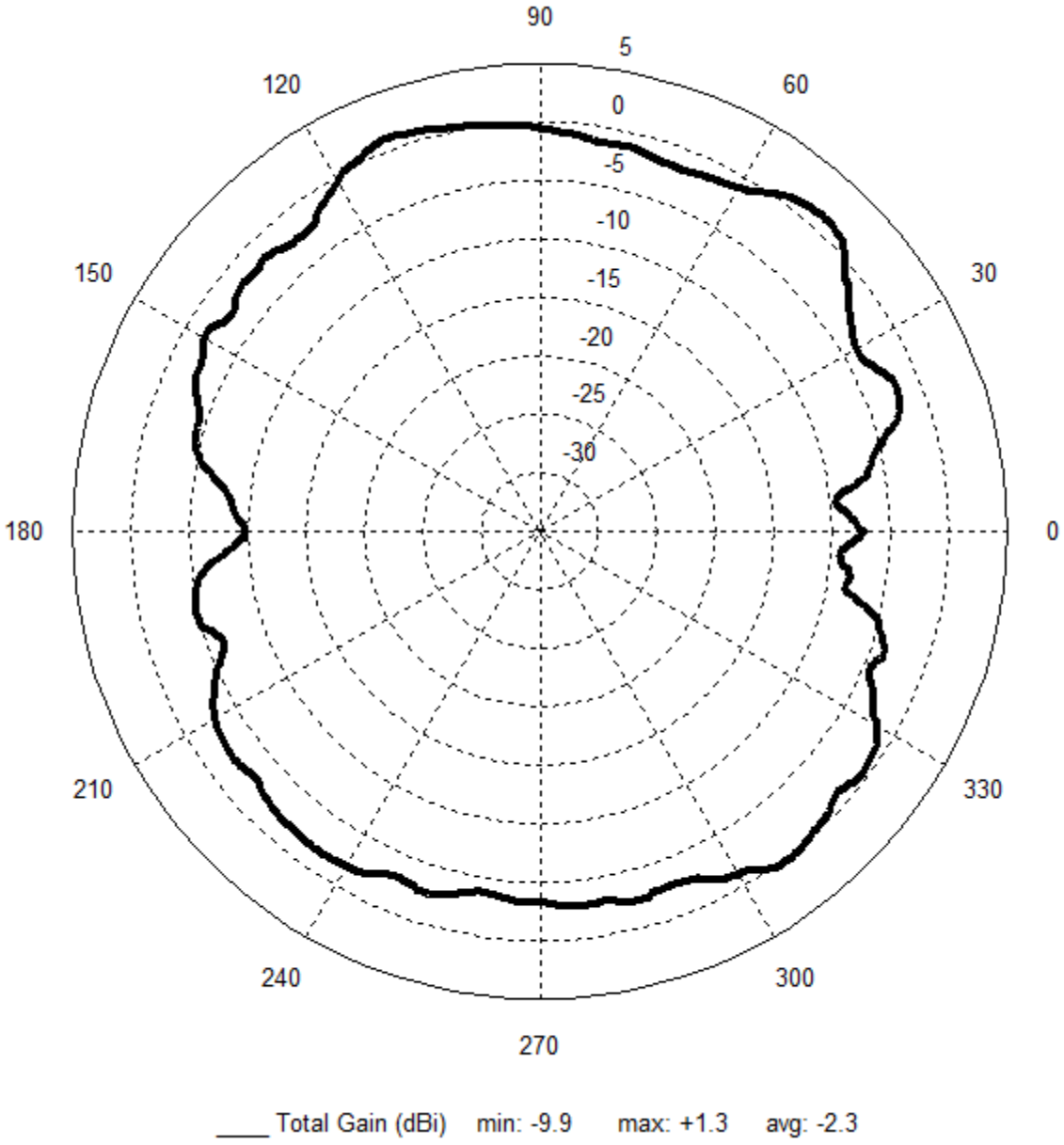


Figure 16 Horizontal Orientation Pattern

Antenna Measurement Set-Up:

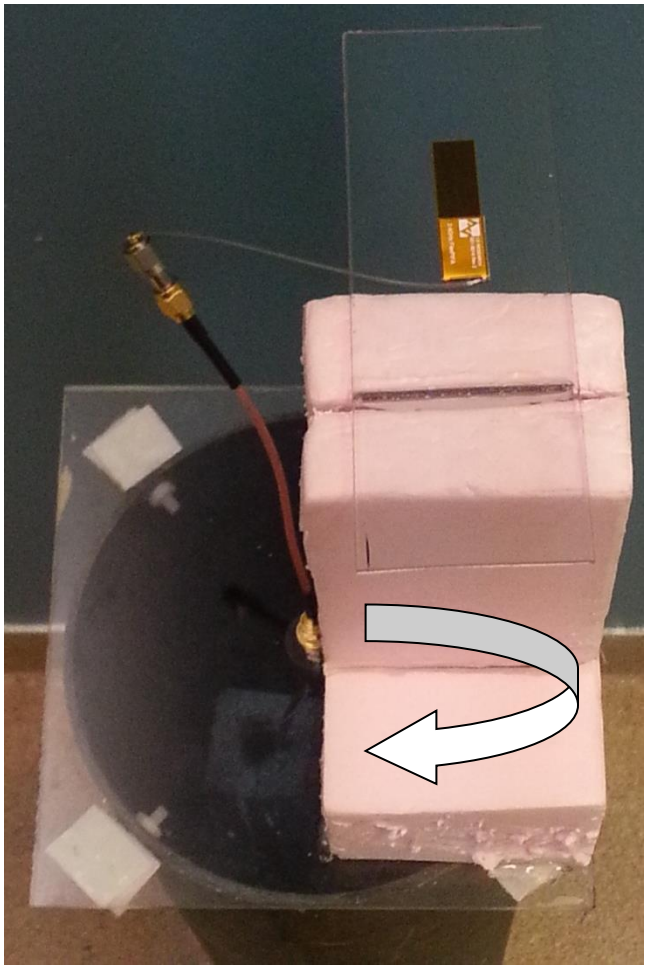


Figure 17 Flat Orientation Set-Up

Flat Orientation at 4900 MHz:

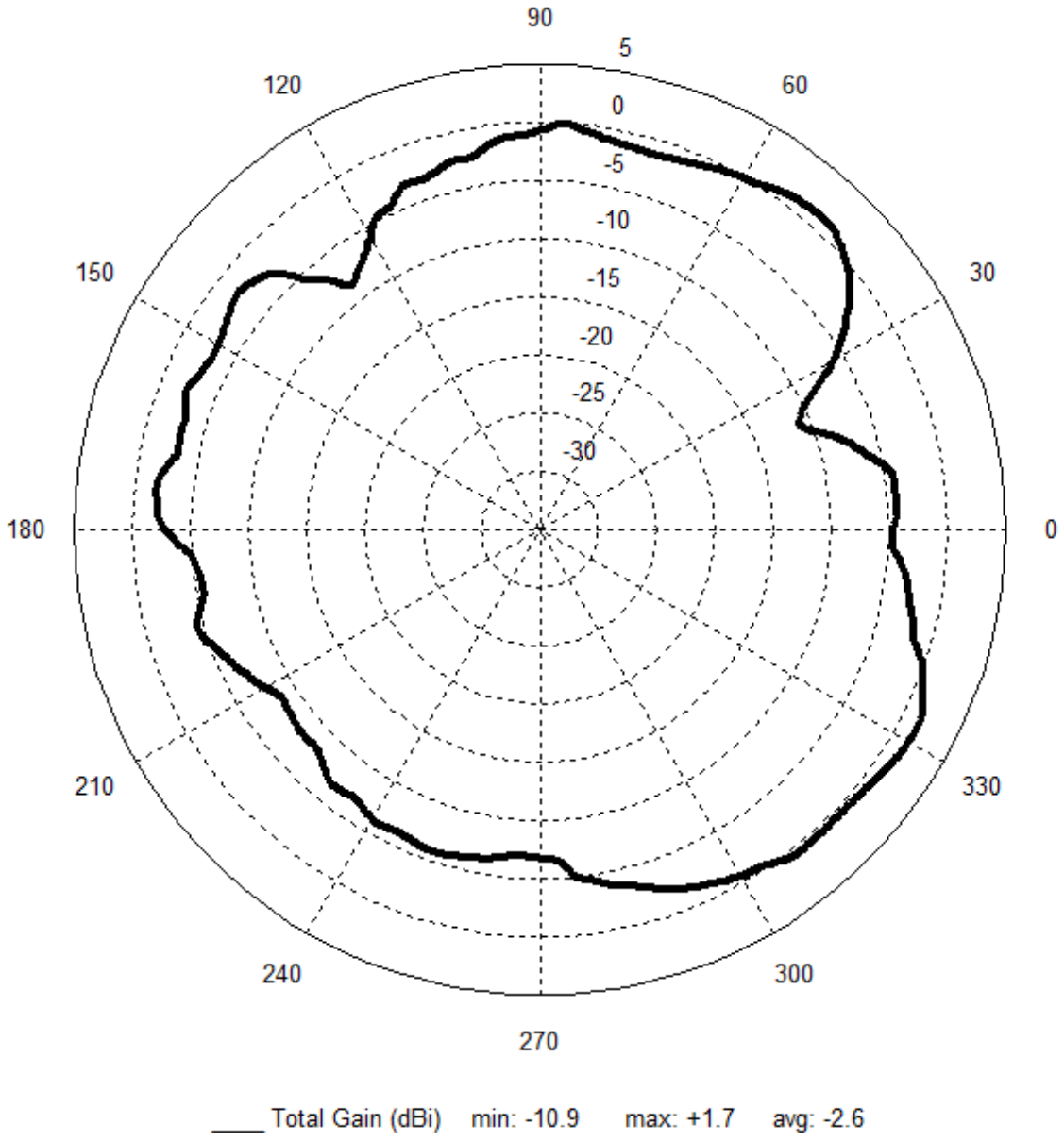


Figure 18 Flat Orientation Pattern

Flat Orientation at 5400 MHz:

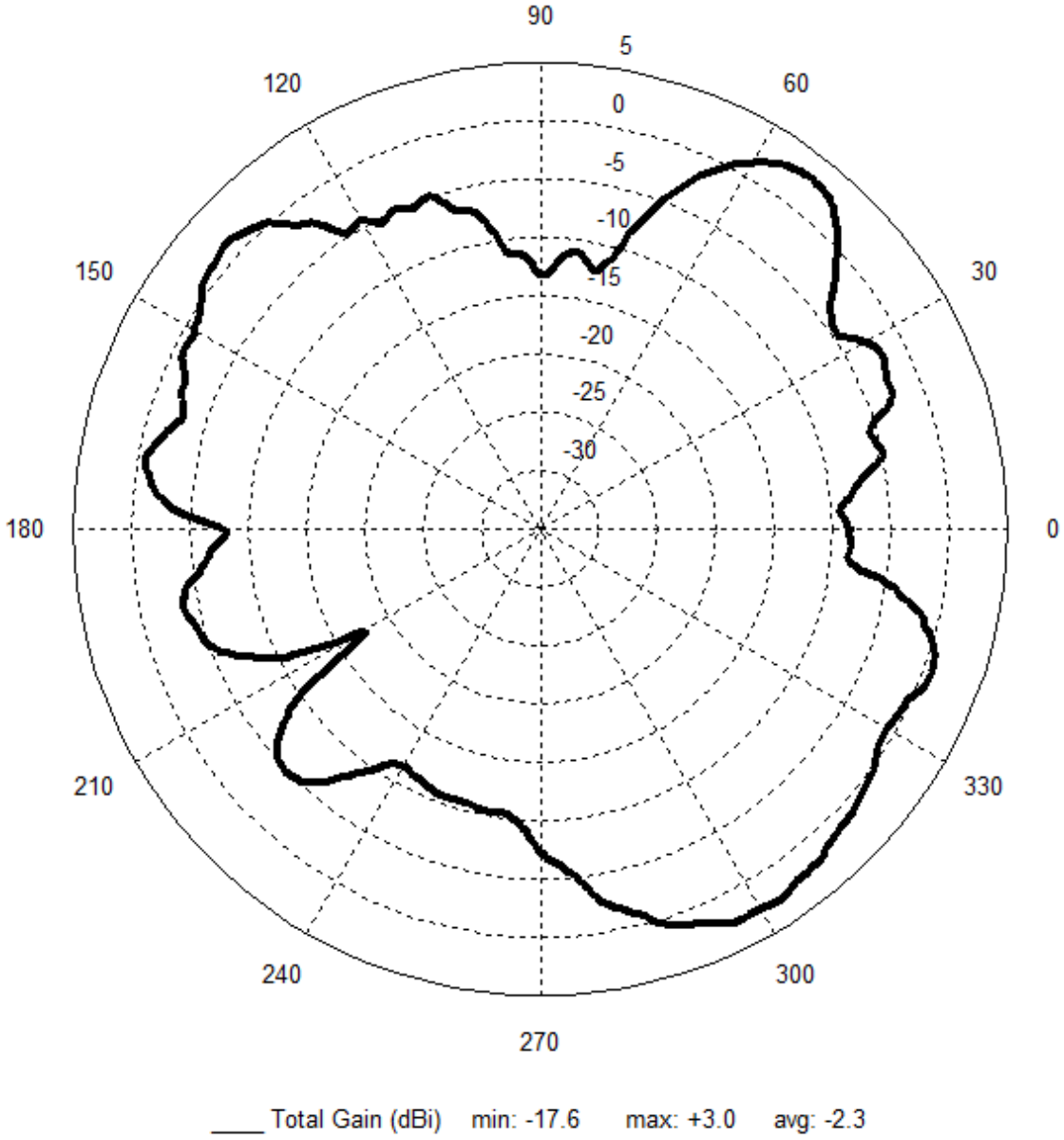


Figure 19 Flat Orientation Pattern

Flat Orientation at 5900 MHz:

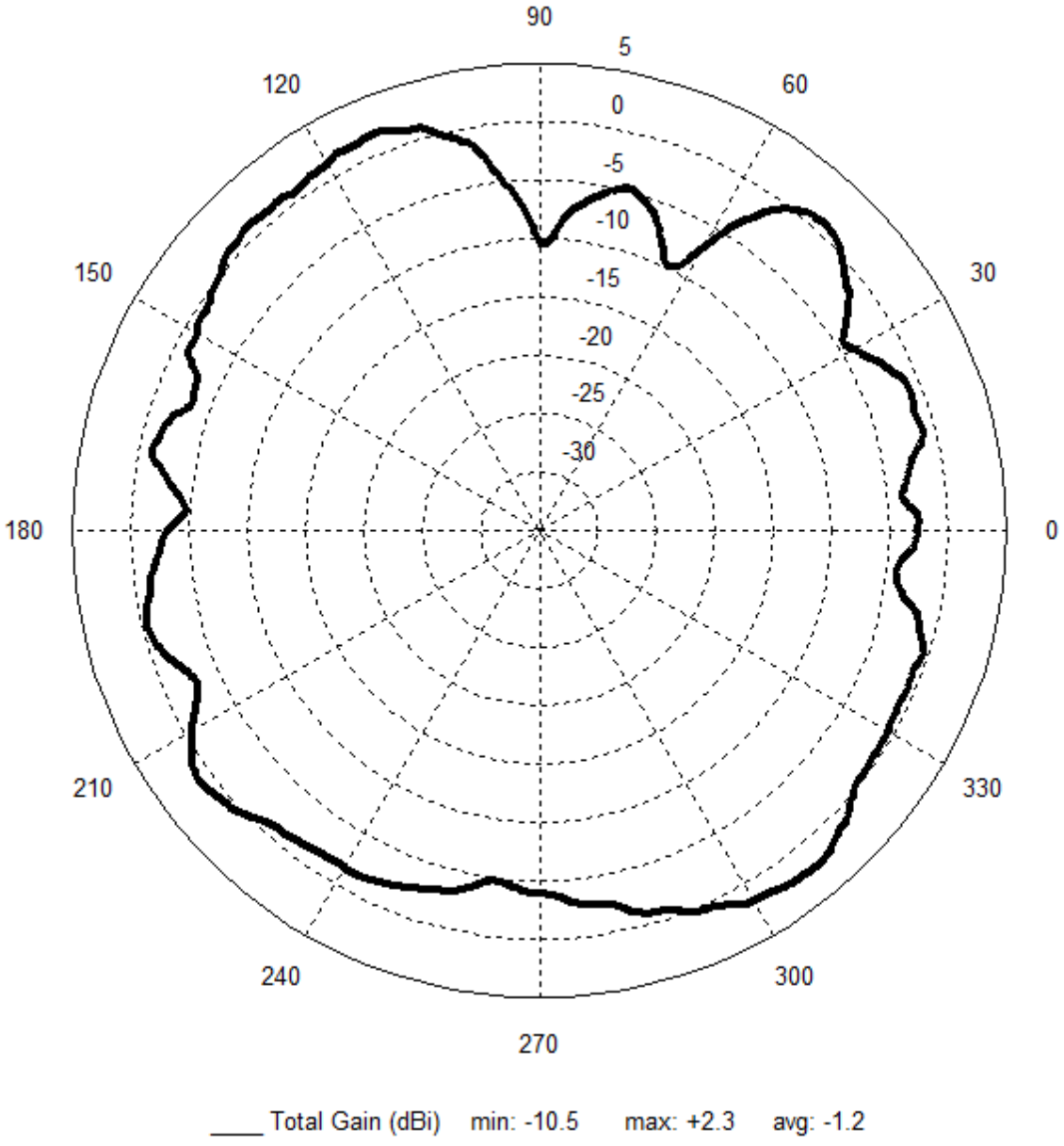


Figure 20 Secondary Elevation Pattern

OPTIMAL INSTALLATION GUIDE

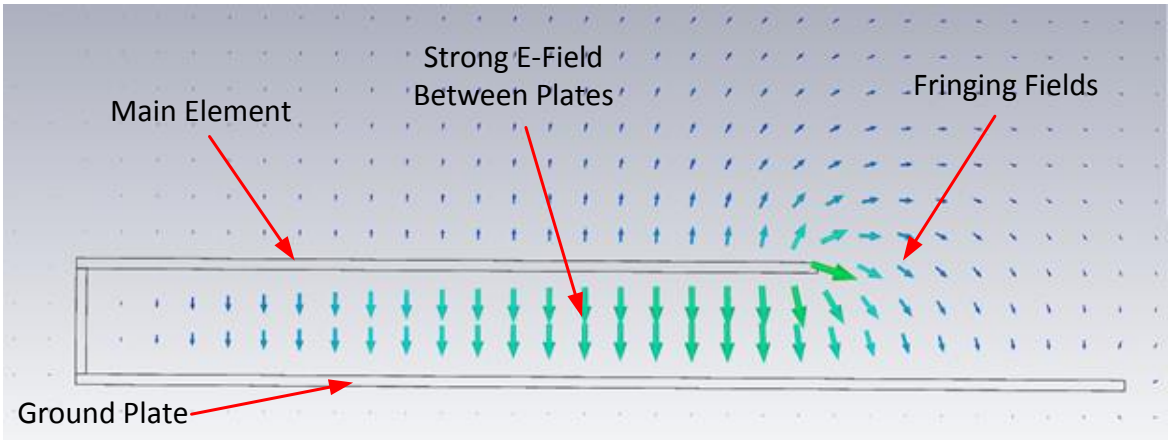


Figure 21 E-Field Radiation from FlexPIFA, Taken from CST Simulation

The main element should be kept clear of any non-metal objects (such as plastics) on top of it by at least 3 mm (see **Figure 22**). Similarly, the two long sides of the FlexPIFA should be kept clear of any non-metal object by at least 2 mm (See **Figure 23**). A 1 mm clearance should be observed from the ground wall to any non-metal object. Mounting the FlexPIFA in a situation that does not allow for these clearance recommendations may change the gain characteristics stated in the datasheet, which could impact overall range of the wireless system.

