Japan Test Report

Equipment	:	**2.4 GHz Bluetooth Low Energy Module**
Model No.	:	**SaBLE-x-R2**
Brand Name	:	**Laird**
Applicant	:	**Laird Technologies, Inc.**
Address	:	**W66N220 Commerce Court, Cedarburg, Wisconsin 53012, USA**
Standard	:	**ARIB STD-T66 Ver. 3.7**
Received Date	:	**Apr. 26, 2017**
Tested Date	:	**May 10, 2017**

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 or the test method more than equivalent.

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

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APPENDIX A. TEST RESULTS A1
APPENDIX B. ANTENNA INFORMATION B1

Release Record

Report No.	Version	Description	Issued Date
JR742502-01	Rev. 01	Initial issue	Jun. 13, 2017

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
3.2(8)	Spreading Bandwidth	Pass
3.2(9)	Spreading Factor	Pass
3.3(1)	Receiver Emission	Pass
3.4.1	Interference prevention function	Pass

1 General Description

1.1 Information

1.1.1 Specification of the Equipment under Test (EUT)

Power Type	DC 1.8V & DC 3.3V from host
Type(s) of Modulation / Technology	GFSK = 1Mbps, 2Mbps, 125 kbps, 500 kbps
Frequency Range (MHz)	2402 ~ 2480 MHz
Total Channel Number	40
HW Version	1.0
SW Version	1.0

1.1.2 Accessories

N/A

1.1.3 Antenna Details

Ant. No.	Type	Connector	Gain (dBi)
1	Dipole	SMA	2
2	PIFA	U.FL	2
3	Notch	U.FL	2

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

1.1.4 Antenna Power

For 125 kbps

Operating Mode	Rated Power (mW)	Measured Conducted Power (mW)	Radiated Power (mW)
LE	3.50	3.184	5.05

For 500 kbps

Operating Mode	Rated Power (mW)	Measured Conducted Power (mW)	Radiated Power (mW)
LE	3.50	3.236	5.13

For 1Mbps

Operating Mode	Rated Power (mW)	Measured Conducted Power (mW)	Radiated Power (mW)
LE	3.50	3.273	5.19

For 2Mbps

Operating Mode	Rated Power (mW)	Measured Conducted Power (mW)	Radiated Power (mW)
LE	3.00	2.710	4.3

1.1.5 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

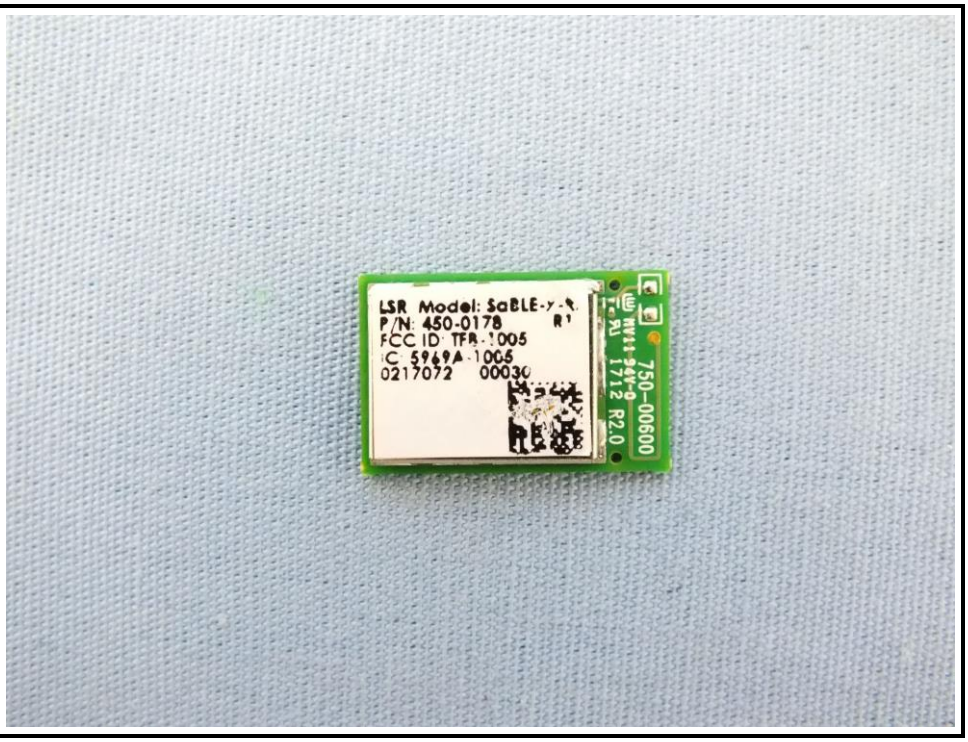
1.1.6 Test Tool and Power Setting

Test Tool
Bluetooth RF Eval Tool, Version: 8.7.0.0

Modulation Mode	Test Frequency (MHz)		
	2402	2440	2480
GFSK/125 kbps	5	5	5
GFSK/500 kbps	5	5	5
GFSK/1Mbps	5	5	5
GFSK/2Mbps	4	4	4

1.1.7 Protection Method for High Frequency and Modulation Section

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

Photo	

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	ROHDE&SCHWARZ	FSV40	101486	Nov. 15, 2016	Nov. 14, 2017
TEMP&HUMIDITY CHAMBER	GIANT FORCE	GCT-225-40-SP-SD	MAF1212-002	Nov. 21, 2016	Nov. 20, 2017
Power Meter	Anritsu	ML2495A	1241002	Oct. 06, 2016	Oct. 05, 2017
Power Sensor	Anritsu	MA2411B	1207366	Oct. 06, 2016	Oct. 05, 2017
Signal Generator	R&S	SMB100A	175727	Oct. 19, 2016	Oct. 18, 2017
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:

ARIB STD-T66 Ver. 3.7

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	24℃ / 67%	Chris Zeng

2.2 Supporting Units

Support Unit	Brand	Model	FCC ID
Notebook	DELL	Latitude E5430	DoC

2.3 The Worst Test Modes and Channel Details

For 125 kbps, 500 kbps
For 125 kbps, 500 kbps

Test item	Mode	Test Frequency (MHz)
Antenna Power Frequency Tolerance	BT LE	2402 / 2440 / 2480

For 1Mbps, 2Mbps

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

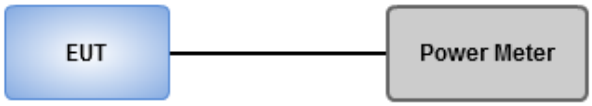
3.1.1 Limit of Antenna Power

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	Test Items
Appendix A 19-LE	LE	1.Test Results 2. Antenna Power (Conducted Power)

3.2 Frequency Tolerance

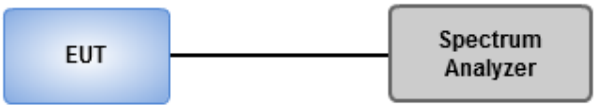
3.2.1 Limit of Frequency Tolerance

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	Test Items
Appendix A 19-LE	LE	1.Test Results

3.3 Occupied Bandwidth

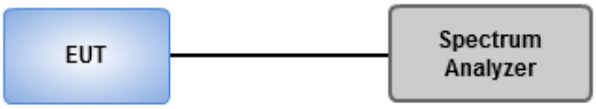
3.3.1 Limit of Occupied Bandwidth

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	Test Items
Appendix A 19-LE	LE	1.Test Results

3.4 Spreading Bandwidth and Factor

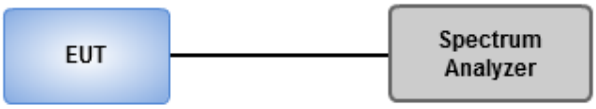
3.4.1 Limit of Spreading Bandwidth and Factor

Item	Limit
Spreading bandwidth	≥ 500kHz
Spreading factor for DSSS (operates at 2400~2483.5 MHz)	≥ 5
Spreading factor for DSSS (operates at 2471~2497 MHz)	≥ 10

3.4.2 Test Procedures

1. Set Span = 20MHz, RBW = VBW = 300kHz, detector = Peak, Sweep time = Auto.
2. Enable OBW (90%) function of spectrum analyzer to measure OBW (90%) and capture test plot.

3.4.3 Test Setup



3.4.4 Test Result of Spreading Bandwidth and Factor

Reference Documents	Test Mode	Test Items
Appendix A 19-LE	LE	1.Test Results

3.5 Transmitter Spurious Emissions

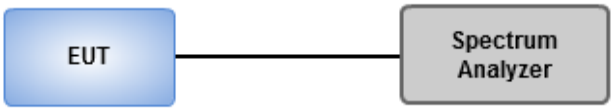
3.5.1 Limit of Transmitter Spurious Emissions

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

3.5.2 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.

3.5.3 Test Setup



3.5.4 Test Result of Transmitter Spurious Emissions

For 1Mbps & 2Mbps

Reference Documents	Test Mode	Test Items
Appendix A 19-LE	LE	1.Test Results 4. Unwanted Emission Intensity

3.6 Interference prevention function

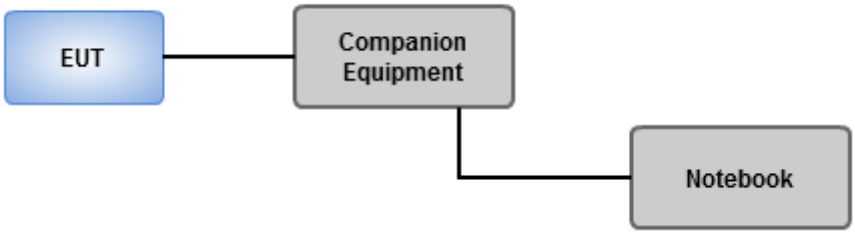
3.6.1 Limit of Interference Prevention Function

Limits
The identification code shall be 48 bits long

3.6.2 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

3.6.3 Test Setup



3.6.4 Test Result of Interference Prevention Function

Reference Documents	Test Mode	Test Items
Appendix A 19-LE	LE	1.Test Results

4 Receiver Test Results

4.1 Receiver Spurious Emissions

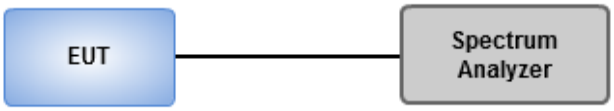
4.1.1 Limit of Receiver Spurious Emissions

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

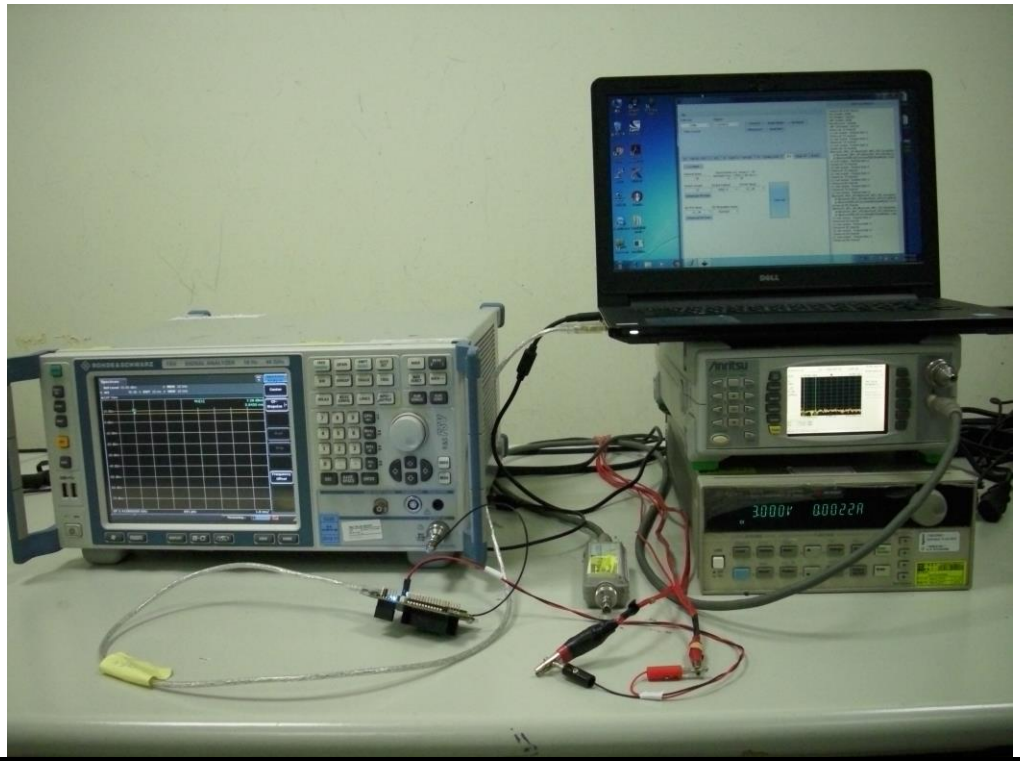


4.1.4 Test Result of Receiver Spurious Emissions

For 1Mbps & 2Mbps

Reference Documents	Test Mode	Test Items
Appendix A 19-LE	LE	1.Test Results 5. Limitation of Collateral Emission of Receiver

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==

Appendix A 19-BLE (1Mbps)

1. Test Results

Testing for Electrical Specification	Test Voltage		V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
	Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	Low/Mid/High of test frequency range
	Measured Frequency		MHz	2402.0014	2440.0003	2480.0024	2402.0020	2440.0021	2480.0010	2402.0021	2440.0022	2479.9930	
	Frequency Error		ppm	0.58	0.12	0.95	0.83	0.86	0.40	0.87	0.90	2.82	Limit ≦ 50 ppm
	Occupied Bandwidth		MHz	1.69	1.71	1.66	1.70	1.71	1.71	1.70	1.71	1.71	Limit ≦ 26 MHz (RB/VB : 300kHz)
	Spread-spectrum Bandwidth		MHz	0.86	0.87	0.87	0.87	0.87	0.87	0.87	0.88	0.88	
	Unwanted Emission Intensity (Power emission within 1MHz bandwidth)	※ 1	μW	0.0215	0.0172	0.0148	0.0169	0.0168	0.0164	0.0215	0.0154	0.0149	Limit ≦ 0.25 μW (-36 dBm)
		※ 2	μW	0.7345	0.3019	0.3209	0.7511	0.3389	0.3099	0.7340	0.2962	0.3464	Limit ≦ 2.5 μW (-26 dBm)
		※ 3	μW	0.4385	0.3668	0.3612	0.4385	0.4444	0.3717	0.4390	0.3984	0.3835	Limit ≦ 25 μW (-16 dBm)
		※ 4	μW	0.4315	0.3818	9.9345	0.3466	0.3557	11.0922	0.4318	0.3752	9.9699	Limit ≦ 25 μW (-16 dBm)
		※ 5	μW	1.5596	1.7573	1.6650	1.8319	1.7448	1.6311	1.5599	1.4687	1.6223	Limit ≦ 2.5 μW (-26 dBm)
	Antenna Power (Measured Power)		mW	3.266	3.069	2.924	3.273	3.076	2.931	3.192	2.999	2.858	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Rated Power)		mW	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	Limit ≦ 10 mW (10 dBm)
	Antenna Power Error		mW	-0.234	-0.431	-0.576	-0.227	-0.424	-0.569	-0.308	-0.501	-0.642	
			%	-6.69	-12.31	-16.45	-6.47	-12.11	-16.26	-8.81	-14.31	-18.35	Limit + 20% ~ - 80%
	Limitation of Collateral Emission of Receiver	※ 6	nW	0.1446	0.2164	0.2288	0.0335	0.4295	0.0831	0.0732	0.1410	0.1849	Limit ≦ 4 nW (-54 dBm)
		※ 7	nW	4.1908	2.8738	1.9741	4.3442	2.9358	1.8705	4.3680	2.7259	1.9660	Limit ≦ 20 nW (-47 dBm)
	Radio Interference Prevention Function		ID Code	Good, MAC Address :B0:91:22:64:B9:1D									
			Carrier Sense	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR: Not Require

※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)
※ 2: Frequency Band 2 (1000 MHz < f ≦ 2387 MHz)
※ 3: Frequency Band 3 (2387 MHz < f ≦ 2400 MHz)
※ 4: Frequency Band 4 (2483.5 MHz ≦ f < 2496.5 MHz)
※ 5: Frequency Band 5 (2496.5 MHz ≦ f < 12.5 GHz)
※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)
※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

2. Antenna Power (Conducted Power)

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
	Power Meter Raw from EUT	dBm	1.77	1.50	1.29	1.77	1.50	1.29	1.77	1.50	1.29	
	Cable Loss	dB	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	Refer to Calibration Result
	Duty Cycle Factor	dB	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	Duty Factor = 10 × 10Log_{10}(1/Duty Cycle)
	Antenna Power (Conducted)	dBm	5.14	4.87	4.66	5.15	4.88	4.67	5.04	4.77	4.56	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Conducted)	mW	3.266	3.069	2.924	3.273	3.076	2.931	3.192	2.999	2.858	
	Antenna Power Error	mW	-0.234	-0.431	-0.576	-0.227	-0.424	-0.569	-0.308	-0.501	-0.642	
		%	-6.69	-12.31	-16.45	-6.47	-12.11	-16.26	-8.81	-14.31	-18.35	Limit + 20% ~ - 80%
	Tranmsitter ON_{Time}	msec	0.4034									RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz
	Tranmsitter $(ON+OFF)_{Time}$	msec	0.6220									
	Tranmsitter Duty Cycle	%	64.86%									

3. Transmission Radiation Angle Width (This test item will not be applied to the EIRP power is lower than 12.14dBm)

No.	Antenna Power	Antenna				Cable			Tatal Gain D=B-C	EIRP F=A+D	Permited Angle	Judgement	Remarks (Antenna Model)
	A (dBm)	Type	Gain B (dBi)	3dB Beam-width Horizontal (Degree)	3dB Beam-width Vertical (Degree)	Model	Length (m)	Loss C (dB)	(dBi)	(dBm)	(Degree)		
1	5.15	Dipole	2.00			-	-		2.00	7.15	288.60	Good	
2	5.15	PIFA	2.00			-	-		2.00	7.15	288.60	Good	
3	5.15	Notch	2.00			-	-		2.00	7.15	288.60	Good	
4													
5													
6													
7													
8													
9													
10													
11													
12													

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4. Unwanted Emission Intensity

	Test Voltage		V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
	Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
Unwanted Emission Intensity	Unwanted Emission Frequency	※ 1	MHz	666.32	960.23	616.85	863.23	790.48	911.73	993.21	935.01	693.48	RBW : 100 kHz ; VBW : 100 kHz
		※ 2	MHz	2385.61	2313.49	2178.26	2385.61	2348.16	1979.92	2386.31	2324.59	2370.36	RBW : 1 MHz ; VBW : 1 MHz
		※ 3	MHz	2400.00	2398.19	2388.26	2400.00	2393.40	2389.57	2400.00	2396.89	2395.83	
		※ 4	MHz	2489.90	2494.26	2483.55	2492.39	2483.98	2483.50	2489.28	2495.49	2483.60	
		※ 5	MHz	10544.32	10526.81	10521.81	11163.28	12496.25	10533.06	12493.75	12477.49	10628.10	
	Cable Loss	※ 1	dB	0.76	0.87	0.73	0.83	0.81	0.85	0.88	0.86	0.77	
		※ 2	dB	1.48	1.46	1.42	1.48	1.47	1.36	1.48	1.46	1.47	
		※ 3	dB	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	
		※ 4	dB	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	
		※ 5	dB	4.60	4.59	4.58	4.95	5.68	4.59	5.68	5.67	4.65	
	Spectrum Raw	※ 1	dBm	-0.76	-48.51	-49.04	-48.55	-48.55	-48.69	-47.56	-48.97	-49.03	
		※ 2	dBm	-1.48	-36.66	-36.36	-32.72	-36.17	-36.45	-32.82	-36.75	-36.08	
		※ 3	dBm	-1.48	-35.84	-35.90	-35.06	-35.00	-35.78	-35.06	-35.48	-35.64	
		※ 4	dBm	-1.50	-35.68	-21.52	-36.10	-35.99	-21.05	-35.14	-35.76	-21.51	
		※ 5	dBm	-4.60	-32.14	-32.37	-32.33	-33.26	-32.46	-33.75	-34.00	-32.54	
	Unwanted Emission Intensity	※ 1	dBm	-46.68	-47.64	-48.30	-47.72	-47.74	-47.84	-46.68	-48.11	-48.26	Limit ≦ 0.25 μW (-36 dBm)
		※ 2	dBm	-31.34	-35.20	-34.94	-31.24	-34.70	-35.09	-31.34	-35.28	-34.60	Limit ≦ 2.5 μW (-26 dBm)
		※ 3	dBm	-33.58	-34.36	-34.42	-33.58	-33.52	-34.30	-33.58	-34.00	-34.16	Limit ≦ 25 μW (-16 dBm)
		※ 4	dBm	-33.65	-34.18	-20.03	-34.60	-34.49	-19.55	-33.65	-34.26	-20.01	Limit ≦ 25 μW (-16 dBm)
		※ 5	dBm	-28.07	-27.55	-27.79	-27.37	-27.58	-27.88	-28.07	-28.33	-27.90	Limit ≦ 2.5 μW (-26 dBm)
	Unwanted Emission Intensity	※ 1	μW	0.0215	0.0172	0.0148	0.0169	0.0168	0.0164	0.0215	0.0154	0.0149	Limit ≦ 0.25 μW (-36 dBm)
		※ 2	μW	0.7345	0.3019	0.3209	0.7511	0.3389	0.3099	0.7340	0.2962	0.3464	Limit ≦ 2.5 μW (-26 dBm)
		※ 3	μW	0.4385	0.3668	0.3612	0.4385	0.4444	0.3717	0.4390	0.3984	0.3835	Limit ≦ 25 μW (-16 dBm)
		※ 4	μW	0.4315	0.3818	9.9345	0.3466	0.3557	11.0922	0.4318	0.3752	9.9699	Limit ≦ 25 μW (-16 dBm)
		※ 5	μW	1.5596	1.7573	1.6650	1.8319	1.7448	1.6311	1.5599	1.4687	1.6223	Limit ≦ 2.5 μW (-26 dBm)

※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)
※ 2: Frequency Band 2 (1000 MHz < f ≦ 2387 MHz)
※ 3: Frequency Band 3 (2387 MHz < f ≦ 2400 MHz)
※ 4: Frequency Band 4 (2483.5 MHz ≦ f < 2496.5 MHz)
※ 5: Frequency Band 5 (2496.5 MHz ≦ f < 12.5 GHz)
※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)
※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

