



a Laird Business

W66 N220 Commerce Court • Cedarburg, WI 53012

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[www.lsr.com](http://www.lsr.com)

**TEST REPORT #: 316053 C**

**LSR Job #: C-2395**

Compliance Testing of:

Sterling LWB

Test Date(s):

July 11<sup>th</sup> to 13<sup>th</sup> 2016

Prepared For:

Attention: Josh Bablitch

LSR

W66N220 Commerce Ct.

Cedarburg, WI 53012

This Test Report is issued under the Authority of:

Khairul Aidi Zainal, Engineering Manager – Test Services

Signature:

Date: 7/19/16

Test Report Reviewed by:

Michael Hintzke, EMC Engineer III

Signature:

Date: 7/18/16

Project Engineer:

Khairul Aidi Zainal, Engineering Manager – Test Services

Signature:

Date: 7/16/16

This Test Report may not be reproduced, except in full, without written approval of LS Research, LLC.

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Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
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## EXHIBIT 1: Introduction

### 1.1 Scope

Normative References:	Article 2 Paragraph 1 of the Certification Ordinance ARIB STD-T66 V2.1 “Second Generation Low Power data Communication System/Wireless LAN System” ARIB STD-T33 1 “Low Power data Communication System/Wireless LAN System” Ordinance Regulating radio Equipment
Purpose of Test:	To test for compliance against the requirements of the Japanese Radio Law for products operating under category WW and Article 2 item (19)
Test procedures:	Radio Law (Law No. 131) Ministerial Ordinance No. 37 (Rules Concerning Technical Regulations Conformity Certification of Specified Radio Equipment) Ordinance Regulating Radio Equipment MIC notice 88 (test methods and appendix to Post of the Ministerial Ordinance N0.37)

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## **1.2 LS Research, LLC in Review**

*As an EMC Testing Laboratory, our Accreditation and Assessments are recognized through the following:*



**A2LA – American Association for Laboratory Accreditation**

*Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation*

*A2LA Certificate Number: 1255.01*



**Federal Communications Commission (FCC) – USA**

*Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948*

*FCC Registration Number: 90758*



**Industry Canada**

*On file, 3 Meter Semi-Anechoic Chamber based on RSS-GEN – Issue 4*

*File Number: IC 3088A-2*

*On file, 3 Meter Semi-Anechoic Chamber based on RSS-GEN – Issue 4*

*File Number: IC 3088A-3*

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## **1.3 Location of Testing**

All testing was performed at the following location utilizing the facilities listed below, unless otherwise noted.

LS Research, LLC  
W66 N220 Commerce Court  
Cedarburg, Wisconsin, 53012 USA,

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## **1.4 Test Equipment Utilized**

A complete list of equipment utilized in testing is provided in Appendix A of this test report. Calibration dates are indicated in Appendix A. All test equipment is calibrated by a calibration laboratory accredited to the requirements of ISO/IEC 17025, and traceable to SI standards.

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## EXHIBIT 2: Client & EUT Information

### **2.1 Client Information**

Manufacturer Name:	LSR
Address:	W66N220 Commerce Ct. Cedarburg. WI 53012
Contact Name:	Josh Bablitch
E-mail address:	Josh.bablitch@lairdtech.com

### **2.2 Equipment Under Test (EUT) Information**

The following information has been supplied by the applicant.

Product Name:	Sterling-LWB
Model Number:	STERLING-LWB
Serial Number:	33

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## 2.3 Summary of EUT Technical Specifications

EUT Frequency Range (in MHz)	2402 MHz to 2480 MHz	
Antenna Power	<input checked="" type="checkbox"/> Conducted Measurement <input type="checkbox"/> Radiated Measurement	
Minimum (mW):	BLE = 4.487	
Maximum (mW):	BLE = 7.278	
Maximum Occupied Bandwidth and Spreading Bandwidth (99% and 90%)	<u>90% (MHz):</u> N/A	<u>99%(MHz):</u> 1.06
Type of Modulation	GFSK	
Frequency Tolerance %, Hz, ppm	Better than 50 ppm	
Antenna Information		
Detachable/non-detachable	Detachable and non-detacheable	
Type	Chip, Dipole, FlexNotch, FlexPIFA	
Gain and Pattern	Peak Gain (dBi): Chip = 1.5 Dipole = 2.0 FlexNotch = 2.0 FlexPIFA = 2.0  Pattern: Omni-directional	

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## **2.4 Product Description**

The Sterling-LWB is a multi-standard module with support for WLAN (802.11 b/g/n), and Bluetooth V2.1 and Bluetooth 4.0 & 4.1 with multiple antenna options.

This device has been designed to operate with the antenna listed below, and having a maximum gain of 2.0 dBi. The required antenna impedance is 50 ohms.

Chip Antenna: Johanson Part # 2450AT18D0100 Peak Gain 1.5 dBi

U.FL Antenna port utilizes the following antenna options:

LSR 2.4 GHz Dipole Antenna 2dBi

LSR 2.4 GHz FlexPIFA 2dBi

LSR 2.4 GHz FlexNotch 2dBi

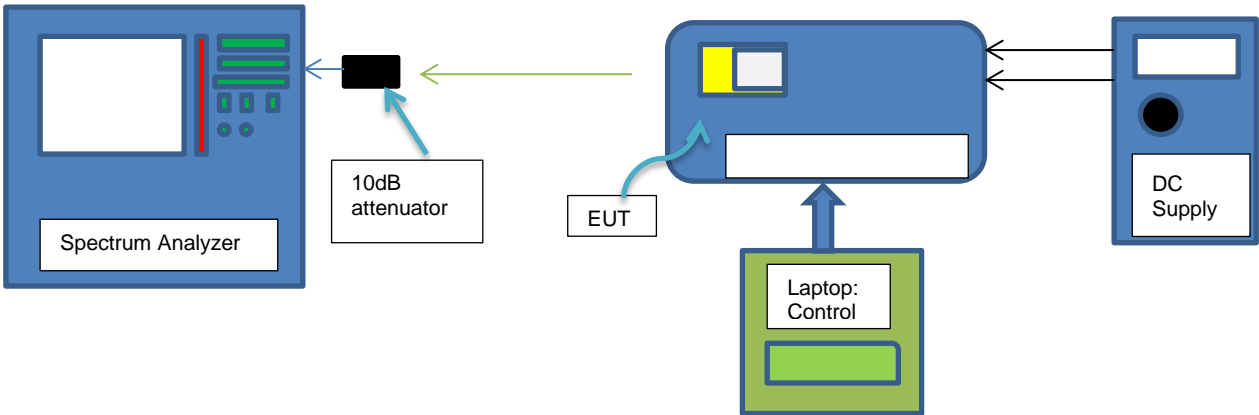
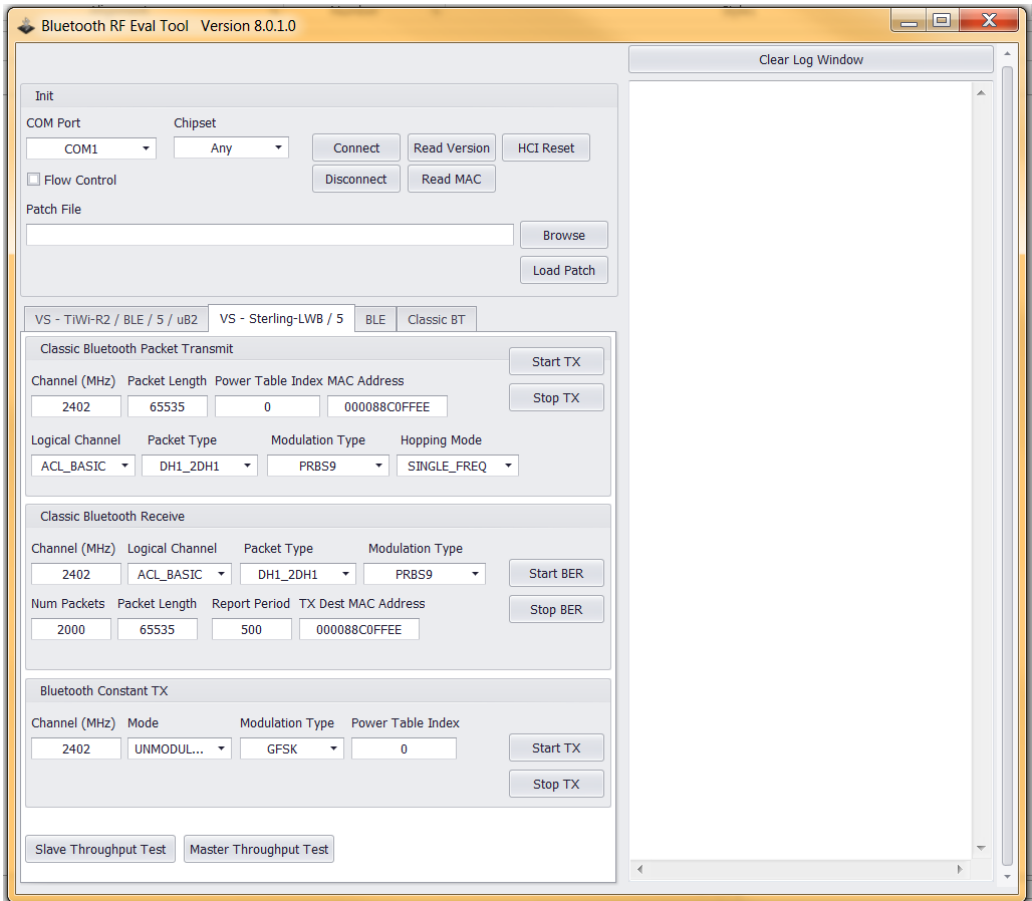
Prepared For: LSR	Product Name: Sterling-LWB
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2.5 Test Configuration

The EUT was powered using a switching mode power supply. The power supply was set to the nominal (+3.3 VDC) voltage and ±10% of the nominal voltage for testing (+3.6 VDC and + 3.0 VDC).

The EUT was connected to a laptop running the Bluetooth RF Eval Tool, Version 8.0.1.0 proprietary software. The EUT was connected to this laptop via a USB A to USB mini cable. The image below is a screen shot of the main control screen:



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## Test Setup Photos:

### Conducted Measurement Setup



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## EXHIBIT 3: Environmental Conditions & Summary of Test Results

### 3.1 Climate Test Conditions

Temperature:	70-71° F
Humidity:	32-35%
Pressure:	729-742mmHg

### 3.2 Summary of Test Results

Ordinance Number	Description	Compliance (Yes/No)
Article 49.20	Frequency Allocation	Yes
Article 5, Annex 1	Frequency Tolerance	Yes
Article 49.20	Antenna Power	Yes
Article 14	Output Power Tolerance	Yes
Article 49.20	Spreading Bandwidth	N/A
Article 6, Annex 2 30	Occupied Bandwidth	Yes
Article 49.20	E.I.R.P	Yes
Article 49.20	Antenna Absolute gain	Yes
Article 49.20	Spreading Factor	N/A
Article 7, Annex 3	Transmitter Spurious emissions	Yes
Article 24	Secondary/receiver emissions	Yes
Article 49.20	Dwell Time	N/A
Article 49.20	Housing Requirement	Yes
Article 9.4.9	Interference Prevention function	Yes
Article 15.1	Voltage fluctuation	Yes
Article 49.20	OFDM Sub-carriers	N/A

### 3.3 Modifications Incorporated in the EUT for Compliance Purposes

☒ None ☐ Yes (explain below)

### 3.4 Deviations & Exclusions from Test Specifications

☒ None ☐ Yes (explain below)

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## EXHIBIT 4: Declaration of Conformity

The EUT was found to MEET the requirements for a Direct Sequence Spread Spectrum and OFDM Transmitter device under Article 2 Paragraph 1 of the Certification Ordinance.

LSR certifies that the data contained herein was taken under conditions that meet or exceed the requirements of the test specifications. The results in this Test Report apply only to the item(s) tested on the above-specified dates. Any modifications made to the EUT subsequent to the indicated test date(s) will invalidate the data herein, and void this certification.

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## EXHIBIT 5: Frequency Allocation

Test Engineer:	Aidi Zainal
Test Date:	7/11/2016

### Requirement:

The requirement per Article 49.20 of the Ordinance Regulating Radio equipment authorizes equipment within the range 2400 MHz to 2483.5MHz

### Result:

The EUT was found to operate between:

1. 2402 MHz to 2480 MHz for BLE mode.

The EUT Complies with the requirements of the Ordinance regulating Radio Equipment.

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## EXHIBIT 6: Frequency Tolerance

Test Engineer:	Aidi Zainal
Test Date:	7/11/2016

### Requirement:

Article 5, Annex 1 tables 7-8 of the Ordinance regulating Radio Equipment has a limit of  $\pm 50$ ppm.