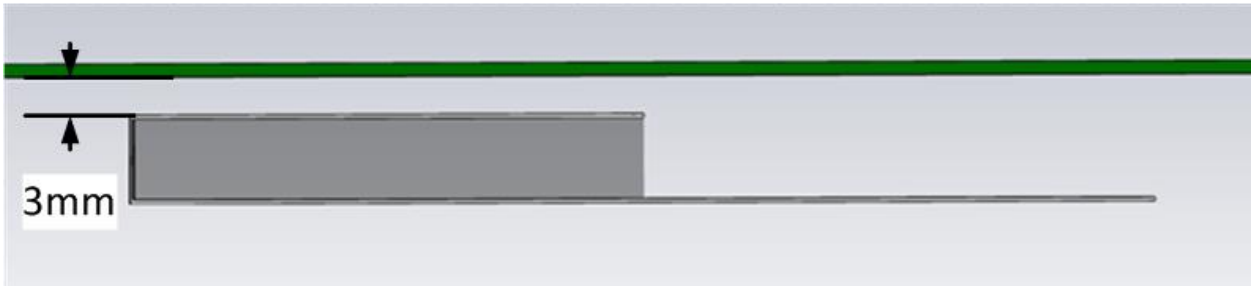
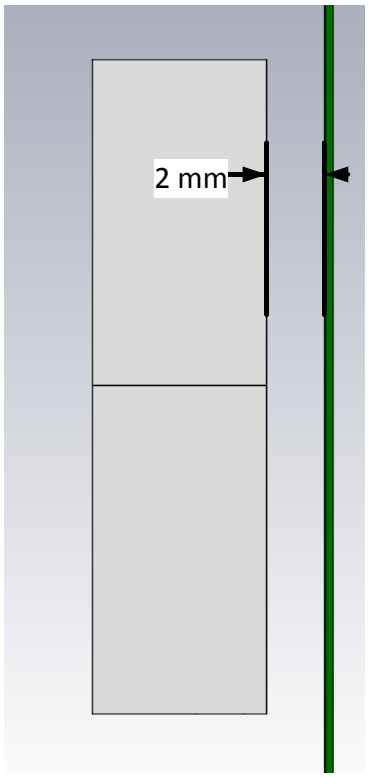
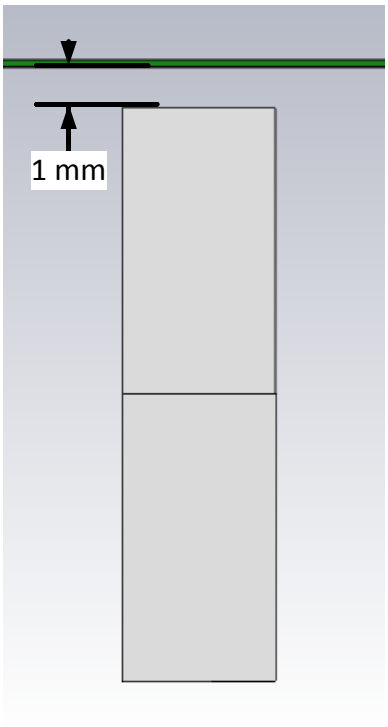


Figure 22 Top Clearance



Side Clearance



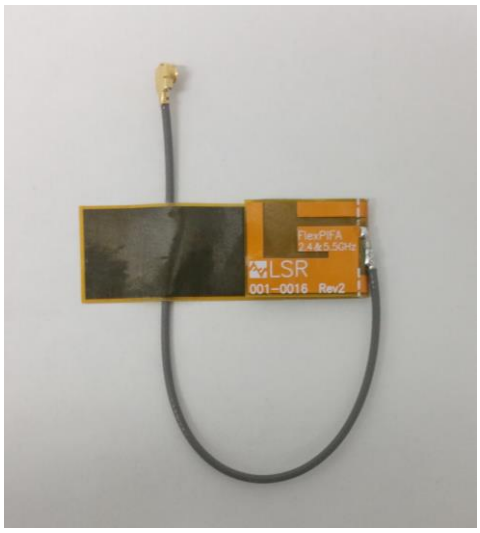
Ground Wall Clearance

Figure 23 Side and Ground Wall Clearance

The ideal material for the FlexPIFA to be mounted on is 1.5 mm thick polycarbonate for maximum performance. However, as previously mentioned, the FlexPIFA can tolerate other non-metallic surfaces and thicknesses and still radiate effectively. Depending on the type of material, the FlexPIFA may be detuned.

The coaxial cable feeding the FlexPIFA should be routed away from the antenna. Do not run the coaxial cable over the top of the FlexPIFA or near the tip of the main element. The cable should be routed perpendicular to the side of the FlexPIFA (this is the way the cable comes assembled), underneath the ground plate, or away from the ground wall. All three of these options are shown in **Figure 24**.

Perpendicular to the side



Underneath the FlexPIFA

Away from the Ground wall

Figure 24 Recommended Cable Routing

As with any antenna, care should be taken not to place conductive materials or objects near the antenna (except as described in the next section). The radiated fields from the antenna will induce currents on the surface of the metal; as a result those currents then produce their own radiation. These re-radiating fields from the metal will interfere with the fields radiating from the FlexPIFA (this is true for any antenna). Other objects, such as an LCD display, placed in close proximity to the antenna may not affect its tuning but it can distort the radiation pattern. Materials that absorb electromagnetic fields should be kept away from the antenna to maximize performance. Common things to keep in mind when placing the antenna:

Wire Routing

Speakers – these generate magnetic fields

Metal Chassis and Frames

Battery Location

Proximity to Human Body

Display Screen – these will absorb radiation

Paint – do not use metallic coating or flakes

Flex Limits of the FlexPIFA

One of the unique features of the FlexPIFA is its ability to flex. However, due to the adhesive there are limits as to how much the antenna can be flexed and remain secured to the device. The FlexPIFA should not be flexed in a convex position with a radius less than 16mm. Going smaller than this may result in the antenna peeling off the surface over time. Should a tighter radius of curvature be required, it is recommended you contact LS Research for assistance.

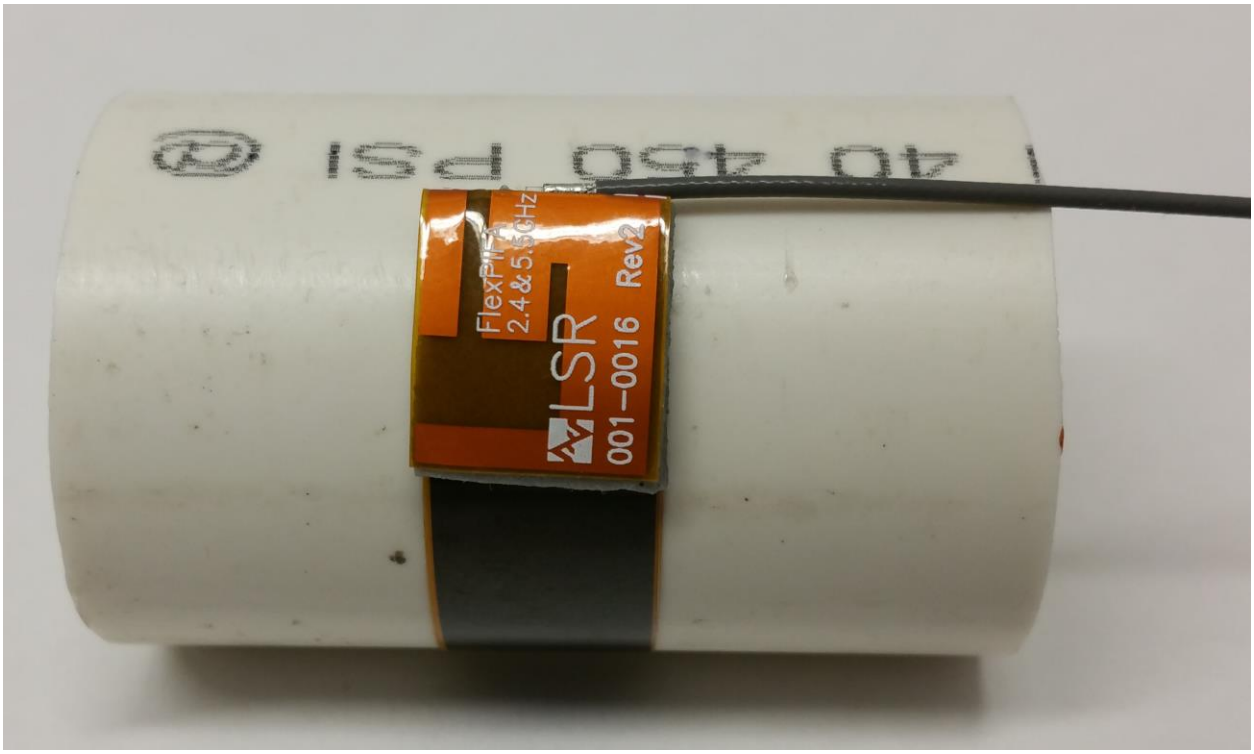


Figure 25 Convex Mounted

The FlexPIFA should not be flexed in a concave position with a radius less than 25mm. In this scenario, the limiting factor is performance. The ground plate of the antenna is pressed closer to the main element. As previously discussed in the introduction of this application note, the fringing fields developing off the end of the element are responsible for most of the radiation. In a concave position with a radius of curvature less than 25mm, the fringing fields are adversely affected and gain suffers. If a tighter radius of curvature is required, it is recommended you contact LS Research for assistance.