5. Limitation of Collateral Emission of Receiver

	Test Voltage		V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks	
	Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480		
Limitation of Collateral Emission	Spurious Emission Frequency	※ 6	MHz	30.00	30.00	30.00	62.01	30.00	62.01	62.01	30.00	31.94	1st	30MHz～1000MHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated.
		※ 6	MHz	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	MHz	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	MHz	4802.19	4878.37	4957.44	4802.19	4878.37	4957.44	4802.19	4878.37	4957.44	1st	1000MHz～12.5GHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated.
		※ 7	MHz	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	MHz	-	-	-	-	-	-	-	-	-	3rd	
	Cable Loss	※ 6	dB	0.26	0.26	0.26	0.29	0.26	0.29	0.29	0.26	0.26	1st	
		※ 6	dB	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	dB	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	dB	1.71	1.72	1.73	1.71	1.72	1.73	1.71	1.72	1.73	1st	
		※ 7	dB	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	dB	-	-	-	-	-	-	-	-	-	3rd	
	Spectrum Raw	※ 6	dBm	-68.14	-66.39	-66.14	-74.45	-63.41	-70.51	-71.06	-68.25	-67.07	1st	
		※ 6	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	dBm	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	dBm	-52.07	-53.70	-55.32	-51.91	-53.61	-55.55	-51.89	-53.93	-55.34	1st	
		※ 7	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	dBm	-	-	-	-	-	-	-	-	-	3rd	
	Spurious Emission Intensity	※ 6	dBm	-68.40	-66.65	-66.40	-74.74	-63.67	-70.80	-71.35	-68.51	-67.33	1st	Limit ≦ 4 nW (-54 dBm) RBW : 100 kHz ; VBW : 100 kHz
		※ 6	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	dBm	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	dBm	-53.78	-55.42	-57.05	-53.62	-55.32	-57.28	-53.60	-55.64	-57.06	1st	Limit ≦ 20 nW (-47 dBm) RBW : 1 MHz ; VBW : 1 MHz
		※ 7	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	dBm	-	-	-	-	-	-	-	-	-	3rd	
	Spurious Emission Intensity	※ 6	nW	0.1446	0.2164	0.2288	0.0335	0.4295	0.0831	0.0732	0.1410	0.1849	Total Emission Power	
		※ 6	nW	0.1446	0.2164	0.2288	0.0335	0.4295	0.0831	0.0732	0.1410	0.1849	1st	Limit ≦ 4 nW (-54 dBm) RBW : 100 kHz ; VBW : 100 kHz
		※ 6	nW	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	nW	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	nW	4.1908	2.8738	1.9741	4.3442	2.9358	1.8705	4.3680	2.7259	1.9660	Total Emission Power	
		※ 7	nW	4.1908	2.8738	1.9741	4.3442	2.9358	1.8705	4.3680	2.7259	1.9660	1st	Limit ≦ 20 nW (-47 dBm) RBW : 1 MHz ; VBW : 1 MHz
		※ 7	nW	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	nW	-	-	-	-	-	-	-	-	-	3rd	

※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)
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Calibration Result

1. Linearity Check

SG Output (dBm)	Spectrum Raw (dBm)	Power Meter Raw (dBm)	Remark
0	-1.3	-0.93	・SG Test Frequency：2450 MHz ・RBW：1 MHz；VBW：1 MHz；SP：0Hz ・ATT(30dB)；Ref：20 dBm
-5	-6.34	-5.88	
-10	-11.17	-10.84	
0	-1.64	-1.66	・SG Test Frequency：5250 MHz ・RBW：1 MHz；VBW：1 MHz；SP：0Hz ・ATT(30dB)；Ref：20 dBm
-5	-6.6	-6.62	
-10	-11.48	-11.58	

2. Frequency Accuracy Confirmation

SG Output (dBm)	Spectrum Raw (MHz)	Freqquency Error (ppm)	Remark
2450	2450.0002	0.0816	・SG Output：0dBm ・RWB：30 kHz；VBW：30 kHz：SP：300kHz ・Limit ≦ 10% of frequency error limits
5250	5250.0012	0.2286	

3. Cable Loss

SG Output (MHz)	Power Meter Raw Without Cable (dBm)	Power Meter Raw With Cable (dBm)	Cable Loss (dB)	Remark
1000	-0.23	-1.11	0.88	・SG Output：0dBm
2450	-0.87	-2.36	1.49	
5250	-1.67	-3.43	1.76	
12500	-3.69	-9.37	5.68	
26000	-5.55	-19.13	13.58	

Appendix A 19-BLE (2Mbps)

1. Test Results

Testing for Electrical Specification	Test Voltage		V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
	Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	Low/Mid/High of test frequency range
	Measured Frequency		MHz	2402.0014	2440.0003	2480.0024	2402.0020	2440.0021	2480.0010	2402.0021	2440.0022	2479.9930	
	Frequency Error		ppm	0.58	0.12	0.95	0.83	0.86	0.40	0.87	0.90	2.82	Limit ≦ 50 ppm
	Occupied Bandwidth		MHz	2.18	2.18	2.19	2.17	2.18	2.19	2.18	2.18	2.19	Limit ≦ 26 MHz (RB/VB : 300kHz)
	Spread-spectrum Bandwidth		MHz	1.37	1.37	1.39	1.36	1.38	1.39	1.36	1.38	1.39	
	Unwanted Emission Intensity (Power emission within 1MHz bandwidth)	※ 1	μW	0.0169	0.0227	0.0171	0.0177	0.0172	0.0164	0.0174	0.0201	0.0180	Limit ≦ 0.25 μW (-36 dBm)
		※ 2	μW	0.0011	0.9520	0.3690	0.0018	1.0419	0.3657	0.0016	0.7577	0.3181	Limit ≦ 2.5 μW (-26 dBm)
		※ 3	μW	0.3447	1.2556	0.3899	0.3374	1.1953	0.3876	0.3679	1.1731	0.4105	Limit ≦ 25 μW (-16 dBm)
		※ 4	μW	0.3838	1.1052	0.0119	0.3438	0.8676	0.0120	0.4169	1.1107	0.0120	Limit ≦ 25 μW (-16 dBm)
		※ 5	μW	1.5967	1.6754	1.8750	1.7237	1.6724	2.1965	1.5948	1.5091	2.0039	Limit ≦ 2.5 μW (-26 dBm)
	Antenna Power (Measured Power)		mW	2.704	2.443	2.193	2.710	2.449	2.198	2.642	2.388	2.143	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Rated Power)		mW	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	Limit ≦ 10 mW (10 dBm)
	Antenna Power Error		mW	-0.296	-0.557	-0.807	-0.290	-0.551	-0.802	-0.358	-0.612	-0.857	
			%	-9.87	-18.55	-26.91	-9.66	-18.36	-26.74	-11.92	-20.41	-28.57	Limit + 20% ~ - 80%
	Limitation of Collateral Emission of Receiver	※ 6	nW	0.0042	0.1087	0.0053	0.0044	0.0022	0.0066	0.0044	0.0023	0.0041	Limit ≦ 4 nW (-54 dBm)
		※ 7	nW	3.5799	2.8126	1.8236	3.5447	2.8128	1.8534	3.7163	2.8531	1.9702	Limit ≦ 20 nW (-47 dBm)
	Radio Interference Prevention Function		ID Code	Good, MAC Address :B0:91:22:64:B9:1D									
			Carrier Sense	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR: Not Require

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※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

2. Antenna Power (Conducted Power)

Testing for Electrical Specification	Test Voltage	V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
	Power Meter Raw from EUT	dBm	-1.74	-2.18	-2.65	-1.74	-2.18	-2.65	-1.74	-2.18	-2.65	
	Cable Loss	dB	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	Refer to Calibration Result
	Duty Cycle Factor	dB	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	4.57	Duty Factor = 10 × 10Log_{10}(1/Duty Cycle)
	Antenna Power (Conducted)	dBm	4.32	3.88	3.41	4.33	3.89	3.42	4.22	3.78	3.31	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Conducted)	mW	2.704	2.443	2.193	2.710	2.449	2.198	2.642	2.388	2.143	
	Antenna Power Error	mW	-0.296	-0.557	-0.807	-0.290	-0.551	-0.802	-0.358	-0.612	-0.857	
		%	-9.87	-18.55	-26.91	-9.66	-18.36	-26.74	-11.92	-20.41	-28.57	Limit + 20% ~ - 80%
	Tranmsitter ON_{Time}	msec	0.2185									RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz
	Tranmsitter $(ON+OFF)_{Time}$	msec	0.6262									
	Tranmsitter Duty Cycle	%	34.89%									

3. Transmission Radiation Angle Width (This test item will not be applied to the EIRP power is lower than 12.14dBm)

No.	Antenna Power	Antenna				Cable			Tatal Gain D=B-C	EIRP F=A+D	Permited Angle	Judgement	Remarks (Antenna Model)
	A (dBm)	Type	Gain B (dBi)	3dB Beam-width Horizontal (Degree)	3dB Beam-width Vertical (Degree)	Model	Length (m)	Loss C (dB)	(dBi)	(dBm)	(Degree)		
1	4.33	Dipole	2.00			-	-		2.00	6.33	348.58	Good	
2	4.33	PIFA	2.00			-	-		2.00	6.33	348.58	Good	
3	4.33	Notch	2.00			-	-		2.00	6.33	348.58	Good	
4													
5													
6													
7													
8													
9													
10													
11													
12													

International Certification Corp.

4. Unwanted Emission Intensity

	Test Voltage		V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
	Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
Unwanted Emission Intensity	Unwanted Emission Frequency	※ 1	MHz	942.77	39.70	903.00	879.72	910.76	909.79	692.51	816.67	830.25	RBW : 100 kHz ; VBW : 100 kHz
		※ 2	MHz	2384.92	2374.52	2377.29	2387.00	2384.23	2380.76	2386.31	2377.29	2373.13	
		※ 3	MHz	2399.99	2397.53	2399.51	2399.99	2399.57	2398.34	2400.00	2399.75	2395.10	RBW : 1 MHz ; VBW : 1 MHz
		※ 4	MHz	2494.11	2494.76	2483.50	2496.05	2493.81	2483.50	2494.20	2493.51	2483.51	
		※ 5	MHz	12386.21	4879.83	4959.86	4803.56	11217.05	2496.50	10913.19	4878.58	10544.32	
	Cable Loss	※ 1	dB	0.86	0.26	0.85	0.84	0.85	0.85	0.77	0.82	0.82	
		※ 2	dB	1.48	1.47	1.48	1.48	1.48	1.48	1.48	1.48	1.47	
		※ 3	dB	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	
		※ 4	dB	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	
		※ 5	dB	5.62	1.72	1.73	1.71	4.99	1.50	4.81	1.72	4.60	
	Spectrum Raw	※ 1	dBm	-46.85	-46.17	-46.83	-46.67	-46.81	-47.01	-46.82	-46.16	-46.62	
		※ 2	dBm	-58.13	-28.74	-32.85	-56.04	-28.34	-32.89	-56.40	-29.73	-33.50	
		※ 3	dBm	-33.15	-27.53	-32.61	-33.24	-27.75	-32.64	-32.86	-27.83	-32.39	
		※ 4	dBm	-32.66	-28.07	-47.73	-33.14	-29.12	-47.70	-32.30	-28.05	-47.72	
		※ 5	dBm	-22.35	-26.04	-25.54	-25.93	-22.78	-25.08	-23.16	-26.50	-22.39	
	Unwanted Emission Intensity	※ 1	dBm	-47.71	-46.44	-47.68	-47.51	-47.66	-47.86	-47.59	-46.97	-47.44	Limit ≦ 0.25 μW (-36 dBm)
		※ 2	dBm	-59.61	-30.21	-34.33	-57.52	-29.82	-34.37	-57.87	-31.21	-34.97	Limit ≦ 2.5 μW (-26 dBm)
		※ 3	dBm	-34.63	-29.01	-34.09	-34.72	-29.23	-34.12	-34.34	-29.31	-33.87	Limit ≦ 25 μW (-16 dBm)
		※ 4	dBm	-34.16	-29.57	-49.23	-34.64	-30.62	-49.19	-33.80	-29.54	-49.21	Limit ≦ 25 μW (-16 dBm)
		※ 5	dBm	-27.97	-27.76	-27.27	-27.64	-27.77	-26.58	-27.97	-28.21	-26.98	Limit ≦ 2.5 μW (-26 dBm)
	Unwanted Emission Intensity	※ 1	μW	0.0169	0.0227	0.0171	0.0177	0.0172	0.0164	0.0174	0.0201	0.0180	Limit ≦ 0.25 μW (-36 dBm)
		※ 2	μW	0.0011	0.9520	0.3690	0.0018	1.0419	0.3657	0.0016	0.7577	0.3181	Limit ≦ 2.5 μW (-26 dBm)
		※ 3	μW	0.3447	1.2556	0.3899	0.3374	1.1953	0.3876	0.3679	1.1731	0.4105	Limit ≦ 25 μW (-16 dBm)
		※ 4	μW	0.3838	1.1052	0.0119	0.3438	0.8676	0.0120	0.4169	1.1107	0.0120	Limit ≦ 25 μW (-16 dBm)
		※ 5	μW	1.5967	1.6754	1.8750	1.7237	1.6724	2.1965	1.5948	1.5091	2.0039	Limit ≦ 2.5 μW (-26 dBm)

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※ 5: Frequency Band 5 (2496.5 MHz ≦ f < 12.5 GHz)
※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)
※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

5. Limitation of Collateral Emission of Receiver

	Test Voltage		V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks	
	Test Frequency		MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480		
Limitation of Collateral Emission	Spurious Emission Frequency	※ 6	MHz	119.24	119.24	120.21	107.60	304.51	119.24	107.60	304.51	119.24	1st	30MHz～1000MHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated.
		※ 6	MHz	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	MHz	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	MHz	4802.19	4878.37	4957.44	4802.19	4878.37	4957.44	4802.19	4878.37	4957.44	1st	1000MHz～12.5GHz:: Maximum emission and all emissions beyond 1/10 of the limitation must be indicated.
		※ 7	MHz	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	MHz	-	-	-	-	-	-	-	-	-	3rd	
	Cable Loss	※ 6	dB	0.37	0.37	0.37	0.35	0.55	0.37	0.35	0.55	0.37	1st	
		※ 6	dB	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	dB	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	dB	1.71	1.72	1.73	1.71	1.72	1.73	1.71	1.72	1.73	1st	
		※ 7	dB	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	dB	-	-	-	-	-	-	-	-	-	3rd	
	Spectrum Raw	※ 6	dBm	-84.15	-70.00	-83.12	-83.89	-87.15	-82.14	-83.87	-86.88	-84.20	1st	
		※ 6	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	dBm	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	dBm	-56.17	-57.23	-59.12	-56.21	-57.23	-59.05	-56.01	-57.16	-58.78	1st	
		※ 7	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	dBm	-	-	-	-	-	-	-	-	-	3rd	
	Spurious Emission Intensity	※ 6	dBm	-83.78	-69.64	-82.76	-83.54	-86.60	-81.77	-83.52	-86.33	-83.83	1st	Limit ≦ 4 nW (-54 dBm) RBW : 100 kHz ; VBW : 100 kHz
		※ 6	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	dBm	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	dBm	-54.46	-55.51	-57.39	-54.50	-55.51	-57.32	-54.30	-55.45	-57.05	1st	Limit ≦ 20 nW (-47 dBm) RBW : 1 MHz ; VBW : 1 MHz
		※ 7	dBm	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	dBm	-	-	-	-	-	-	-	-	-	3rd	
	Spurious Emission Intensity	※ 6	nW	0.0042	0.1087	0.0053	0.0044	0.0022	0.0066	0.0044	0.0023	0.0041	Total Emission Power	
		※ 6	nW	0.0042	0.1087	0.0053	0.0044	0.0022	0.0066	0.0044	0.0023	0.0041	1st	Limit ≦ 4 nW (-54 dBm) RBW : 100 kHz ; VBW : 100 kHz
		※ 6	nW	-	-	-	-	-	-	-	-	-	2nd	
		※ 6	nW	-	-	-	-	-	-	-	-	-	3rd	
		※ 7	nW	3.5799	2.8126	1.8236	3.5447	2.8128	1.8534	3.7163	2.8531	1.9702	Total Emission Power	
		※ 7	nW	3.5799	2.8126	1.8236	3.5447	2.8128	1.8534	3.7163	2.8531	1.9702	1st	Limit ≦ 20 nW (-47 dBm) RBW : 1 MHz ; VBW : 1 MHz
		※ 7	nW	-	-	-	-	-	-	-	-	-	2nd	
		※ 7	nW	-	-	-	-	-	-	-	-	-	3rd	

※ 1: Frequency Band 1 (30 MHz ≦ f ≦ 1000 MHz)
※ 2: Frequency Band 2 (1000 MHz < f ≦ 2387 MHz)
※ 3: Frequency Band 3 (2387 MHz < f ≦ 2400 MHz)
※ 4: Frequency Band 4 (2483.5 MHz ≦ f < 2496.5 MHz)
※ 5: Frequency Band 5 (2496.5 MHz ≦ f < 12.5 GHz)
※ 6: Frequency Band 6 (30 MHz ≦ f < 1000 MHz)
※ 7: Frequency Band 7 (1000 MHz ≦ f < 12.5 GHz)

Calibration Result

1. Linearity Check

SG Output (dBm)	Spectrum Raw (dBm)	Power Meter Raw (dBm)	Remark
0	-1.3	-0.93	・SG Test Frequency：2450 MHz ・RBW：1 MHz；VBW：1 MHz；SP：0Hz ・ATT(30dB)；Ref：20 dBm
-5	-6.34	-5.88	
-10	-11.17	-10.84	
0	-1.64	-1.66	・SG Test Frequency：5250 MHz ・RBW：1 MHz；VBW：1 MHz；SP：0Hz ・ATT(30dB)；Ref：20 dBm
-5	-6.6	-6.62	
-10	-11.48	-11.58	

2. Frequency Accuracy Confirmation

SG Output (dBm)	Spectrum Raw (MHz)	Freqquency Error (ppm)	Remark
2450	2450.0002	0.0816	・SG Output：0dBm ・RWB：30 kHz；VBW：30 kHz：SP：300kHz ・Limit ≦ 10% of frequency error limits
5250	5250.0012	0.2286	

3. Cable Loss

SG Output (MHz)	Power Meter Raw Without Cable (dBm)	Power Meter Raw With Cable (dBm)	Cable Loss (dB)	Remark
1000	-0.23	-1.11	0.88	・SG Output：0dBm
2450	-0.87	-2.36	1.49	
5250	-1.67	-3.43	1.76	
12500	-3.69	-9.37	5.68	
26000	-5.55	-19.13	13.58	

Appendix A 19-BLE (125kbps)

1. Test Results

	Test Voltage	V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
Testing for Electrical Specification	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	Low/Mid/High of test frequency range
	Antenna Power (Measured Power)	mW	3.177	3.006	2.864	3.184	3.013	2.871	3.105	2.938	2.799	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Rated Power)	mW	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	Limit ≦ 10 mW (10 dBm)
	Antenna Power Error	mW	-0.323	-0.494	-0.636	-0.316	-0.487	-0.629	-0.395	-0.562	-0.701	
		%	-9.23	-14.11	-18.17	-9.02	-13.91	-17.98	-11.30	-16.07	-20.03	Limit + 20% ~ - 80%

2. Antenna Power (Conducted Power)

	Test Voltage	V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
Testing for Electrical Specification	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
	Power Meter Raw from EUT	dBm	1.65	1.41	1.20	1.65	1.41	1.20	1.65	1.41	1.20	
	Cable Loss	dB	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	Refer to Calibration Result
	Duty Cycle Factor	dB	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	Duty Factor = 10 × $10Log_{10}$(1/Duty Cycle)
	Antenna Power (Conducted)	dBm	5.02	4.78	4.57	5.03	4.79	4.58	4.92	4.68	4.47	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Conducted)	mW	3.177	3.006	2.864	3.184	3.013	2.871	3.105	2.938	2.799	
	Antenna Power Error	mW	-0.323	-0.494	-0.636	-0.316	-0.487	-0.629	-0.395	-0.562	-0.701	
		%	-9.23	-14.11	-18.17	-9.02	-13.91	-17.98	-11.30	-16.07	-20.03	Limit + 20% ~ - 80%
	Tranmsitter ON_{Time}	msec	0.4034									RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz
	Tranmsitter $(ON+OFF)_{Time}$	msec	0.6220									
	Tranmsitter Duty Cycle	%	64.86%									

3. Transmission Radiation Angle Width (This test item will not be applied to the EIRP power is lower than 12.14dBm)

No.	Antenna Power	Antenna				Cable			Tatal Gain D=B-C	EIRP F=A+D	Permited Angle	Judgement	Remarks (Antenna Model)
	A (dBm)	Type	Gain B (dBi)	3dB Beam-width Horizontal (Degree)	3dB Beam-width Vertical (Degree)	Model	Length (m)	Loss C (dB)	(dBi)	(dBm)	(Degree)		
1	5.03	Dipole	2.00			-	-		2.00	7.03	296.69	Good	
2	5.03	PIFA	2.00			-	-		2.00	7.03	296.69	Good	
3	5.03	Notch	2.00			-	-		2.00	7.03	296.69	Good	
4													
5													
6													
7													
8													
9													
10													
11													
12													

Appendix A 19-BLE (500kbps)

1. Test Results

	Test Voltage	V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
Testing for Electrical Specification	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	Low/Mid/High of test frequency range
	Antenna Power (Measured Power)	mW	3.228	3.041	2.891	3.236	3.048	2.897	3.155	2.972	2.825	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Rated Power)	mW	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50	Limit ≦ 10 mW (10 dBm)
	Antenna Power Error	mW	-0.272	-0.459	-0.609	-0.264	-0.452	-0.603	-0.345	-0.528	-0.675	
		%	-7.76	-13.12	-17.41	-7.54	-12.92	-17.22	-9.86	-15.10	-19.29	Limit + 20% ~ - 80%

2. Antenna Power (Conducted Power)

	Test Voltage	V	Normal Voltage (3 V)			High Voltage (3.3V)			Low Voltage (1.8V)			Remarks
Testing for Electrical Specification	Test Frequency	MHz	2402	2440	2480	2402	2440	2480	2402	2440	2480	
	Power Meter Raw from EUT	dBm	1.72	1.46	1.24	1.72	1.46	1.24	1.72	1.46	1.24	
	Cable Loss	dB	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	Refer to Calibration Result
	Duty Cycle Factor	dB	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	1.88	Duty Factor = 10 × $10Log_{10}$(1/Duty Cycle)
	Antenna Power (Conducted)	dBm	5.09	4.83	4.61	5.10	4.84	4.62	4.99	4.73	4.51	Limit ≦ 10 mW (10 dBm)
	Antenna Power (Conducted)	mW	3.228	3.041	2.891	3.236	3.048	2.897	3.155	2.972	2.825	
	Antenna Power Error	mW	-0.272	-0.459	-0.609	-0.264	-0.452	-0.603	-0.345	-0.528	-0.675	
		%	-7.76	-13.12	-17.41	-7.54	-12.92	-17.22	-9.86	-15.10	-19.29	Limit + 20% ~ - 80%
	Tranmsitter ON_{Time}	msec	0.4034									RBW : 1 MHz ; VBW : 1 MHz ; SP : 0Hz
	Tranmsitter $(ON+OFF)_{Time}$	msec	0.6220									
	Tranmsitter Duty Cycle	%	64.86%									

