# Japan Test Report

| | | |
|---|---|---|
| **Equipment** | : | **Sterling-LWB5 Module** |
| **Model No.** | : | **450-0168, 450-0169**<br>**(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 |
|---|---|---|---|
| JR770305-01AD | Rev. 01 | Initial issue | Oct. 08, 2018 |

# Summary of Test Results

| Ref. Std. Clause | Description | Result |
|---|---|---|
| 3.2(2)(3) | Antenna Power / Tolerances for 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 |
| 3.2(11) | Dwell time | Pass |
| 3.4.1 | Interference prevention function | Pass |
| 3.3(1) | Receiver Spurious Emission | 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** | FHSS / GFSK = 1Mbps, π/4DQPSK = 2Mbps, 8DPSK = 3Mbps |
| **Frequency Range (MHz)** | 2402 ~ 2480 MHz |
| **Total Channel Number** | 79 |
| **HW Version** | 1.0 |
| **SW Version** | 6.37.39.77 |

### 1.1.3 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 I for more details about antenna pattern and other information.

### 1.1.4 Antenna Power

| Operating Mode | Rated Power (mW/MHz) | Measured Conducted Power (mW/MHz) | Radiated Power (mW/MHz) |
|---|---|---|---|
| BT-BR (1Mbps) | 0.10 | 0.08851 | 0.15740 |
| BT-EDR (3Mbps) | 0.10 | 0.06577 | 0.11695 |
| BT-BR-AFH (1Mbps) | 0.40 | 0.33343 | 0.59293 |
| BT-EDR-AFH (3Mbps) | 0.40 | 0.24889 | 0.44259 |

### 1.1.5 Channel List

| Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) | Channel | Frequency (MHz) |
|---|---|---|---|---|---|---|---|
| 0 | 2402 | 20 | 2422 | 40 | 2442 | 60 | 2462 |
| 1 | 2403 | 21 | 2423 | 41 | 2443 | 61 | 2463 |
| 2 | 2404 | 22 | 2424 | 42 | 2444 | 62 | 2464 |
| 3 | 2405 | 23 | 2425 | 43 | 2445 | 63 | 2465 |
| 4 | 2406 | 24 | 2426 | 44 | 2446 | 64 | 2466 |
| 5 | 2407 | 25 | 2427 | 45 | 2447 | 65 | 2467 |
| 6 | 2408 | 26 | 2428 | 46 | 2448 | 66 | 2468 |
| 7 | 2409 | 27 | 2429 | 47 | 2449 | 67 | 2469 |
| 8 | 2410 | 28 | 2430 | 48 | 2450 | 68 | 2470 |
| 9 | 2411 | 29 | 2431 | 49 | 2451 | 69 | 2471 |
| 10 | 2412 | 30 | 2432 | 50 | 2452 | 70 | 2472 |
| 11 | 2413 | 31 | 2433 | 51 | 2453 | 71 | 2473 |
| 12 | 2414 | 32 | 2434 | 52 | 2454 | 72 | 2474 |
| 13 | 2415 | 33 | 2435 | 53 | 2455 | 73 | 2475 |
| 14 | 2416 | 34 | 2436 | 54 | 2456 | 74 | 2476 |
| 15 | 2417 | 35 | 2437 | 55 | 2457 | 75 | 2477 |
| 16 | 2418 | 36 | 2438 | 56 | 2458 | 76 | 2478 |
| 17 | 2419 | 37 | 2439 | 57 | 2459 | 77 | 2479 |
| 18 | 2420 | 38 | 2440 | 58 | 2460 | 78 | 2480 |
| 19 | 2421 | 39 | 2441 | 59 | 2461 | | |

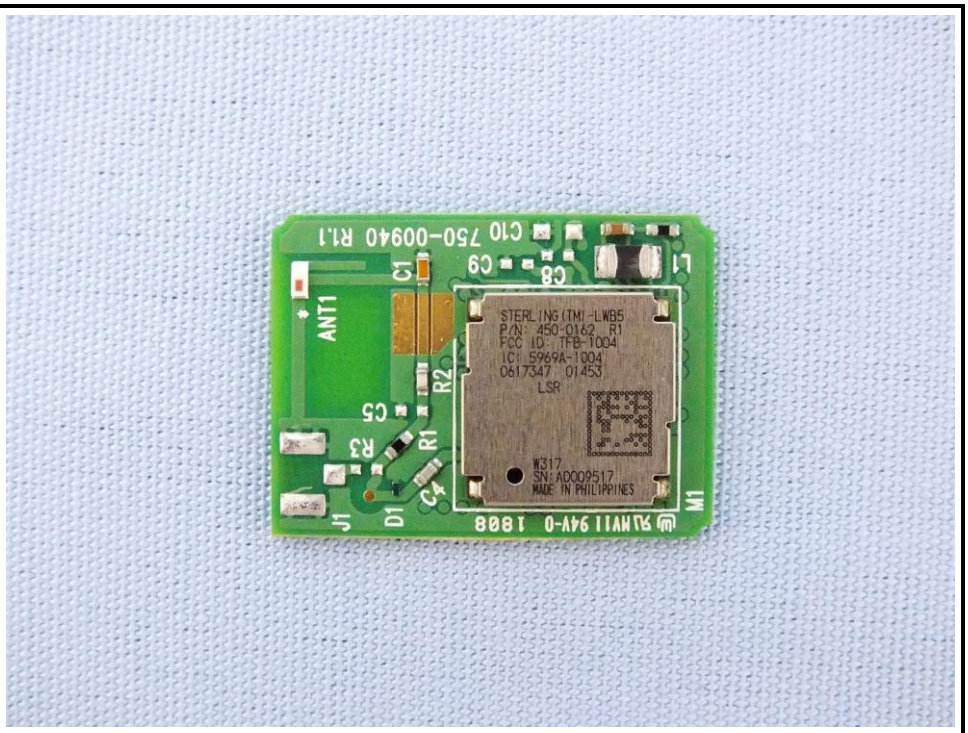
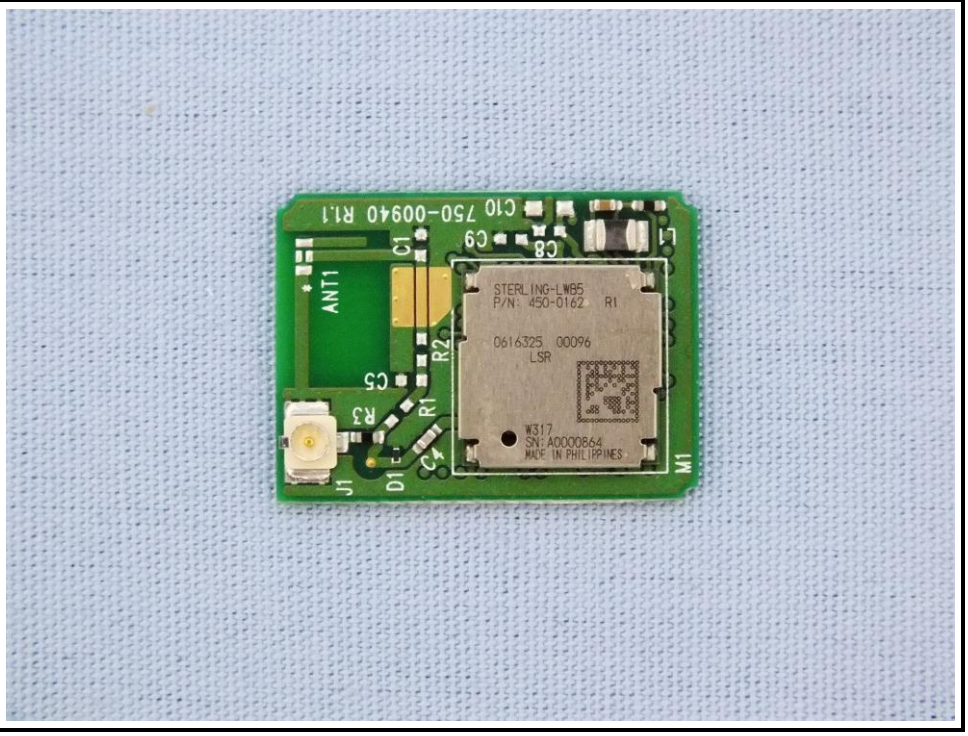
### 1.1.6 Test Tool and Power Setting

| Test Tool |
|---|
| BT RF Eval Tool v. 2.10.0.0 |

| Power Setting | | | |
|---|---|---|---|
| **Channel** | **Frequency (MHz)** | **GFSK** | **8DPSK** |
| 0 | 2402 | CBT Power Max | CBT Power Max |
| 39 | 2441 | CBT Power Max | CBT Power Max |
| 78 | 2480 | CBT Power Max | CBT Power Max |

### 1.1.7 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<br>(Chip Antenna Module) |  |
| Photo\|<br>(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 |
| Bluetooth Tester | R&S | CBT | 100959 | Sep. 28, 2017 | Sep. 27, 2018 |
| Note 1: Calibration Interval of instruments listed above is one year.<br>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 |
|---|---|---|---|
| Bluetooth Tester | ROHDE&SCHWARZ | CBT | --- |

## 2.3 The Worst Test Modes and Channel Details

| Test item | Mode | Test channel |
|---|---|---|
| Antenna Power | GFSK, 8DPSK | 0 ~ 78 |
| Frequency Tolerance | GFSK, 8DPSK | 0 / 39 / 78 |
| Transmitter Spurious Emission | GFSK, 8DPSK | 0 ~ 78 |
| Occupied Bandwidth | GFSK, 8DPSK | 0 ~ 78 |
| Spreading Bandwidth | GFSK, 8DPSK | 0 ~ 78 |
| Spreading Factor | GFSK, 8DPSK | 0 ~ 78 |
| Dwell time | GFSK, 8DPSK | 0 ~ 78 |
| Receiver Spurious Emission | GFSK, 8DPSK | 0 / 39 / 78 |

# 3 Transmitter Test Results

## 3.1 Antenna Power

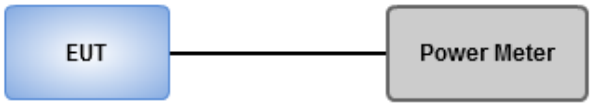
### 3.1.1 Limit of Antenna Power

| 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

1. Measure the total power by Power Meter in a state of hopping mode
2. Measure the burst ratio. Then calculate the real total power by burst ratio.
3. Calculate the mean power per 1MHz by dividing the total power by spread bandwidth
4. Output Power Density (mW/MHz) = Total Output Power (mW) / Burst Ratio / Spread Bandwidth (MHz)

### 3.1.3 Test Setup




### 3.1.4 Test Result of Maximum Transmit Power

| Reference Documents | Test Mode |
|---|---|
| Appendix A1, A2 | BT-BR (1Mbps) |
| Appendix A1, A2 | BT-EDR (3Mbps) |
| Appendix A1, A2 | BT-BR-AFH (1Mbps) |
| Appendix A1, A2 | BT-EDR-AFH (3Mbps) |

## 3.2 Frequency Tolerance

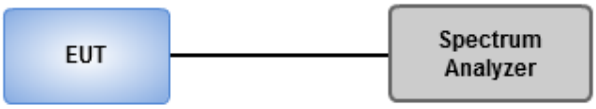
### 3.2.1 Limit of Frequency Tolerance

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-BR (1Mbps) |
| Appendix B | BT-EDR (3Mbps) |

## 3.3 Occupied Bandwidth

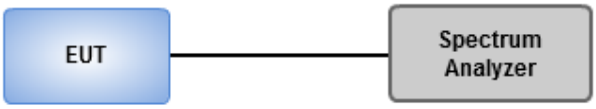
### 3.3.1 Limit of Occupied Bandwidth

| 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 = 200MHz, RBW = VBW = 300kHz, detector = Peak, Sweep time = Auto.
2. Enable OBW function of spectrum analyzer to measure 99% bandwidth of total power.

### 3.3.3 Test Setup




### 3.3.4 Test Result of Occupied Bandwidth

| Reference Documents | Test Mode |
|---|---|
| Appendix C | BT-BR (1Mbps) |
| Appendix C | BT-EDR (3Mbps) |
| Appendix C | BT-BR-AFH (1Mbps) |
| Appendix C | BT-EDR-AFH (3Mbps) |

## 3.4 Spreading Bandwidth and Factor

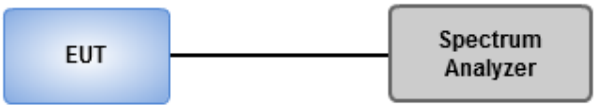
### 3.4.1 Limit of Spreading Bandwidth and Factor

| 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 90% bandwidth of total power.

### 3.4.3 Test Setup




### 3.4.4 Test Result of Spreading Bandwidth and Factor

| Reference Documents | Test Mode |
|---|---|
| Appendix D | BT-BR (1Mbps) |
| Appendix D | BT-EDR (3Mbps) |
| Appendix D | BT-BR-AFH(1Mbps) |
| Appendix D | BT-EDR-AFH(3Mbps) |

## 3.5 Transmitter Spurious Emissions

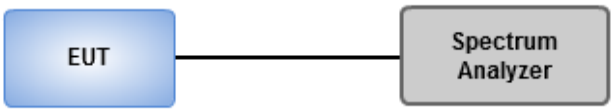
### 3.5.1 Limit of Transmitter Spurious Emissions

| Item | Limits |
|---|---|
| Tx Spurious Emission | ≤ 2.5 μW (2387MHz > f ; 2496.5MHz < f ). |
| | ≤ 25 μW.<br>(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

| Reference Documents | Test Mode |
|---|---|
| Appendix E | BT-BR (1Mbps) |
| Appendix E | BT-EDR (3Mbps) |

## 3.6 Dwell time

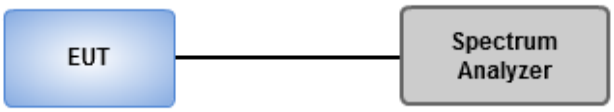
### 3.6.1 Limit of Dwell time

| | |
|---|---|
| **Limits** | Shall be less than 0.4 second |

### 3.6.2 Test Procedures

1. Set EUT to transmit at rated power and channel to perform test.
2. Set RBW = VBW = 300kHz, Detector type = Peak, Span = Zero Span, Sweep time = 5 msec.
3. Use marker function to measure Burst on and off time.
4. Burst ratio = On Time / ( On Time + Off time)

### 3.6.3 Test Setup




### 3.6.4 Test Result of Dwell time

| Reference Documents | Test Mode |
|---|---|
| Appendix F | BT-BR (1Mbps) |
| Appendix F | BT-EDR (3Mbps) |
| Appendix F | BT-BR-AFH (1Mbps) |
| Appendix F | BT-EDR-AFH (3Mbps) |

## 3.7 Interference Prevention Function

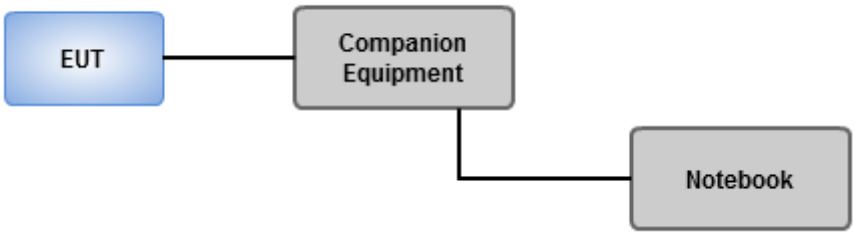
### 3.7.1 Limit of Interference Prevention Function

| Limits |
|---|
| The identification code shall be 48 bits long |

### 3.7.2 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

### 3.7.3 Test Setup




### 3.7.4 Test Result of Interference Prevention Function

| Reference Documents | Test Mode |
|---|---|
| Appendix G | BT-BR (1Mbps) |
| Appendix G | BT-EDR (3Mbps) |
| Appendix G | BT-BR-AFH (1Mbps) |
| Appendix G | BT-EDR-AFH (3Mbps) |

# 4 Receiver Test Results

## 4.1 Receiver Spurious Emissions

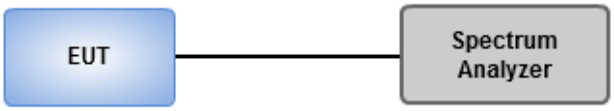
### 4.1.1 Limit of Receiver Spurious Emissions

| 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.

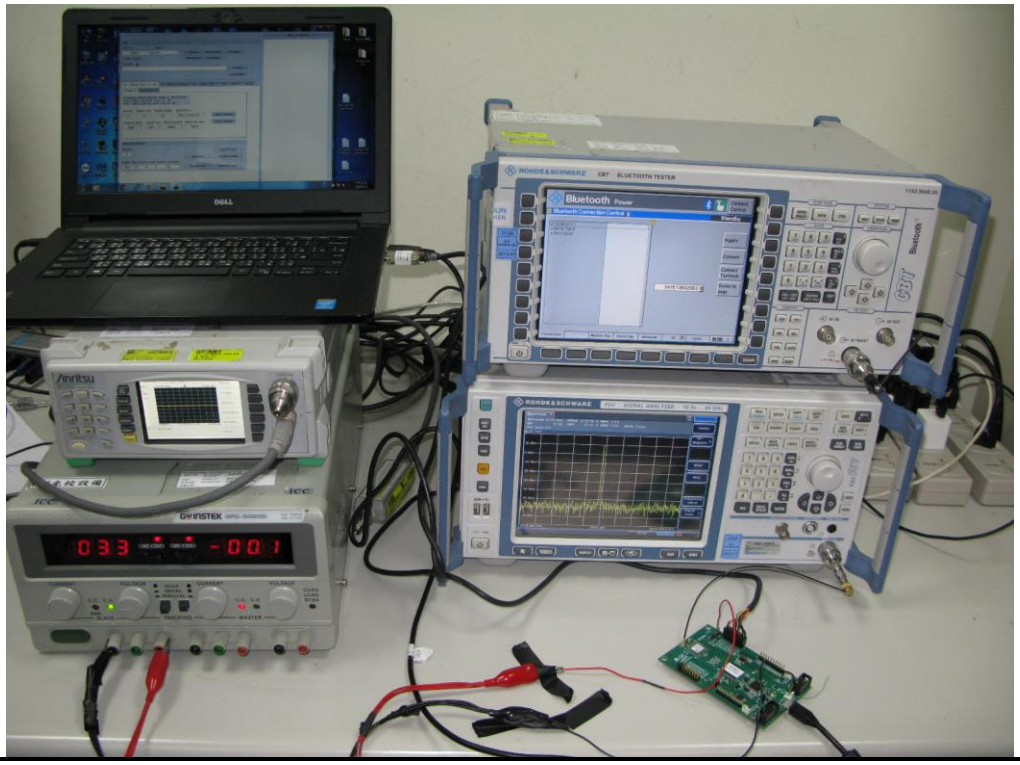
### 4.1.3 Test Setup




### 4.1.4 Test Result of Receiver Spurious Emissions

| Reference Documents | Test Mode |
|---|---|
| Appendix H | BT-BR (1Mbps) |
| Appendix H | BT-EDR (3Mbps) |

# 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==**

## *Power-FHSS Result*

Appendix A.1

**Summary**

| Mode | Power (dBm/MHz) | Power (mW/MHz) | EIRP (dBm/MHz) | EIRP (mW/MHz) |
|---|---|---|---|---|
| 2.4-2.4835GHz | - | - | - | - |
| BT-BR(1Mbps) | -10.53 | 0.08851 | -8.03 | 0.15740 |
| BT-EDR(3Mbps) | -11.82 | 0.06577 | -9.32 | 0.11695 |
| BT-BR-AFH(1Mbps) | -4.77 | 0.33343 | -2.27 | 0.59293 |
| BT-EDR-AFH(3Mbps) | -6.04 | 0.24889 | -3.54 | 0.44259 |

**PD** = Antenna Power (Power Density)sum by **P1**; **P1** = Port 1 PD;

**Result**

| Mode | Result | Gain (dBi) | Power (dBm/MHz) | Power (mW/MHz) | Power Lim. (mW/MHz) | EIRP (dBm/MHz) | EIRP (mW/MHz) | EIRP Lim. (mW/MHz) |
|---|---|---|---|---|---|---|---|---|
| BT-BR(1Mbps) | - | - | - | - | - | - | - | - |
| 2441MHz_TnomVnom | Pass | 2.50 | -10.53 | 0.08851 | 3 | -8.03 | 0.15740 | 4.91 |
| 2441MHz_TnomVmin | Pass | 2.50 | -10.54 | 0.08831 | 3 | -8.04 | 0.15704 | 4.91 |
| 2441MHz_TnomVmax | Pass | 2.50 | -10.62 | 0.08670 | 3 | -8.12 | 0.15417 | 4.91 |
| BT-EDR(3Mbps) | - | - | - | - | - | - | - | - |
| 2441MHz_TnomVnom | Pass | 2.50 | -11.82 | 0.06577 | 3 | -9.32 | 0.11695 | 4.91 |
| 2441MHz_TnomVmin | Pass | 2.50 | -11.88 | 0.06486 | 3 | -9.38 | 0.11535 | 4.91 |
| 2441MHz_TnomVmax | Pass | 2.50 | -11.85 | 0.06531 | 3 | -9.35 | 0.11614 | 4.91 |
| BT-BR-AFH(1Mbps) | - | - | - | - | - | - | - | - |
| 2441MHz_TnomVnom | Pass | 2.50 | -4.81 | 0.33037 | 3 | -2.31 | 0.58749 | 4.91 |
| 2441MHz_TnomVmin | Pass | 2.50 | -4.80 | 0.33113 | 3 | -2.30 | 0.58884 | 4.91 |
| 2441MHz_TnomVmax | Pass | 2.50 | -4.77 | 0.33343 | 3 | -2.27 | 0.59293 | 4.91 |
| BT-EDR-AFH(3Mbps) | - | - | - | - | - | - | - | - |
| 2441MHz_TnomVnom | Pass | 2.50 | -6.12 | 0.24434 | 3 | -3.62 | 0.43451 | 4.91 |
| 2441MHz_TnomVmin | Pass | 2.50 | -6.04 | 0.24889 | 3 | -3.54 | 0.44259 | 4.91 |
| 2441MHz_TnomVmax | Pass | 2.50 | -6.13 | 0.24378 | 3 | -3.63 | 0.43351 | 4.91 |

**PD** = Antenna Power (Power Density)sum by **P1**;**P1** = Port 1 PD;

**Summary**

| Mode | Result | Power (dBm/MHz) | Power (mW/MHz) | Declare (mW/MHz) | Tolerance (%) | Limit+ (%) | Limit- (%) |
|---|---|---|---|---|---|---|---|
| 2.4-2.4835GHz | - | - | - | - | - | - | - |
| BT-BR(1Mbps) | Pass | -10.53 | 0.08851 | 0.10 | -11.49 | 20 | -80 |
| BT-EDR(3Mbps) | Pass | -11.88 | 0.06486 | 0.10 | -35.14 | 20 | -80 |
| BT-BR-AFH(1Mbps) | Pass | -4.77 | 0.33343 | 0.40 | -16.64 | 20 | -80 |
| BT-EDR-AFH(3Mbps) | Pass | -6.13 | 0.24378 | 0.40 | -39.05 | 20 | -80 |

**Result**

| Mode | Result | Power (dBm/MHz) | Power (mW/MHz) | Declare (mW/MHz) | Tolerance (%) | Limit+ (%) | Limit- (%) |
|---|---|---|---|---|---|---|---|
| BT-BR(1Mbps) | - | - | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | -10.53 | 0.08851 | 0.10 | -11.49 | 20 | -80 |
| Hopping Mode_TnomVmin | Pass | -10.54 | 0.08831 | 0.10 | -11.69 | 20 | -80 |
| Hopping Mode_TnomVmax | Pass | -10.62 | 0.08670 | 0.10 | -13.30 | 20 | -80 |
| BT-EDR(3Mbps) | - | - | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | -11.82 | 0.06577 | 0.10 | -34.23 | 20 | -80 |
| Hopping Mode_TnomVmin | Pass | -11.88 | 0.06486 | 0.10 | -35.14 | 20 | -80 |
| Hopping Mode_TnomVmax | Pass | -11.85 | 0.06531 | 0.10 | -34.69 | 20 | -80 |
| BT-BR-AFH(1Mbps) | - | - | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | -4.81 | 0.33037 | 0.40 | -17.41 | 20 | -80 |
| Hopping Mode_TnomVmin | Pass | -4.80 | 0.33113 | 0.40 | -17.22 | 20 | -80 |
| Hopping Mode_TnomVmax | Pass | -4.77 | 0.33343 | 0.40 | -16.64 | 20 | -80 |
| BT-EDR-AFH(3Mbps) | - | - | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | -6.12 | 0.24434 | 0.40 | -38.91 | 20 | -80 |
| Hopping Mode_TnomVmin | Pass | -6.04 | 0.24889 | 0.40 | -37.78 | 20 | -80 |
| Hopping Mode_TnomVmax | Pass | -6.13 | 0.24378 | 0.40 | -39.05 | 20 | -80 |

**Summary**

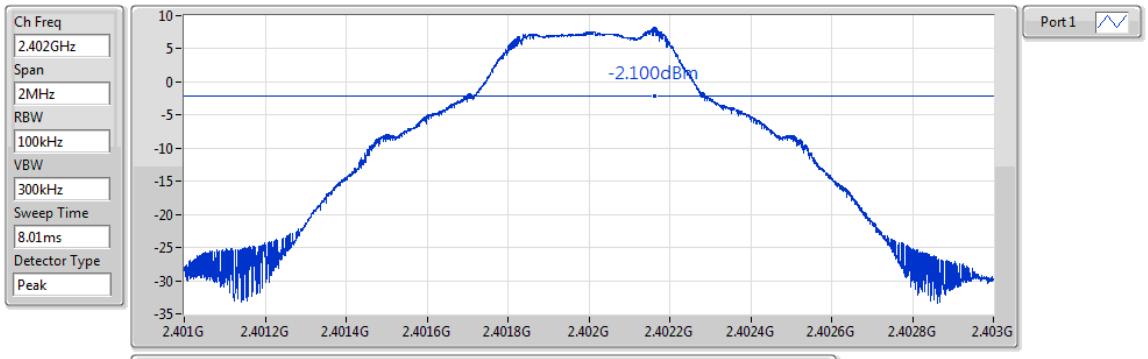
| Mode | Result | Ch (Hz) | Center (Hz) | ppm | Limit (ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.4-2.4835GHz | - | - | - | - | - | - | - |
| BT-BR(1Mbps) | Pass | 2.48G | 2.479982G | -7.107 | ±50 | 1 | - |
| BT-EDR(3Mbps) | Pass | 2.48G | 2.479975G | -10.232 | ±50 | 1 | - |

**Result**

| Mode | Result | Ch (Hz) | Center (Hz) | ppm | Limit (ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| BT-BR(1Mbps) | - | - | - | - | - | - | - |
| 2402MHz_TnomVnom | Pass | 2.402G | 2.401993G | -3.122 | ±50 | 1 | - |
| 2402MHz_TnomVmin | Pass | 2.402G | 2.402001G | 0.572 | ±50 | 1 | - |
| 2402MHz_TnomVmax | Pass | 2.402G | 2.402001G | 0.468 | ±50 | 1 | - |
| 2441MHz_TnomVnom | Pass | 2.441G | 2.440989G | -4.711 | ±50 | 1 | - |
| 2441MHz_TnomVmin | Pass | 2.441G | 2.440989G | -4.711 | ±50 | 1 | - |
| 2441MHz_TnomVmax | Pass | 2.441G | 2.440987G | -5.172 | ±50 | 1 | - |
| 2480MHz_TnomVnom | Pass | 2.48G | 2.479982G | -7.107 | ±50 | 1 | - |
| 2480MHz_TnomVmin | Pass | 2.48G | 2.479987G | -5.343 | ±50 | 1 | - |
| 2480MHz_TnomVmax | Pass | 2.48G | 2.479988G | -4.839 | ±50 | 1 | - |
| BT-EDR(3Mbps) | - | - | - | - | - | - | - |
| 2402MHz_TnomVnom | Pass | 2.402G | 2.401991G | -3.643 | ±50 | 1 | - |
| 2402MHz_TnomVmin | Pass | 2.402G | 2.401992G | -3.174 | ±50 | 1 | - |
| 2402MHz_TnomVmax | Pass | 2.402G | 2.401991G | -3.591 | ±50 | 1 | - |
| 2441MHz_TnomVnom | Pass | 2.441G | 2.440984G | -6.657 | ±50 | 1 | - |
| 2441MHz_TnomVmin | Pass | 2.441G | 2.440983G | -6.913 | ±50 | 1 | - |
| 2441MHz_TnomVmax | Pass | 2.441G | 2.440984G | -6.708 | ±50 | 1 | - |
| 2480MHz_TnomVnom | Pass | 2.48G | 2.479976G | -9.627 | ±50 | 1 | - |
| 2480MHz_TnomVmin | Pass | 2.48G | 2.479975G | -10.232 | ±50 | 1 | - |
| 2480MHz_TnomVmax | Pass | 2.48G | 2.479976G | -9.728 | ±50 | 1 | - |

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

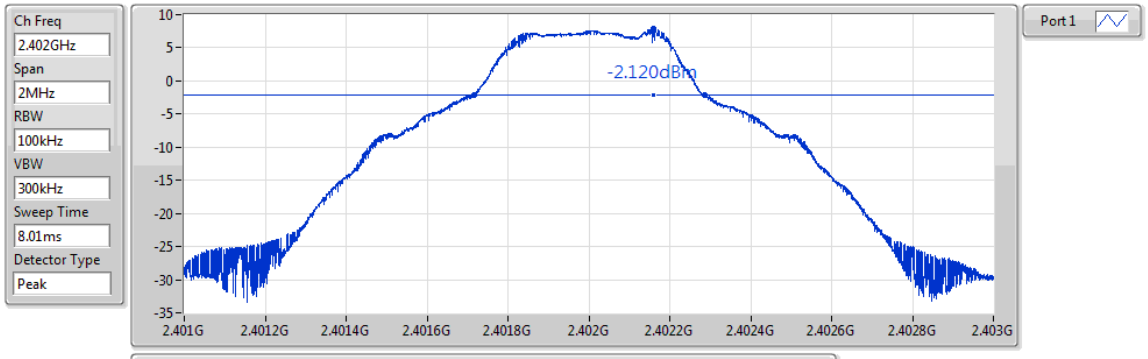
**2402MHz_TnomVnom**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.402G | 2.401993G | 2.401704G | 2.402281G | -3.122 | ±50 | 1 | - |

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

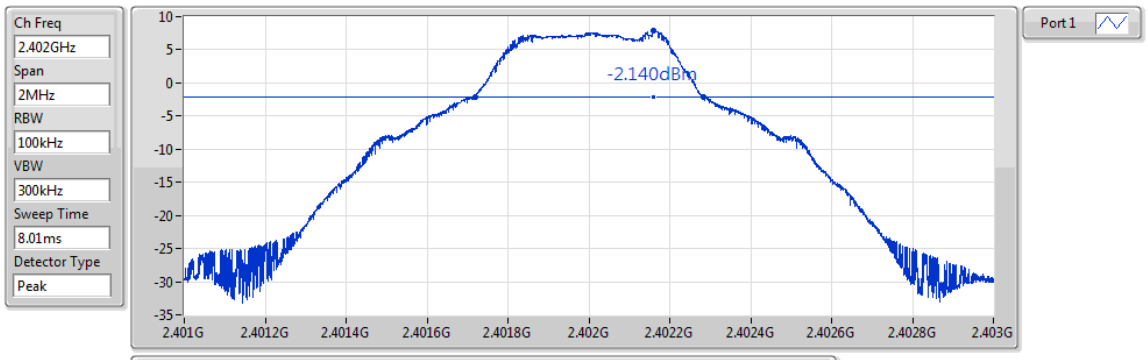
**2402MHz_TnomVmin**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.402G | 2.402001G | 2.401717G | 2.402286G | 0.572 | ±50 | 1 | - |

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

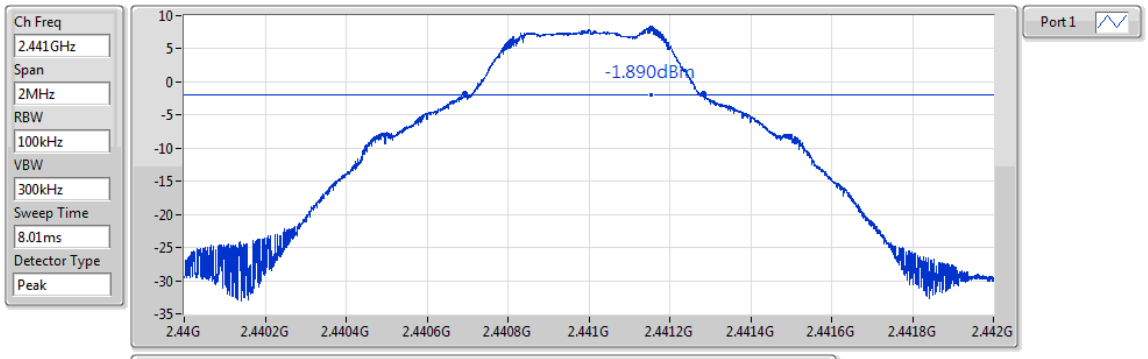
**2402MHz_TnomVmax**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.402G | 2.402001G | 2.401718G | 2.402284G | 0.468 | ±50 | 1 | - |

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

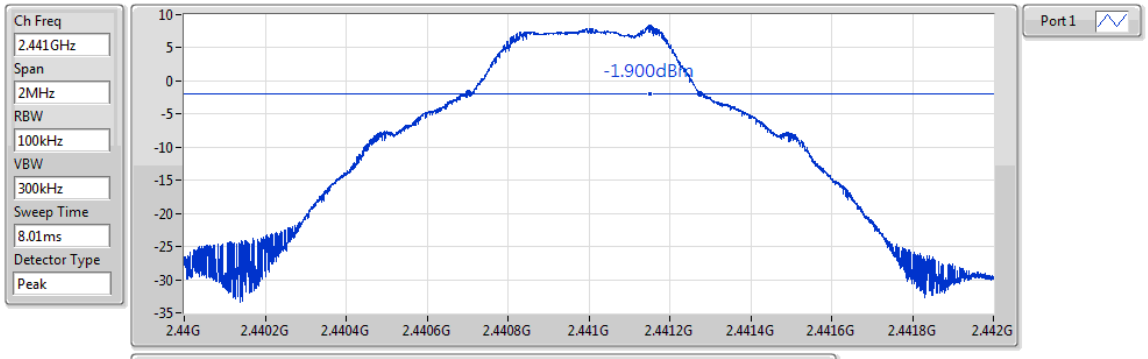
**2441MHz_TnomVnom**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.441G | 2.440989G | 2.440692G | 2.441285G | -4.711 | ±50 | 1 | - |

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

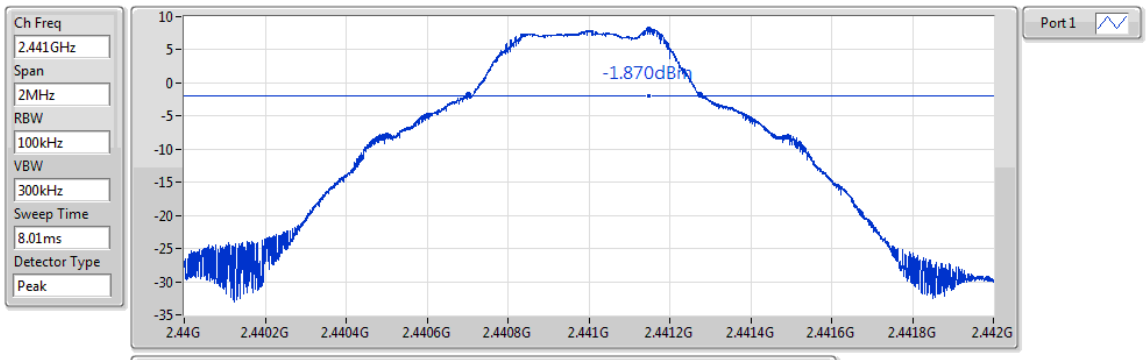
**2441MHz_TnomVmin**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.441G | 2.440989G | 2.440701G | 2.441276G | -4.711 | ±50 | 1 | - |

