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TESTING CERT #1255.01

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**ENGINEERING TEST REPORT # 315054**  
**LSR Job #: C-2167**

Compliance Testing of:

SaBLE-x

Test Date(s)

April 14<sup>th</sup> – 23<sup>rd</sup>, 2015

Prepared For:

LSR

Attn: Josh Bablitch

W66N220 Commerce Court

Cedarburg, WI 53012

**This Test Report is issued under the Authority of:** Shane D. Rismeyer, EMC Engineer

Signature:  Date: 4/25/15

**Test Report Reviewed by:**

Khairul Aidi Zainal, Sr. EMC Engineer

Signature:  Date: 4/24/15

**Report by:**

Shane D. Rismeyer, EMC Engineer

Signature:  Date: 4/24/15

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<b>Prepared For: LSR</b>	<b>Model Number: SaBLE-x</b>	<b>Report #: 315054</b>
<b>EUT: SaBLE-x</b>	<b>Serial Number: 450-0144-R1</b>	<b>LSR Job #: C-2176</b>

## LS Research, LLC in Review

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

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TESTING CERT #1255.01

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope of Accreditation  
A2LA Certificate Number: 1255.01

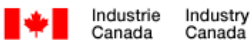
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Federal Communications Commission (FCC) – USA

Listing of 3 Meter Semi-Anechoic Chamber based on Title 47 CFR – Part 2.948  
FCC Registration Number: 90756

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**Canada**

Industry Canada

On file, 3 Meter Semi-Anechoic Chamber based on RSS-212 – Issue 1  
File Number: IC 3088-A  
On file, 3 and 10 Meter OATS based on RSS-212 – Issue 1  
File Number: IC 3088

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U. S. Conformity Assessment Body (CAB) Validation

Validated by the European Commission as a U. S. Competent Body operating under the U. S./EU, Mutual Recognition Agreement (MRA) operating under the European Union Electromagnetic Compatibility – Council Directive 2004/108/EC (formerly 89/336/EEC, Article 10.2).  
Date of Validation: January 16, 2001

Validated by the European Commission as a U.S. Notified Body operating under the U.S. /EU, Mutual Recognition Agreement (MRA) operating under the European Union Telecommunication Equipment – Council Directive 99/5/EC, Annex V.  
Date of Validation: November 20, 2002  
Notified Body Identification Number: 1243

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Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

## 1.0 Summary of Test Report

In April 2015 the EUT, SaBLE-x, was tested and MEETS the following requirements:

FCC and IC Paragraph	Test Requirements	Compliance (Yes/No)
FCC:15.247 (a)(2) IC: RSS 210 A8.2 (a)	6 dB Bandwidth of a Digital Modulation System	Yes
FCC : 15.247(b) & 1.1310 IC : RSS 210 A8.4	Maximum Output Power	Yes
FCC:15.247 (d) IC: RSS 210 A8.2 (b)	Power Spectral Density of a Digital Modulation System	Yes
FCC :15.247(d) IC : RSS 210 A8.5	RF Conducted Spurious Emissions at the Transmitter Antenna Terminal	Yes
FCC : 15.247(c), 15.209 & 15.205 IC : RSS 210 A8.2(b), section 2.2, 2.6 and 2.7	Transmitter Radiated Emissions	Yes
FCC : 15.109 IC : RSS GEN	Receive Mode (Digital Device) Radiated Emissions	Yes
FCC : 2.1055 (d)	Frequency Stability	Yes
FCC : 15.207 IC : RSS GEN sect. 7.2.2	Power Line Conducted Emissions Measurements	Yes

## 2.0 Test Facilities

All testing was performed at:

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

LS Research, LLC is accredited by A2LA (American Association for Laboratory Accreditation) to the requirements of ISO/IEC 17025, 2005 “General Requirements for the Competence of Calibration and Testing Laboratories”.

LS Research, LLC’s scope of accreditation includes all test methods listed herein, unless otherwise noted.

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

### 3.0 Client Information

<b>Manufacturer Name:</b>	LSR
<b>Address:</b>	W66N220 Commerce Court
<b>Contact Person:</b>	Josh Bablitch

### 3.1 Equipment Under Test (EUT) Information

*The following information has been supplied by the applicant.*

<b>Product Name:</b>	SaBLE-x
<b>Model Number:</b>	SaBLE-x
<b>Serial Number:</b>	450-0144-R1
<b>FCC ID</b>	TFB-1002
<b>IC Number</b>	5969A-1002

### 3.2 Product Description

The SaBLE-x module fully supports the single mode Bluetooth Low Energy operation, and the output power can support class 2. The module provides the ability to either put your entire application into the integrated ARM Cortex M3 microcontroller, or use the module in Network Processor mode in conjunction with the microcontroller of your choice. RF Core's dedicated ARM Cortex M0 improves system performance and frees up FLASH memory for custom applications.

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

None noted at time of test

### 3.4 Deviations & Exclusions from Test Specifications

None noted at time of test

### 3.5 Additional Information

Low Channel 1 (2402 MHz), Middle Channel 19 (2440 MHz), High Channel 39 (2480 MHz). EUT programmed for continuous transmit or receive on selectable channel using a programming board and LSR BT Tool v5.0.0.0.

<b>Prepared For: LSR</b>	<b>Model Number: SaBLE-x</b>	<b>Report #: 315054</b>
<b>EUT: SaBLE-x</b>	<b>Serial Number: 450-0144-R1</b>	<b>LSR Job #: C-2176</b>

#### 4.0 Conditions of Test

Environmental:

Temperature: 20-25° C  
Relative Humidity: 30-60%  
Atmospheric Pressure: 86-106 kPa

Voltage: 3.3VDC

#### 5.0 Test Equipment

All test equipment is calibrated by a calibration laboratory accredited by A2LA to the requirements of ISO 17025. For a complete list of test equipment and calibration dates, see Appendix A. Unless otherwise noted, resolution bandwidth of measuring instrument used during testing for given frequency range, see below.

Frequency Range	Resolution Bandwidth
9 kHz – 150 kHz	200 Hz
150 kHz – 30 MHz	9 kHz
30 MHz – 1000 MHz	120 kHz
Above 1000 MHz	1 MHz

#### 6.0 Conformance Summary

The EUT was found to MEET the requirements as described within the specification of FCC Title 47, CFR Part 15.247, 15.109, Industry Canada RSS-210, Issue 8 (2010), Annex 8, RSS-GEN Issue 4 (2014).

If some emissions are seen to be within 3 dB of their respective limits:

As these levels are within the tolerances of the test equipment and site employed, there is a possibility that this unit, or a similar unit selected out of production may not meet the required limit specification if tested by another agency.

LS Research, LLC 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.

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

# Appendix A – Test Equipment



Date: 22-Apr-2015 Type Test: Radiated Emissions Job #: C-2210  
 Prepared By: Shane Rismeyer Customer: JDSU Quote #: 31503

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	10/19/2014	10/19/2015	Active Calibration
2	EE 960088	8GHz MXE Spectrum Analyzer	Agilent	N9038A	MY51210138	1/9/2015	1/9/2016	Active Calibration
3	AA 960078	Log Periodic Antenna	EMCO	93H6	3701-4855	1/19/2015	1/19/2016	Active Calibration
4	AA 960150	Biconical Antenna	ETS	310B	0003-3346	1/22/2015	1/22/2016	Active Calibration
5	EE 960146	Std. Gain Horn Ant. w/preamp	Adv. Micro / EMC	\LA622-4 / 3160-09	123001	8/20/2014	8/20/2015	Active Calibration
6	AA 960137	Standard Gain Horn Ant.	EMCO	3160-10	69259	8/20/2014	8/20/2015	Active Calibration
7	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	6/20/2014	6/20/2015	Active Calibration
8	EE 960159	0.8 - 21GHz LNA	Mini-Circuits	ZVA-213X-S+	740411007	6/20/2014	6/20/2015	Active Calibration
9	AA 960161	Highpass Filter	K&L Microwave	11SH10-8000	2	2/6/2015	2/6/2016	Active Calibration
10	EE 960084	LISN - 15A	CDM-POWER	LI-215A	191920	5/2/2014	5/2/2015	Active Calibration

Project Engineer: *Shane Rismeyer* Quality Assurance: *Peter Finken*



Date: 12-Mar-2015 Type Test: Conducted Measurements Job #: C-2176  
 Prepared By: Shane Rismeyer Customer: LSR Quote #: 315054

No.	Asset #	Description	Manufacturer	Model #	Serial #	Cal Date	Cal Due Date	Equipment Status
1	EE 960087	44GHz EXA Spectrum Analyzer	Agilent	N9010A	MY53400296	12/11/2014	12/11/2015	Active Calibration
2	AA 960143	Phaseflex	Gore	EKD01D01048.0	5546519	6/14/2013	6/14/2015	Active Calibration

Project Engineer: *Shane Rismeyer* Quality Assurance: *Hynd*

Prepared For: <b>LSR</b>	Model Number: <b>SaBLE-x</b>	Report #: <b>315054</b>
EUT: <b>SaBLE-x</b>	Serial Number: <b>450-0144-R1</b>	LSR Job #: <b>C-2176</b>

## Appendix B – Test Data

### B.1 – RF Conducted Emissions

Manufacturer	LSR
Test Location	LS Research
Rule Part	FCC Part 15.247 / RSS-210 Annex 8
General Measurement Procedure	FCC KDB 558074 D01 DTS Meas Guidance v03r02 ANSI C63.10-2009 Section 6.7
General Description of Measurement	A direct measurement of the transmitted signal was performed at the antenna port of the EUT via a cable connection to a spectrum analyzer. An attenuator was placed in series with the cable to protect the spectrum analyzer. The loss from the cable and the attenuator were added on the analyzer as gain offset settings there by allowing direct measurements, without the need for any further corrections. The EUT was configured to run in a continuous transmit mode, while being supplied with typical data as a modulation source.

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176



### B.1.1 – RF Conducted – Fundamental Bandwidth

Manufacturer	LSR
Date	4/14/15
Operator	Aidi Zainal
Temp. / R.H.	20 - 25° C / 30 - 60% R.H.
Rule Part	FCC Part 15.247 / RSS-210 A8
Specific Measurement Procedure	FCC KDB 558074 Section 8.0 DTS bandwidth ANSI C63.10-2009 Section 6.9 RSS-GEN Section 4.6
Additional Description of Measurement	Peak detector used
Additional Notes	Continuous transmit modulated used for this test.

