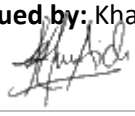
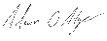
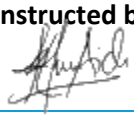
Test Report # 317126 A

Equipment Under Test:	IQvitals Zone
Test Date(s):	10/3/2017 to 10/10/2017
Prepared for:	Midmark Attn: Carlos Castillo 690 Knox ST. Torrence, CA 90502

Report Issued by: Khairul Aidi Zainal, Laboratory Manager
Signature:  Date: 12/4/2017

Report Reviewed by: Adam Alger, Quality Systems Engineer
Signature:  Date: 12/4/2017

Report Constructed by: Khairul Aidi Zainal, Laboratory Manager
Signature:  Date: 11/03/2017

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Laird Technologies Test Services in Review

The Laird Technologies, Inc. laboratory located at W66 N220 Commerce Court Cedarburg, Wisconsin, 53012 USA is recognized through the following organizations:

A2LA – American Association for Laboratory Accreditation

Accreditation based on ISO/IEC 17025: 2005 with Electrical (EMC) Scope
A2LA Certificate Number: 1255.01
Scope of accreditation includes all test methods listed herein, unless otherwise noted.

Federal Communications Commission (FCC) – USA

Accredited recognition of two 3 meter Semi-Anechoic Chambers

Accredited Test Firm Registration Number: 953492

Government of Canada

Innovation, Science and Economic Development Canada

ISED Site listing of two 3 meter Semi-Anechoic Chambers based on RSS-GEN – Issue 4
File Number: IC 3088A-2
File Number: IC 3088A-3

1 TEST REPORT SUMMARY

During 10/3/2017 to 10/10/2017, the Equipment Under Test (EUT), **IQvitals zone**, as provided by **Midmark** was tested to the following requirements:

Requirement	Description	Specification	Method	Result
FCC: 15.247 (a)(2) IC: RSS-247 5.2 (a)	Digital Modulation System 6 dB bandwidth	500 kHz	KDB 558074	Pass
FCC: 2.1049 IC: RSS-GEN 6.6	Occupied Bandwidth (99%)	Reported	KDB 558074	Pass
FCC: 15.247 (b)(3) IC: RSS-247 5.4 (d)	Maximum Conducted Output Power	30 dBm	KDB 558074	Pass
FCC: 15.247 (e) IC: RSS-247 5.2 (b)	Digital Modulation System Power Spectral Density	8 dBm / 3 kHz	KDB 558074	Pass
FCC: 15.247 (d) IC: RSS-247 5.5	RF Spurious Emissions at the Transmitter Antenna Terminal	20 dBc	KDB 558074	Pass
FCC: 15.247 (d) IC: RSS-247 3.3	Spurious Radiated Emissions in Restricted Bands	FCC 15.209 RSS-GEN 8.9	ANSI C63.10	Pass
FCC: 2.1055 (d) IC: RSS-GEN 6.11	Frequency Stability	Reported	ANSI C63.10	Pass
FCC: 15.207 IC: RSS-GEN 8.8	AC Power Line Conducted Emissions	0.150-30 MHz	ANSI C63.10	Pass

Notice:

The results relate only to the item tested and described in this report. Any modifications made to the equipment under test after the specified test date(s) may invalidate the data herein.

If the resulting measurement margin is seen to be within the uncertainty value, as listed in this report, the possibility exists that this unit may not meet the required limit specification if subsequently tested.

2 CLIENT INFORMATION

Company Name	Midmark
Contact Person	Carlos Castillo
Address	690 Knox Street
E-mail address	ccastillo@midmark.com

2.1 Equipment Under Test (EUT) Information

The following information has been supplied by the client

Product Name	IQvitals Zone
Model Number	5-200-0253
Serial Number	17190017 (Conducted measurements), 17190004 (Radiated emissions)
FCC ID	2AF4M-5-200-0253
IC ID	20691-52000253

2.2 Product Description

Bluetooth Low Energy module utilizing PCB trace antenna

2.3 Modifications Incorporated for Compliance

None at time of test

2.4 Deviations and Exclusions from Test Specifications

None at time of test

2.5 Additional Information

The module was put into the specific test modes and channels using a program called *EverestBootloaderTestApplication.exe* which was provided by the customer. The program provided control for both BLE radio on the module. In this report, the BLE radios are named (as it is addressed in the test mode program):

1. Wireless_BLE
2. Wireless_BLE2

In addition, the BLE radios have an adjustable power setting, hence testing was performed for both radios at maximum and minimum power setting.

Testing was performed on the low (2402MHz), middle (2440MHz) and high (2480MHz) channels. The EUT was powered using a generic 100-240 VAC wall-wart which represents end-use case.

Since there will be instances where both transmitters can transmit simultaneously, testing has been performed with both transmitters transmitting. It was found that individual transmitter emissions characteristics did not change when both were transmitting at the same time (Simultaneously). In addition, potential IM emissions were investigated and none were found.

3 REFERENCES

Publication	Edition	Date
CFR 47 Part 15	-	2017
ANSI C63.10	-	2013
RSS-247	2	2017
RSS GEN	4	2014
KDB 558074	4	2017

4 UNCERTAINTY SUMMARY

Using the guidance of the following publications the calculated measurement uncertainty represents an expanded uncertainty expressed at approximately the 95 % confidence level, using a coverage factor of k = 2.

References	Version / Date
CISPR 16-4-1	Ed. 2 (2009-02)
CISPR 16-4-2	Ed. 2 (2011-06)
CISPR 32	Ed. 1 (2012-01)
ANSI C63.23	2012
A2LA P103	February 4, 2016
A2LA P103c	August 10, 2015
ETSI TR 100-028	V1.3.1 (2001-03)

Measurement Type	Configuration	Uncertainty ±
Radiated Emissions	Biconical Antenna	5.0 dB
Radiated Emissions	Log Periodic Antenna	5.3 dB
Radiated Emissions	Horn Antenna	4.7 dB
AC Line Conducted Emissions	Artificial Mains Network	3.4 dB
Telecom Conducted Emissions	Asymmetric Artificial Network	4.9 dB
Disturbance Power Emissions	Absorbing Clamp	4.1 dB
Radiated Immunity	3 Volts/meter	2.2 dB
Conducted Immunity	CDN/EM/BCI	2.4/3.5/3.4 dB
EFT Burst/Surge	Peak pulse voltage	164 volts
ESD Immunity	15 kV level	1377 Volts

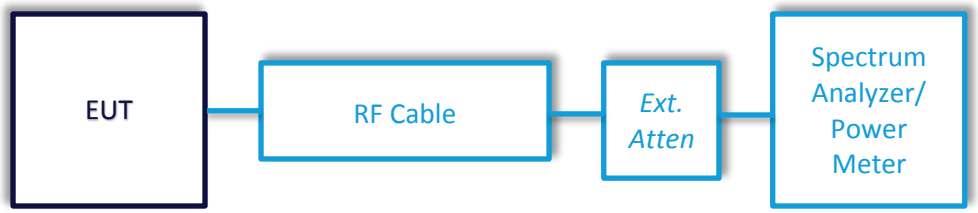
Parameter	ETSI U.C. ±	U.C. ±
Radio Frequency, from F0	$1x10^{-7}$	$0.55x10^{-7}$
Occupied Channel Bandwidth	5 %	2 %
RF conducted Power (Power Meter)	1.5 dB	1.2 dB
RF conducted emissions (Spectrum Analyzer)	3.0 dB	1.7 dB
All emissions, radiated	6.0 dB	5.3 dB
Temperature	1° C	0.65° C
Humidity	5 %	2.9 %
Supply voltages	3 %	1 %

5 TEST DATA

5.1 Antenna Port Conducted Emissions

Description of Measurement	The direct measurement of emissions at the antenna port of the EUT is achieved by use of a RF connection to a spectrum analyzer or power meter. The cable and attenuator factors are loaded into the analyzer or power meter allowing for direct measurement readings without the need for further corrections.
Example Calculations	Measurement (dBm) + Cable factor (dB) + External Attenuator (dB) = Corrected Reading (dBm) Margin (dB) = Limit (dBm) – Corrected Reading (dBm)

Block Diagram



Instrumentation

Smart Technology. Delivered.

Date : 3-Oct-2017 Test : Conducted measurements Job : C-2848

PE : Aidi Zainal Customer : Midmark Quote : 317126

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960073	Spectrum Analyzer	Agilent	E4446A	US45300564	11/21/2016	11/21/2017	Active Calibration

5.1.1 Antenna Port Conducted Emissions – DTS and 99% Bandwidth

Operator	Aidi Zainal
QA	Zach
Test Date	10/10/2017
Location	Conducted measurement area
Temp. / R.H.	70F / 76
Requirement	15.247 (a) (2)
Method	FCC KDB 558074 D01 DTS Meas Guidance V04, section 8.2 (option 2), C63.10 section 6.9.3

Limits:

Minimum 6 dB BW (MHz)
0.5

Test Parameters

Frequency	2402,2440,2480 MHz
Settings	Peak detector with Max hold
Settings	RBW=100kHz (DTS BW)
Settings	Span >2 times BW
Notes	BW measurement for both 6B and 99% did not change between the maximum and minimum power settings. Only plots for maximum power setting presented.