### Test Notes:

1. EUT was set to single channel transmission (low, medium and high).
2. EUT was set to continuously transmitting un-modulated.
3. Frequency counter function of the Spectrum analyzer was used to measure the frequency.
4. Measurement performed at nominal, +10% nominal and -10% nominal supply voltage.

### Result:

The EUT had a maximum deviation of 221 Hz, better than 50ppm. The EUT complies with the requirement of the Ordinance regulating Radio Equipment.

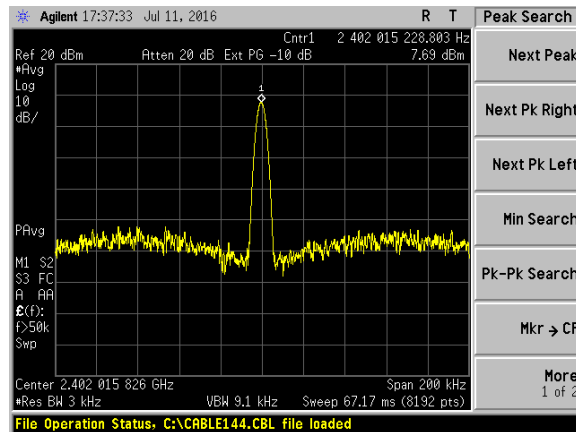
### Data:

Channel	Channel Frequency (Hz)			Max Deviation (Hz)
	Nominal	+10%	-10%	
Low	2402015228	2402015266	2402015244	38
Middle	2440019822	2440019691	2440019912	221
High	2480024549	2480024517	2480024538	32

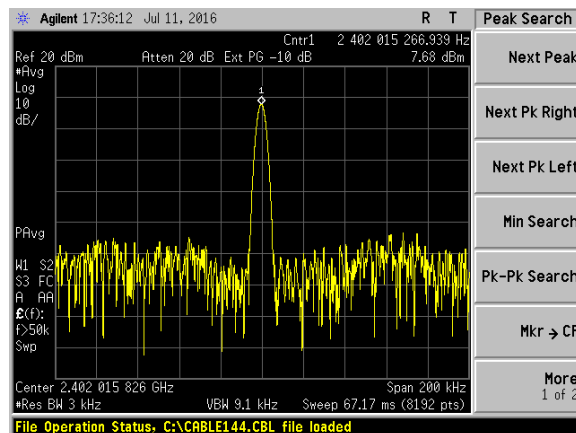
Prepared For: LSR	Product Name: Sterling-LWB
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Screen Captures (Only low channel presented):

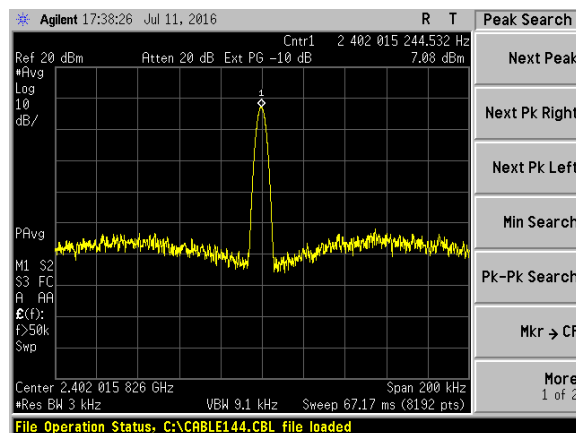
**2402 MHz:**



Nominal Supply Voltage (3.3 VDC)



+10% Nominal Supply Voltage (3.6 VDC)



-10% Nominal Supply Voltage (3.0 VDC)

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## EXHIBIT 7: Antenna Power and EIRP

Test Engineer:	Aidi Zainal
Test Date:	7/11/2016 to 7/12/2016

### Requirement:

Article 49.20 of the Ordinance regulating Radio Equipment allows an absolute maximum (including +20% tolerance) antenna power of 10mW for other digital modulation system that occupies the frequency range 2400 to 2483.5 MHz. It also allows for a maximum EIRP of 12.14 dBm for non-directional antennas and 22.14 dBm for directional antennas.

### Test Notes:

1. The EUT was tested at the lowest, middle and high channels.
2. Measurement performed at nominal, +10% nominal and -10% nominal supply voltage.
3. Antenna gain used in EIRP calculation is 2.0 dBi (from data sheet)
4. Measurement procedure:
  - a. Spectrum Analyzer Settings:
    - i. Spectrum analyzer Center frequency: Center of the channel or band
    - ii. Resolution BW = 3 MHz
    - iii. Video BW = 8 MHz
    - iv. Detector = RMS
    - v. Trace mode = Max Hold

### Result:

The EUT has a maximum antenna power and maximum EIRP power which are below the stated limits and is therefore found to be compliant to the requirement of the Ordinance regulating Radio Equipment.

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Data:

Bluetooth Low Energy

Low channel (2402 MHz)									
EUT supply voltage (V)	RMS power (dBm)	RMS power (mW)	RMS power limit (dBm)	RMS power margin (dB)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	EIRP limit (dBm)	EIRP margin (dB)
3.3VDC (Nominal)	8.3	6.808	9.2	0.9	2.0	10.3	10.789	11.3	1.0
2.97VDC (-10%)	8.1	6.412	9.2	1.1	2.0	10.1	10.162	11.3	1.2
3.6VDC (Max declared)	8.6	7.278	9.2	0.6	2.0	10.6	11.535	11.3	0.7

Low Channel

Middle Channel (2440 MHz)									
EUT supply voltage (V)	RMS power (dBm)	RMS power (mW)	RMS power limit (dBm)	RMS power margin (dB)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	EIRP limit (dBm)	EIRP margin (dB)
3.3VDC (Nominal)	7.8	5.957	9.2	1.5	2.0	9.8	9.441	11.3	1.6
2.97VDC (-10%)	7.5	5.572	9.2	1.7	2.0	9.5	8.831	11.3	1.8
3.6VDC (Max declared)	8.1	6.516	9.2	1.1	2.0	10.1	10.328	11.3	1.2

Mid Channel

High Channel (2480 MHz)									
EUT supply voltage (V)	RMS power (dBm)	RMS power (mW)	RMS power limit (dBm)	RMS power margin (dB)	Antenna Gain (dBi)	EIRP (dBm)	EIRP (mW)	EIRP limit (dBm)	EIRP margin (dB)
3.3VDC (Nominal)	7.2	5.297	9.2	2.0	2.0	9.2	8.395	11.3	2.1
2.97VDC (-10%)	6.5	4.487	9.2	2.7	2.0	8.5	7.112	11.3	2.8
3.6VDC (Max declared)	7.6	5.754	9.2	1.6	2.0	9.6	9.120	11.3	1.7

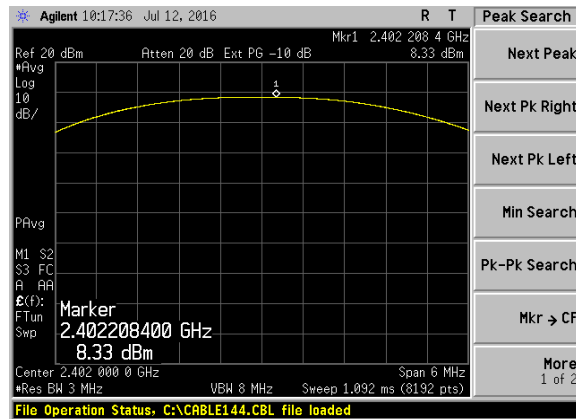
High Channel

Note: The limits listed in the tables above take into account the upper end of the output power tolerance (+20%) hence is shown to be lower than the 10 mW.

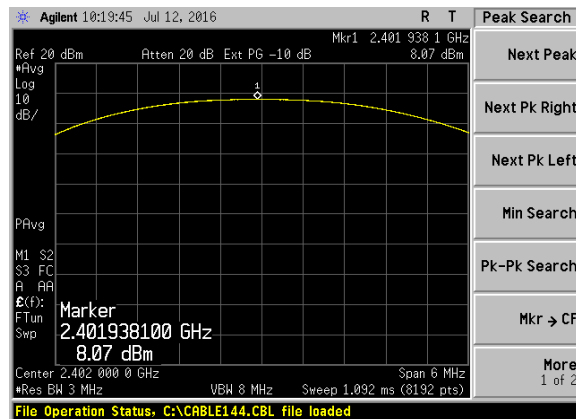
Prepared For: LSR	Product Name: Sterling-LWB
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## Screen Captures:

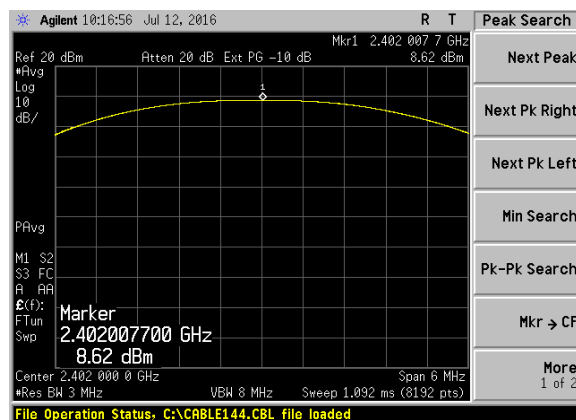
### Low Channel



*Nominal Supply Voltage*



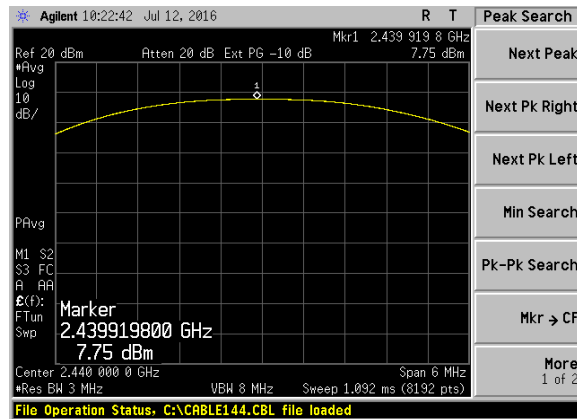
*-10% Supply Voltage*



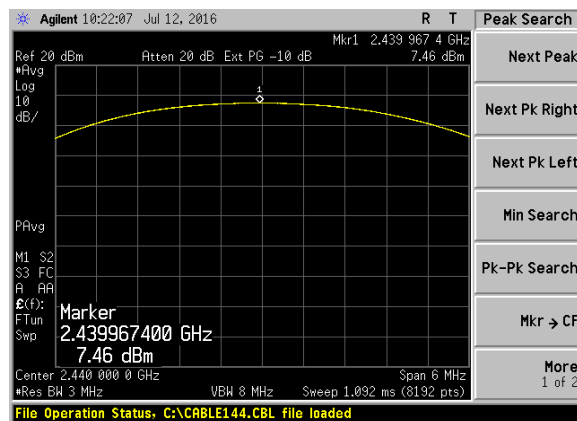
*+10% Supply Voltage*

Prepared For: LSR	Product Name: Sterling-LWB
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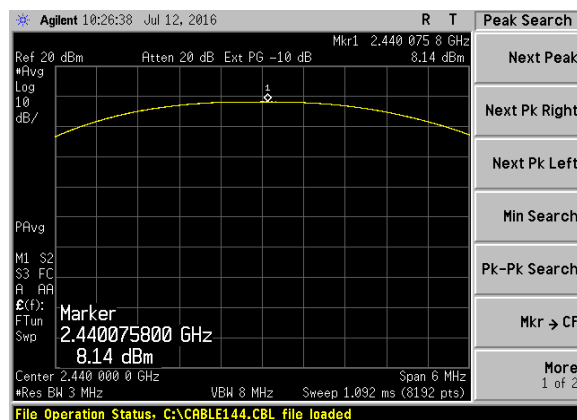
## Mid Channel



*Nominal Supply Voltage*



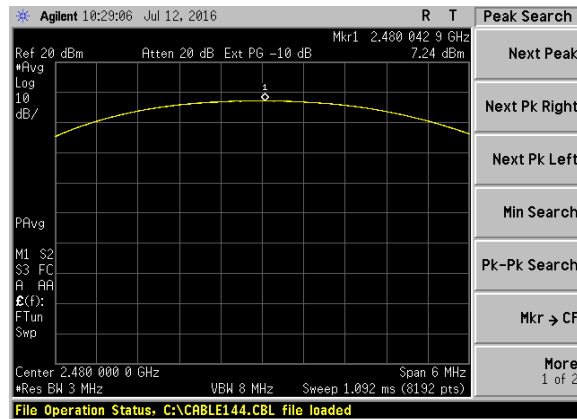
*-10% Supply Voltage*



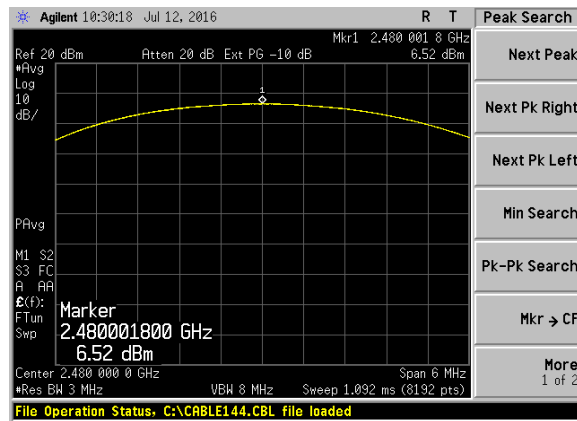
*+10% Supply Voltage*

Prepared For: LSR	Product Name: Sterling-LWB
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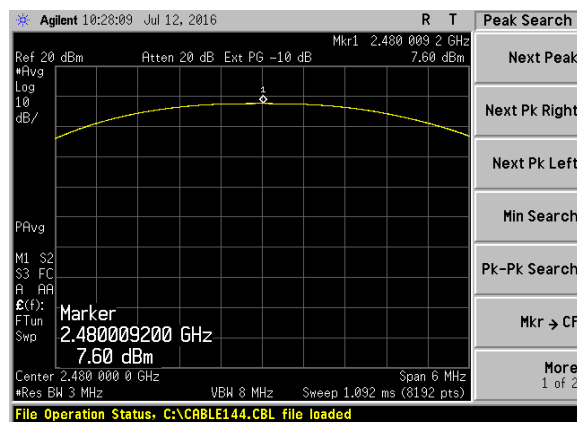
## High Channel



*Nominal Supply Voltage*



*-10% Supply Voltage*



*+10% Supply Voltage*

Prepared For: LSR	Product Name: Sterling-LWB
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## EXHIBIT 8: Absolute Antenna Gain

Test Engineer:	N/A
Test Date:	N/A

### Requirement:

The absolute maximum antenna gain allowed by Article 49.20 of the Ordinance regulating Radio Equipment is 12.14 dBi.