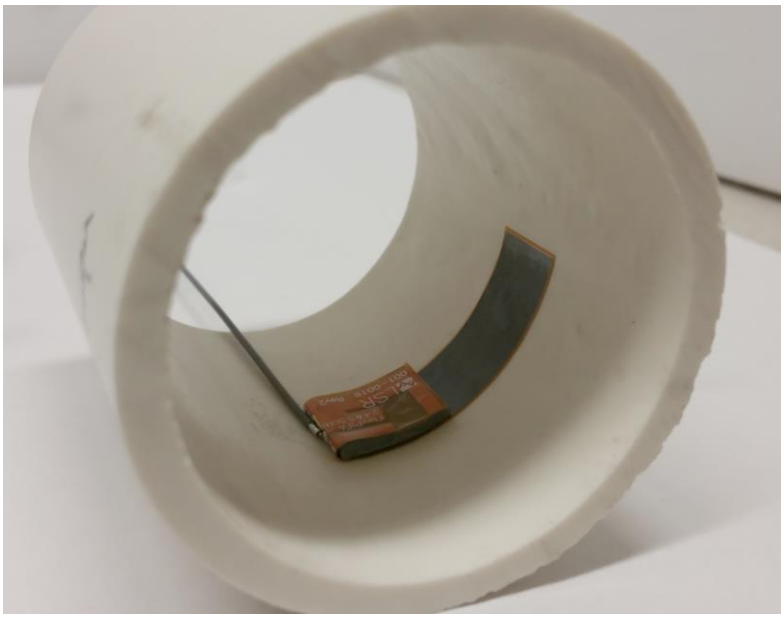


Figure 26 Concave Mounted

The FlexPIFA is not designed to be twisted or crumpled. The adhesive back should lay flush with the surface it is mounted on.

Mounting on Metal and Body Loaded Applications

The FlexPIFA can tolerate being mounted on conductive surfaces. There will be some detuning of the antenna, which translates into some gain reduction. Even though the FlexPIFA is optimized to work on non-metallic surfaces, it still radiates efficiently due to the fringing fields (Shown in **Figure 21**). The ground plate of the FlexPIFA carries the adhesive backing; placing the antenna onto a metal surface simply enlarges the size of the ground beneath the main element. Previously the fringing fields only interacted with the small ground of the FlexPIFA - however they are now interacting with the much larger ground. The fringing fields still develop and radiate, but the antenna will no longer tune as well to the 2.4 GHz frequency band. Consequently the VSWR increases and there is some loss in radiated power. If the FlexPIFA cannot meet your range requirements after being implemented on a metal surface, contact LSR Design Services for a custom antenna build to help meet your application needs.

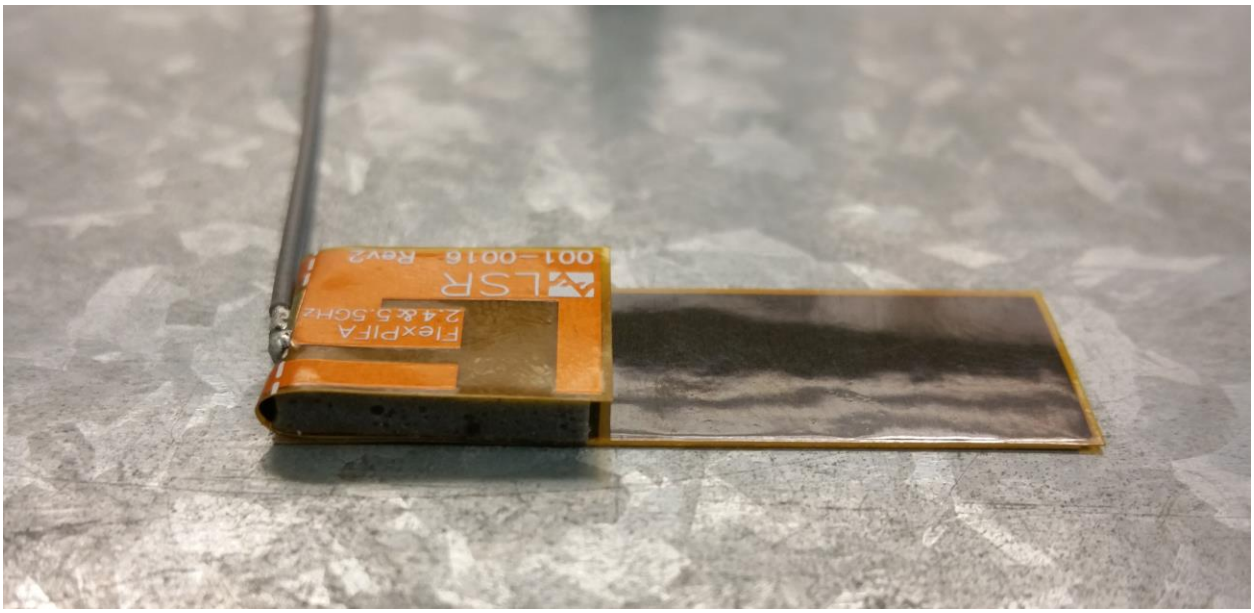


Figure 27 FlexPIFA Mounted on Metal

Do not mount the FlexPIFA where metal is within 10 mm above the main element (see **Figure 29**). Not only will this severely limit the radiation pattern (mainly due to the re-radiation problem previously described) it will detune the antenna inside of this range. Similarly, the two long sides of the FlexPIFA should be kept clear of any metal object by at least 5 mm. These keep out requirements pertain to **conductive** materials only, and are different from those listed in the previous sections which apply to **non-conductive** materials. In general, it is good practice to always keep metals as far away from the antenna as possible.

For the best performance, a spacer should be placed between the FlexPIFA and the conductive surface (see **Figure 28**). The spacer should be 1.5 mm thick polycarbonate. This will significantly improve performance and tuning of the FlexPIFA on a metal surface. Other non-conductive materials such as ABS plastic can be used; however polycarbonate will provide the best results.

Figure 28 FlexPIFA Mounted on Metal Surface with 1.5mm Thick Polycarbonate Spacer

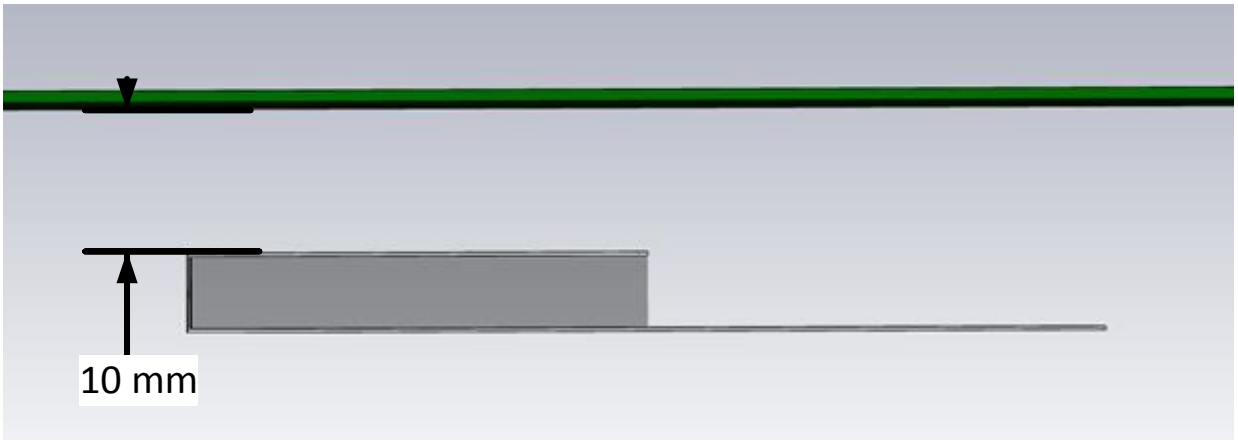


Figure 29 Metal near Main Element

For body worn applications, the FlexPIFA can tolerate the presence of the human body. It is not recommended that the antenna be mounted directly on body tissue, this will detune the FlexPIFA. Additionally the human body is an excellent absorber of 2.4GHz RF signals. As a result of this, expect a reduction in range due to the presence of a body. In a body worn application, the ground plate of the FlexPIFA should be closest to the body tissue. The main element should be pointed away from the body. Additionally, for handheld devices the FlexPIFA should be mounted in a location where it will not be covered by the hand. If the antenna is mounted in a location where the main element will be covered or near a human body, ensure that there is at least a 10mm separation distance between the main element and the body as shown in **Figure 29**.

Additionally, when the FlexPIFA is mounted very close to body tissue, use a spacer to create separation distance between the body tissue and ground plate. This will ensure maximum performance and prevent the antenna from detuning. As previously mentioned, the ideal spacer material is 1.5 mm thick polycarbonate.

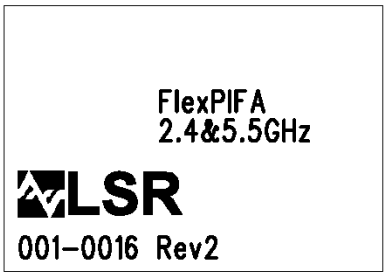
Quite often this separation distance between the body tissue and the FlexPIFA is already provided by the enclosure. **Figure 30** below is an example of a bracelet with the FlexPIFA integrated inside it. The enclosure provides enough spacing between the antenna and body tissue to prevent any major detuning. The enclosure is made of polycarbonate.