Table

A. Wireless_BLE

DTS Bandwidth

1MBPS Wireless_BLE Max power setting				
Channel	Frequency (MHz)	DTS Bandwidth (MHz)	Limit (MHz)	Margin (MHz)
0	2402	0.7	0.5	0.2
19	2440	0.7	0.5	0.2
39	2480	0.7	0.5	0.2

1MBPS Wireless_BLE Min power setting				
Channel	Frequency (MHz)	DTS Bandwidth (MHz)	Limit (MHz)	Margin (MHz)
0	2402	0.7	0.5	0.2
19	2440	0.7	0.5	0.2
39	2480	0.7	0.5	0.2

99% Bandwidth

1MBPS, Wireless_BLE Max power		
Channel	Frequency (MHz)	99% Bandwidth (MHz)
0	2402	1.1
19	2440	1.1
39	2480	1.1

1MBPS, Wireless_BLE Min power		
Channel	Frequency (MHz)	99% Bandwidth (MHz)
0	2402	1.1
19	2440	1.1
39	2480	1.1

B. Wireless_BLE2

DTS Bandwidth

1MBPS Wireless_BLE2 Max power setting				
Channel	Frequency (MHz)	DTS Bandwidth (MHz)	Limit (MHz)	Margin (MHz)
0	2402	0.7	0.5	0.2
19	2440	0.7	0.5	0.2
39	2480	0.7	0.5	0.2

1MBPS Wireless_BLE2 Min power setting				
Channel	Frequency (MHz)	DTS Bandwidth (MHz)	Limit (MHz)	Margin (MHz)
0	2402	0.7	0.5	0.2
19	2440	0.7	0.5	0.2
39	2480	0.7	0.5	0.2

99% Bandwidth

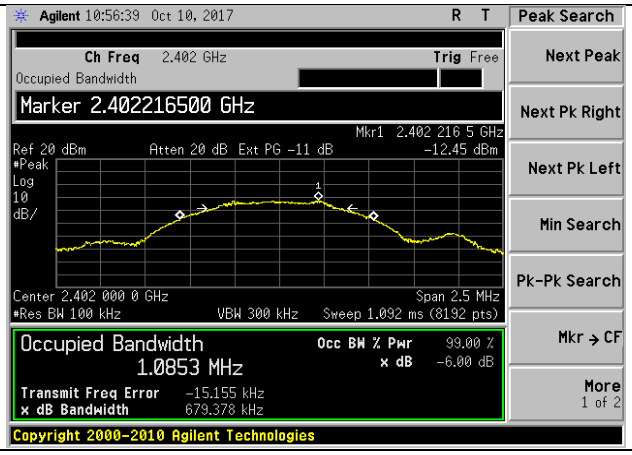
1MBPS, Wireless_BLE2 Max power		
Channel	Frequency (MHz)	99% Bandwidth (MHz)
0	2402	1.1
19	2440	1.1
39	2480	1.1

1MBPS, Wireless_BLE2 Min power		
Channel	Frequency (MHz)	99% Bandwidth (MHz)
0	2402	1.1
19	2440	1.1
39	2480	1.1