3. Transmission Radiation Angle Width (This test item will not be applied to the EIRP power is lower than 12.14dBm)

No.	Antenna Power	Antenna				Cable			Tatal Gain D=B-C	EIRP F=A+D	Permited Angle	Judgement	Remarks (Antenna Model)
	A (dBm)	Type	Gain B (dBi)	3dB Beam-width Horizontal (Degree)	3dB Beam-width Vertical (Degree)	Model	Length (m)	Loss C (dB)	(dBi)	(dBm)	(Degree)		
1	5.10	Dipole	2.00			-	-		2.00	7.10	291.95	Good	
2	5.10	PIFA	2.00			-	-		2.00	7.10	291.95	Good	
3	5.10	Notch	2.00			-	-		2.00	7.10	291.95	Good	
4													
5													
6													
7													
8													
9													
10													
11													
12													

Calibration Result

1. Linearity Check

SG Output (dBm)	Spectrum Raw (dBm)	Power Meter Raw (dBm)	Remark
0	-1.3	-0.93	・SG Test Frequency：2450 MHz ・RBW：1 MHz；VBW：1 MHz；SP：0Hz ・ATT(30dB)；Ref：20 dBm
-5	-6.34	-5.88	
-10	-11.17	-10.84	
0	-1.64	-1.66	・SG Test Frequency：5250 MHz ・RBW：1 MHz；VBW：1 MHz；SP：0Hz ・ATT(30dB)；Ref：20 dBm
-5	-6.6	-6.62	
-10	-11.48	-11.58	

2. Frequency Accuracy Confirmation

SG Output (dBm)	Spectrum Raw (MHz)	Freqquency Error (ppm)	Remark
2450	2450.0002	0.0816	・SG Output：0dBm ・RWB：30 kHz；VBW：30 kHz：SP：300kHz ・Limit ≦ 10% of frequency error limits
5250	5250.0012	0.2286	

3. Cable Loss

SG Output (MHz)	Power Meter Raw Without Cable (dBm)	Power Meter Raw With Cable (dBm)	Cable Loss (dB)	Remark
1000	-0.23	-1.11	0.88	・SG Output：0dBm
2450	-0.87	-2.36	1.49	
5250	-1.67	-3.43	1.76	
12500	-3.69	-9.37	5.68	
26000	-5.55	-19.13	13.58	

Appendix B. Antenna Information

2.4 GHz – 2.5 GHz Dipole 2dBi Antenna for Reverse Polarity SMA

ORDERING INFORMATION

Order Number	Description
001-0001	2.4 GHz 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
Peak Gain	+2 dBi
Impedance	50 ohms, Nominal
Type	Dipole
Polarization	Linear Vertical
VSWR	≤2.5：1, Maximum
Frequency	2400-2500MHz
Weight	13g
Size	105×10 mm
Antenna Color	Black
Operating Temp	-20°C to +65°C
UL Rating	UL 94HB

Table 2 Specifications

PHYSICAL DIMENSIONS (MM)

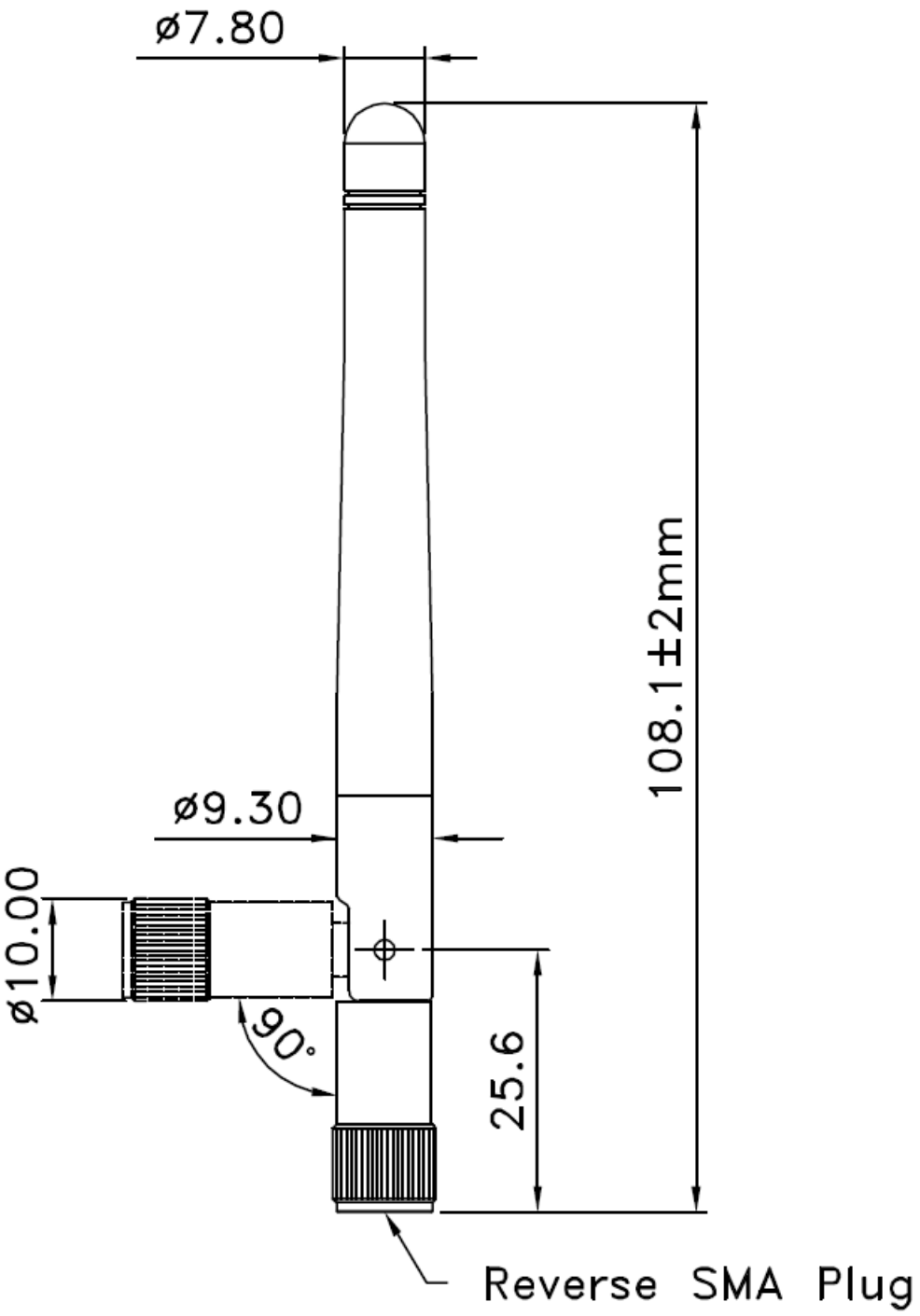


Figure 1 Physical Dimensions

TYPICAL ANTENNA REFLECTION PERFORMANCE

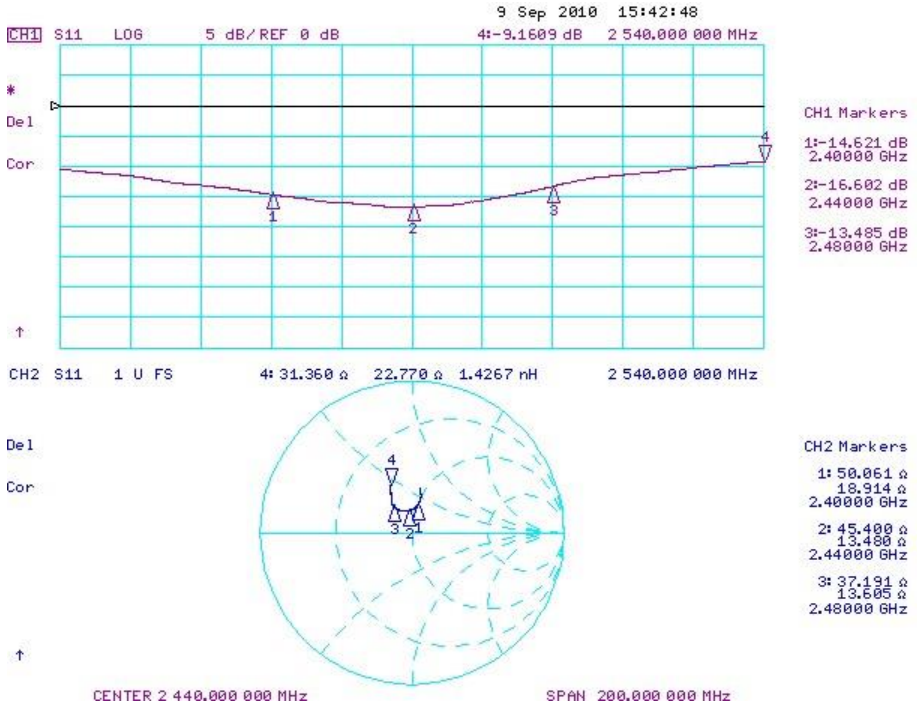


Figure 2 Reflection Parameters for Extended Configuration (S11)

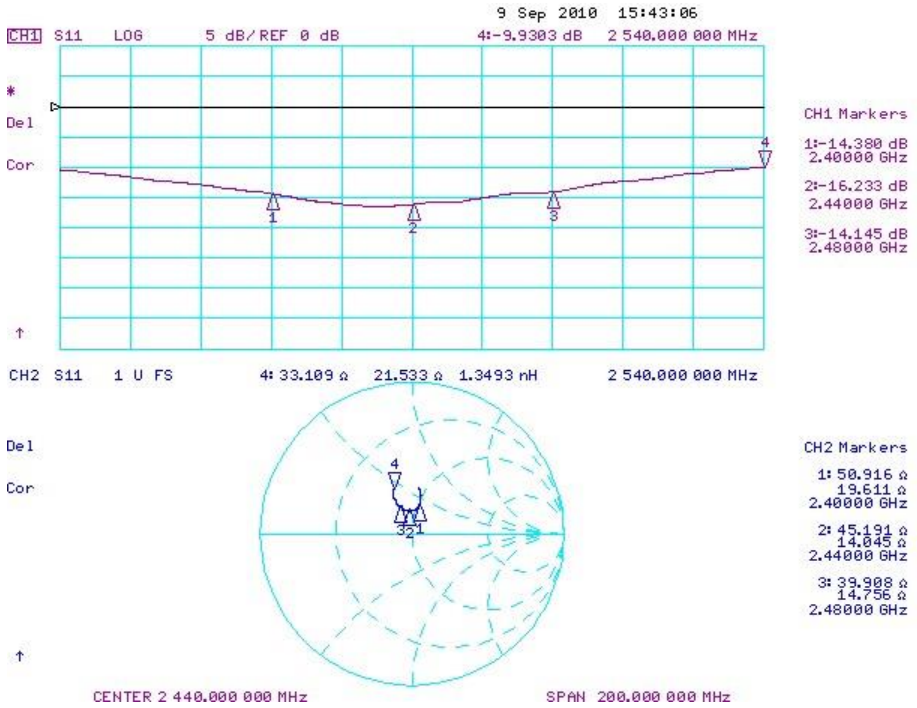
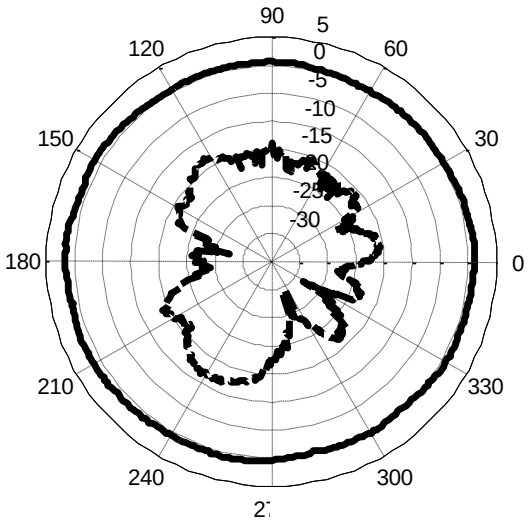


Figure 3 Reflection Parameters for Folded Configuration (S11)

TYPICAL ANTENNA RADIATION PERFORMANCE

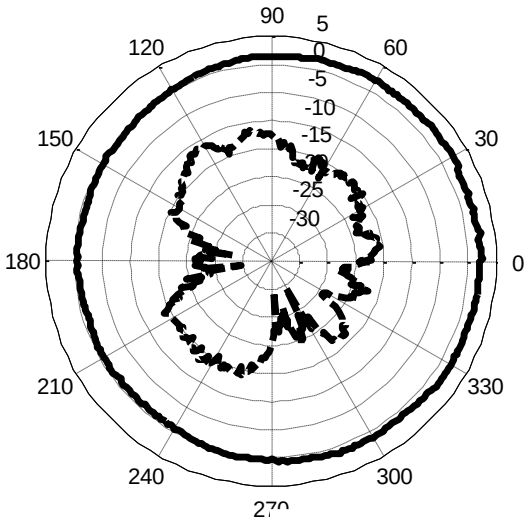
LSR ANTENNA STRAIGHT 2405 MHz



____Vertical Polarization Gain (dBi)

------- Horizontal Polarization Gain (dBi) min: -29.7 max: -11.2 avg: -17.7

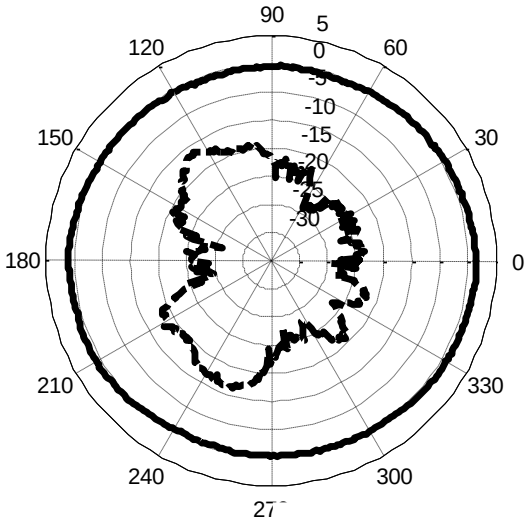
LSR ANTENNA STRAIGHT 2440 MHz



____Vertical Polarization Gain (dBi)

------- Horizontal Polarization Gain (dBi) min: -29.8 max: -11.2 avg: -17.3

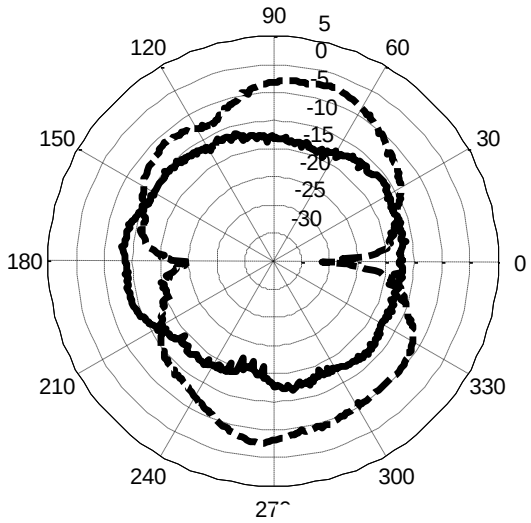
LSR ANTENNA STRAIGHT 2480 MHz



____Vertical Polarization Gain (dBi)

------- Horizontal Polarization Gain (dBi) min: -26.0 max: -11.1 avg: -17.7

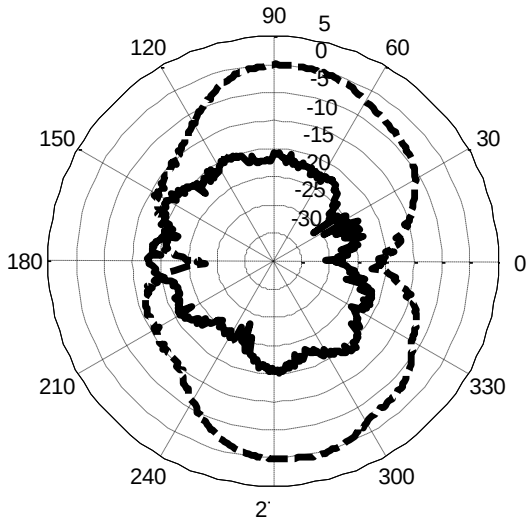
LSR ANTENNA BENT 2405 MHz



____Vertical Polarization Gain (dBi)

------- Horizontal Polarization Gain (dBi) min: -26.2 max: -2.1 avg: -8.6

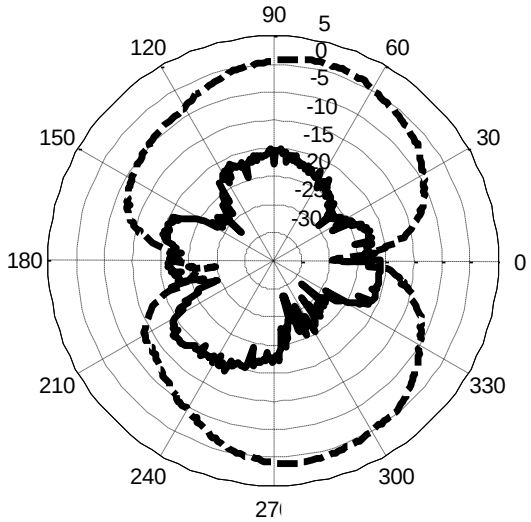
LSR ANTENNA BENT 2440 MHz



____Vertical Polarization Gain (dBi)

------- Horizontal Polarization Gain (dBi) min: -22.8 max: +0.6 avg: -7.1

LSR ANTENNA BENT 2480 MHz



____Vertical Polarization Gain (dBi)

------- Horizontal Polarization Gain (dBi) min: -24.7 max: +1.4 avg: -5.7

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
Technical Support	forum.lsr.com
Sales Contact	sales@lsr.com

2.4 GHz – 2.5 GHz FlexPIFA 2 dBi Antenna w/U.FL Cable, 100mm

ORDERING INFORMATION

Order Number	Description
001-0014	2.4 GHz FlexPIFA Antenna w/U.FL Cable, 100mm
001-0022	2.4 GHz FlexPIFA Antenna w/MHF4L Cable, 100mm
001-0025	2.4 GHz FlexPIFA Antenna w/U.FL Cable, 100mm, LH

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.
- Can be installed on flat or curved surfaces.
- Quick and easy Installation
- Adhesive holds to surface during humidity exposure and hot/cold cycles.
- RoHS Compliant

SPECIFICATIONS

Specification	Value
Peak Gain	+2 dBi
Average Gain	>-1.5 dBi
Impedance	50 ohms
Type	Flexible Planar Inverted F Antenna (FlexPIFA)
Polarization	Linear
VSWR	< 2.0:1, 2400 - 2480 MHz
Frequency	2400 – 2480 MHz
Weight	1.13g
Size	40.1mm × 11mm × 2.5mm
Antenna Color	Clear Yellow
Adhesive	3M 100MP
Operating Temp	-40°C to +85°C
Connector Height	U.FL: 2.5mm Max
	MHF4L: 1.4mm Max

Table 2 Specifications

PHYSICAL DIMENSIONS (MM) (001-0014 & 001-0022)

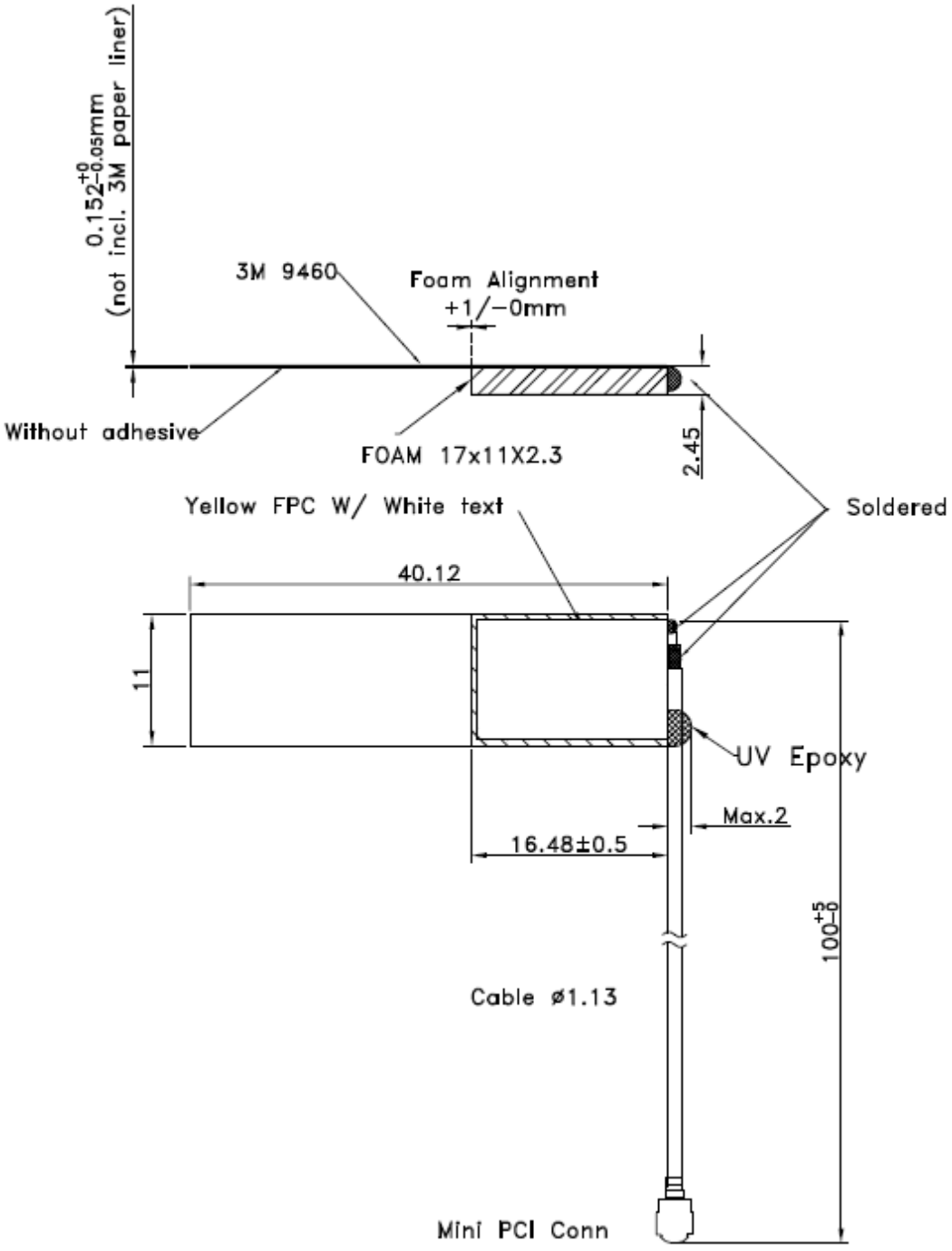


Figure 1 Physical Dimensions

PHYSICAL DIMENSIONS (MM) (001-0025)

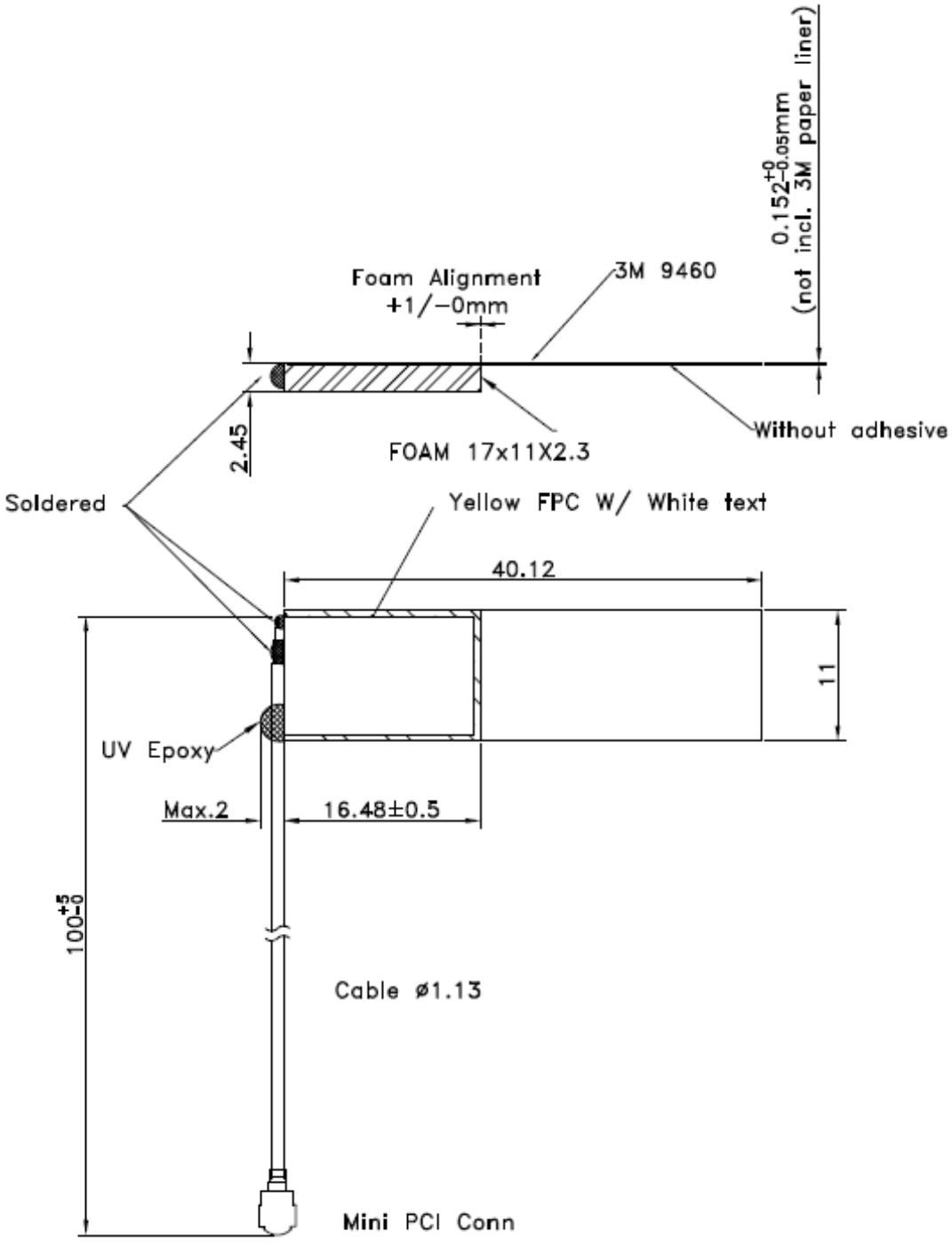


Figure 2 Physical Dimensions

TEST SETUP

Antenna measurements such as VSWR were measured with an Agilent E5071C Vector Network Analyzer. Radiation patterns were measured with a CMT Planar 804/1 Vector Network Analyzer in a Howland Company 3100 Chamber equivalent. Phase Center is 9 inches above the Phi positioner.