**Table**

Channel	Frequency (MHz)	6 dB DTS BW (MHz)	99% BW (MHz)	20 dB BW (MHz)
1	2402	0.7	1.1	1.2
19	2440	0.7	1.1	1.2
39	2480	0.7	1.1	1.2

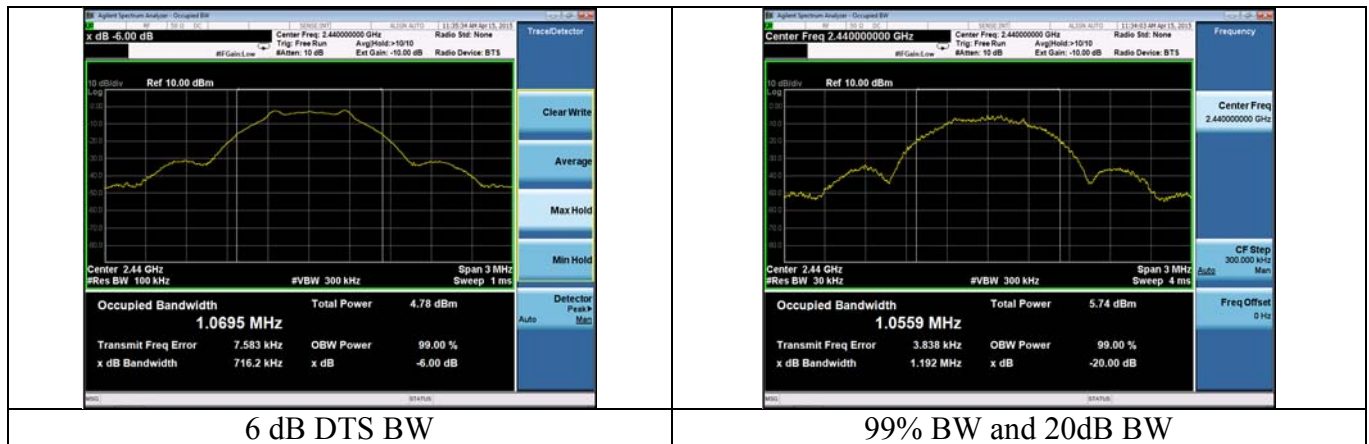
Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

# Plots

## Low Channel – 2402 MHz



## Mid Channel – 2440 MHz



## High Channel – 2480 MHz



Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

### B.1.2 – RF Conducted – Fundamental Power and Spectral Density

Manufacturer	LSR
Date	4/14/15
Operator	Aidi Zainal
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247 / RSS-210 A8
Specific Measurement Procedure	FCC KDB 558074 Section 9.2.2.2 FCC KDB 558074 Section 10.2
Additional Description of Measurement	100 kHz resolution bandwidth used for Power Spectral Density measurement
Additional Notes	Continuous transmit modulated used for this test. Sample Calculation: Margin (dB) = Limit – Measured level <b>Average Output power = 4.9 dBm &lt; 30 dBm (limit)</b>

#### Output Power Table

Channel	Frequency (MHz)	Power (dBm)	Limit (dBm)	Margin (dBm)
1	2402	4.9	30	25.1
19	2440	4.7		25.3
39	2480	4.3		25.7

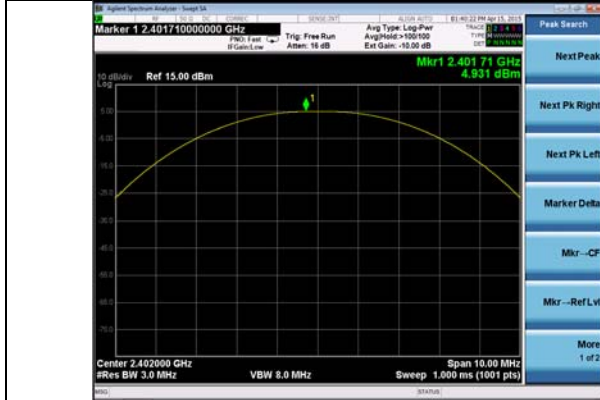
#### PSD Table

Channel	Frequency (MHz)	Power Spectral Density (dBm)	Limit (dBm)	Margin (dBm)
1	2402	4.7	8	3.3
19	2440	4.6		3.4
39	2480	4.2		3.8

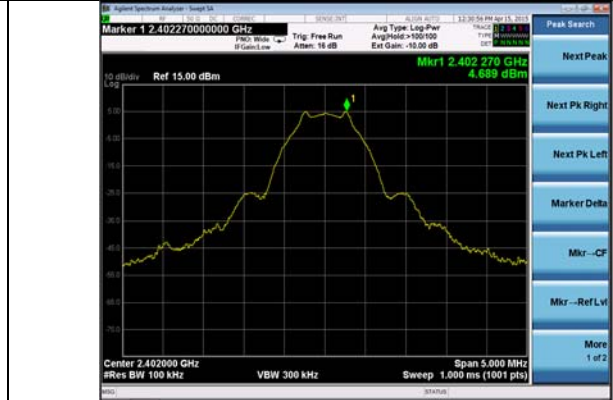
Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

## Plots

### Low Channel – 2402 MHz

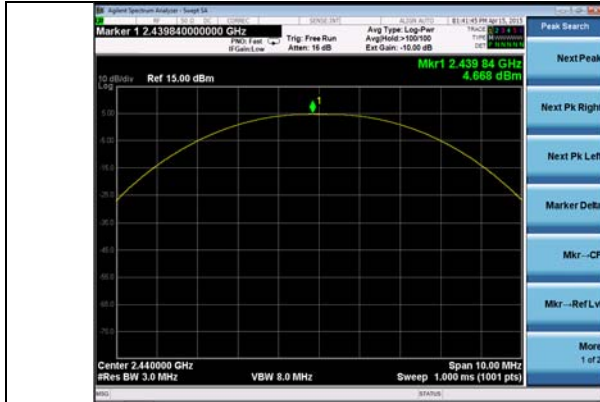


Output Power

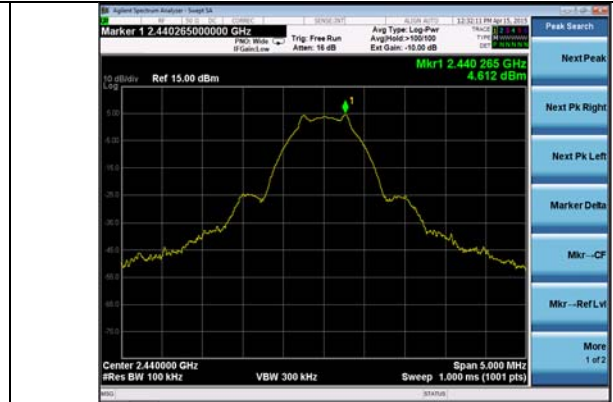


Power Spectral Density

### Mid Channel – 2440 MHz



Output Power

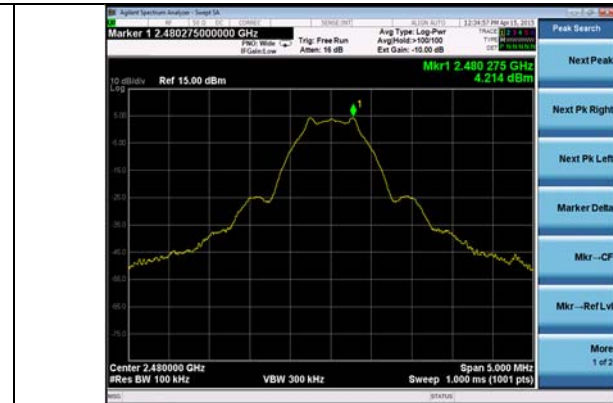


Power Spectral Density

### High Channel – 2480 MHz



Output Power



Power Spectral Density

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

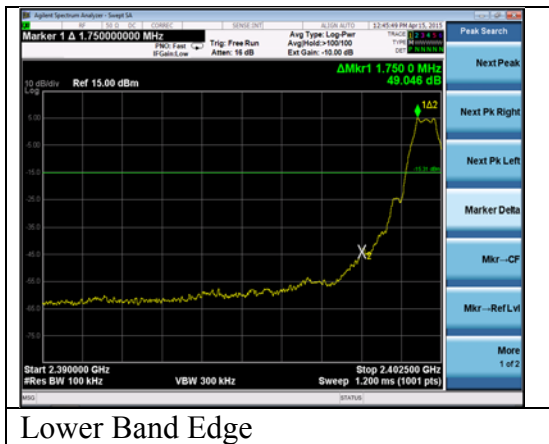
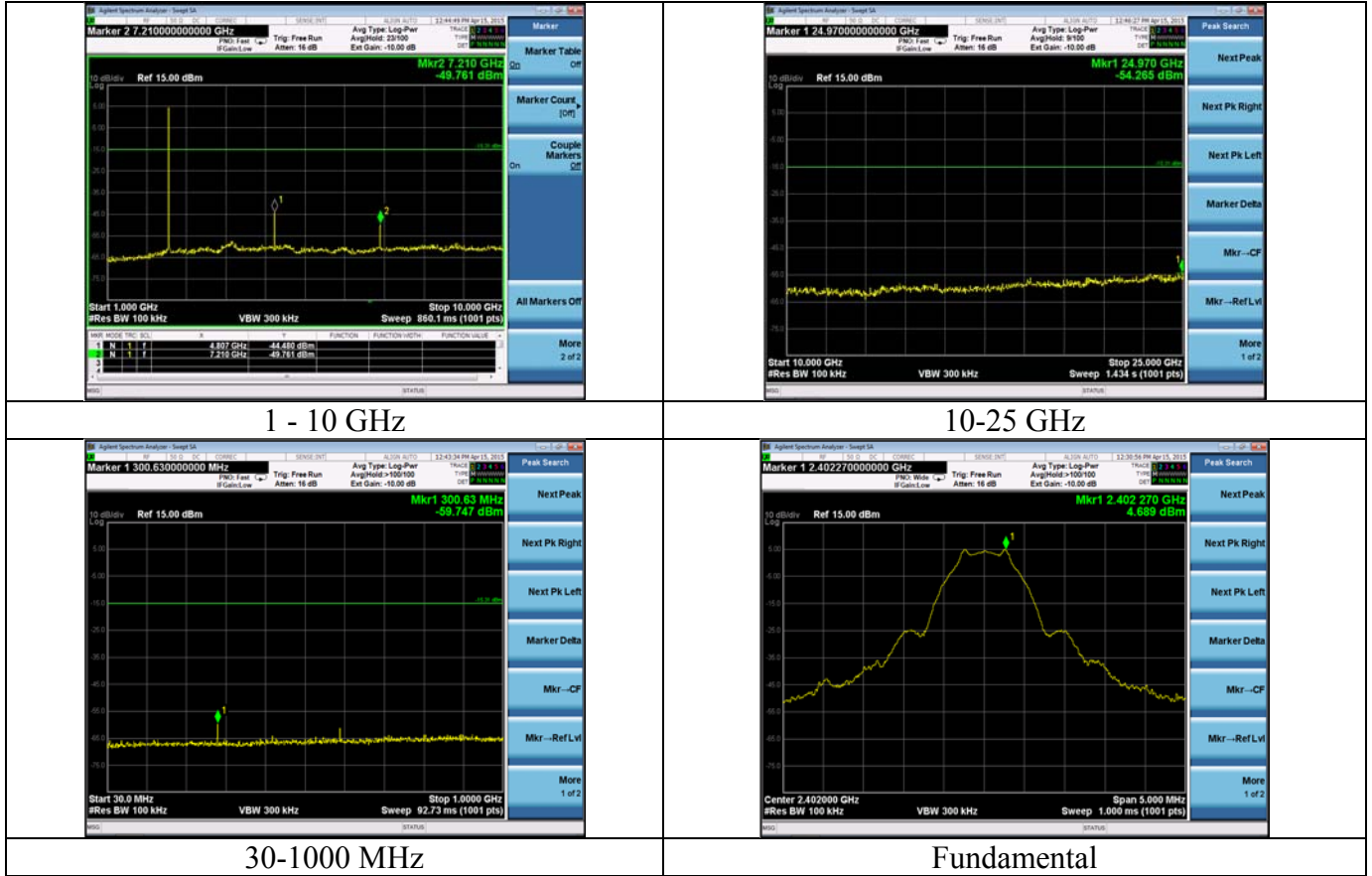
### B.1.3 – RF Conducted – Emissions in 100kHz bandwidth

Manufacturer	LSR
Date	4/14/15
Operator	Aidi Zainal
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247 / RSS-210 A8
Specific Measurement Procedure	FCC KDB 558074 Section 11.0 – Emissions in non-restricted frequency bands
Additional Description of Measurement	RF Conducted Measurement
Additional Notes	No Emissions found to be within 15 dB of limit Continuous transmit modulated used for this test.