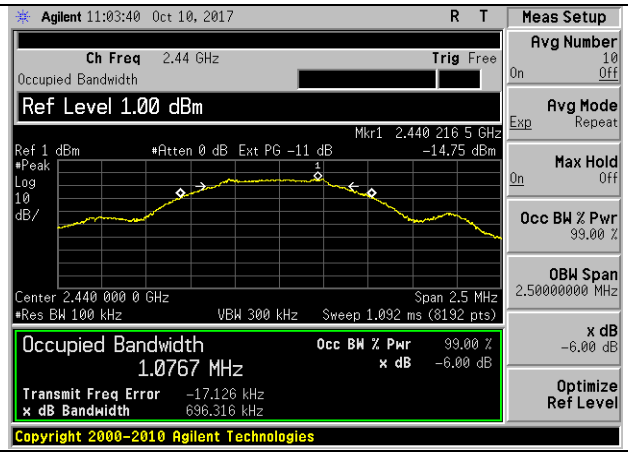
Plots

DTS Bandwidth

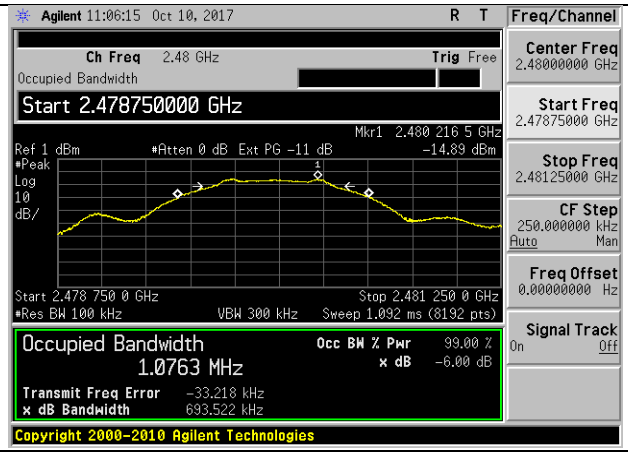
A. Wireless_BLE



2402MHz

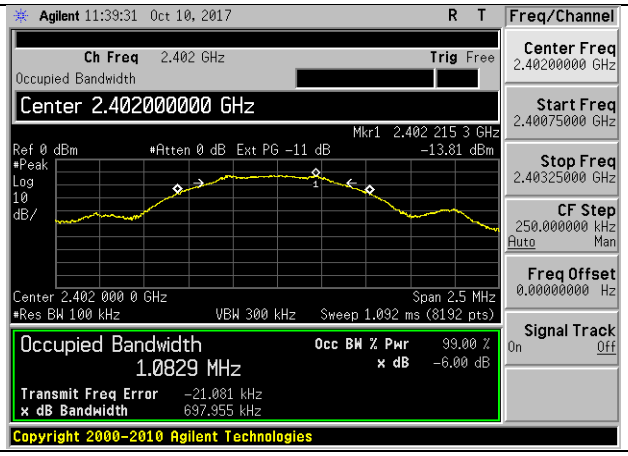


2440MHz

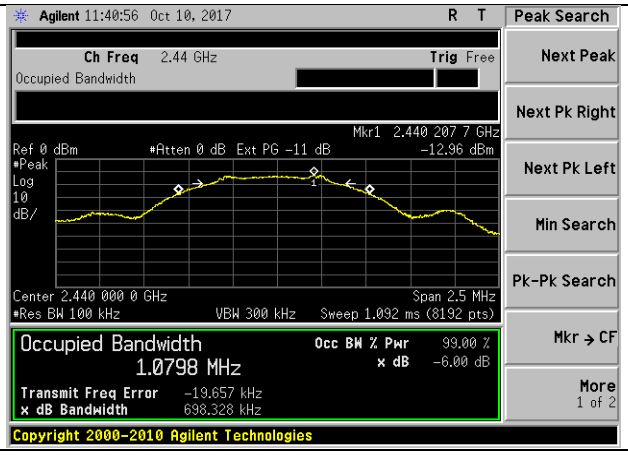


2480MHz

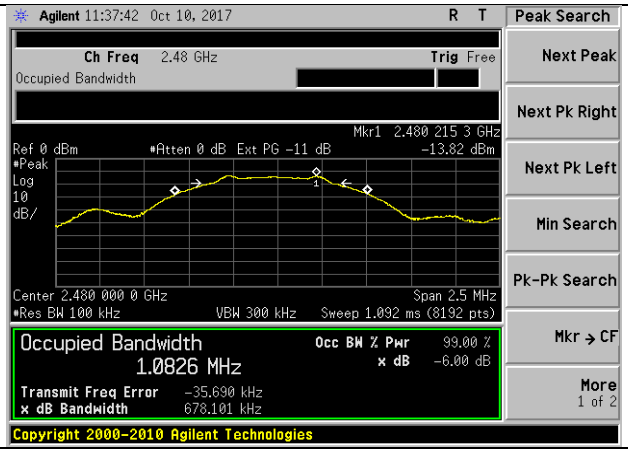
B. Wireless_BLE2



2402MHz



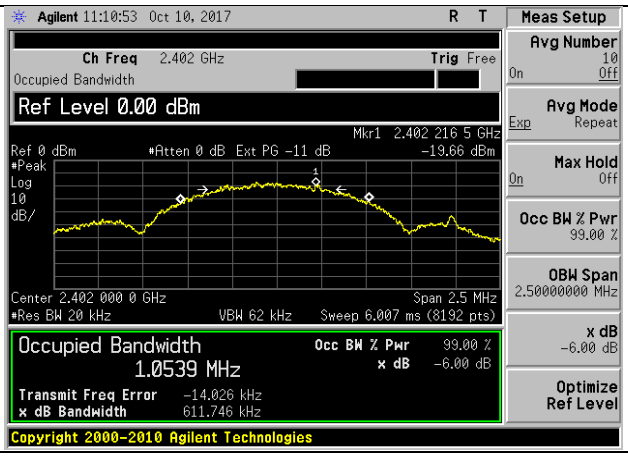
2440MHz



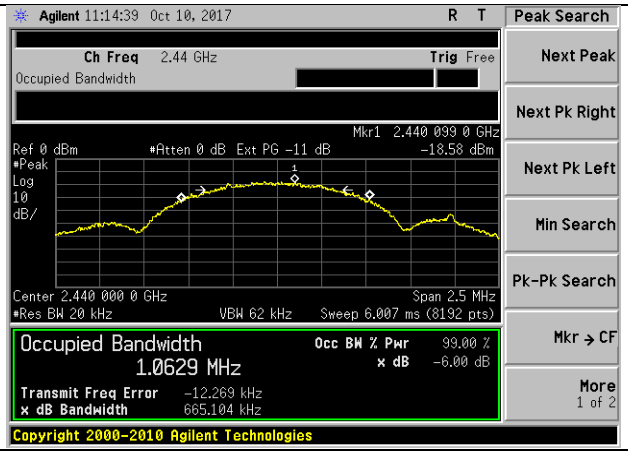
2480MHz

99% Bandwidth

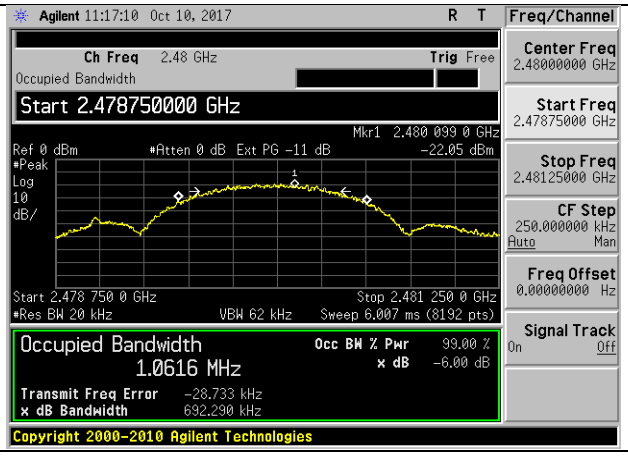
A. Wireless_BLE



2402MHz

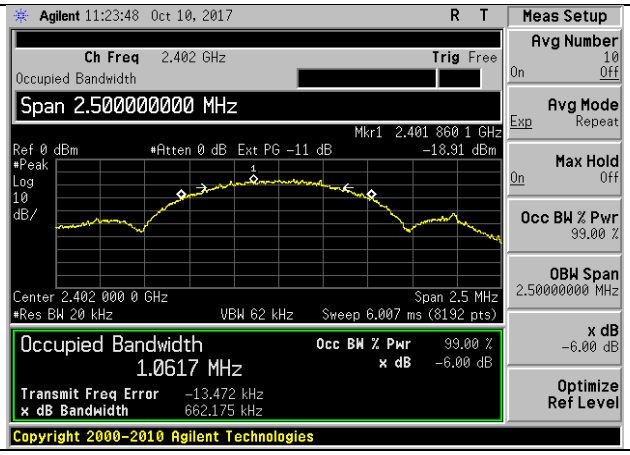


2440MHz

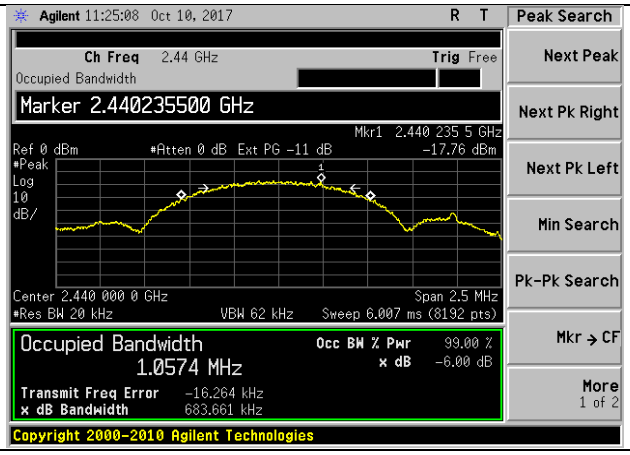


2480MHz

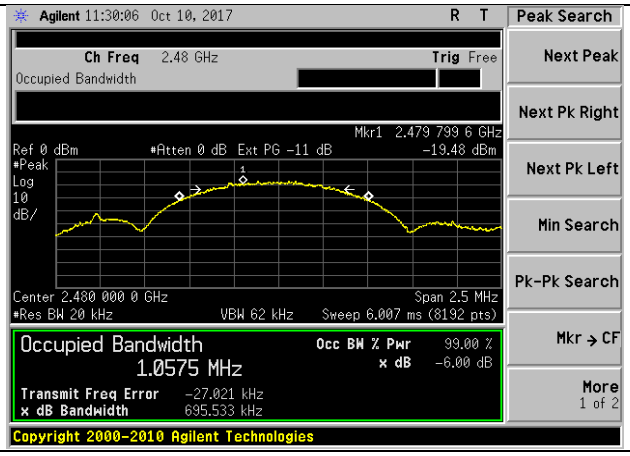
B. Wireless_BLE2



2402MHz



2440MHz



2480MHz

5.1.2 Antenna Port Conducted Emissions – Conducted Output Power

Operator	Aidi
QA	Coty
Test Date	10/5/2017
Location	Conducted measurement area
Temp. / R.H.	70/60
Requirement	15.247 (b) (3)
Method	FCC KDB 558074 D01 DTS Meas Guidance V04, section 9.1.1

Limits:

Maximum Conducted Output Power (dBm)	Maximum Conducted Output Power (watts)
30	1

Test Parameters

Frequency	2402, 2440, 2480 MHz
Settings	Channel mode = Modulated
Settings	RBW=3MHz
Settings	VBW=8MHz
Notes	All measurements made over max power setting (min attenuation) and lowest power setting (max attenuation)

Table

A. Wireless_BLE

1MBPS, Wireless_BLE Max power				
Channel	Frequency (MHz)	Peak Output power (dBm)	Limit (dBm)	Margin (dB)
0	2402.0	-12.1	30.0	42.1
19	2440.0	-12.9	30.0	42.9
39	2480.0	-13.8	30.0	43.8

1MBPS, Wireless_BLE Min power				
Channel	Frequency (MHz)	Peak Output power (dBm)	Limit (dBm)	Margin (dB)
0	2402.0	-41.3	30.0	71.3
19	2440.0	-42.0	30.0	72.0
39	2480.0	-42.7	30.0	72.7

B. Wireless_BLE2

1MBPS, Wireless_BLE2 Max power				
Channel	Frequency (MHz)	Peak Output power (dBm)	Limit (dBm)	Margin (dB)
0	2402.0	-11.4	30.0	41.4
19	2440.0	-12.1	30.0	42.1
39	2480.0	-13.0	30.0	43.0

1MBPS, Wireless_BLE2 Min power				
Channel	Frequency (MHz)	Peak Output power (dBm)	Limit (dBm)	Margin (dB)
0	2402.0	-40.5	30.0	70.5
19	2440.0	-41.5	30.0	71.5
39	2480.0	-42.0	30.0	72.0

C. Combined output power

Combined power for Maximum power setting								
Channel	Frequency (MHz)	Radio 1 Peak Output power (dBm)	Radio 1 Peak Output power (mW)	Radio 2 Peak Output power (dBm)	Radio 2 Peak Output power (mW)	Combined Peak output power (dBm)	Limit (dBm)	Margin (dB)
0	2402.0	-12.1	0.062	-11.4	0.073	-8.7	30.0	38.7
19	2440.0	-12.9	0.051	-12.1	0.062	-9.5	30.0	39.5
39	2480.0	-13.8	0.042	-13.0	0.050	-10.4	30.0	40.4

Combined power for Minimum power setting								
Channel	Frequency (MHz)	Radio 1 Peak Output power (dBm)	Radio 1 Peak Output power (mW)	Radio 2 Peak Output power (dBm)	Radio 2 Peak Output power (mW)	Combined Peak output power (dBm)	Limit (dBm)	Margin (dB)
0	2402.0	-41.3	0.000	-40.5	0.000	-37.9	30.0	67.9
19	2440.0	-42.0	0.000	-41.5	0.000	-38.8	30.0	68.8
39	2480.0	-42.7	0.000	-42.0	0.000	-39.3	30.0	69.3

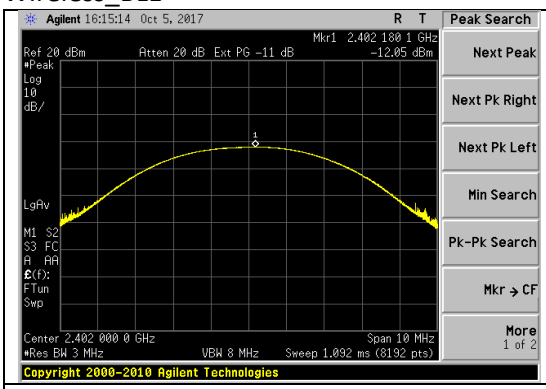
Note:

1. Combined peak output power (mW) = Radio 1 peak output power (mW) + Radio 2 peak output power (mW)
2. Combined peak output power (dBm) = 10*LOG [Combined peak output power (mW)]
3. The tables above is necessary for the possible situation where both transmitters transmit at the same time on the same frequency.