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

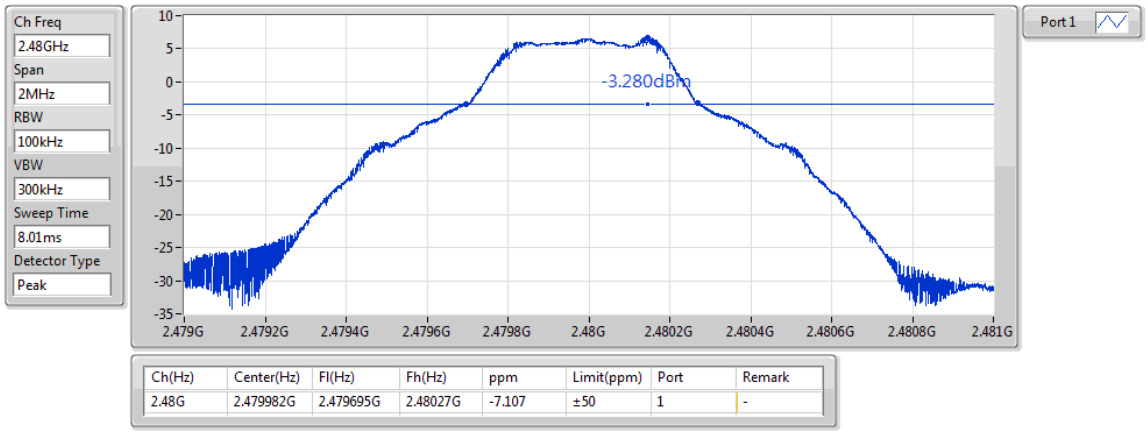
**2441MHz_TnomVmax**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.441G | 2.440987G | 2.440701G | 2.441274G | -5.172 | ±50 | 1 | - |

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

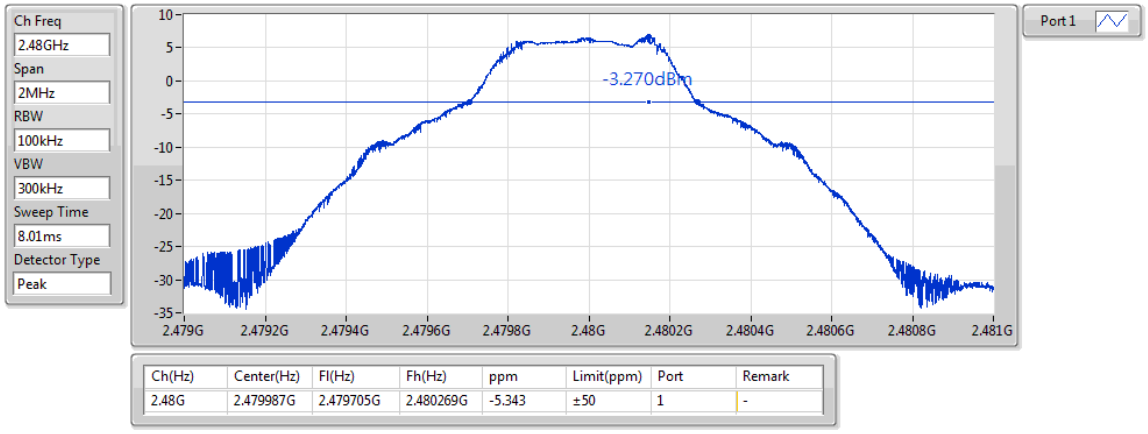
**2480MHz_TnomVnom**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.48G | 2.479982G | 2.479695G | 2.48027G | -7.107 | ±50 | 1 | - |

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

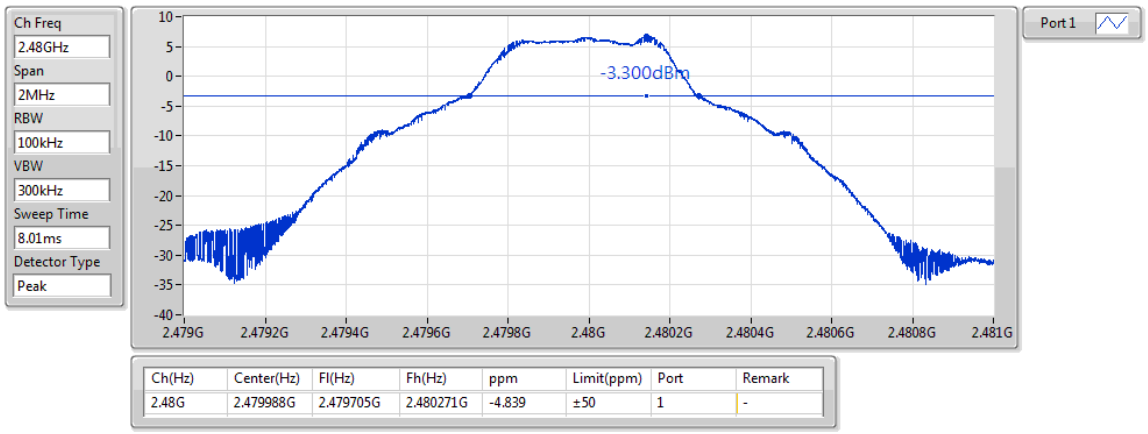
**2480MHz_TnomVmin**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.48G | 2.479987G | 2.479705G | 2.480269G | -5.343 | ±50 | 1 | - |

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

**2480MHz_TnomVmax**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.48G | 2.479988G | 2.479705G | 2.480271G | -4.839 | ±50 | 1 | - |

**BT-EDR(3Mbps)** **Freq. Stability**

**2402MHz_TnomVnom**


| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.402G | 2.401991G | 2.401404G | 2.402578G | -3.643 | ±50 | 1 | - |

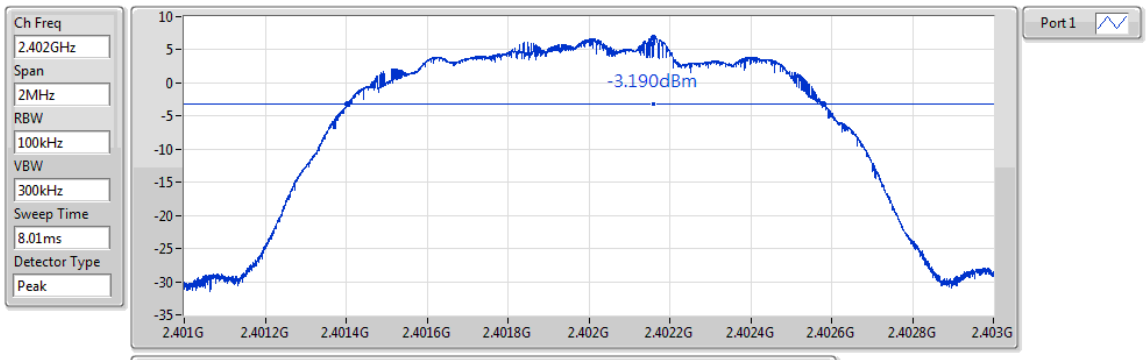
**BT-EDR(3Mbps)** **Freq. Stability**

**2402MHz_TnomVmin**


| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.402G | 2.401992G | 2.401404G | 2.402581G | -3.174 | ±50 | 1 | - |

**BT-EDR(3Mbps)** **Freq. Stability**

**2402MHz_TnomVmax**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.402G | 2.401991G | 2.401403G | 2.40258G | -3.591 | ±50 | 1 | - |

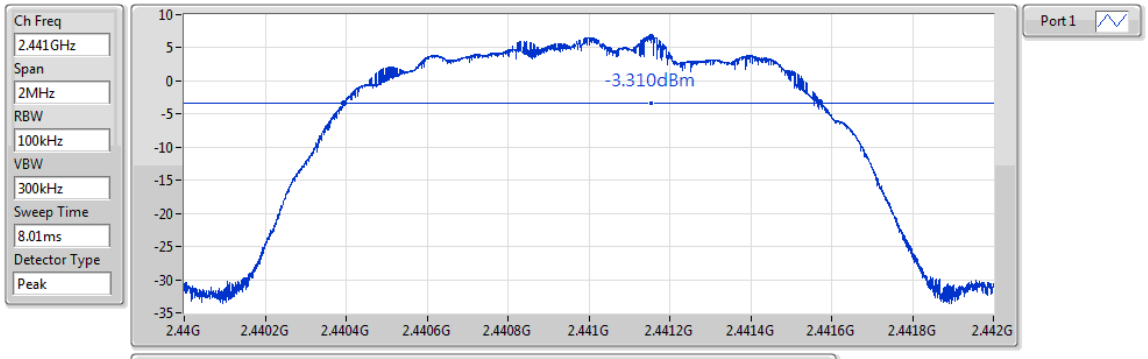
**BT-EDR(3Mbps)** **Freq. Stability**

**2441MHz_TnomVnom**


| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.441G | 2.440984G | 2.440396G | 2.441572G | -6.657 | ±50 | 1 | - |

**BT-EDR(3Mbps)** **Freq. Stability**

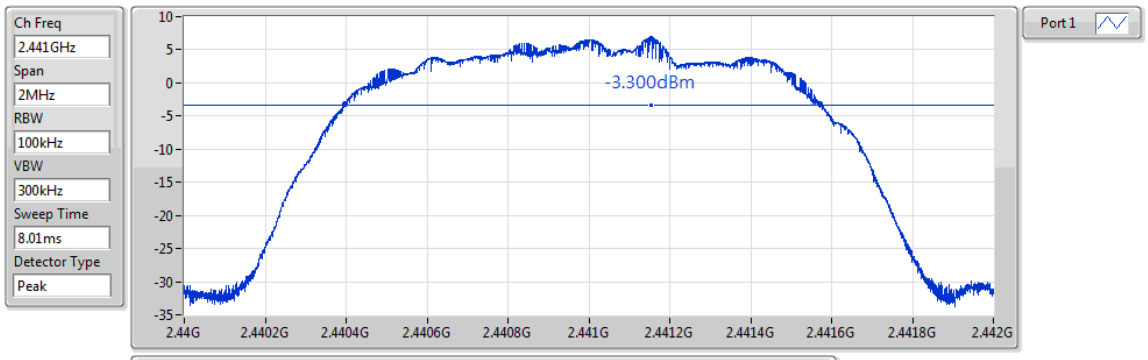
**2441MHz_TnomVmin**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.441G | 2.440983G | 2.440395G | 2.441572G | -6.913 | ±50 | 1 | - |

**BT-EDR(3Mbps)** **Freq. Stability**

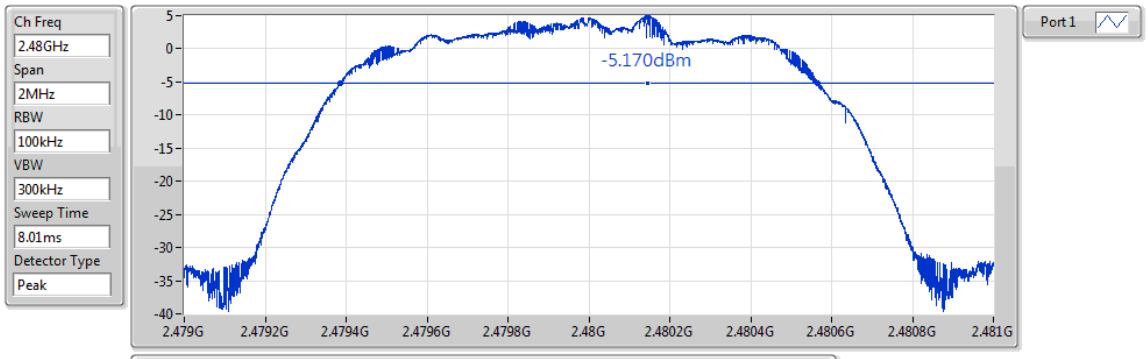
**2441MHz_TnomVmax**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.441G | 2.440984G | 2.440396G | 2.441572G | -6.708 | ±50 | 1 | - |

**BT-EDR(3Mbps)** **Freq. Stability**

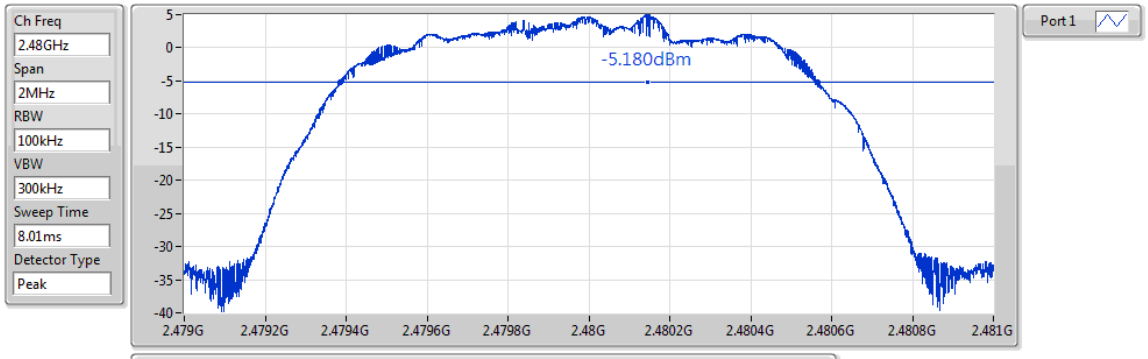
**2480MHz_TnomVnom**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.48G | 2.479976G | 2.479386G | 2.480566G | -9.627 | ±50 | 1 | - |

**BT-EDR(3Mbps)** **Freq. Stability**

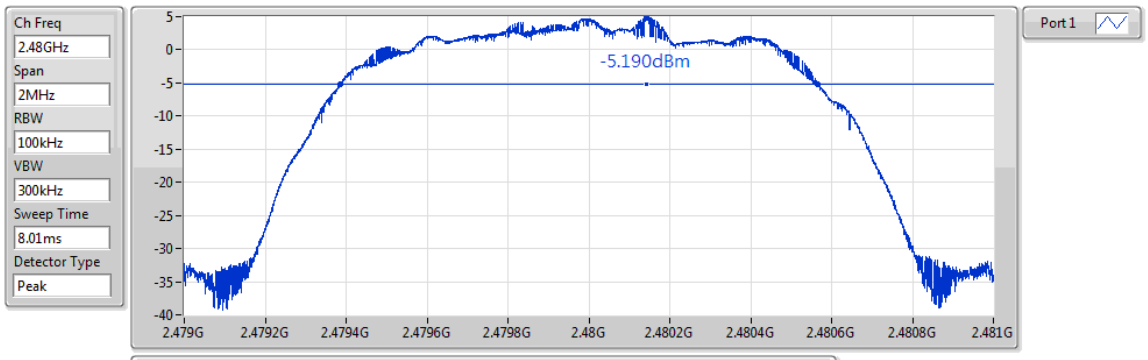
**2480MHz_TnomVmin**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.48G | 2.479975G | 2.479385G | 2.480565G | -10.232 | ±50 | 1 | - |

**BT-EDR(3Mbps)** **Freq. Stability**

**2480MHz_TnomVmax**




| Ch(Hz) | Center(Hz) | Fl(Hz) | Fh(Hz) | ppm | Limit(ppm) | Port | Remark |
|---|---|---|---|---|---|---|---|
| 2.48G | 2.479976G | 2.479386G | 2.480566G | -9.728 | ±50 | 1 | - |

## *Occupied Bandwidth-FHSS Result* Appendix C

### Summary

| Mode | Max-OBW (MHz) | ITU-Code | Min-OBW (MHz) |
|---|---|---|---|
| 2.4-2.4835GHz | - | - | - |
| BT-BR(1Mbps) | 78.561 | 78M6F1D | 78.561 |
| BT-EDR(3Mbps) | 78.661 | 78M7G1D | 78.661 |
| BT-BR-AFH(1Mbps) | 20.49 | 20M5F1D | 20.49 |
| BT-EDR-AFH(3Mbps) | 20.89 | 20M9G1D | 20.89 |

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

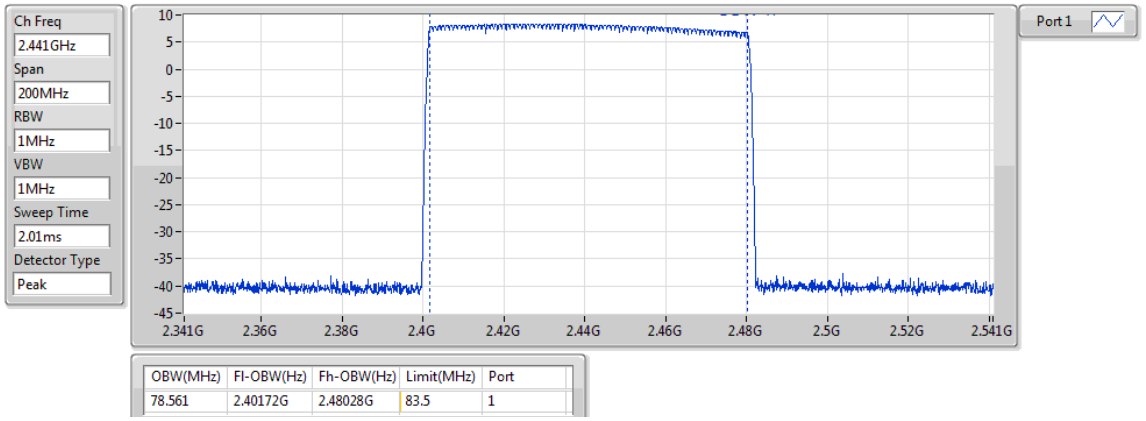
### Result

| Mode | Result | Limit (MHz) | P1-OBW (MHz) |
|---|---|---|---|
| BT-BR(1Mbps) | - | - | - |
| Hopping Mode_TnomVnom | Pass | 83.5 | 78.561 |
| Hopping Mode_TnomVmin | Pass | 83.5 | 78.561 |
| Hopping Mode_TnomVmax | Pass | 83.5 | 78.561 |
| BT-EDR(3Mbps) | - | - | - |
| Hopping Mode_TnomVnom | Pass | 83.5 | 78.661 |
| Hopping Mode_TnomVmin | Pass | 83.5 | 78.661 |
| Hopping Mode_TnomVmax | Pass | 83.5 | 78.661 |
| BT-BR-AFH(1Mbps) | - | - | - |
| Hopping Mode_TnomVnom | Pass | 83.5 | 20.49 |
| Hopping Mode_TnomVmin | Pass | 83.5 | 20.49 |
| Hopping Mode_TnomVmax | Pass | 83.5 | 20.49 |
| BT-EDR-AFH(3Mbps) | - | - | - |
| Hopping Mode_TnomVnom | Pass | 83.5 | 20.89 |
| Hopping Mode_TnomVmin | Pass | 83.5 | 20.89 |
| Hopping Mode_TnomVmax | Pass | 83.5 | 20.89 |

**P1-OBW** = Port 1 99% occupied bandwidth;

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

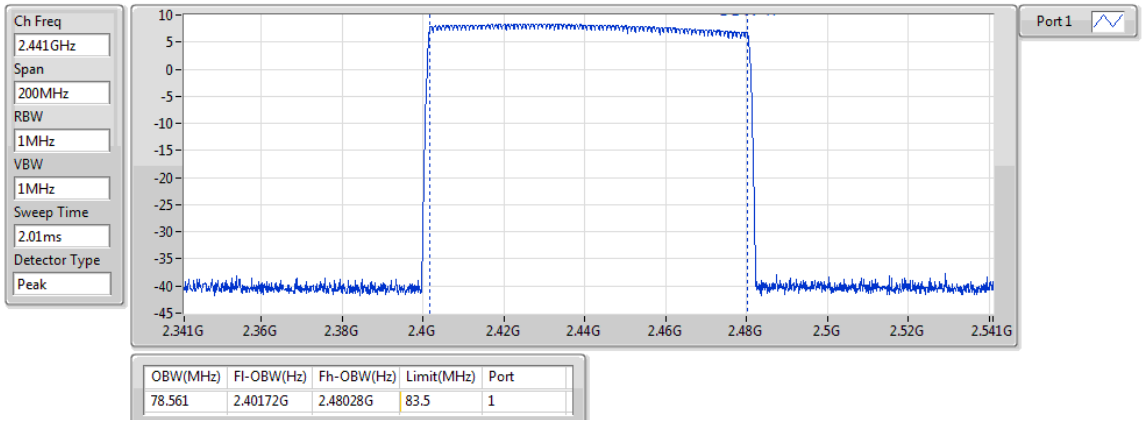
**Hopping Mode_TnomVnom**




| OBW(MHz) | Fl-OBW(Hz) | Fh-OBW(Hz) | Limit(MHz) | Port |
|---|---|---|---|---|
| 78.561 | 2.40172G | 2.48028G | 83.5 | 1 |

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

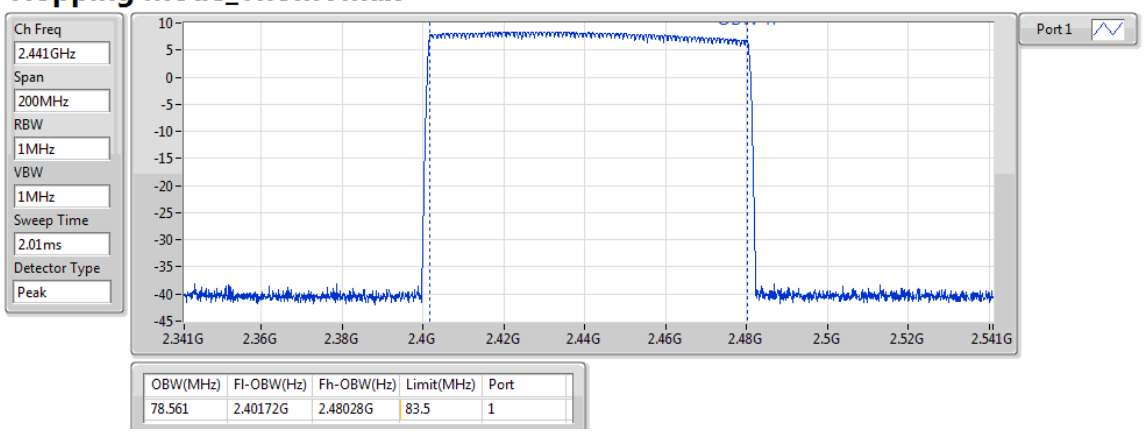
**Hopping Mode_TnomVmin**




| OBW(MHz) | Fl-OBW(Hz) | Fh-OBW(Hz) | Limit(MHz) | Port |
|---|---|---|---|---|
| 78.561 | 2.40172G | 2.48028G | 83.5 | 1 |

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

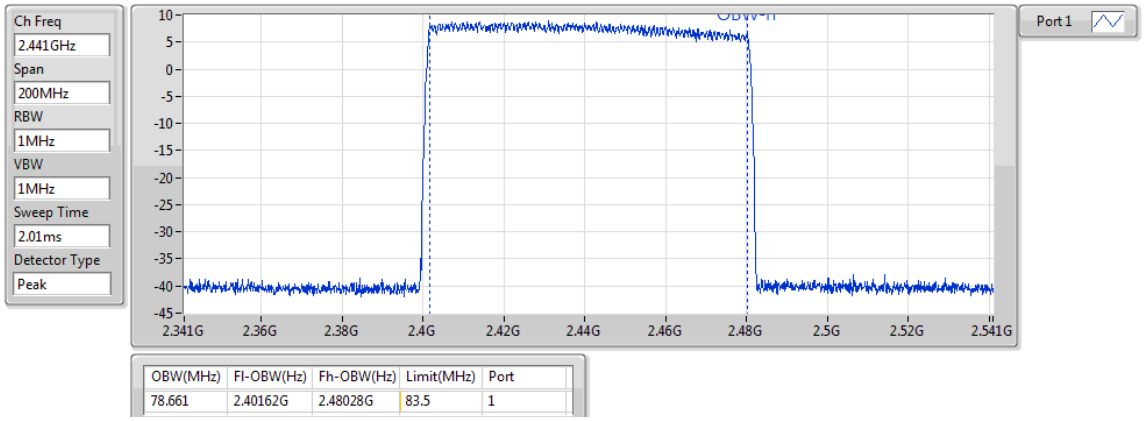
**Hopping Mode_TnomVmax**




| OBW(MHz) | Fl-OBW(Hz) | Fh-OBW(Hz) | Limit(MHz) | Port |
|---|---|---|---|---|
| 78.561 | 2.40172G | 2.48028G | 83.5 | 1 |

**BT-EDR(3Mbps)** **OBW**

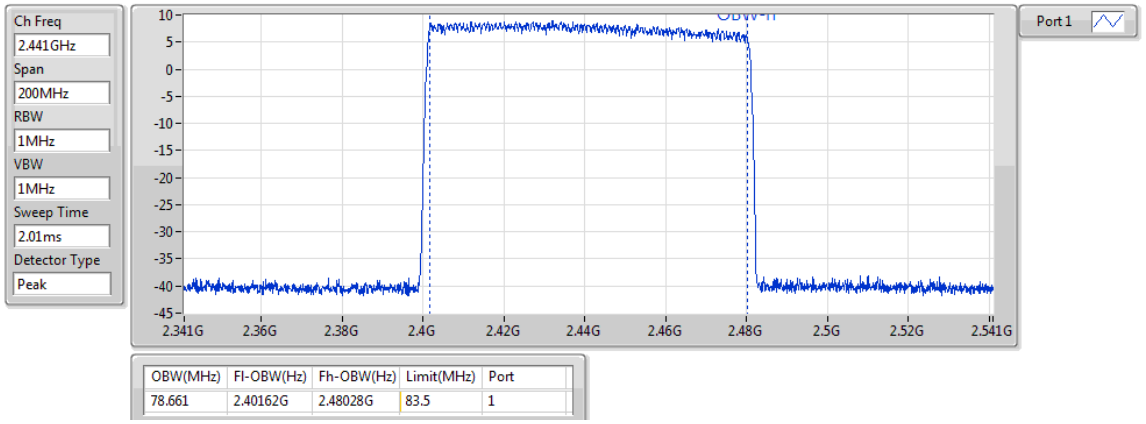
**Hopping Mode_TnomVnom**




| OBW(MHz) | Fl-OBW(Hz) | Fh-OBW(Hz) | Limit(MHz) | Port |
|---|---|---|---|---|
| 78.661 | 2.40162G | 2.48028G | 83.5 | 1 |

**BT-EDR(3Mbps)** **OBW**

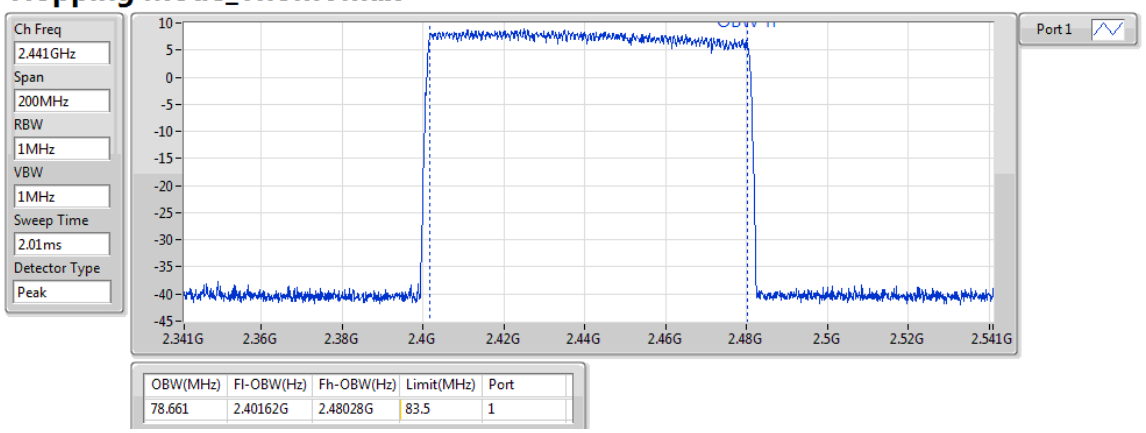
**Hopping Mode_TnomVmin**




| OBW(MHz) | Fl-OBW(Hz) | Fh-OBW(Hz) | Limit(MHz) | Port |
|---|---|---|---|---|
| 78.661 | 2.40162G | 2.48028G | 83.5 | 1 |

**BT-EDR(3Mbps)** **OBW**

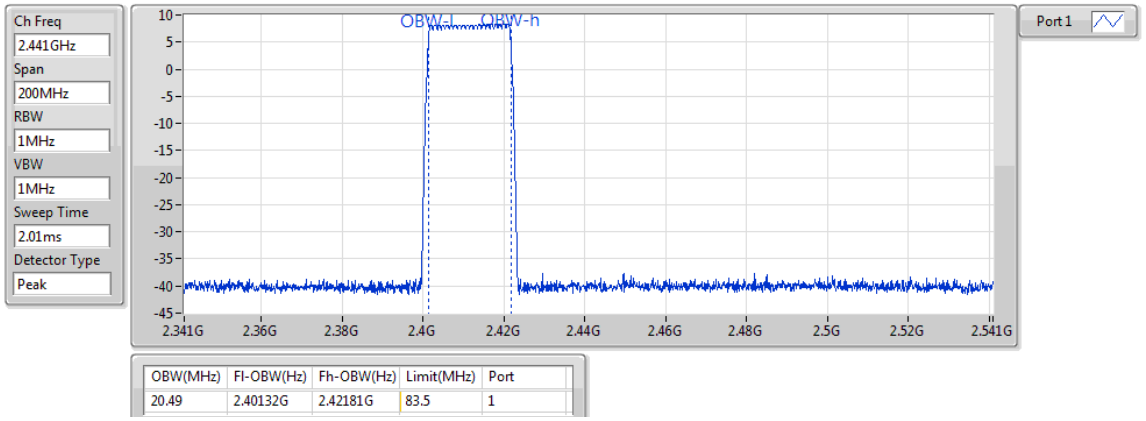
**Hopping Mode_TnomVmax**




| OBW(MHz) | Fl-OBW(Hz) | Fh-OBW(Hz) | Limit(MHz) | Port |
|---|---|---|---|---|
| 78.661 | 2.40162G | 2.48028G | 83.5 | 1 |

**BT-BR-AFH(1Mbps)** **OBW**

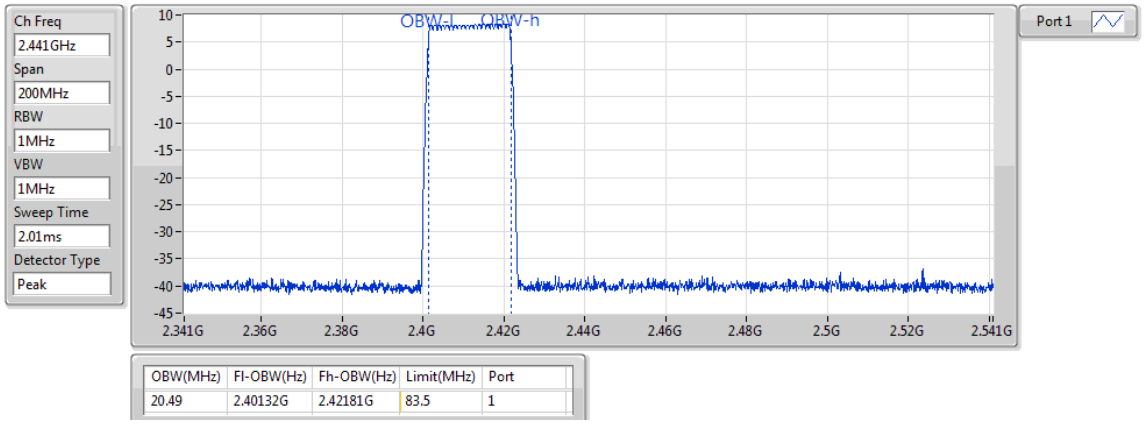
**Hopping Mode_TnomVnom**




| OBW(MHz) | Fl-OBW(Hz) | Fh-OBW(Hz) | Limit(MHz) | Port |
|---|---|---|---|---|
| 20.49 | 2.40132G | 2.42181G | 83.5 | 1 |

**BT-BR-AFH(1Mbps)** **OBW**

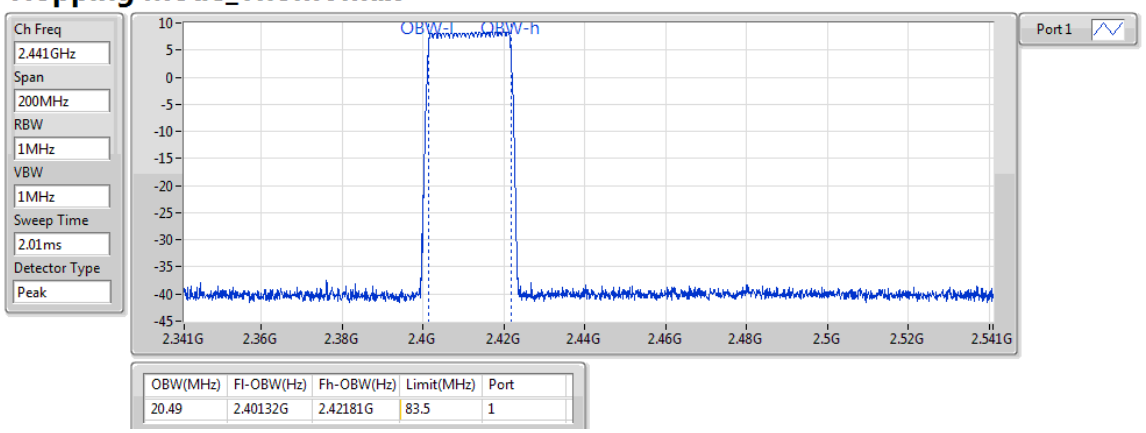
**Hopping Mode_TnomVmin**




| OBW(MHz) | Fl-OBW(Hz) | Fh-OBW(Hz) | Limit(MHz) | Port |
|---|---|---|---|---|
| 20.49 | 2.40132G | 2.42181G | 83.5 | 1 |

**BT-BR-AFH(1Mbps)** **OBW**

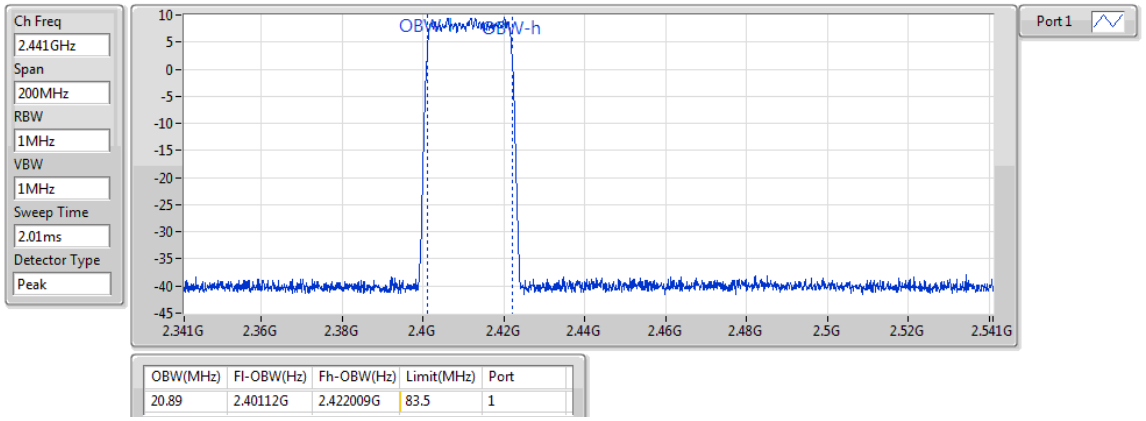
**Hopping Mode_TnomVmax**




| OBW(MHz) | Fl-OBW(Hz) | Fh-OBW(Hz) | Limit(MHz) | Port |
|---|---|---|---|---|
| 20.49 | 2.40132G | 2.42181G | 83.5 | 1 |

**BT-EDR-AFH(3Mbps)** **OBW**

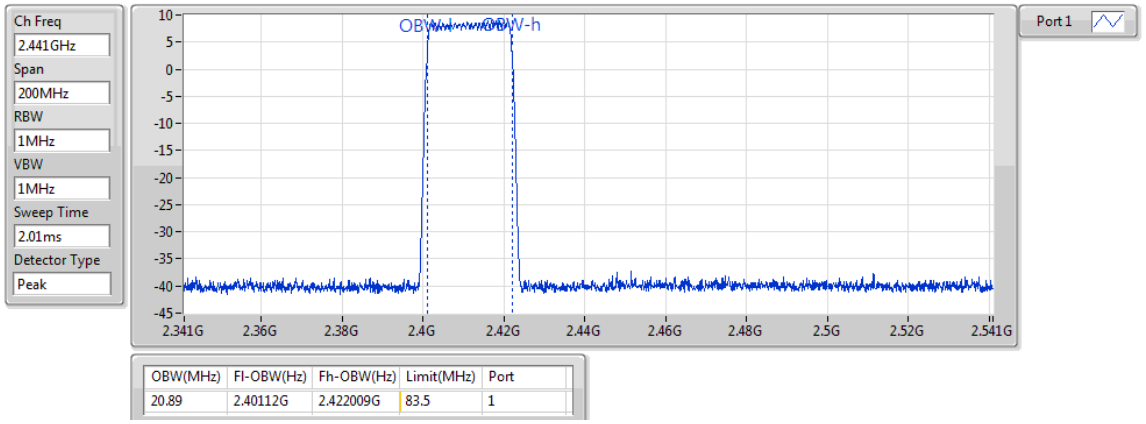
**Hopping Mode_TnomVnom**




| OBW(MHz) | Fl-OBW(Hz) | Fh-OBW(Hz) | Limit(MHz) | Port |
|---|---|---|---|---|
| 20.89 | 2.40112G | 2.422009G | 83.5 | 1 |