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.

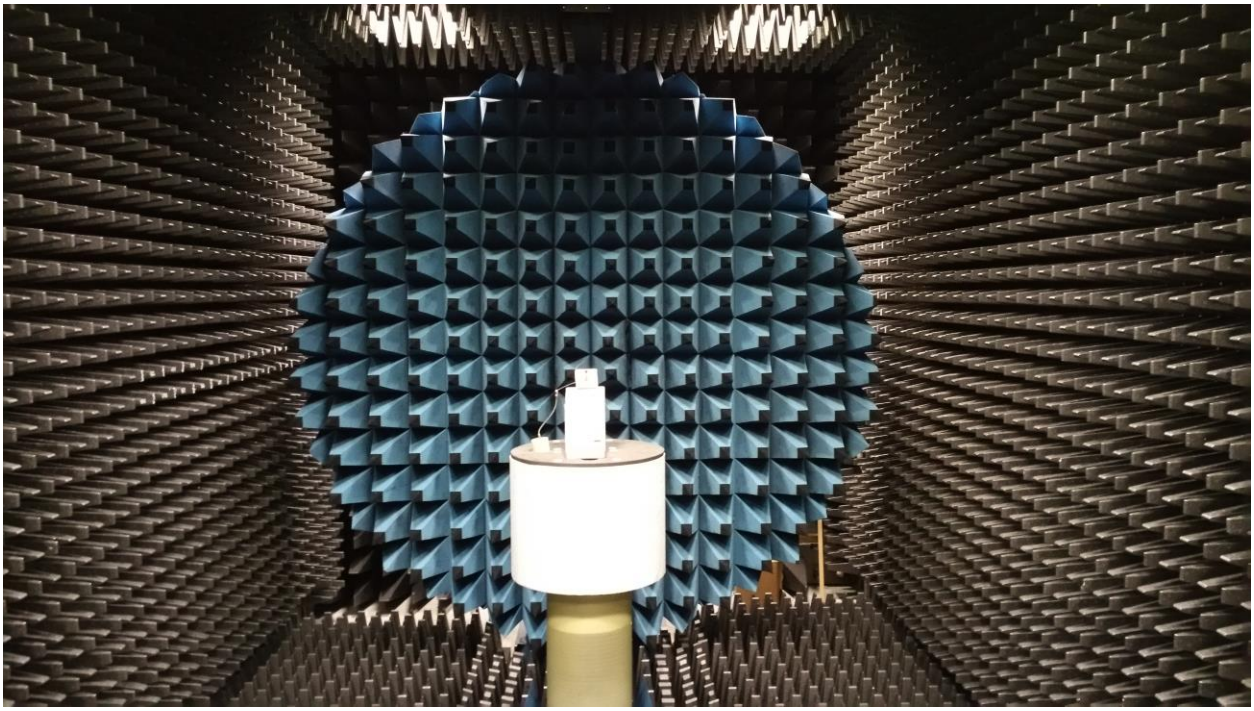


Figure 3 Antenna Chamber

FLAT SURFACE ANTENNA MEASUREMENTS

VSWR

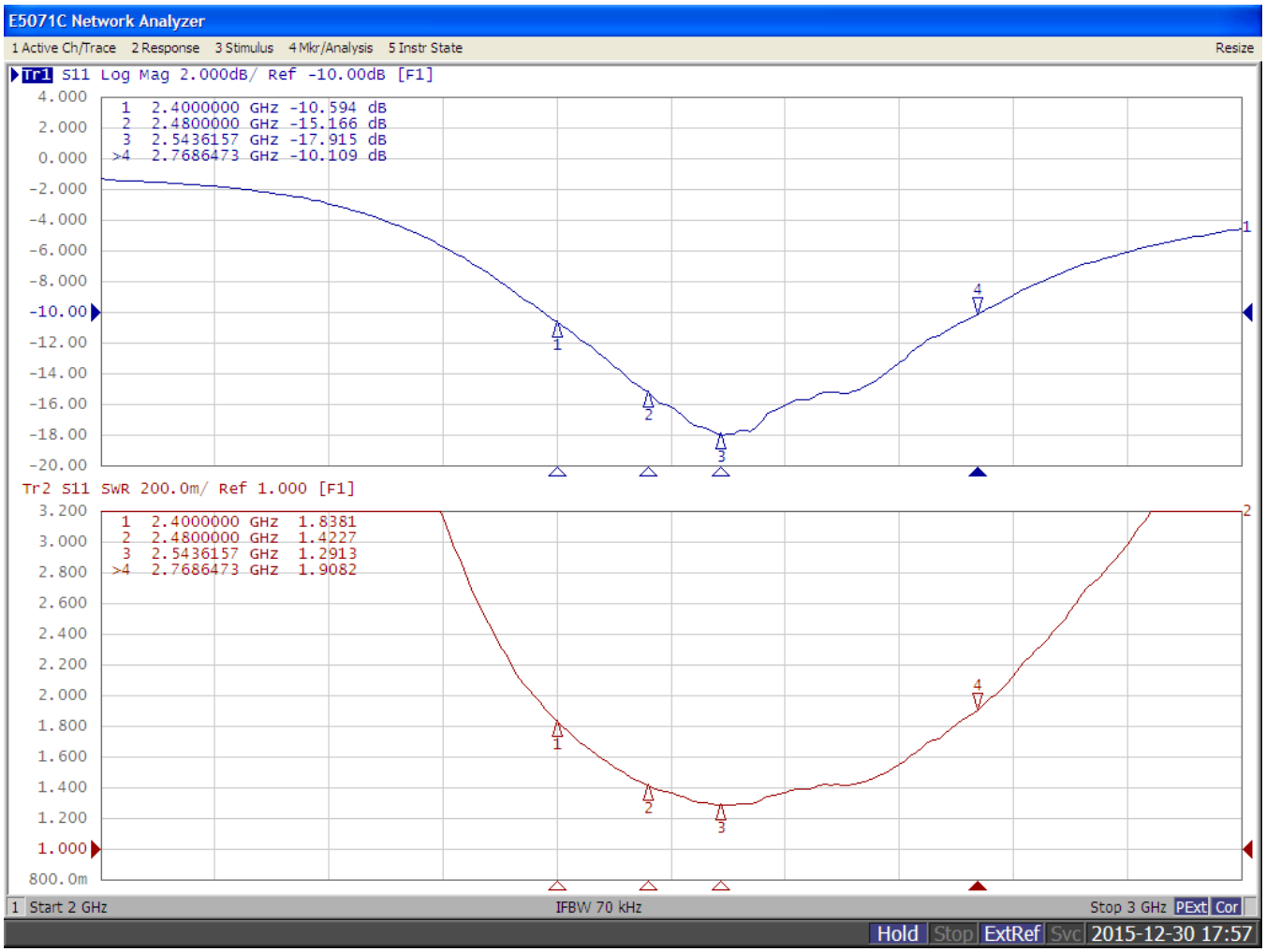


Figure 4 Antenna VSWR measured on a 1.5 mm thick plate of Polycarbonate

FLAT SURFACE ANTENNA RADIATION PERFORMANCE

FlexPIFA centered on a 1.5 mm thick plate of Polycarbonate

Antenna Measurement Set-Up:

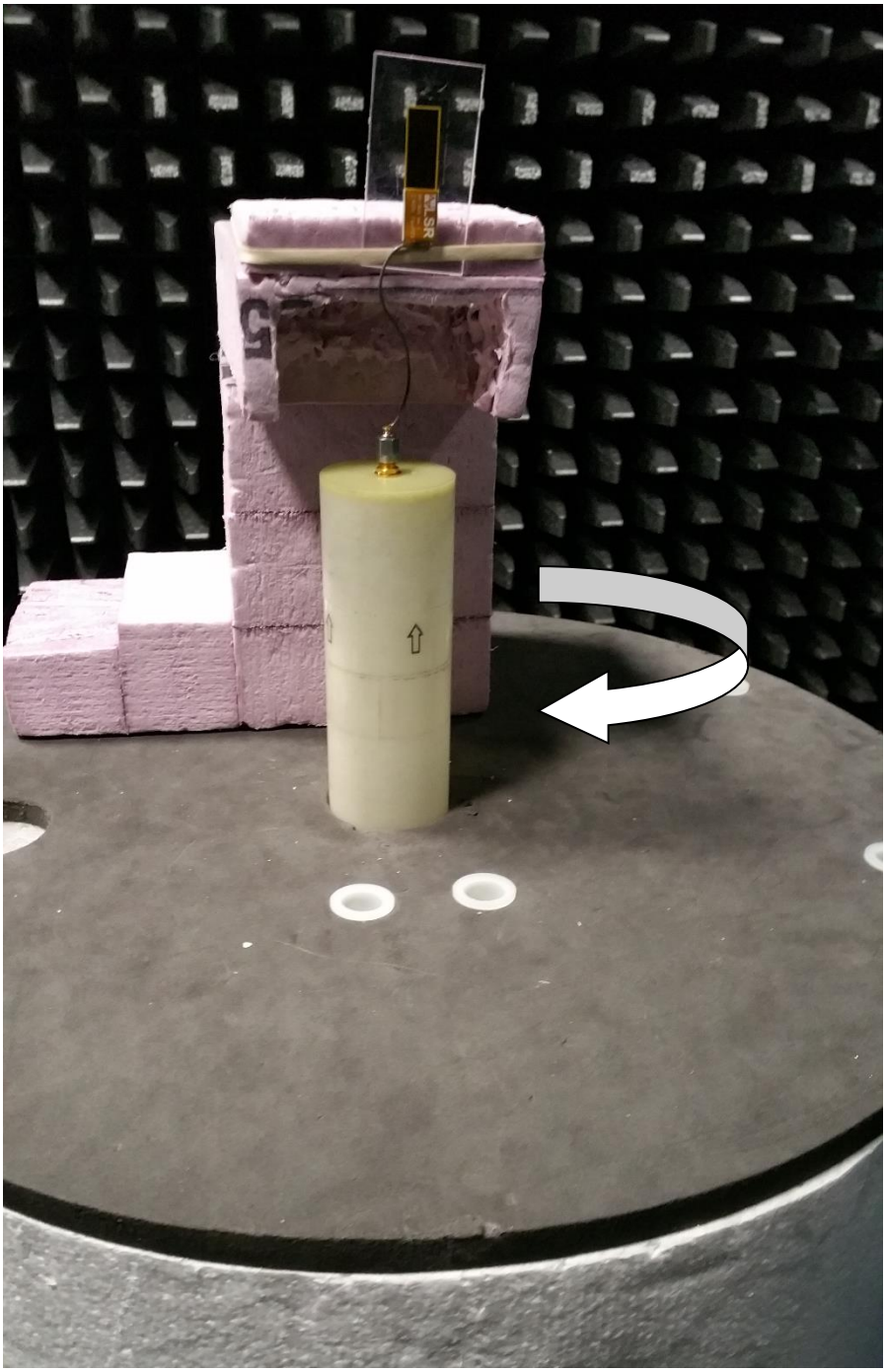


Figure 5 Flat Surface Set-Up

Azimuthal Conical Cuts at 2400 MHz:

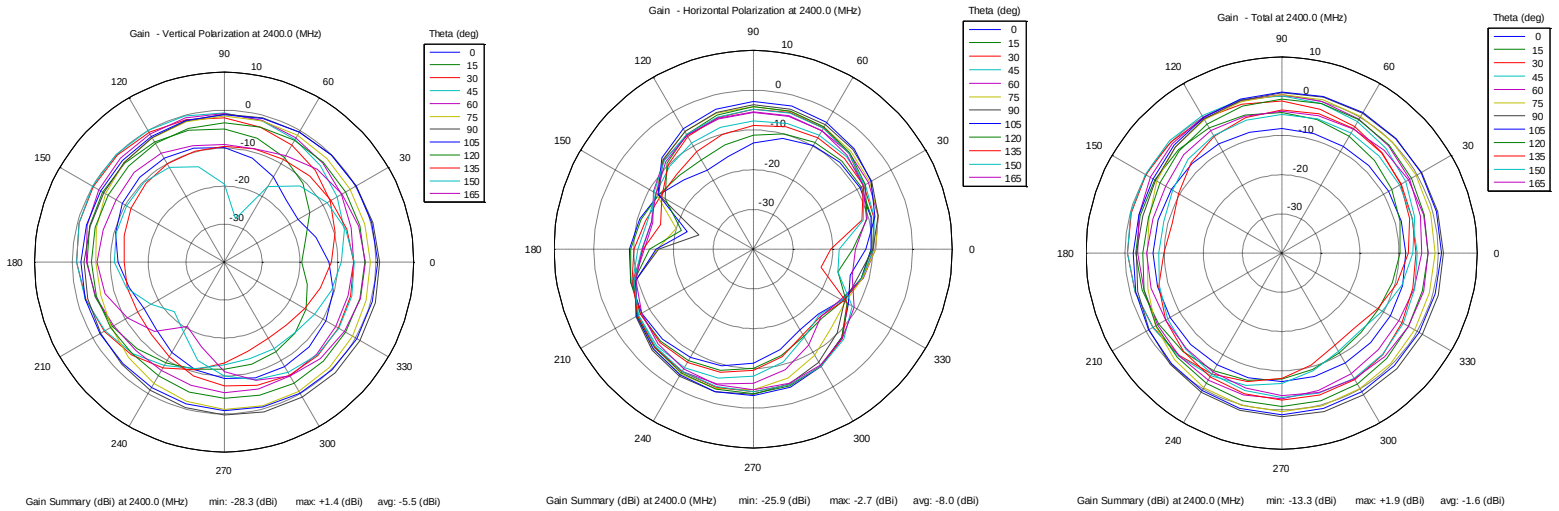


Figure 6 Vertical, Horizontal, and Total Gain Patterns

3D Plots at 2400 MHz:

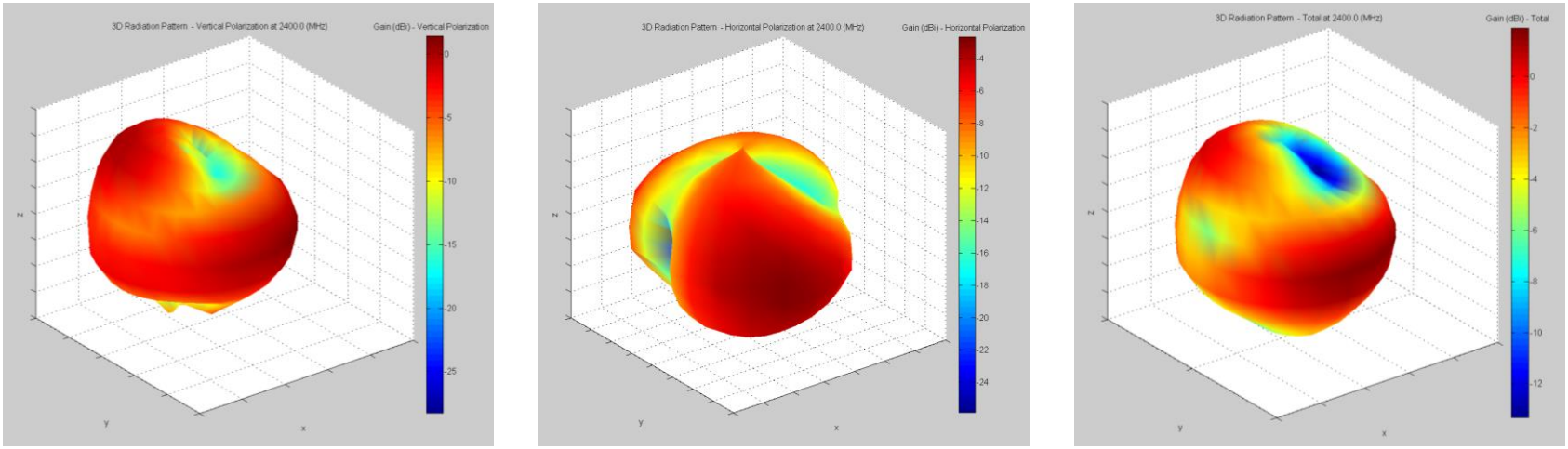


Figure 7 Vertical, Horizontal, and Total Gain Plots

Azimuthal Conical Cuts at 2440 MHz:

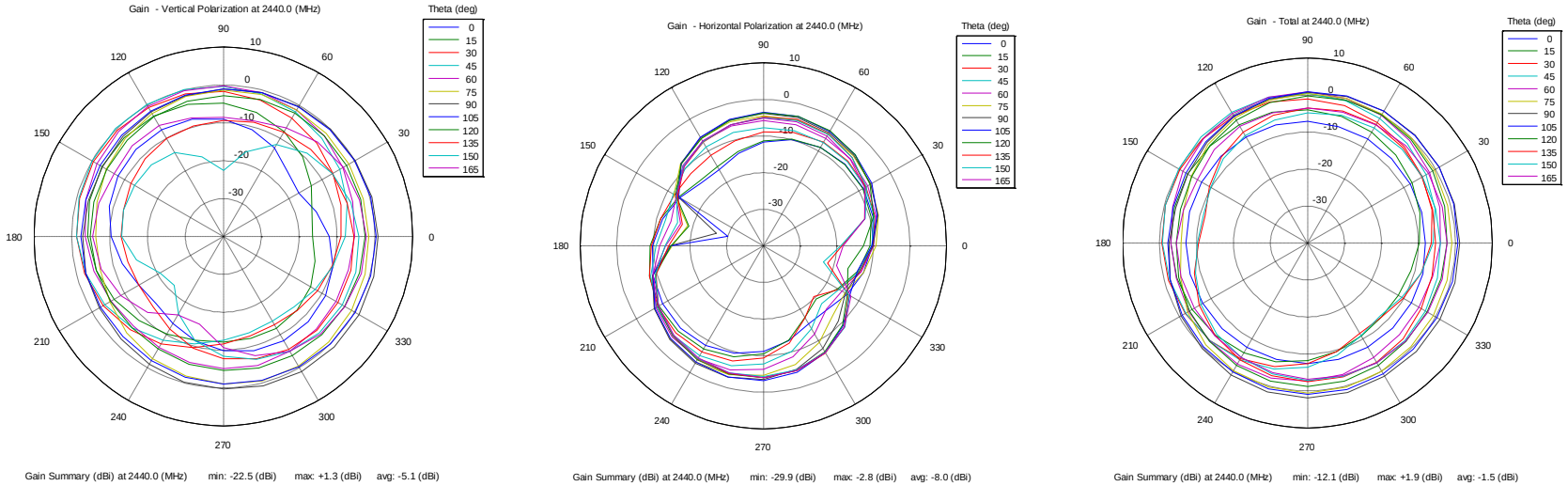


Figure 8 Vertical, Horizontal, and Total Gain Patterns

3D Plots at 2440 MHz:

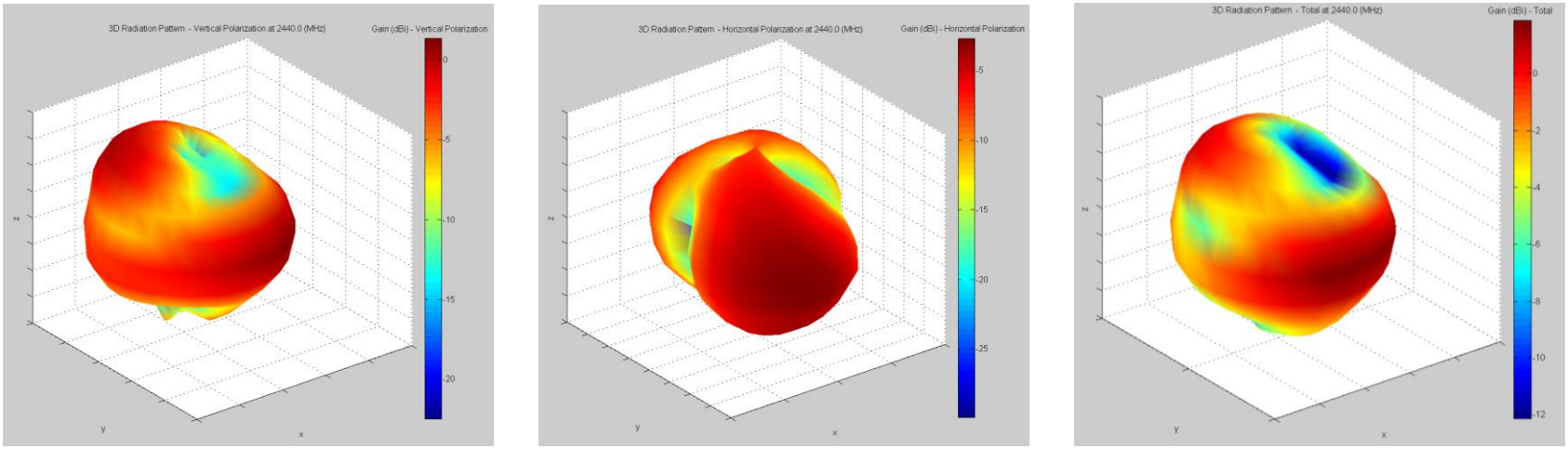


Figure 9 Vertical, Horizontal, and Total Gain Plots

Azimuthal Conical Cuts at 2480 MHz:

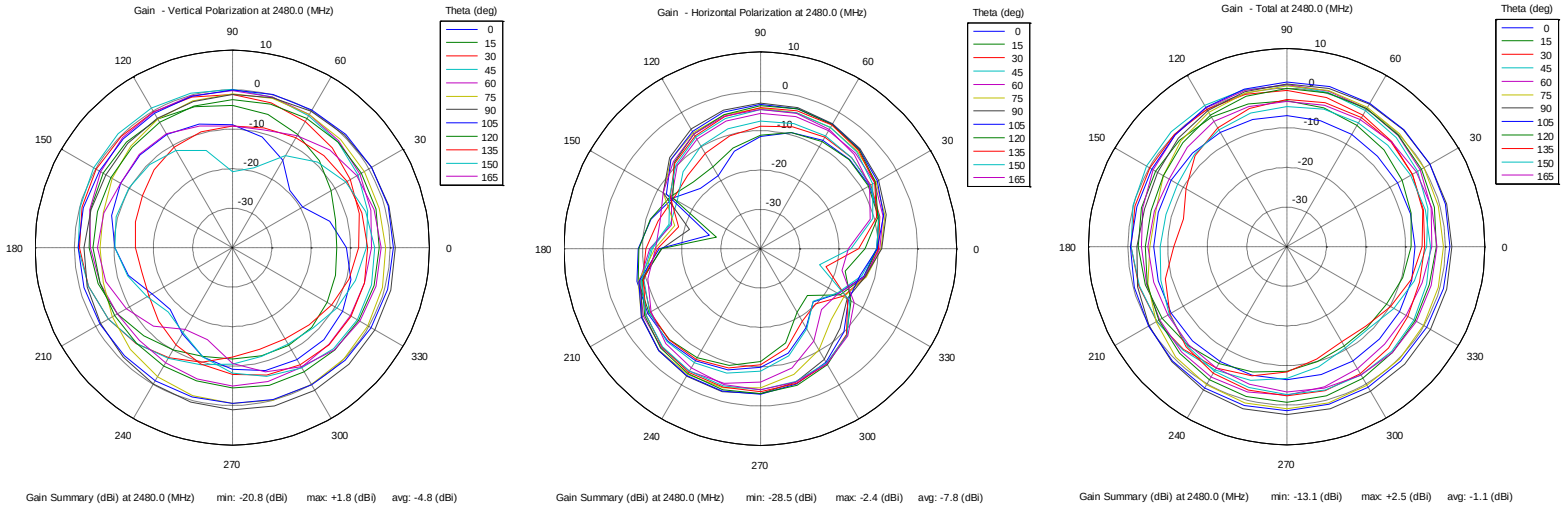


Figure 10 Vertical, Horizontal, and Total Gain Patterns

3D Plots at 2480 MHz:

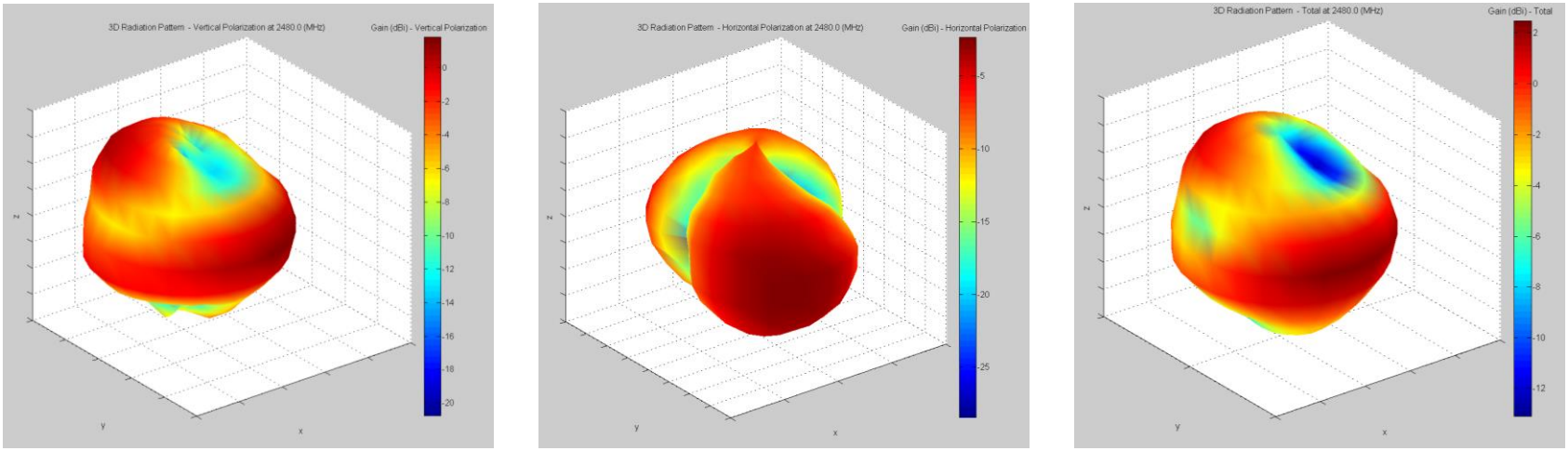


Figure 11 Vertical, Horizontal, and Total Gain Plots

CURVED SURFACE ANTENNA RADIATION PERFORMANCE

Flex PIFA inside 51 mm Inner Diameter PVC tube.

Antenna Measurement Set-Up:

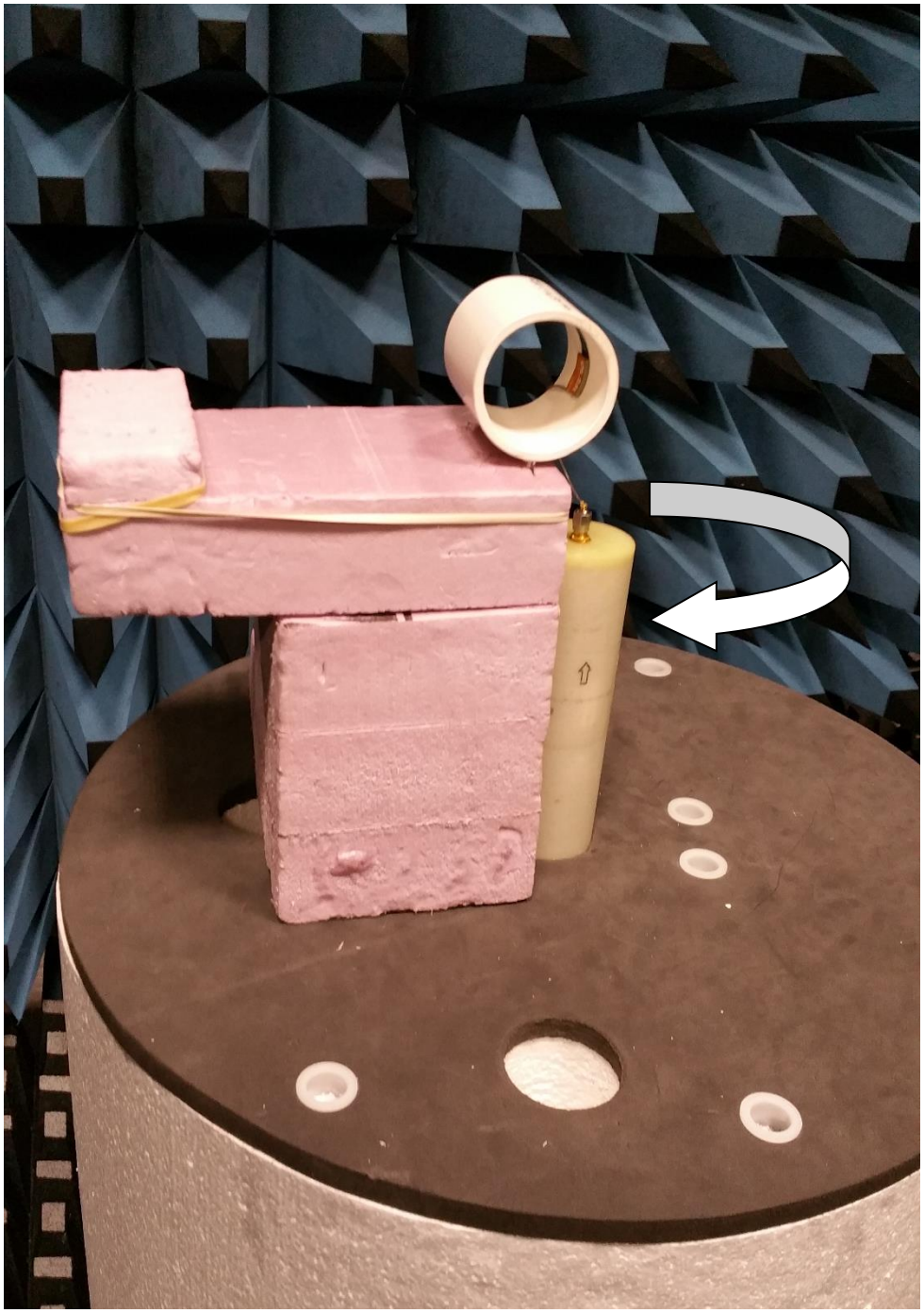


Figure 12 Concave Curve Set-Up

Azimuthal Conical Cuts at 2440 MHz:

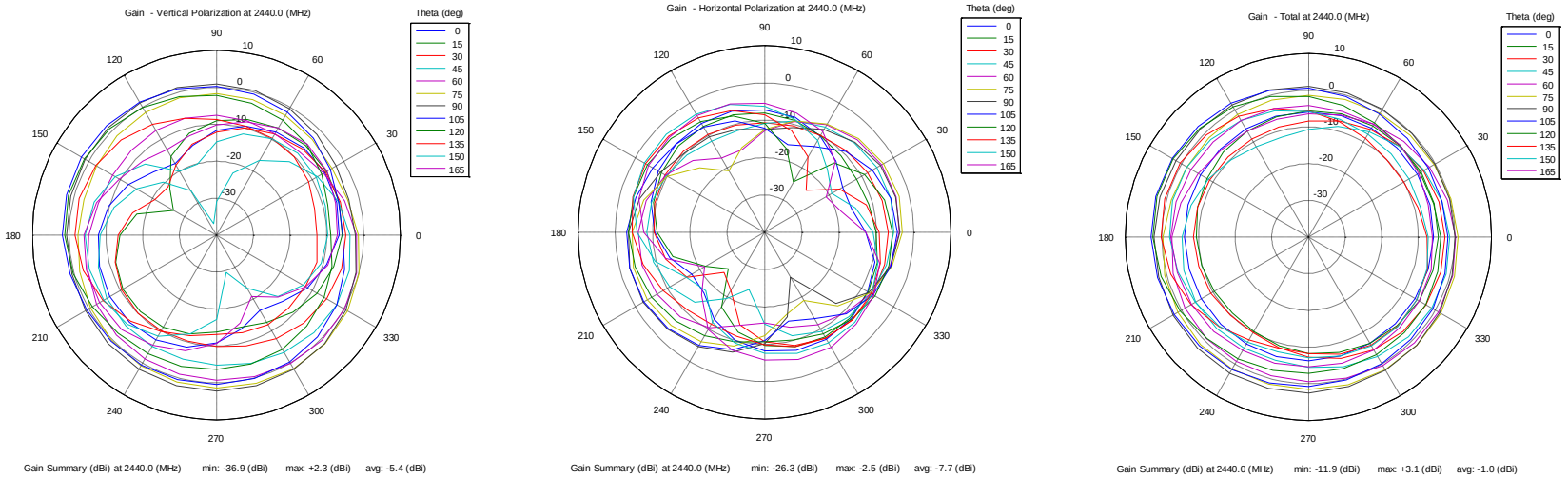


Figure 13 Vertical, Horizontal, and Total Gain Patterns

3D Plots at 2440 MHz:

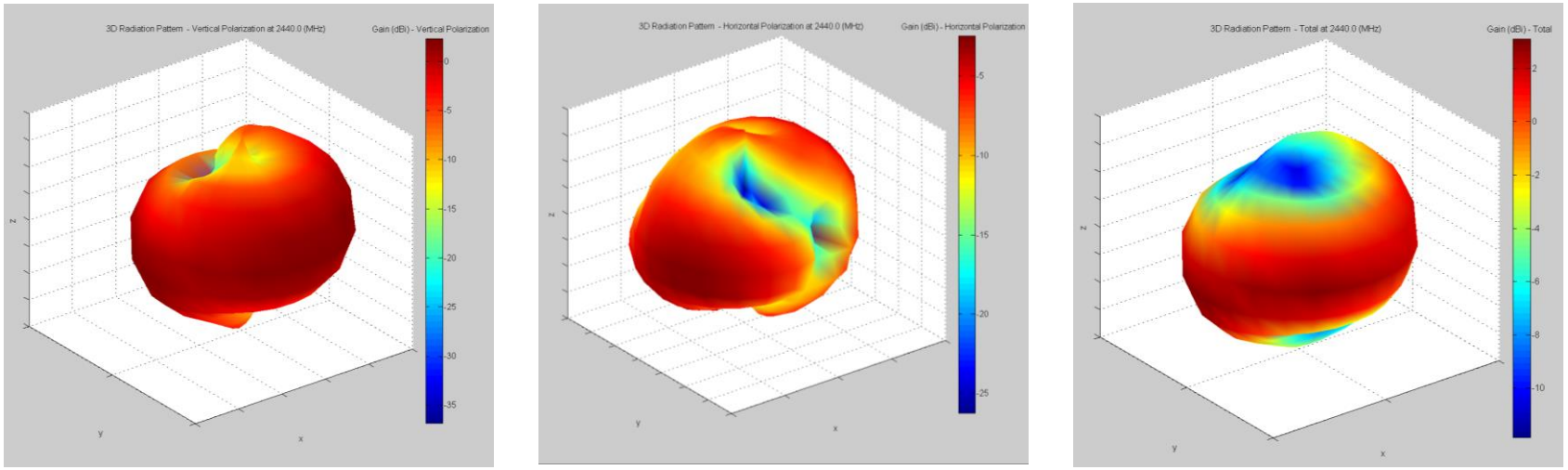


Figure 14 Vertical, Horizontal, and Total Gain Plots

Flex PIFA outside 60 mm Outer Diameter PVC tube.

Antenna Measurement Set-Up:

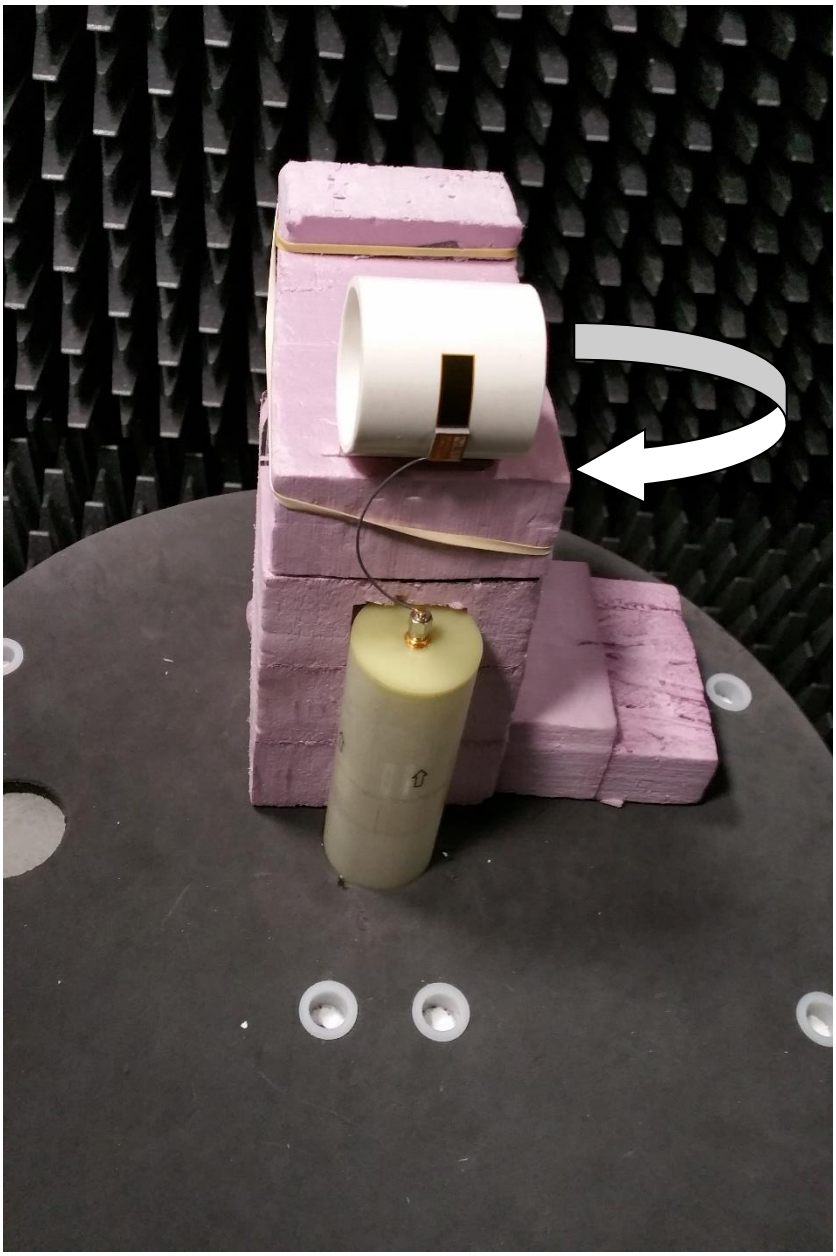


Figure 15 Convex Curve Set-Up

Azimuthal Conical Cuts at 2440 MHz:

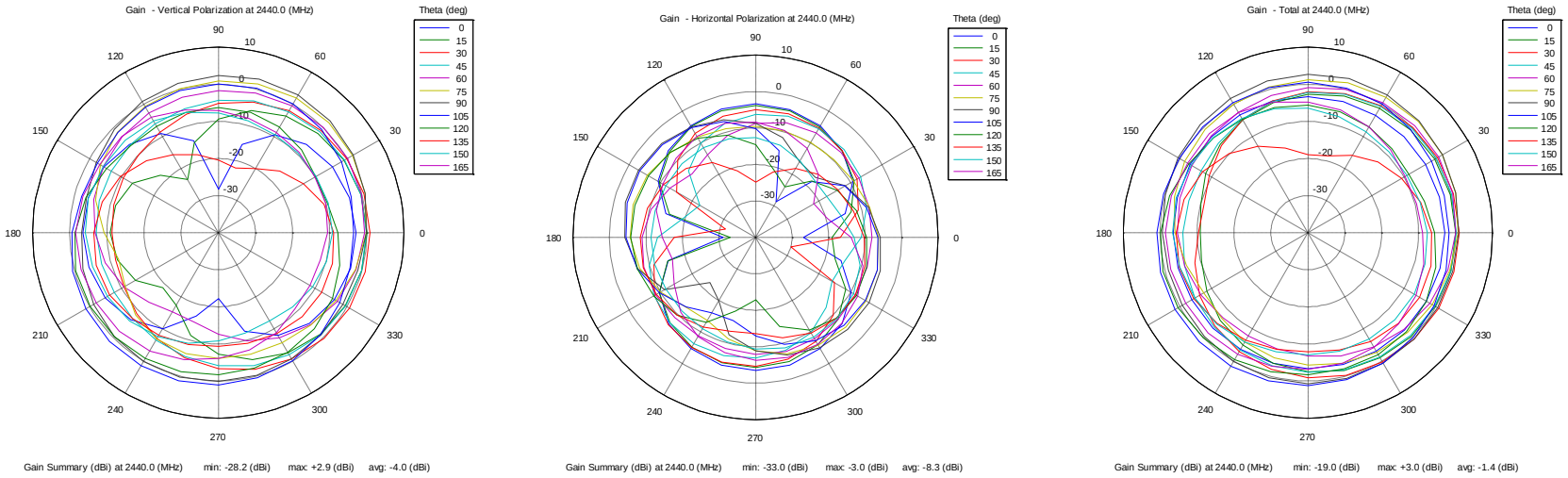


Figure 16 Vertical, Horizontal, and Total Gain Patterns

3D Plots at 2440 MHz:

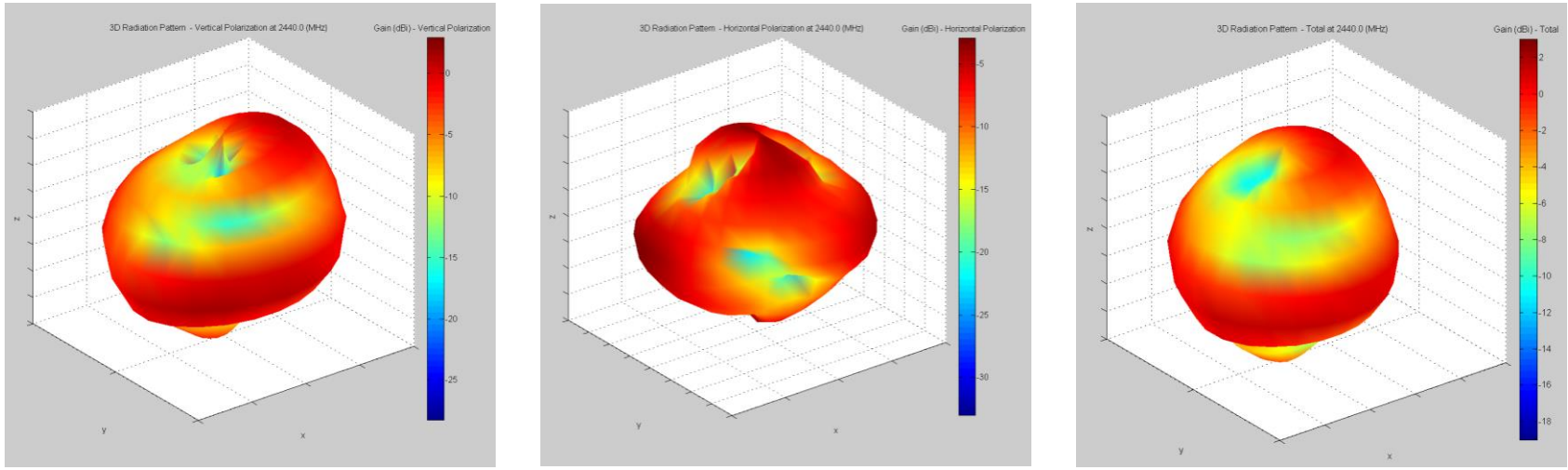


Figure 17 Vertical, Horizontal, and Total Gain Plots

OPTIMAL INSTALLATION GUIDE

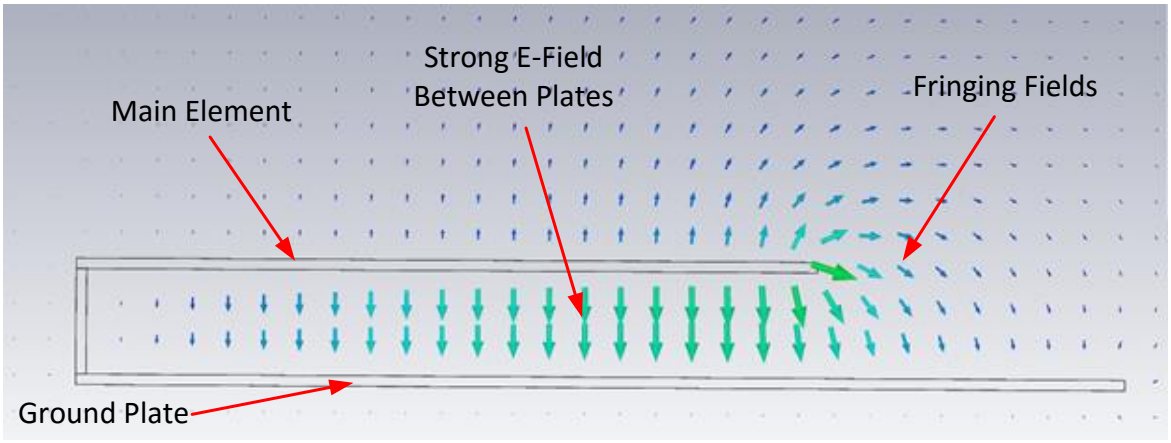


Figure 18 E-Field Radiation from FlexPIFA, Taken from CST Simulation

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 19**). Similarly, the two long sides of the FlexPIFA should be kept clear of any non-metal object by at least 2 mm (See **Figure 20**). 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.