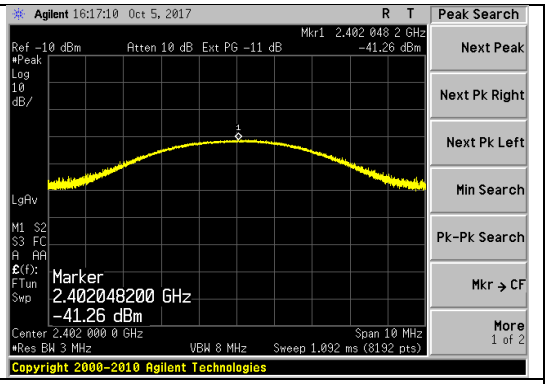
Plot

Output power

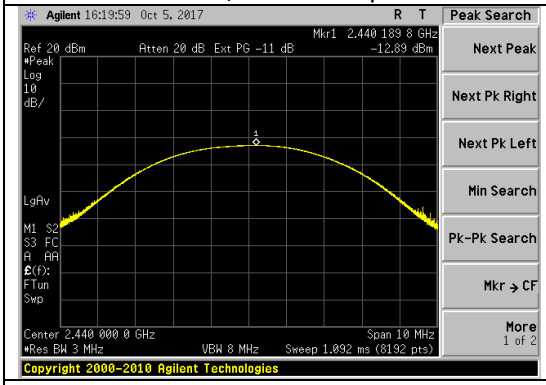
A. Wireless_BLE



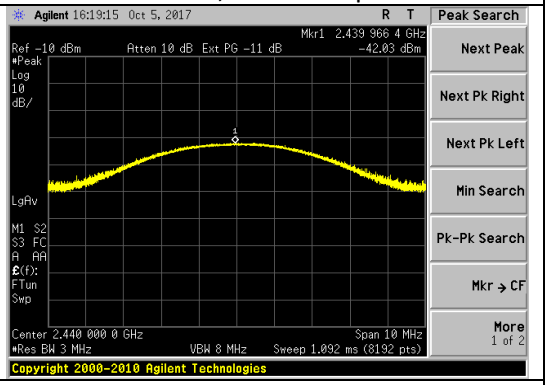
2402MHz, Maximum power



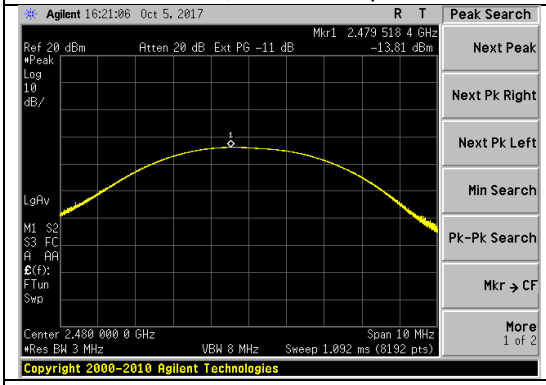
2402MHz, Minimum power



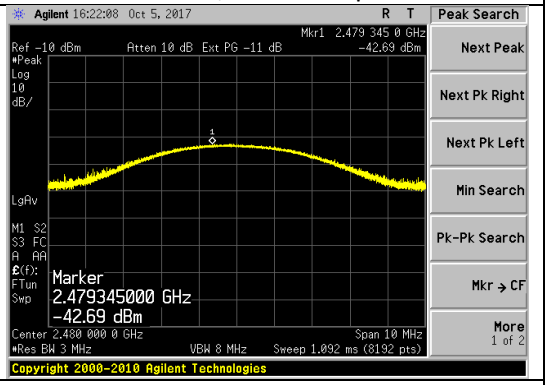
2440MHz, Maximum power



2440MHz, Minimum power

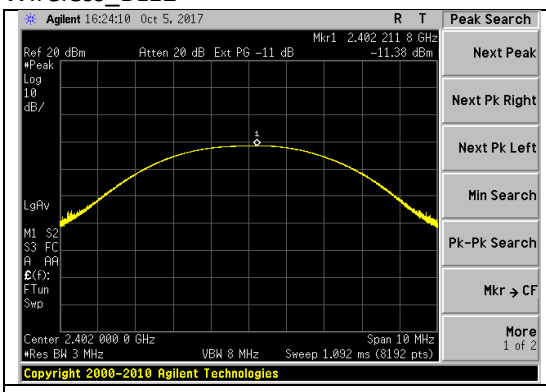


2480MHz, Maximum power

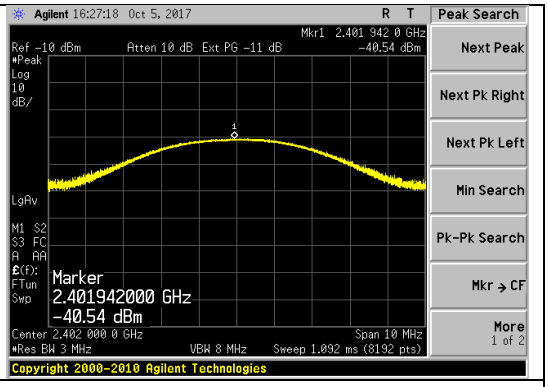


2480MHz, Minimum power

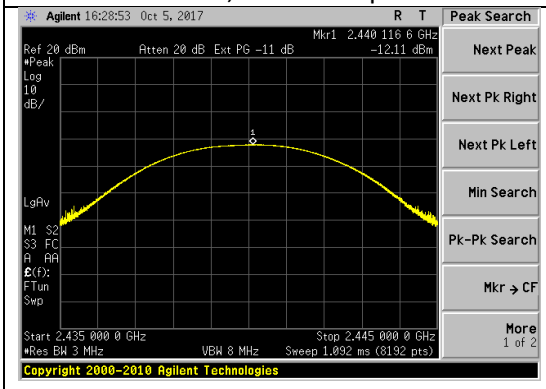
B. Wireless_BLE2



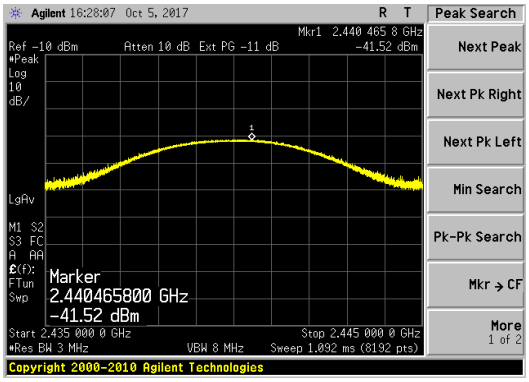
2402MHz, Maximum power



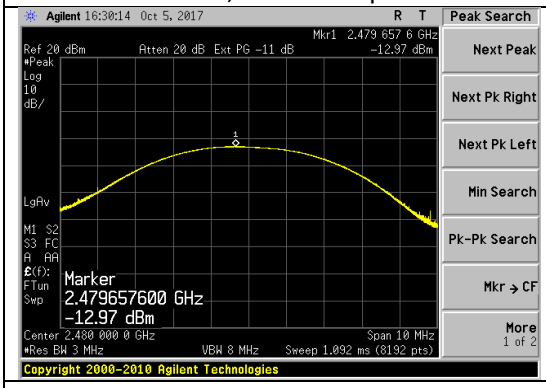
2402MHz, Minimum power



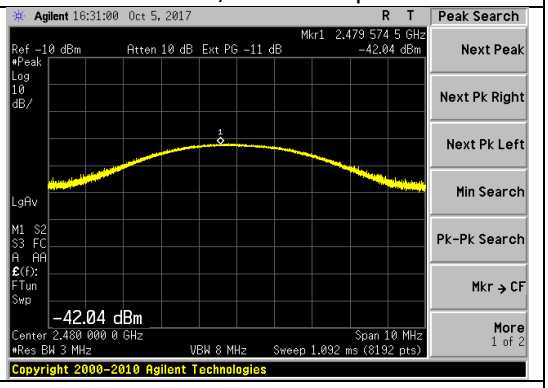
2440MHz, Maximum power



2440MHz, Minimum power



2480MHz, Maximum power



2480MHz, Minimum power

5.1.3 Antenna Port Conducted Emissions – Power Spectral Density

Operator	Aidi Zainal
QA	Zach
Test Date	10/10/2017
Location	Conducted measurement area
Temp. / R.H.	70F / 76
Requirement	15.247 (e)
Method	FCC KDB 558074 D01 DTS Meas Guidance V04, Section 10.2

Limits:

Power Spectral Density (dBm/ 3 kHz)
8

Test Parameters

Frequency	2402,2440,2480 MHz
Settings	Peak detector with Max hold
Settings	RBW=100kHz
Settings	Span 1.5 times DTS BW
Notes	All measurements made over maximum power setting (minimum attenuation) and lowest power setting (maximum attenuation)

Table

A. Wireless_BLE

1MBPS, Wireless_BLE MAX power setting				
Channel	Frequency (MHz)	100kHz PSD (dBm)	3kHz PSD Limit (dBm)	Margin (dB)
0	2402	-12.6	8.0	20.6
19	2440	-13.6	8.0	21.6
39	2480	-14.4	8.0	22.4

1MBPS, Wireless_BLE MIN power setting				
Channel	Frequency (MHz)	100kHz PSD (dBm)	3kHz PSD Limit (dBm)	Margin (dB)
0	2402	-43.1	8.0	51.1
19	2440	-44.3	8.0	52.3
39	2480	-44.8	8.0	52.8

B. Wireless_BLE2

1MBPS, Wireless_BLE2 MAX power setting				
Channel	Frequency (MHz)	100kHz PSD (dBm)	3kHz PSD Limit (dBm)	Margin (dB)
0	2402	-11.8	8.0	19.8
19	2440	-12.5	8.0	20.5
39	2480	-13.5	8.0	21.5

1MBPS, Wireless_BLE2 MIN power setting				
Channel	Frequency (MHz)	100kHz PSD (dBm)	3kHz PSD Limit (dBm)	Margin (dB)
0	2402	-42.4	8.0	50.4
19	2440	-43.0	8.0	51.0
39	2480	-43.8	8.0	51.8

C. Combined PSD

Combined PSD for Maximum power setting								
Channel	Frequency (MHz)	Radio 1 PSD in 100kHz (dBm)	Radio 1 PSD (mW)	Radio 2 PSD in 100kHz (dBm)	Radio 2 PSD (mW)	Combined PSD in 100kHz (dBm)	PSD Limit in 3kHz (dBm)	Margin (dB)
0	2402.0	-12.6	0.055	-11.8	0.066	-9.2	8.0	17.2
19	2440.0	-13.6	0.044	-12.5	0.056	-10.0	8.0	18.0
39	2480.0	-14.4	0.036	-13.5	0.045	-10.9	8.0	18.9

Combined power for Minimum power setting								
Channel	Frequency (MHz)	Radio 1 PSD in 100kHz (dBm)	Radio 1 PSD (mW)	Radio 2 PSD in 100kHz (dBm)	Radio 2 PSD (mW)	Combined PSD in 100kHz (dBm)	PSD Limit in 3kHz (dBm)	Margin (dB)
0	2402.0	-43.1	0.000	-42.4	0.000	-39.7	8.0	47.7
19	2440.0	-44.3	0.000	-43.0	0.000	-40.6	8.0	48.6
39	2480.0	-44.8	0.000	-43.8	0.000	-41.2	8.0	49.2

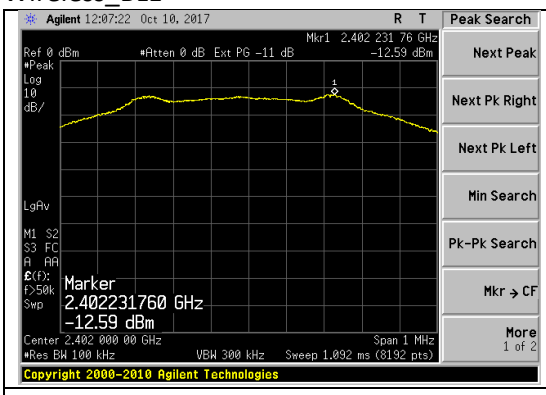
Note:

4. Combined PSD (mW) = Radio 1 PSD (mW) + Radio 2 PSD (mW)
5. Combined PSD (dBm) = 10*LOG [Combined PSD (mW)]
6. The tables above is necessary for the possible situation where both transmitters transmit at the same time on the same frequency.