**BT-EDR-AFH(3Mbps)** **OBW**

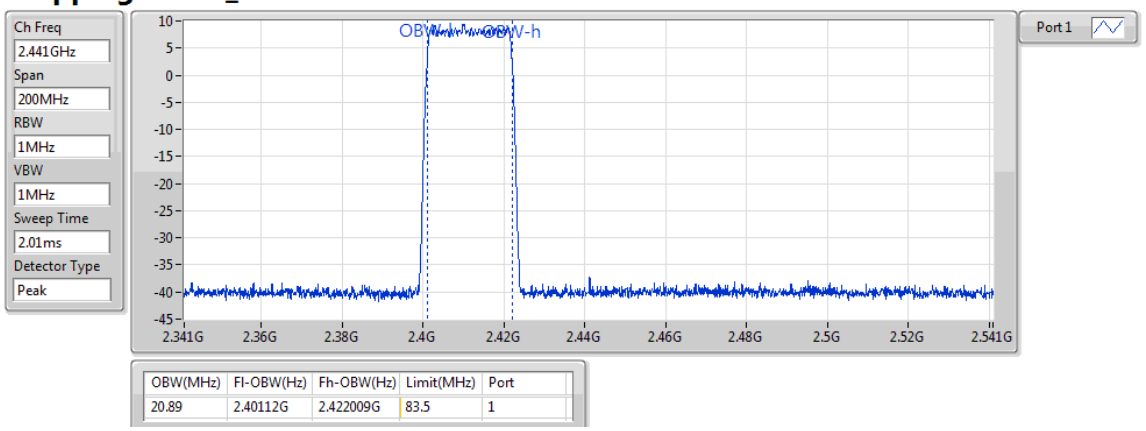
**Hopping Mode_TnomVmin**




| OBW(MHz) | Fl-OBW(Hz) | Fh-OBW(Hz) | Limit(MHz) | Port |
|---|---|---|---|---|
| 20.89 | 2.40112G | 2.422009G | 83.5 | 1 |

**BT-EDR-AFH(3Mbps)** **OBW**

**Hopping Mode_TnomVmax**




| OBW(MHz) | Fl-OBW(Hz) | Fh-OBW(Hz) | Limit(MHz) | Port |
|---|---|---|---|---|
| 20.89 | 2.40112G | 2.422009G | 83.5 | 1 |

**Summary**

| Mode | Max-SBW (MHz) | Min-SBW (MHz) | Max-SF | Min-SF |
|---|---|---|---|---|
| 2.4-2.4835GHz | - | - | - | - |
| BT-BR(1Mbps) | 70.565 | 70.565 | 70.565 | 70.565 |
| BT-EDR(3Mbps) | 70.665 | 70.465 | 70.665 | 70.465 |
| BT-BR-AFH(1Mbps) | 18.591 | 18.591 | 18.591 | 18.591 |
| BT-EDR-AFH(3Mbps) | 18.791 | 18.691 | 18.791 | 18.691 |

**Max-SBW** = Maximum spreading bandwidth; **Min-SBW** = Minimum spreading bandwidth;
**Max-SF** = Maximum spreading factor; **Min-SF** = Minimum spreading factor;

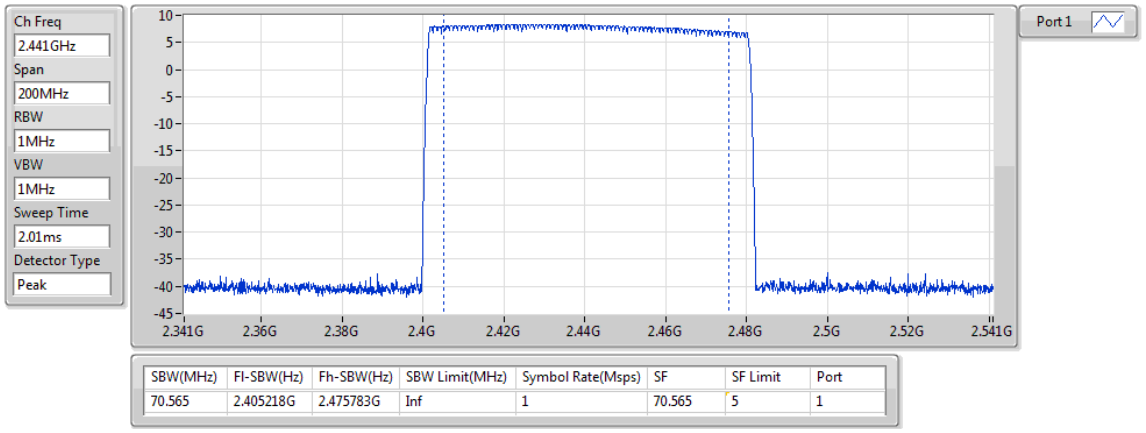
**Result**

| Mode | Result | Symbol Rate (Msps) | SF Limit | P1-SBW (MHz) | P1-SF |
|---|---|---|---|---|---|
| BT-BR(1Mbps) | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 1 | 5 | 70.565 | 70.565 |
| Hopping Mode_TnomVmin | Pass | 1 | 5 | 70.565 | 70.565 |
| Hopping Mode_TnomVmax | Pass | 1 | 5 | 70.565 | 70.565 |
| BT-EDR(3Mbps) | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 1 | 5 | 70.465 | 70.465 |
| Hopping Mode_TnomVmin | Pass | 1 | 5 | 70.665 | 70.665 |
| Hopping Mode_TnomVmax | Pass | 1 | 5 | 70.465 | 70.465 |
| BT-BR-AFH(1Mbps) | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 1 | 5 | 18.591 | 18.591 |
| Hopping Mode_TnomVmin | Pass | 1 | 5 | 18.591 | 18.591 |
| Hopping Mode_TnomVmax | Pass | 1 | 5 | 18.591 | 18.591 |
| BT-EDR-AFH(3Mbps) | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 1 | 5 | 18.691 | 18.691 |
| Hopping Mode_TnomVmin | Pass | 1 | 5 | 18.691 | 18.691 |
| Hopping Mode_TnomVmax | Pass | 1 | 5 | 18.791 | 18.791 |

**P1-SBW** = Port 1 spreading bandwidth;**P1-SF** = Port 1 spreading factor;

**BT-BR(1Mbps)** **SBW**

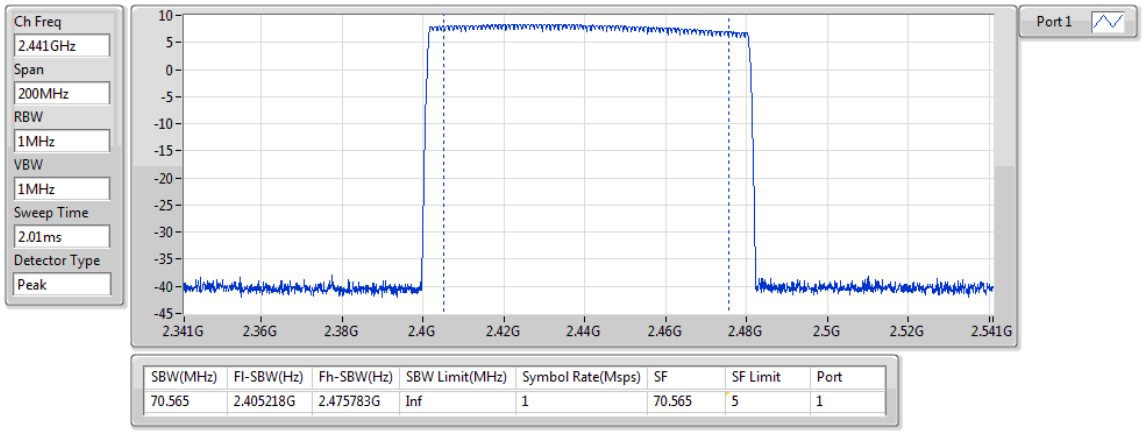
**Hopping Mode_TnomVnom**




| SBW(MHz) | FI-SBW(Hz) | Fh-SBW(Hz) | SBW Limit(MHz) | Symbol Rate(Msps) | SF | SF Limit | Port |
|---|---|---|---|---|---|---|---|
| 70.565 | 2.405218G | 2.475783G | Inf | 1 | 70.565 | 5 | 1 |

**BT-BR(1Mbps)** **SBW**

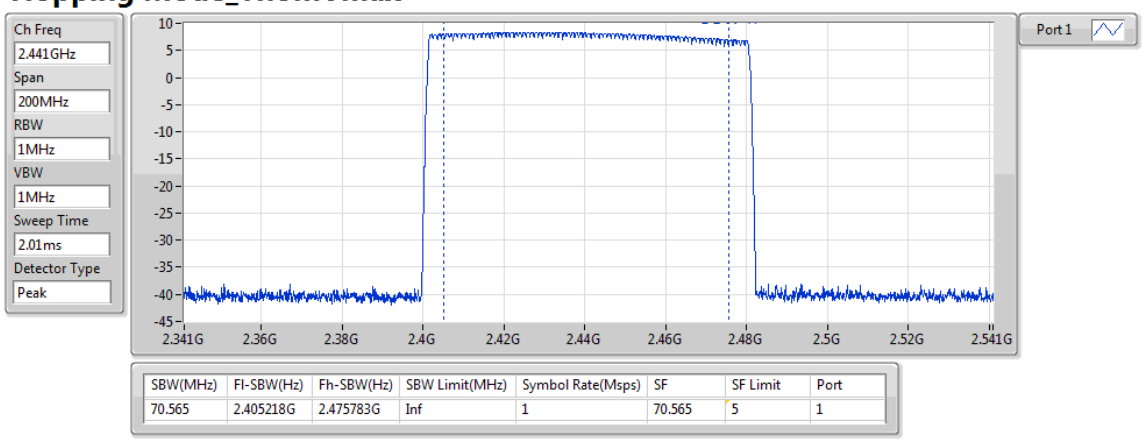
**Hopping Mode_TnomVmin**




| SBW(MHz) | FI-SBW(Hz) | Fh-SBW(Hz) | SBW Limit(MHz) | Symbol Rate(Msps) | SF | SF Limit | Port |
|---|---|---|---|---|---|---|---|
| 70.565 | 2.405218G | 2.475783G | Inf | 1 | 70.565 | 5 | 1 |

**BT-BR(1Mbps)** **SBW**

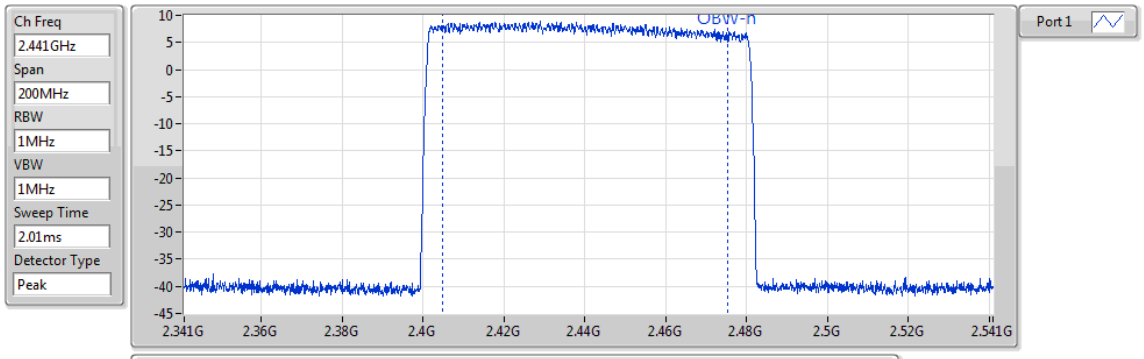
**Hopping Mode_TnomVmax**




| SBW(MHz) | FI-SBW(Hz) | Fh-SBW(Hz) | SBW Limit(MHz) | Symbol Rate(Msps) | SF | SF Limit | Port |
|---|---|---|---|---|---|---|---|
| 70.565 | 2.405218G | 2.475783G | Inf | 1 | 70.565 | 5 | 1 |

**BT-EDR(3Mbps)** **SBW**

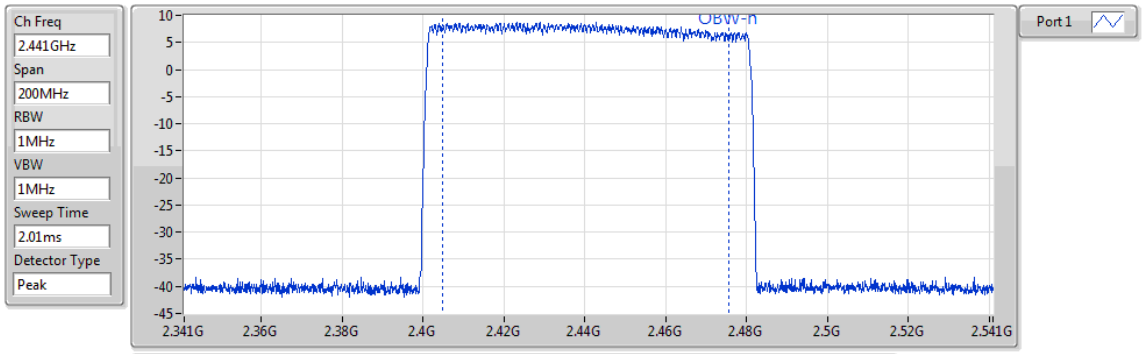
**Hopping Mode_TnomVnom**




| SBW(MHz) | FI-SBW(Hz) | Fh-SBW(Hz) | SBW Limit(MHz) | Symbol Rate(Msps) | SF | SF Limit | Port |
|---|---|---|---|---|---|---|---|
| 70.465 | 2.405018G | 2.475483G | Inf | 1 | 70.465 | 5 | 1 |

**BT-EDR(3Mbps)** **SBW**

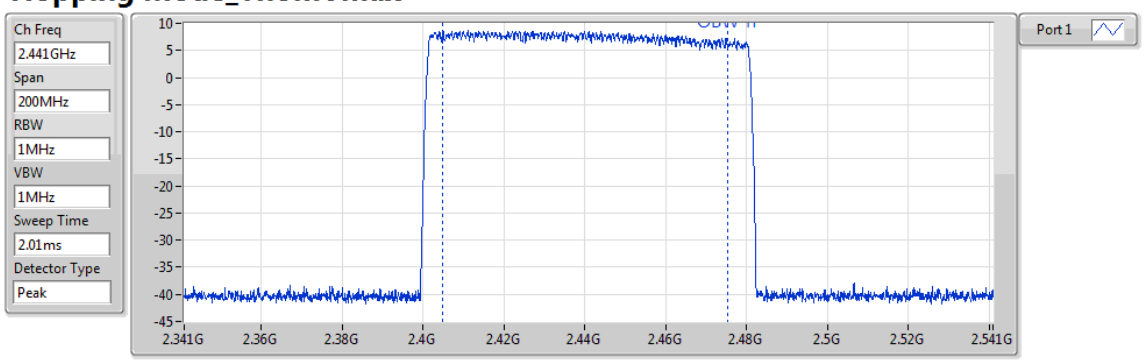
**Hopping Mode_TnomVmin**




| SBW(MHz) | FI-SBW(Hz) | Fh-SBW(Hz) | SBW Limit(MHz) | Symbol Rate(Msps) | SF | SF Limit | Port |
|---|---|---|---|---|---|---|---|
| 70.665 | 2.404918G | 2.475583G | Inf | 1 | 70.665 | 5 | 1 |

**BT-EDR(3Mbps)** **SBW**

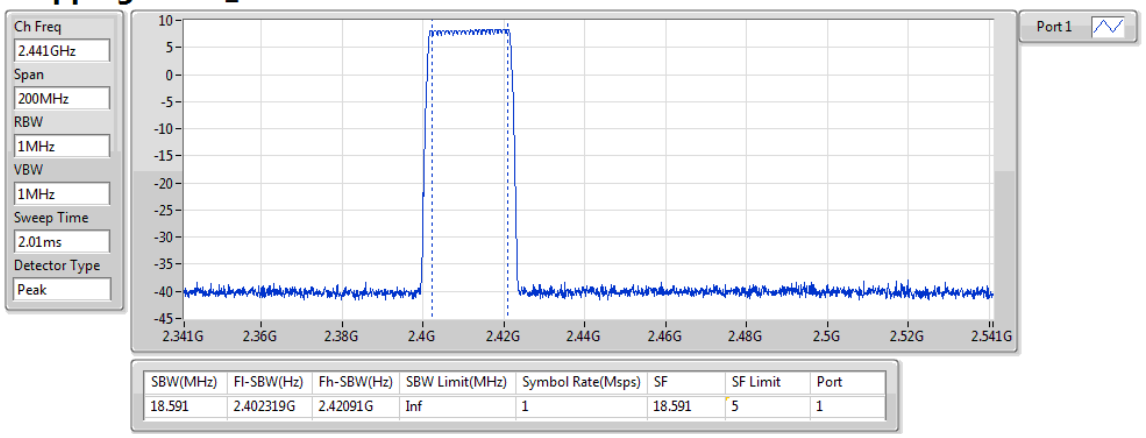
**Hopping Mode_TnomVmax**




| SBW(MHz) | FI-SBW(Hz) | Fh-SBW(Hz) | SBW Limit(MHz) | Symbol Rate(Msps) | SF | SF Limit | Port |
|---|---|---|---|---|---|---|---|
| 70.465 | 2.404918G | 2.475383G | Inf | 1 | 70.465 | 5 | 1 |

**BT-BR-AFH(1Mbps)** **SBW**

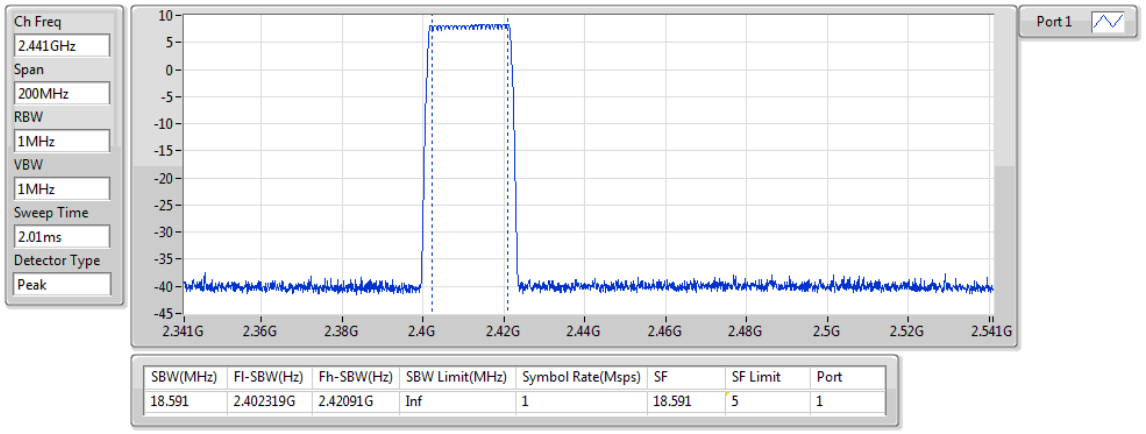
**Hopping Mode_TnomVnom**




| SBW(MHz) | FI-SBW(Hz) | Fh-SBW(Hz) | SBW Limit(MHz) | Symbol Rate(Msps) | SF | SF Limit | Port |
|---|---|---|---|---|---|---|---|
| 18.591 | 2.402319G | 2.42091G | Inf | 1 | 18.591 | 5 | 1 |

**BT-BR-AFH(1Mbps)** **SBW**

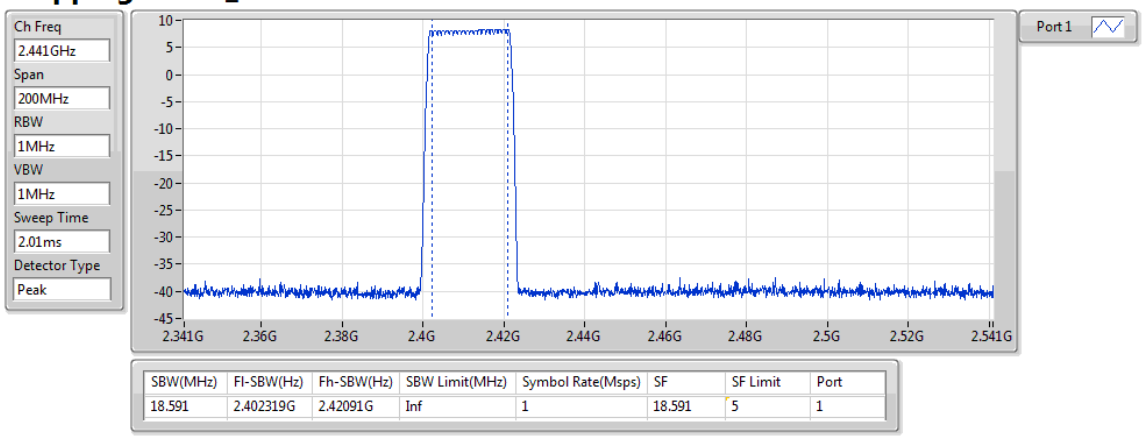
**Hopping Mode_TnomVmin**




| SBW(MHz) | FI-SBW(Hz) | Fh-SBW(Hz) | SBW Limit(MHz) | Symbol Rate(Msps) | SF | SF Limit | Port |
|---|---|---|---|---|---|---|---|
| 18.591 | 2.402319G | 2.42091G | Inf | 1 | 18.591 | 5 | 1 |

**BT-BR-AFH(1Mbps)** **SBW**

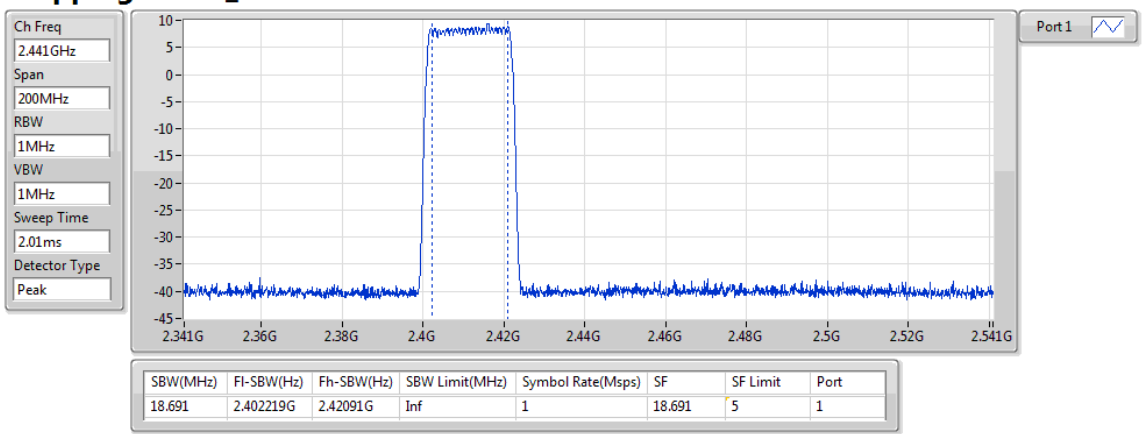
**Hopping Mode_TnomVmax**




| SBW(MHz) | FI-SBW(Hz) | Fh-SBW(Hz) | SBW Limit(MHz) | Symbol Rate(Msps) | SF | SF Limit | Port |
|---|---|---|---|---|---|---|---|
| 18.591 | 2.402319G | 2.42091G | Inf | 1 | 18.591 | 5 | 1 |

**BT-EDR-AFH(3Mbps)** **SBW**

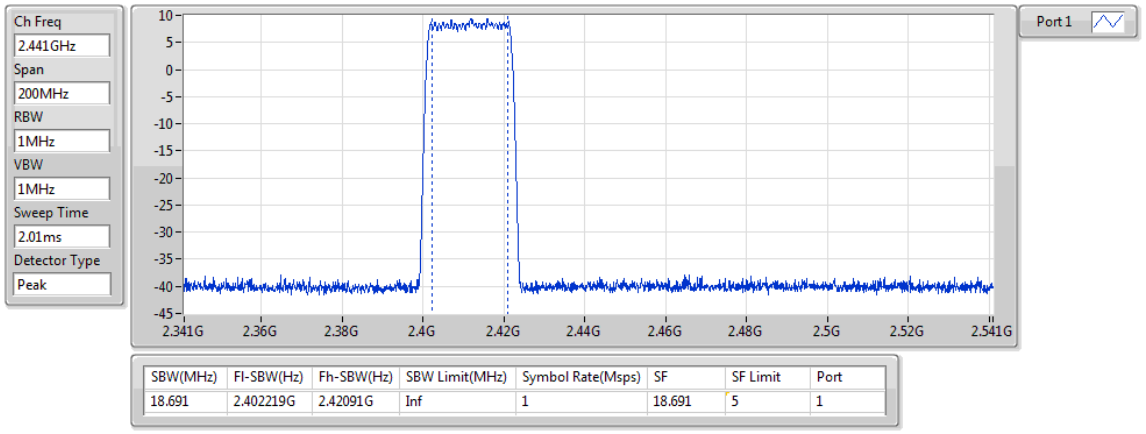
**Hopping Mode_TnomVnom**




| SBW(MHz) | FI-SBW(Hz) | Fh-SBW(Hz) | SBW Limit(MHz) | Symbol Rate(Msps) | SF | SF Limit | Port |
|---|---|---|---|---|---|---|---|
| 18.691 | 2.402219G | 2.42091G | Inf | 1 | 18.691 | 5 | 1 |

**BT-EDR-AFH(3Mbps)** **SBW**

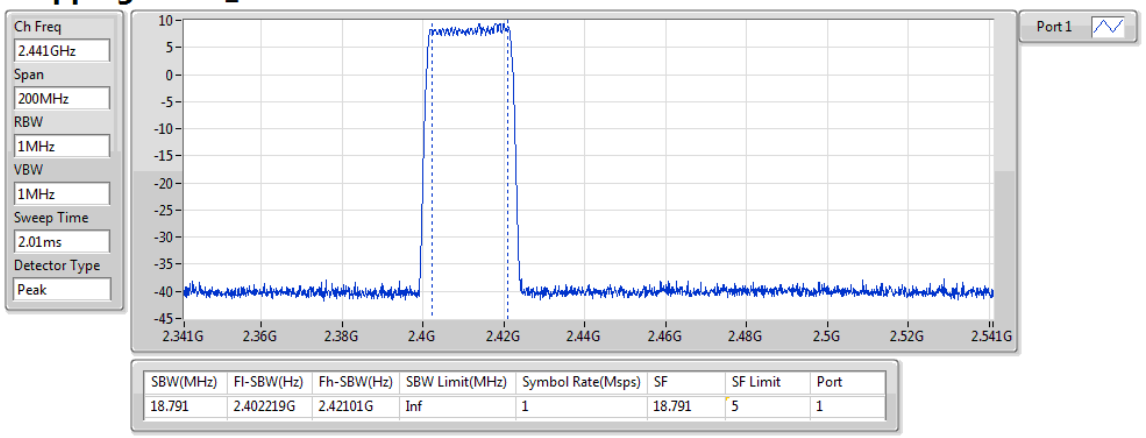
**Hopping Mode_TnomVmin**




| SBW(MHz) | FI-SBW(Hz) | Fh-SBW(Hz) | SBW Limit(MHz) | Symbol Rate(Msps) | SF | SF Limit | Port |
|---|---|---|---|---|---|---|---|
| 18.691 | 2.402219G | 2.42091G | Inf | 1 | 18.691 | 5 | 1 |

**BT-EDR-AFH(3Mbps)** **SBW**

**Hopping Mode_TnomVmax**




| SBW(MHz) | FI-SBW(Hz) | Fh-SBW(Hz) | SBW Limit(MHz) | Symbol Rate(Msps) | SF | SF Limit | Port |
|---|---|---|---|---|---|---|---|
| 18.791 | 2.402219G | 2.42101G | Inf | 1 | 18.791 | 5 | 1 |

**Summary**

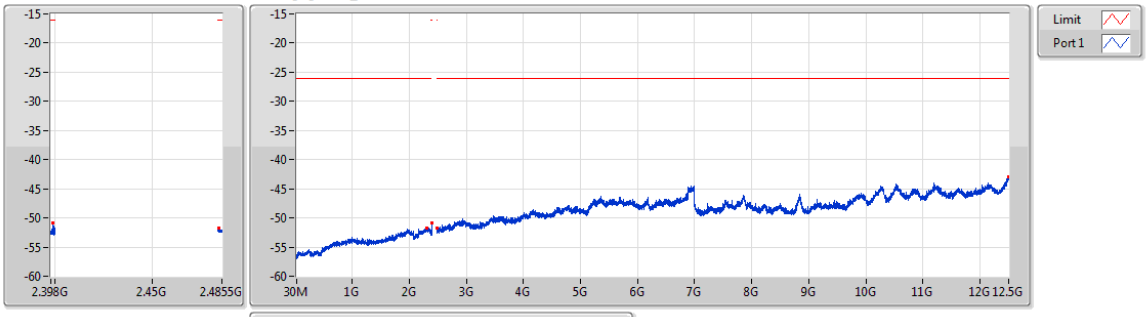
| Mode | Result | F-Start (Hz) | F-Stop (Hz) | RBW (Hz) | Freq (MHz) | Psum (dBm) | Psum (uW/MHz) | Limit (dBm) | Limit (uW/MHz) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.4-2.4835GHz | - | - | - | - | - | - | - | - | - | - |
| BT-BR(1Mbps) | Pass | 2.4965G | 12.5G | 1M | 12498.75 | -42.90 | 0.05129 | -26.02 | 2.5 | -16.88 |
| BT-EDR(3Mbps) | Pass | 2.387G | 2.4G | 1M | 2399.948 | -27.17 | 1.91867 | -16.02 | 25 | -11.15 |

**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-BR(1Mbps) | - | - | - | - | - | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 30M | 2.387G | 1M | 2302.148 | -51.67 | 0.00681 | -26.02 | 2.5 | -25.65 |
| Hopping Mode_TnomVnom | Pass | 2.387G | 2.4G | 1M | 2399.272 | -50.82 | 0.00828 | -16.02 | 25 | -34.80 |
| Hopping Mode_TnomVnom | Pass | 2.4835G | 2.4965G | 1M | 2483.708 | -51.73 | 0.00671 | -16.02 | 25 | -35.71 |
| Hopping Mode_TnomVnom | Pass | 2.4965G | 12.5G | 1M | 12498.75 | -42.90 | 0.05129 | -26.02 | 2.5 | -16.88 |
| Hopping Mode_TnomVmin | Pass | 30M | 2.387G | 1M | 2282.113 | -51.68 | 0.00679 | -26.02 | 2.5 | -25.66 |
| Hopping Mode_TnomVmin | Pass | 2.387G | 2.4G | 1M | 2399.792 | -40.24 | 0.09462 | -16.02 | 25 | -24.22 |
| Hopping Mode_TnomVmin | Pass | 2.4835G | 2.4965G | 1M | 2484.67 | -52.01 | 0.0063 | -16.02 | 25 | -35.99 |
| Hopping Mode_TnomVmin | Pass | 2.4965G | 12.5G | 1M | 12500 | -43.05 | 0.04955 | -26.02 | 2.5 | -17.03 |
| Hopping Mode_TnomVmax | Pass | 30M | 2.387G | 1M | 2298.613 | -51.24 | 0.00752 | -26.02 | 2.5 | -25.22 |
| Hopping Mode_TnomVmax | Pass | 2.387G | 2.4G | 1M | 2399.74 | -42.27 | 0.05929 | -16.02 | 25 | -26.25 |
| Hopping Mode_TnomVmax | Pass | 2.4835G | 2.4965G | 1M | 2483.63 | -51.85 | 0.00653 | -16.02 | 25 | -35.83 |
| Hopping Mode_TnomVmax | Pass | 2.4965G | 12.5G | 1M | 12497.499 | -43.01 | 0.05 | -26.02 | 2.5 | -16.99 |
| BT-EDR(3Mbps) | - | - | - | - | - | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 30M | 2.387G | 1M | 2312.755 | -51.71 | 0.00675 | -26.02 | 2.5 | -25.69 |
| Hopping Mode_TnomVnom | Pass | 2.387G | 2.4G | 1M | 2399.896 | -28.92 | 1.28233 | -16.02 | 25 | -12.90 |
| Hopping Mode_TnomVnom | Pass | 2.4835G | 2.4965G | 1M | 2483.604 | -51.91 | 0.00644 | -16.02 | 25 | -35.89 |
| Hopping Mode_TnomVnom | Pass | 2.4965G | 12.5G | 1M | 12489.996 | -42.79 | 0.0526 | -26.02 | 2.5 | -16.77 |
| Hopping Mode_TnomVmin | Pass | 30M | 2.387G | 1M | 2312.755 | -51.55 | 0.007 | -26.02 | 2.5 | -25.53 |
| Hopping Mode_TnomVmin | Pass | 2.387G | 2.4G | 1M | 2398.96 | -50.06 | 0.00986 | -16.02 | 25 | -34.04 |
| Hopping Mode_TnomVmin | Pass | 2.4835G | 2.4965G | 1M | 2483.89 | -51.94 | 0.0064 | -16.02 | 25 | -35.92 |
| Hopping Mode_TnomVmin | Pass | 2.4965G | 12.5G | 1M | 12493.748 | -42.93 | 0.05093 | -26.02 | 2.5 | -16.91 |
| Hopping Mode_TnomVmax | Pass | 30M | 2.387G | 1M | 2338.682 | -51.66 | 0.00682 | -26.02 | 2.5 | -25.64 |
| Hopping Mode_TnomVmax | Pass | 2.387G | 2.4G | 1M | 2399.948 | -27.17 | 1.91867 | -16.02 | 25 | -11.15 |
| Hopping Mode_TnomVmax | Pass | 2.4835G | 2.4965G | 1M | 2484.306 | -51.99 | 0.00632 | -16.02 | 25 | -35.97 |
| Hopping Mode_TnomVmax | Pass | 2.4965G | 12.5G | 1M | 12492.497 | -42.71 | 0.05358 | -26.02 | 2.5 | -16.69 |

**BT-BR(1Mbps)** **CSE-TX-FS**

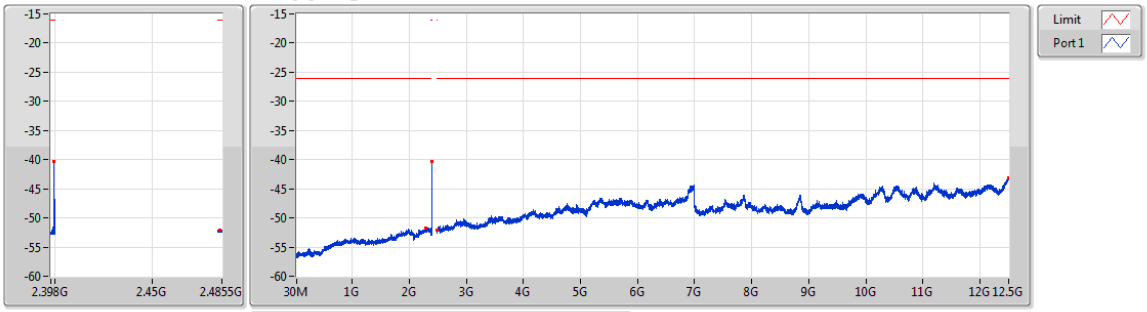
**Hopping Mode_TnomVnom**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 2302.148 | -51.67 | -26.02 | -25.65 | -51.67 |
| 2399.272 | -50.82 | -16.02 | -34.80 | -50.82 |
| 2483.708 | -51.73 | -16.02 | -35.71 | -51.73 |
| 12498.75 | -42.90 | -26.02 | -16.88 | -42.90 |

**BT-BR(1Mbps)** **CSE-TX-FS**

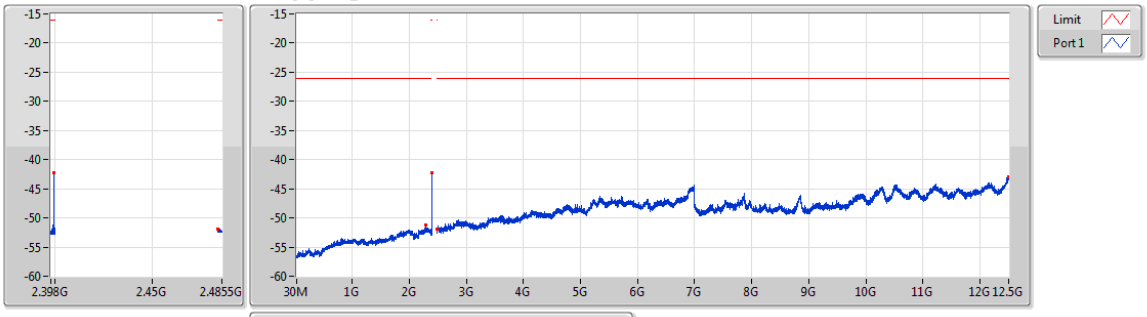
**Hopping Mode_TnomVmin**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 2282.113 | -51.68 | -26.02 | -25.66 | -51.68 |
| 2399.792 | -40.24 | -16.02 | -24.22 | -40.24 |
| 2484.67 | -52.01 | -16.02 | -35.99 | -52.01 |
| 12500 | -43.05 | -26.02 | -17.03 | -43.05 |