### Result:

This device has been designed to operate with the antenna listed below, and having a maximum gain of 2.0 dBi. The required antenna impedance is 50 ohms.

Chip Antenna: Johanson Part # 2450AT18D0100 Peak Gain 1.5 dBi

U.FL Antenna port utilizes the following antenna options:

LSR 2.4 GHz Dipole Antenna 2dBi

LSR 2.4 GHz FlexPIFA 2dBi

LSR 2.4 GHz FlexNotch 2dBi

The peak gain value is below the stated limit and is therefore compliant to the requirement of the Ordinance regulating Radio Equipment.

### Data:

The following information has been obtained from the antenna manufacturer's data sheet.

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## Chip Antenna:

### "High Frequency Ceramic Solutions"

2.45 GHz SMD Antenna, EIA 1210, Detuning resilient, Edge Mount Design

P/N 2450AT18D0100

Detail Specification: 9/17/2015

Page 1 of 6

This antenna is optimal for edge middle mounting; rectangular and circular PCB shape applications, go to pages 2-4 for more info.

#### General Specifications

Part Number	2450AT18D0100	Input/Output Power	2W max. (CW)
Frequency (MHz)	2400 - 2500	Impedance	50 $\Omega$
Peak Gain	1.5 dBi typ. (XZ-total)	Reel Quantity	3,000
Average Gain	-1.0 dBi typ. (XZ-total)	Storage Temp	-40 to +85°C
Return Loss	10.0 dB min.	Total Radiation Efficiency <sup>1</sup>	72%
Operating Temperature	-40 to +125°C	<sup>1</sup> Efficiency measured on 2450AT18D0100-EB18MA 40x20mm EVB on page 2	

### "High Frequency Ceramic Solutions"

2.45 GHz SMD Antenna, EIA 1210, Detuning resilient, Edge Mount Design

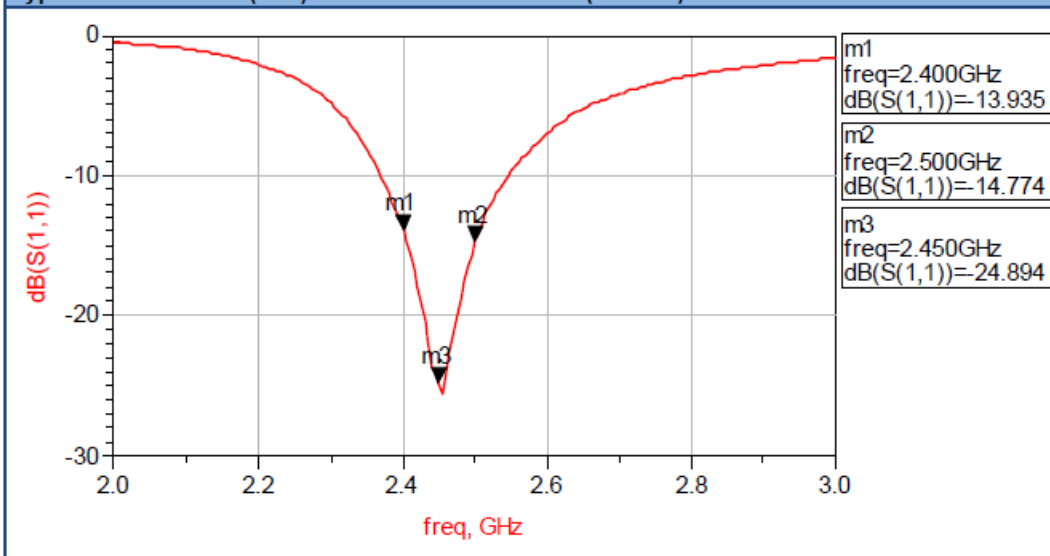
P/N 2450AT18D0100

Detail Specification: 04/04/12

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This antenna is optimal for edge middle mounting; rectangular and circular PCB shape applications, go to pages 2-4 for more info.

#### Typical Return Loss (S11) Electrical Performance (T=25°C)



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# "High Frequency Ceramic Solutions"

2.45 GHz SMD Antenna, EIA 1210, Detuning resilient, Edge Mount Design

P/N 2450AT18D0100

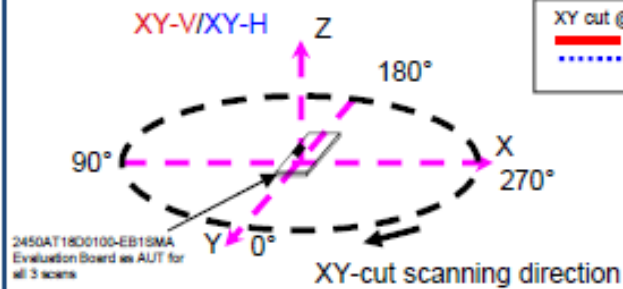
Detail Specification: 9/17/2015

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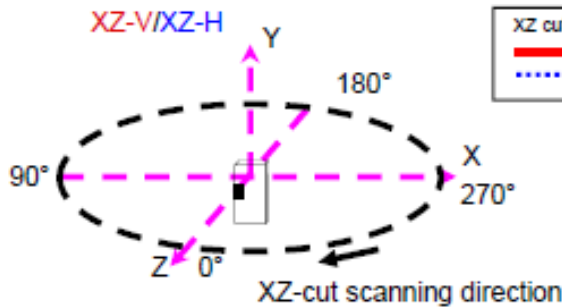
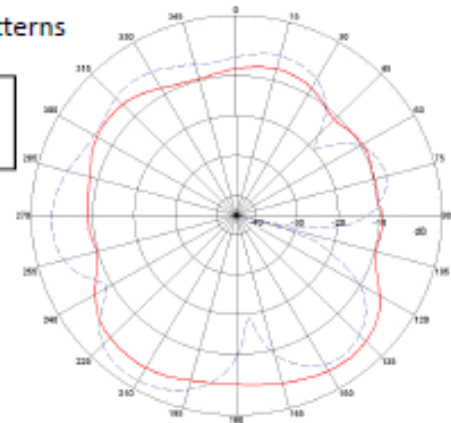
This antenna is optimal for edge middle mounting; rectangular and circular PCB shape applications, go to pages 2-4 for more info.

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

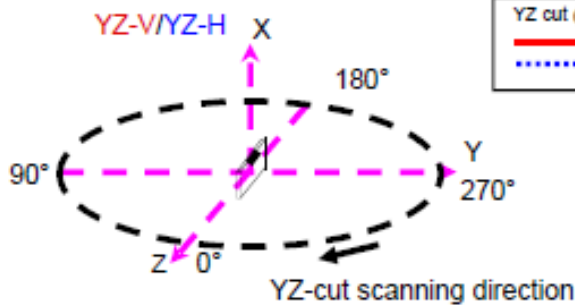
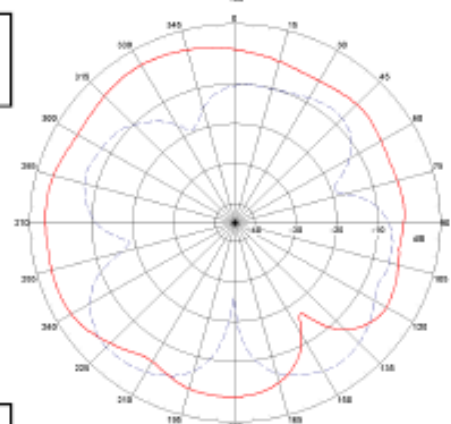
### Typical Radiation Patterns



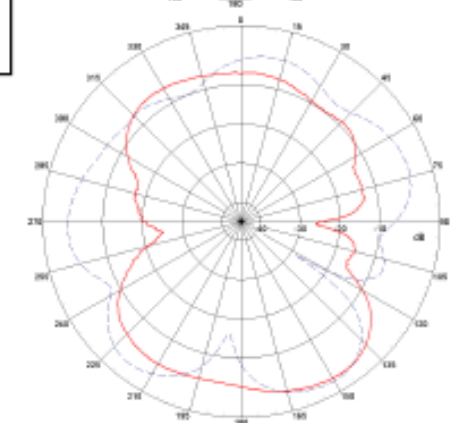
XY cut @2.45GHz  
— Vertical  
..... Horizontal



XZ cut @2.45GHz  
— Vertical  
..... Horizontal



YZ cut @2.45GHz  
— Vertical  
..... Horizontal



Prepared For: LSR

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## Dipole Antenna:



## ModFLEX Accessories – 2.4 GHz Dipole Antenna DATASHEET

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



## ORDERING INFORMATION

Order Number	Description
001-0001	2.4 GHz dipole antenna for reverse polarity SMA connector.

## SPECIFICATIONS

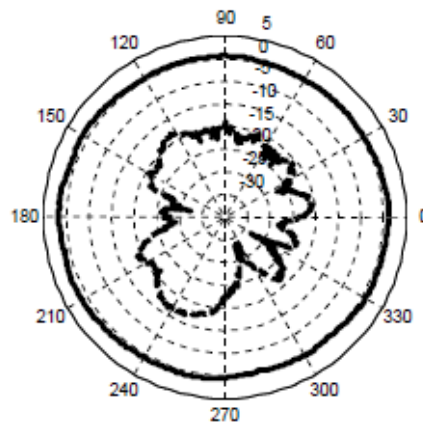
Specification	Value
Gain	+2 dBi
Impedance	50 ohms, Nominal
Type	Dipole
Polarization	Linear Vertical
VSWR	$\leq 2.5 : 1$ , Maximum
Frequency	2400-2500MHz
Weight	13g
Size	105×10 mm
Antenna Color	Black

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33



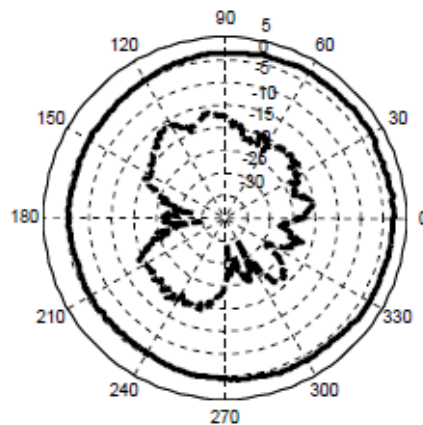
## TYPICAL ANTENNA RADIATION PERFORMANCE

### LSR ANTENNA STRAIGHT 2405 MHz



\_\_\_\_ Vertical Polarization Gain (dBi)  
----- Horizontal Polarization Gain (dBi)

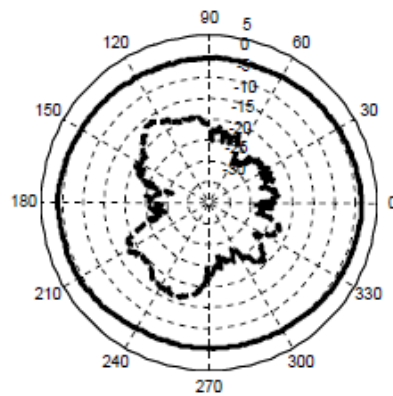
### LSR ANTENNA STRAIGHT 2440 MHz



\_\_\_\_ Vertical Polarization Gain (dBi)  
----- Horizontal Polarization Gain (dBi)