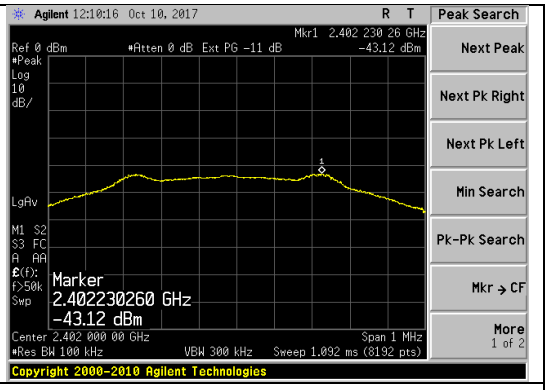
Plot

Output power

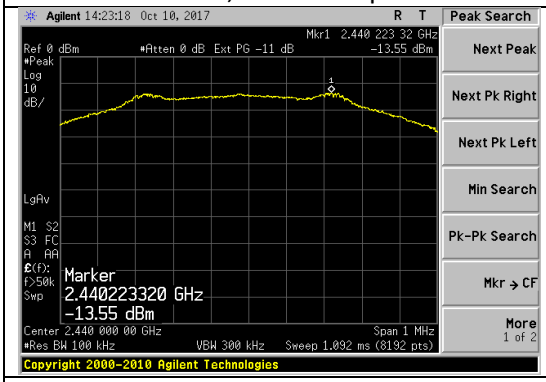
A. Wireless_BLE



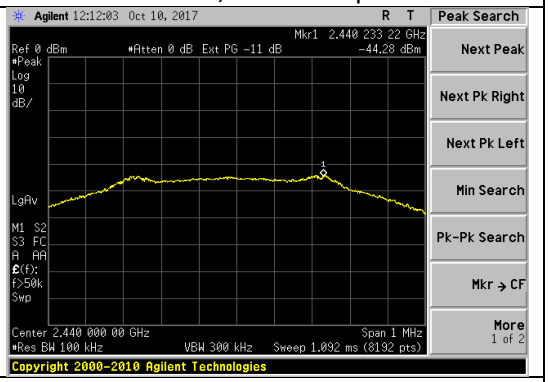
2402MHz, Maximum power



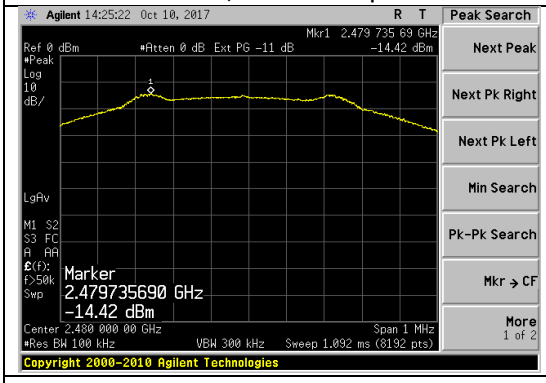
2402MHz, Minimum power



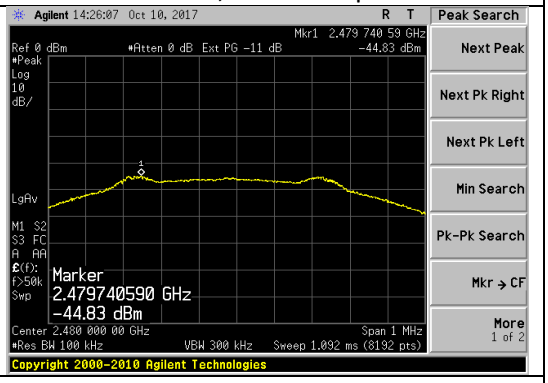
2440MHz, Maximum power



2440MHz, Minimum power

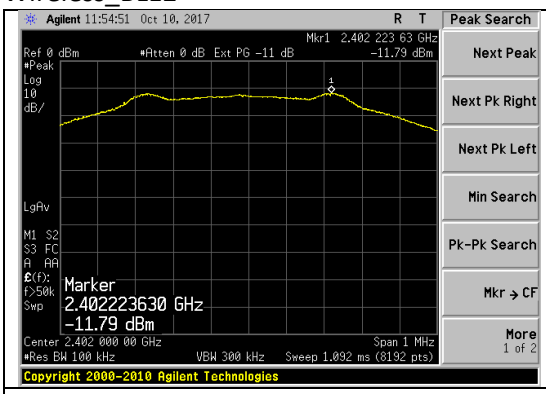


2480MHz, Maximum power

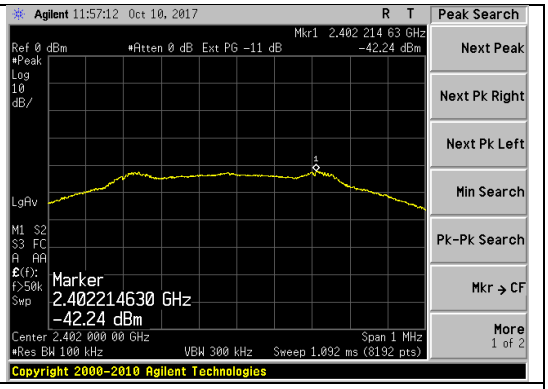


2480MHz, Minimum power

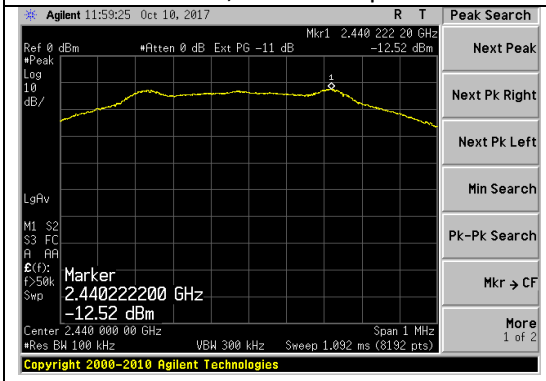
B. Wireless_BLE2



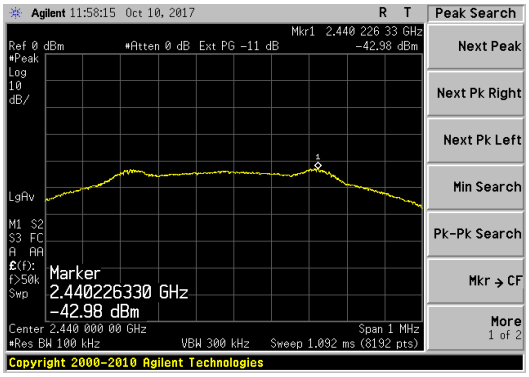
2402MHz, Maximum power



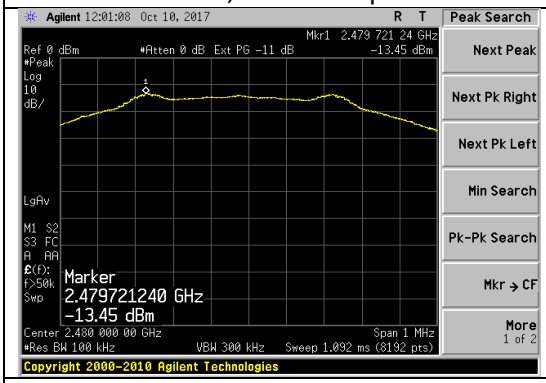
2402MHz, Minimum power



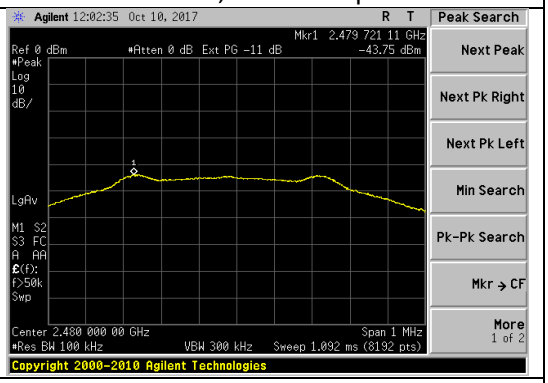
2440MHz, Maximum power



2440MHz, Minimum power



2480MHz, Maximum power



2480MHz, Minimum power

5.1.4 Antenna Port Conducted Emissions – Tx Conducted Spurious

Operator	Aidi Zainal
QA	Zach
Test Date	10/10/2017
Location	Conducted measurement area
Temp. / R.H.	72F / 76%
Requirement	15.247 (d)
Method	FCC KDB 558074 D01 DTS Meas Guidance V04, section 11

Limits:

Spurious Emissions Limit (dBc from Reference Point)
20

Test Parameters

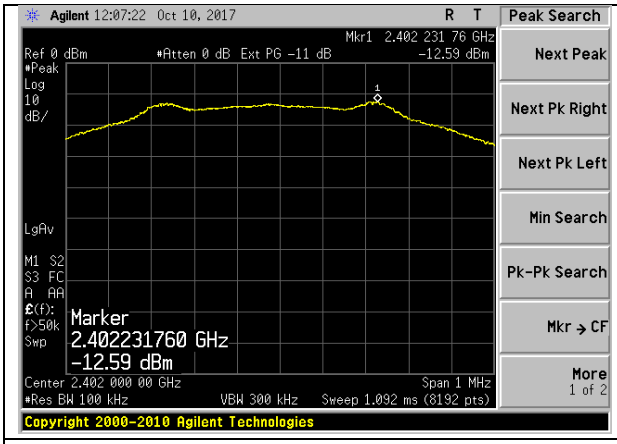
Frequency	2402, 2440, 2480 MHz
Settings	Peak detector with Max hold
Settings	RBW=100kHz
Settings	VBW = 300kHz
Notes	Spurious emissions < 20dBc
Notes	EUT supply = 9 VDC

All emissions within the range of investigation were found to be greater than 10dB below the limit.