**Plots start next page**

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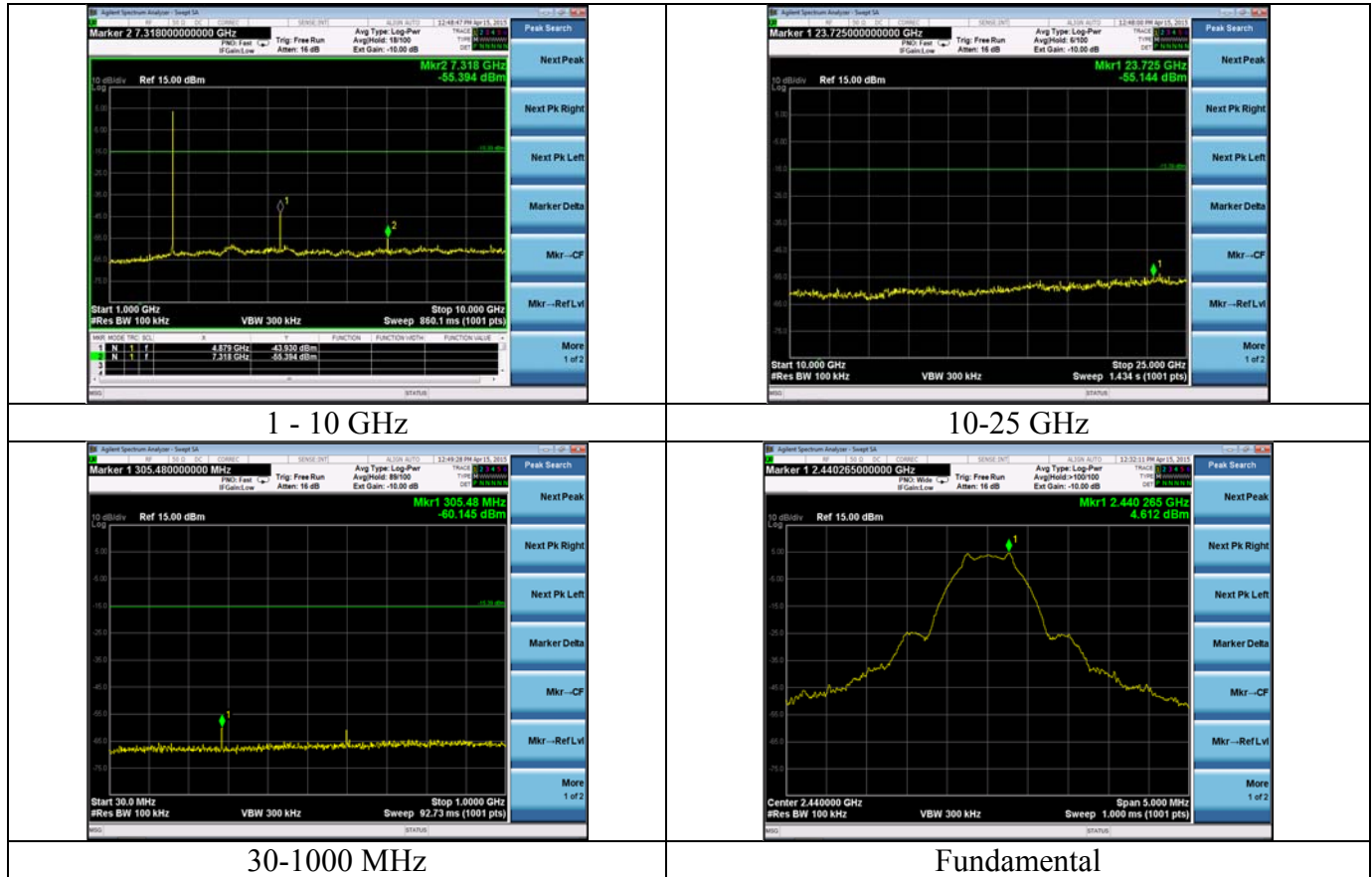
## Low Channel – 2402 MHz



Lower Band Edge

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

# Mid Channel – 2440 MHz



1 - 10 GHz

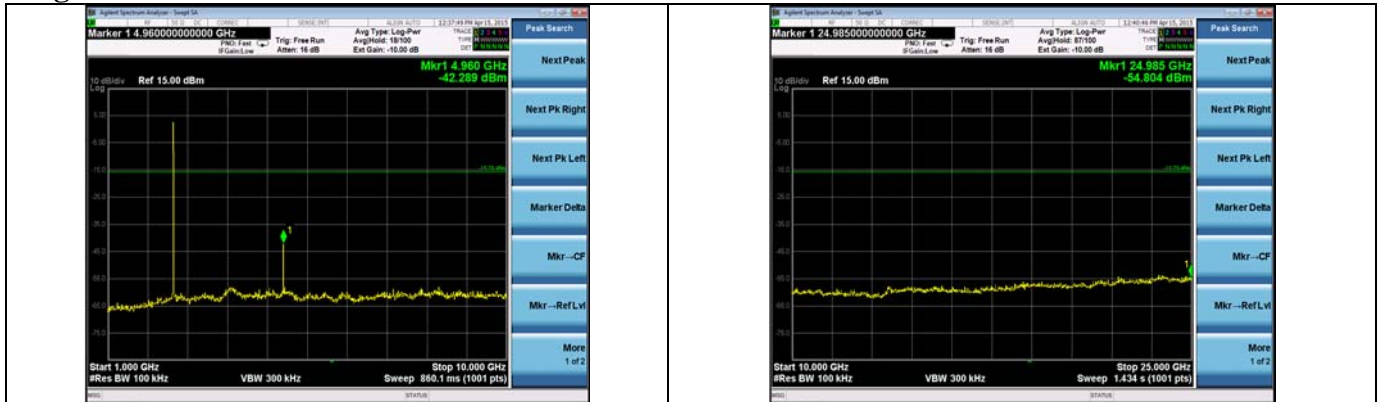
10-25 GHz

30-1000 MHz

Fundamental

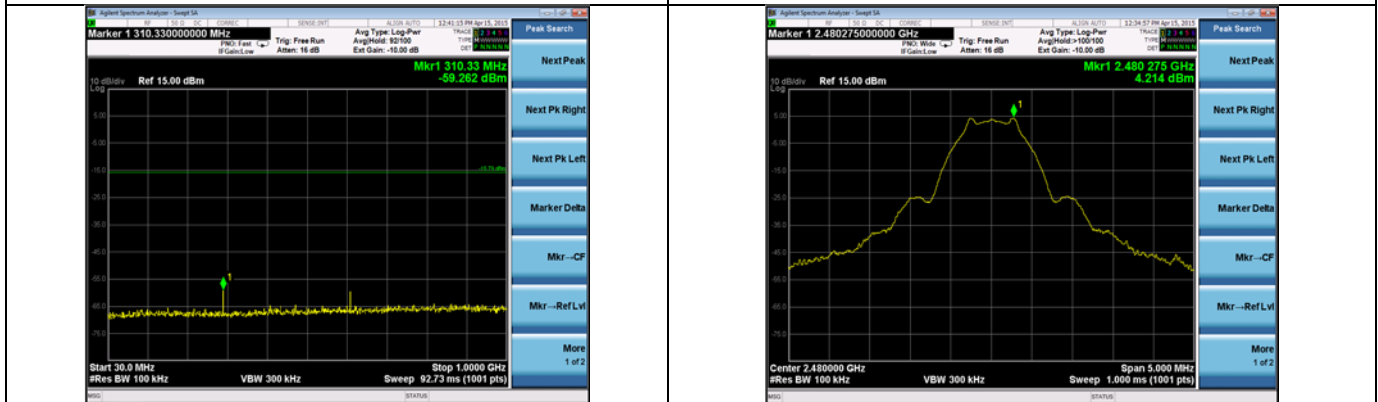
Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

# High Channel – 2480 MHz



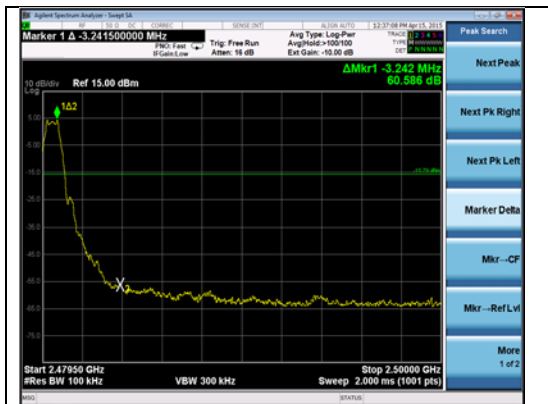
1 - 10 GHz

10-25 GHz



30-1000 MHz

Fundamental



Upper Band Edge

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
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### B.1.4 – RF Conducted – Emissions in restricted frequency bands and band-edge measurements

Manufacturer	LSR
Date	4/14/15
Operator	Aidi Zainal
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247 / RSS-210 A8
Specific Measurement Procedure	KDB 558074 D01 Meas Guidance v03r02: Section 12.2 (states that at band-edge use either peak in band antenna gain or 2dBi whichever is greatest)
Additional Description of Measurement	RF Conducted Measurement
Additional Notes	Continuous transmit modulated used for this test.