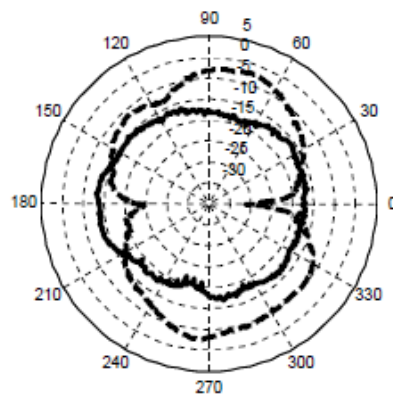
Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

### LSR ANTENNA STRAIGHT 2480 MHz



— Vertical Polarization Gain (dBi)  
--- Horizontal Polarization Gain (dBi)

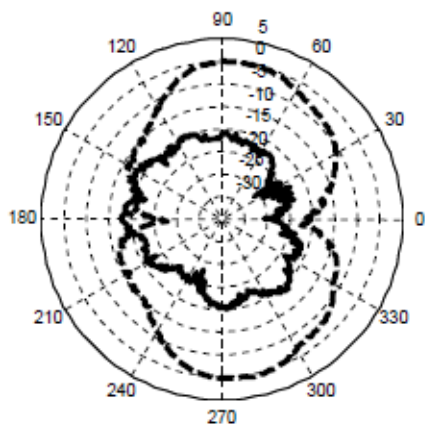
### LSR ANTENNA BENT 2405 MHz



— Vertical Polarization Gain (dBi)  
--- Horizontal Polarization Gain (dBi)

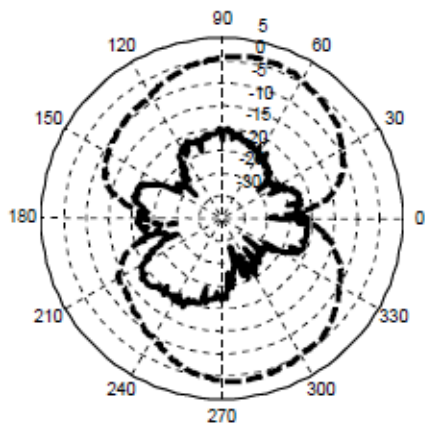
Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

## LSR ANTENNA BENT 2440 MHz



— Vertical Polarization Gain (dBi)  
--- Horizontal Polarization Gain (dBi)

## LSR ANTENNA BENT 2480 MHz



— Vertical Polarization Gain (dBi)  
--- Horizontal Polarization Gain (dBi)

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

## FlexNotch Antenna:



## 2.4 GHz FlexNotch Antenna, 100mm Datasheet

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



## ORDERING INFORMATION

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

Table 1 Orderable Part Numbers

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

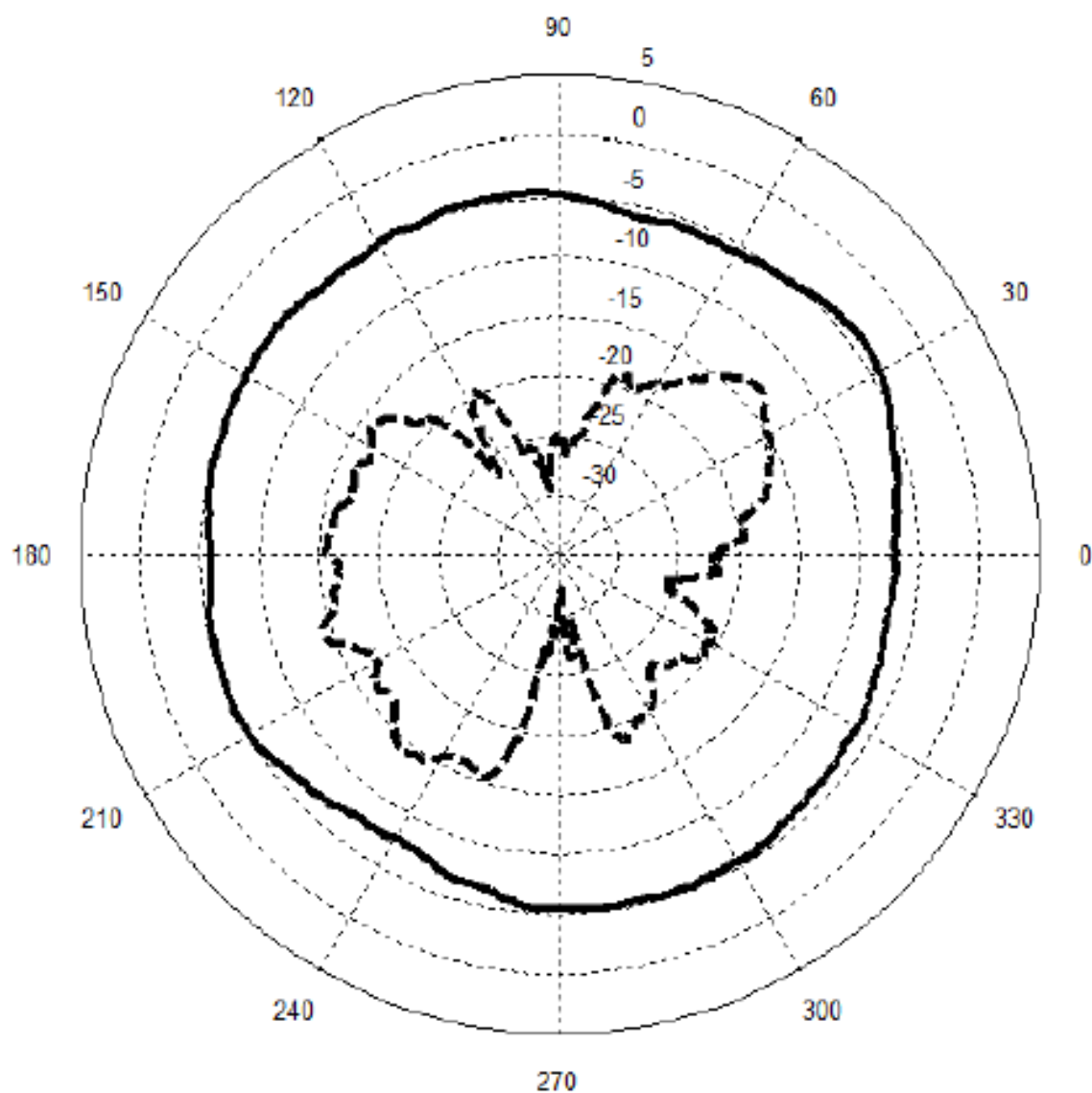
## SPECIFICATIONS

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

**Table 2 Specifications**

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

Horizontal Orientation at 2440 MHz:



\_\_\_\_ Vertical Polarization Gain (dBi)    min: -7.8    max: -3.9    avg: -5.6  
 - - - Horizontal Polarization Gain (dBi)    min: -32.3    max: -13.2    avg: -18.1

Figure 4 Horizontal Orientation Pattern

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

Vertical Orientation at 2440 MHz:

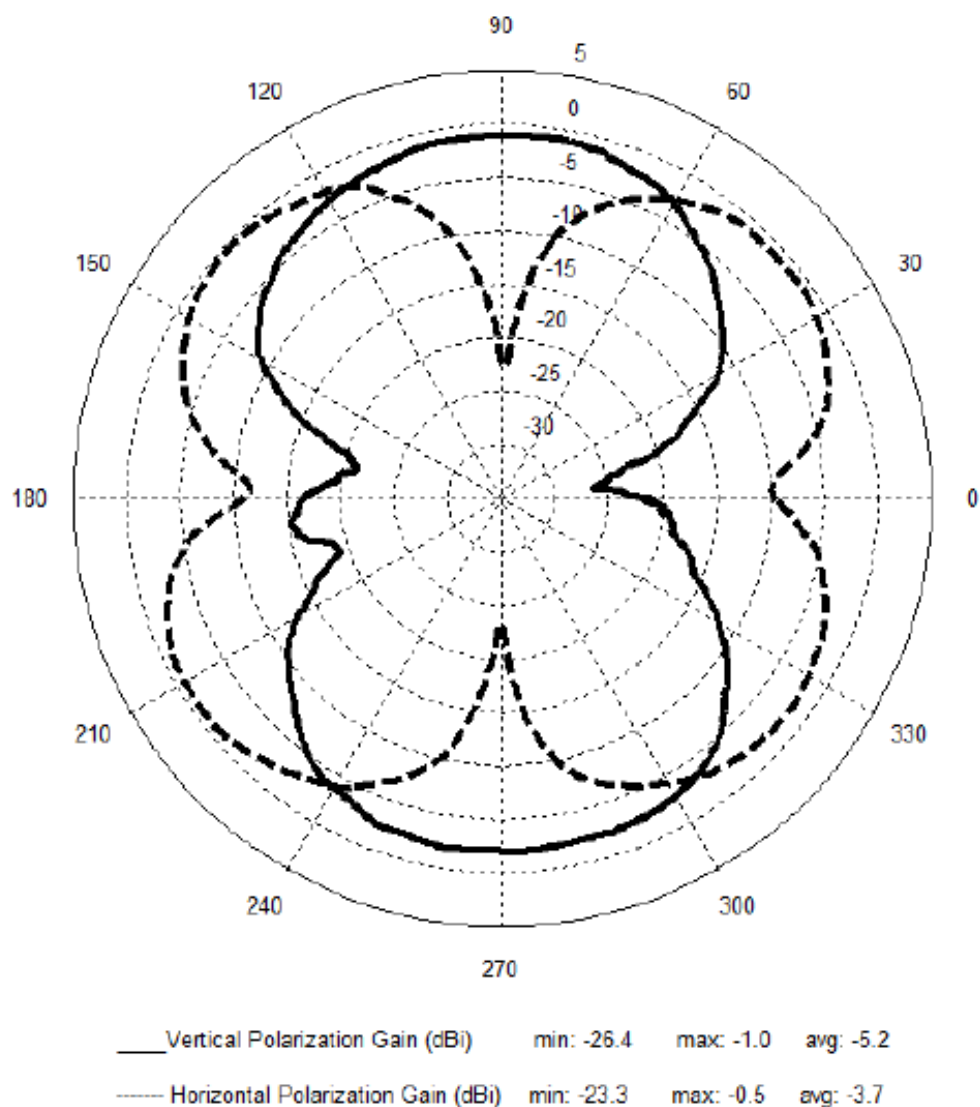


Figure 6 Vertical Orientation Pattern

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

Flat Orientation at 2440 MHz:

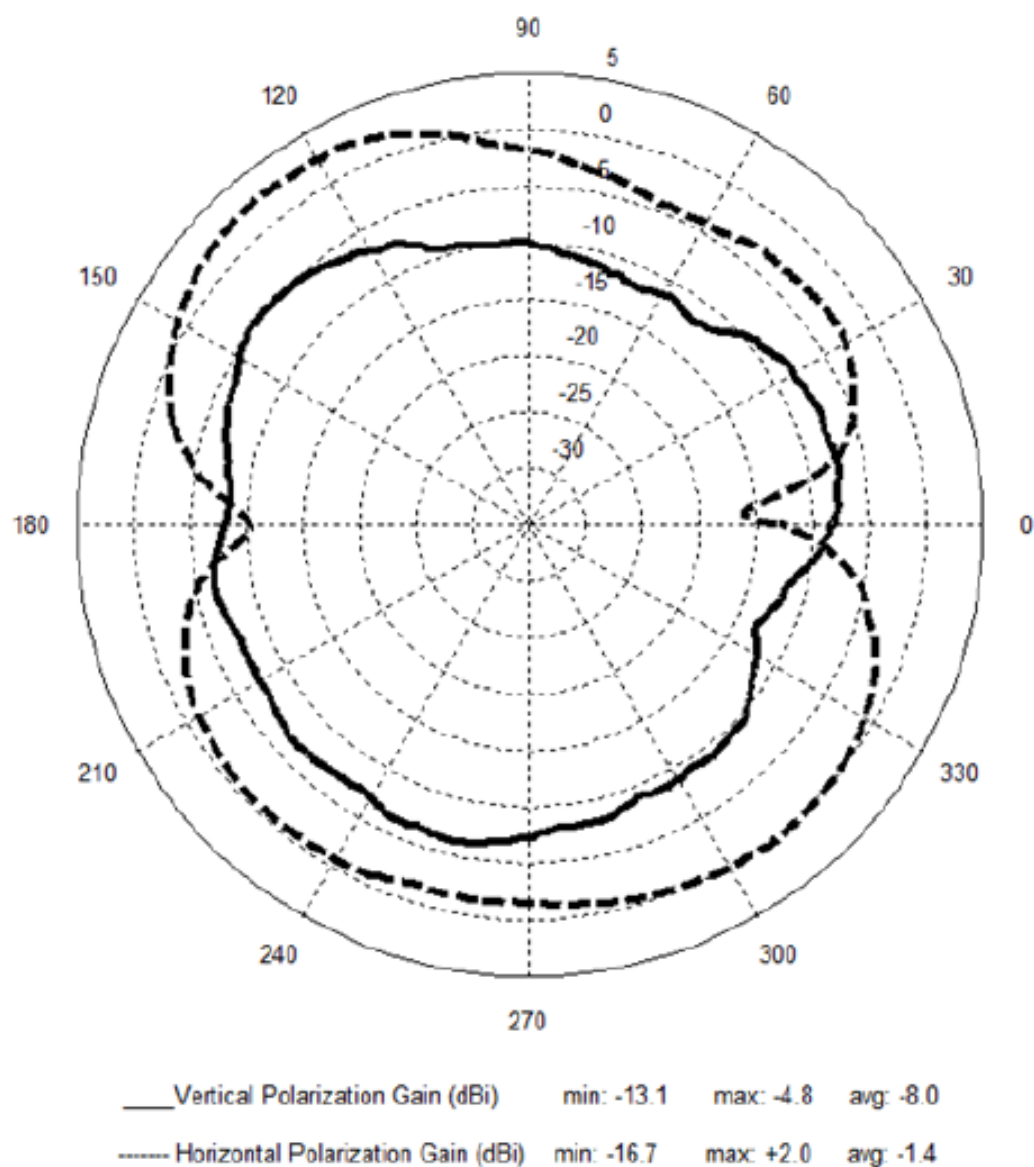


Figure 8 Flat Orientation Pattern

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33



## FlexPIFA antenna:



## 2.4 GHz FlexPIFA Antenna, 100mm Datasheet

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



## ORDERING INFORMATION

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

**Table 1 Orderable Part Numbers**

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

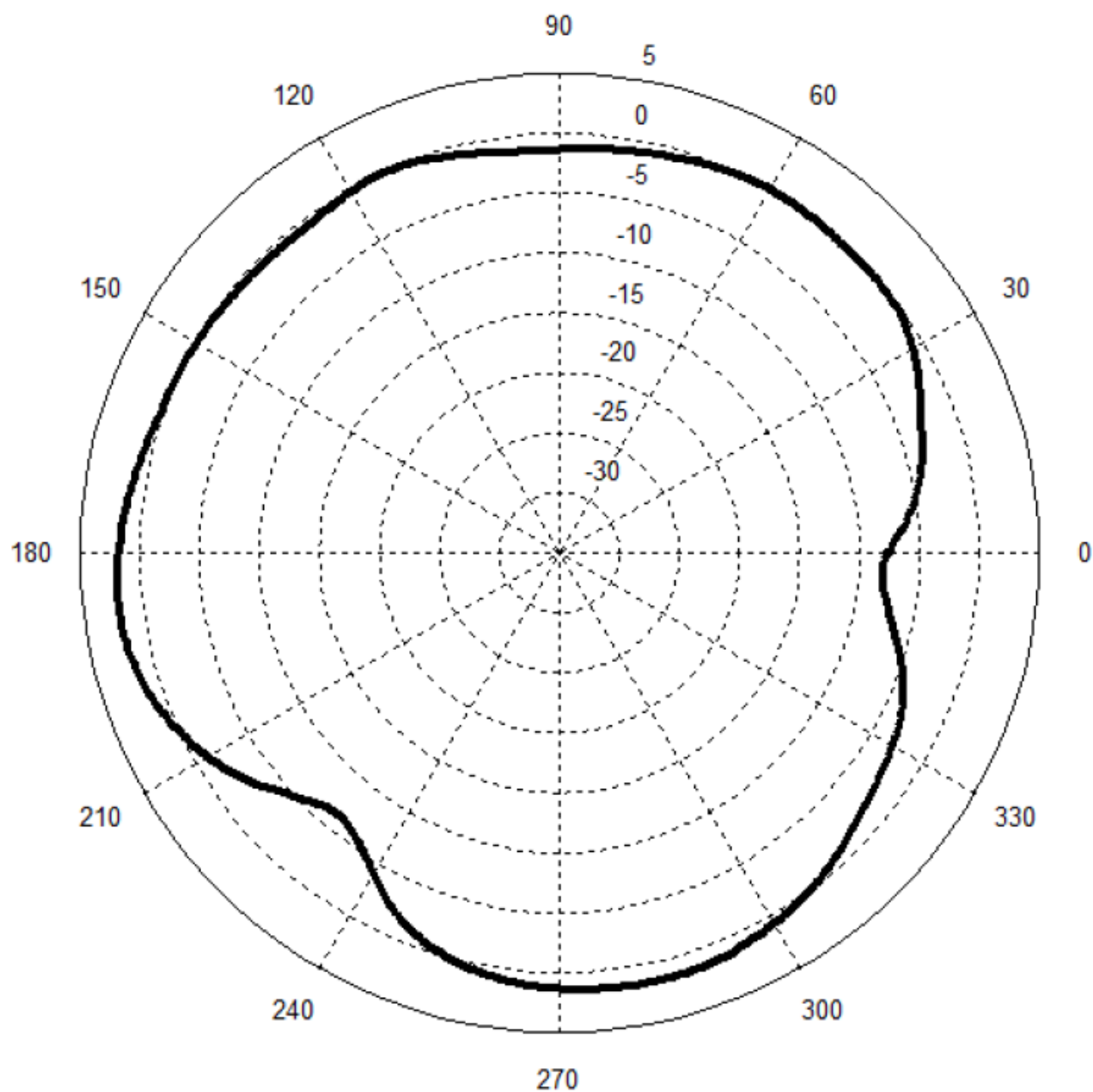
## SPECIFICATIONS

Specification	Value
Peak Gain	+2 dBi
Average Gain	>-2.3 dBi
Impedance	50 ohms
Type	Flexible Planar Inverted F Antenna (FlexPIFA)
Polarization	Linear
VSWR	< 2.0:1, 2400 - 2480 MHz
Frequency	2400 – 2480 MHz
Weight	1.13g
Size	40.1mm × 11mm × 2.5mm
Antenna Color	Clear Yellow
Adhesive	3M 100MP
Operating Temp	-40°C to +85°C

**Table 2 Specifications**

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

Vertical Orientation at 2440 MHz:



\_\_\_\_ Total Gain (dBi) min: -8.0 max: +2.0 avg: -0.7

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

Horizontal Orientation at 2440 MHz:

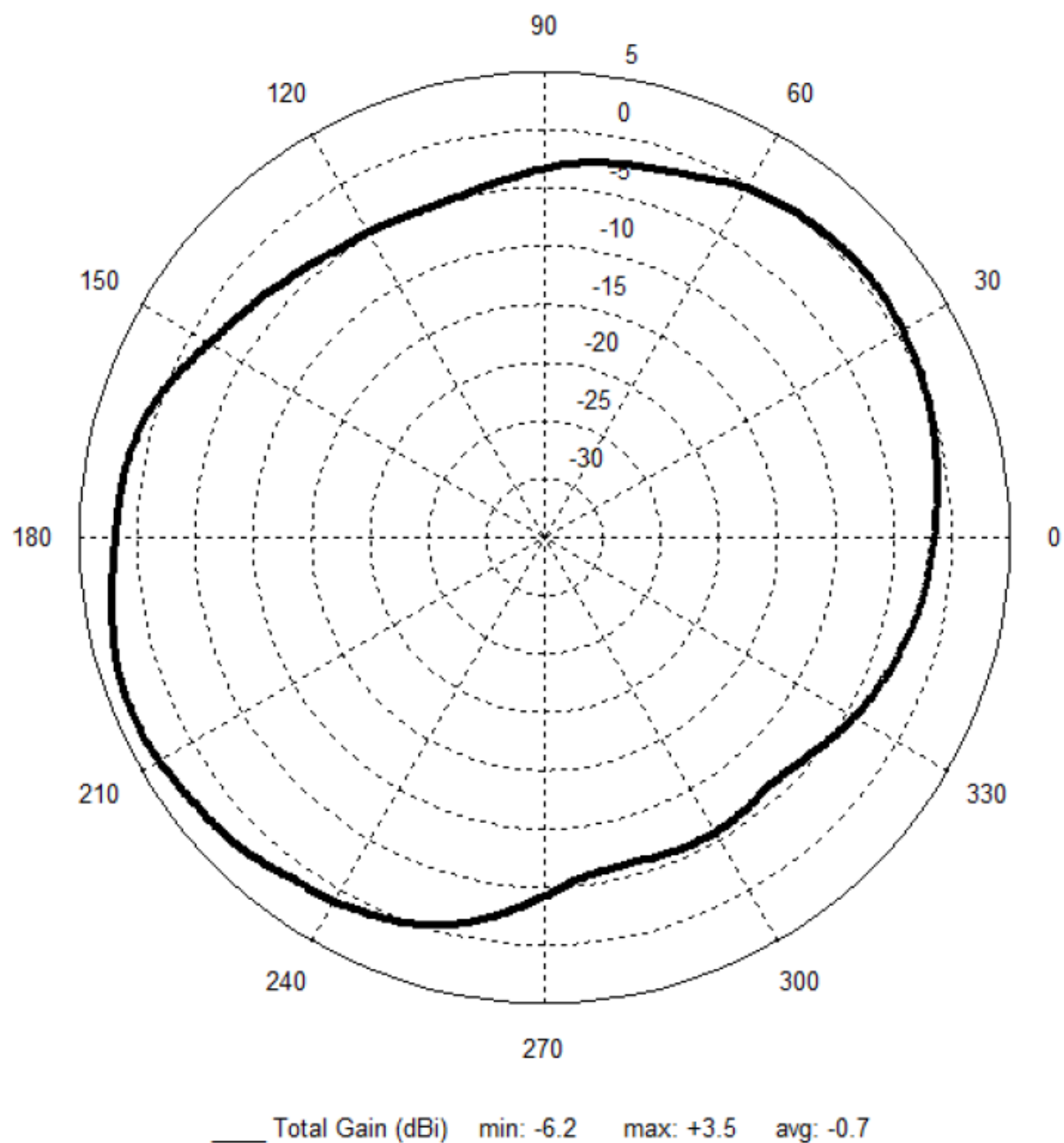
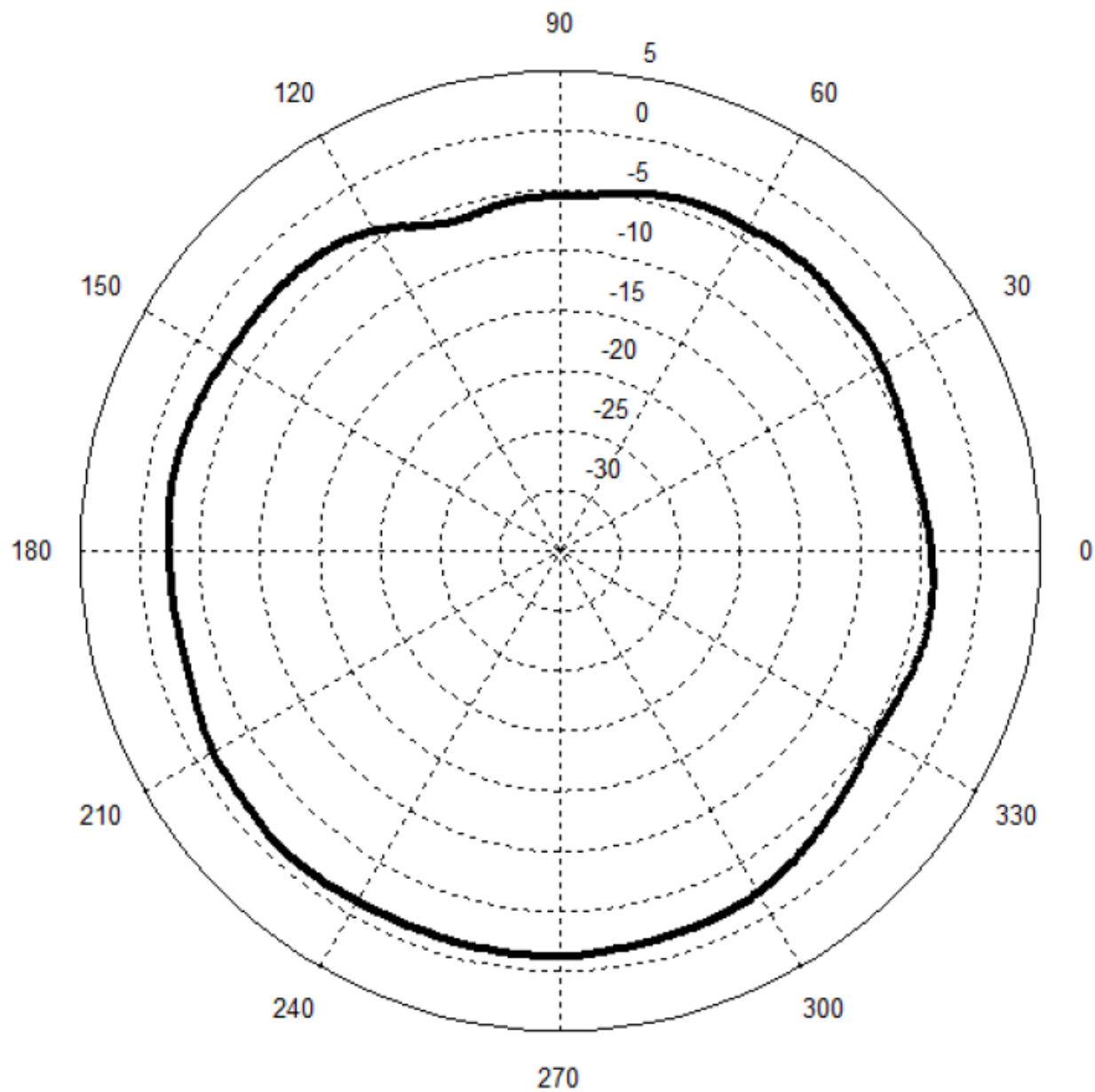


Figure 6 Horizontal Orientation Pattern

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

Flat Orientation at 2440 MHz:



\_\_\_\_ Total Gain (dBi) min: -6.2 max: -1.1 avg: -3.0

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

## EXHIBIT 9: Occupied Bandwidth

Test Engineer:	Aidi Zainal
Test Date:	7/11/2016

### Requirement:

Article 6, Annex 2 of the Ordinance regulating Radio Equipment requires that the occupied bandwidth, defined as the 99% bandwidth, shall be less than 26 MHz for DSSS systems.