**BT-BR(1Mbps)** **CSE-TX-FS**

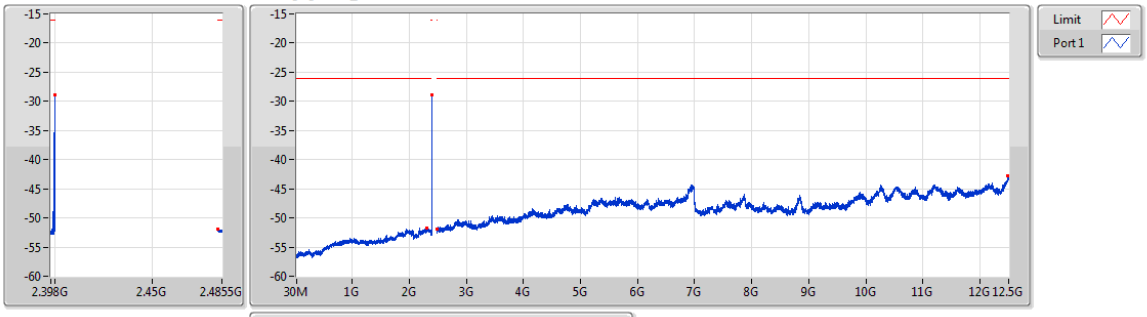
**Hopping Mode_TnomVmax**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 2298.613 | -51.24 | -26.02 | -25.22 | -51.24 |
| 2399.74 | -42.27 | -16.02 | -26.25 | -42.27 |
| 2483.63 | -51.85 | -16.02 | -35.83 | -51.85 |
| 12497.499 | -43.01 | -26.02 | -16.99 | -43.01 |

**BT-EDR(3Mbps)** **CSE-TX-FS**

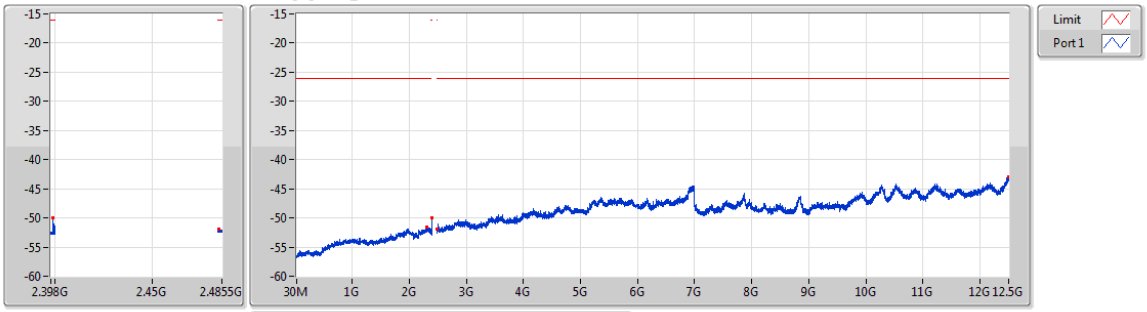
**Hopping Mode_TnomVnom**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 2312.755 | -51.71 | -26.02 | -25.69 | -51.71 |
| 2399.896 | -28.92 | -16.02 | -12.90 | -28.92 |
| 2483.604 | -51.91 | -16.02 | -35.89 | -51.91 |
| 12489.996 | -42.79 | -26.02 | -16.77 | -42.79 |

**BT-EDR(3Mbps)** **CSE-TX-FS**

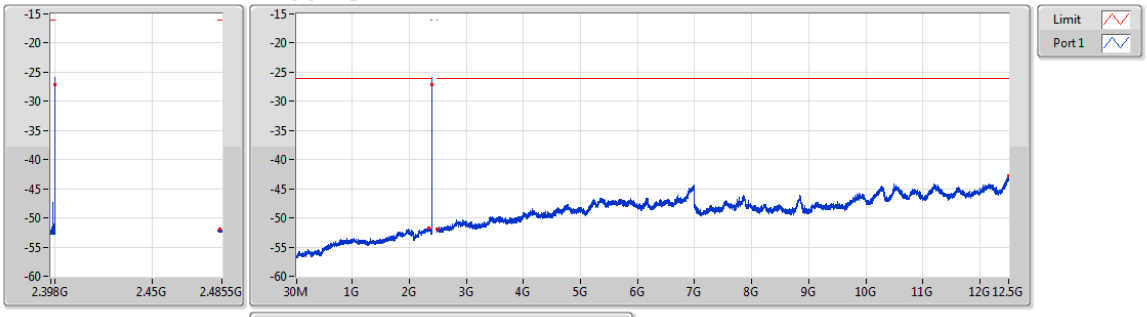
**Hopping Mode_TnomVmin**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 2312.755 | -51.55 | -26.02 | -25.53 | -51.55 |
| 2398.96 | -50.06 | -16.02 | -34.04 | -50.06 |
| 2483.89 | -51.94 | -16.02 | -35.92 | -51.94 |
| 12493.748 | -42.93 | -26.02 | -16.91 | -42.93 |

**BT-EDR(3Mbps)** **CSE-TX-FS**

**Hopping Mode_TnomVmax**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 2338.682 | -51.66 | -26.02 | -25.64 | -51.66 |
| 2399.948 | -27.17 | -16.02 | -11.15 | -27.17 |
| 2484.306 | -51.99 | -16.02 | -35.97 | -51.99 |
| 12492.497 | -42.71 | -26.02 | -16.69 | -42.71 |

**Summary**

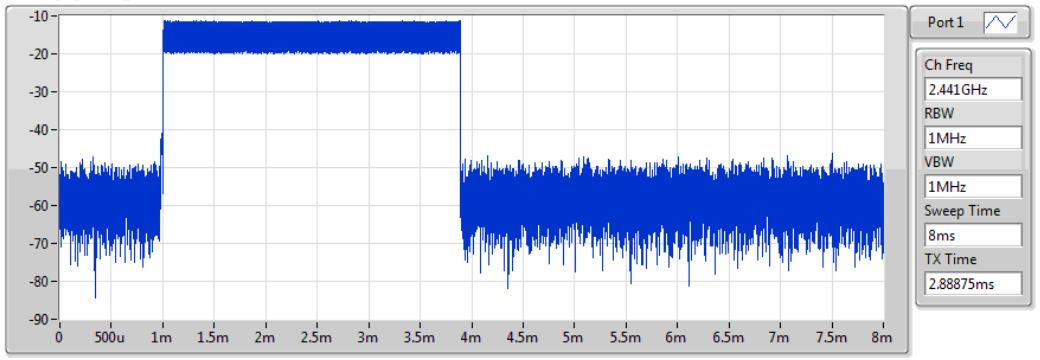
| Mode | Max-Dwell (s) |
|---|---|
| 2.4-2.4835GHz | - |
| BT-BR(1Mbps) | 275.271807m |
| BT-EDR(3Mbps) | 276.067464m |
| BT-BR-AFH(1Mbps) | 143.219831m |
| BT-EDR-AFH(3Mbps) | 145.011134m |

**Result**

| Mode | Result | Period (s) | Dwell (s) | Limit (s) | Tx On (s) |
|---|---|---|---|---|---|
| BT-BR(1Mbps) | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 28.226 | 275.271807m | 400m | 2.88875m |
| Hopping Mode_TnomVmin | Pass | 28.226 | 275.247984m | 400m | 2.8885m |
| Hopping Mode_TnomVmax | Pass | 28.226 | 275.247984m | 400m | 2.8885m |
| BT-EDR(3Mbps) | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 28.186 | 275.35749m | 400m | 2.89375m |
| Hopping Mode_TnomVmin | Pass | 28.266 | 276.067464m | 400m | 2.893m |
| Hopping Mode_TnomVmax | Pass | 28.186 | 275.35749m | 400m | 2.89375m |
| BT-BR-AFH(1Mbps) | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 7.4364 | 143.219831m | 400m | 2.88875m |
| Hopping Mode_TnomVmin | Pass | 7.4364 | 143.207436m | 400m | 2.8885m |
| Hopping Mode_TnomVmax | Pass | 7.4364 | 143.207436m | 400m | 2.8885m |
| BT-EDR-AFH(3Mbps) | - | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 7.4764 | 144.239428m | 400m | 2.89375m |
| Hopping Mode_TnomVmin | Pass | 7.4764 | 144.239428m | 400m | 2.89375m |
| Hopping Mode_TnomVmax | Pass | 7.5164 | 145.011134m | 400m | 2.89375m |

**BT-BR(1Mbps)** **Dwell**

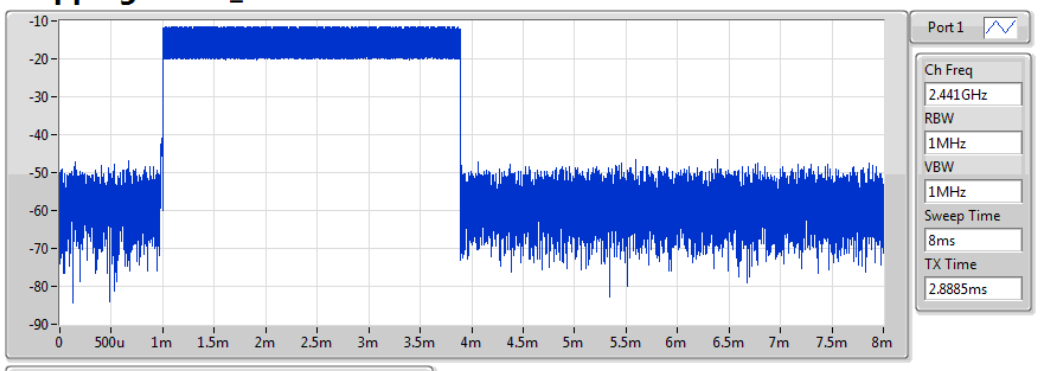
**Hopping Mode_TnomVnom**




| Period(s) | Dwell(s) | Limit(s) | Tx On(s) |
|---|---|---|---|
| 28.226 | 275.271807m | 400m | 2.88875m |

**BT-BR(1Mbps)** **Dwell**

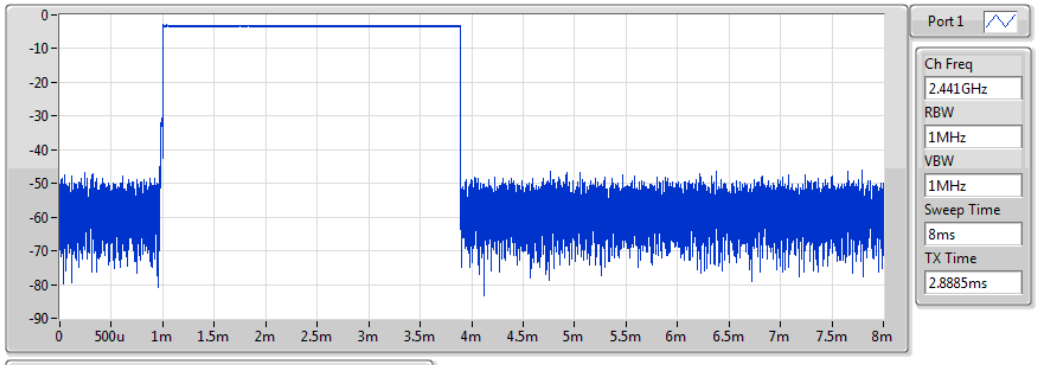
**Hopping Mode_TnomVmin**




| Period(s) | Dwell(s) | Limit(s) | Tx On(s) |
|---|---|---|---|
| 28.226 | 275.247984m | 400m | 2.8885m |

**BT-BR(1Mbps)** **Dwell**

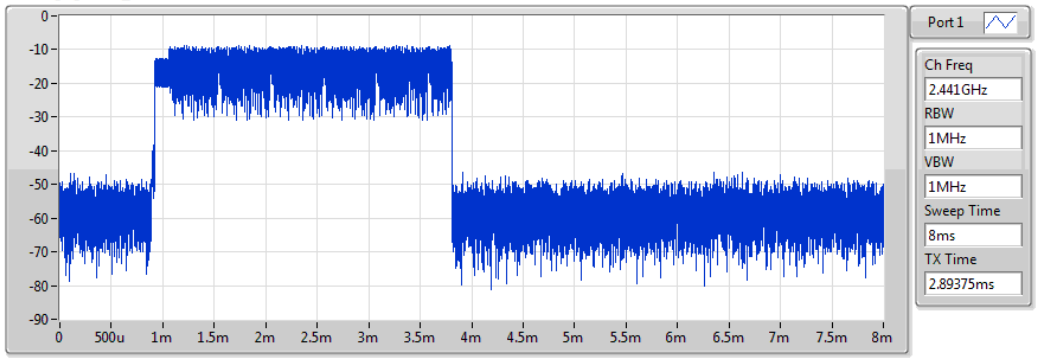
**Hopping Mode_TnomVmax**




| Period(s) | Dwell(s) | Limit(s) | Tx On(s) |
|---|---|---|---|
| 28.226 | 275.247984m | 400m | 2.8885m |

**BT-EDR(3Mbps)** **Dwell**

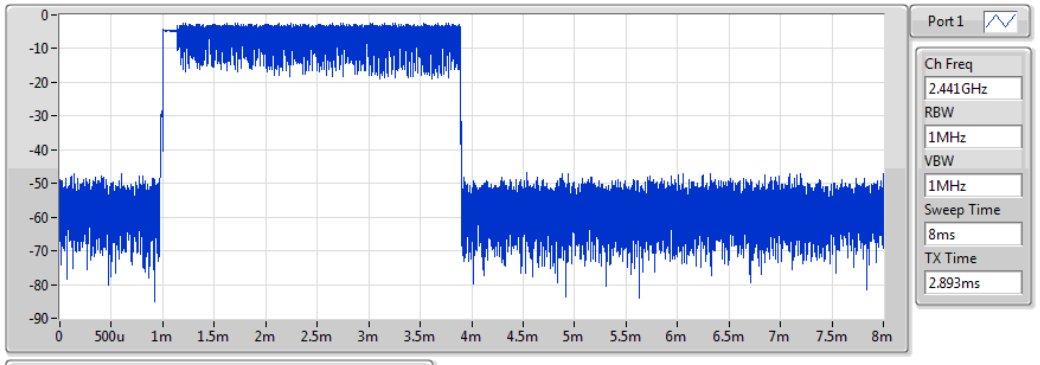
**Hopping Mode_TnomVnom**




| Period(s) | Dwell(s) | Limit(s) | Tx On(s) |
|---|---|---|---|
| 28.186 | 275.35749m | 400m | 2.89375m |

**BT-EDR(3Mbps)** **Dwell**

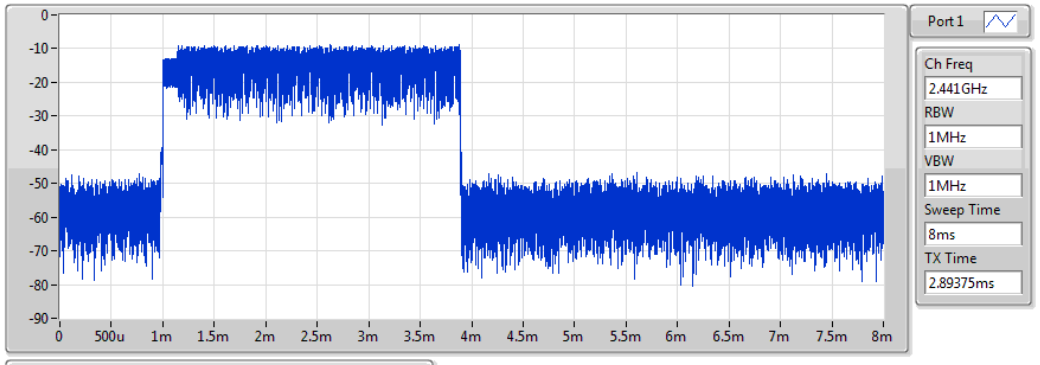
**Hopping Mode_TnomVmin**




| Period(s) | Dwell(s) | Limit(s) | Tx On(s) |
|---|---|---|---|
| 28.266 | 276.067464m | 400m | 2.893m |

**BT-EDR(3Mbps)** **Dwell**

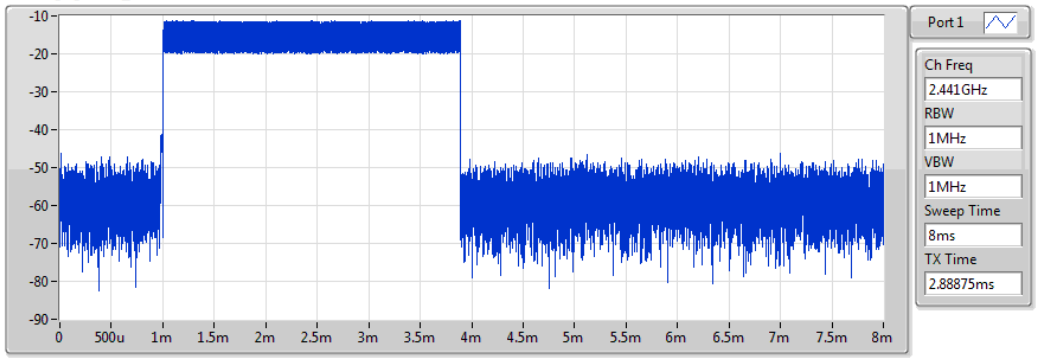
**Hopping Mode_TnomVmax**




| Period(s) | Dwell(s) | Limit(s) | Tx On(s) |
|---|---|---|---|
| 28.186 | 275.35749m | 400m | 2.89375m |

**BT-BR-AFH(1Mbps)** **Dwell**

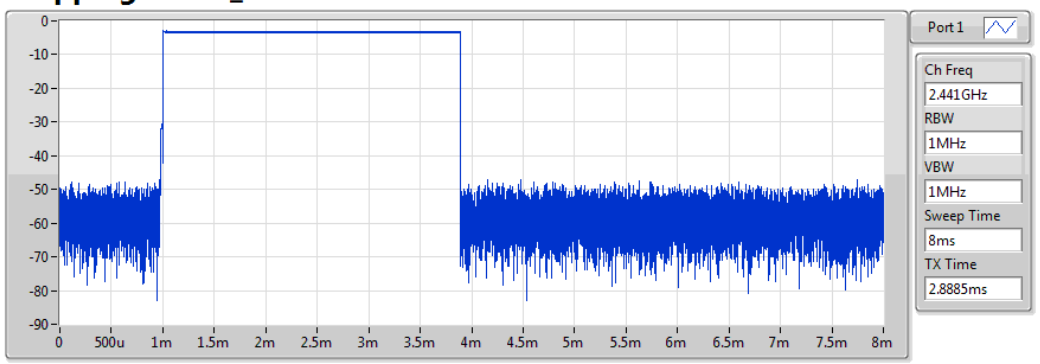
**Hopping Mode_TnomVnom**




| Period(s) | Dwell(s) | Limit(s) | Tx On(s) |
|---|---|---|---|
| 7.4364 | 143.219831m | 400m | 2.88875m |

**BT-BR-AFH(1Mbps)** **Dwell**

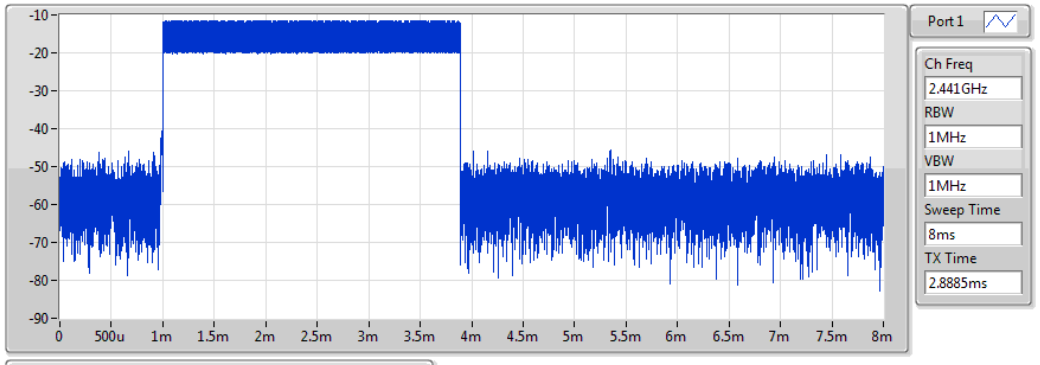
**Hopping Mode_TnomVmin**




| Period(s) | Dwell(s) | Limit(s) | Tx On(s) |
|---|---|---|---|
| 7.4364 | 143.207436m | 400m | 2.8885m |

**BT-BR-AFH(1Mbps)** **Dwell**

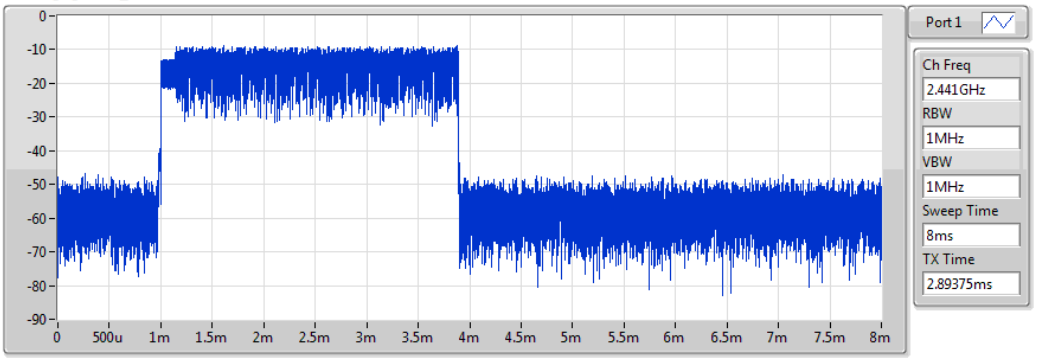
**Hopping Mode_TnomVmax**




| Period(s) | Dwell(s) | Limit(s) | Tx On(s) |
|---|---|---|---|
| 7.4364 | 143.207436m | 400m | 2.8885m |

**BT-EDR-AFH(3Mbps)** **Dwell**

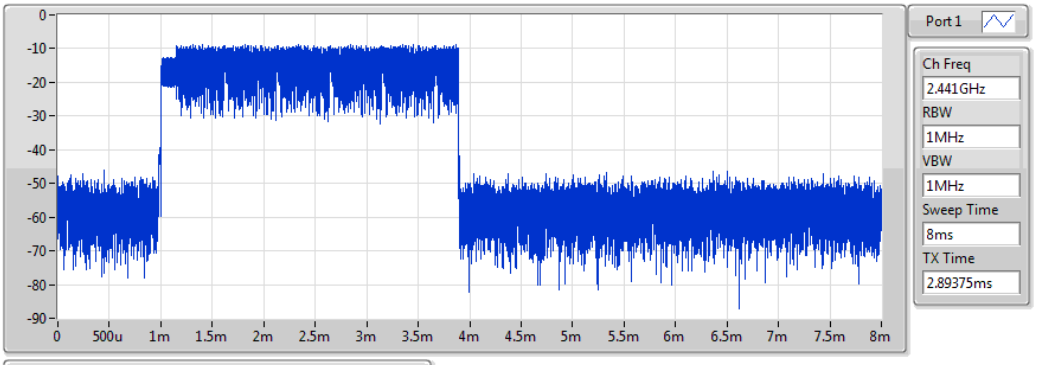
**Hopping Mode_TnomVnom**




| Period(s) | Dwell(s) | Limit(s) | Tx On(s) |
|---|---|---|---|
| 7.4764 | 144.239428m | 400m | 2.89375m |

**BT-EDR-AFH(3Mbps)** **Dwell**

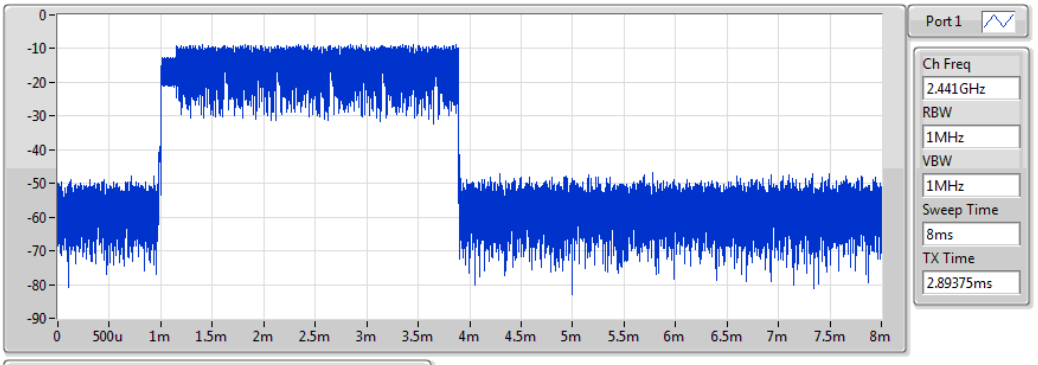
**Hopping Mode_TnomVmin**




| Period(s) | Dwell(s) | Limit(s) | Tx On(s) |
|---|---|---|---|
| 7.4764 | 144.239428m | 400m | 2.89375m |

**BT-EDR-AFH(3Mbps)** **Dwell**

**Hopping Mode_TnomVmax**




| Period(s) | Dwell(s) | Limit(s) | Tx On(s) |
|---|---|---|---|
| 7.5164 | 145.011134m | 400m | 2.89375m |

**Summary**

| Mode | Result | ID Length | ID Limit | Function |
|---|---|---|---|---|
| 2.4-2.4835GHz | - | - | - | - |
| BT-BR(1Mbps) | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| BT-EDR(3Mbps) | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| BT-BR-AFH(1Mbps) | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| BT-EDR-AFH(3Mbps) | Pass | 10:4E:89:49:72:43 | 48 bits | Good |

**Result**

| Mode | Result | ID Length | ID Limit | Function |
|---|---|---|---|---|
| BT-BR(1Mbps) | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| Hopping Mode_TnomVmin | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| Hopping Mode_TnomVmax | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| BT-EDR(3Mbps) | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| Hopping Mode_TnomVmin | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| Hopping Mode_TnomVmax | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| BT-BR-AFH(1Mbps) | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| Hopping Mode_TnomVmin | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| Hopping Mode_TnomVmax | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| BT-EDR-AFH(3Mbps) | - | - | - | - |
| Hopping Mode_TnomVnom | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| Hopping Mode_TnomVmin | Pass | 10:4E:89:49:72:43 | 48 bits | Good |
| Hopping Mode_TnomVmax | Pass | 10:4E:89:49:72:43 | 48 bits | Good |

**Summary**

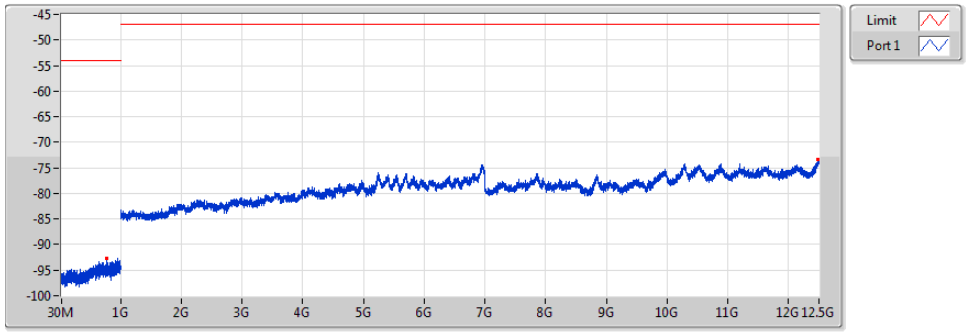
| Mode | Result | F-Start (Hz) | F-Stop (Hz) | RBW (Hz) | Freq (MHz) | Psum (dBm) | Psum (nW/MHz) | Limit (dBm) | Limit (nW/MHz) | Margin (dB) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.4-2.4835GHz | - | - | - | - | - | - | - | - | - | - |
| BT-BR(1Mbps) | Pass | 1G | 12.5G | 1M | 10524.875 | -71.18 | 0.07621 | -46.99 | 20 | -24.19 |
| BT-EDR(3Mbps) | Pass | 1G | 12.5G | 1M | 12484.187 | -73.20 | 0.04786 | -46.99 | 20 | -26.21 |

**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-BR(1Mbps) | - | - | - | - | - | - | - | - | - | - |
| 2402MHz_TnomVnom | Pass | 30M | 1G | 100k | 765.745 | -92.62 | 0.00055 | -53.98 | 4 | -38.64 |
| 2402MHz_TnomVnom | Pass | 1G | 12.5G | 1M | 12485.625 | -73.28 | 0.04699 | -46.99 | 20 | -26.29 |
| 2402MHz_TnomVmin | Pass | 30M | 1G | 100k | 773.505 | -90.73 | 0.00085 | -53.98 | 4 | -36.75 |
| 2402MHz_TnomVmin | Pass | 1G | 12.5G | 1M | 12491.375 | -73.37 | 0.04603 | -46.99 | 20 | -26.38 |
| 2402MHz_TnomVmax | Pass | 30M | 1G | 100k | 933.07 | -92.86 | 0.00052 | -53.98 | 4 | -38.88 |
| 2402MHz_TnomVmax | Pass | 1G | 12.5G | 1M | 12487.062 | -73.53 | 0.04436 | -46.99 | 20 | -26.54 |
| 2441MHz_TnomVnom | Pass | 30M | 1G | 100k | 939.375 | -93.10 | 0.00049 | -53.98 | 4 | -39.12 |
| 2441MHz_TnomVnom | Pass | 1G | 12.5G | 1M | 12497.125 | -73.44 | 0.04529 | -46.99 | 20 | -26.45 |
| 2441MHz_TnomVmin | Pass | 30M | 1G | 100k | 776.9 | -92.77 | 0.00053 | -53.98 | 4 | -38.79 |
| 2441MHz_TnomVmin | Pass | 1G | 12.5G | 1M | 10524.875 | -71.18 | 0.07621 | -46.99 | 20 | -24.19 |
| 2441MHz_TnomVmax | Pass | 30M | 1G | 100k | 782.72 | -92.58 | 0.00055 | -53.98 | 4 | -38.60 |
| 2441MHz_TnomVmax | Pass | 1G | 12.5G | 1M | 12482.75 | -73.68 | 0.04285 | -46.99 | 20 | -26.69 |
| 2480MHz_TnomVnom | Pass | 30M | 1G | 100k | 714.335 | -92.88 | 0.00052 | -53.98 | 4 | -38.90 |
| 2480MHz_TnomVnom | Pass | 1G | 12.5G | 1M | 10524.875 | -71.52 | 0.07047 | -46.99 | 20 | -24.53 |
| 2480MHz_TnomVmin | Pass | 30M | 1G | 100k | 771.08 | -92.85 | 0.00052 | -53.98 | 4 | -38.87 |
| 2480MHz_TnomVmin | Pass | 1G | 12.5G | 1M | 12485.625 | -73.57 | 0.04395 | -46.99 | 20 | -26.58 |
| 2480MHz_TnomVmax | Pass | 30M | 1G | 100k | 854.5 | -92.85 | 0.00052 | -53.98 | 4 | -38.87 |
| 2480MHz_TnomVmax | Pass | 1G | 12.5G | 1M | 10524.875 | -72.69 | 0.05383 | -46.99 | 20 | -25.70 |
| BT-EDR(3Mbps) | - | - | - | - | - | - | - | - | - | - |
| 2402MHz_TnomVnom | Pass | 30M | 1G | 100k | 945.195 | -92.80 | 0.00052 | -53.98 | 4 | -38.82 |
| 2402MHz_TnomVnom | Pass | 1G | 12.5G | 1M | 12491.375 | -73.65 | 0.04315 | -46.99 | 20 | -26.66 |
| 2402MHz_TnomVmin | Pass | 30M | 1G | 100k | 995.635 | -92.67 | 0.00054 | -53.98 | 4 | -38.69 |
| 2402MHz_TnomVmin | Pass | 1G | 12.5G | 1M | 12492.812 | -73.54 | 0.04426 | -46.99 | 20 | -26.55 |
| 2402MHz_TnomVmax | Pass | 30M | 1G | 100k | 844.8 | -92.79 | 0.00053 | -53.98 | 4 | -38.81 |
| 2402MHz_TnomVmax | Pass | 1G | 12.5G | 1M | 12491.375 | -73.43 | 0.04539 | -46.99 | 20 | -26.44 |
| 2441MHz_TnomVnom | Pass | 30M | 1G | 100k | 967.99 | -93.14 | 0.00049 | -53.98 | 4 | -39.16 |
| 2441MHz_TnomVnom | Pass | 1G | 12.5G | 1M | 12484.187 | -73.40 | 0.04571 | -46.99 | 20 | -26.41 |
| 2441MHz_TnomVmin | Pass | 30M | 1G | 100k | 903.485 | -92.67 | 0.00054 | -53.98 | 4 | -38.69 |
| 2441MHz_TnomVmin | Pass | 1G | 12.5G | 1M | 12495.687 | -73.47 | 0.04498 | -46.99 | 20 | -26.48 |
| 2441MHz_TnomVmax | Pass | 30M | 1G | 100k | 886.51 | -92.73 | 0.00053 | -53.98 | 4 | -38.75 |
| 2441MHz_TnomVmax | Pass | 1G | 12.5G | 1M | 12494.25 | -73.26 | 0.04721 | -46.99 | 20 | -26.27 |
| 2480MHz_TnomVnom | Pass | 30M | 1G | 100k | 886.51 | -93.00 | 0.0005 | -53.98 | 4 | -39.02 |
| 2480MHz_TnomVnom | Pass | 1G | 12.5G | 1M | 12492.812 | -73.25 | 0.04732 | -46.99 | 20 | -26.26 |
| 2480MHz_TnomVmin | Pass | 30M | 1G | 100k | 781.75 | -92.79 | 0.00053 | -53.98 | 4 | -38.81 |
| 2480MHz_TnomVmin | Pass | 1G | 12.5G | 1M | 12484.187 | -73.20 | 0.04786 | -46.99 | 20 | -26.21 |
| 2480MHz_TnomVmax | Pass | 30M | 1G | 100k | 920.945 | -92.60 | 0.00055 | -53.98 | 4 | -38.62 |
| 2480MHz_TnomVmax | Pass | 1G | 12.5G | 1M | 12500 | -73.53 | 0.04436 | -46.99 | 20 | -26.54 |

**BT-BR(1Mbps)** **CSE-RX-FS**

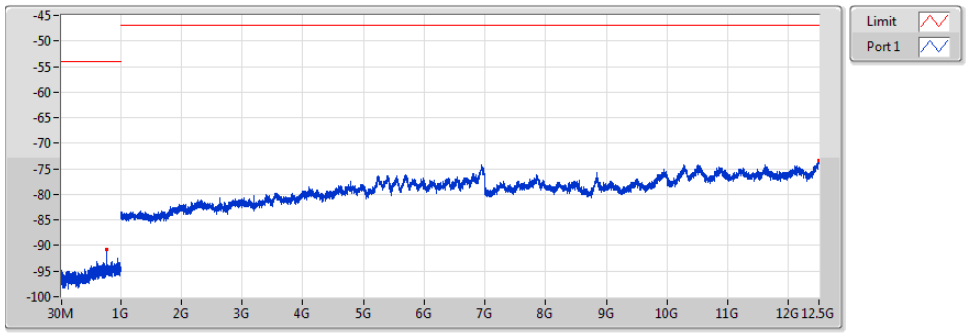
**2402MHz_TnomVnom**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 765.745 | -92.62 | -53.98 | -38.64 | -92.62 |
| 12485.625 | -73.28 | -46.99 | -26.29 | -73.28 |

**BT-BR(1Mbps)** **CSE-RX-FS**

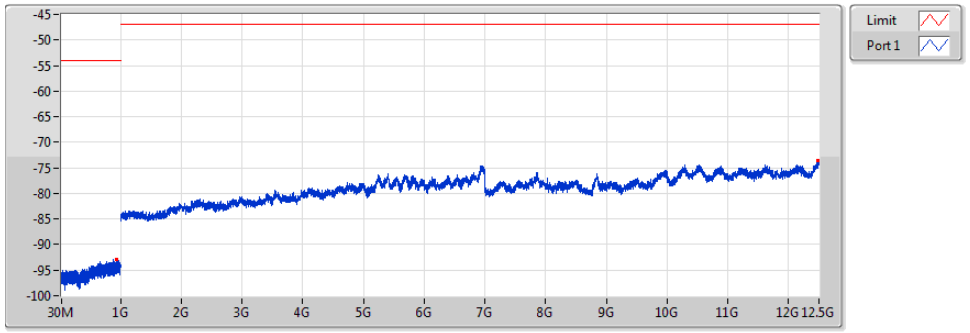
**2402MHz_TnomVmin**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 773.505 | -90.73 | -53.98 | -36.75 | -90.73 |
| 12491.375 | -73.37 | -46.99 | -26.38 | -73.37 |