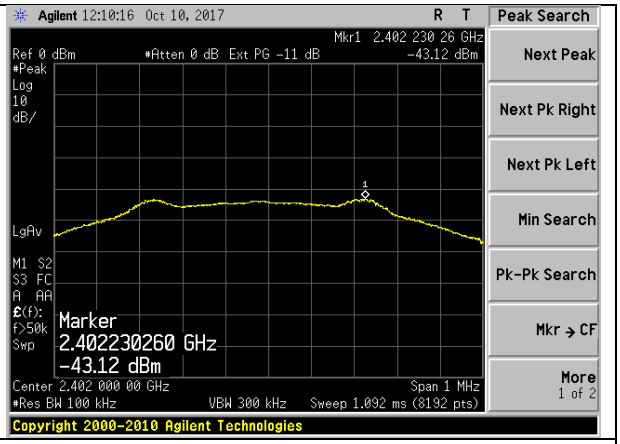
Plots

A. Wireless_BLE

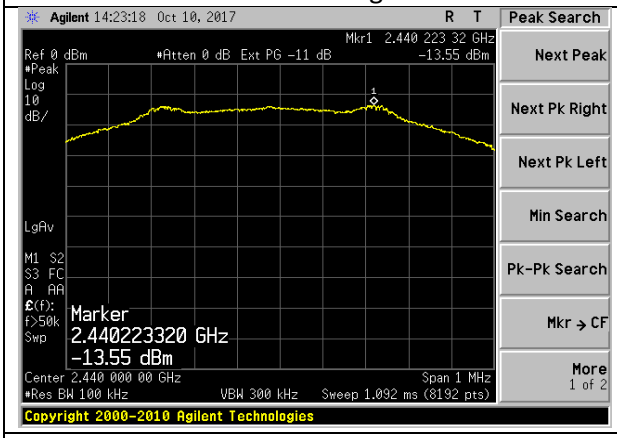
Reference level



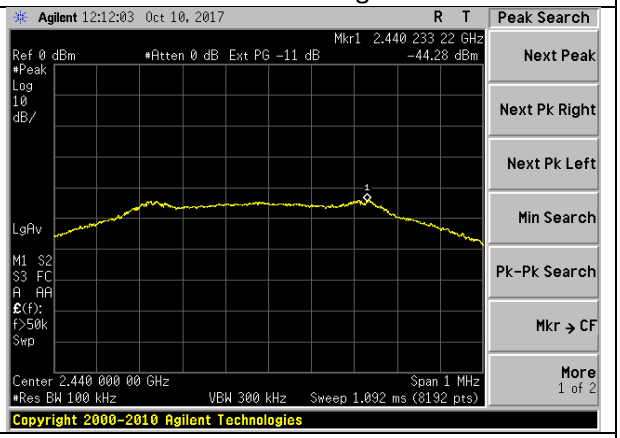
Maximum Power setting Low channel



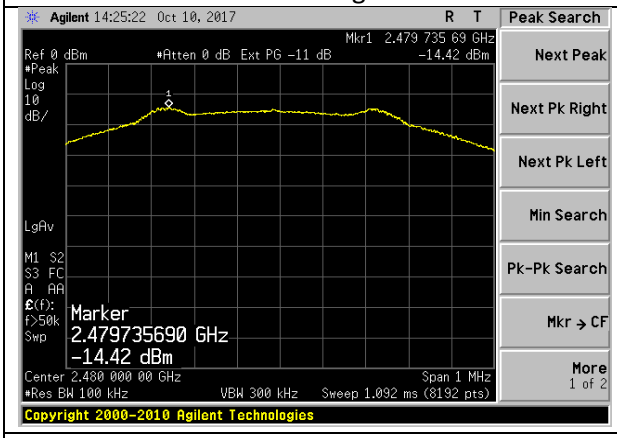
Minimum Power setting Low channel



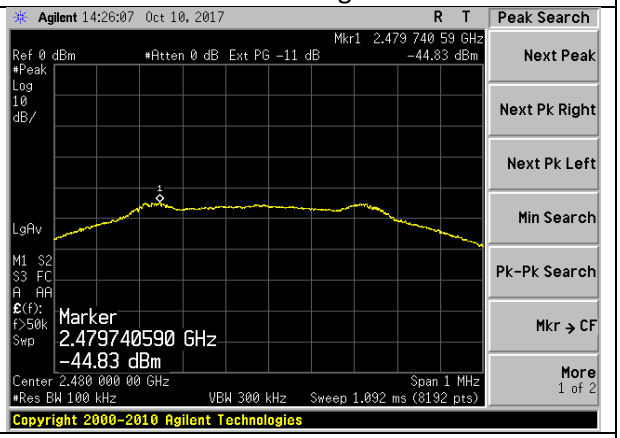
Maximum Power setting Middle channel



Minimum Power setting Middle channel

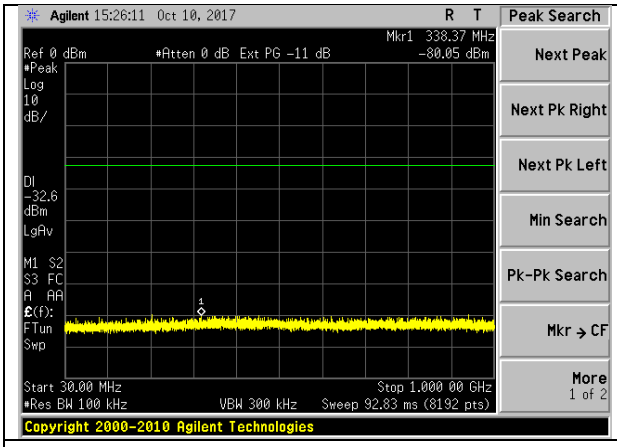


Maximum Power setting High channel

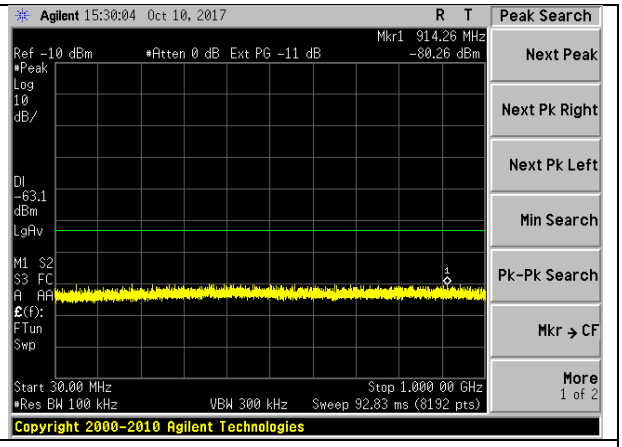


Minimum Power setting High channel

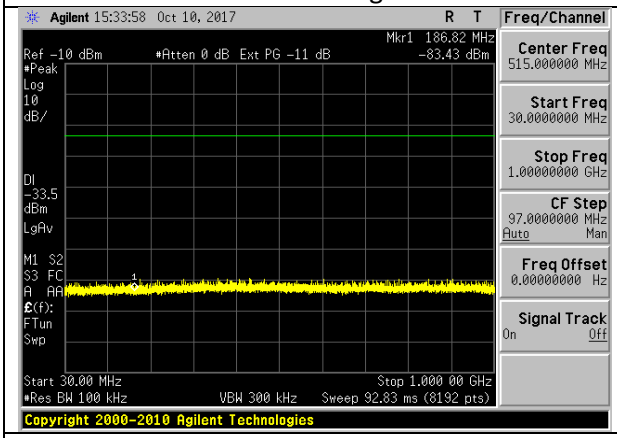
30MHz to 1000MHz



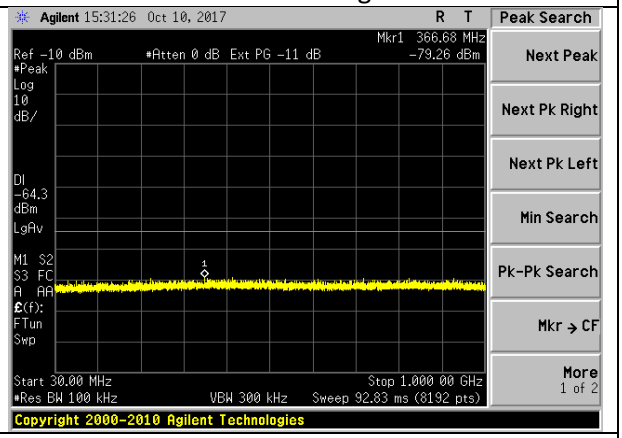
Maximum Power setting Low channel



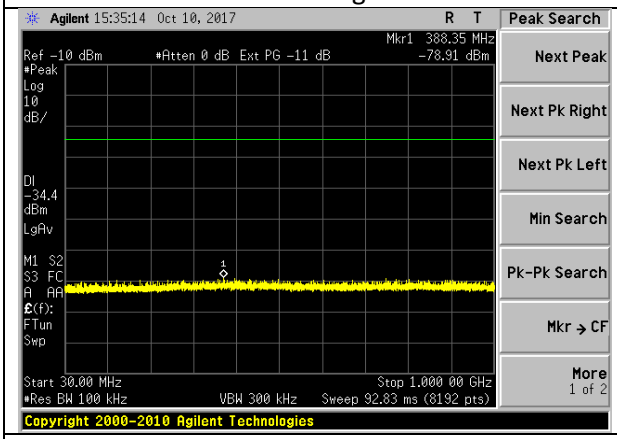
Minimum Power setting Low channel



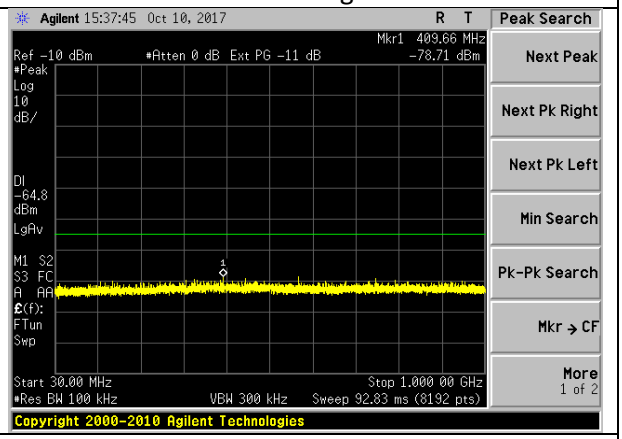