### Test Notes:

1. The EUT was tested at the lowest, middle and high channels.
2. Measurement performed at nominal, +10% nominal and -10% nominal supply voltage.
3. The Occupied Bandwidth measurement function of the Spectrum analyzer was used to perform the measurements.

### Result:

The occupied bandwidth value is below the stated limit and is therefore compliant to the requirement of the Ordinance regulating Radio Equipment.

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

Data:

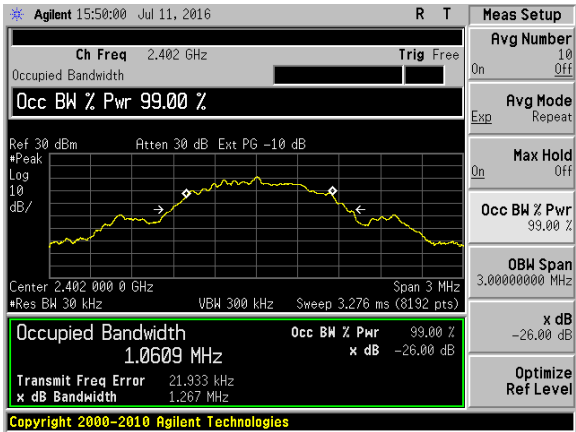
Low Channel (2402 MHz)						
EUT supply voltage (V)	Occupied Bandwidth / 99% BW (MHz)	Limit (MHz)	Margin (MHz)	Spreading Bandwidth/ 90% BW (kHz)	Limit (kHz)- minimum	Margin (kHz)
3.3VDC (Nominal)	1.06	26.0	24.9	N/A	N/A	N/A
2.97VDC (-10%)	1.06	26.0	24.9	N/A	N/A	N/A
3.6VDC (Max declared)	1.06	26.0	24.9	N/A	N/A	N/A

Middle channel (2440 MHz)						
EUT supply voltage (V)	Occupied Bandwidth / 99% BW (MHz)	Limit (MHz)	Margin (MHz)	Spreading Bandwidth/ 90% BW (kHz)	Limit (kHz)- minimum	Margin (kHz)
3.3VDC (Nominal)	1.06	26.0	24.9	N/A	N/A	N/A
2.97VDC (-10%)	1.06	26.0	24.9	N/A	N/A	N/A
3.6VDC (Max declared)	1.06	26.0	24.9	N/A	N/A	N/A

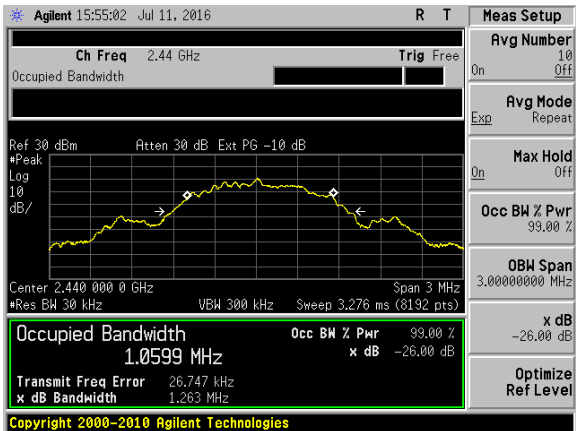
High Channel (2480 MHz)						
EUT supply voltage (V)	Occupied Bandwidth / 99% BW (MHz)	Limit (MHz)	Margin (MHz)	Spreading Bandwidth/ 90% BW (kHz)	Limit (kHz)- minimum	Margin (kHz)
3.3VDC (Nominal)	1.06	26.0	24.9	N/A	N/A	N/A
2.97VDC (-10%)	1.06	26.0	24.9	N/A	N/A	N/A
3.6VDC (Max declared)	1.06	26.0	24.9	N/A	N/A	N/A

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

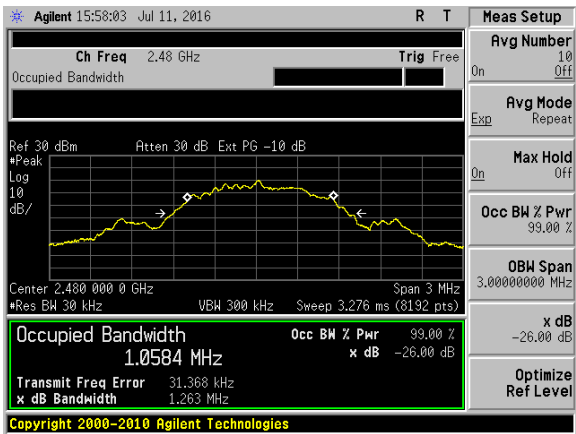
Screen Captures (Only Nominal supply voltage shown):



Low Channel



Middle Channel



High Channel

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33



## EXHIBIT 10: Transmitter Spurious Emissions

Test Engineer:	Aidi Zainal
Test Date:	7/11/16 – 7/13/16

### Requirement:

Article 7 of the Ordinance Regulating Radio Equipment, table 3, sets forth the requirements for transmitter spurious emissions.

Limits for category WW are as follows:

Frequency Band	Limit*
30 MHz – 2378 MHz	2.5 $\mu$ W/MHz or less
2387 MHz – 2400 MHz	25 $\mu$ W/MHz or less
2483.5 MHz – 2496.5 MHz	25 $\mu$ W/MHz or less
2496.5 MHz – 12.5 GHz	2.5 $\mu$ W/MHz or less

\*Permissible average power at 1 MHz bandwidth of spurious emission.

### Test Notes:

1. EUT was tested at the lowest, middle and high channels.
2. Measurement performed at nominal, +10% nominal and -10% nominal supply voltage.
3. Spectrum Analyzer Settings:
  - a. RBW=VBW=1MHz
  - b. Measure emissions that are within 3dB of the limit (over or under)
  - c. Sweep points > 400 points
  - d. Detector = RMS (Final measurement), Peak (Pre-scan)
  - e. Sweep time >= 1 second (Final measurement), Auto (pre-scan)

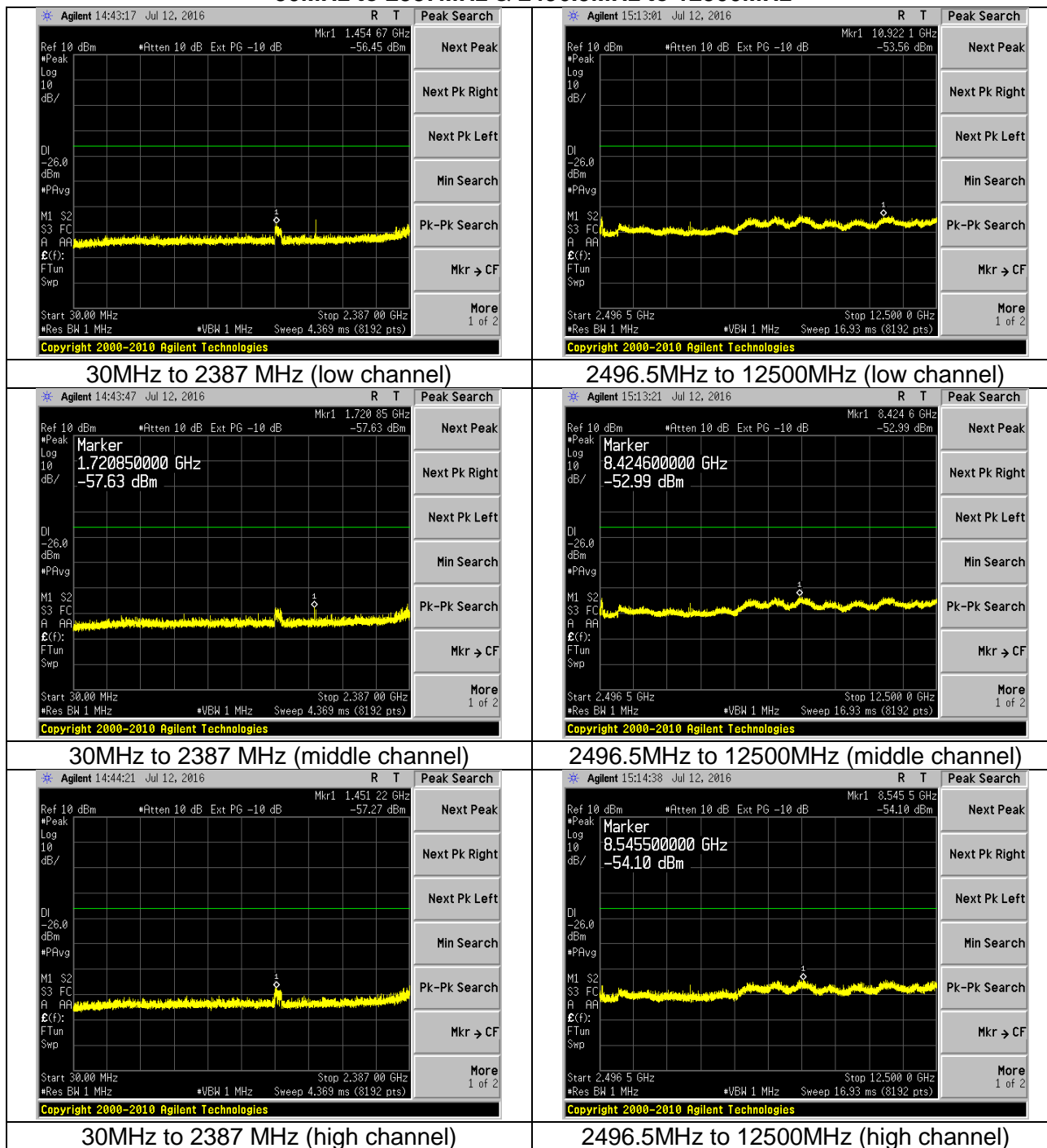
### Result:

The transmitter spurious emissions of the EUT were more than 6dB below the limit. The EUT is found to be compliant to the requirement of the Ordinance regulating Radio Equipment.