Low channel										
Frequency (MHz)	Measured Peak (dBm)	Measured Avg (dBm)	Duty Cycle correction (dB)	Antenna gain (dBi)	Final peak (dBm)	Peak Limit (dBm)	Peak Margin (dB)	DC corrected average (dBm)	Average Limit (dBm)	Average Margin (dB)
4804.0	-40.8	-43.3	14.9	2.0	-38.8	-21.2	17.5	-53.7	-41.2	12.4
7206.0	-46.6	-50.8	14.9	2.0	-44.6	-21.2	23.3	-59.5	-41.2	18.2

Middle channel										
Frequency (MHz)	Measured Peak (dBm)	Measured Avg (dBm)	Duty Cycle correction (dB)	Antenna gain (dBi)	Final peak (dBm)	Peak Limit (dBm)	Peak Margin (dB)	DC corrected average (dBm)	Average Limit (dBm)	Average Margin (dB)
4880.0	-40.8	-43.3	14.9	2.0	-38.8	-21.2	17.5	-53.7	-41.2	12.4
7320.0	-50.8	-56.3	14.9	2.0	-48.8	-21.2	27.5	-63.7	-41.2	22.4

High channel										
Frequency (MHz)	Measured Peak (dBm)	Measured Avg (dBm)	Duty Cycle correction (dB)	Antenna gain (dBi)	Final peak (dBm)	Peak Limit (dBm)	Peak Margin (dB)	DC corrected average (dBm)	Average Limit (dBm)	Average Margin (dB)
4960.0	-39.7	-42.2	14.9	2.0	-37.7	-21.2	16.5	-52.6	-41.2	11.4
7440.0	-54.6	-61.5	14.9	2.0	-52.6	-21.2	31.3	-67.5	-41.2	26.2

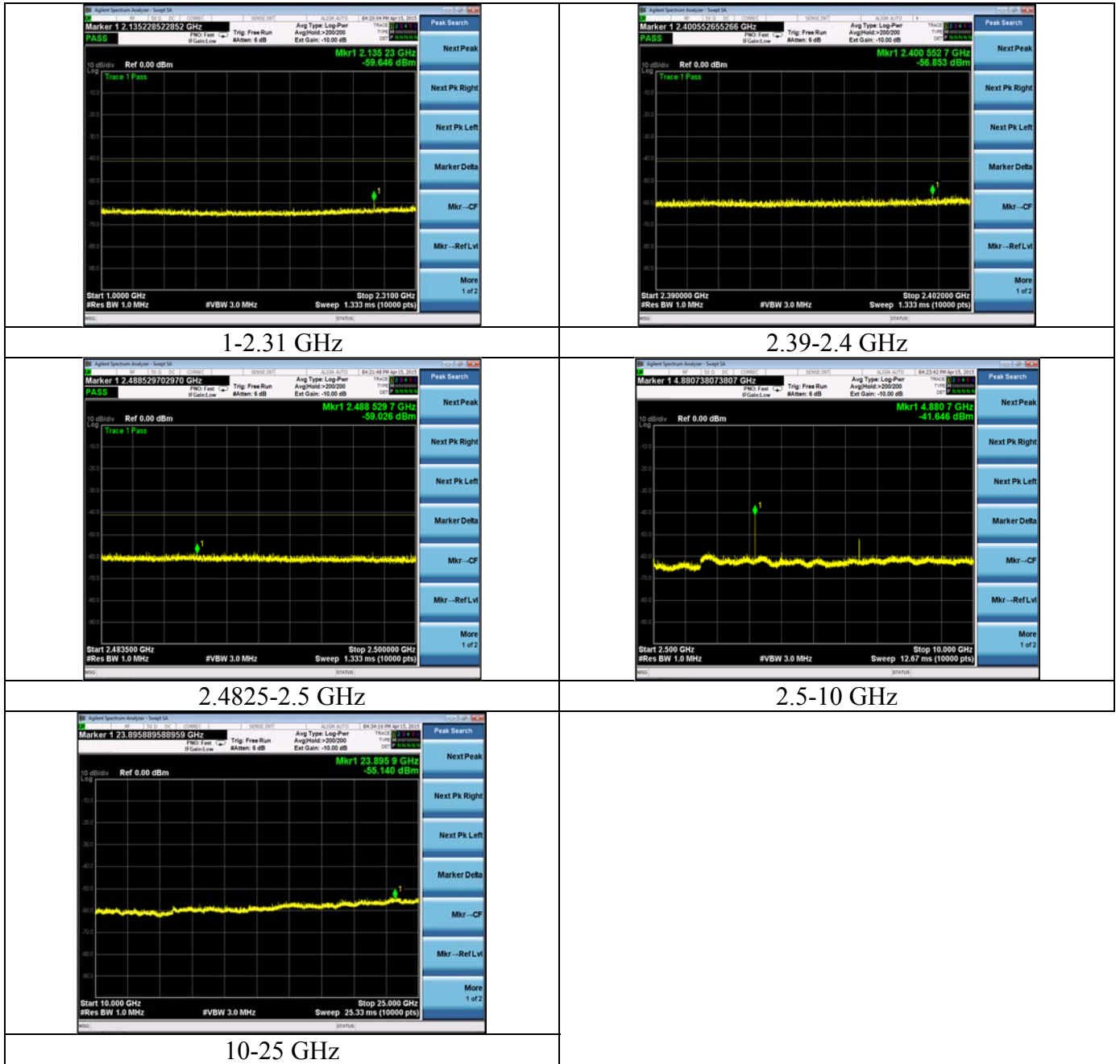
DC corrected average = Measured Peak - DC correction factor + gain

Upper band edge data												
Data Rate (MBPS)	Peak data Frequency (MHz)	Restricted band edge: Peak (dBm)	Average data Frequency (MHz)	Restricted band edge: Avg (dBm)	Antenna gain (dBi)	Final peak Band-	Peak Limit (dBm)	Peak Margin (dB)	Final average Band-	Average Limit (dBm)	Average Margin (dB)	
1	2484.0	-45.8	2483.5	-57.6	2.0	-43.8	-21.2	22.6	-55.6	-41.2	14.3	

Note: See Appendix E for Duty Cycle justification.

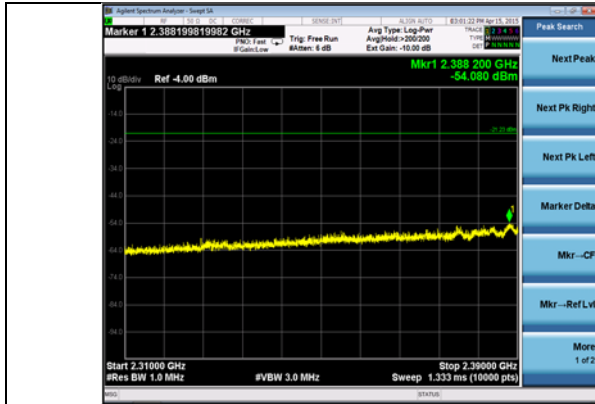
Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
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# Mid Channel



Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

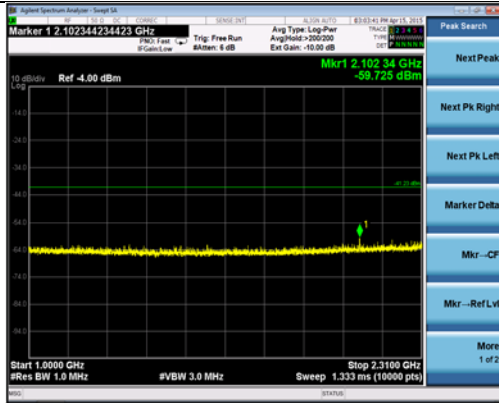
# Low Channel



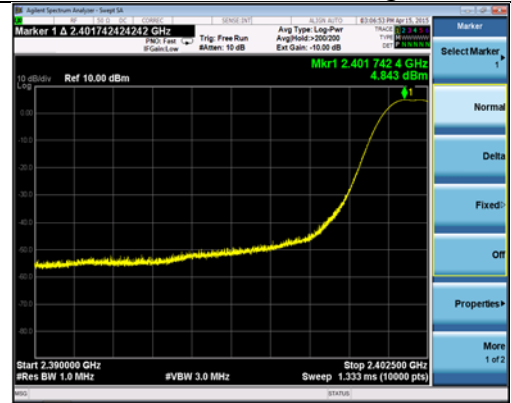
2.31-2.39 GHz Peak



2.31-2.39 GHz Average



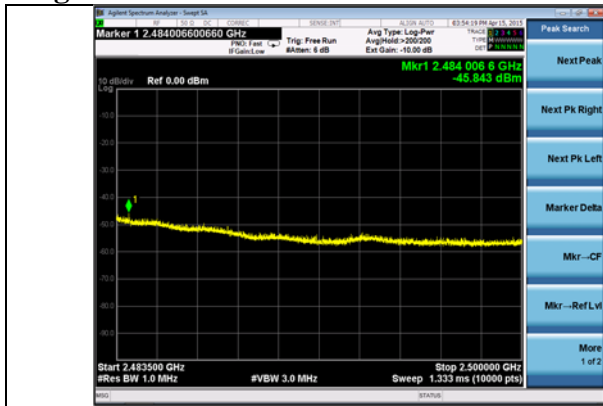
1-2.31 GHz



2.39-2.4025 GHz

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
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# High Channel



2.4835-2.5 GHz Peak



2.4835-2.5 GHz Average

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
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## B.2 – Radiated Emissions

Rule Part(s)	FCC: 15.247 / 15.205 / 15.209 IC: RSS-210 A8 / RSS-210 Section 2.2			
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 – 2009 FCC KDB 558074 D01 DTS Meas Guidance v03r02			
Test Location	LS Research, LLC - FCC Listed 3 meter Semi-Anechoic Chamber			
Test Distance	See data section			
EUT Placement	80 cm height non-conductive table above reference ground plane			
Frequency Range of Measurement	Biconical: 30-300 MHz	Log Periodic Dipole Array: 300-1000 MHz	Double-Ridged Waveguide Horn: 1-18 GHz	Standard Gain Horn: 18-26GHz
Measurement Detectors	30-1000MHz RBW: 120 kHz VBW: At least 300 kHz		1 - 40 GHz: RBW : 1MHz VBW: At least 3 (MHz) Peak 10 Hz Average	
Description of Measurement	<p>1) The antenna, cable, pre-amp, and other necessary measurement system correction factors are loaded onto the EMI receiver / spectrum analyzer when the measurements are performed. The data is gathered and reported as the corrected values.</p> <p>2) The EUT is placed on a non-conductive pedestal centered on a turn-table in the test location with the antenna at the test distance from the EUT</p> <p>3) Maximum radiated RF emissions are determined by rotation of azimuth and scanning the sense antenna between 1 and 4 meters in height using both horizontal and vertical antenna polarities. Maximized levels are manually noted at degree values of azimuth and at sense antenna height.</p> <p>4) Measurements performed with the antenna port terminated with 50Ω</p>			
Example Calculations	Reported Measurement data = Raw receiver measurement + Antenna Correction Factor + Cable factor (dB) - amplification factor (when applicable) + Additional factor (when applicable)			

### FCC Part 15.209 / IC RSS-210 Section 2.7 Limits:

Frequency (MHz)	3 m Limit ( $\mu\text{V/m}$ )	3 m Limit ( $\text{dB}\mu\text{V/m}$ )	Type
30-88	100	40.0	Quasi-Peak
88-216	150	43.5	Quasi-Peak
216-960	200	46.0	Quasi-Peak
Above 960	500	54.0	Average (>1 GHz)

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

### B.2.1 – Radiated Band-Edge Restricted Bands

Manufacturer	LSR
Date	4/22/15
Operator	Mike Hintzke
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 - 2009 FCC KDB 558074 v03r02 Section 12.2.7 Radiated spurious emission test
Test Distance	3 meter (1-4 GHz)
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak; RBW 1MHz VBW 3 MHz (10Hz VBW for average measurements)
Additional Notes	1) EUT maximized in azimuth and antenna height with maximum results reported.