Figure 30 FlexPIFA Integrated into Bracelet

PRODUCT REVISION HISTORY

Rev 1: Initial Production Release

Rev 2:



Updated LSR Logo

CONTACTING LSR

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LS Research, LLC
W66 N220 Commerce Court
Cedarburg, WI 53012-2636
USA
Tel: 1(262) 375-4400
Fax: 1(262) 375-4248

Website www.lsr.com

Technical Support forum.lsr.com

Sales Contact sales@lsr.com

2.4 GHz / 5.5 GHz Waterproof Dipole 2 dBi Antenna, IP67

ORDERING INFORMATION

Order Number	Description
001-0012	2.4/5.5 GHz Waterproof Dipole Antenna for Reverse Polarity SMA Connector, IP67
080-0013	U.FL to Reverse Polarity SMA Cable, 105mm, O-Ring Seal
080-0014	U.FL to Reverse Polarity SMA Cable, 210mm, O-Ring Seal

Table 1 Orderable Part Numbers

SPECIFICATIONS

Specification	Value
2.4 Ghz Band Gain	+2 dBi
5 GHz Band Gain	+2 dBi
Impedance	50 ohms
Type	Dipole
Polarization	Linear Vertical
VSWR	≤2.5：1
Frequency	2400 - 2500MHz, 4910 - 5850MHz
Weight	18g
Size	114 mm × 13 mm
Antenna Color	Black
Operating Temp	-40°C to +85°C
UL Rating	UL 94HB

Table 2 Specifications

PHYSICAL DIMENSIONS (MM)