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

## Screen Captures:

### 30MHz to 2387MHz & 2496.5MHz to 12500MHz



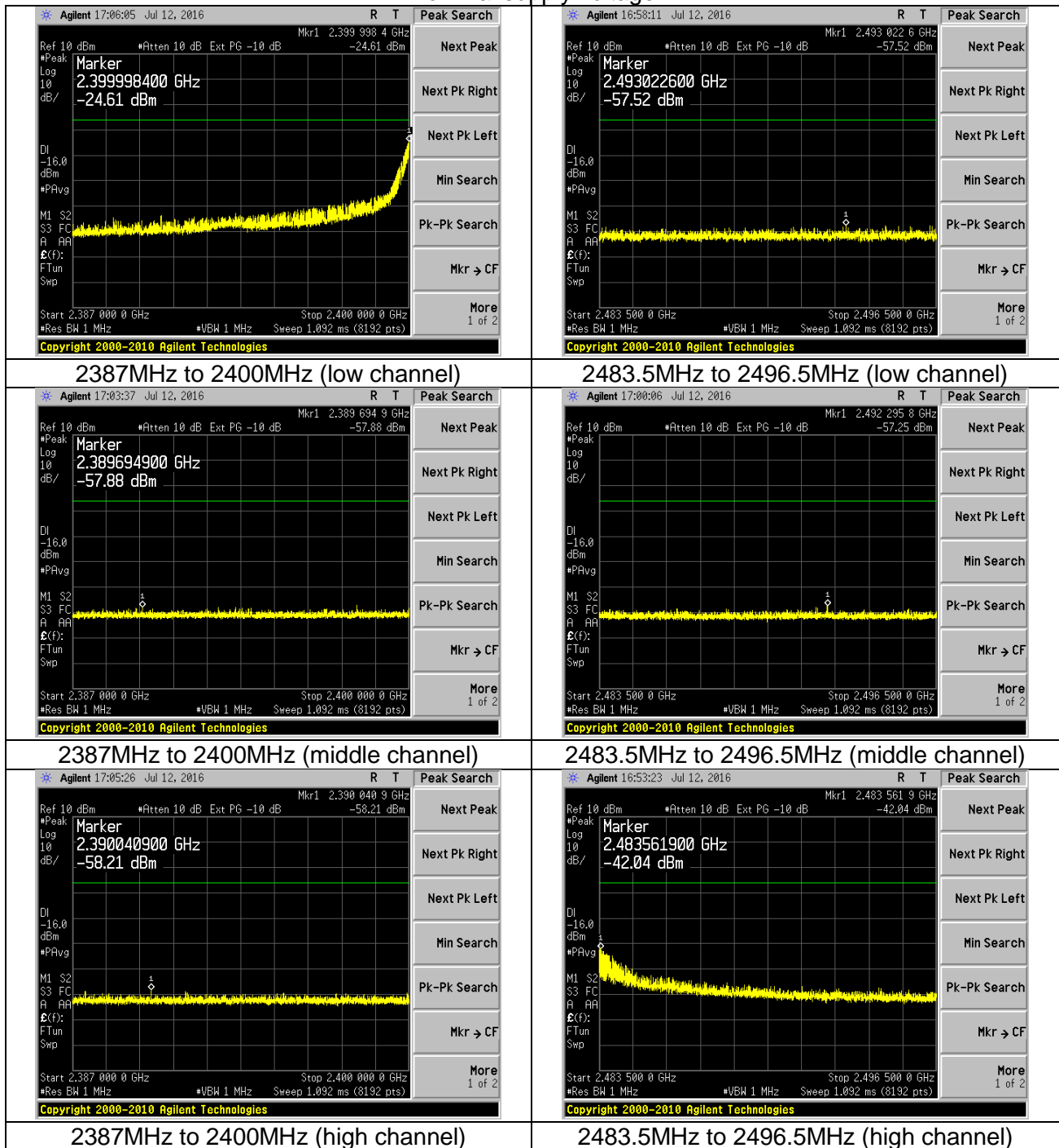
Note:

1. The plots above were obtained at nominal supply voltage. Emissions were unchanged at different supply voltages

Prepared For: LSR	Product Name: Sterling-LWB
Report: TR 316053 C	Model Number: STERLING-LWB
LSR Job Number: C-2395	Serial Number: 33

## 2387MHz to 2400MHz & 2483.5MHz to 2496.5MHz

Nominal supply voltage



Prepared For: Nikon Metrology

Report: TR 314281A

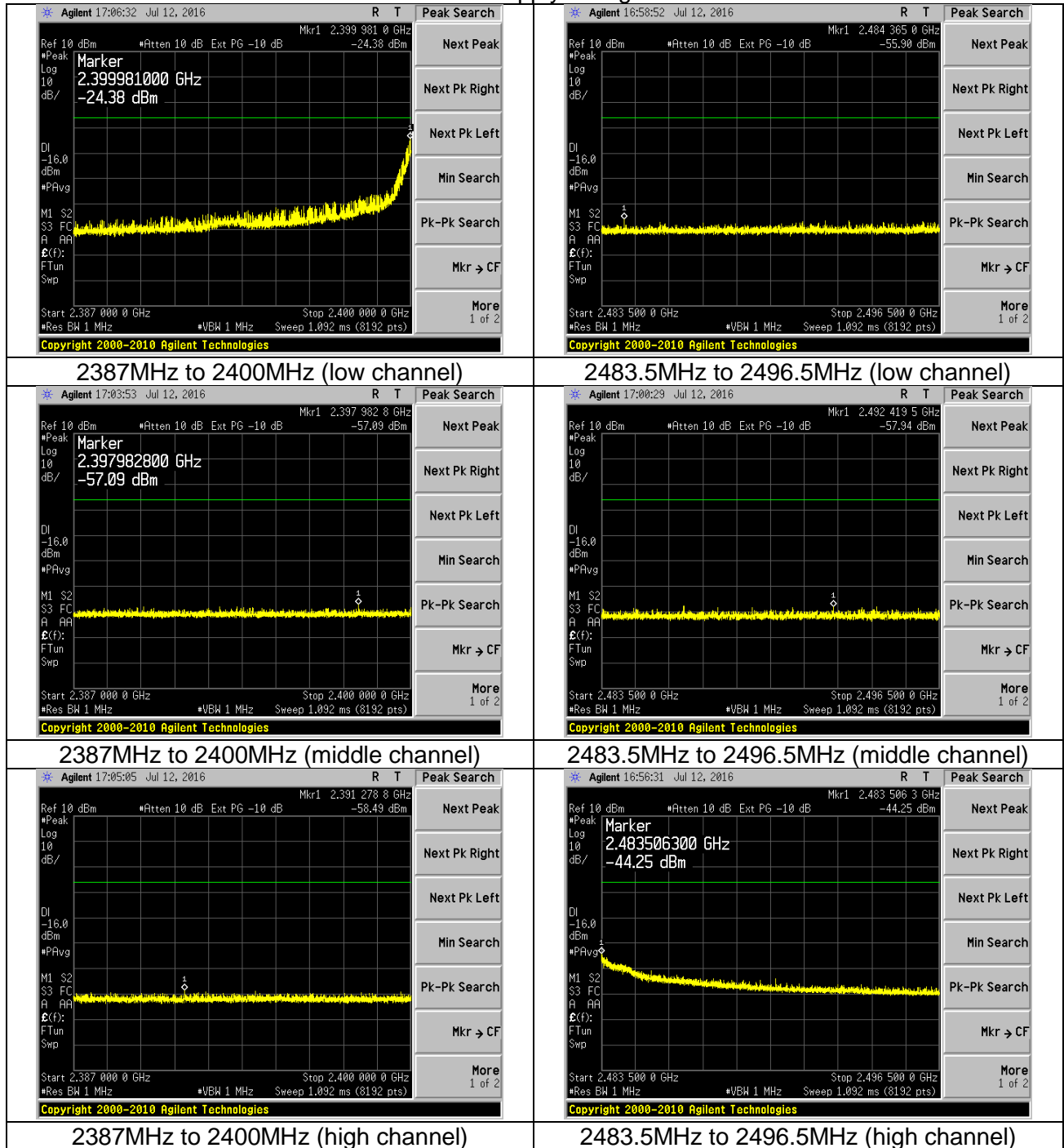
LSR Job Number: C-2408

Product Name: TiWi5 with Ethertronics  
Presta™ WLAN Embedded Antenna

Model Number: Engineering Sample

Serial Number: Engineering Sample

+10% supply voltage



Prepared For: Nikon Metrology

Report: TR 314281A

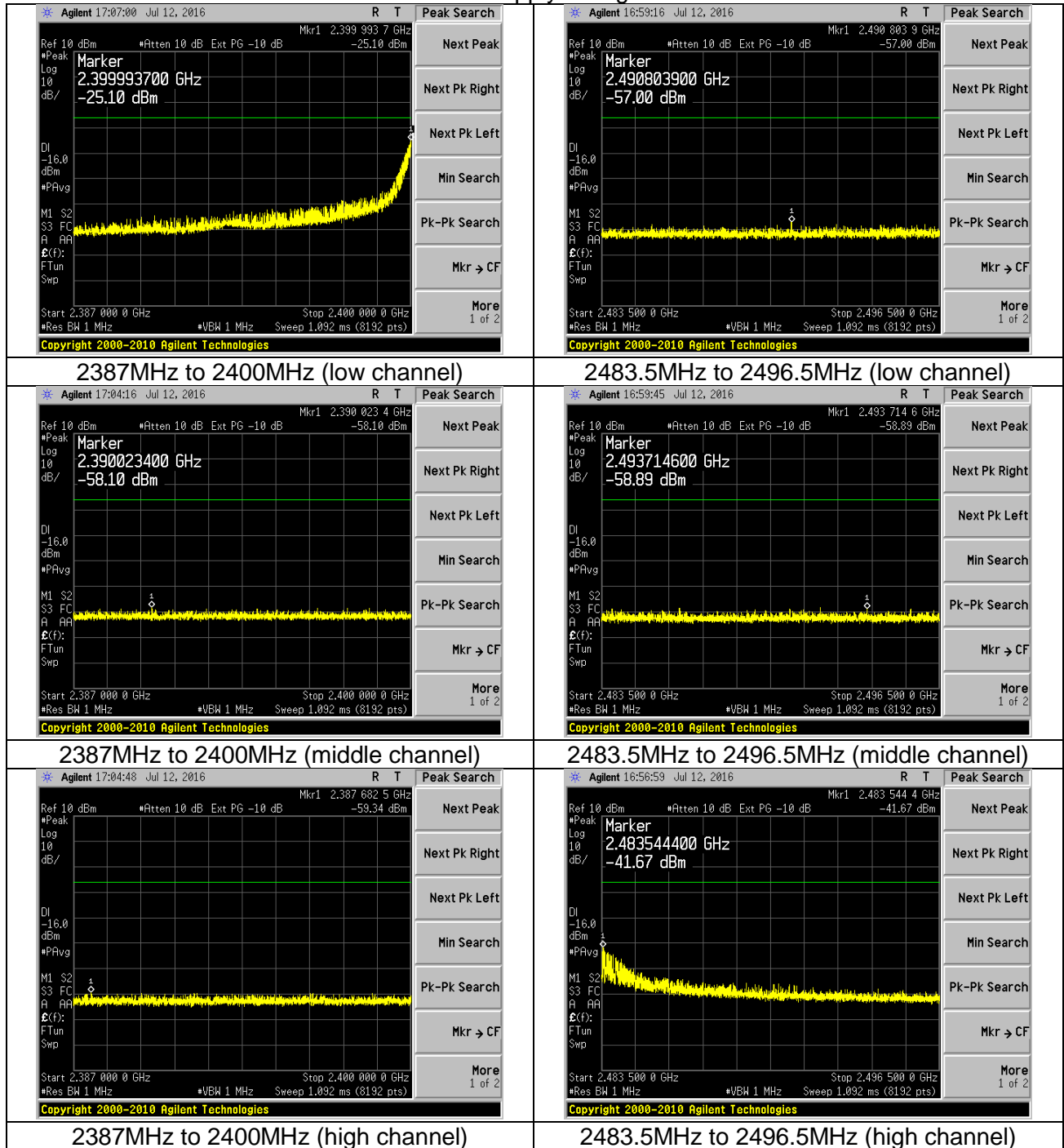
LSR Job Number: C-2408

Product Name: TiWi5 with Ethertronics  
Prestta™ WLAN Embedded Antenna

Model Number: Engineering Sample

Serial Number: Engineering Sample

-10% supply voltage



Prepared For: Nikon Metrology

Report: TR 314281A

LSR Job Number: C-2408

Product Name: TiWi5 with Ethertronics  
Prestta™ WLAN Embedded Antenna

Model Number: Engineering Sample

Serial Number: Engineering Sample

## EXHIBIT 11: Secondary Emissions

Test Engineer:	Aidi Zainal
Test Date:	7/12/16 – 7/13/16

### Requirement:

Article 24 of the Ordinance Regulating Radio Equipment sets forth the requirements for secondary/receiver emissions.

Limits for category WW are as follows:

Frequency Band	Limit
30 MHz – 1000 MHz	4 nW/ or less
1 GHz – 12.5 GHz	20 nW/ or less

### Test Notes:

1. EUT was tested at the lowest, middle and high channels.
2. Measurement performed at nominal, +10% nominal and -10% nominal supply voltage.