Maximum Power setting Middle channel



Minimum Power setting Middle channel

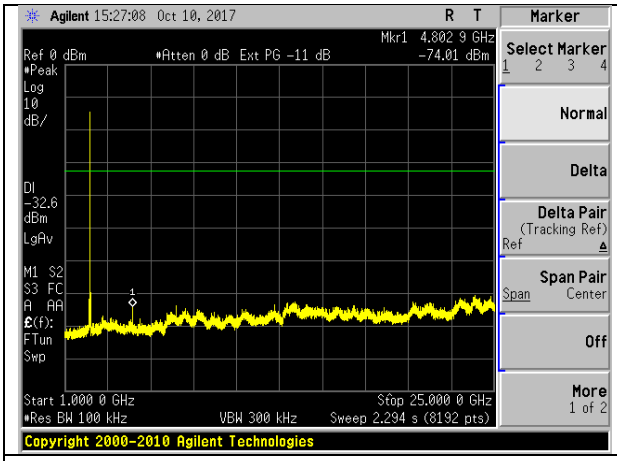


Maximum Power setting High channel

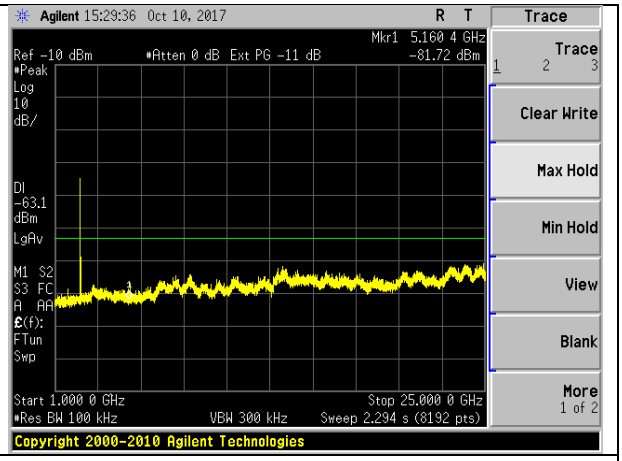


Minimum Power setting High channel

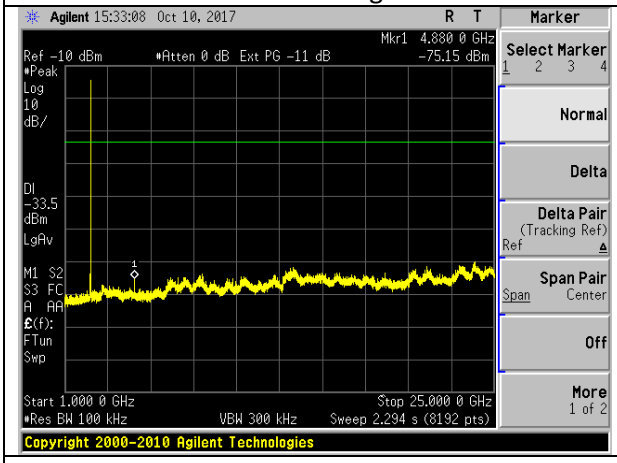
1000MHz to 25000MHz



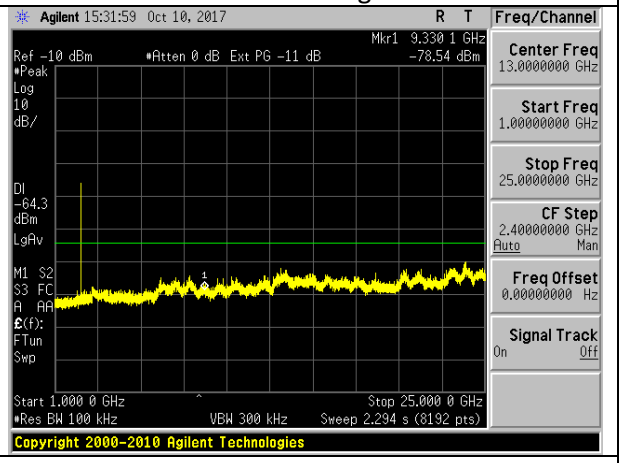
Maximum Power setting Low channel



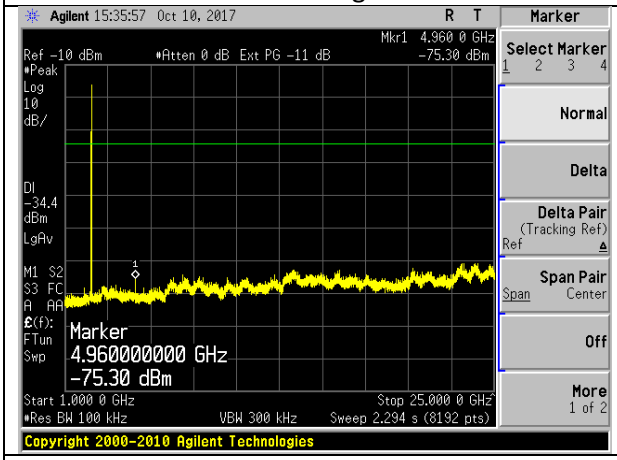
Minimum Power setting Low channel



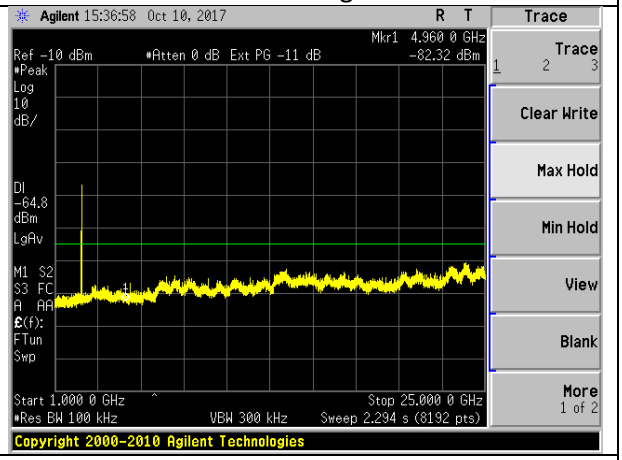
Maximum Power setting Middle channel



Minimum Power setting Middle channel

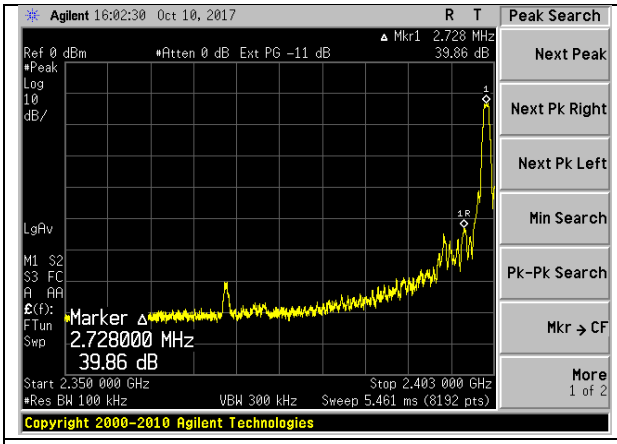


Maximum Power setting High channel

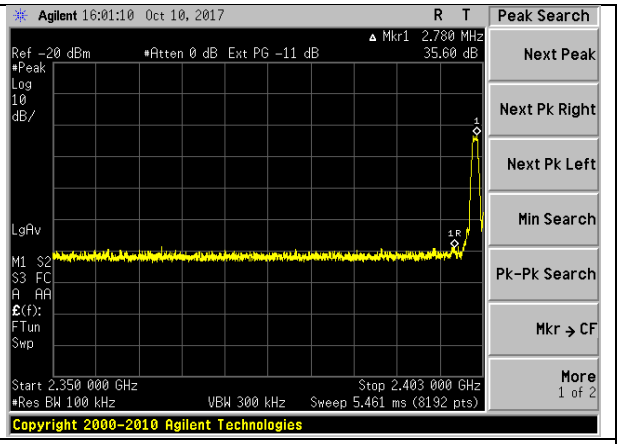


Minimum Power setting High channel

Lower band edge

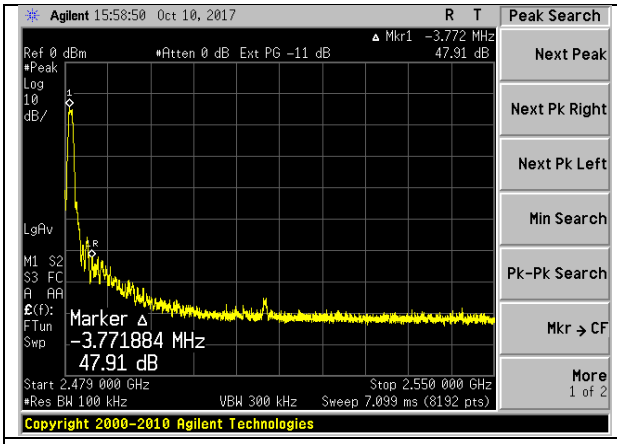


Maximum Power setting

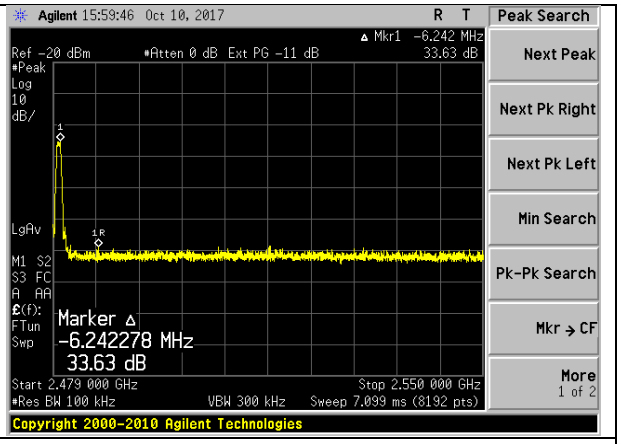