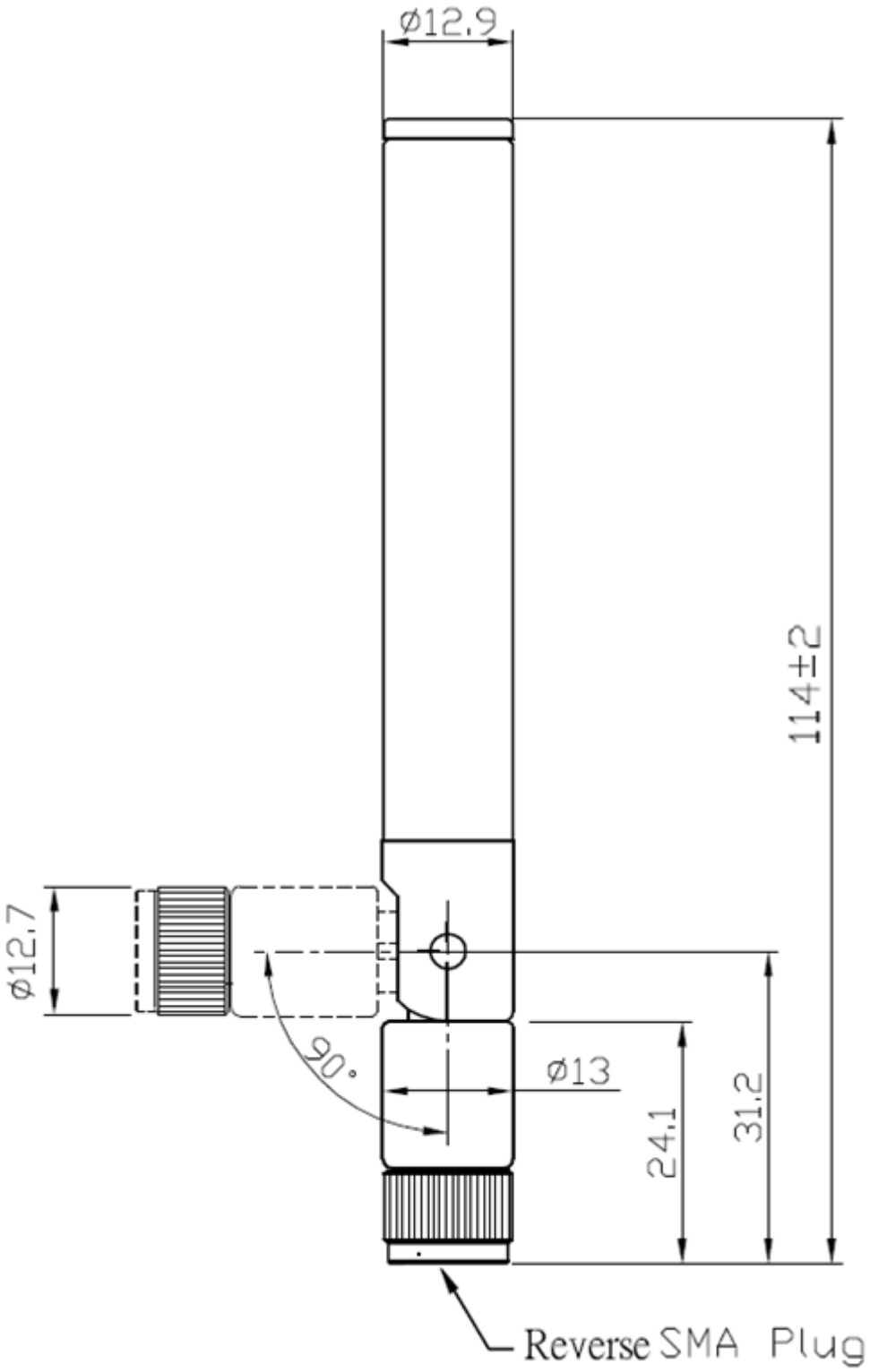


Figure 1 Physical Dimensions

TYPICAL ANTENNA REFLECTION PERFORMANCE

Straight Antenna Position

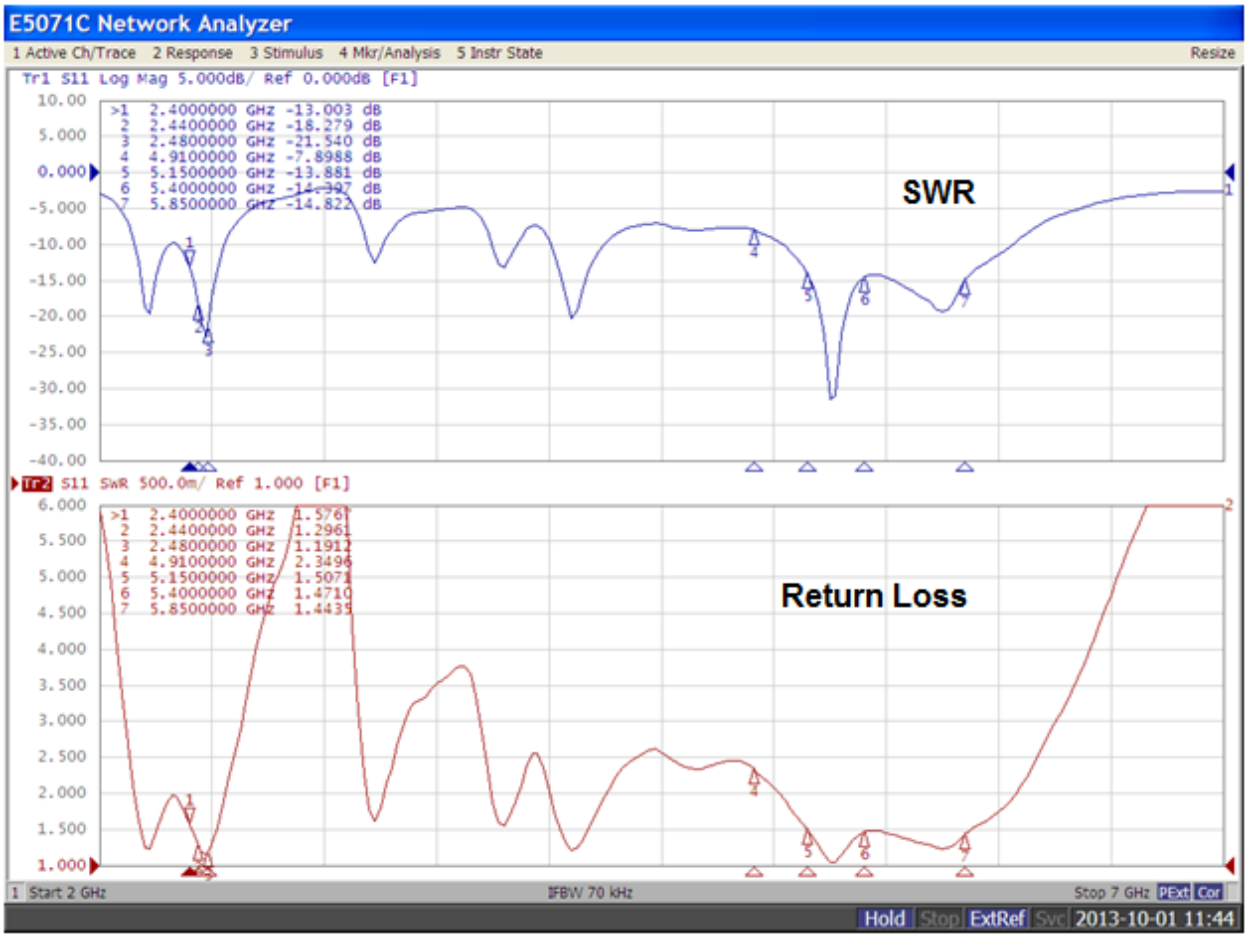


Figure 2 Typical Straight Position Reflection Performance

Bent Antenna Position

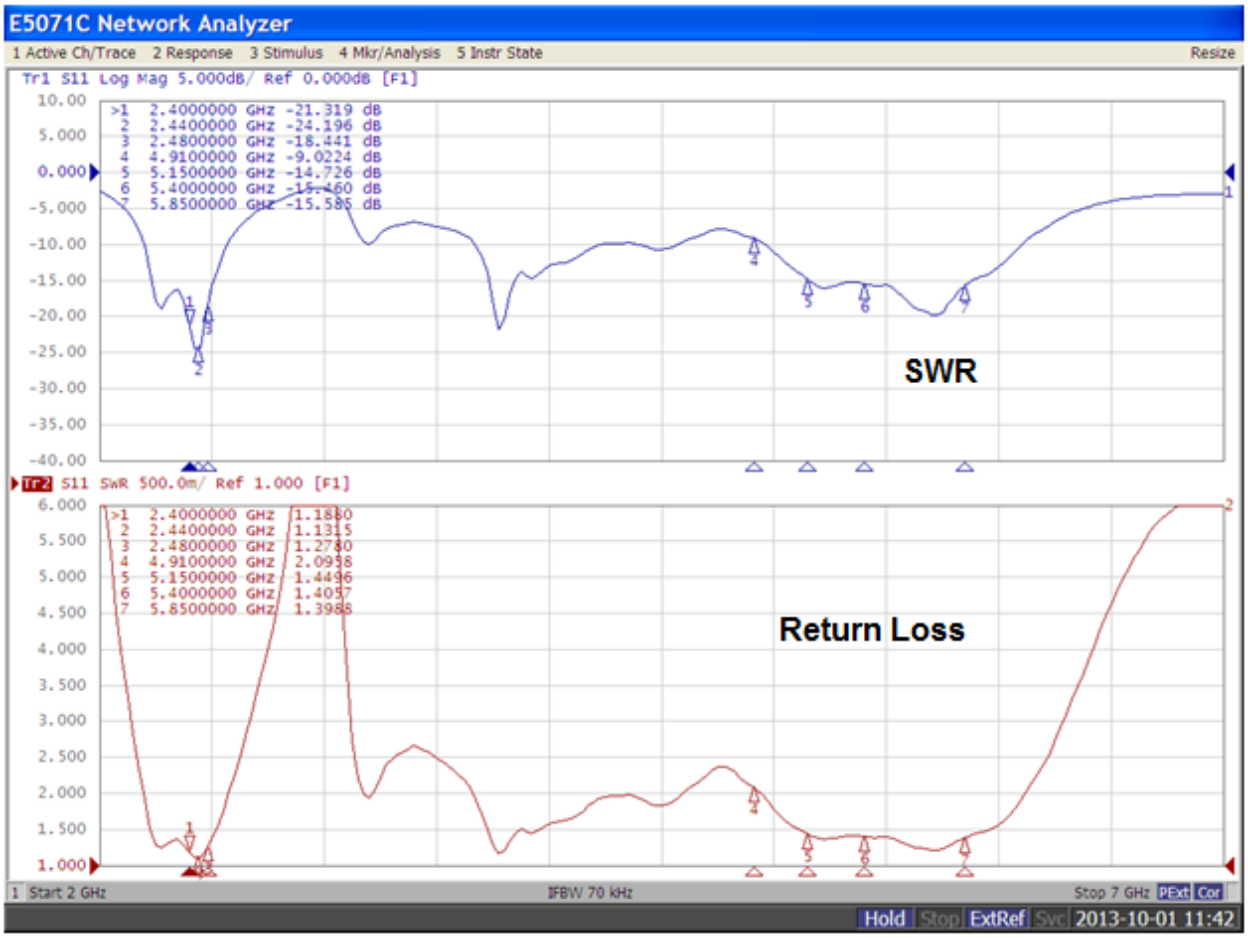


Figure 3 Typical Bent Position Reflection Performance

TYPICAL ANTENNA RADIATION PERFORMANCE

2.4 GHz Band

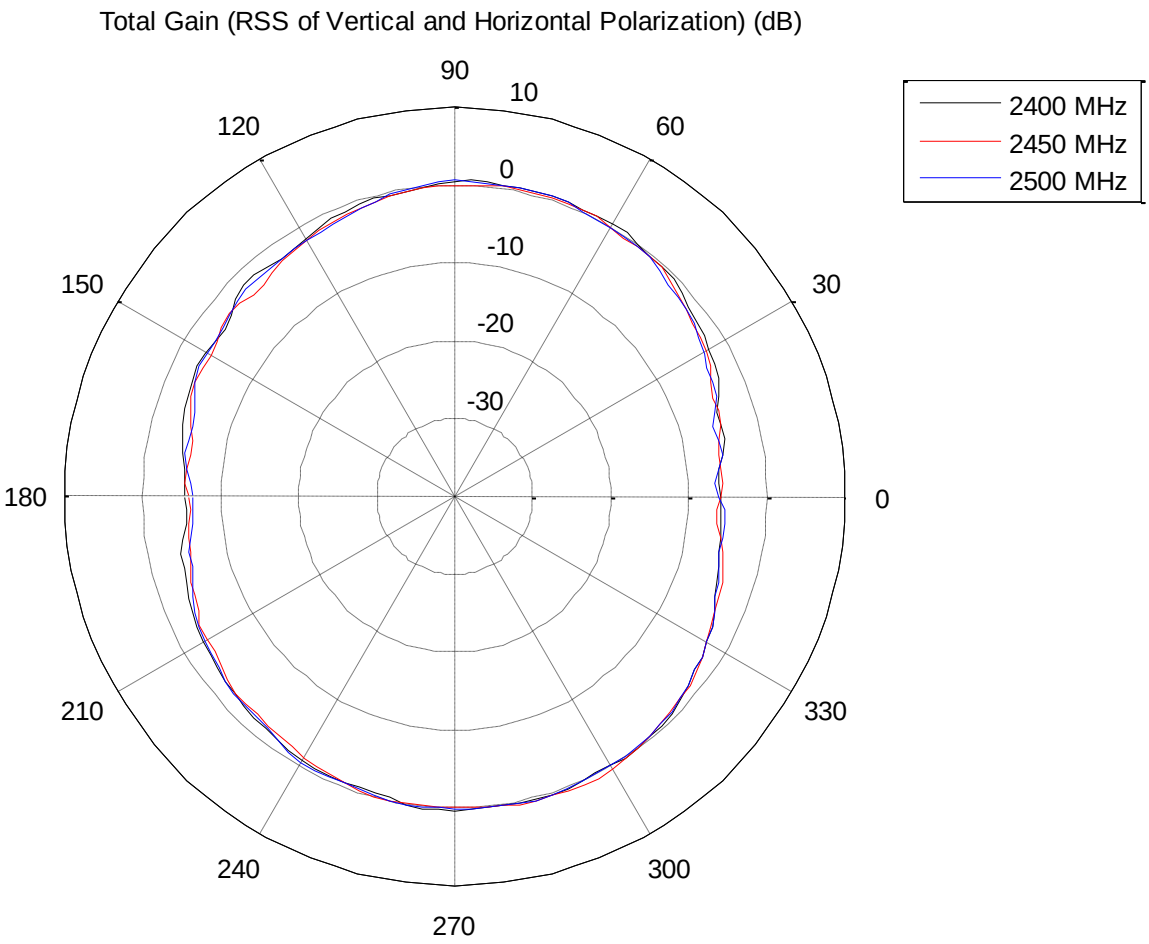


Figure 4 Typical E-Plane Performance

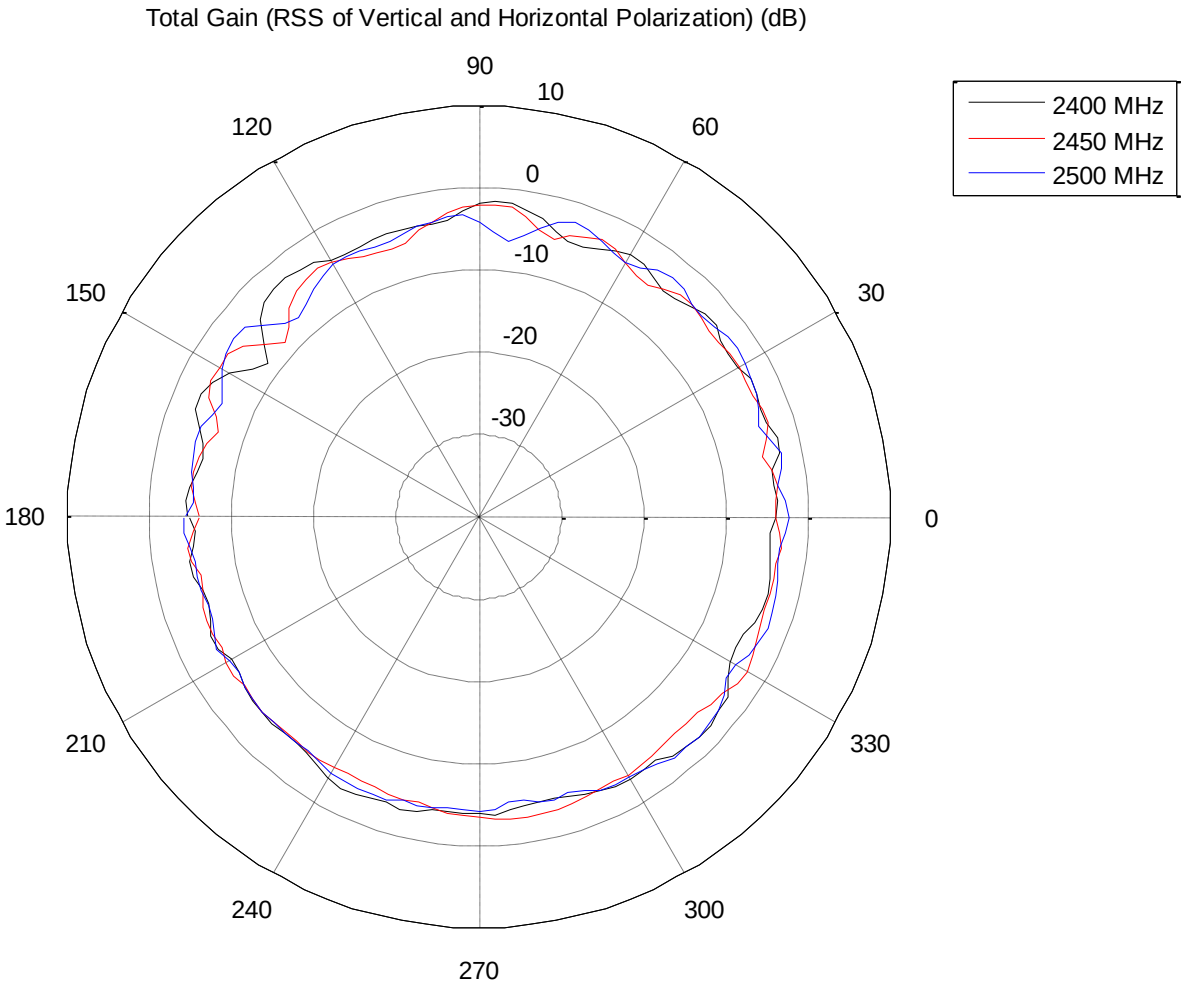


Figure 5 Typical H-Plane Performance

5 GHz Band

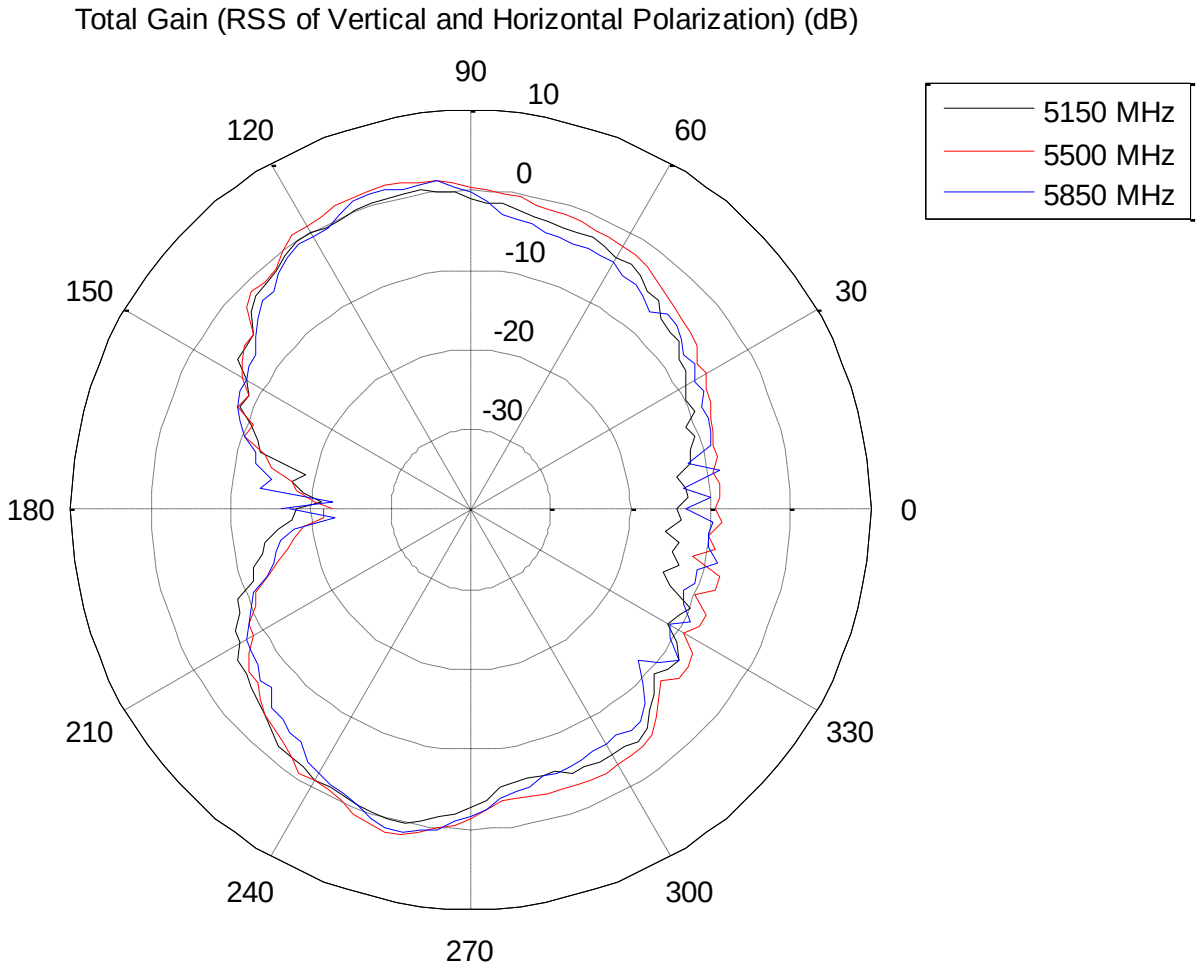


Figure 6 Typical E-Plane Performance

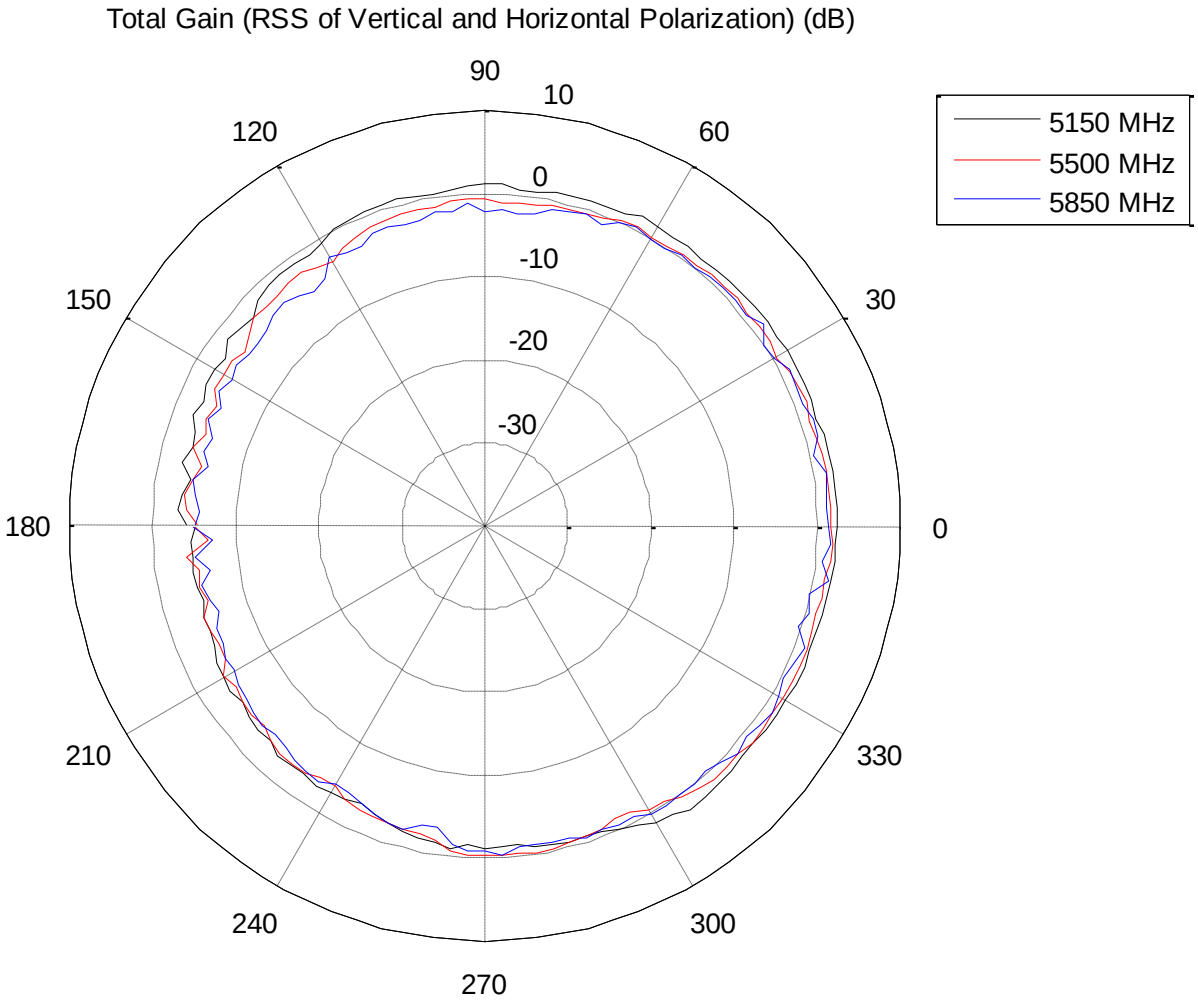


Figure 7 Typical H-Plane Performance

CONTACTING LS RESEARCH

Headquarters	LS Research, LLC W66 N220 Commerce Court Cedarburg, WI 53012-2636 USA Tel: 1(262) 375-4400 Fax: 1(262) 375-4248
Website	www.lsr.com
Wiki	www.lsr.com/products-wiki
Technical Support	www.lsr.com/products-forum
Sales Contact	sales@lsr.com

Limited Web Version

"High Frequency Ceramic Solutions"

802.11 Dual Band 2.45/5 GHz Mini Chip Antenna. WiFi, Wireless LAN, I **P/N 2450AD14A5500**

Detail Specification: 10/26/2017