**BT-BR(1Mbps)** **CSE-RX-FS**

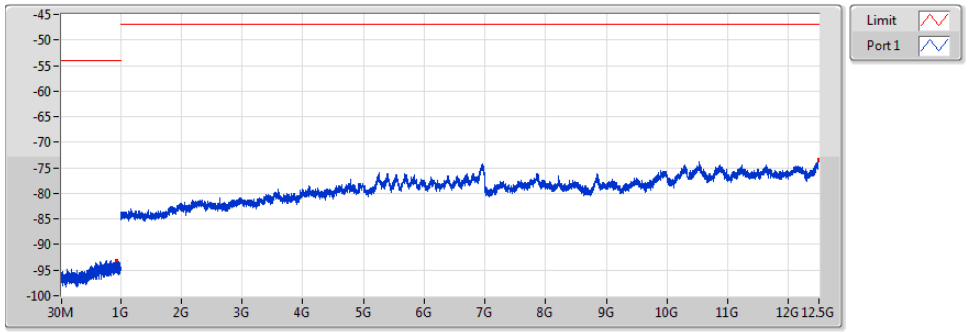
**2402MHz_TnomVmax**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 933.07 | -92.86 | -53.98 | -38.88 | -92.86 |
| 12487.062 | -73.53 | -46.99 | -26.54 | -73.53 |

**BT-BR(1Mbps)** **CSE-RX-FS**

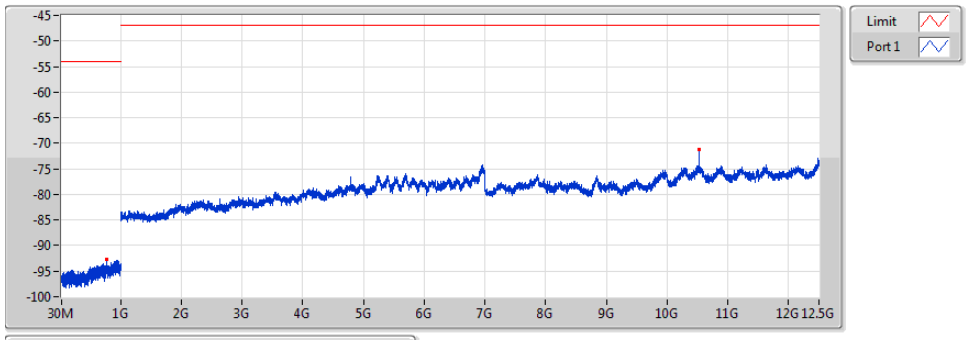
**2441MHz_TnomVnom**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 939.375 | -93.10 | -53.98 | -39.12 | -93.10 |
| 12497.125 | -73.44 | -46.99 | -26.45 | -73.44 |

**BT-BR(1Mbps)** **CSE-RX-FS**

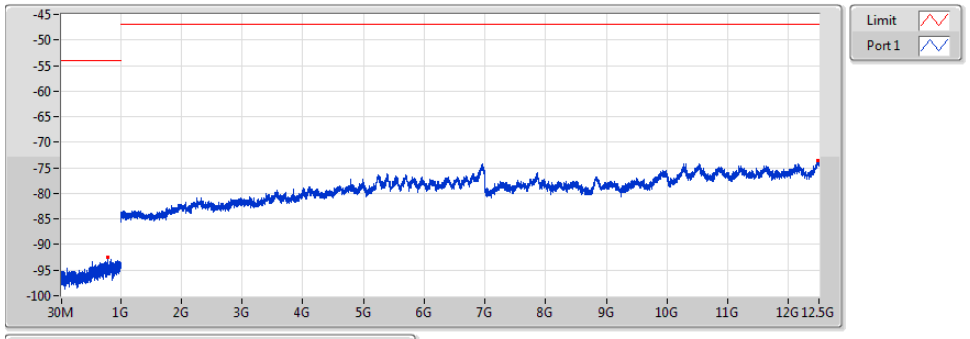
**2441MHz_TnomVmin**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 776.9 | -92.77 | -53.98 | -38.79 | -92.77 |
| 10524.875 | -71.18 | -46.99 | -24.19 | -71.18 |

**BT-BR(1Mbps)** **CSE-RX-FS**

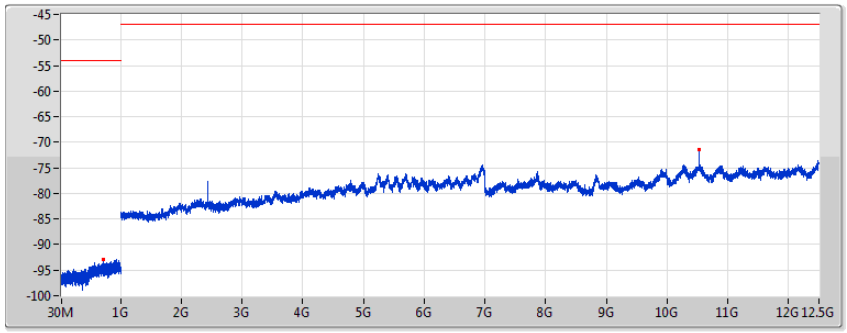
**2441MHz_TnomVmax**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 782.72 | -92.58 | -53.98 | -38.60 | -92.58 |
| 12482.75 | -73.68 | -46.99 | -26.69 | -73.68 |

**BT-BR(1Mbps)** **CSE-RX-FS**

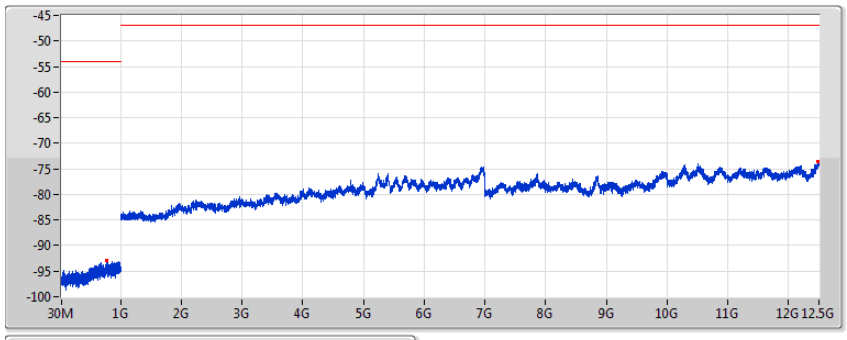
**2480MHz_TnomVnom**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 714.335 | -92.88 | -53.98 | -38.90 | -92.88 |
| 10524.875 | -71.52 | -46.99 | -24.53 | -71.52 |

**BT-BR(1Mbps)** **CSE-RX-FS**

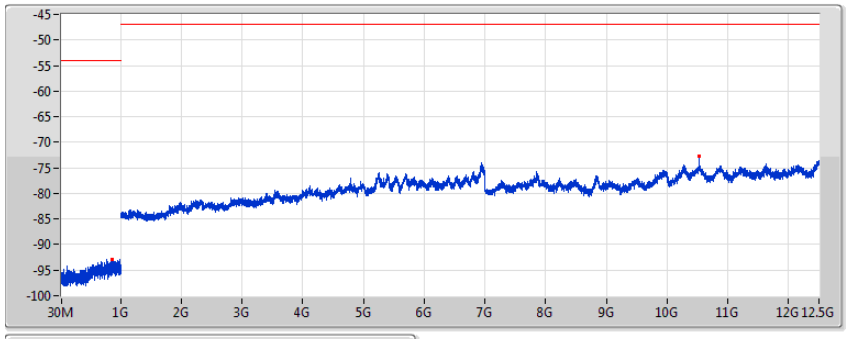
**2480MHz_TnomVmin**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 771.08 | -92.85 | -53.98 | -38.87 | -92.85 |
| 12485.625 | -73.57 | -46.99 | -26.58 | -73.57 |

**BT-BR(1Mbps)** **CSE-RX-FS**

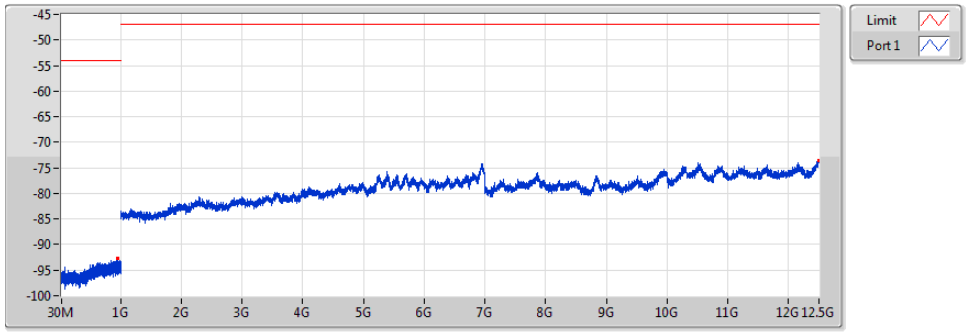
**2480MHz_TnomVmax**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 854.5 | -92.85 | -53.98 | -38.87 | -92.85 |
| 10524.875 | -72.69 | -46.99 | -25.70 | -72.69 |

**BT-EDR(3Mbps)** **CSE-RX-FS**

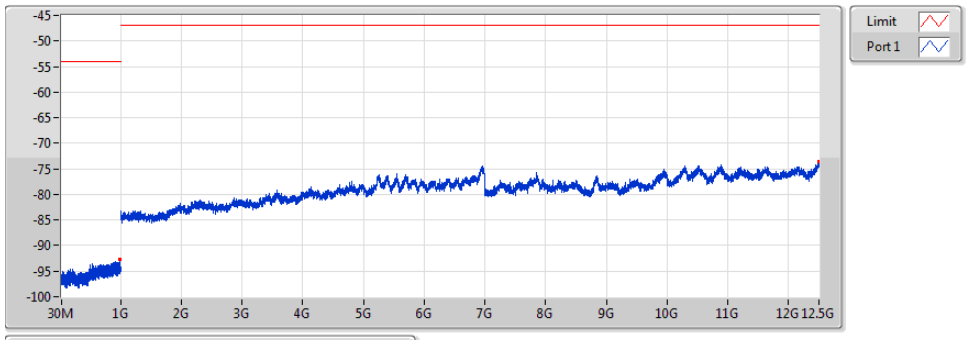
**2402MHz_TnomVnom**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 945.195 | -92.80 | -53.98 | -38.82 | -92.80 |
| 12491.375 | -73.65 | -46.99 | -26.66 | -73.65 |

**BT-EDR(3Mbps)** **CSE-RX-FS**

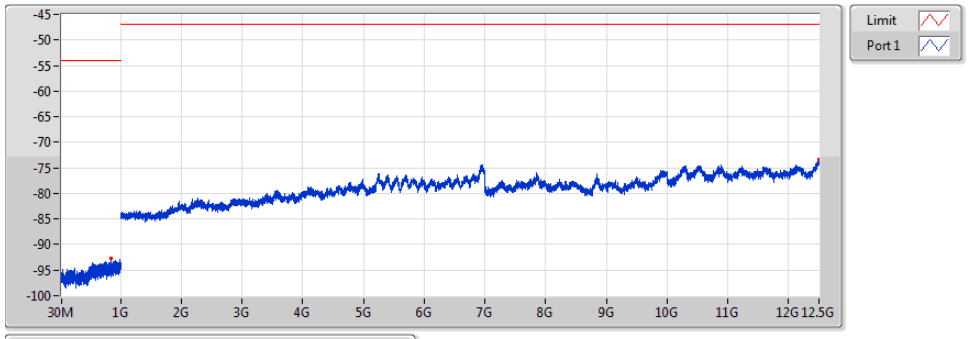
**2402MHz_TnomVmin**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 995.635 | -92.67 | -53.98 | -38.69 | -92.67 |
| 12492.812 | -73.54 | -46.99 | -26.55 | -73.54 |

**BT-EDR(3Mbps)** **CSE-RX-FS**

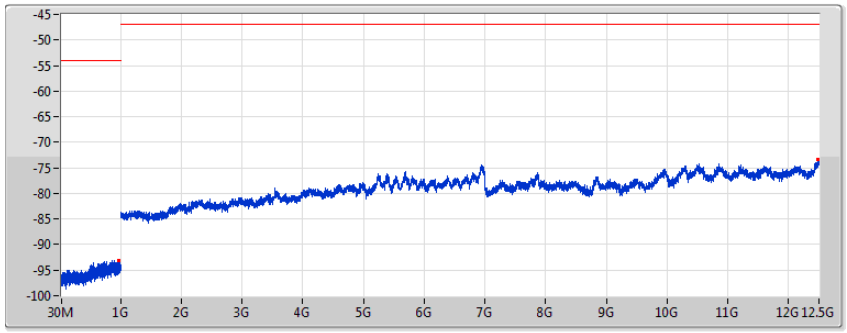
**2402MHz_TnomVmax**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 844.8 | -92.79 | -53.98 | -38.81 | -92.79 |
| 12491.375 | -73.43 | -46.99 | -26.44 | -73.43 |

**BT-EDR(3Mbps)** **CSE-RX-FS**

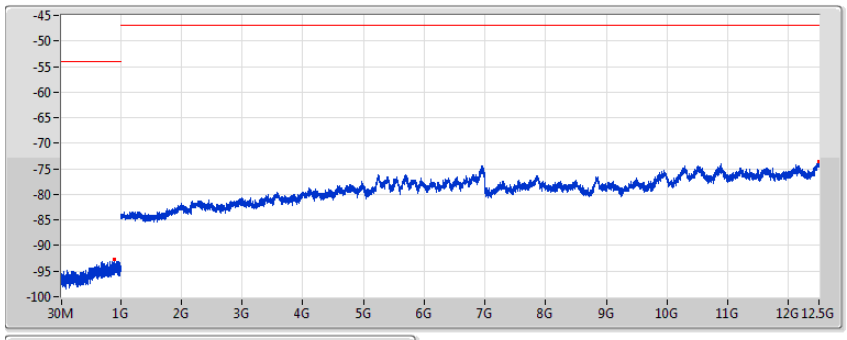
**2441MHz_TnomVnom**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 967.99 | -93.14 | -53.98 | -39.16 | -93.14 |
| 12484.187 | -73.40 | -46.99 | -26.41 | -73.40 |

**BT-EDR(3Mbps)** **CSE-RX-FS**

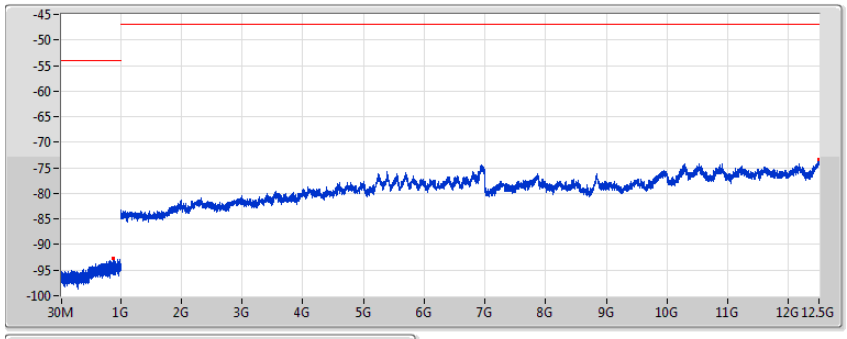
**2441MHz_TnomVmin**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 903.485 | -92.67 | -53.98 | -38.69 | -92.67 |
| 12495.687 | -73.47 | -46.99 | -26.48 | -73.47 |

**BT-EDR(3Mbps)** **CSE-RX-FS**

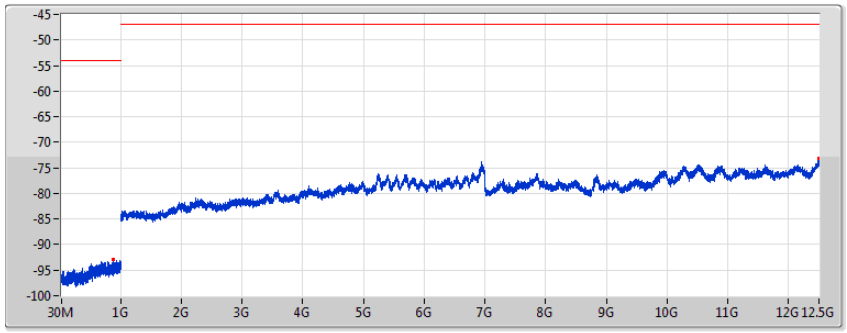
**2441MHz_TnomVmax**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 886.51 | -92.73 | -53.98 | -38.75 | -92.73 |
| 12494.25 | -73.26 | -46.99 | -26.27 | -73.26 |

**BT-EDR(3Mbps)** **CSE-RX-FS**

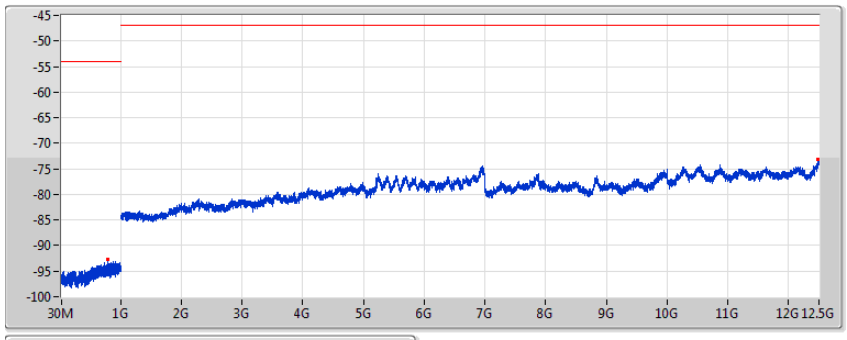
**2480MHz_TnomVnom**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 886.51 | -93.00 | -53.98 | -39.02 | -93.00 |
| 12492.812 | -73.25 | -46.99 | -26.26 | -73.25 |

**BT-EDR(3Mbps)** **CSE-RX-FS**

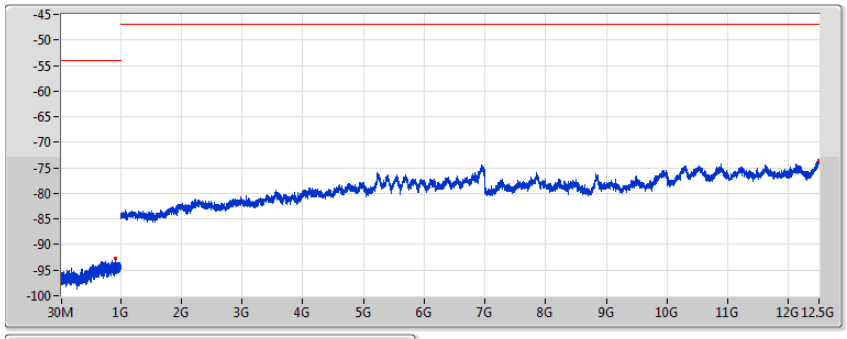
**2480MHz_TnomVmin**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 781.75 | -92.79 | -53.98 | -38.81 | -92.79 |
| 12484.187 | -73.20 | -46.99 | -26.21 | -73.20 |

**BT-EDR(3Mbps)** **CSE-RX-FS**

**2480MHz_TnomVmax**




| Freq(MHz) | Psum(dBm) | Limit(dBm) | Margin(dB) | P1(dBm) |
|---|---|---|---|---|
| 920.945 | -92.60 | -53.98 | -38.62 | -92.60 |
| 12500 | -73.53 | -46.99 | -26.54 | -73.53 |