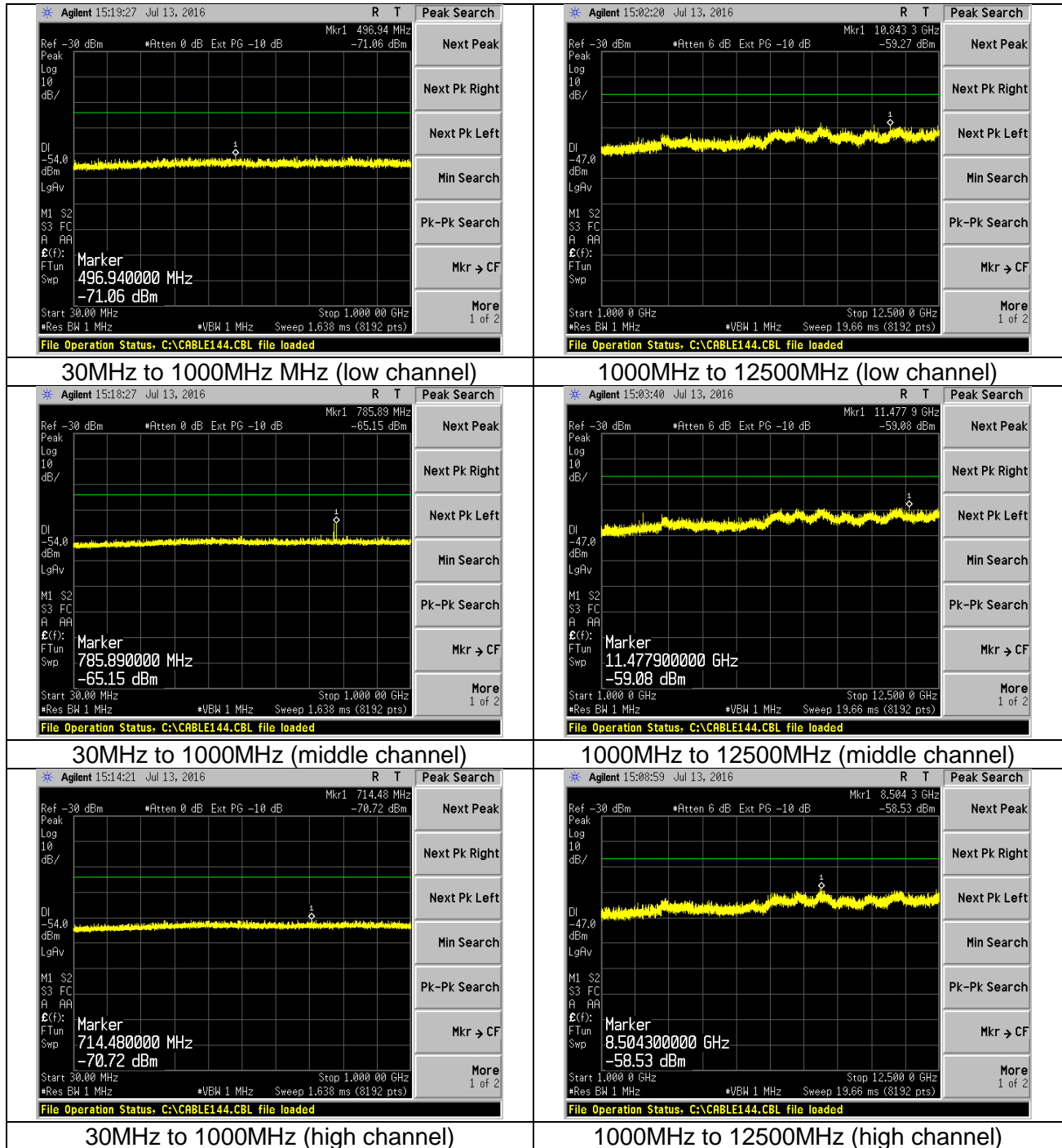
### Result:

The secondary emissions of the EUT were more than 6dB below the limit. The EUT is found to be compliant to the requirement of the Ordinance regulating Radio Equipment.

Prepared For: Nikon Metrology	Product Name: TiWi5 with Ethertronics Prestta™ WLAN Embedded Antenna
Report: TR 314281A	Model Number: Engineering Sample
LSR Job Number: C-2408	Serial Number: Engineering Sample

## Screen Captures:

### 30MHz to 1000MHz & 1000MHz to 12500MHz



Note:

1. The plots above were obtained at nominal supply voltage. Emissions were unchanged at different supply voltages.
2. The limit line is presented on the plots.

Prepared For: Nikon Metrology	Product Name: TiWi5 with Ethertronics Prestta™ WLAN Embedded Antenna
Report: TR 314281A	Model Number: Engineering Sample
LSR Job Number: C-2408	Serial Number: Engineering Sample

## EXHIBIT 12: Dwell Time

Test Engineer:	N/A
Test Date:	N/A

### Requirement:

Article 49.20 and article 2 of the Ordinance Regulating Radio Equipment sets forth the requirements for dwell time/retention time. This requirement only applies to FHSS systems with direct modulation.

The dwell time of an FHSS system is limited to 0.4 seconds or less.

### Result:

**This test is not applicable since this EUT mode is not an FHSS.**

Prepared For: Nikon Metrology	Product Name: TiWi5 with Ethertronics Prestta™ WLAN Embedded Antenna
Report: TR 314281A	Model Number: Engineering Sample
LSR Job Number: C-2408	Serial Number: Engineering Sample



## EXHIBIT 13: Spreading Factor

Test Engineer:	N/A
Test Date:	N/A

### Requirement:

Article 49.20 of the Ordinance Regulating Radio Equipment sets forth the requirements for spreading factor.

The spreading factor for category WW is greater than 5.

### Result:

**There are no requirements for systems classified as other digital method.**

### Data:

Prepared For: Nikon Metrology	Product Name: TiWi5 with Ethertronics Prestta™ WLAN Embedded Antenna
Report: TR 314281A	Model Number: Engineering Sample
LSR Job Number: C-2408	Serial Number: Engineering Sample

## EXHIBIT 14: Antenna Power Tolerance

Test Engineer:	Aidi Zainal
Test Date:	7/11/16 – 7/12/16

### Requirement:

Article 14 of the Ordinance Regulating Radio Equipment sets forth the requirements for antenna power tolerance. The antenna power of a device shall be within -80% and +20% of the rated or declared antenna power.

### Result:

The measured antenna power for the EUT was within the prescribed range. The EUT is found to be compliant to the requirement of the Ordinance regulating Radio Equipment.

### Data:

EUT supply voltage (V)	Low channel (2402 MHz)					Middle Channel (2440 MHz)					High Channel (2480 MHz)				
	RMS power (dBm)	RMS power, P (mW)	Rated RMS power (mW)	Tolerance	Pass/Fail	RMS power (dBm)	RMS power, P (mW)	Rated RMS power (mW)	Tolerance	Pass/Fail	RMS power (dBm)	RMS power, P (mW)	Rated RMS power (mW)	Tolerance	Pass/Fail
3.3VDC (Nominal)	8.3	6.808	6.200	4.960mW < P < 7.440mW	Pass	7.8	5.957	6.200	4.960mW < P < 7.440mW	Pass	7.2	5.297	6.200	4.960mW < P < 7.440mW	Pass
2.97VDC (-10%)	8.1	6.412	6.200	4.960mW < P < 7.440mW	Pass	7.5	5.572	6.200	4.960mW < P < 7.440mW	Pass	6.5	4.487	6.200	4.960mW < P < 7.440mW	Pass
3.6VDC (Max declared)	8.6	7.278	6.200	4.960mW < P < 7.440mW	Pass	8.1	6.516	6.200	4.960mW < P < 7.440mW	Pass	7.6	5.754	6.200	4.960mW < P < 7.440mW	Pass

Prepared For: Nikon Metrology	Product Name: TiWi5 with Ethertronics Prestta™ WLAN Embedded Antenna
Report: TR 314281A	Model Number: Engineering Sample
LSR Job Number: C-2408	Serial Number: Engineering Sample

## EXHIBIT 15: Number of Carriers

### Requirement:

Article 2, Item (19) 49.20 1) g / 49.20 3) h Notice 88 Appendix 43, 44, 45 requires that if OFDM is applied the amount of carriers within 1 MHz shall be 1 or more.

### Result:

There are no requirements for systems classified as other digital method.

Prepared For: Nikon Metrology	Product Name: TiWi5 with Ethertronics Prestta™ WLAN Embedded Antenna
Report: TR 314281A	Model Number: Engineering Sample
LSR Job Number: C-2408	Serial Number: Engineering Sample

## EXHIBIT 16. Housing Requirements

### Requirement:

Article 2 of the Ordinance Regulating Radio Equipment states that the EUT shall be constructed in such a way that the RF parts cannot be reached easily by the user

### Result:

The radio module, except for the antenna port, is located under a shield

The EUT is found to be compliant to the requirement of the Ordinance regulating Radio Equipment.

Prepared For: Nikon Metrology	Product Name: TiWi5 with Ethertronics Prestta™ WLAN Embedded Antenna
Report: TR 314281A	Model Number: Engineering Sample
LSR Job Number: C-2408	Serial Number: Engineering Sample

## EXHIBIT 17: Voltage Fluctuation

### Requirement:

Article 15-1 of the Ordinance Regulating Radio Equipment states that all measurements shall be carried out with three different supply voltages: The rated nominal value, -10% and +10%. However if the EUT uses an internal voltage regulator, supplying power to all critical parts of the radio circuitry, it is acceptable to restrict the measurements to the nominal supply voltage value under the condition that the regulator is able to reduce the voltage variation to a value less than 1% of input (if the input is varied by 10%).

### Result:

All testing was performed with supply voltage varied at  $\pm 10\%$  of the nominal voltage. Results indicate no change to the radio parameters with the supply voltage varied by  $\pm 10\%$  of the nominal voltage

Prepared For: Nikon Metrology	Product Name: TiWi5 with Ethertronics Prestta™ WLAN Embedded Antenna
Report: TR 314281A	Model Number: Engineering Sample
LSR Job Number: C-2408	Serial Number: Engineering Sample

## EXHIBIT 18: Interference Prevention Function

### Requirement:

Article 2 of the Ordinance Regulating Radio Equipment states that the EUT shall have the capability to transmit or to receive the MAC identification automatically, so that sender and receiver shall exclude other equipment.

### Result:

Statement from manufacturer:

Per Bluetooth Specification Version 4.0 [Vol 6], modules are identified using a device address. The module will have either a unique 48 bit MAC public device address and/or a user defined 48 bit address which is embedded data packets sent.

Prepared For: Nikon Metrology	Product Name: TiWi5 with Ethertronics Prestta™ WLAN Embedded Antenna
Report: TR 314281A	Model Number: Engineering Sample
LSR Job Number: C-2408	Serial Number: Engineering Sample

## APPENDIX A: Test Equipment List



Date : 6-May-2016

Type Test : Conducted measurements

Job # : C-2395

Prepared By: Aidi

Customer : LSR

Quote #: 316053

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960090	Power Meter	Anritsu	ML2495A	1335006	3/25/2015	3/25/2016	Active Calibration
2	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	10/25/2015	10/25/2016	Active Calibration
3	AA 960144	Phasemeter	Gore	EKD01D010720	5800373	Verification	Verification	System
4	EE 960054	Multimeter	HP	971A	JP40011152	3/16/2015	3/16/2016	Active Calibration

Project Engineer:

Quality Assurance:

Prepared For: Nikon Metrology	Product Name: TiWi5 with Ethertronics Prestta™ WLAN Embedded Antenna
Report: TR 314281A	Model Number: Engineering Sample
LSR Job Number: C-2408	Serial Number: Engineering Sample

## **APPENDIX B: Uncertainty Statement**

***Table of Expanded Uncertainty Values, (K=2) for Specified Measurements***

<b><i>Measurement Type</i></b>	<b><i>Particular Configuration</i></b>	<b><i>Uncertainty Values</i></b>
<i>Radiated Emissions</i>	<i>3 – Meter chamber, Biconical Antenna</i>	<i>4.82 dB</i>
<i>Radiated Emissions</i>	<i>3-Meter Chamber, Log Periodic Antenna</i>	<i>4.88 dB</i>
<i>Radiated Emissions</i>	<i>3-Meter Chamber, Horn Antenna</i>	<i>4.85 dB</i>
<i>Radiated Emissions</i>	<i>10-Meter OATS, Biconical Antenna</i>	<i>4.32 dB</i>
<i>Radiated Emissions</i>	<i>10-Meter OATS, Log Periodic Antenna</i>	<i>3.63 dB</i>
<i>Absolute Conducted Emissions</i>	<i>Agilent PSA/ESA Series</i>	<i>1.38 dB</i>
<i>AC Line Conducted Emissions</i>	<i>Shielded Room/EMCO LISN</i>	<i>3.20 dB</i>
<i>Radiated Immunity</i>	<i>3 Volts/Meter in 3-Meter Chamber</i>	<i>2.05 Volts/Meter</i>
<i>Conducted Immunity</i>	<i>3 Volts level</i>	<i>2.33 V</i>
<i>EFT Burst, Surge, VDI</i>	<i>230 VAC</i>	<i>54.4 V</i>
<i>ESD Immunity</i>	<i>Discharge at 15kV</i>	<i>3200 V</i>
<i>Temperature/Humidity</i>	<i>Thermo-hygrometer</i>	<i>0.64° / 2.88 %RH</i>

Prepared For: Nikon Metrology	Product Name: TiWi5 with Ethertronics Prestta™ WLAN Embedded Antenna
Report: TR 314281A	Model Number: Engineering Sample
LSR Job Number: C-2408	Serial Number: Engineering Sample