#### Example Calculation:

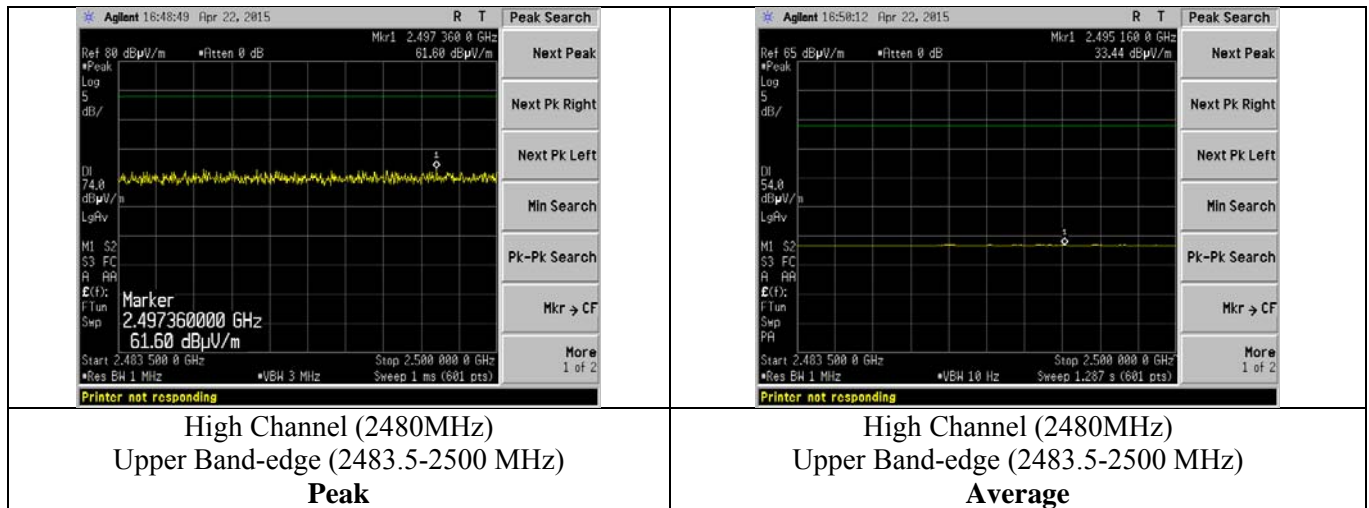
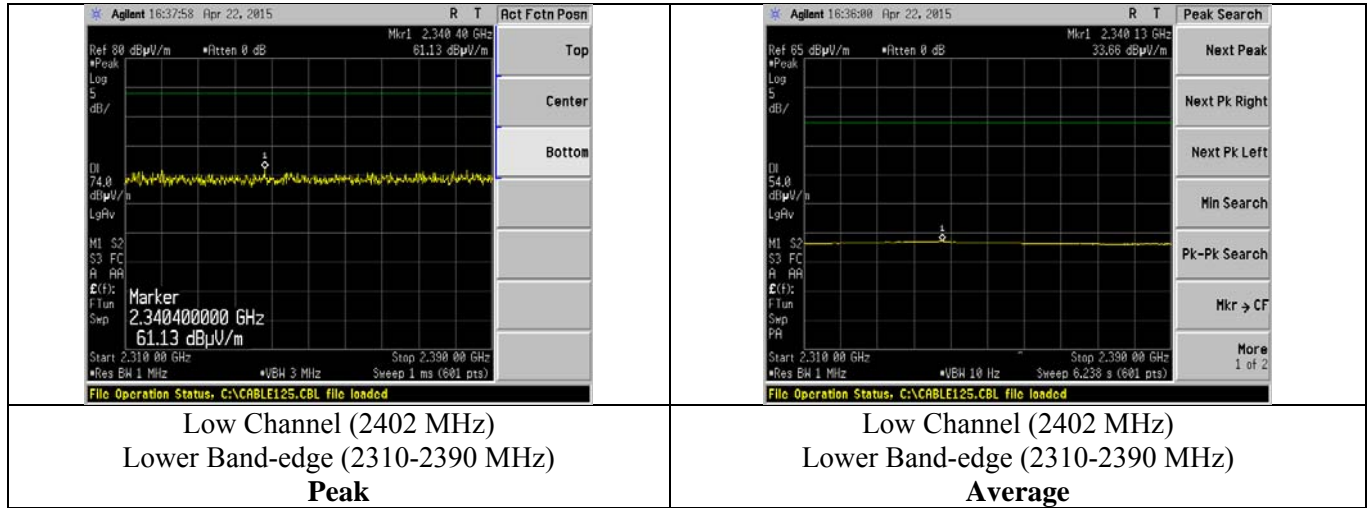
FCC 15.209 Average Limit @ 3 meter (dBµV/m) – Peak Reading (dBµV/m) = Margin

#### Data Table

Channel	Frequency (MHz)	EUT orientation/ Antenna Polarity	Height (cm)	Azimuth (degree)	Peak Reading (dBµV/m)	Peak Limit (dBµV/m)	Margin (dB)	Avg Reading (dBµV/m)	Avg Limit (dBµV/m)	Margin (dB)
1	2340	Vertical Vertical	253	242	61.1	74.0	12.9	33.7	54.0	20.3
39	2497	Vertical Vertical	267	263	61.6	74.0	12.4	33.4	54.0	20.6

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

# Plots



Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

## B.2.2 – Radiated Harmonics in Restricted Bands

Manufacturer	LSR
Date	4/22/15-4/23/15
Operator	Peter Feilen and Mike Hintzke
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 - 2009 ANSI C63.10 - 2009
Test Distance	3 meters 4-26 GHz
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Peak; RBW 1 MHz Average VBW (10Hz)
Additional Notes	1) Tested in continuous transmit modulated mode with EUT in three orientations at maximum power. 2) 50Ω Termination used on antenna port

### Example Calculation:

FCC 15.209 Average Limit @ 3 meters (dBμV/m) – Peak Reading (dBμV/m) = Margin

### Data Table

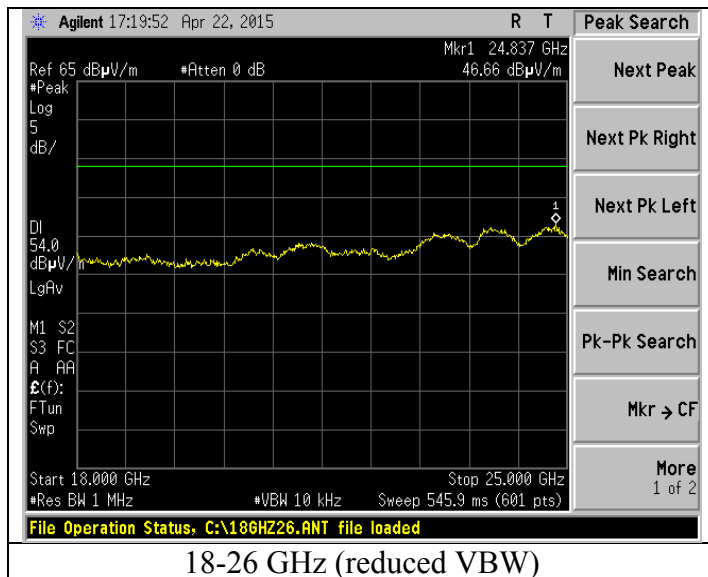
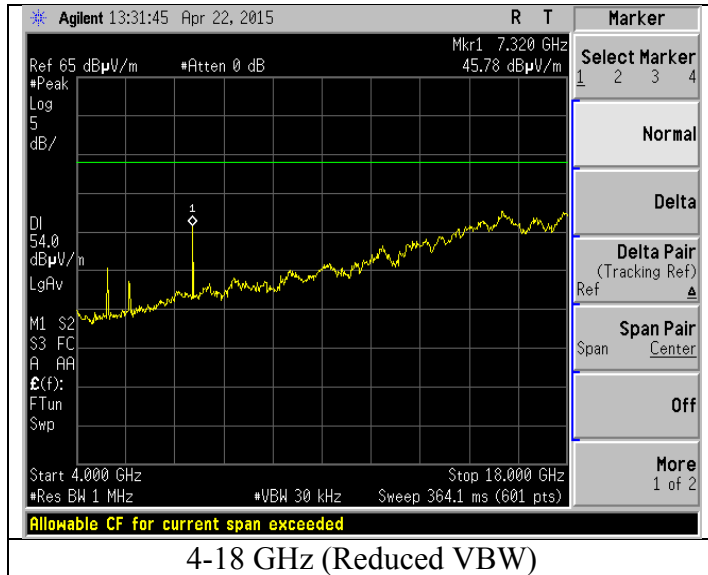
Frequency (MHz)	Height (cm)	Azimuth (degree)	Peak Reading (dBμV/m)	Avg Limit (dBμV/m)	Margin (dB)	Antenna Polarity	Channel/Orientation	Note
4804	223	70	45.7	54.0	8.3	H	Low Ch – Side Pos	1
7320	155	310	52.3	54.0	1.7	V	Mid Ch – Side Pos	1
7440	147	333	52.4	54.0	1.6	V	High Ch – Side Pos	1

**Note 1:** Peak measurements below Average limit.

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176



## Plots - Middle Channel



Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

### B.2.3 – Radiated Emissions Transmit Mode

Manufacturer	LSR
Date	4/21/15-4/22/15
Operator	Mike Hintzke
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.247/ 15.205 / 15.209
Measurement Procedure	ANSI C63.4 – 2009 ANSI C63.10 - 2009
Test Distance	3 meter 30-4000 MHz
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Quasi-Peak; 120 kHz and Peak; RBW 1 MHz
Additional Notes	1) Tested in continuous transmit modulated mode with EUT in three orientations at maximum power. 2) Emissions not effected by channel or transmit or receive mode.