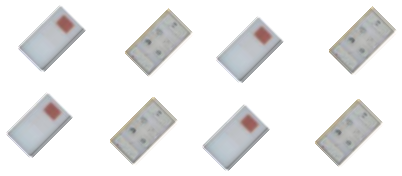
This is the Web version of this datasheet, for the full datasheet, please contact us at: www.johansontechnology.com/ask-a-question

General Specifications

Part Number	2450AD14A5500	
Frequency (MHz)	2400 - 2480	5150 - 5850
Ave. Rad Efficiency	60%	80%
Peak Gain (dBi typ.)	1.0 dBi typ. (XZ-Total)	4.0 dBi typ. (XZ-Total)
Average Gain (dBi typ.)	-3.5 dBi typ. (XZ-Total)	-2.5 dBi typ. (XZ-Total)
Return Loss (dB)	6 min.	6 min.
Impedance	50 Ω	
Input Power	2 Watts max. (CW)	

Let us help you with the antenna design, optimization, and tuning!

www.johansontechnology.com/ipc-antenna-services



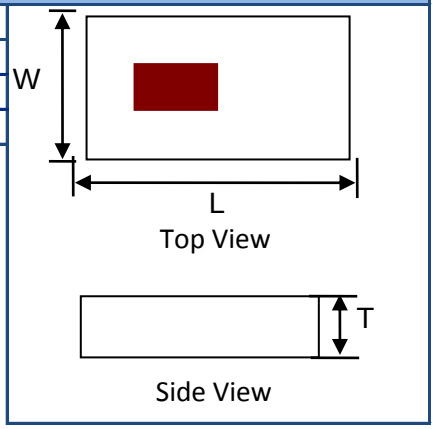
Storage Period	18 months max.
Storage Temperature	-40 to +85°C
Operating Temperature	-40 to +85°C
Reel Quantity	4000

Part Number Explanation

P/N Suffix	**Packing Style**	Bulk (loose)	Suffix = S	e.g. 2450AD14A5500S
		T & R	Suffix = T	e.g. 2450AD14A5500T
		100% Tin	Suffix = T or S	e.g. 2450AD14A5500(T or S)
	Evaluation Board	2450AD14A5500-EB1SMA & 2450AD14A5500-EB2SMA		

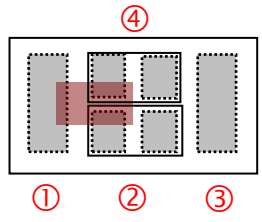
Mechanical Dimensions

	In			mm		
L	0.063	±	0.004	1.60	±	0.10
W	0.031	±	0.004	0.80	±	0.10
T	0.016		max.	0.40		max.