# Appendix I. 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)

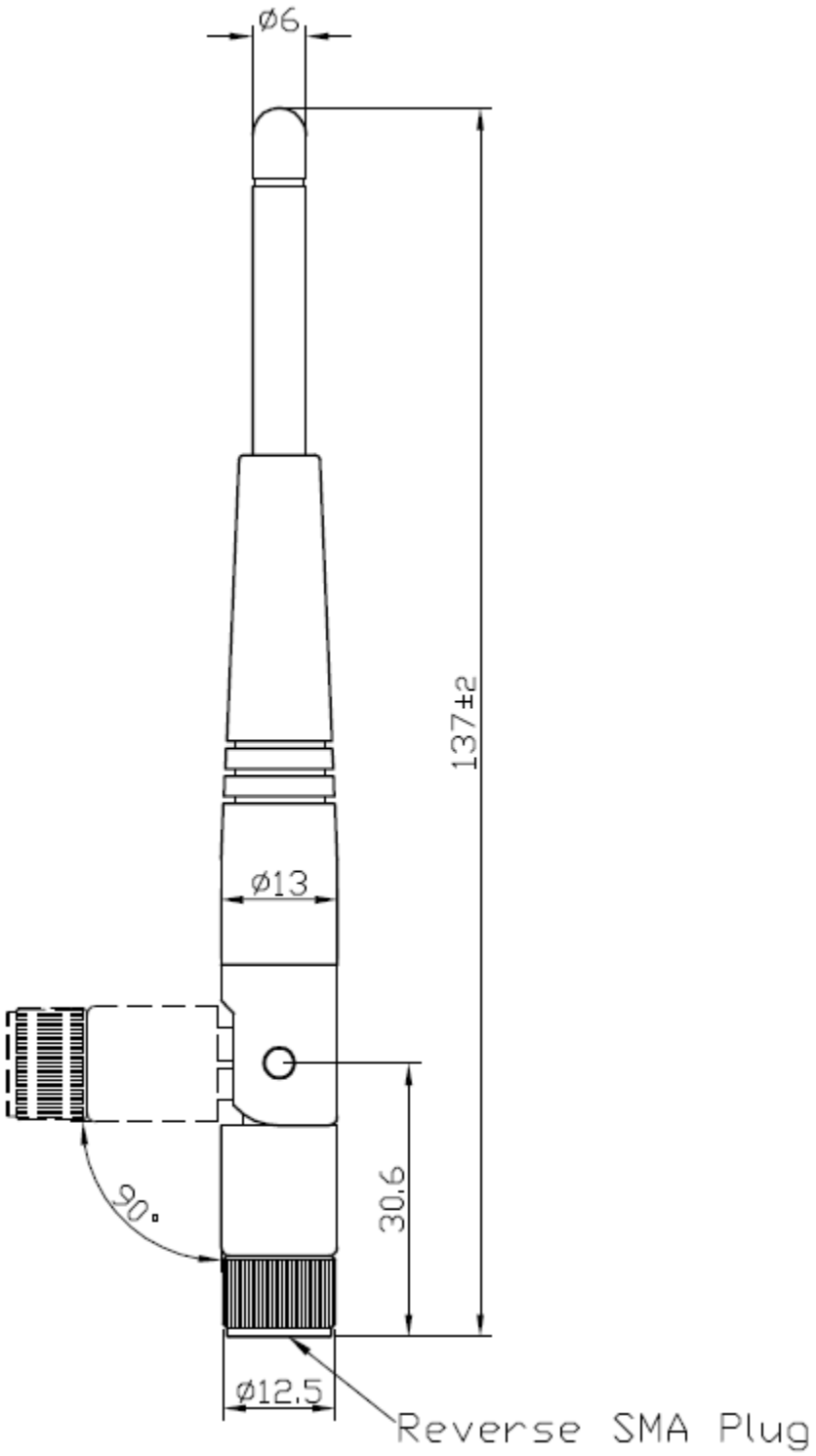



**Figure 1 Physical Dimensions**

## TYPICAL ANTENNA REFLECTION PERFORMANCE

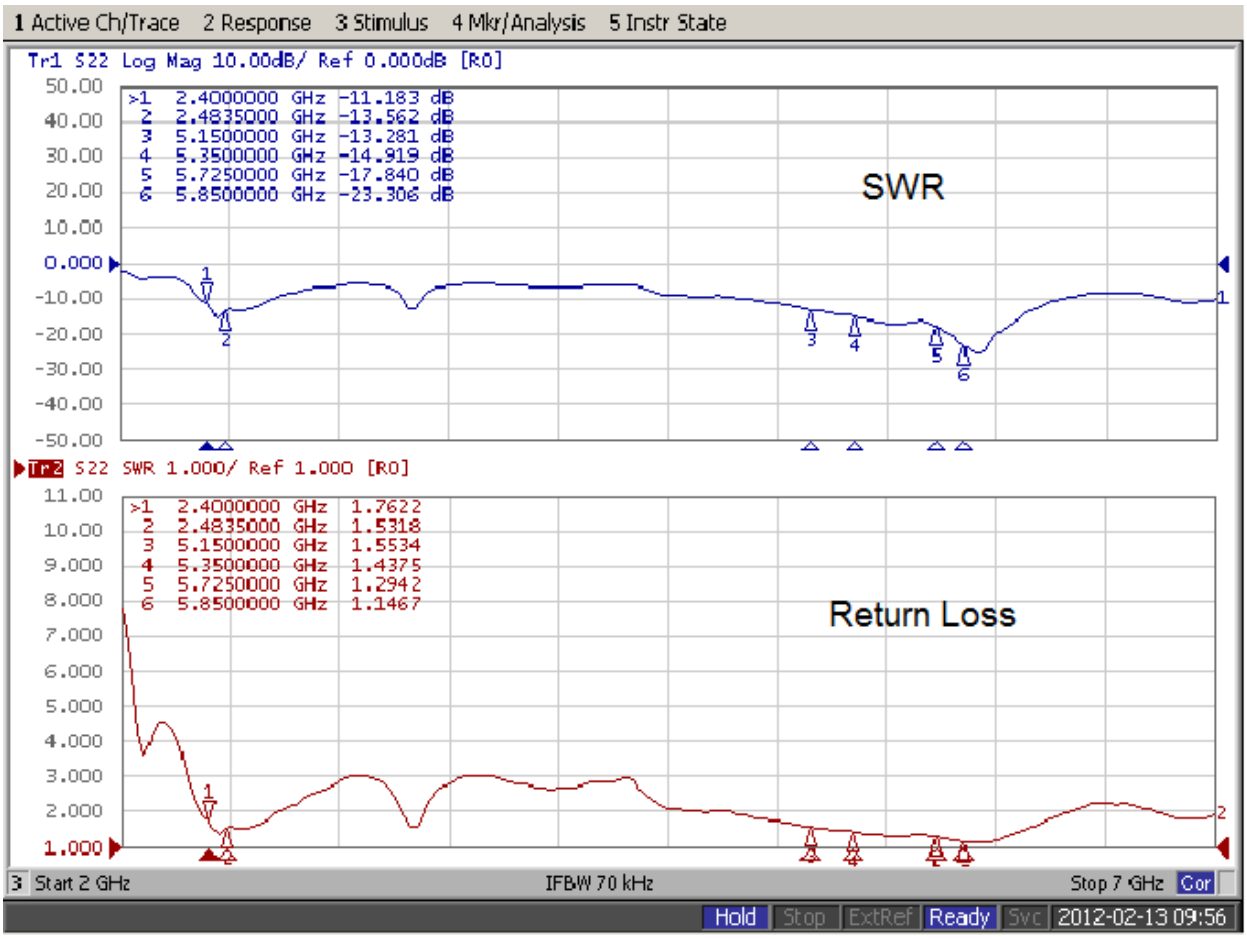



**Figure 2 Typical Antenna Reflection Performance**

## TYPICAL ANTENNA RADIATION PERFORMANCE

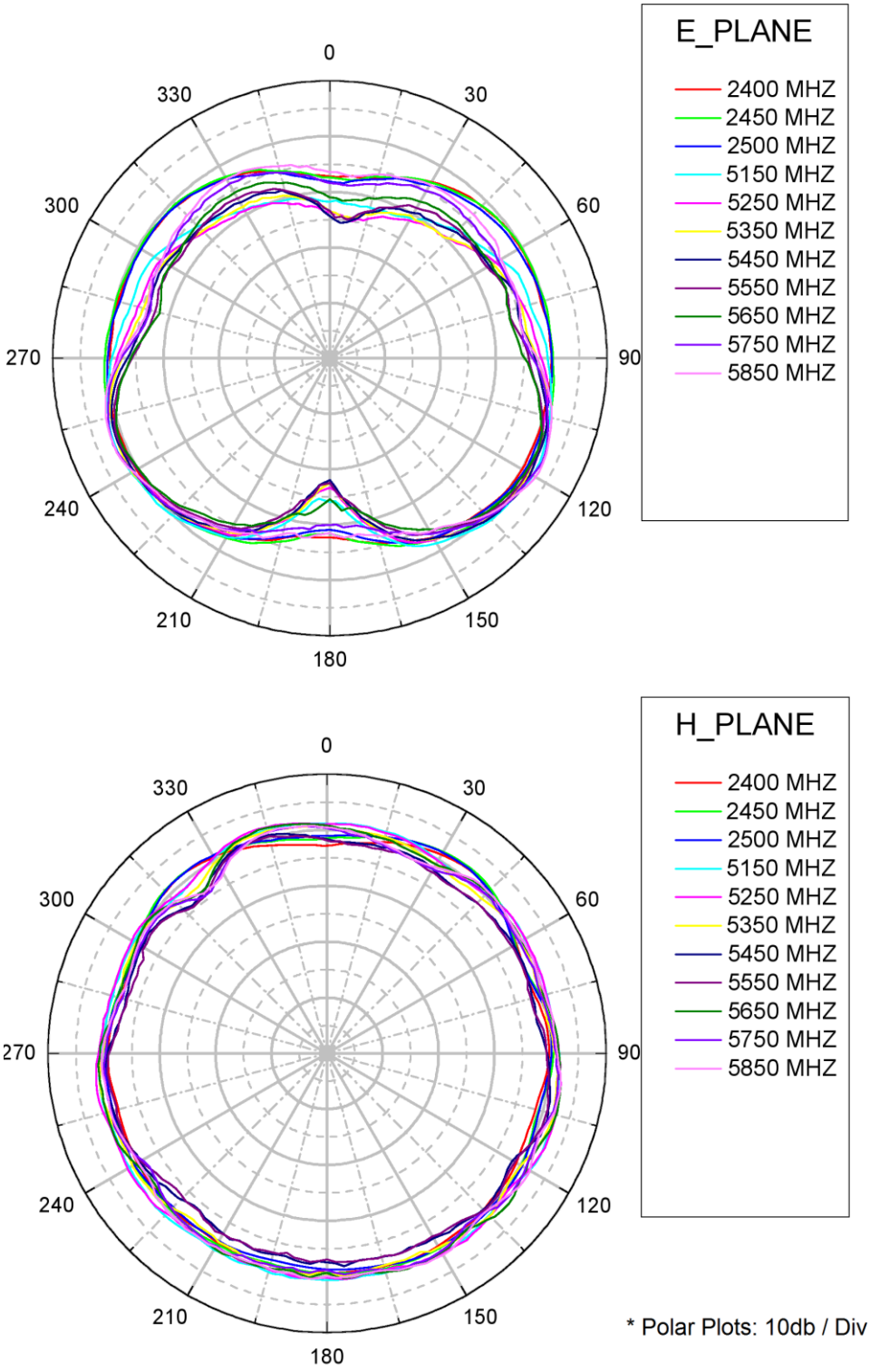



**Figure 3 Typical Antenna Radiation Performance**

## CONTACTING LS RESEARCH

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

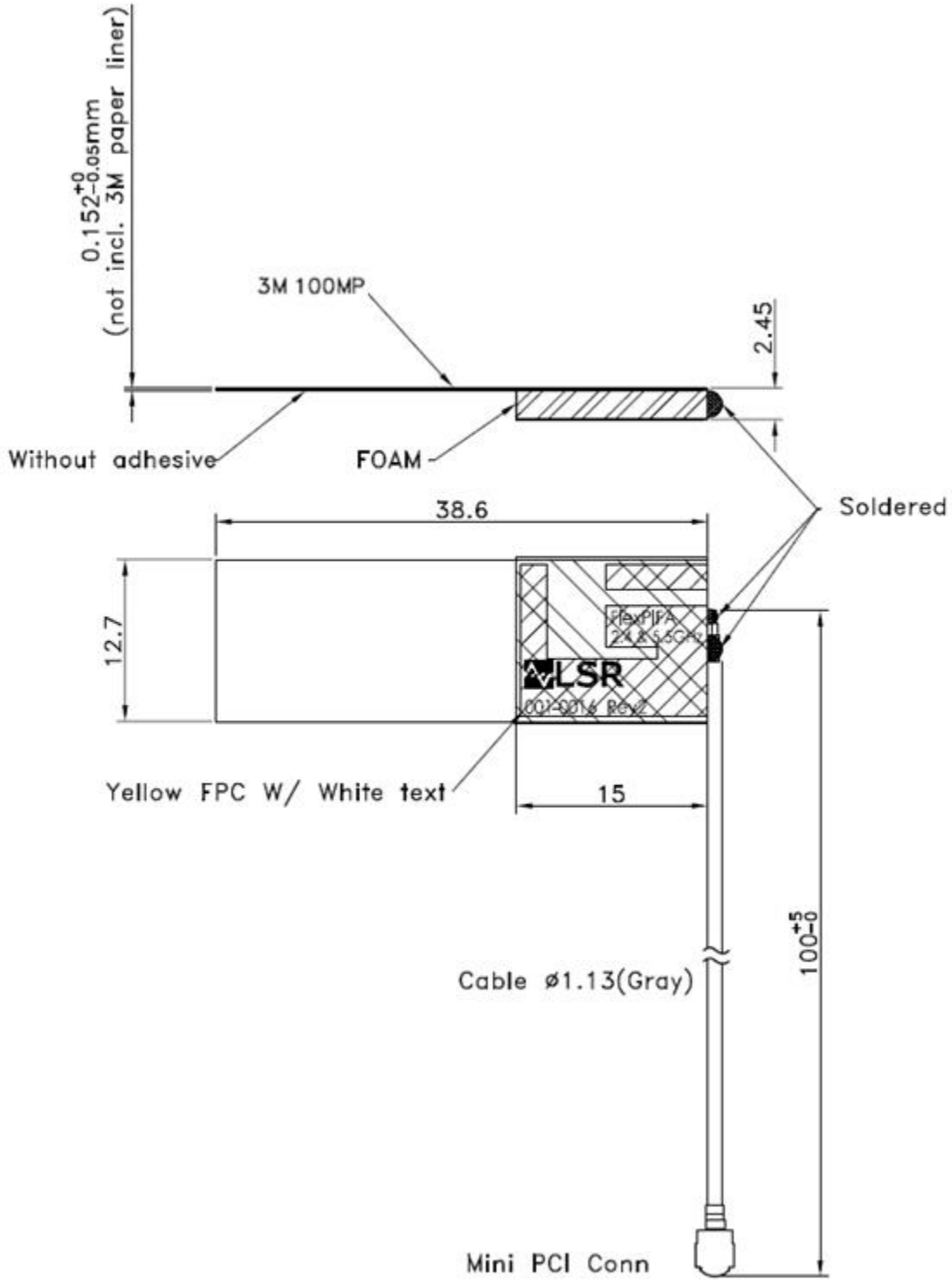



**Figure 1 Physical Dimensions**

## 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

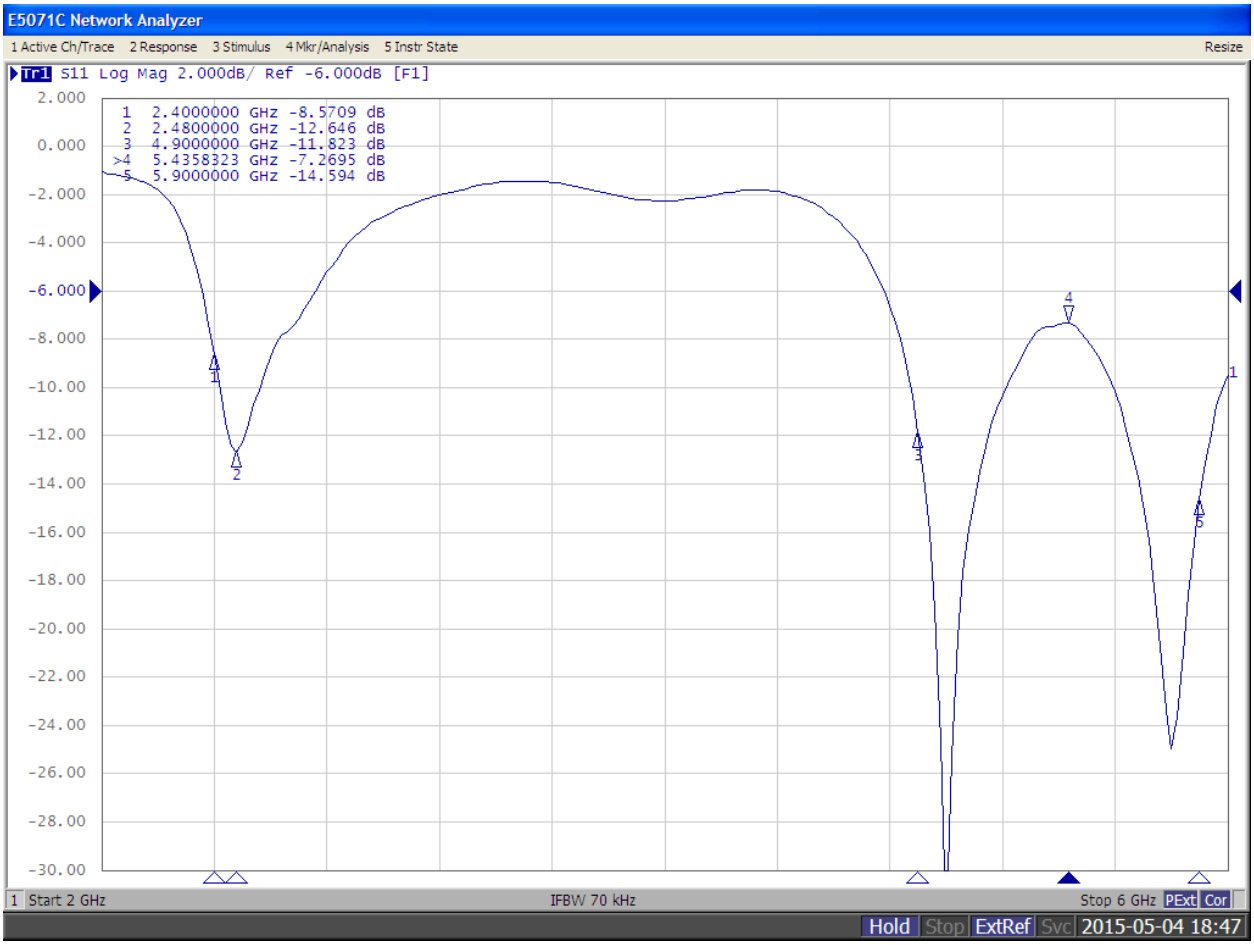



**Figure 2 Antenna VSWR measured on a 1.5 mm thick plate of Polycarbonate**

## FLAT SURFACE ANTENNA RADIATION PERFORMANCE

**FlexPIFA centered on a 1.5 mm thick plate of Polycarbonate**

**Antenna Measurement Set-Up:**

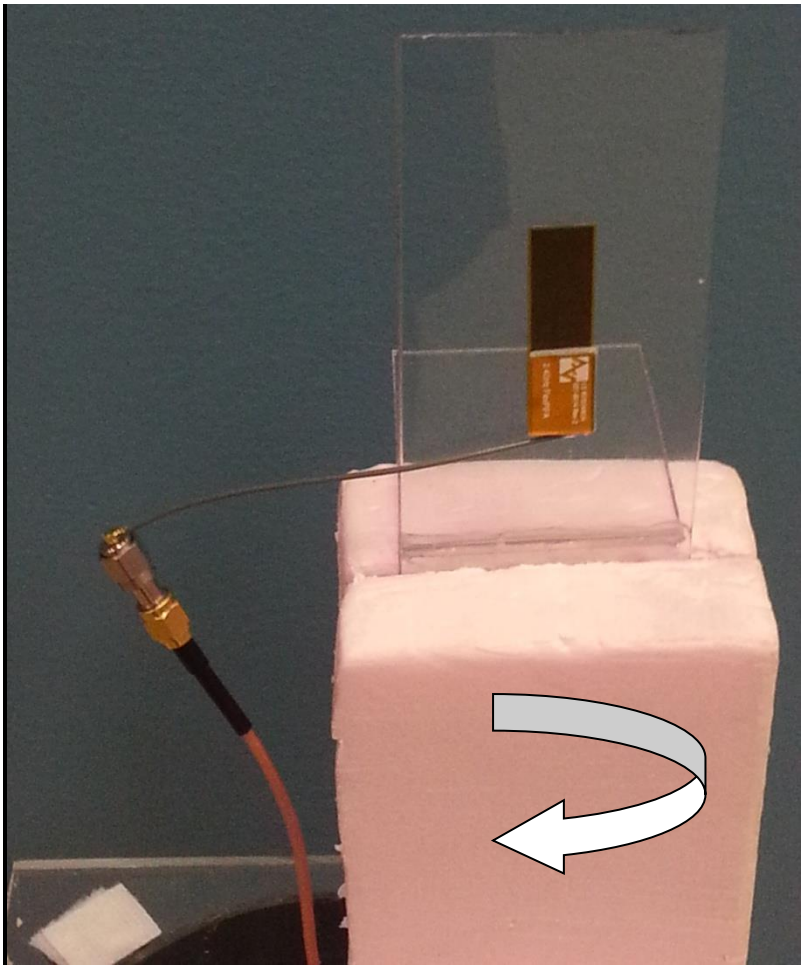


**Figure 3 Vertical Orientation Set-Up**

**Vertical Orientation at 2440 MHz:**


**Figure 4 Vertical Orientation Pattern**

**Antenna Measurement Set-Up:**

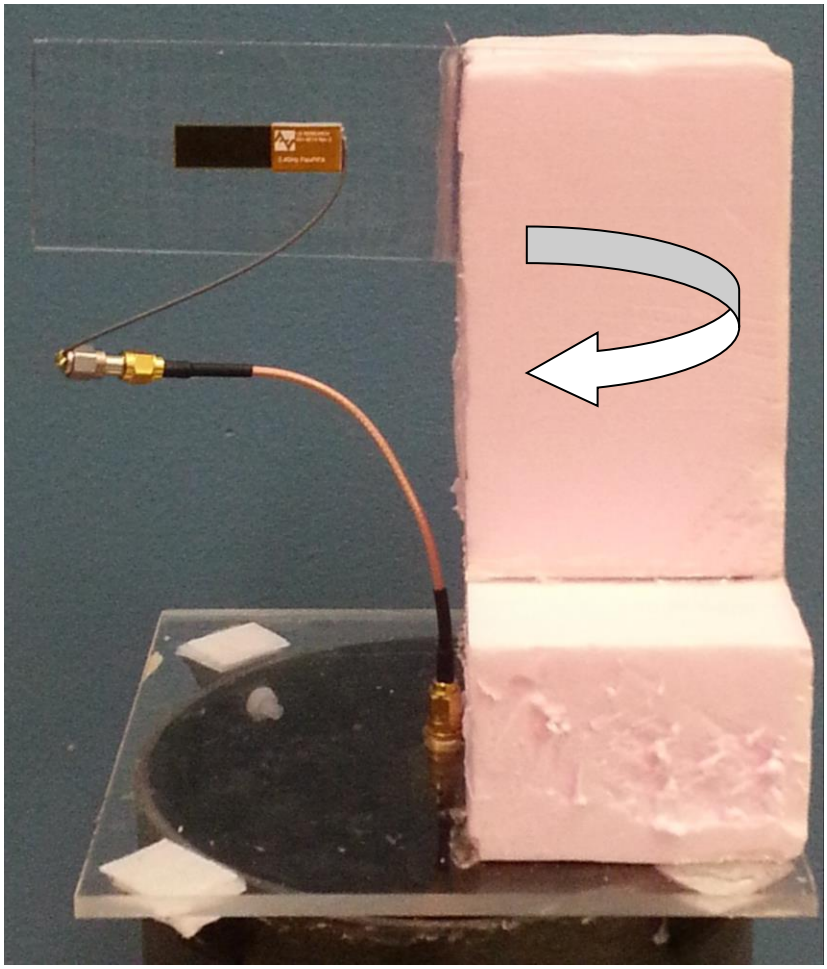


**Figure 5 Horizontal Orientation Set-Up**

**Horizontal Orientation at 2440 MHz:**

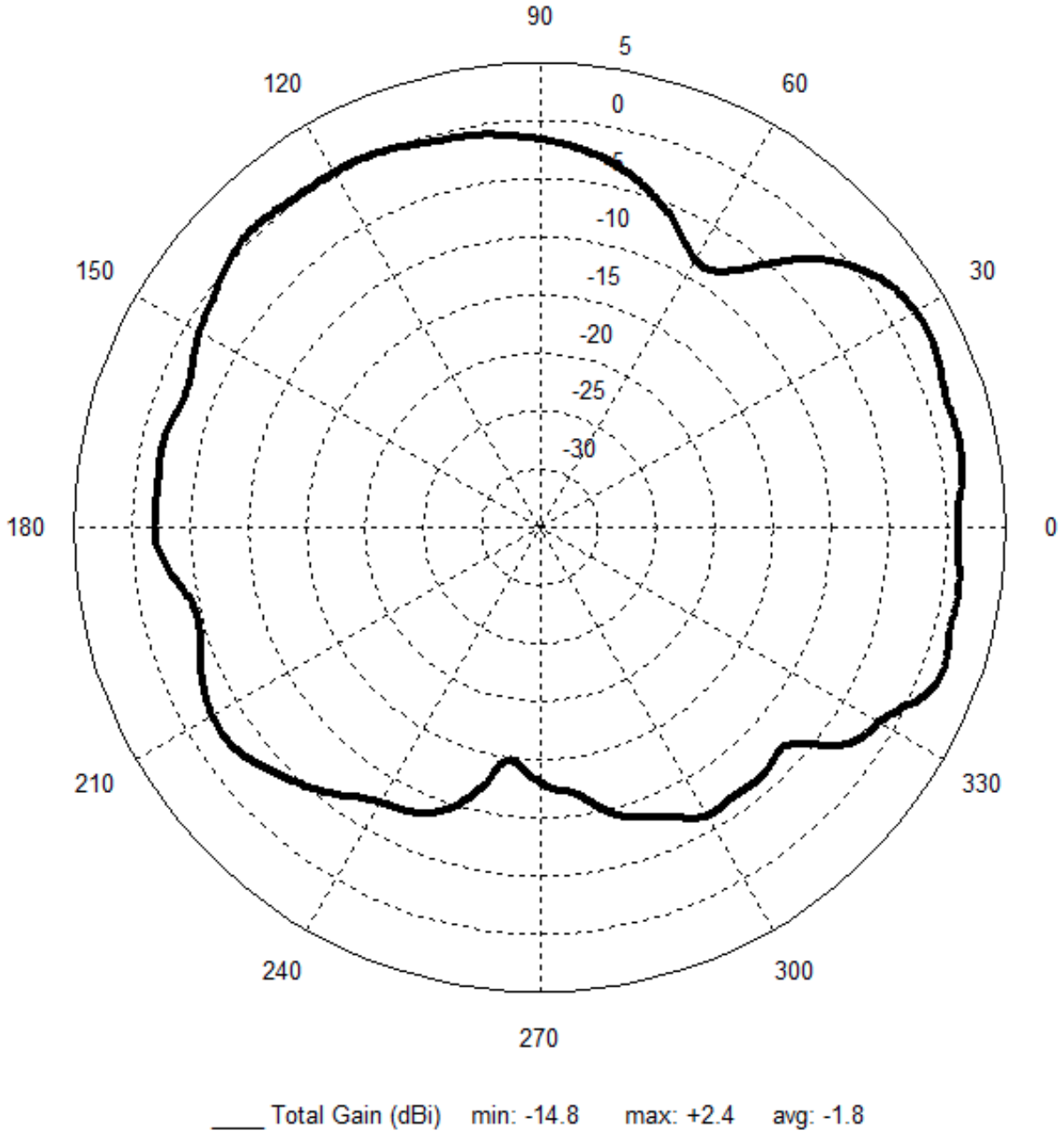



**Figure 6 Horizontal Orientation Pattern**

**Antenna Measurement Set-Up:**

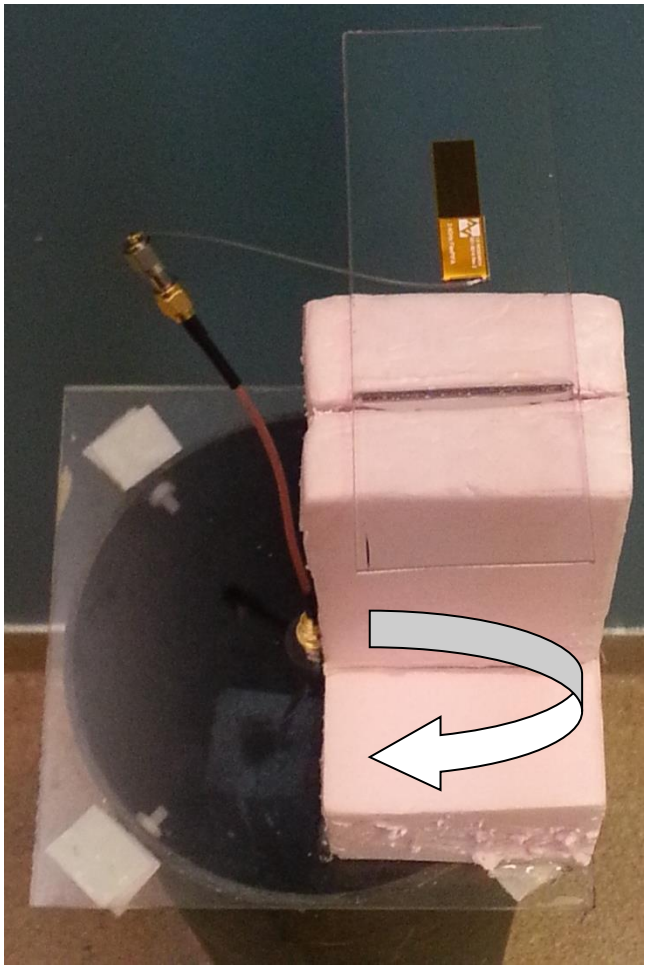


**Figure 7 Flat Orientation Set-Up**

**Flat Orientation at 2440 MHz:**

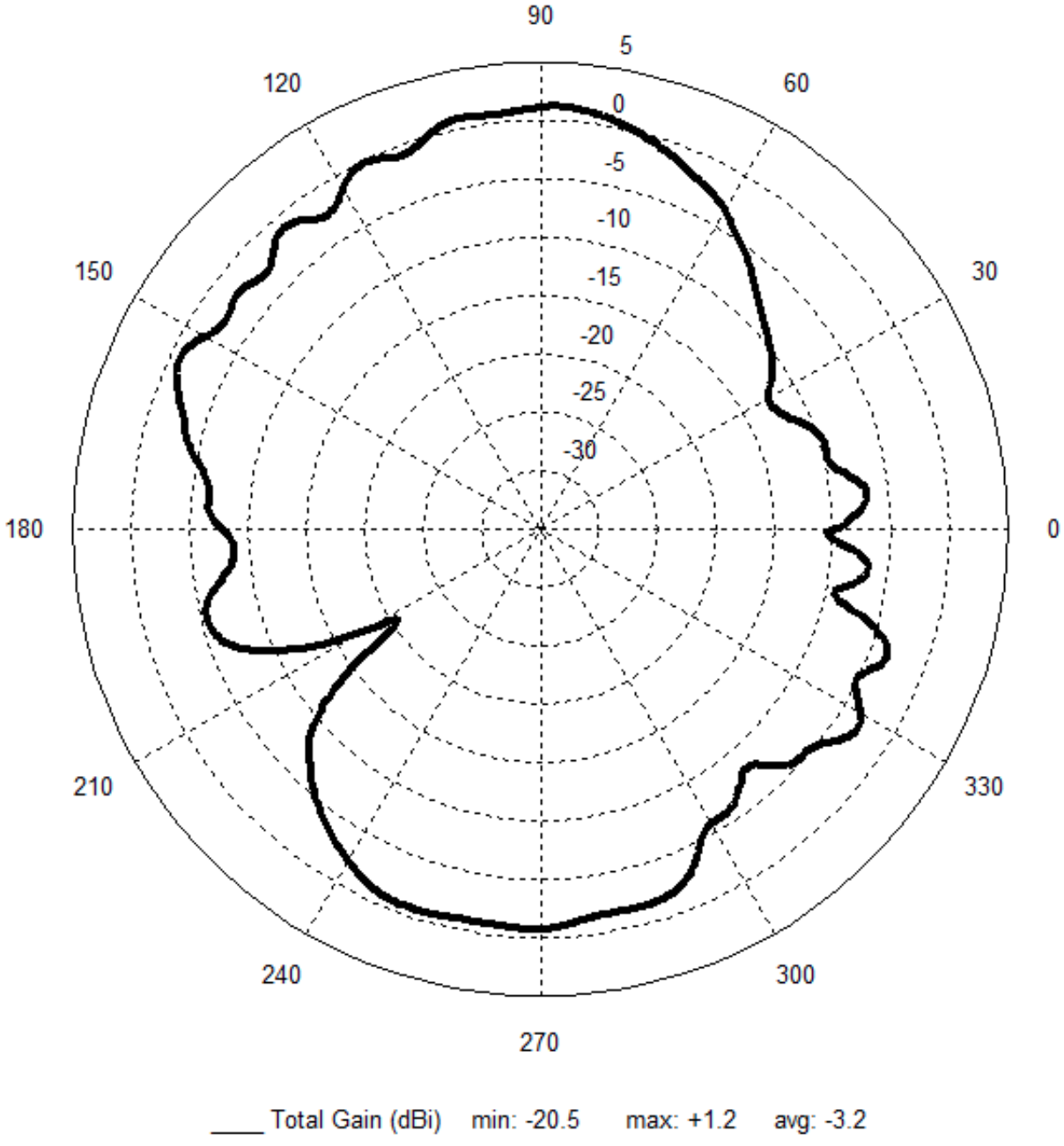



**Figure 8 Flat Orientation Pattern**

**5 GHz Band**

**FlexPIFA centered on a 1.5 mm thick plate of Polycarbonate**

**Antenna Measurement Set-Up:**

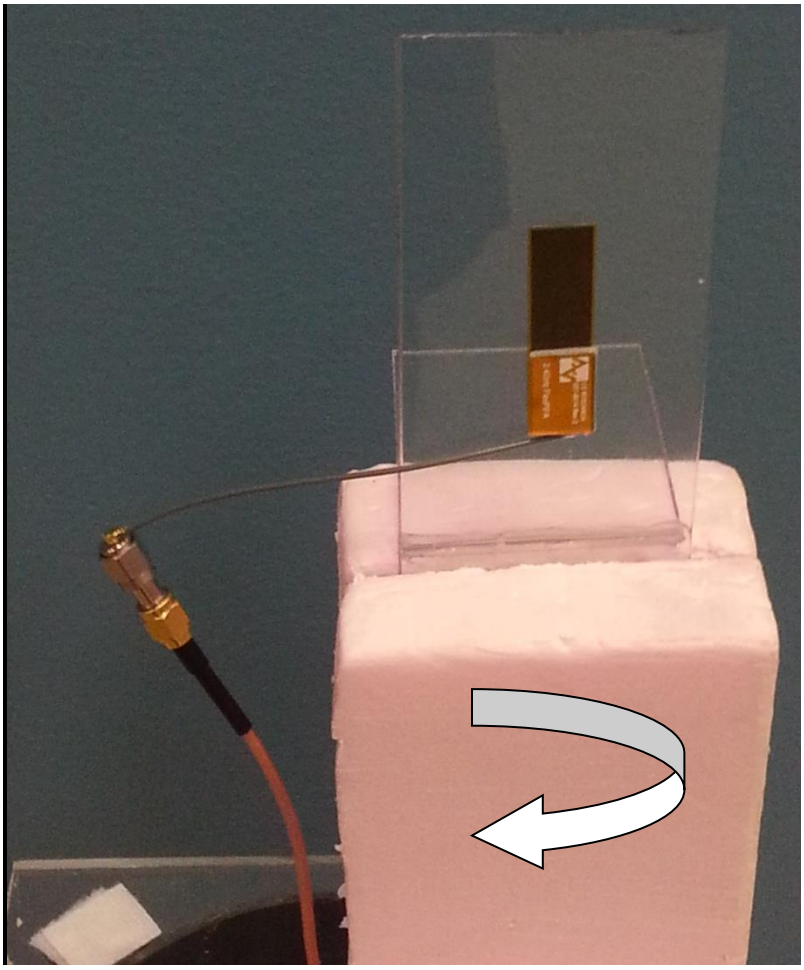


**Figure 9 Vertical Orientation Set-Up**

**Vertical Orientation at 4900 MHz:**

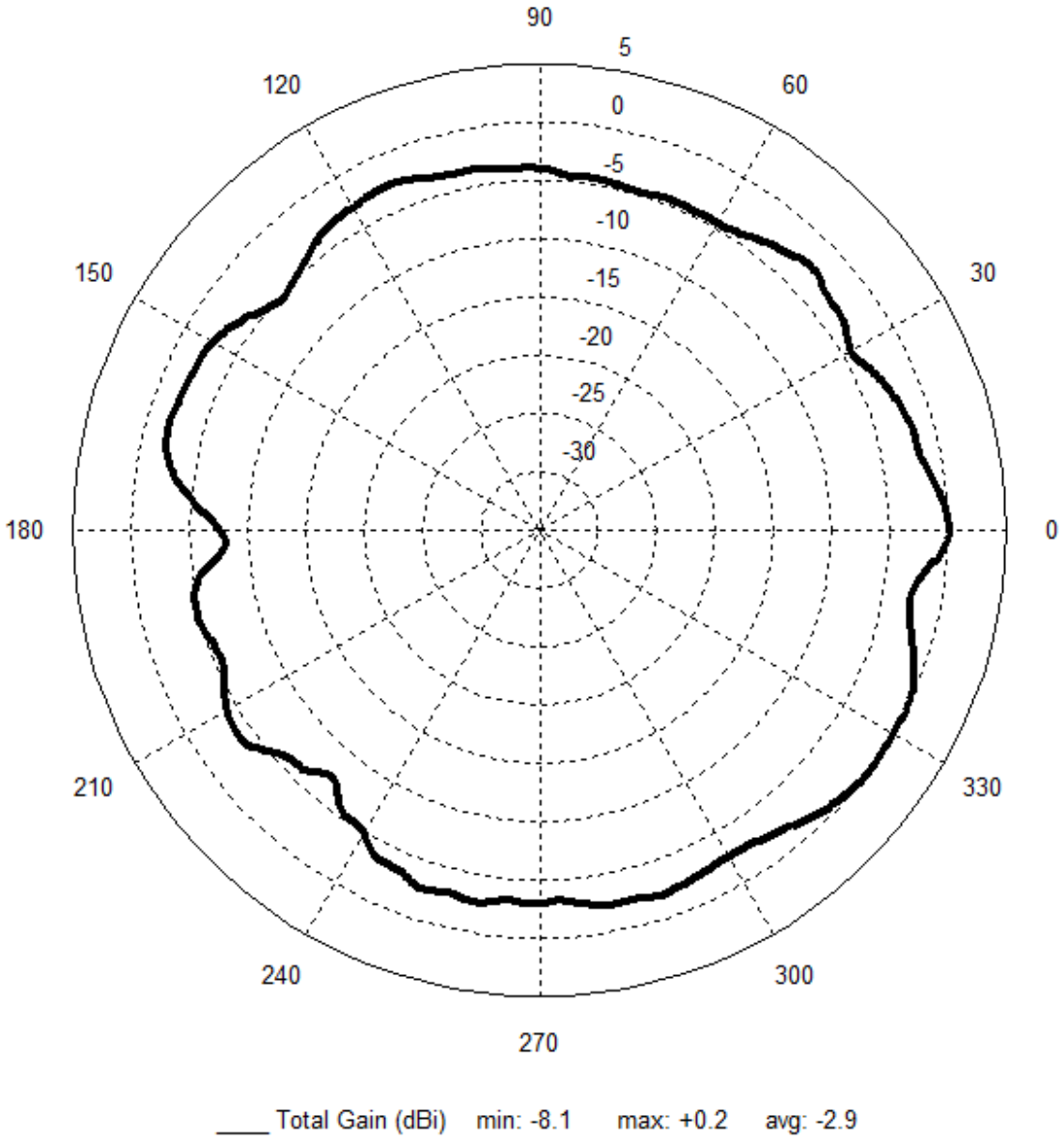



**Figure 10 Vertical Orientation Pattern**

**Vertical Orientation at 5400 MHz:**

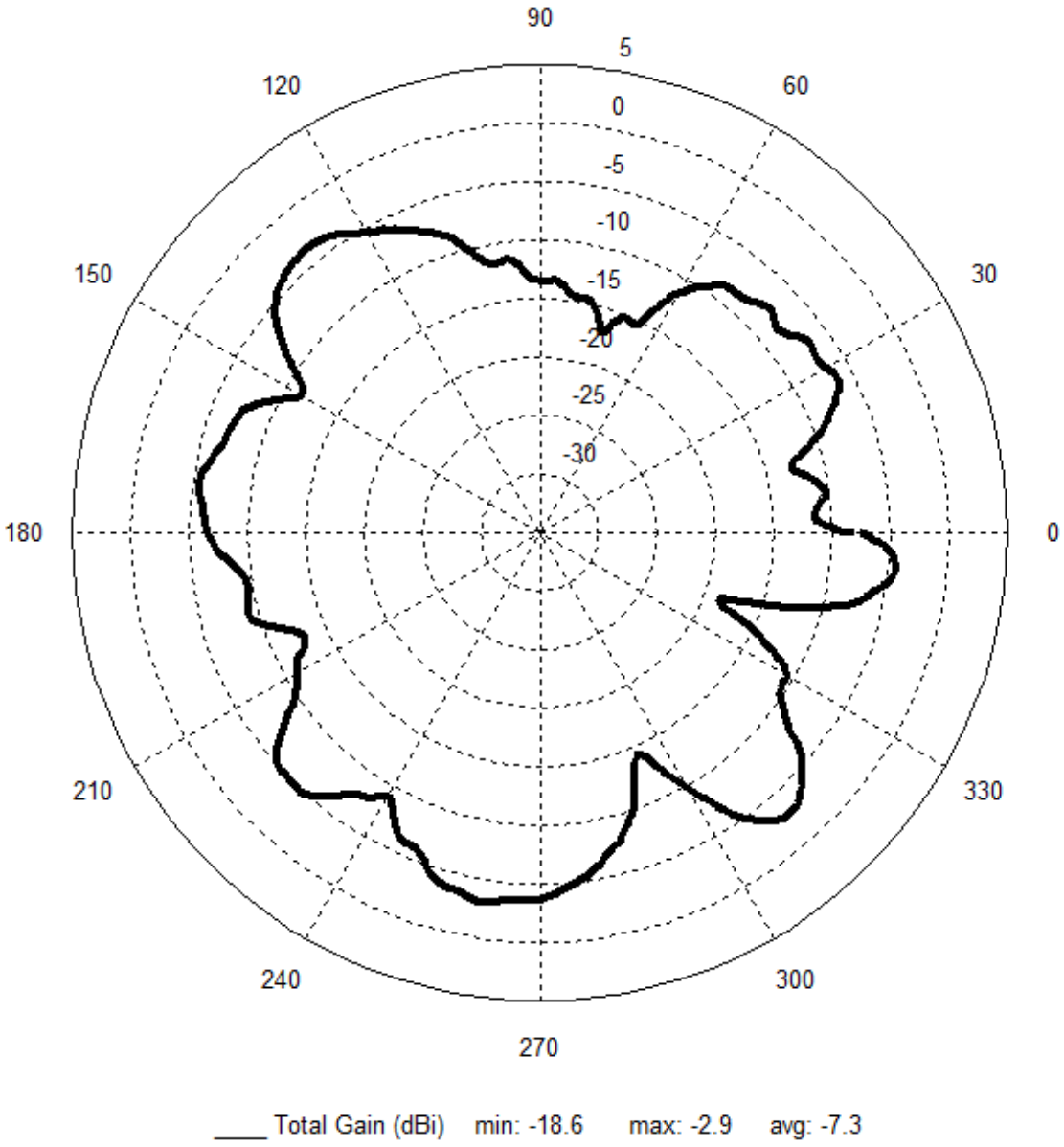



**Figure 11 Vertical Orientation Pattern**

**Vertical Orientation at 5900 MHz:**

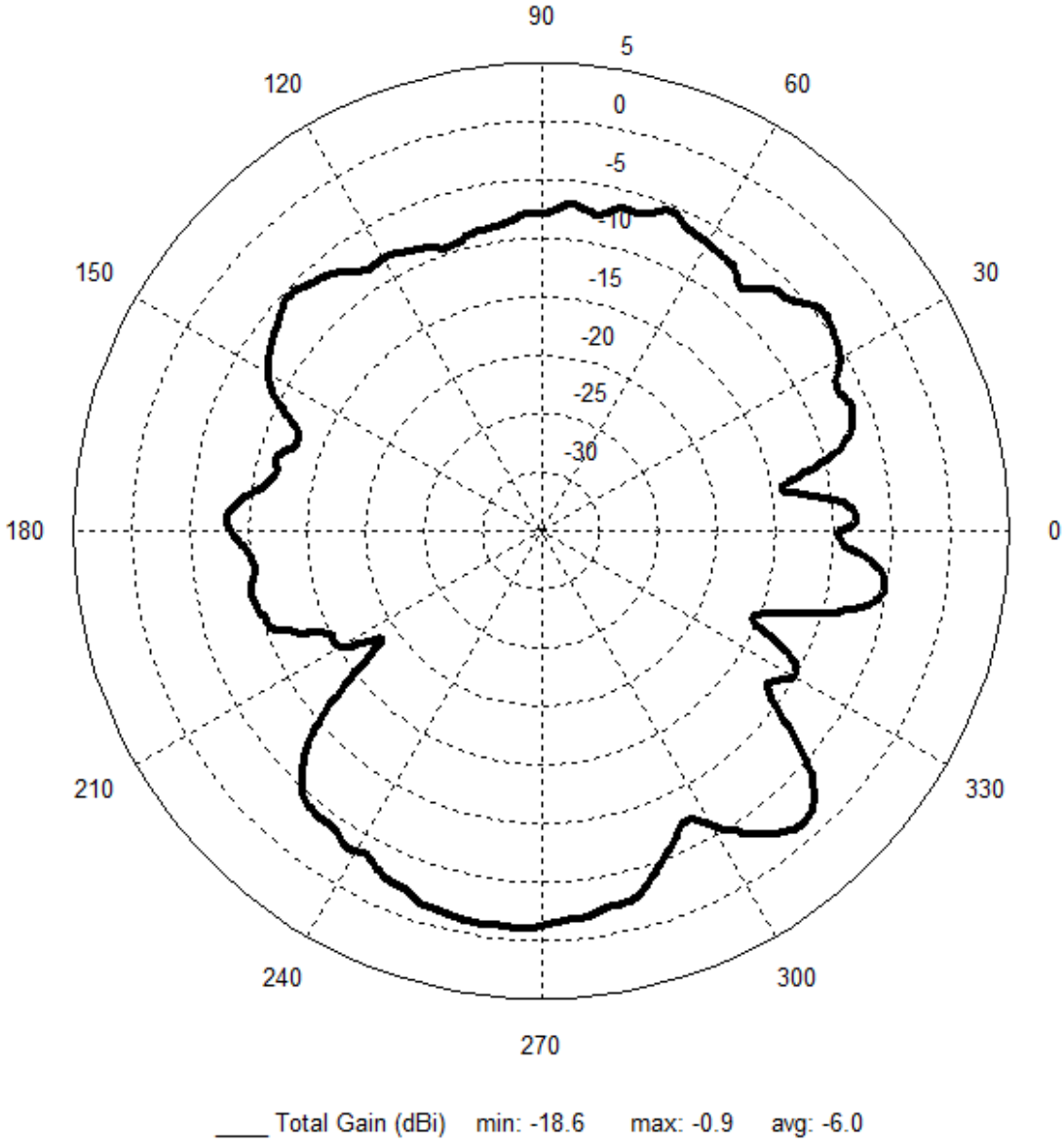