#### Example Calculation:

Limit (dB $\mu$ V/m) – Reading (dB $\mu$ V/m) = Margin

Data on the following page

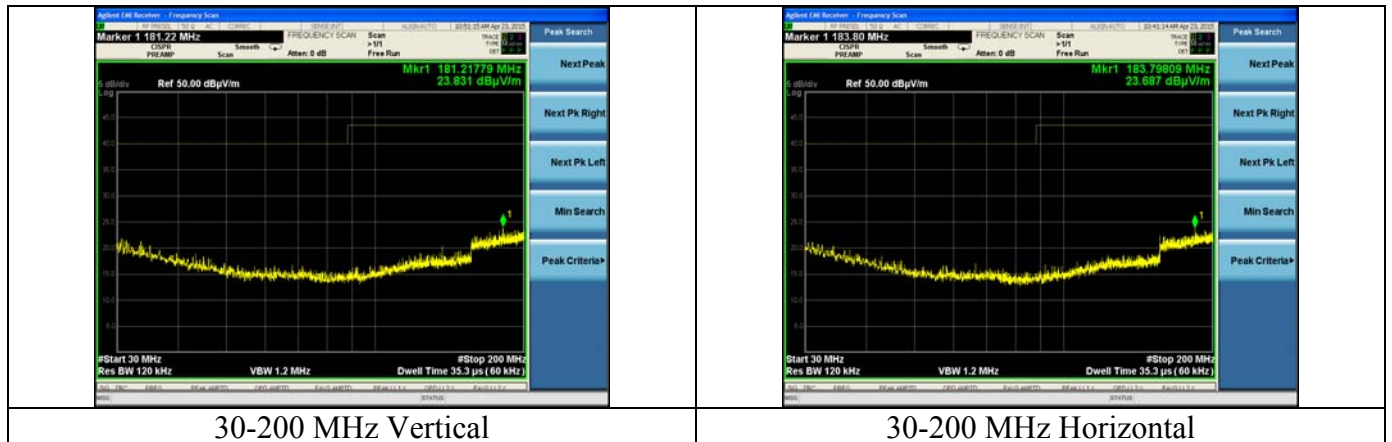
Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

## Table

Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dB $\mu$ V/m)	Quasi Peak Limit (dB $\mu$ V/m)	Margin (dB)	Antenna Polarity	EUT orientation	EUT Channel	Notes
182.0	1.00	0	17.55	43.5	26.0	H	TT	Low	1,3,4
194.7	1.00	0	17.84	43.5	25.7	V	TT	Low	1,3,4
194.1	1.00	0	17.83	43.5	25.7	H	TT	Mid	1,3,4
192.4	1.00	0	17.71	43.5	25.8	V	TT	Mid	1,3,4
189.4	1.00	0	17.55	43.5	26.0	H	TT	High	1,3,4
199.1	1.00	0	18.14	43.5	25.4	V	TT	High	1,3,4
992.9	1.00	0	28.42	54.0	25.6	H	TT	Low	1,3,4
994.2	1.00	0	28.65	54.0	25.4	V	TT	Low	1,3,4
998.4	1.00	0	28.79	54.0	25.2	H	TT	Mid	1,3,4
951.3	1.00	0	28.08	46.0	17.9	V	TT	Mid	1,3,4
956.1	1.00	0	28.09	46.0	17.9	H	TT	High	1,3,4
995.5	1.00	0	28.73	54.0	25.3	V	TT	High	1,3,4

Note 1:	EUT in transmit mode
Note 2:	EUT in receive mode
Note 3:	Measurements were obtained with EUT antenna port terminated. Emissions did not change due to EUT orientation
Note 4:	system noise floor measurement

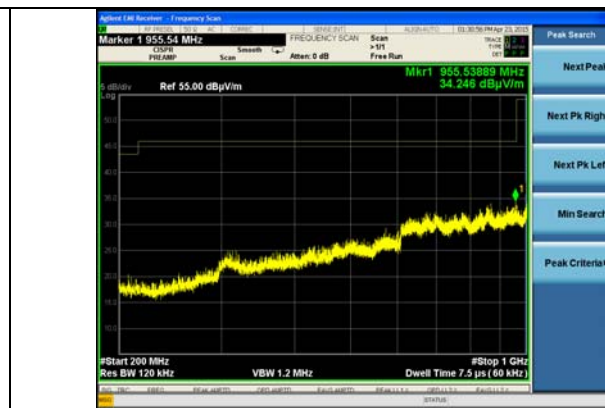
## Plots



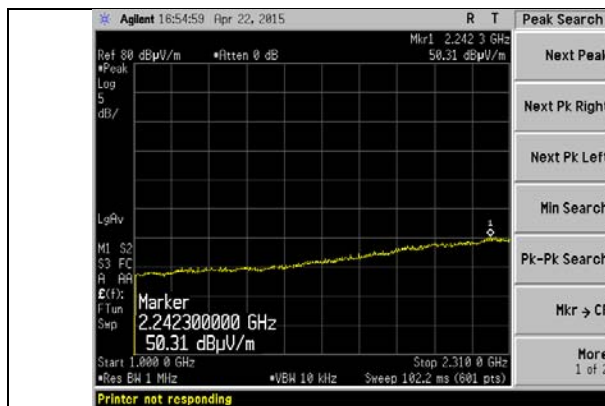
Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176



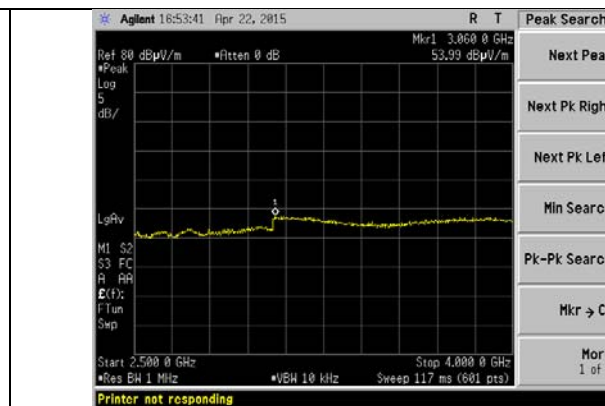
200-1000 MHz Vertical



200-1000 MHz Horizontal



1000 - 2310 MHz



2500 - 4000 MHz

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

### B.2.4 – Radiated Emissions Receive Mode

Manufacturer	LSR
Date	4/21/15-4/22/15
Operator	Mike Hintzke
Temp. / R.H.	20 - 25° C / 30-60% R.H.
Rule Part	15.109 / RSS-GEN
Measurement Procedure	ANSI C63.4 – 2009 ANSI C63.10 - 2009
Test Distance	3 meter 30-25000MHz
EUT Placement	80 cm height non-conductive table centered on turn-table
Detectors	Quasi-Peak; RBW 120 kHz and Peak; RBW 1 MHz
Additional Notes	<ol style="list-style-type: none"> <li>1) Tested in continuous transmit modulated mode with EUT in three orientations at maximum power.</li> <li>2) Maximum results reported</li> <li>3) Emissions not effected by channel or transmit or receive mode.</li> </ol>

#### Example Calculation:

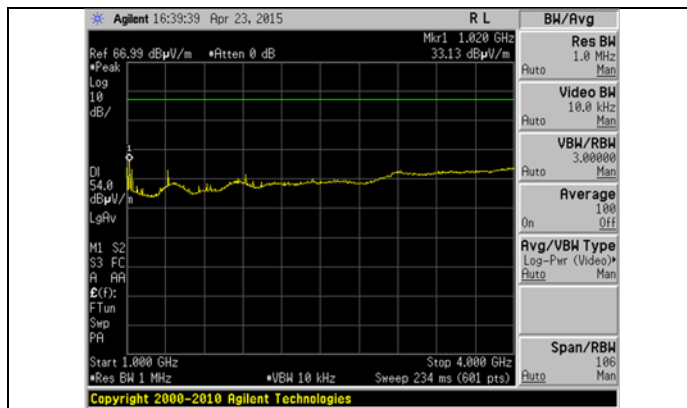
$$\text{Limit (dB}\mu\text{V/m)} - \text{Reading (dB}\mu\text{V/m)} = \text{Margin}$$

**Table**

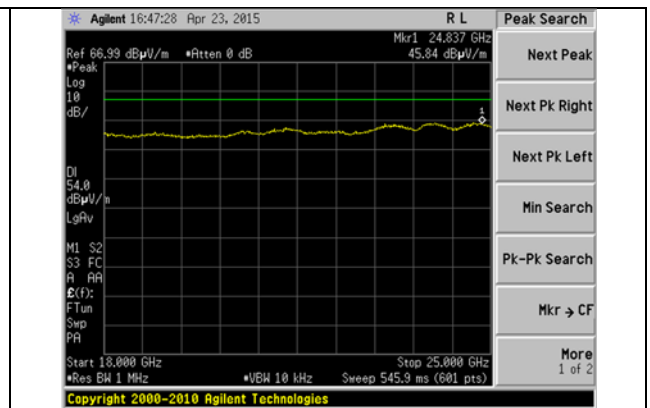
Frequency (MHz)	Height (m)	Azimuth (degree)	Quasi Peak Reading (dBμV/m)	Quasi Peak Limit (dBμV/m)	Margin (dB)	Antenna Polarity	EUT orientation	EUT Channel	Notes
193.1	1.00	0	17.76	43.5	25.7	H	TT	Low	2,3,4
199.3	1.00	0	18.07	43.5	25.4	V	TT	Low	2,3,4
198.1	1.00	0	18.01	43.5	25.5	H	TT	Mid	2,3,4
199.0	1.00	0	19.36	43.5	24.1	V	TT	Mid	2,3,4
190.2	1.00	0	17.44	43.5	26.1	H	TT	High	2,3,4
198.0	1.00	0	18.03	43.5	25.5	V	TT	High	2,3,4
925.7	1.00	0	27.97	46.0	18.0	H	TT	Low	2,3,4
995.2	1.00	0	28.73	54.0	25.3	V	TT	Low	2,3,4
998.9	1.00	0	28.78	54.0	25.2	H	TT	Mid	2,3,4
993.2	1.00	0	28.43	54.0	25.6	V	TT	Mid	2,3,4
936.7	1.00	0	27.6	46.0	18.4	H	TT	High	2,3,4
996.6	1.00	0	28.75	54.0	25.3	V	TT	High	2,3,4

Note 1:	EUT in transmit mode
Note 2:	EUT in receive mode
Note 3:	Measurements were obtained with EUT antenna port terminated. Emissions did not change due to EUT orientation
Note 4:	system noise floor measurement

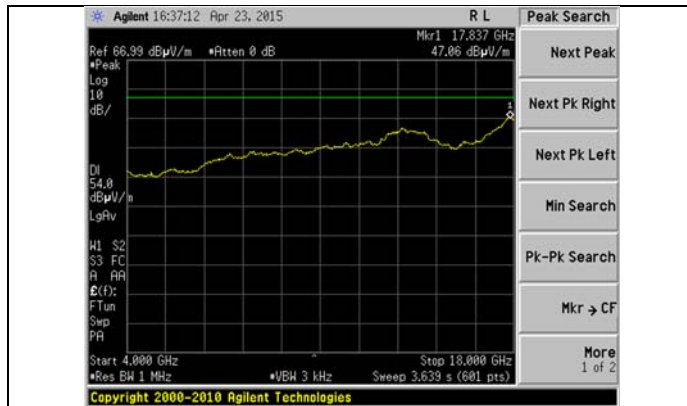
Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176



1000 – 4000 MHz (reduced VBW)

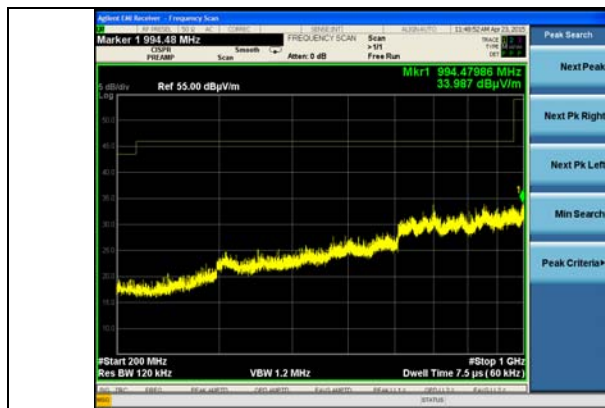


18-26 GHz (reduced VBW)