Terminal Configuration

No.	Function
1	GND
2	FEED
3	NC
4	NC



Top View looking "through" the component

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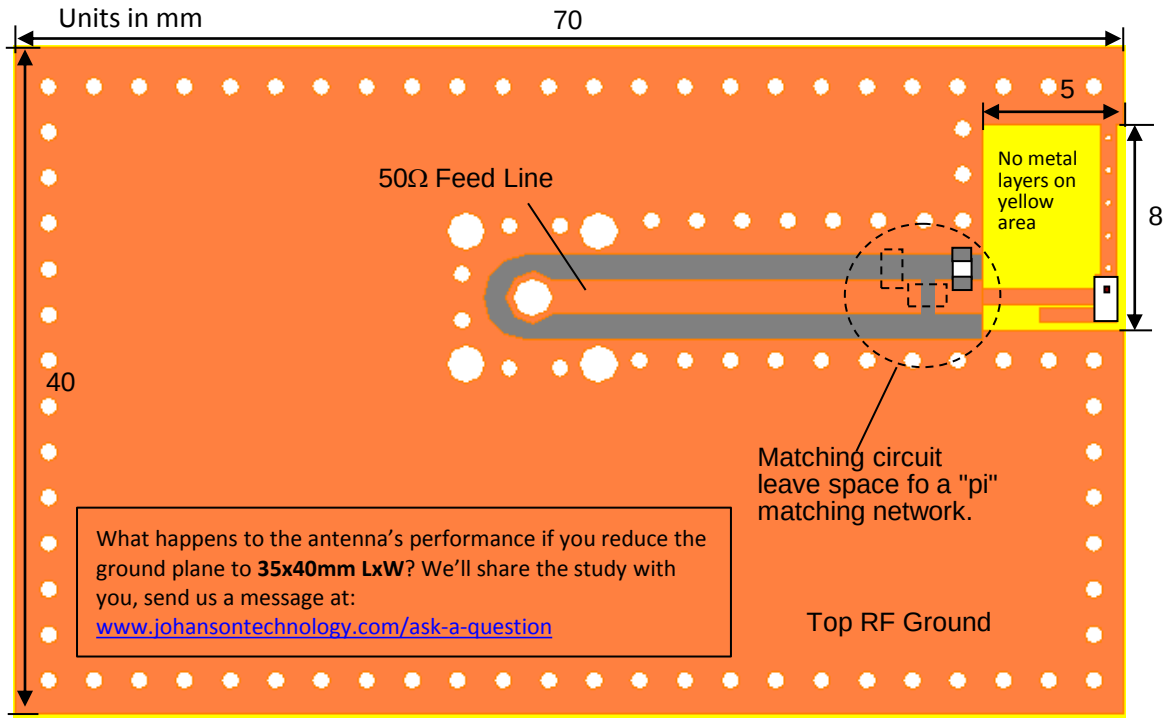
Mounting Considerations 1: Evaluation Board, 65x70mm (Scenario 1 Terminal Configuration)



To order teh ABOVE pre-tuned 50Ω EVB with a female SMA connector
click here: www.johansontechnology.com/request-a-sample

Would you like the layout file of the above? Have antenna tuning issues?
Please contact us if you have any questions regarding the implementation of this antenna in your PCB's layout. We'll be happy to guide you to maximize the antenna's performance.
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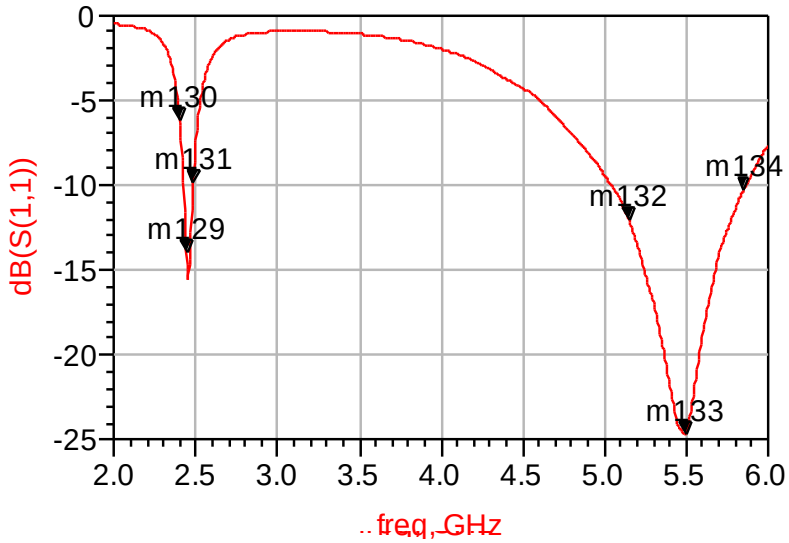
Mounting Considerations 2: Typical Electrical Performance (T=25°C)



m130 freq=2.400GHz dB(S(1,1))=-6.202	m129 freq=2.442GHz dB(S(1,1))=-14.010	m131 freq=2.484GHz dB(S(1,1))=-9.880
m132 freq=5.150GHz dB(S(1,1))=-12.066	m133 freq=5.500GHz dB(S(1,1))=-24.657	m134 freq=5.850GHz dB(S(1,1))=-10.323

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802.11 Dual Band 2.45/5 GHz Mini Chip Antenna. WiFi, Wireless LAN, IoT P/N 2450AD14A5500

Detail Specification: 10/26/2017

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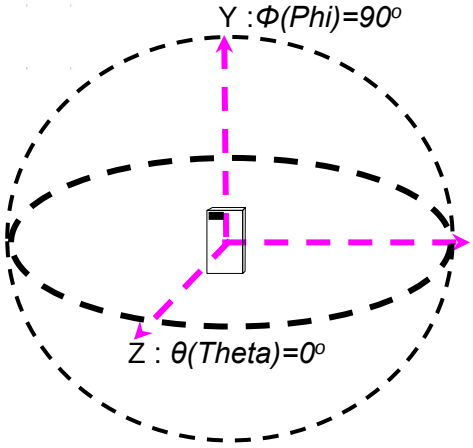
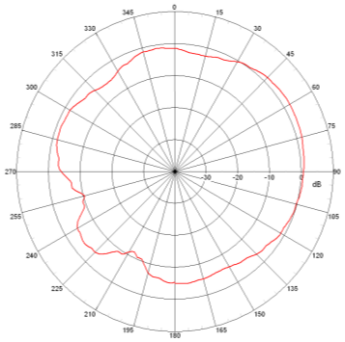
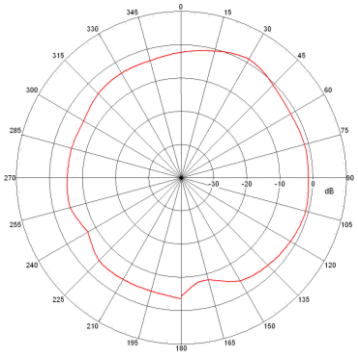
Typical EM Radiation Performance @ 2.44GHz (T=25°C)



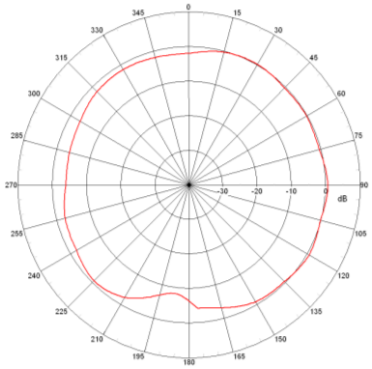
XY-plane @2440MHz
Total



XZ-plane @2440MHz
Total



YZ-plane @2440MHz
Total



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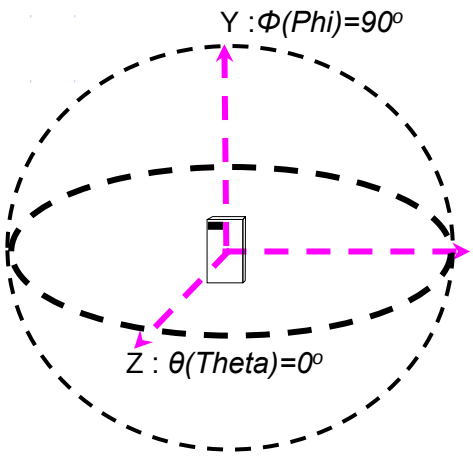
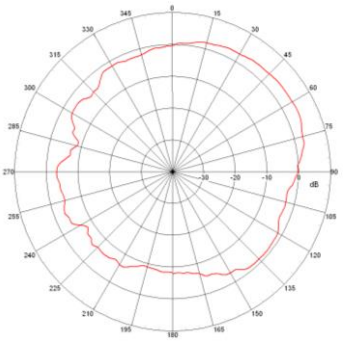
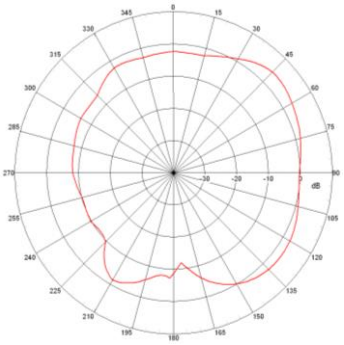
Typical EM Radiation Performance @ 5.50 GHz (T=25°C)



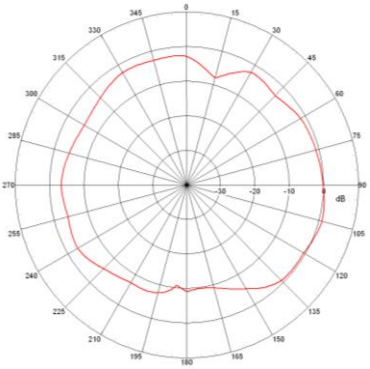
XY-plane @5500MHz
Total



XZ-plane @5500MHz
Total



YZ-plane @5500MHz



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