**Figure 12 Vertical Orientation Pattern**

**Antenna Measurement Set-Up:**

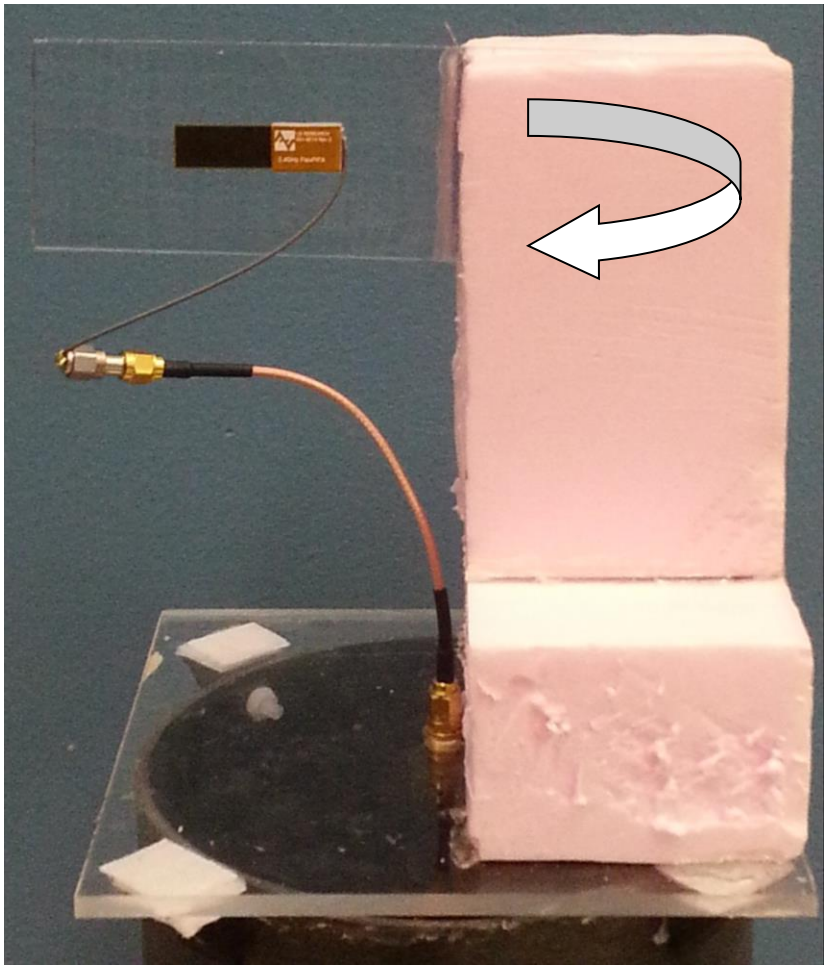


**Figure 13 Horizontal Orientation Set-Up**

**Horizontal Orientation at 4900 MHz:**

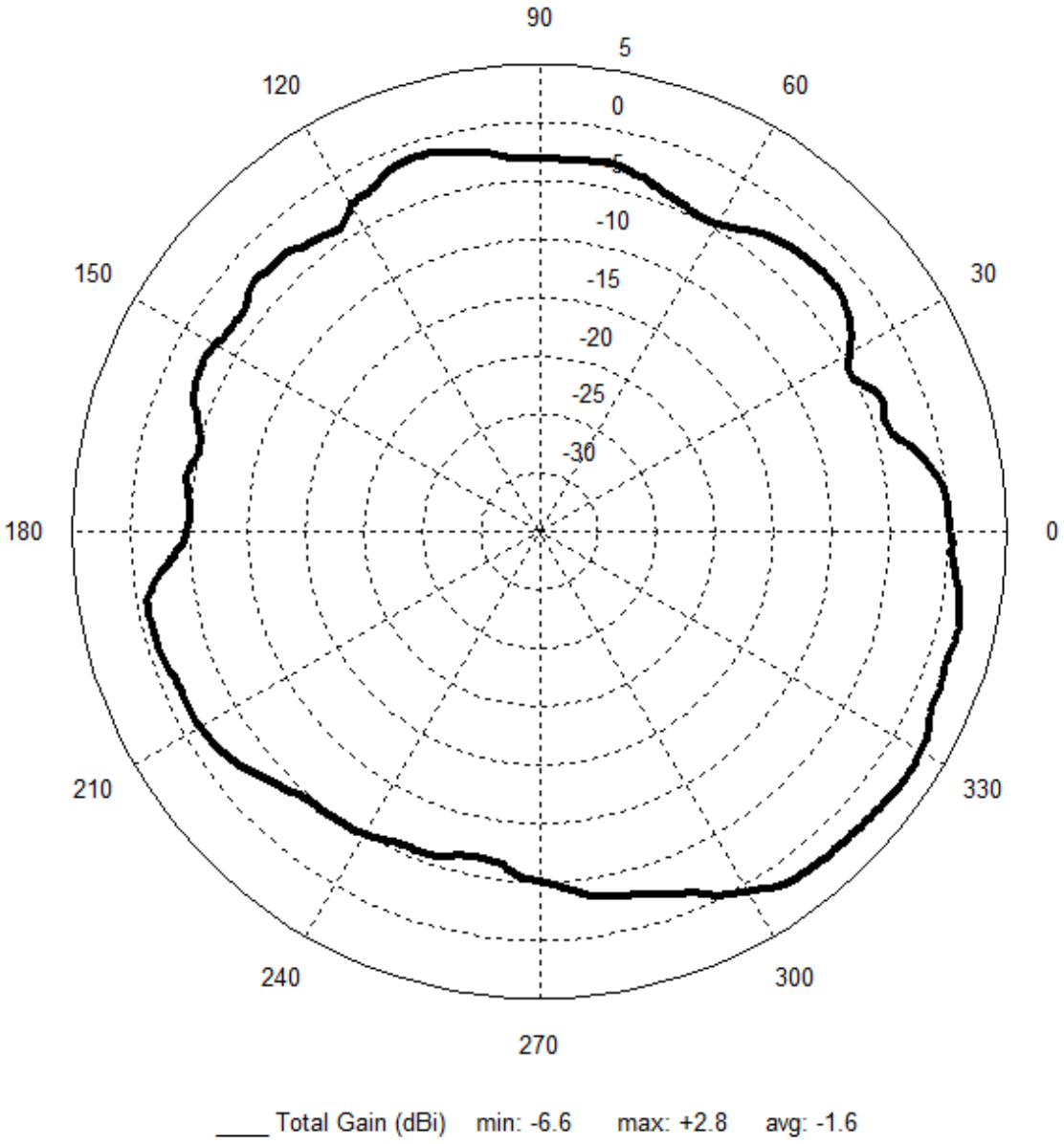



**Figure 14 Horizontal Orientation Pattern**

**Horizontal Orientation at 5400 MHz:**

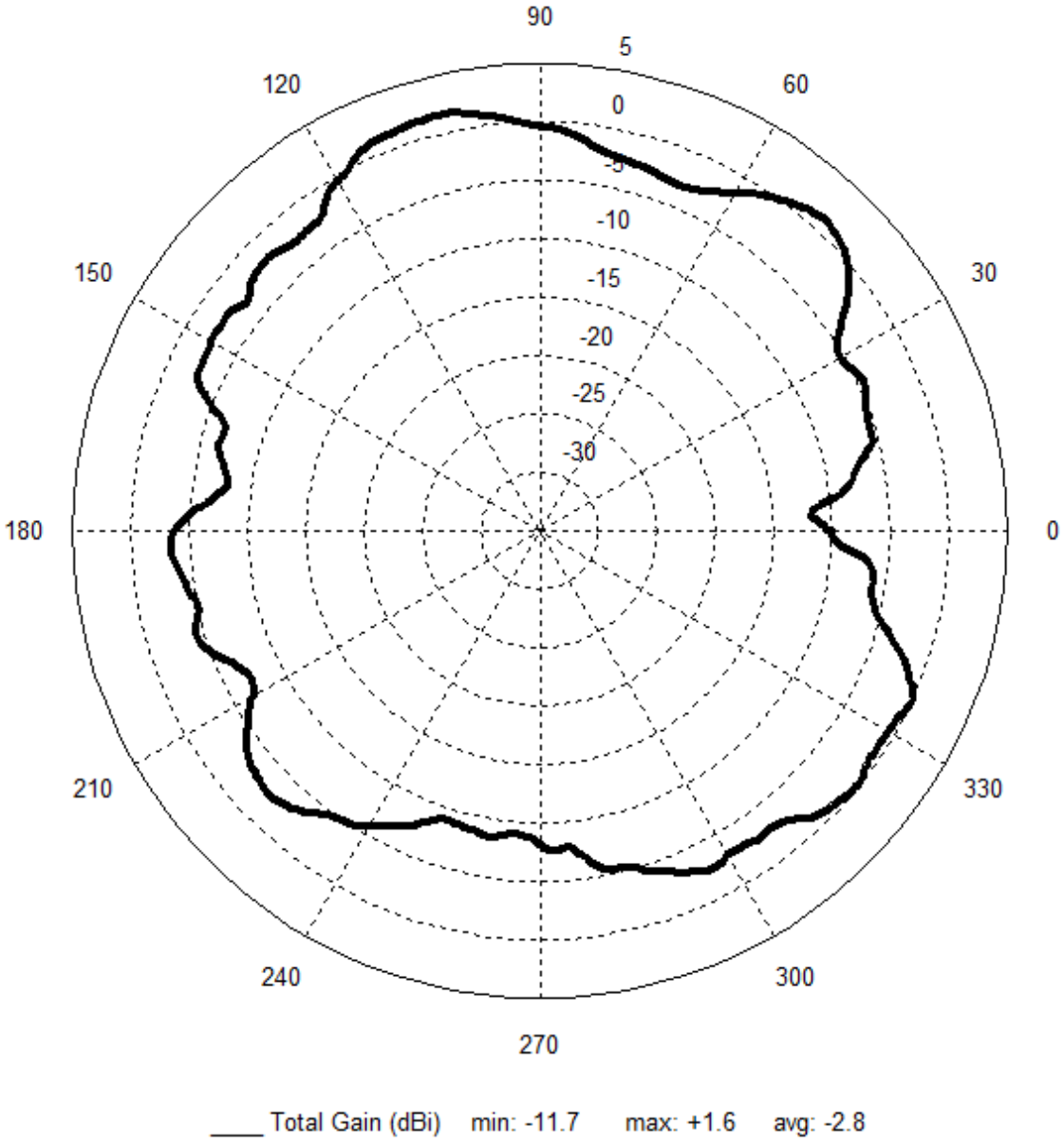



**Figure 15 Horizontal Orientation Pattern**

**Horizontal Orientation at 5900 MHz:**

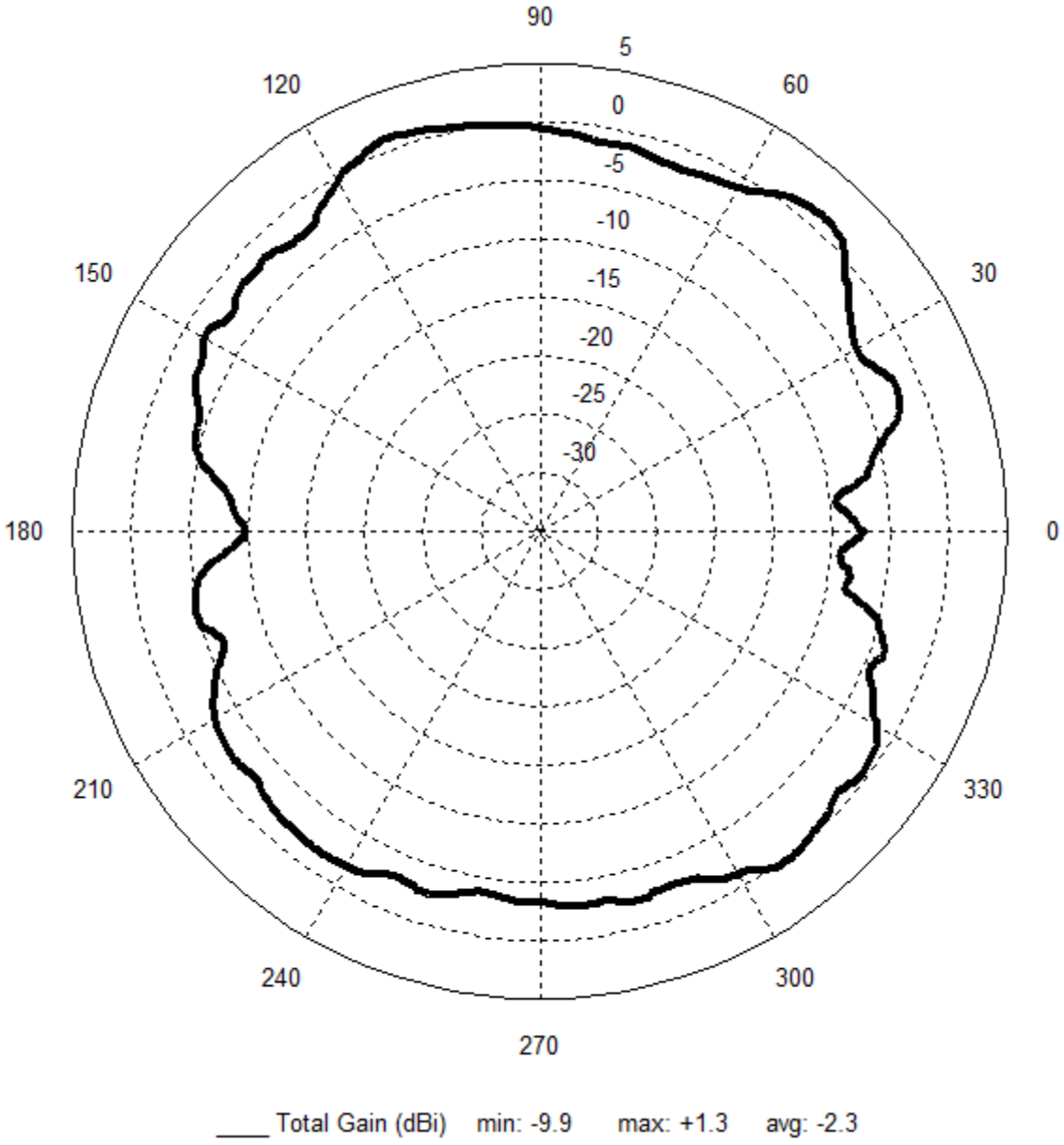



**Figure 16 Horizontal Orientation Pattern**

**Antenna Measurement Set-Up:**

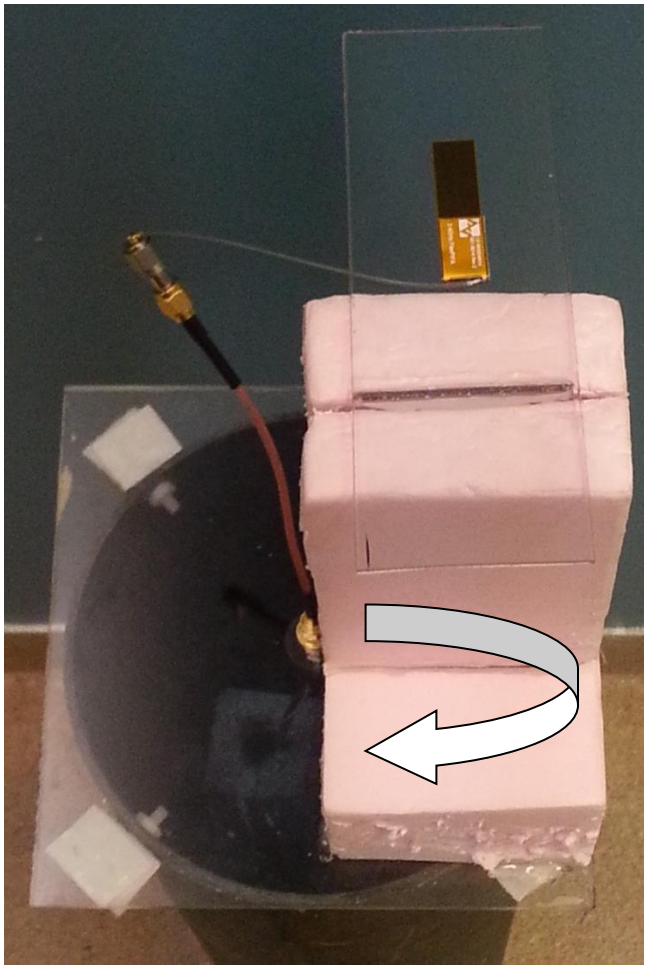


**Figure 17 Flat Orientation Set-Up**

**Flat Orientation at 4900 MHz:**

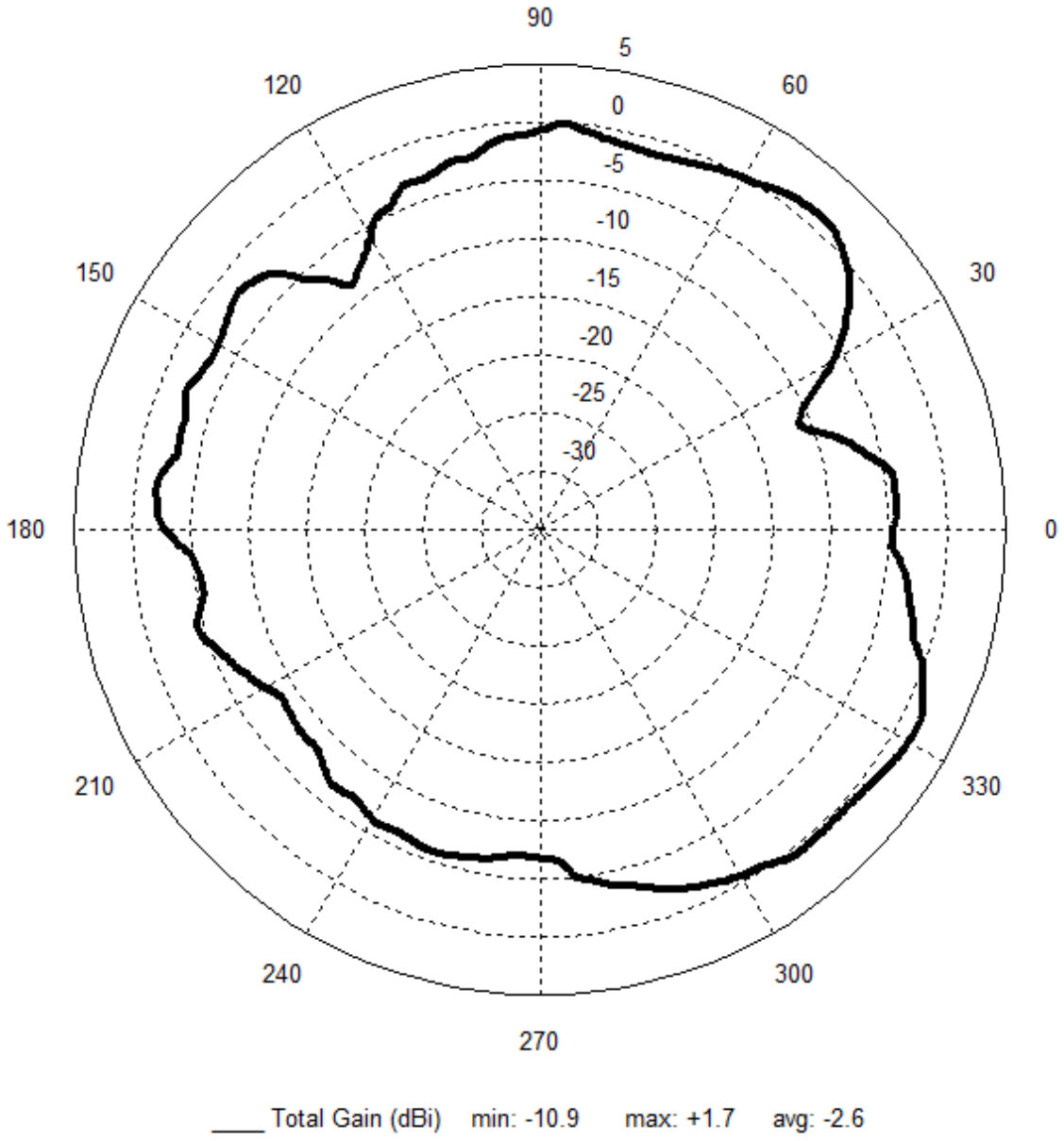



**Figure 18 Flat Orientation Pattern**

**Flat Orientation at 5400 MHz:**

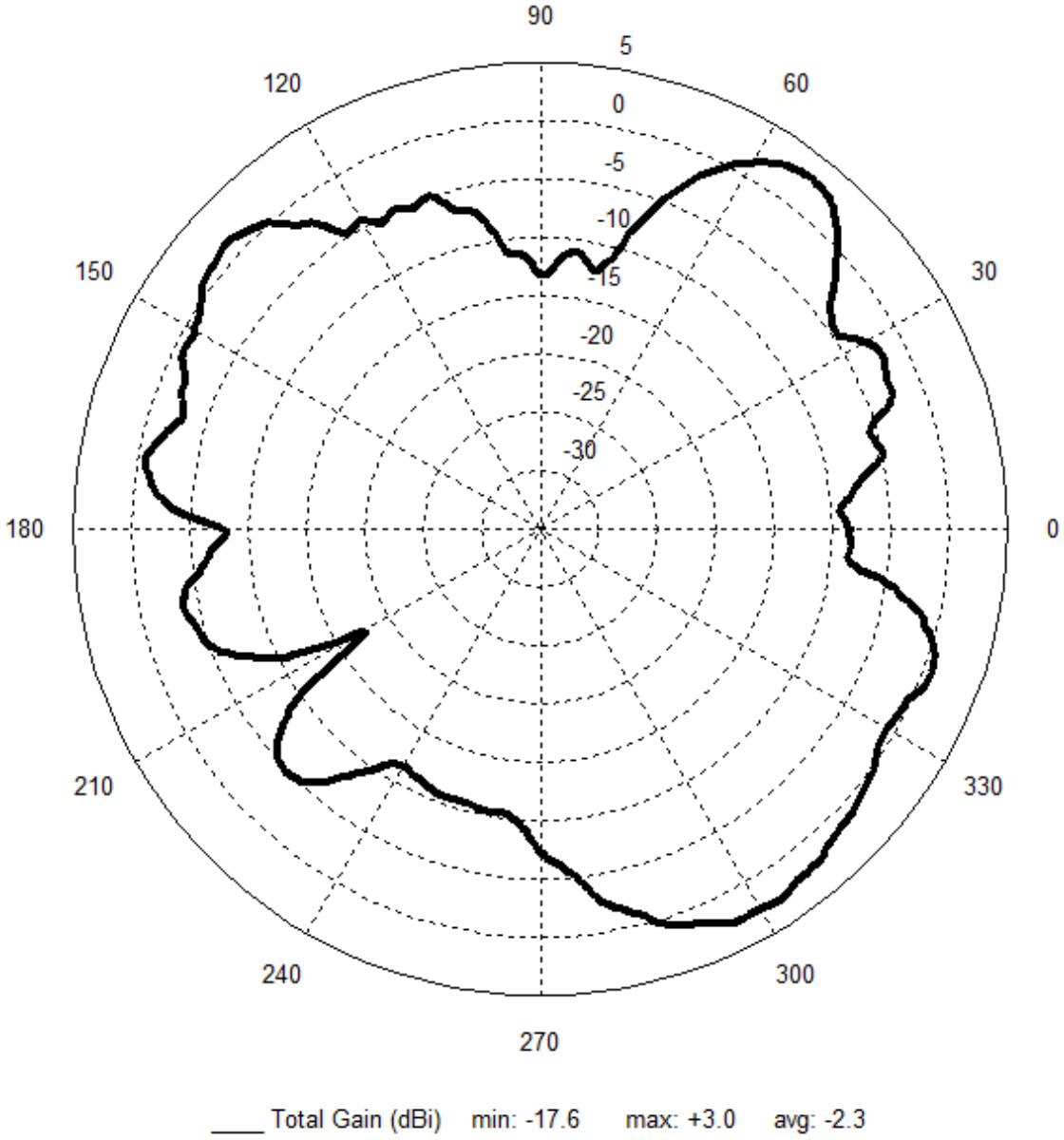



**Figure 19 Flat Orientation Pattern**

**Flat Orientation at 5900 MHz:**

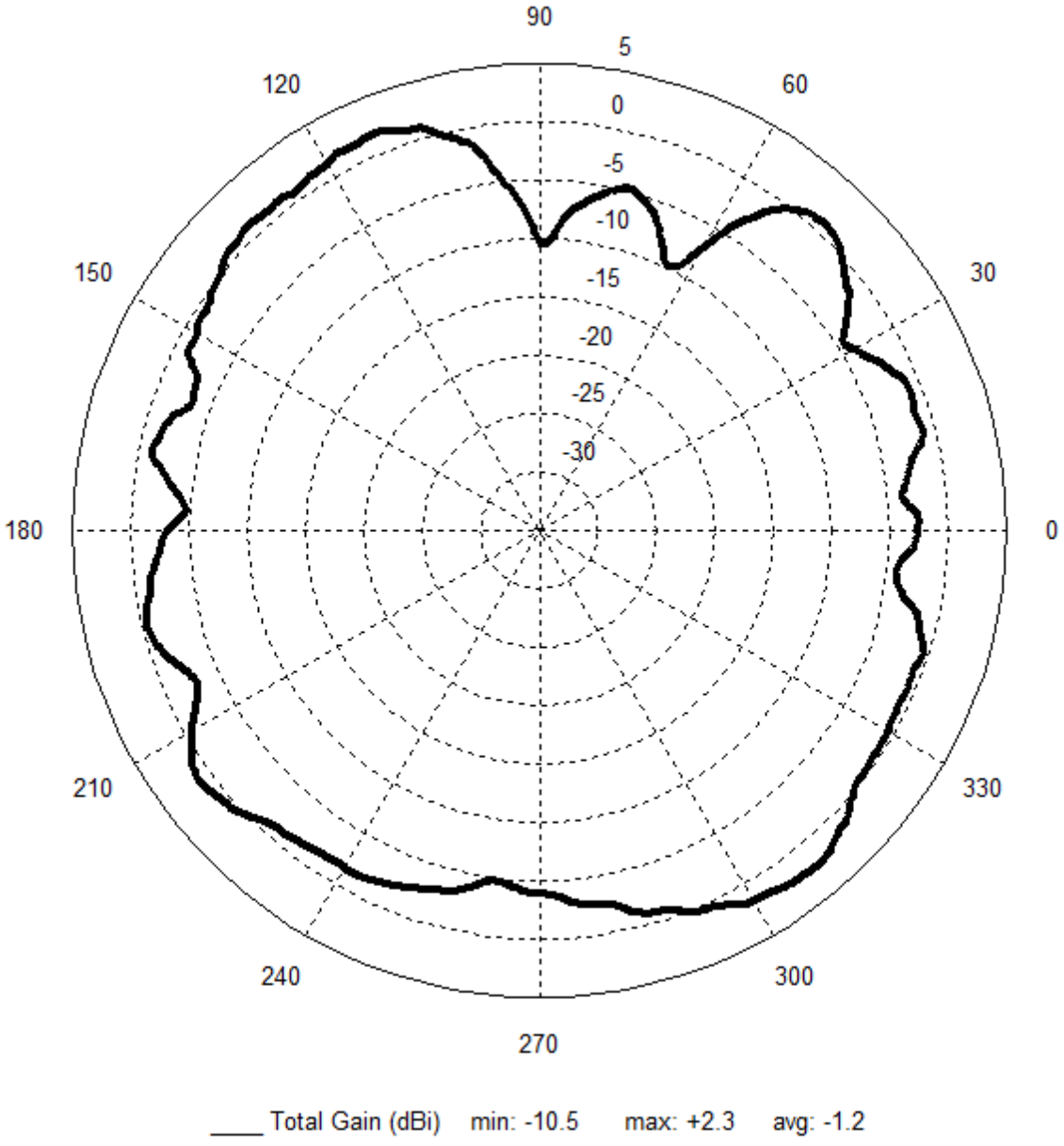



**Figure 20 Secondary Elevation Pattern**

## OPTIMAL INSTALLATION GUIDE

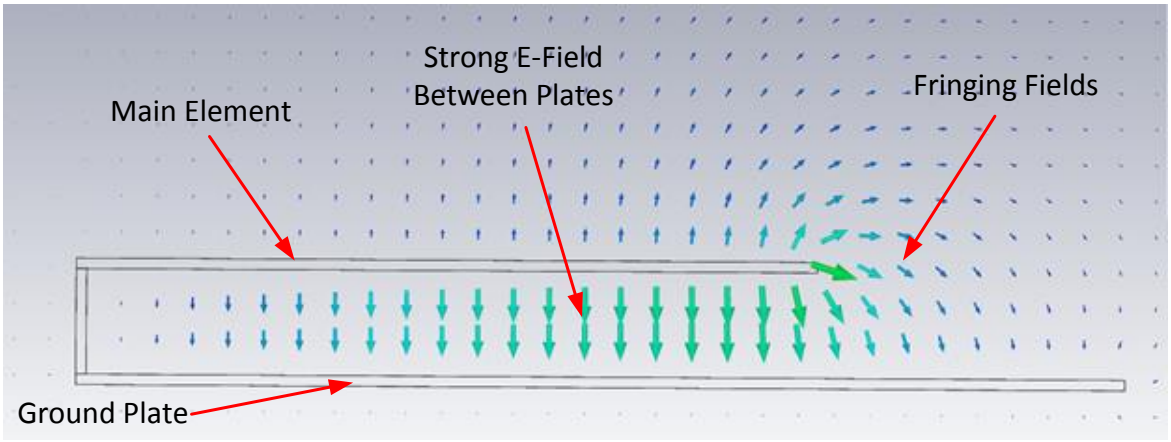



**Figure 21 E-Field Radiation from FlexPIFA, Taken from CST Simulation**

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.

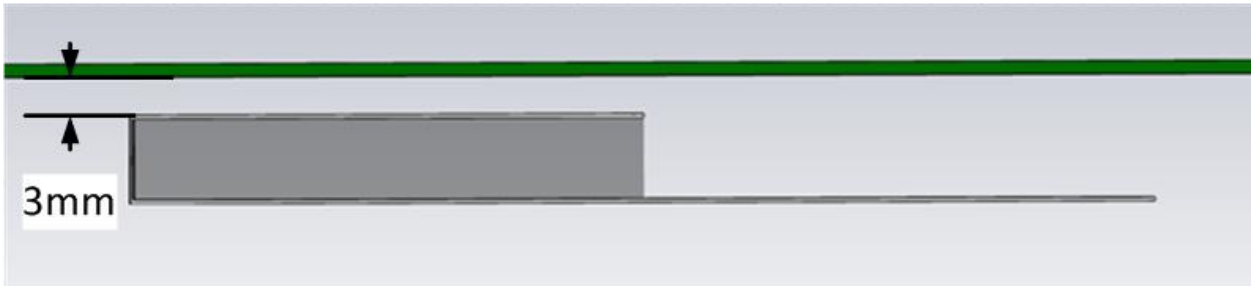
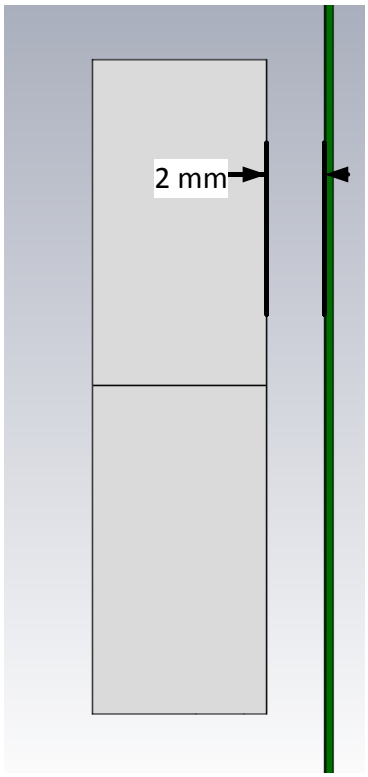
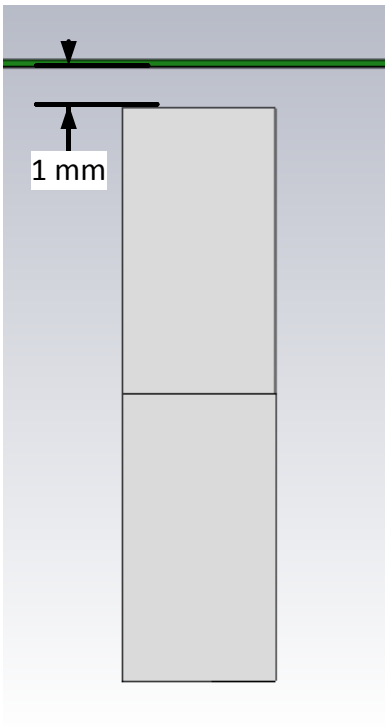



**Figure 22 Top Clearance**




Side Clearance



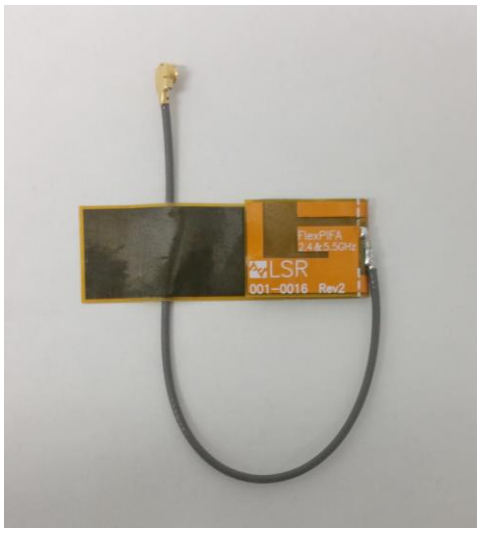

Ground Wall Clearance

**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.

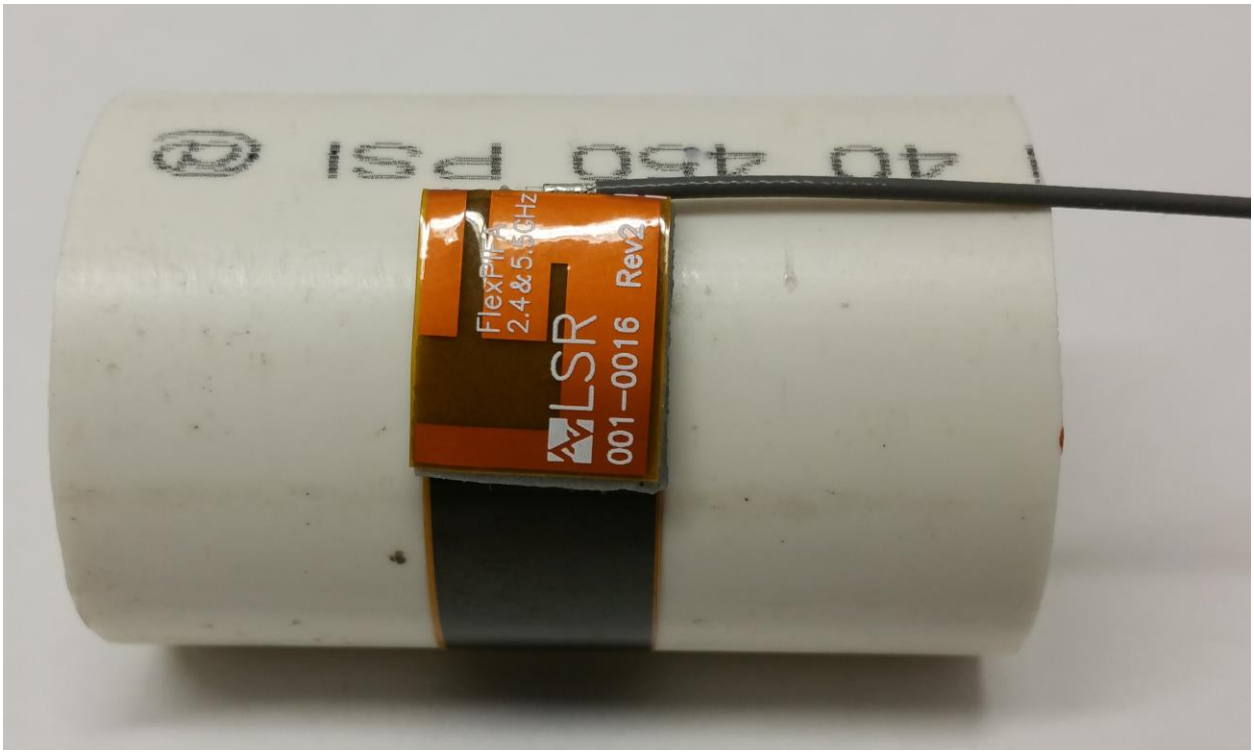



**Figure 25 Convex Mounted**

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.

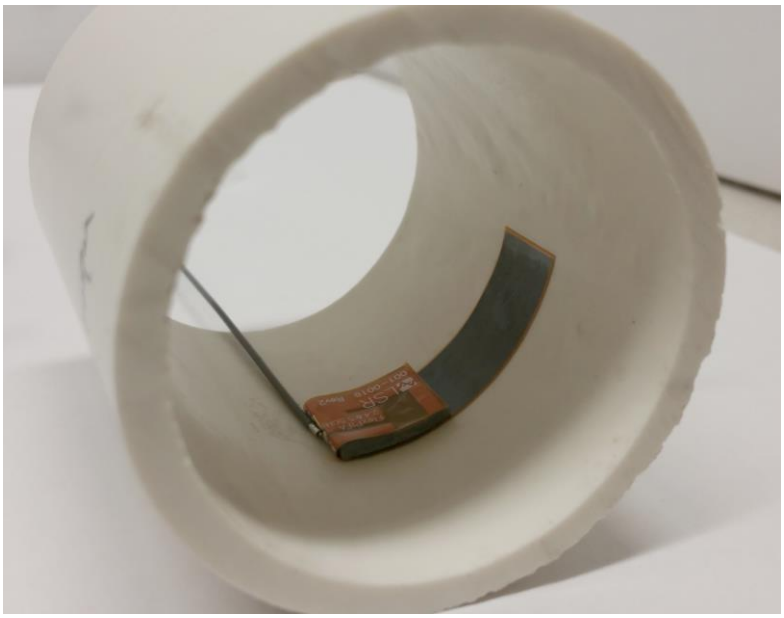


**Figure 26 Concave Mounted**

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.

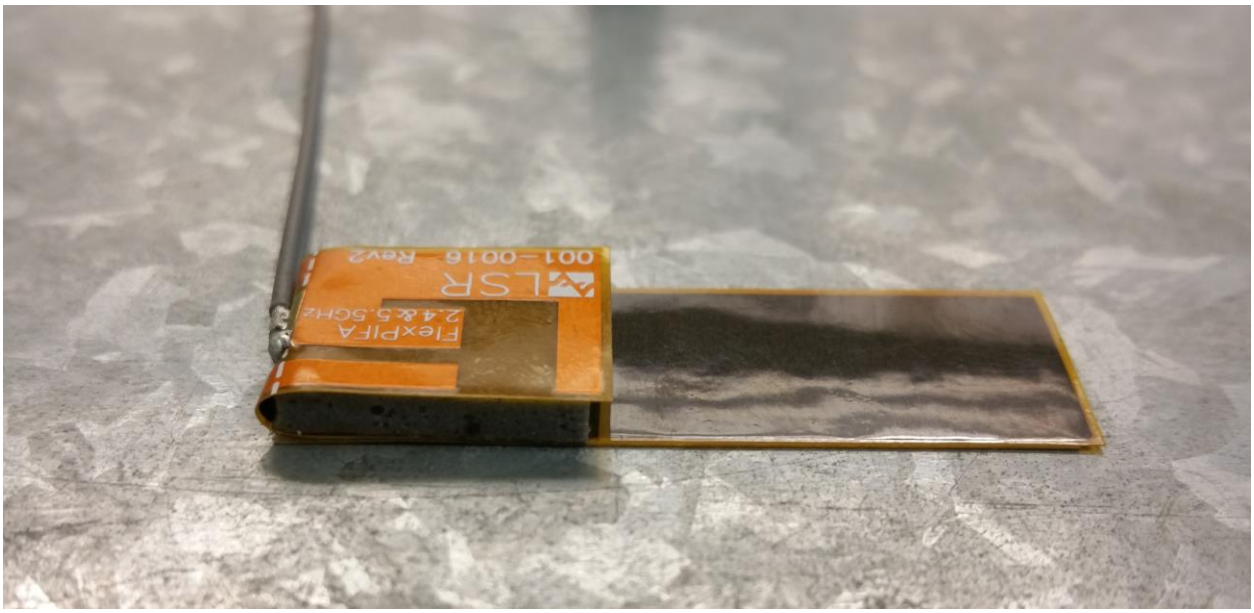



**Figure 27 FlexPIFA Mounted on Metal**

**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**

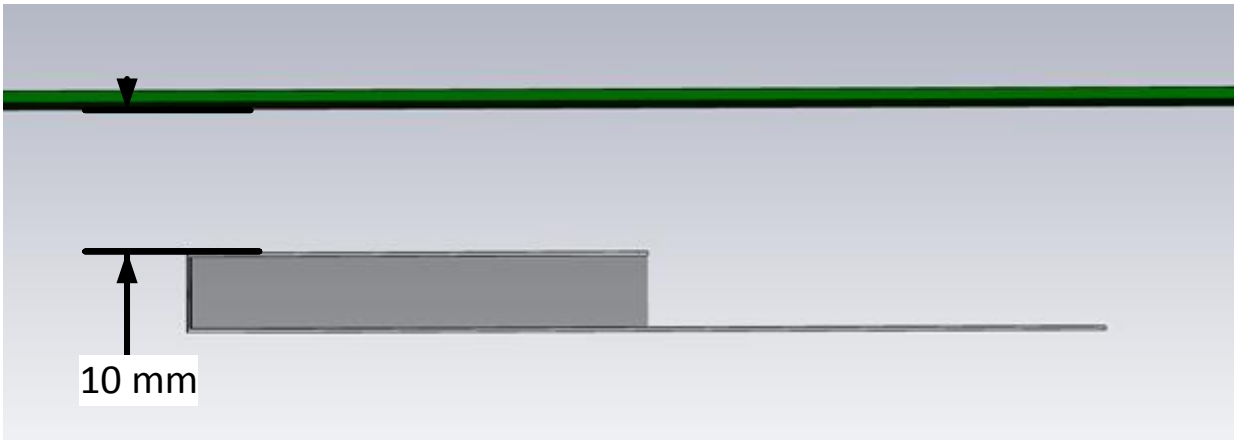



**Figure 29 Metal near Main Element**

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.