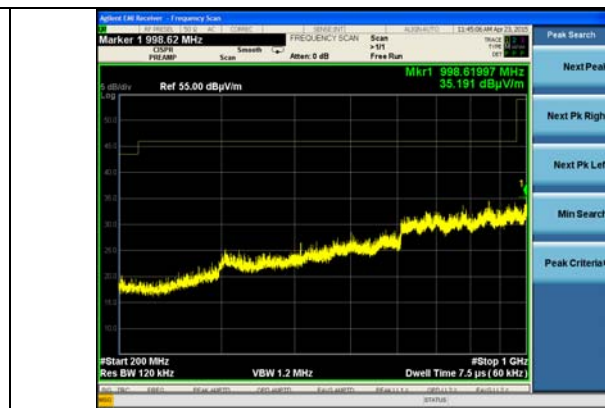


4-18 GHz (reduced VBW)

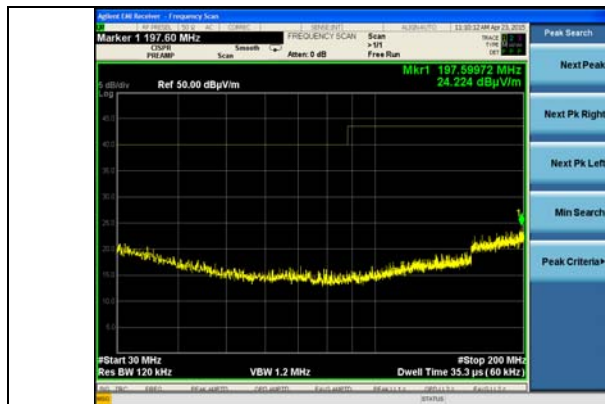
Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176



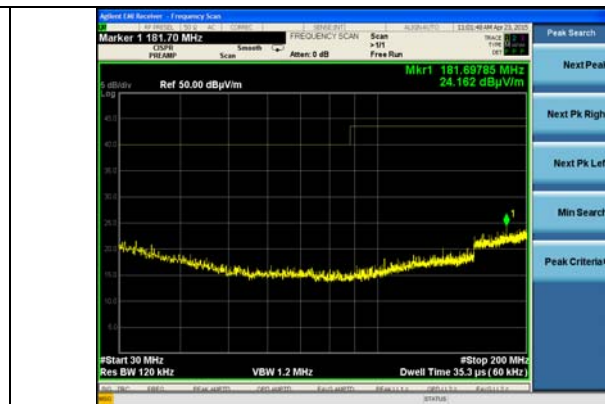
200-1000 MHz Vertical



200-1000 MHz Horizontal



30-200 MHz Vertical



30-200 MHz Horizontal

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

### B3 – Frequency Stability

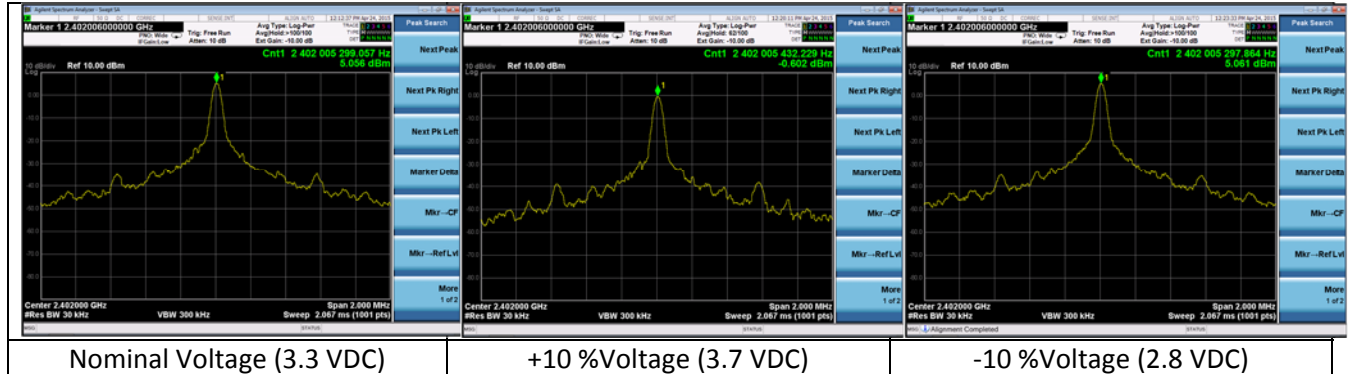
Manufacturer	LSR
Operator	Aidi Zainal
Measurement Procedure	ANSI C63.10 - 2009
Additional Notes	<p>The power and frequency stability of the device was examined as a function of the input voltage available to the EUT. A Spectrum Analyzer was used to measure the RF output power and frequency at the appropriate frequency markers. Power was supplied by an external bench-type DC power supply and was varied from the nominal.</p> <p>The power was then cycled On/Off to observe system response. No unusual response was observed, the emission characteristics were well behaved, and the system returned to the same state of operation as before the power cycle.</p> <p>Below is data showing stability of the fundamental frequency.</p> <p>Continuous transmit modulated used for this test.</p>

Channel	Channel Frequency (Hz)			Max Deviation (Hz)
	Nominal	+10%	-10%	
Low	2402005299	2402005432	2402005297	135
Middle	2440006277	2440006275	2440006304	29
High	2480004958	2480004975	2480004959	17

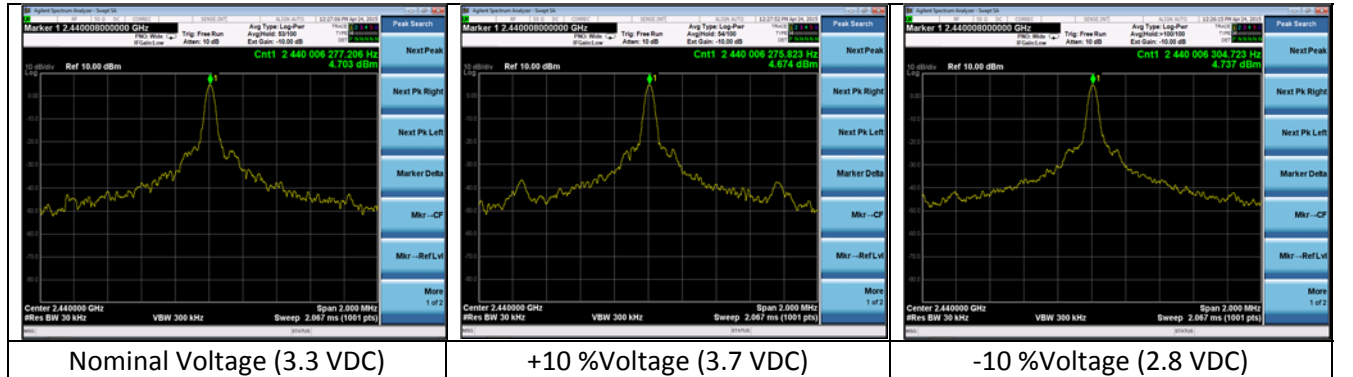
Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176



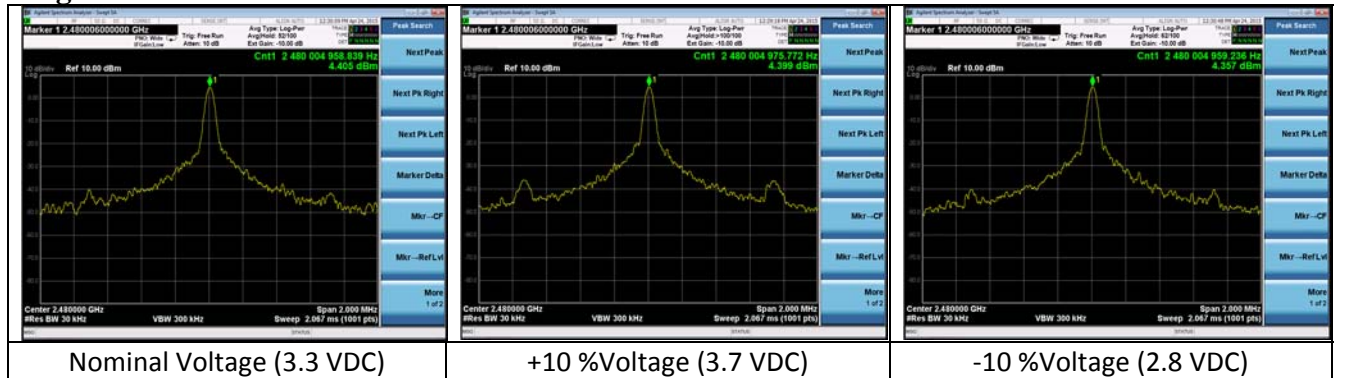
### Low Channel



### Mid Channel



### High Channel



Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

## B4 – AC Mains Conducted Emissions

### Test Setup

The test area and setup are in accordance with ANSI C63.4-2009 and with Title 47 CFR, FCC Part 15, Industry Canada RSS-210 and RSS GEN. The EUT was placed on a non-conductive table, with a height of 80 cm above the reference ground plane. The EUT's power cable was plugged into a Line Impedance Stabilization Network (LISN). The AC power supply of 120VAC was provided via an appropriate broadband EMI Filter, and then to the LISN line input. Final readings were then taken and recorded. After the EUT was setup and connected to the LISN, the RF Sampling Port of the LISN was connected to a 10 dB Attenuator-Limiter (internal to the EMI Receiver), and then to the EMI Receiver. The LISN used has the ability to terminate the unused port with a 50Ω (ohm) load when switched to either L1 (line) or L2 (neutral).

### Test Procedure

The EUT was investigated in continuous modulated transmit mode for this portion of the testing. The appropriate frequency range and bandwidths were selected on the EMI Receiver, and measurements were made. The bandwidth used for these measurements was as specified for Quasi-Peak and Average detectors in the frequency range of 150 kHz to 30 MHz. Final readings were then taken and recorded.

### Limits of Conducted Emissions at the AC Mains Ports

Frequency Range (MHz)	Class B Limits (dBμV)		Measuring Bandwidth
	Quasi-Peak	Average	
0.150 -0.50 *	66-56	56-46	RBW = 9 kHz
0.5 – 5.0	56	46	
5.0 – 30	60	50	
* The limit decreases linearly with the logarithm of the frequency in this range.			