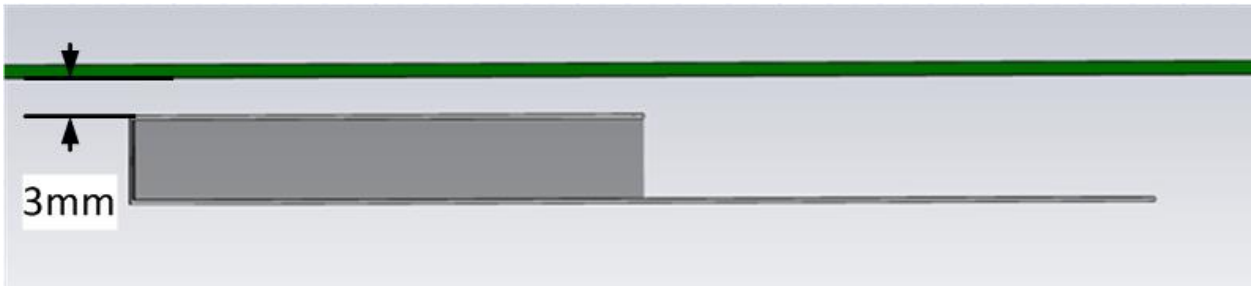
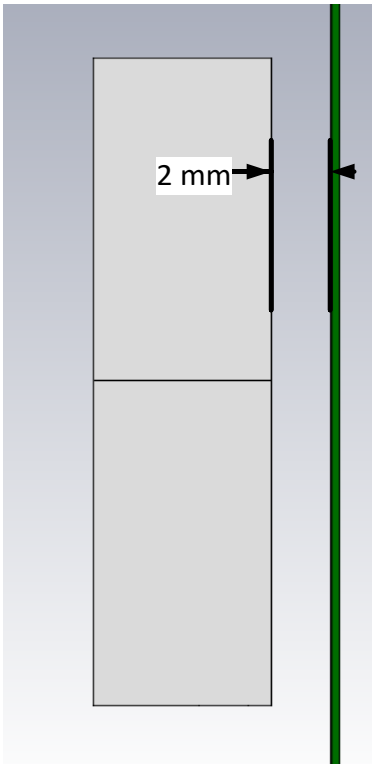
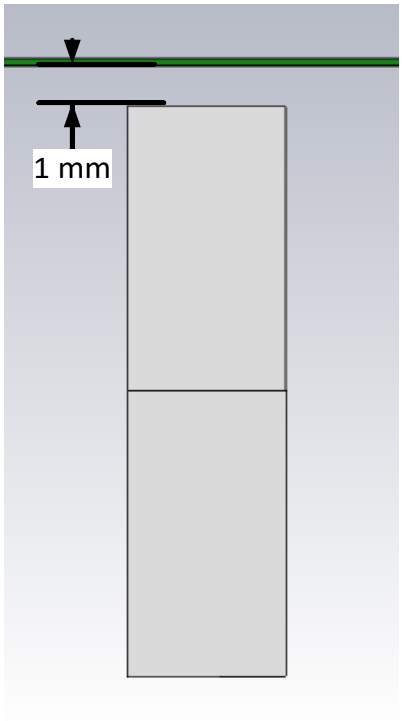


Figure 19 Top Clearance



Side Clearance



Ground Wall Clearance

Figure 20 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 as shown in **Figure 21**.

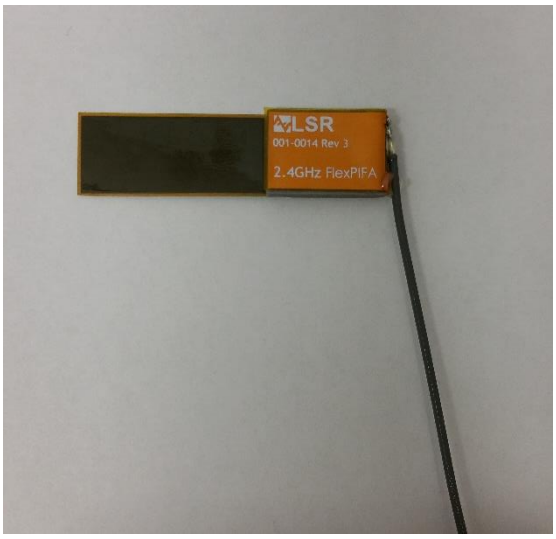


Figure 21 Recommended Cable Routing

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 LSR for assistance.

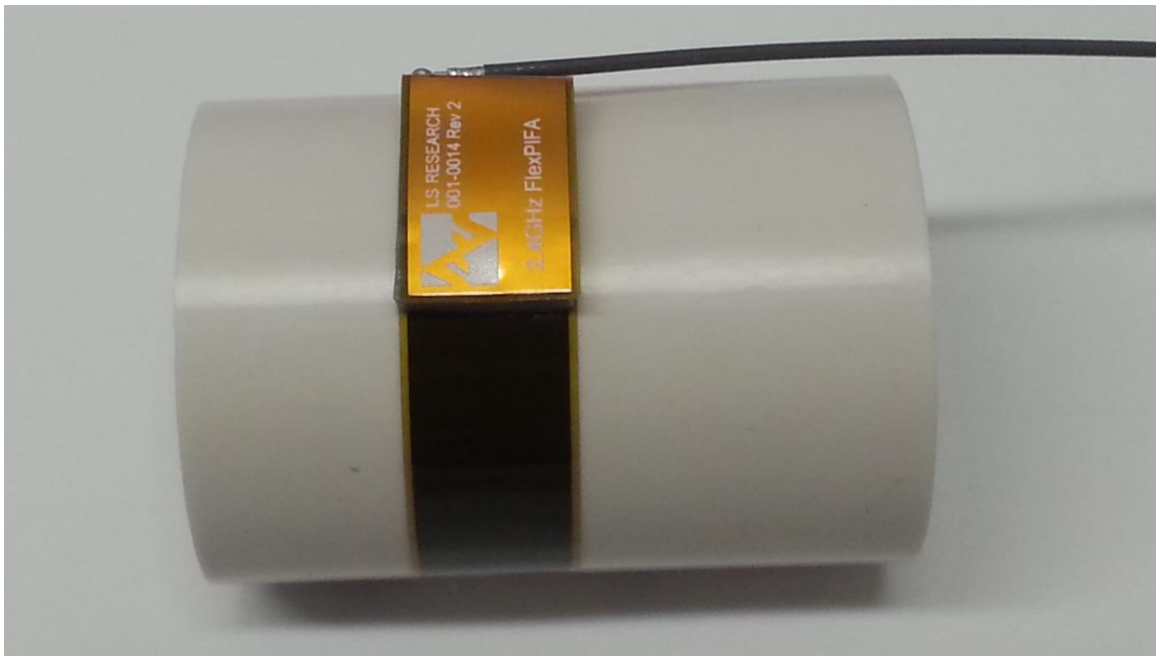


Figure 22 Convex Mounted

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 LSR for assistance.

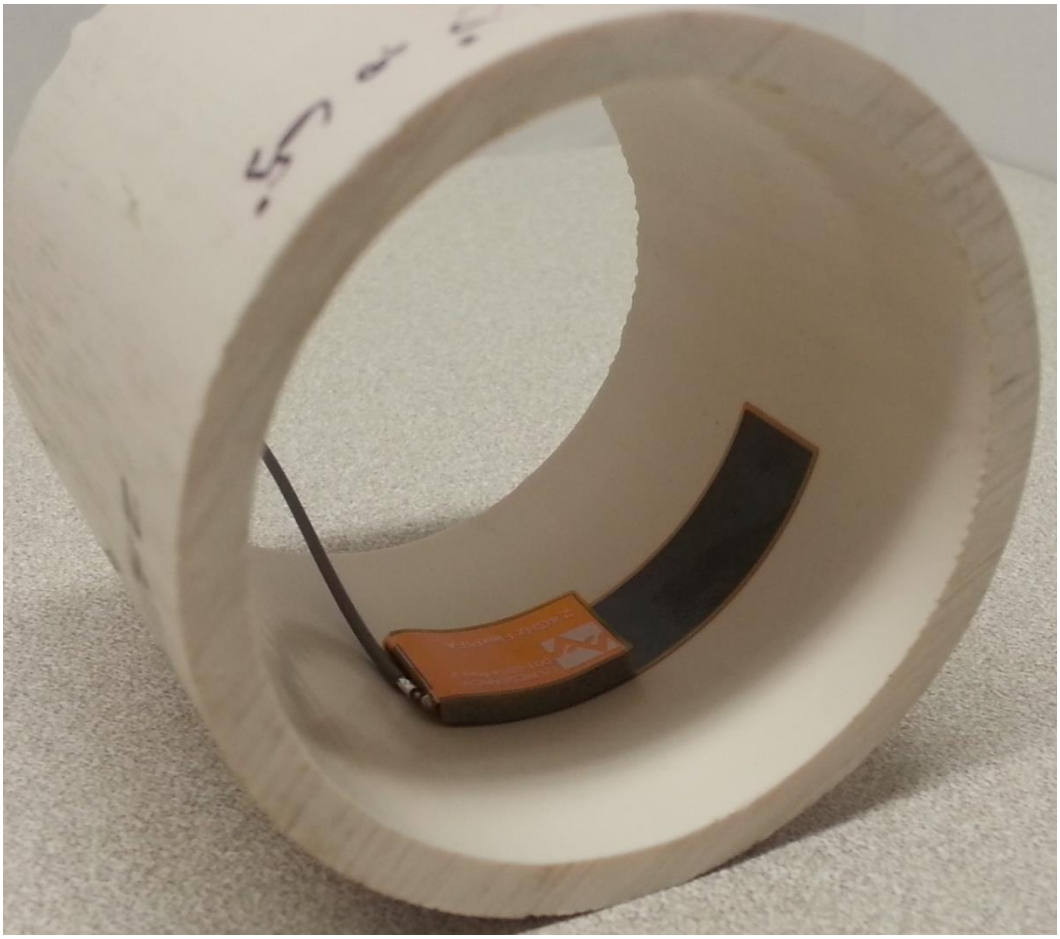


Figure 23 Concave Mounted

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 18**). 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.

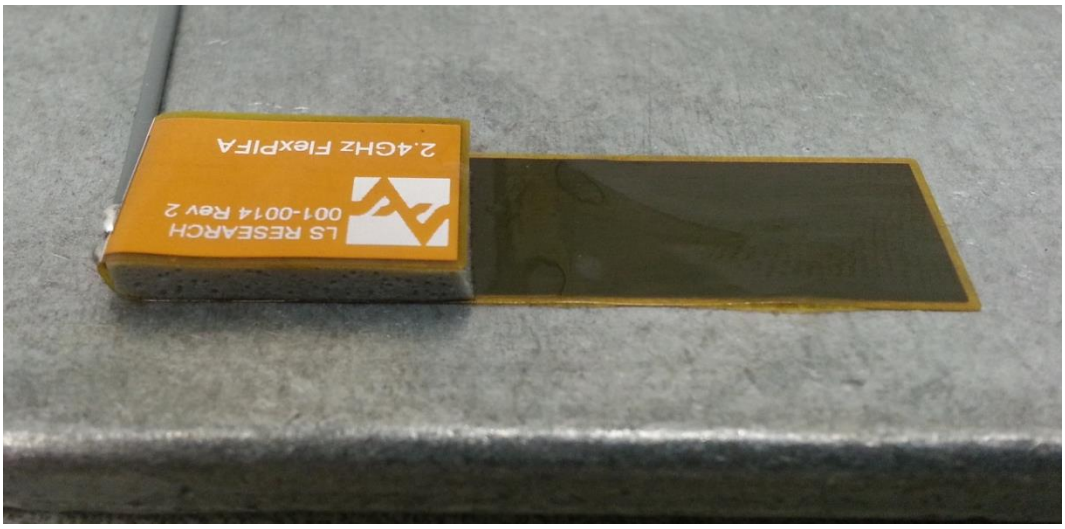


Figure 24 FlexPIFA Mounted on Metal

Do not mount the FlexPIFA where metal is within 10 mm above the main element (see **Figure 26**). 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 25**). 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.

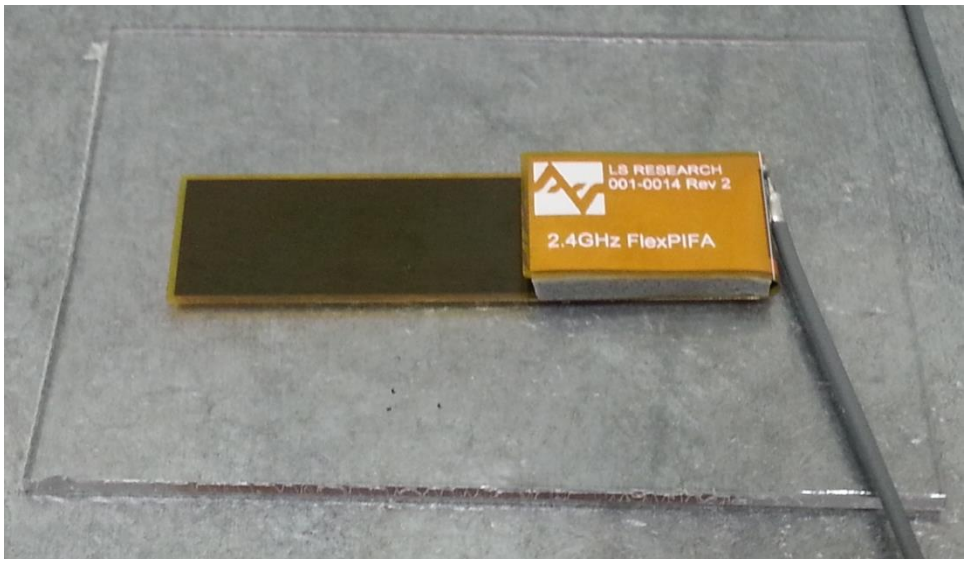


Figure 25 FlexPIFA Mounted on Metal Surface with 1.5mm Thick Polycarbonate Spacer

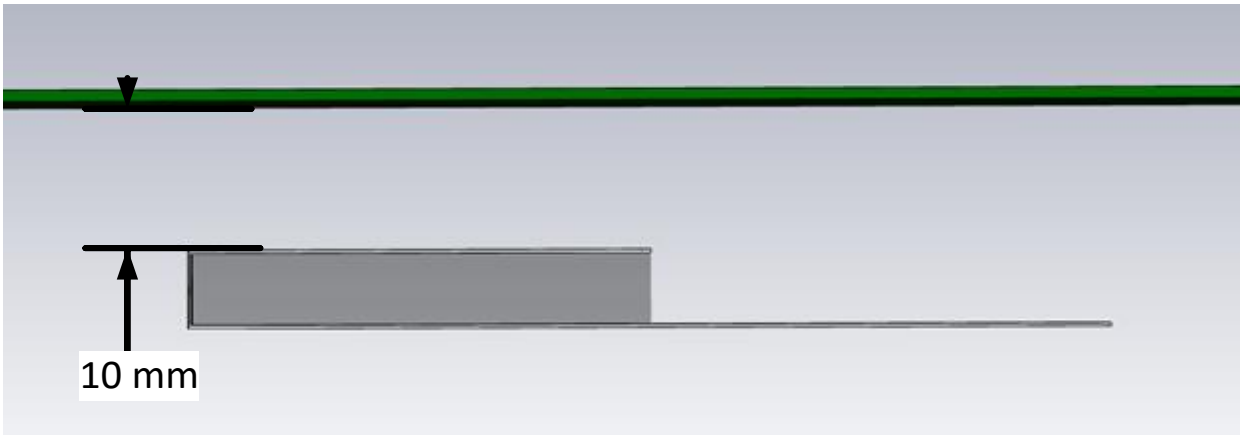


Figure 26 Metal near Main Element

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 26**. 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 27** 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 27 FlexPIFA Integrated into Bracelet

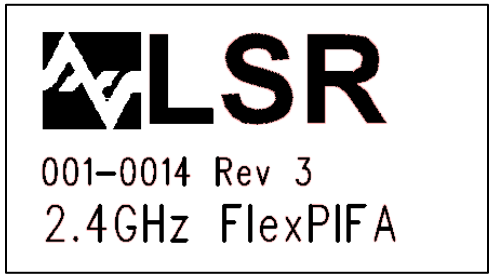
PRODUCT REVISION HISTORY

001-0014 (U.FL Connector)

Rev 1: Pre-Production Release

Rev 2: Initial Release

Rev 3: Changed Exposed Area of Solder Pads (Improve Soldering), Applying UV Glue (Strengthen Cable Joint) and increased top length from 15.2mm to 16.6mm – Silkscreen Side of FPC (Improve Tuning)



Rev 4: Added U.S. Patent and Laird Logo to Silkscreen

001-0022 (MHF4L Connector)

Rev 1: Initial Release

Rev 2: Added U.S. Patent and Laird Logo to Silkscreen

001-0025 (U.FL Connector Left-Hand Position)

Rev 1: Initial Release

CONTACTING LSR

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Website www.lsr.com

Technical Support forum.lsr.com

Sales Contact sales@lsr.com

2.4 GHz – 2.5 GHz FlexNotch 2 dBi Antenna w/U.FL Cable, 100mm

ORDERING INFORMATION

Order Number	Description
001-0015	2.4 GHz FlexNotch Antenna w/U.FL Cable, 100mm
001-0023	2.4GHz FlexNotch Antenna w/ MHF4L Cable, 100mm

Table 1 Orderable Part Numbers

KEY FEATURES

- Can be installed on flat or curved surfaces.
- Simple custom options with trimming length.
- Quick and easy Installation
- Flexible, ultra-low profile
- RoHS Compliant
- Adhesive holds to surface during humidity exposure and hot/cold cycles

SPECIFICATIONS

Specification	Value
Peak Gain	+2 dBi
Average Gain	>-1.6 dBi
Impedance	50 ohms
Type	Flexible Notch
Polarization	Linear
VSWR	< 2.5:1, 2400 - 2480 MHz
Frequency	2400 – 2480 MHz
Weight	0.85g
Size	32.0mm × 21.08mm
Antenna Color	Clear Yellow
Adhesive	3M 100MP
Operating Temp	-40°C to +85°C
Connector Height	U.FL: 2.5mm Max
	MHF4L: 1.4mm Max

Table 2 Specifications

PHYSICAL DIMENSIONS (MM)

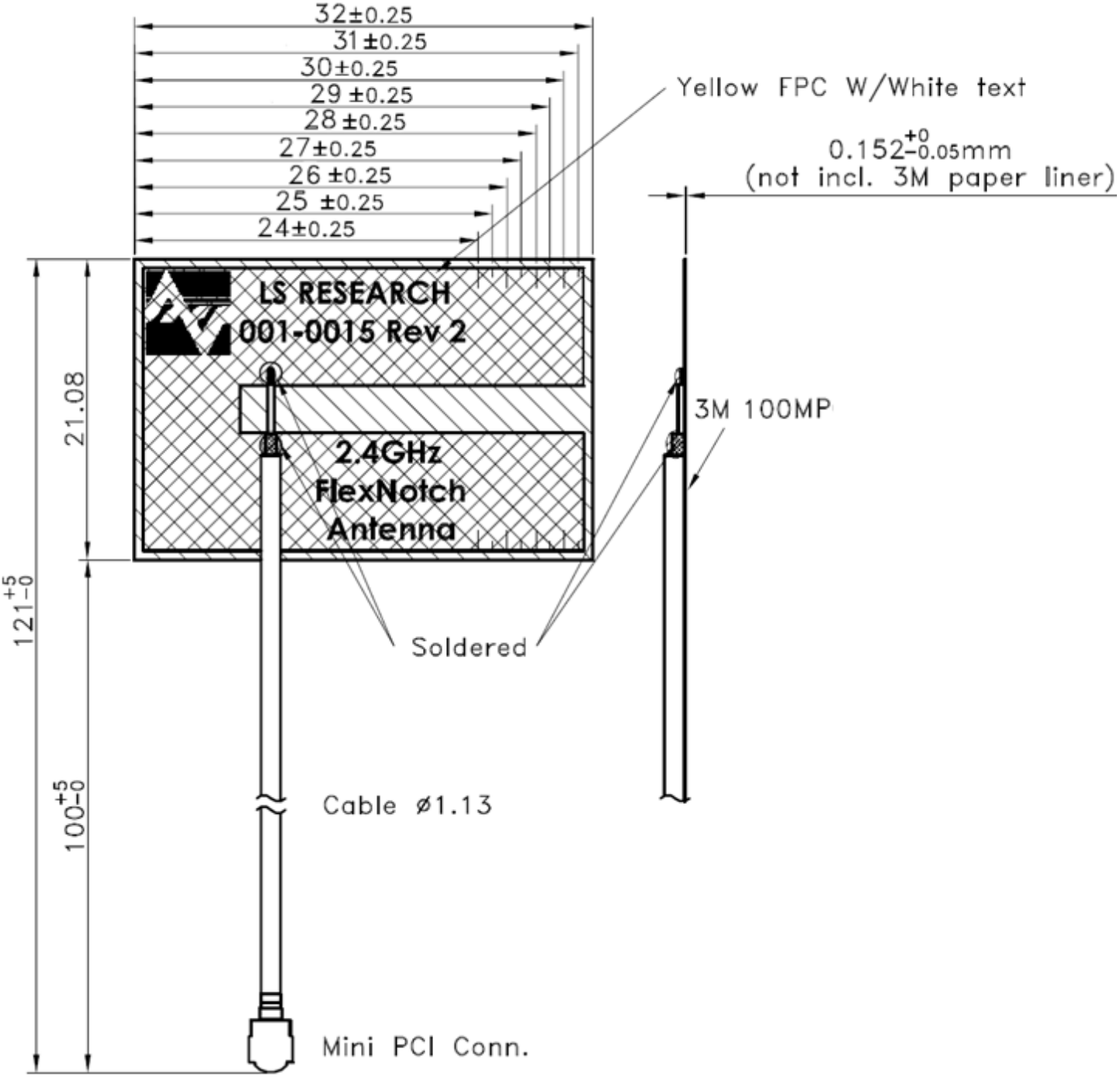


Figure 1 Physical Dimensions

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.