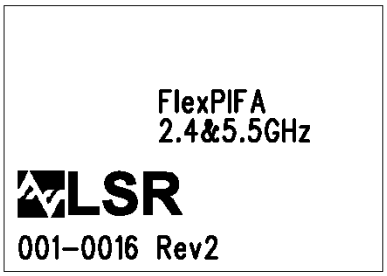

**Figure 30 FlexPIFA Integrated into Bracelet**

## PRODUCT REVISION HISTORY

**Rev 1: Initial Production Release**


**Rev 2:**




**Updated LSR Logo**

## CONTACTING LSR

**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 / 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)

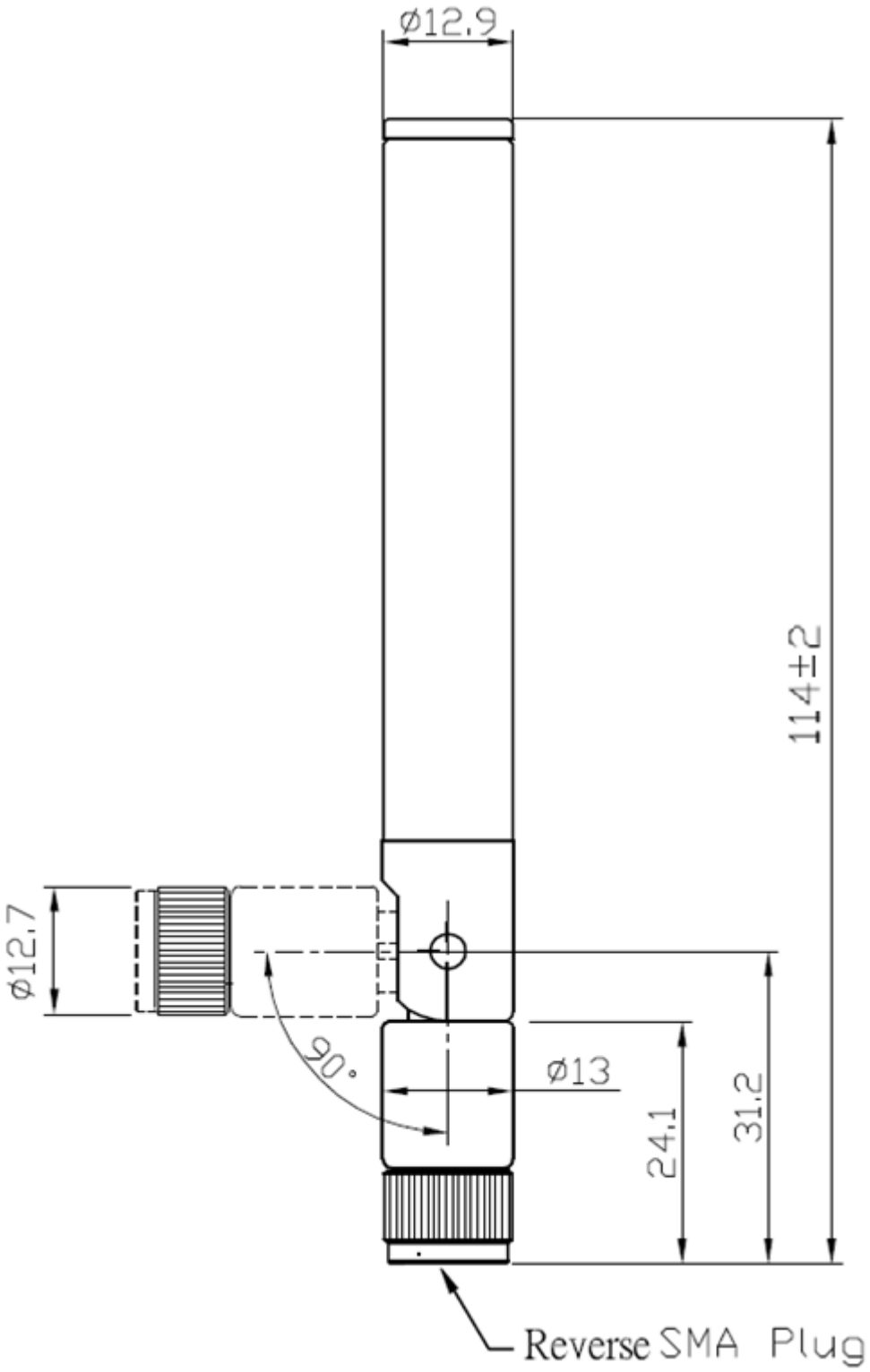



**Figure 1 Physical Dimensions**

## TYPICAL ANTENNA REFLECTION PERFORMANCE

### Straight Antenna Position

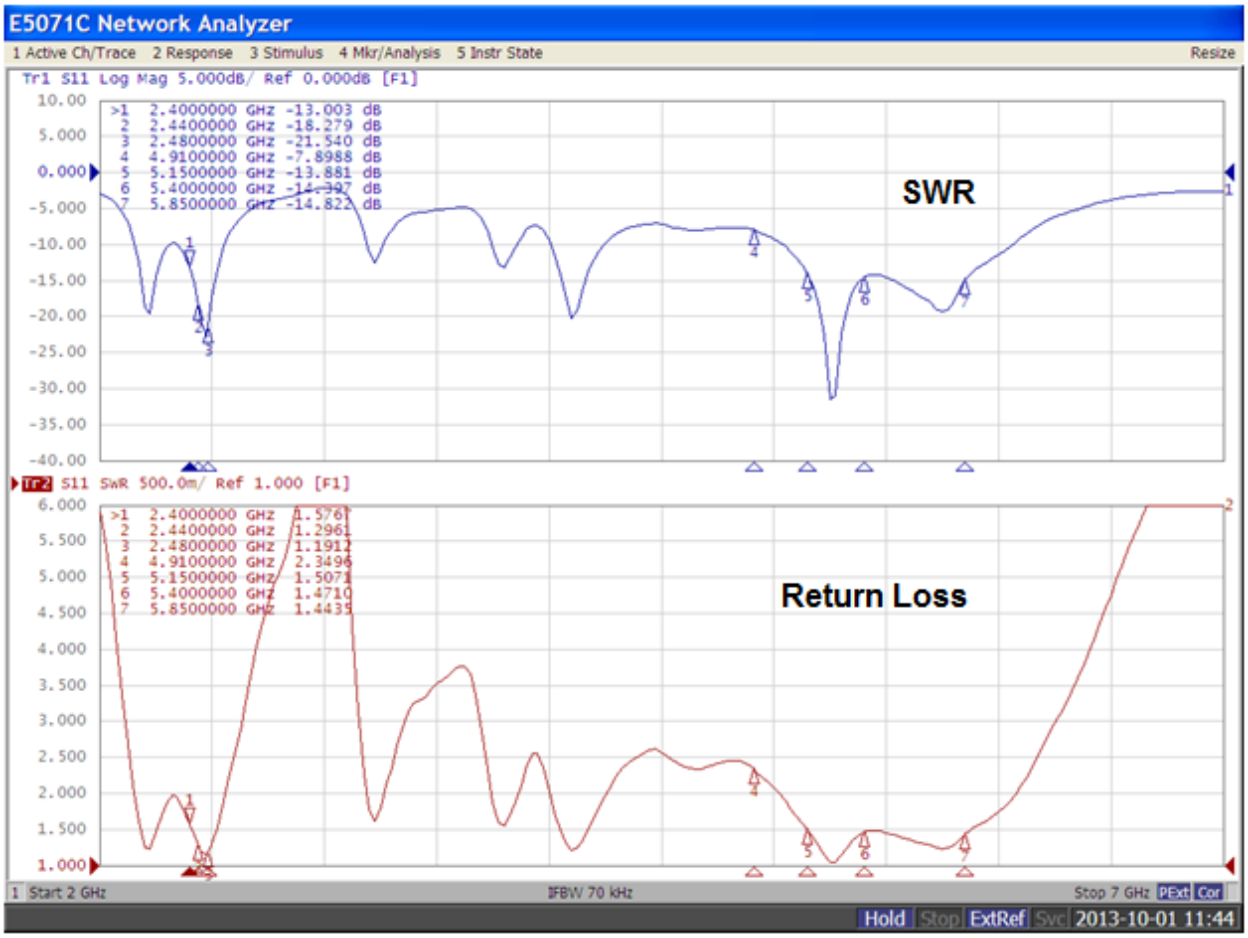



**Figure 2 Typical Straight Position Reflection Performance**

## Bent Antenna Position

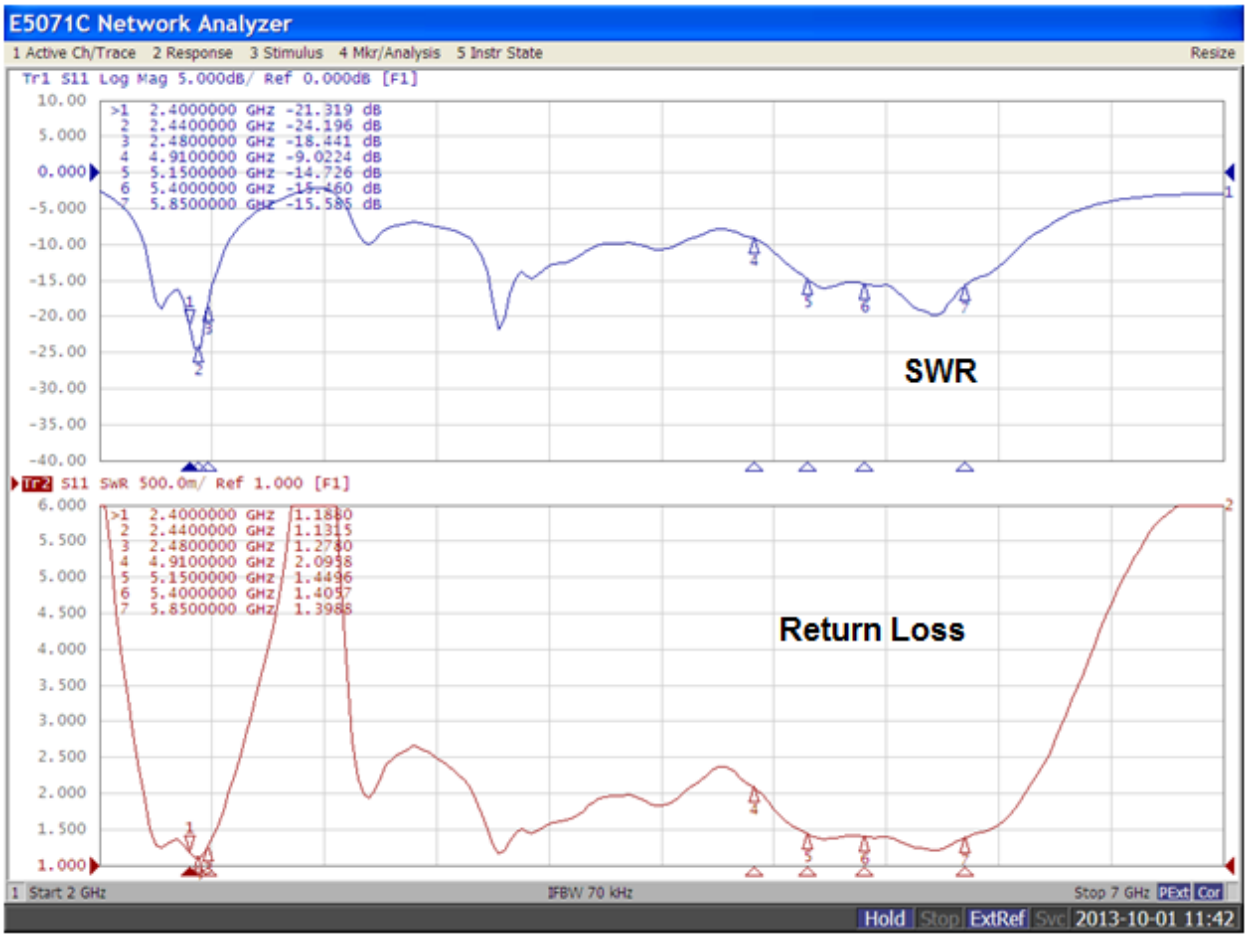



**Figure 3 Typical Bent Position Reflection Performance**

## TYPICAL ANTENNA RADIATION PERFORMANCE

### 2.4 GHz Band

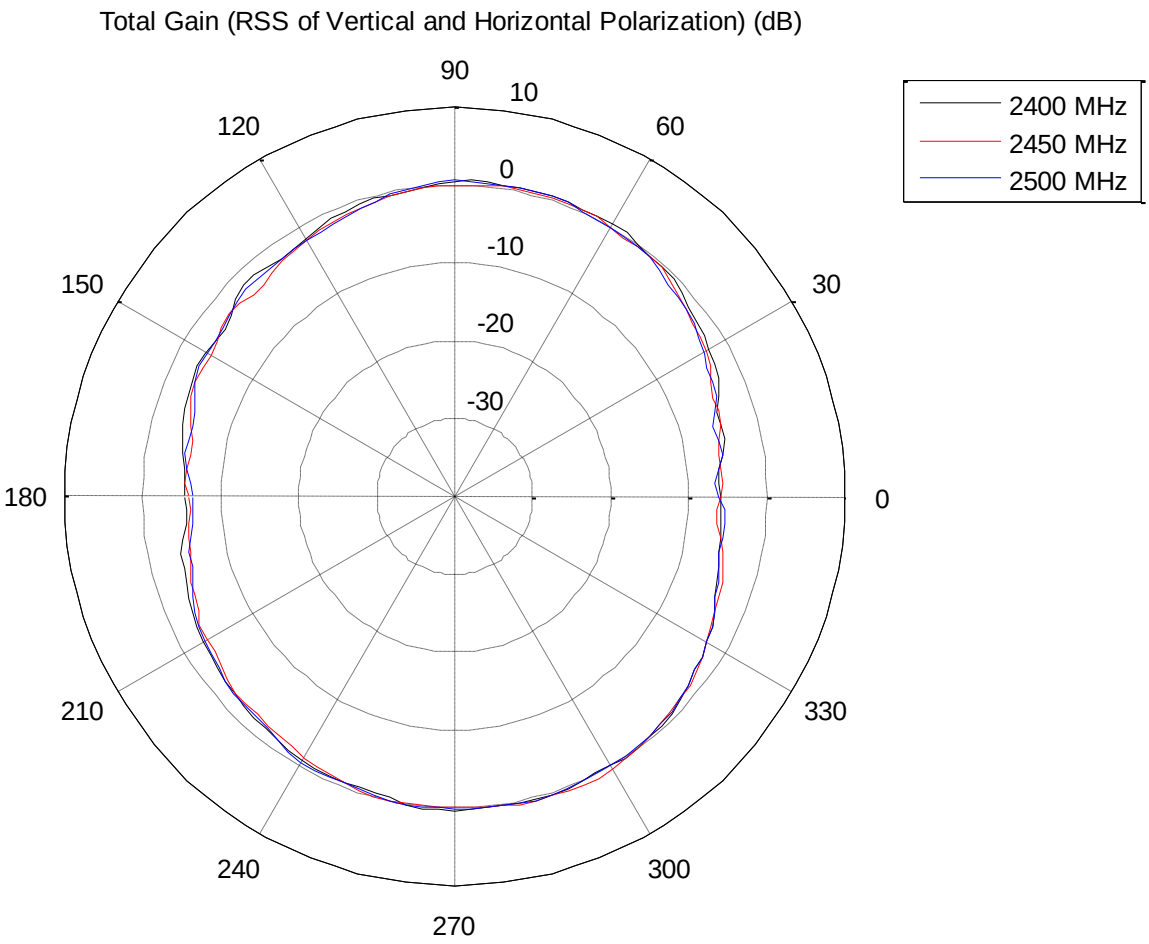



**Figure 4 Typical E-Plane Performance**

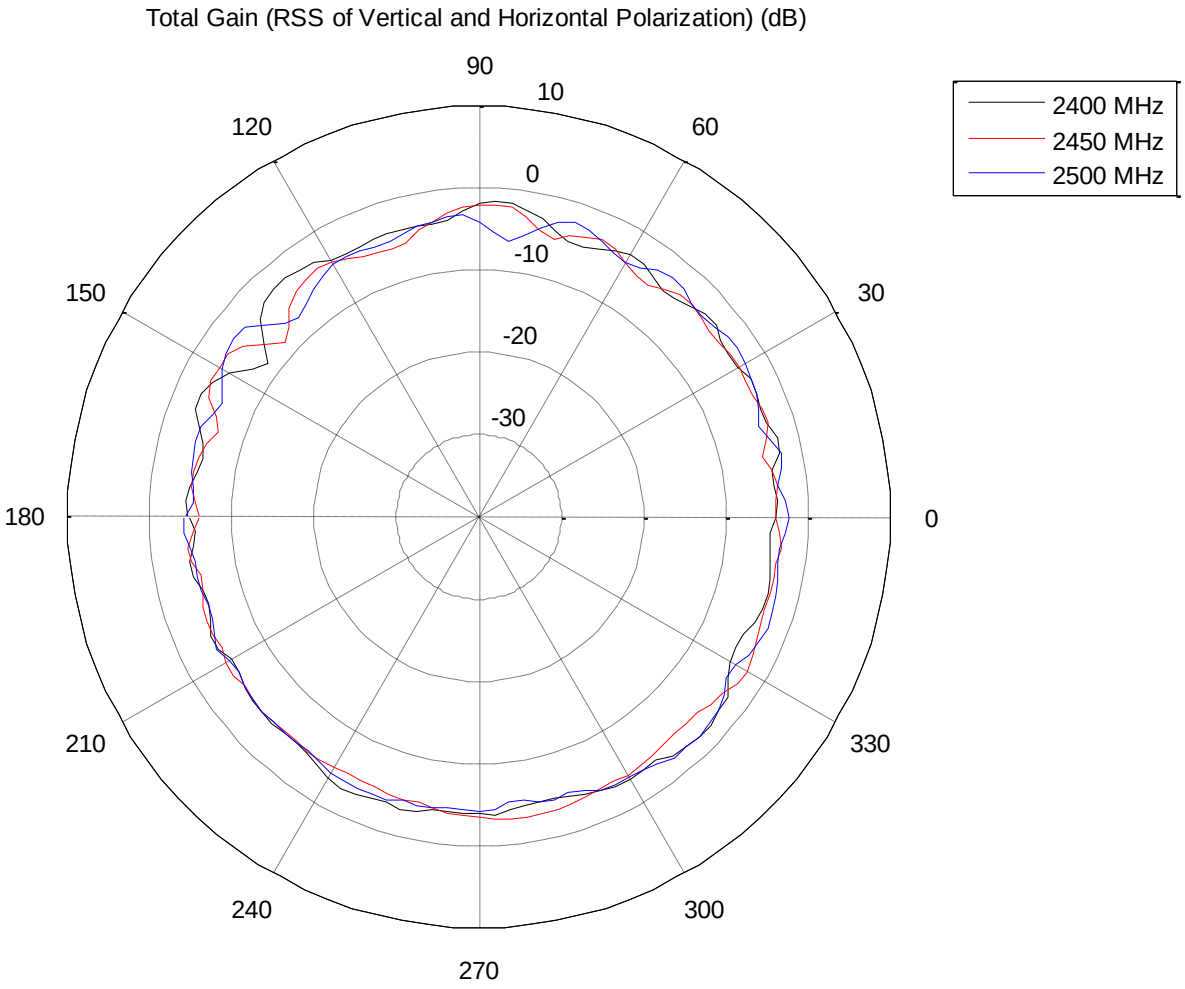



**Figure 5 Typical H-Plane Performance**

**5 GHz Band**

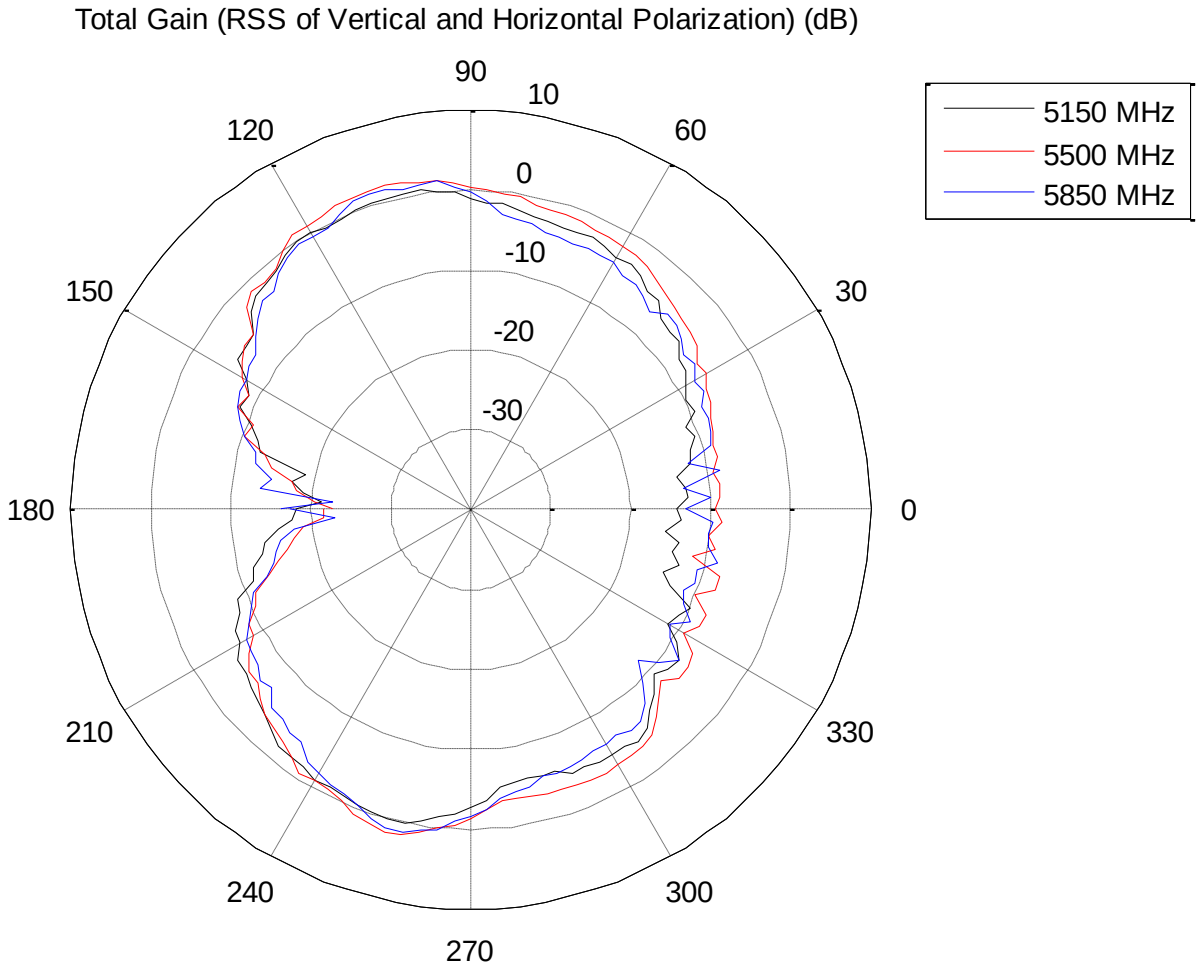



**Figure 6 Typical E-Plane Performance**

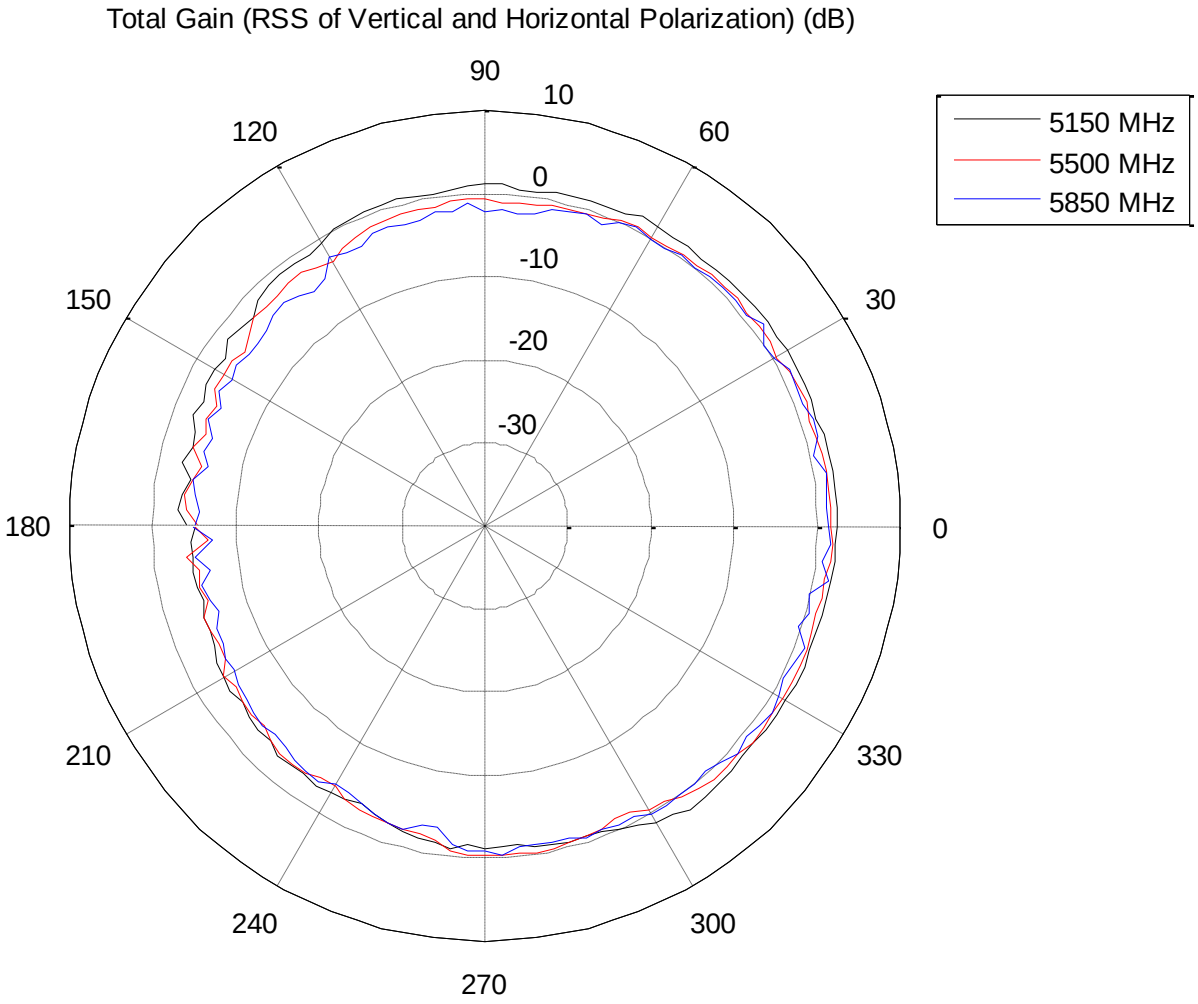



**Figure 7 Typical H-Plane Performance**

## CONTACTING LS RESEARCH

| | |
|---|---|
| **Headquarters** | LS Research, LLC<br>W66 N220 Commerce Court<br>Cedarburg, WI 53012-2636<br>USA<br>Tel: 1(262) 375-4400<br>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!*

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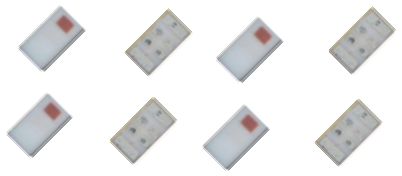


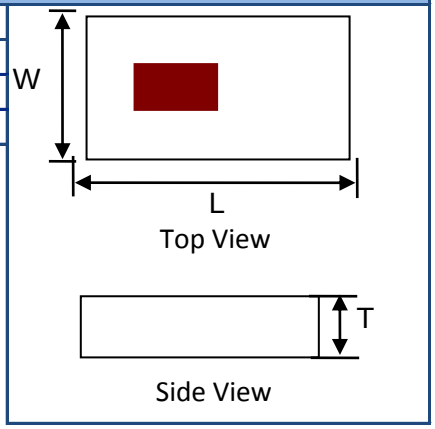
| | |
|---|---|
| **Storage Period** | 18 months max. |
| **Storage Temperature** | -40 to +85°C |
| **Operating Temperature** | -40 to +85°C |
| **Reel Quantity** | 4000 |

## 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 | | |

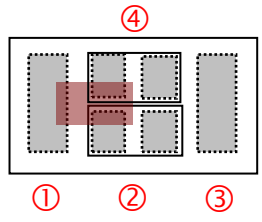
## Mechanical Dimensions

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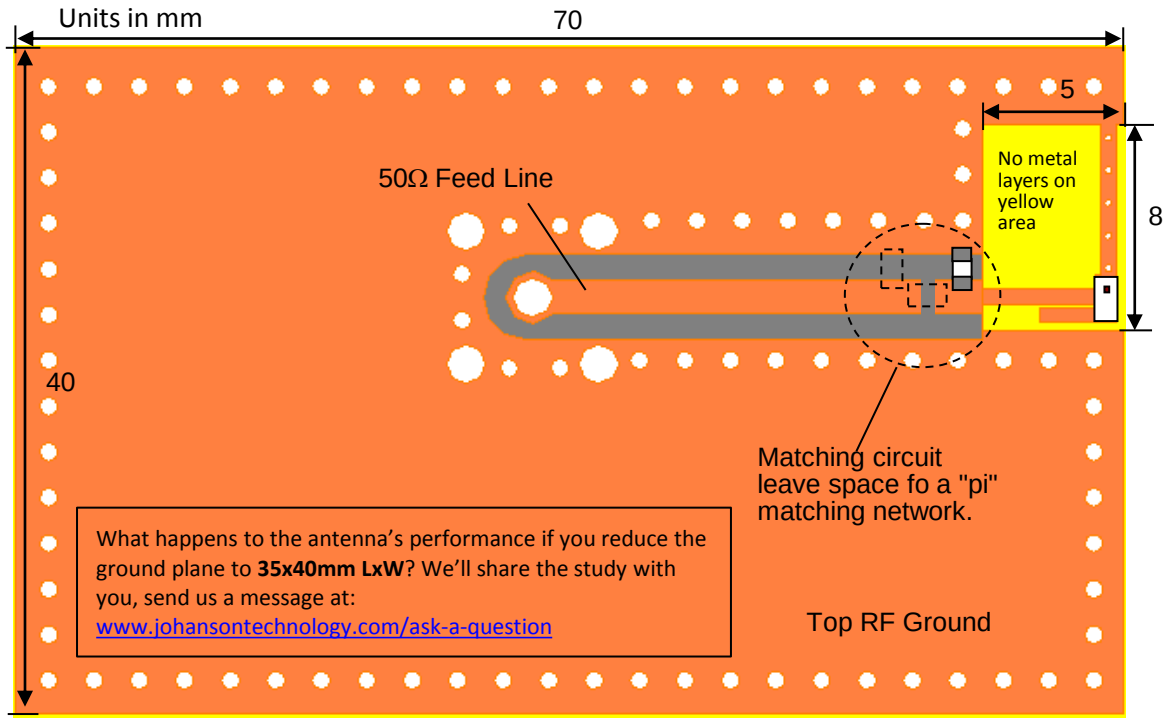
## Mounting Considerations 1: Evaluation Board, 65x70mm (Scenario 1 Terminal Configuration)




**To order teh ABOVE pre-tuned 50Ω EVB with a female SMA connector**
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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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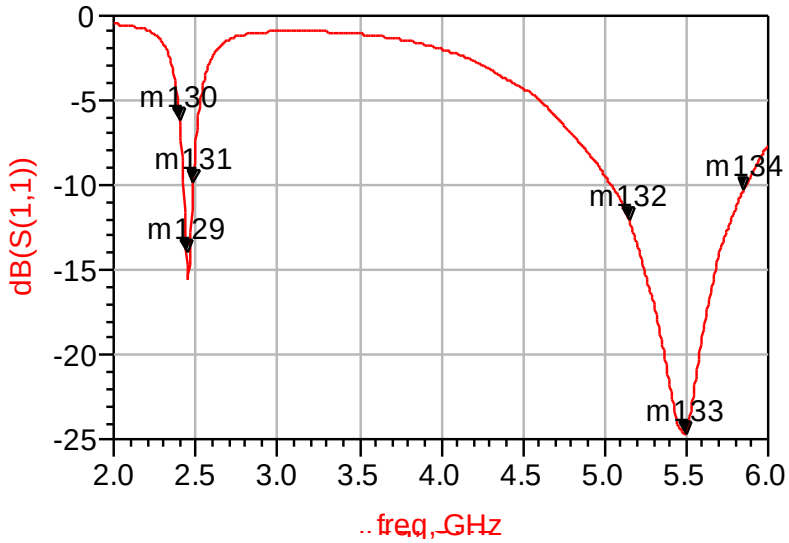
## Mounting Considerations 2: Typical Electrical Performance (T=25°C)




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

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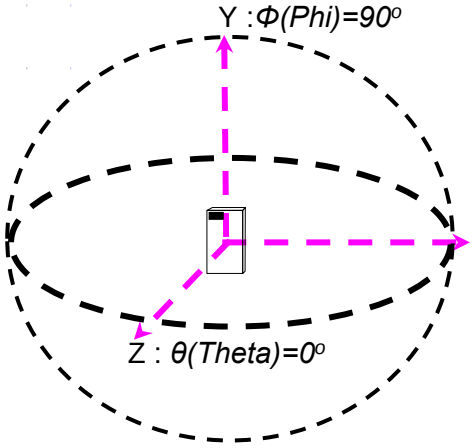
**802.11 Dual Band 2.45/5 GHz Mini Chip Antenna. WiFi, Wireless LAN, IoT P/N 2450AD14A5500**

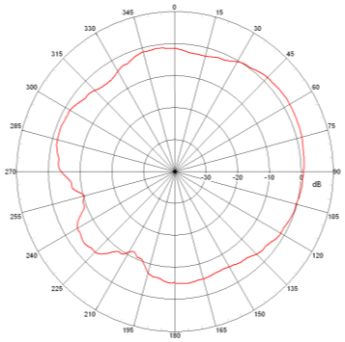
Detail Specification: 10/26/2017 

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

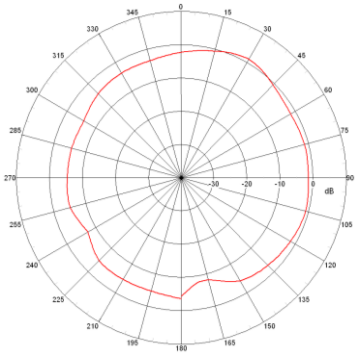
## Typical EM Radiation Performance @ 2.44GHz (T=25°C)



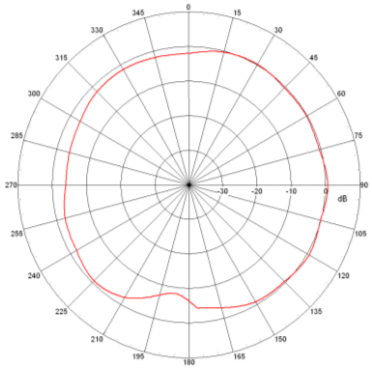

XY-plane @2440MHz
Total



XZ-plane @2440MHz
Total



YZ-plane @2440MHz
Total



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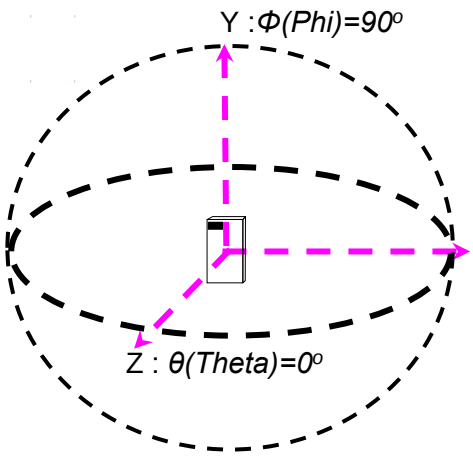
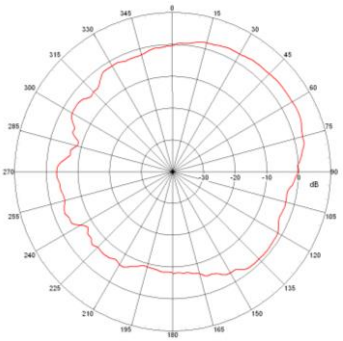
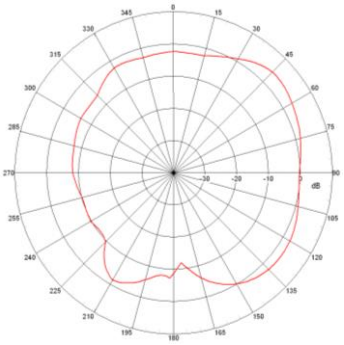
## Typical EM Radiation Performance @ 5.50 GHz (T=25°C)



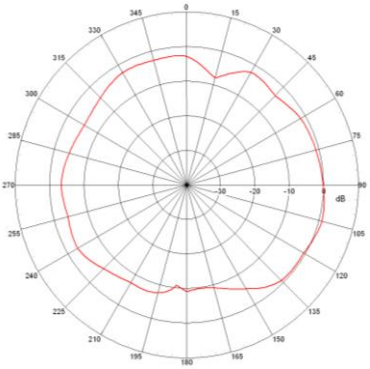

XY-plane @5500MHz
Total



XZ-plane @5500MHz
Total



YZ-plane @5500MHz



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| |
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2 Free layout reviews and if you need us to tune and characterize the antenna on your product (inside anechoic chamber) we can do that too. Small lab fee may apply for the latter.

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