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

## Test Data

Manufacturer:	LSR				
Date(s) of Test:	4/24/15				
Test Engineer:	Shane Rismeyer				
Voltage:	3.3VDC (Supplied from AC/DC Converter)				
Operation Mode:	Continuous transmit modulated used for this test. (No significant difference between transmit or receive or channel selection)				
Environmental Conditions in the Lab:	Temperature: 71° F Relative Humidity: 40%				
Test Location:	X	AC Mains Test area			Chamber
EUT Placed On:	X	40cm from Vertical Ground Plane			10cm Spacers
	X	80cm above Ground Plane			Other:
Measurements:		Pre-Compliance		Preliminary	X Final
Detectors Used		Peak	X	Quasi-Peak	X Average

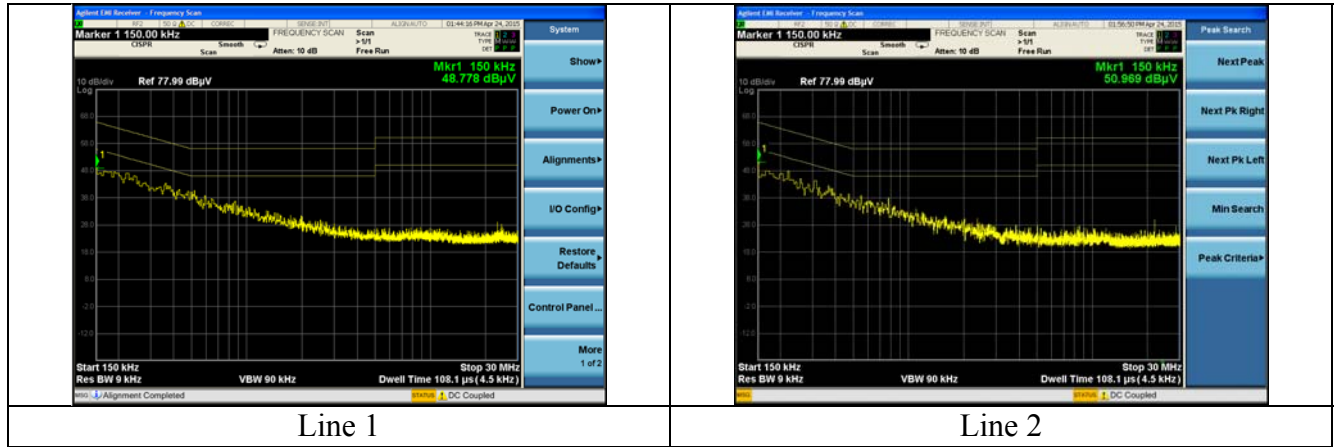
## Sample Calculation:

Margin (dB) = Limit (dBμV) – Reading (dBμV)

Frequency (MHz)	Line	Quasi-Peak			Average		
		Q-Peak Reading (dBμV)	Q-Peak Limit (dBμV)	Quasi-Peak Margin (dB)	Average Reading (dBμV)	Average Limit (dBμV)	Average Margin (dB)
0.150	1.000	42.400	66.000	23.600	31.900	56.000	24.100
0.226	1.000	38.900	62.596	23.696	28.300	52.596	24.296
0.361	1.000	34.300	58.707	24.407	23.900	48.707	24.807
0.150	2.000	38.500	66.000	27.500	20.400	56.000	35.600
0.225	2.000	35.700	62.633	26.933	17.200	52.633	35.433
0.307	2.000	36.800	60.053	23.253	15.600	50.053	34.453

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

These screen captures represent Peak Emissions. For conducted emission measurements, both a Quasi-Peak detector function and an Average detector function are utilized. The emissions must meet both the Quasi-peak limit and the Average limit as described in 47 CFR 15.207 and RSS GEN 7.2.2 (Table 2).



Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

## Appendix C - Uncertainty Summary

This uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k=2.

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

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

## Appendix D - References

Publication	Year	Title
FCC CFR Parts 0-15	2015	Code of Federal Regulations – Telecommunications
ANSI C63.4	2009	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.
RSS-210 Annex 8	2010	Low-power License-exempt Radio communication Devices (All Frequency Bands): Category I Equipment
RSS-GEN Issue 4	2014	General Requirements and Information for the Certification of Radio Apparatus
ANSI C63.10	2009	American National Standard for Testing Unlicensed Wireless Devices
FCC KDB 558074 D01 DTS Meas Guidance v03r02	2014	Guidance for Performing Compliance Measurements on Digital Transmission Systems (DTS) Operating Under §15.247

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

## Appendix E – Duty Cycle Calculation

PDU Type b <sub>3</sub> b <sub>2</sub> b <sub>1</sub> b <sub>0</sub>	Packet Name
0000	ADV_IND
0001	ADV_DIRECT_IND
0010	ADV_NONCONN_IND
0011	SCAN_REQ
0100	SCAN_RSP
0101	CONNECT_REQ
0110	ADV_SCAN_IND
0111-1111	Reserved

Table D1: Advertising channel PDU Header's PDU Type field encoding

ADV\_IND = 37 octets (47)  
ADV\_DIRECT\_IND= 12 octets (22)  
DV\_NONCONN\_IND=37 octets (47)  
ADV\_SCAN\_=37 octets (47)  
SCAN\_REQ=12 octets (22)  
SCAN\_RSP = 37 octets (47)  
CONNECT\_REQ=34 octets. (44)

(Plus 1 octet for preamble.  
Plus 4 octets for adress.  
Plus 2 octets for PDU header.  
Plus 3 octets for CRC.)

47 octets is 376 bits, stated as worst case length packet.

Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

## Undirected Advertising Events

For all undirected advertising events, the time between the start of two consecutive advertising events ( $T_{advEvent}$ ) is computed as follows for each advertising event:

$$T_{advEvent} = advInterval + advDelay$$

The  $advInterval$  shall be an integer multiple of 0.625 ms in the range of 20 ms to 10.24 s. If the advertising event type is either a scannable undirected event type or a non-connectable undirected event type, the  $advInterval$  shall not be less than 100 ms. If the advertising event type is a connectable undirected event type, the  $advInterval$  can be 20 ms or greater.

The  $advDelay$  is a pseudo-random value with a range of 0 ms to 10 ms generated by the Link Layer for each advertising event.

As illustrated in Figure D1, the advertising events are perturbed in time using the  $advDelay$ .

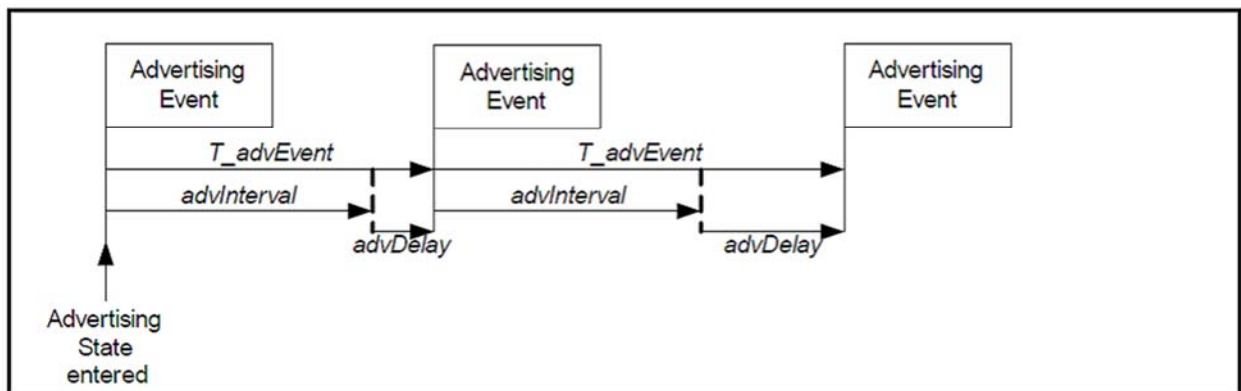
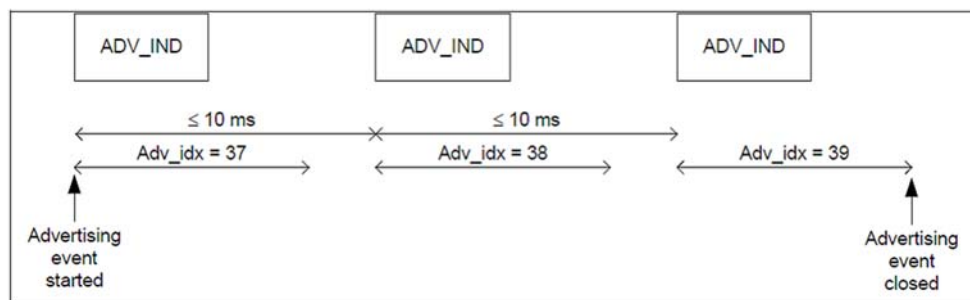


Figure D1: Advertising events perturbed in time using  $advDelay$



Prepared For: LSR	Model Number: SaBLE-x	Report #: 315054
EUT: SaBLE-x	Serial Number: 450-0144-R1	LSR Job #: C-2176

Figure D2: Connectable undirected advertising event with only advertising PDUs

Duty Factor for Connectable Undirected Advertising Event, per advertising channel:

ADV\_IND = 376 uS duration. (ON channel 37)  
 IFS = 150 uS (OFF)  
 ADV\_IND = 376 uS duration (OFF channel 38)  
 IFS =150 uS (OFF)  
 ADV\_IND = 376 uS duration (OFF Channel 39).  
 Adv\_Internal (min) = 20 mS.

$$DF = 376 / (376 * 3 + 150 * 2 + 20000) = 0.0175$$

$$\text{Relaxation factor} = -\min(20 * \log_{10}(DF), -20 \text{ dB}) = -\min(-35.119, -20) = 20 \text{ dB}$$

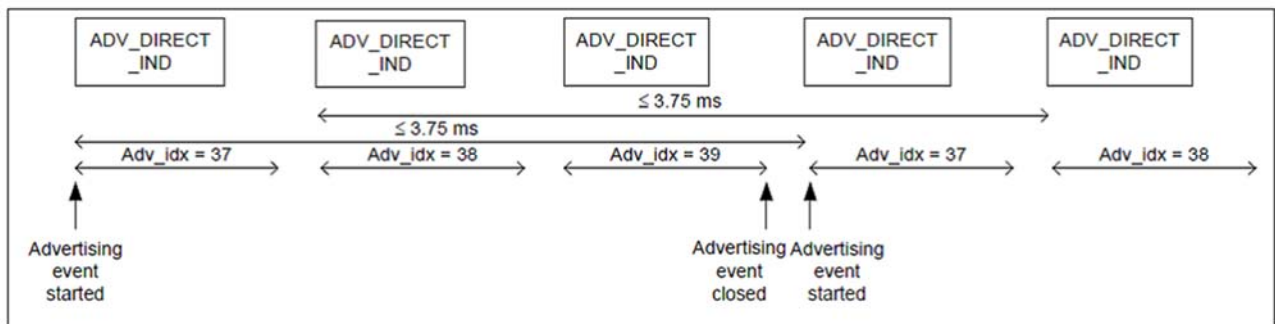


Figure D3: Connectable directed advertising event type with only advertising PDUs

Duty Factor for Connectable Directed Advertising Event, per advertising channel

ADV\_DIRECT\_IND = 176 uS duration. (22 octets) (ON channel 37)  
 IFS = 150 uS (OFF)  
 ADV\_IND = 176 uS duration (OFF channel 38)  
 IFS =150 uS (OFF)  
 ADV\_IND = 176 uS duration (OFF Channel 39).  
 IFS=150 uS (OFF)

$$\text{Time from open to close of advertising event} = 3 * 176 + 3 * 150 = 978 \text{ uS}$$

$$DF = 176 / (978) = 0.179$$

$$\text{Relaxation factor} = -\min(20 * \log_{10}(DF), -20 \text{ dB}) = -\min(-14.9, -20) = 14.9 \text{ dB}$$

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