FLAT SURFACE ANTENNA MEASUREMENTS

VSWR

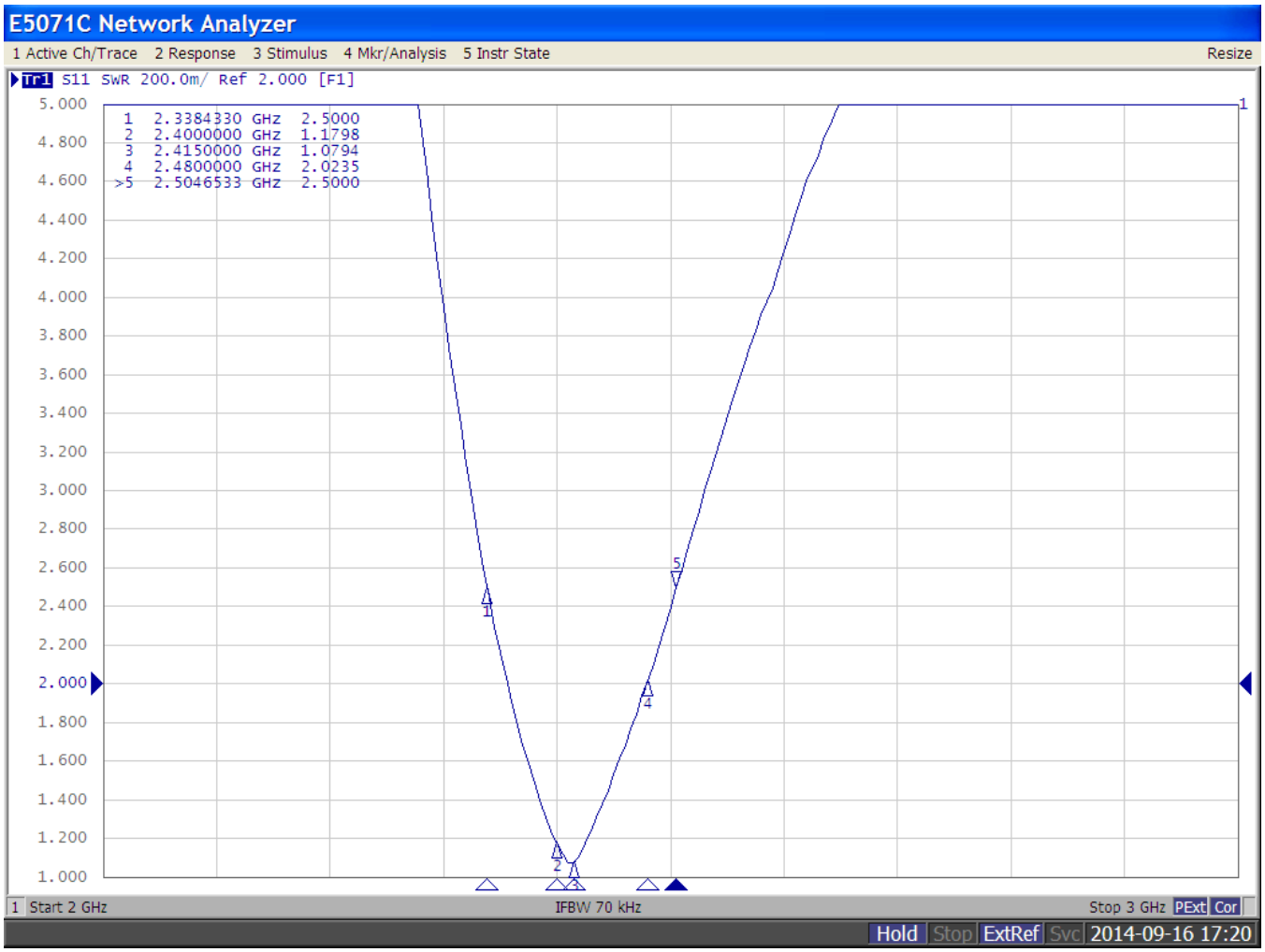


Figure 2 Antenna VSWR measured on a 1.5 mm thick plate of Polycarbonate

FLAT SURFACE ANTENNA RADIATION PERFORMANCE

FlexNotch centered on a 1.5 mm thick plate of Polycarbonate

Antenna Measurement Set-Up

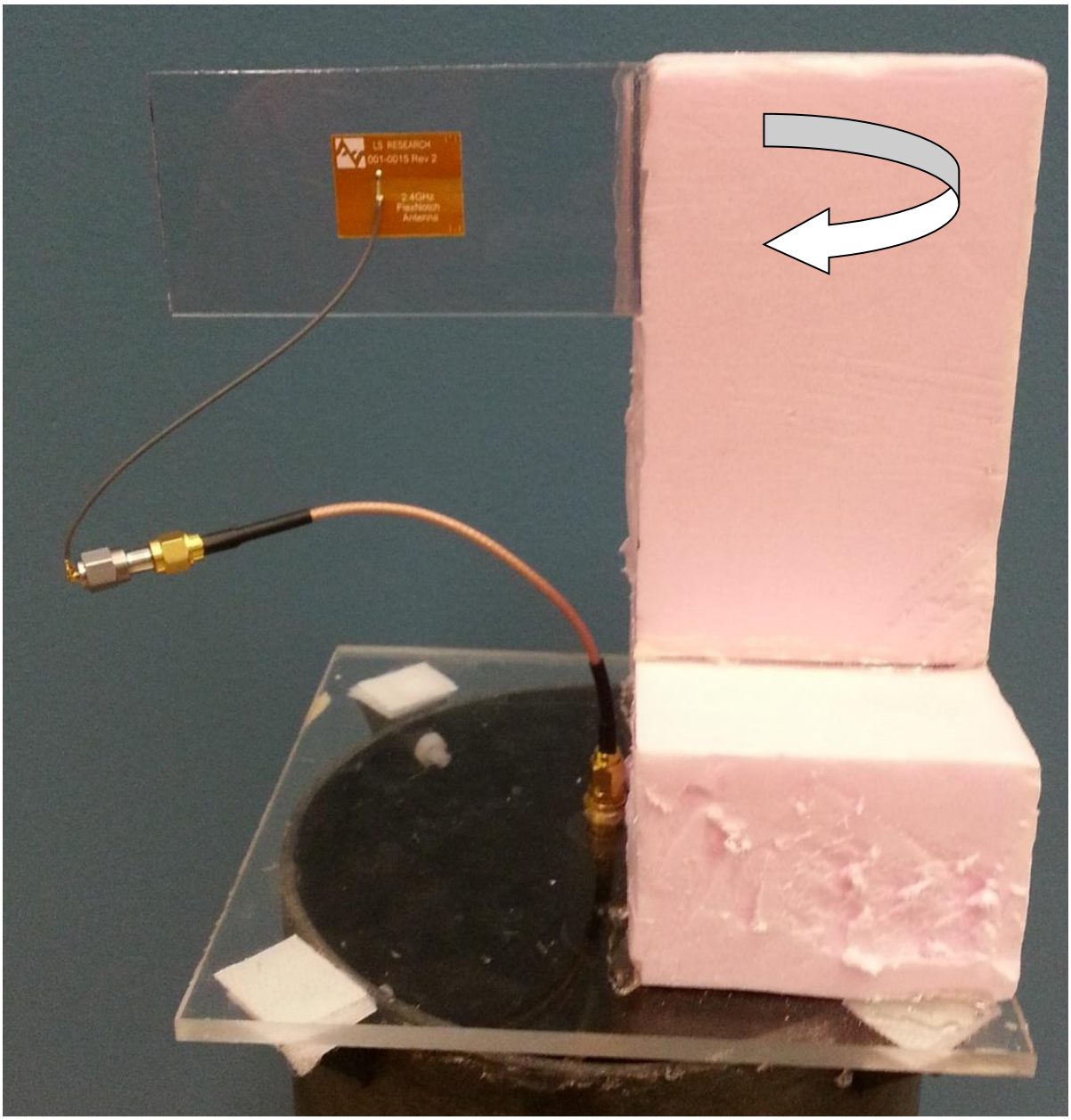


Figure 3 Horizontal Orientation Measurement

Horizontal Orientation at 2440 MHz:

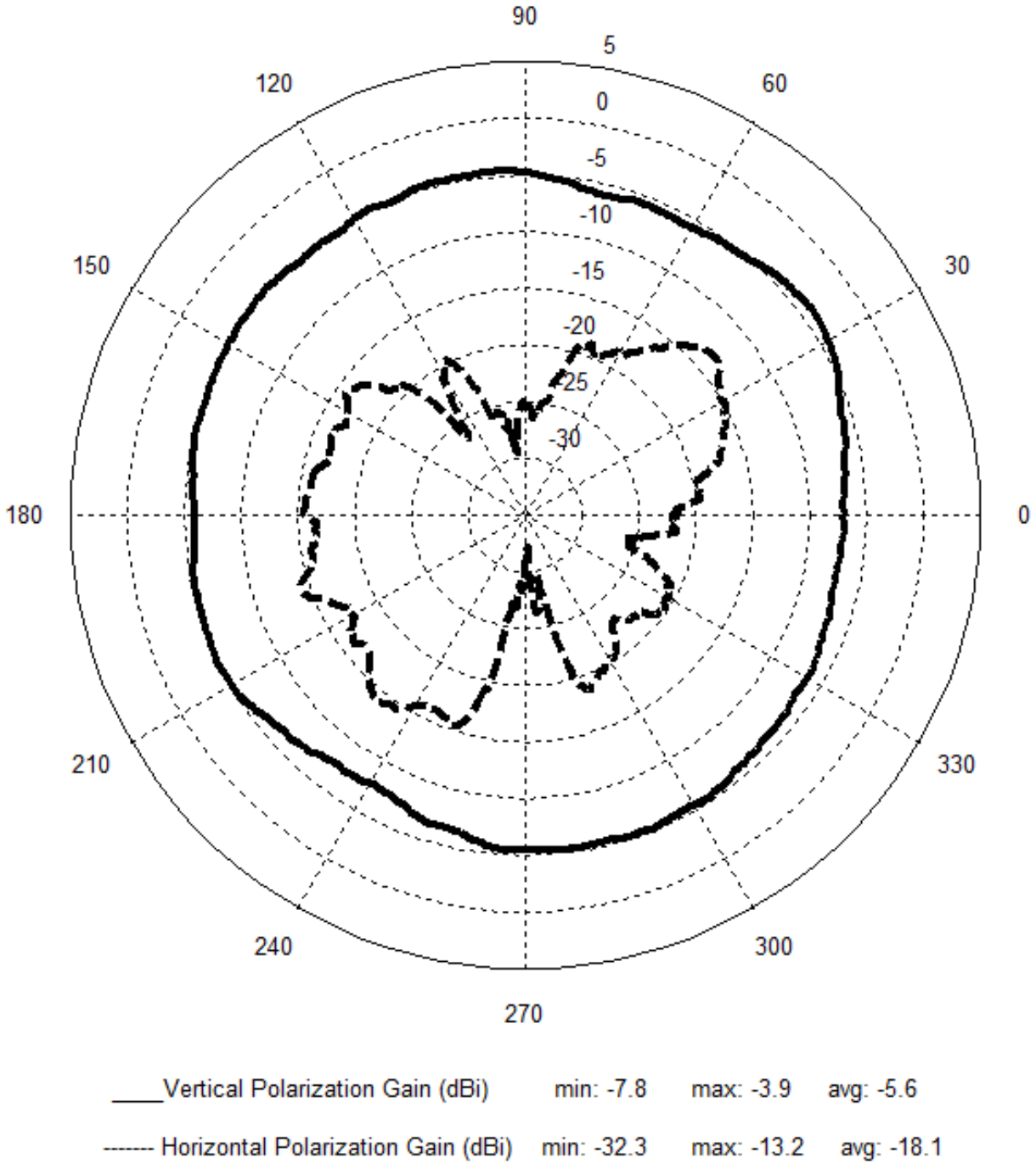


Figure 4 Horizontal Orientation Pattern

Antenna Measurement Set-Up

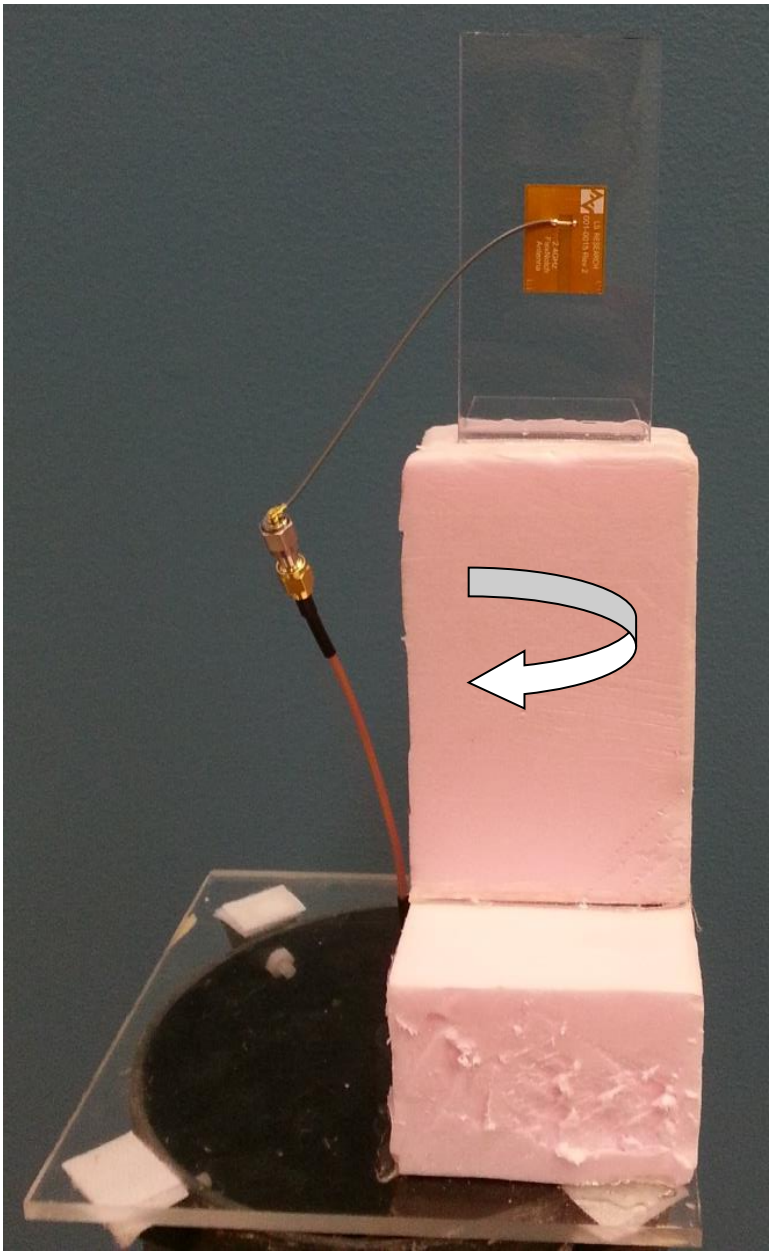


Figure 5 Vertical Orientation Measurement

Vertical Orientation at 2440 MHz:

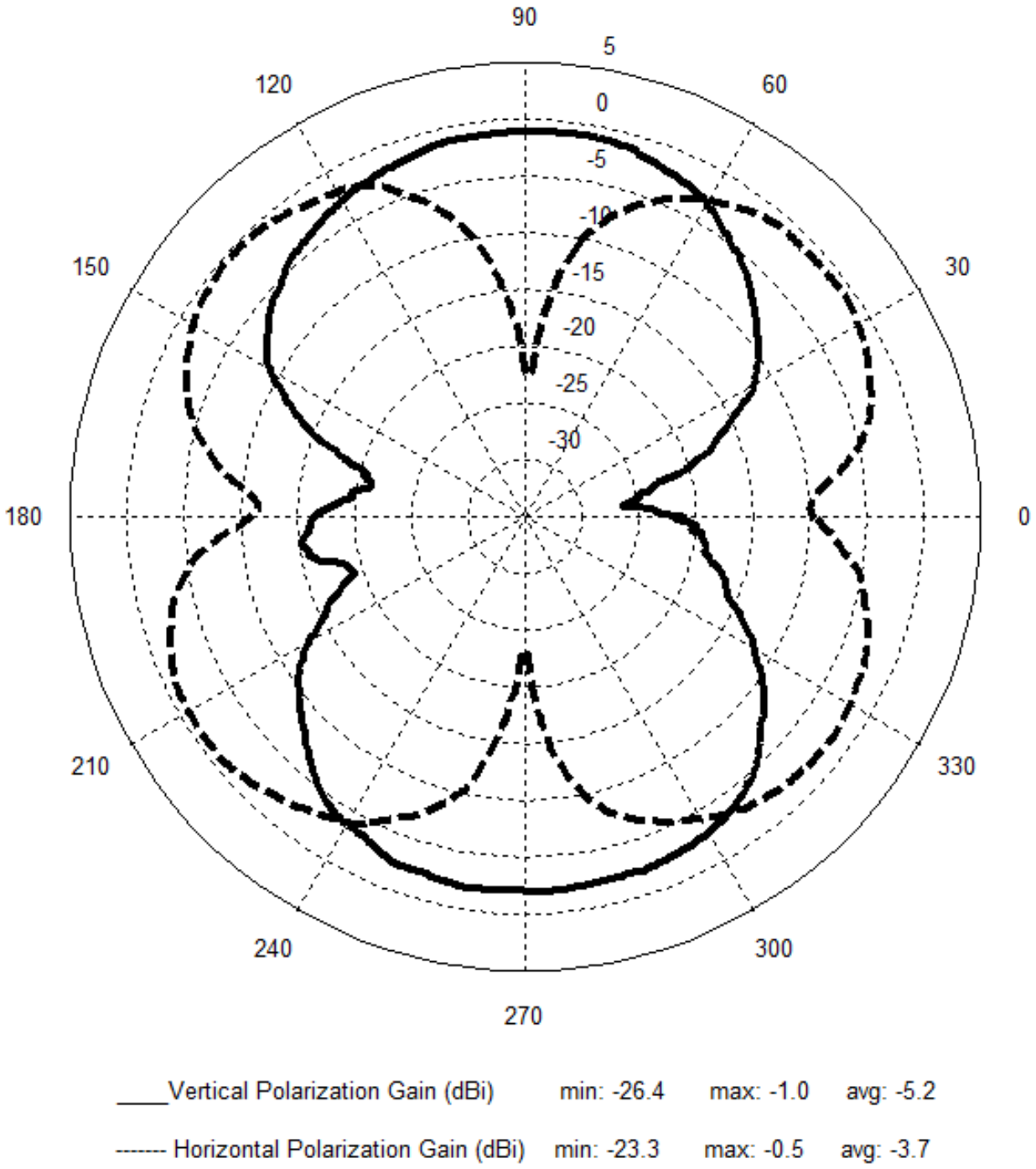


Figure 6 Vertical Orientation Pattern

Antenna Measurement Set-Up

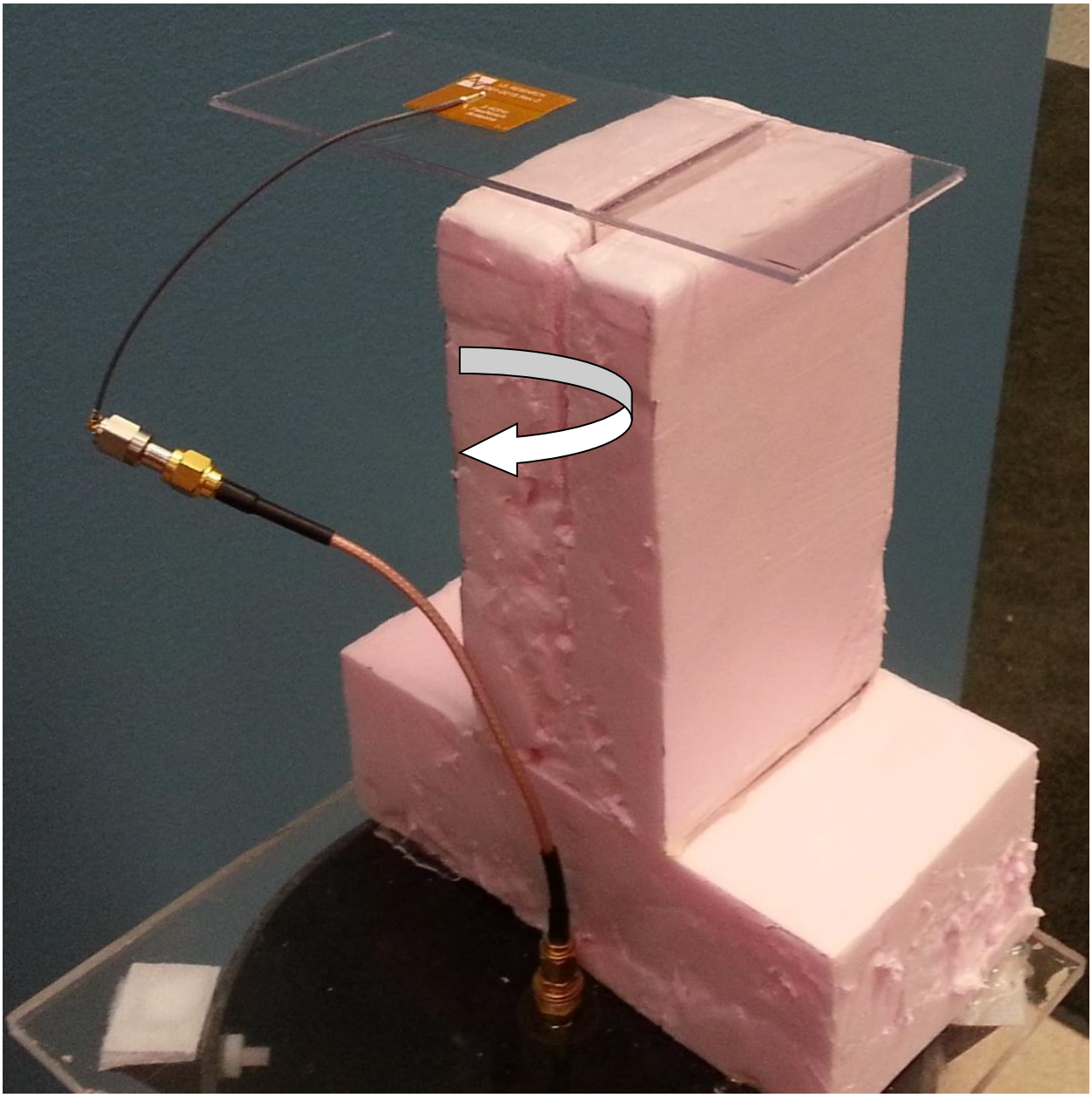


Figure 7 Flat Orientation Measurement

Flat Orientation at 2440 MHz:

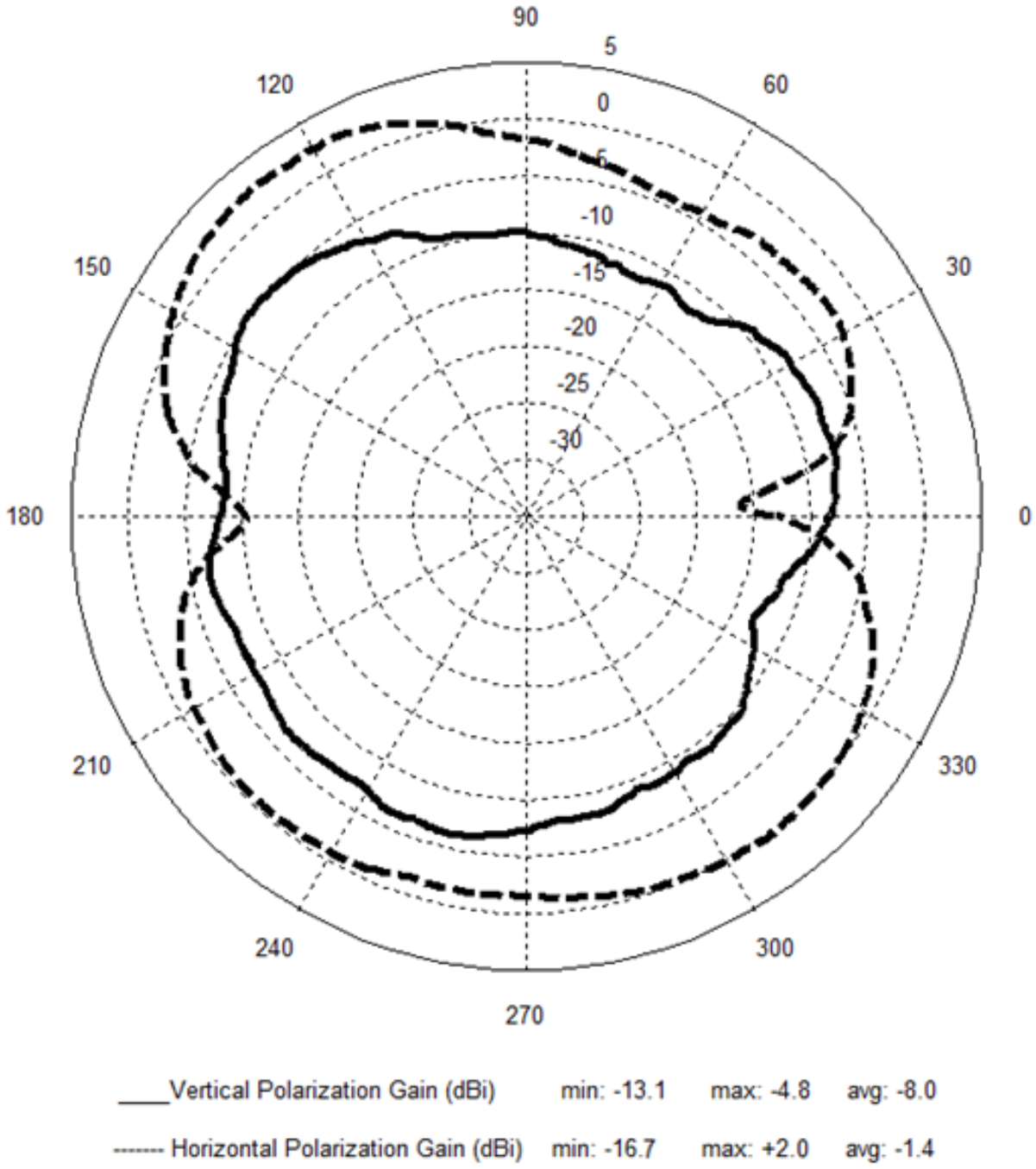


Figure 8 Flat Orientation Pattern

OPTIMAL INSTALLATION GUIDE

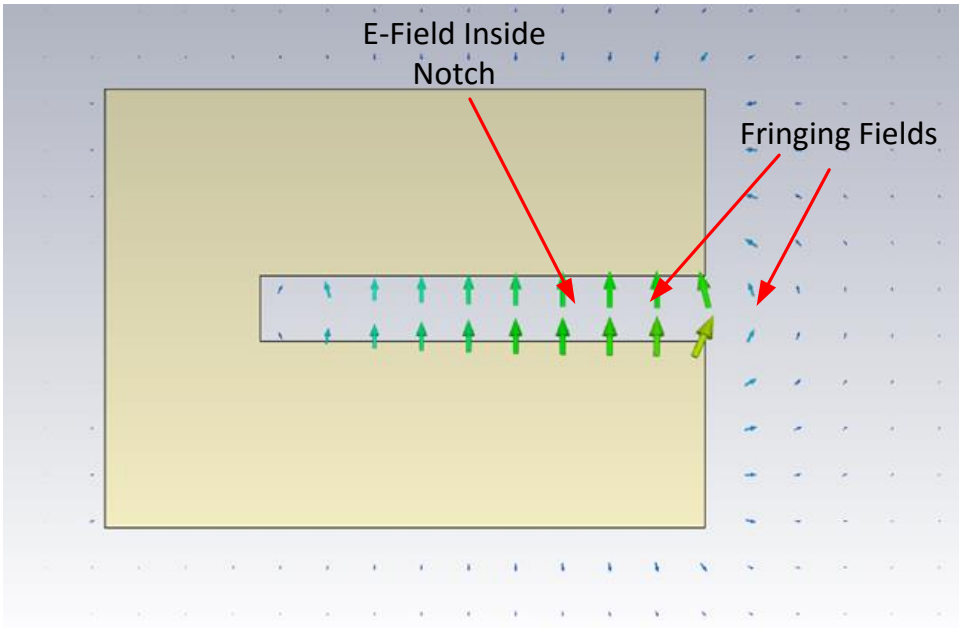


Figure 9 E-Field Radiation from FlexNotch, Taken from CST Simulation

The FlexNotch should be kept clear of any non-metal objects (such as plastics) on top of it by at least 5 mm (see **Figure 10**). Similarly, all four sides of the FlexNotch should be kept clear of any non-metal object by at least 1 mm (See **Figure 11** and **Figure 12**). Mounting the FlexNotch 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.

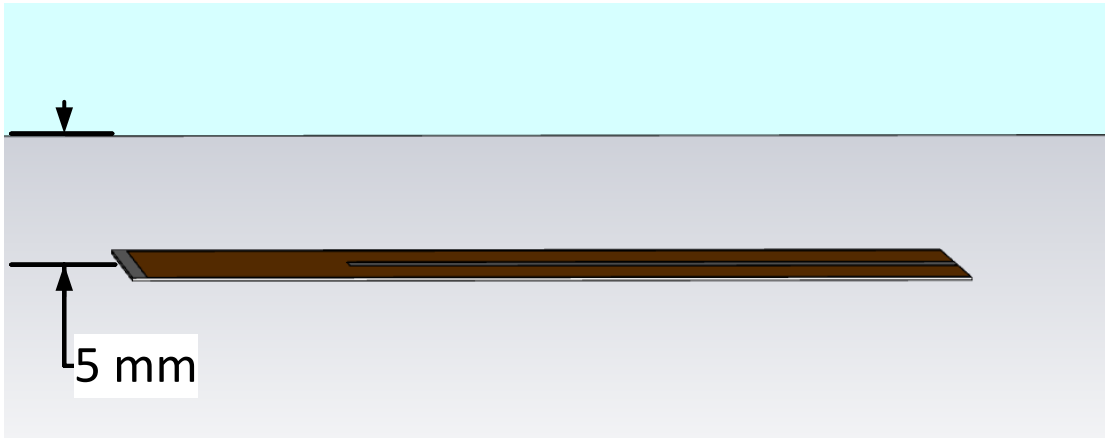
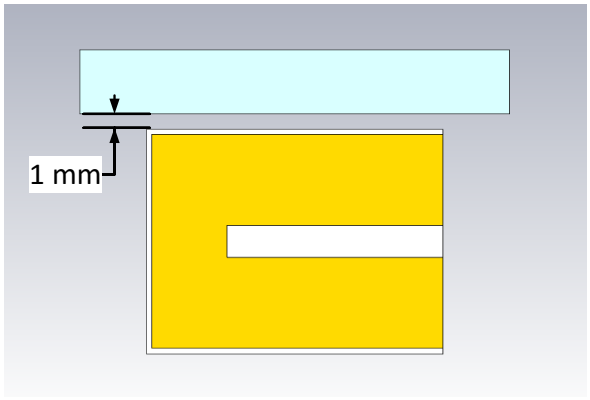
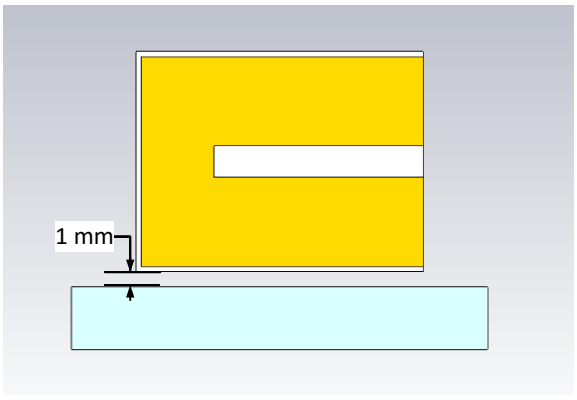


Figure 10 Above FlexNotch Clearance

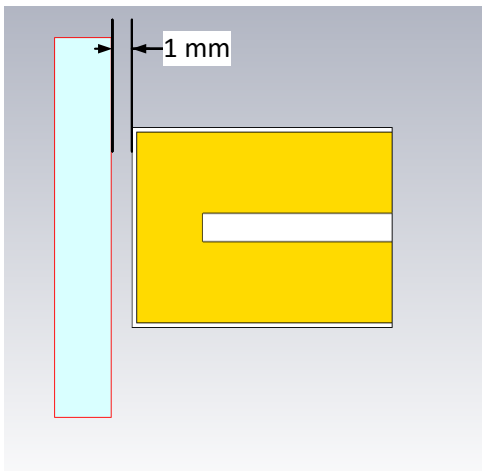


Top Clearance

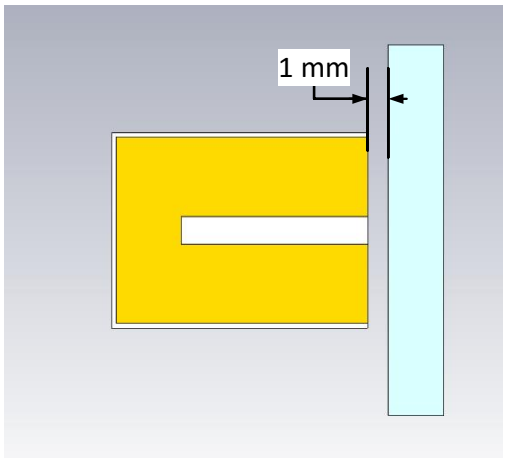


Bottom Clearance

Figure 11 Top and Bottom Clearance



Left 'Cold' Side Clearance

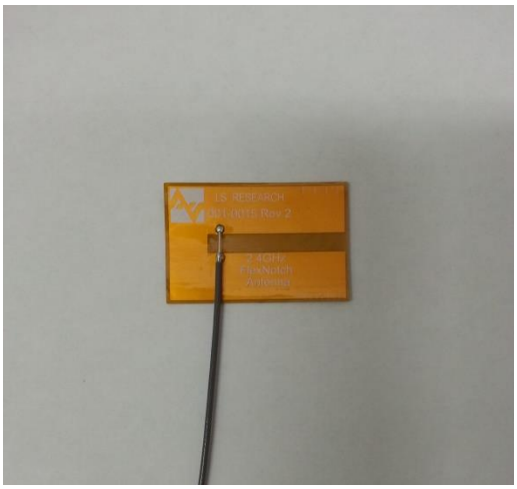


Open Side Clearance

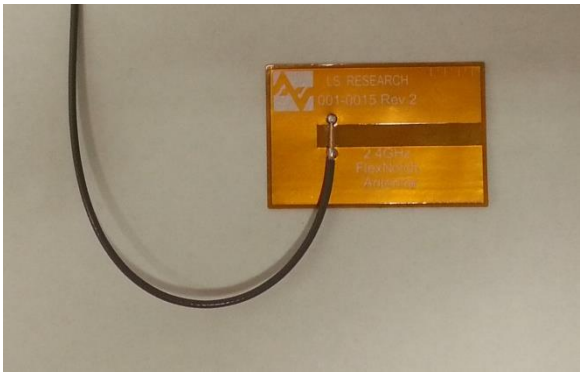
Figure 12 Open Side Clearance

The ideal material for the FlexNotch to be mounted on is 1.5 mm thick polycarbonate; this will result in maximum performance. If the FlexNotch is mounted on a different material, the tuning will change. This can cause a decrease in performance. LSR can retune the FlexNotch for specific implementations and different materials on request.

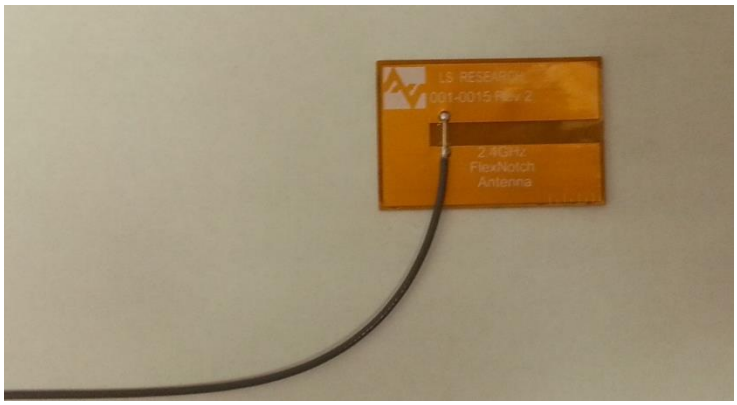
The coaxial cable feeding the FlexNotch should be routed away from the antenna. Do not run the coaxial cable above the FlexNotch or near the open end of the notch. The cable should be routed perpendicular to the side of the FlexNotch (this is the way the cable comes assembled), around the cold side, or away from the ground wall. All three of these options are shown in **Figure 13**.



Perpendicular to the side



Around the 'Cold' Side



Away from the Notch wall

Figure 13 Recommended Cable Routing

As with any antenna, care should be taken not to place conductive materials or objects near the antenna. The radiated fields from the antenna will induce currents on the conductive surface; 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 FlexNotch (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:

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Speakers – these generate magnetic fields

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Battery Location

Proximity to Human Body

Display Screen – these will absorb radiation

Paint – do not use metallic coating or flakes

Flex Limits of the FlexNotch

One of the unique features of the FlexNotch 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 FlexNotch should not be flexed in a convex position with a radius less than 16 mm. 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 LSR Design Services for assistance.

Figure 14 Convex Mounted

The FlexNotch should not be flexed in a concave position with a radius less than 16 mm. Similar to the restrictions on the convex position, potential exists for the adhesive to peel off over time if the FlexNotch is bent beyond a 16 mm radius. If a tighter radius of curvature is required, it is recommended you contact LSR for assistance. The FlexNotch is not designed to be twisted or crumpled. The adhesive back should lay flush with the surface it is mounted on.

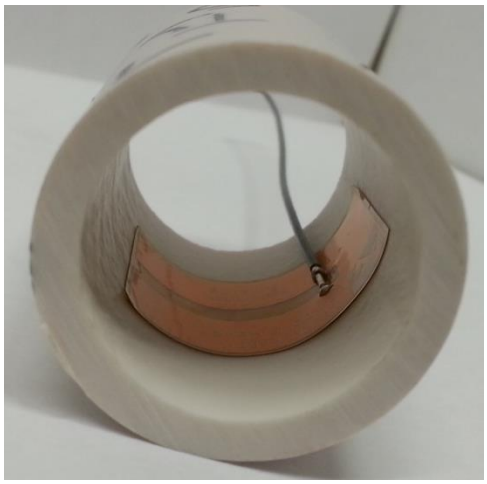


Figure 15 Concave Mounted

Mounting on Metal and Body Loaded Applications

The FlexNotch can tolerate being near conductive surfaces. A 1 mm clearance should be observed between the top, bottom, and cold sides of the FlexNotch from any metal (see **Figure 11**). Metal should be kept away from the open end of the FlexNotch by at least 10 mm. However, any metal in close proximity to the open end will disrupt the radiation pattern and could cause a decrease in antenna gain.

Keep any metal above the FlexNotch away by at least 10 mm; this will prevent the antenna from detuning. However this will still cause some distortion of the radiation pattern. **Do NOT mount the FlexNotch on a metal surface**.

These same guidelines also apply to body worn applications.

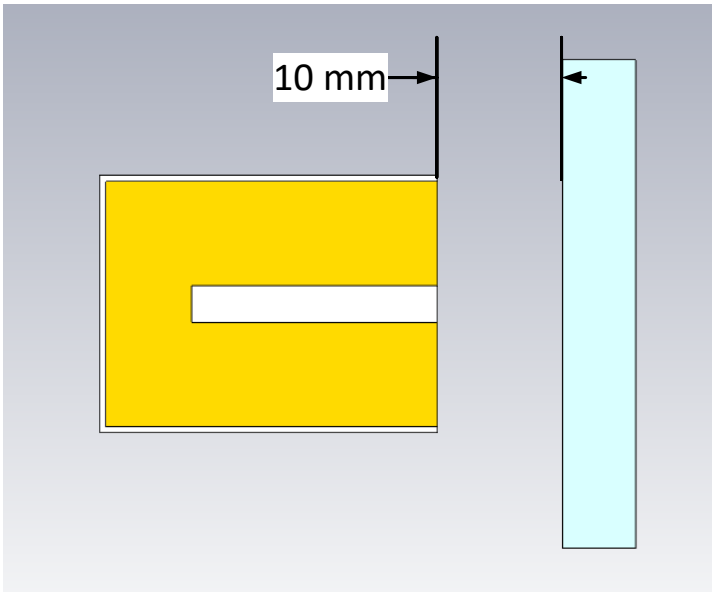


Figure 16 Open Side Metal Clearance

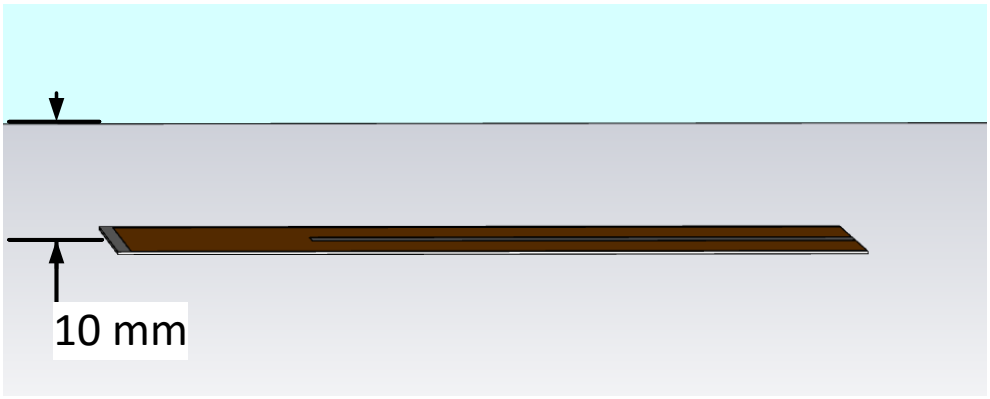


Figure 17 Above Notch Metal Clearance

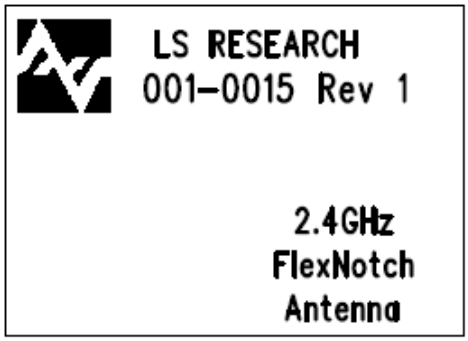
CUSTOMER SPECIFIC TUNING

LSR will assist with custom tuning of the antenna for your specific end product. Simply send LSR a sample of your enclosure or platform, and LSR will tune an antenna for you. LSR will send the results back indicating which trim mark the antenna should be cut to, to optimize performance. You then trim the antennas at time of assembly to the indicated hash mark, and stick to your product.

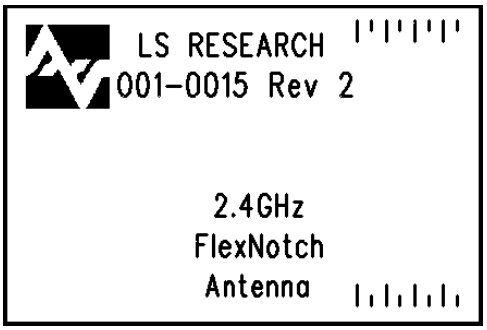
PRODUCT REVISION HISTORY

001-0015 (U.FL Connector)

Rev 1: Initial Production Release



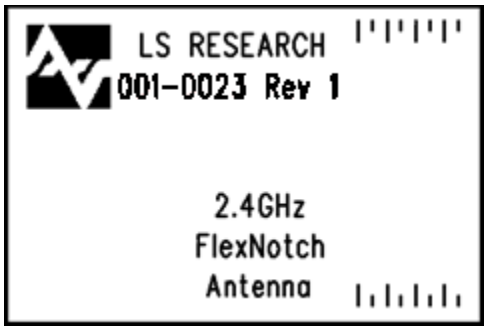
Rev 2:



- Added Cut Hash Marks in intervals of 1 mm (Small Mark) and 2 mm (Large Mark)

001-0023 (MHF4L Connector)

Rev 1: Initial Production Release



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