Minimum Power setting

Upper band edge



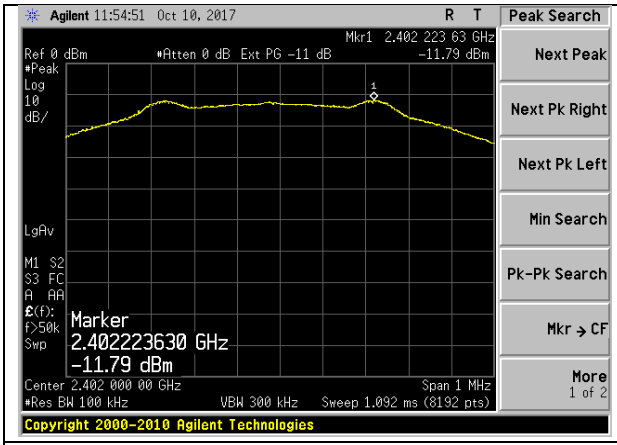
Maximum Power setting



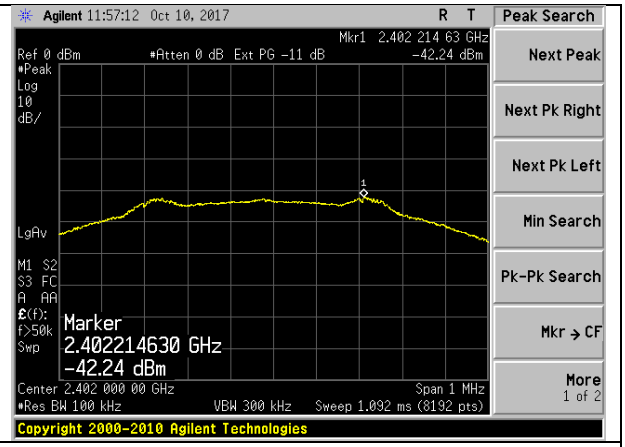
Minimum Power setting

B. Wireless_BLE2

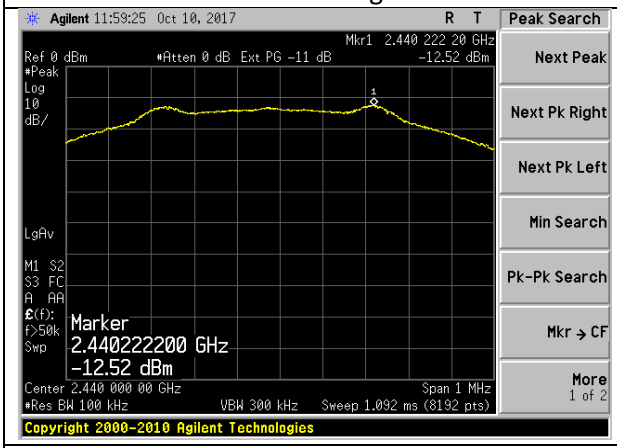
Reference level



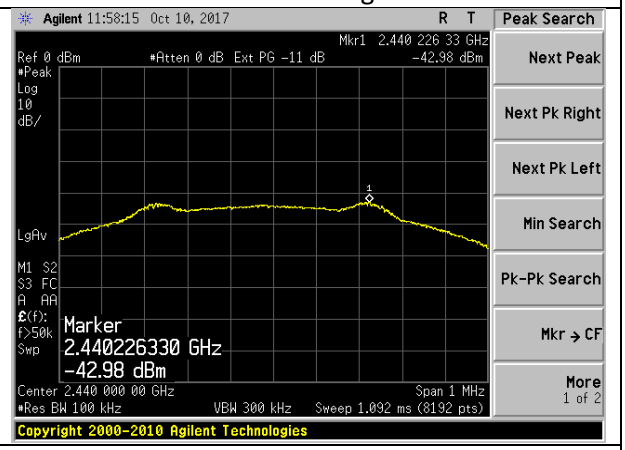
Maximum Power setting Low channel



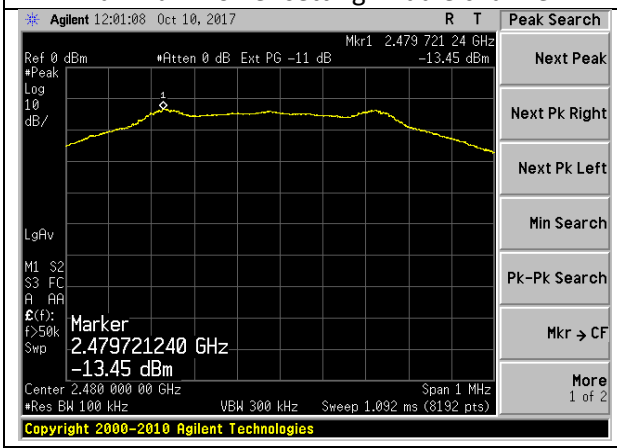
Minimum Power setting Low channel



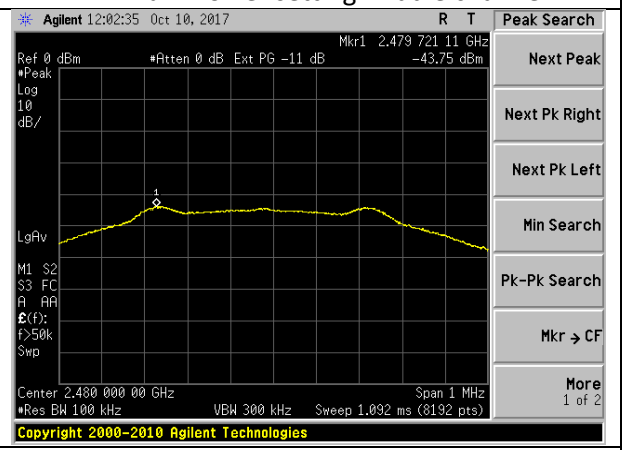
Maximum Power setting Middle channel



Minimum Power setting Middle channel

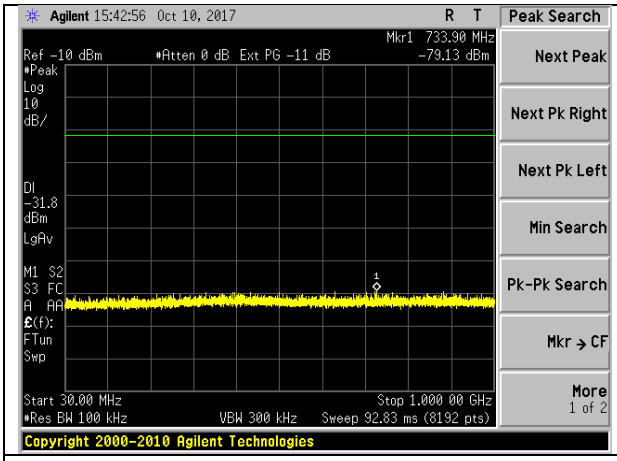


Maximum Power setting High channel

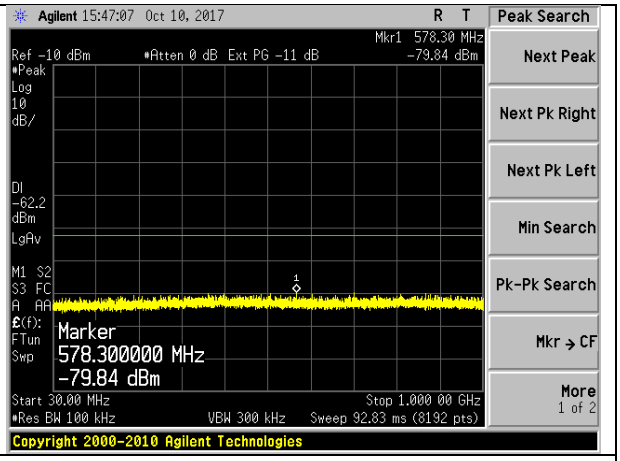


Minimum Power setting High channel

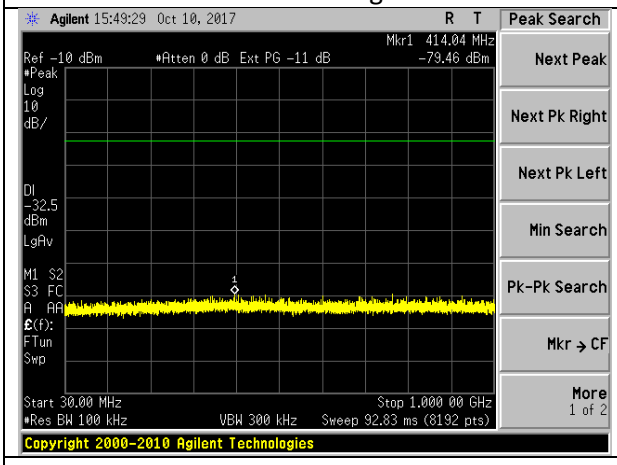
30MHz to 1000MHz



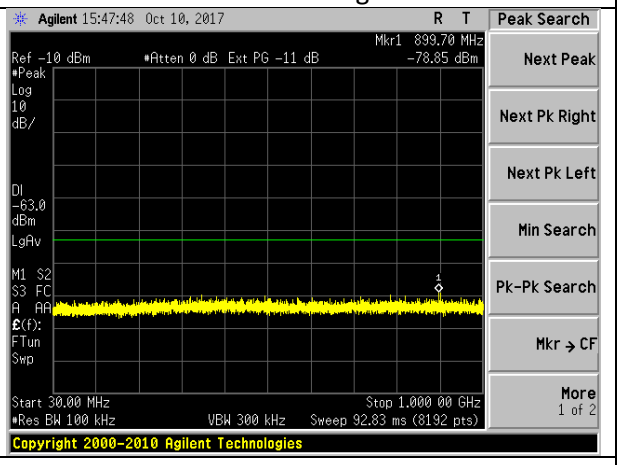
Maximum Power setting Low channel



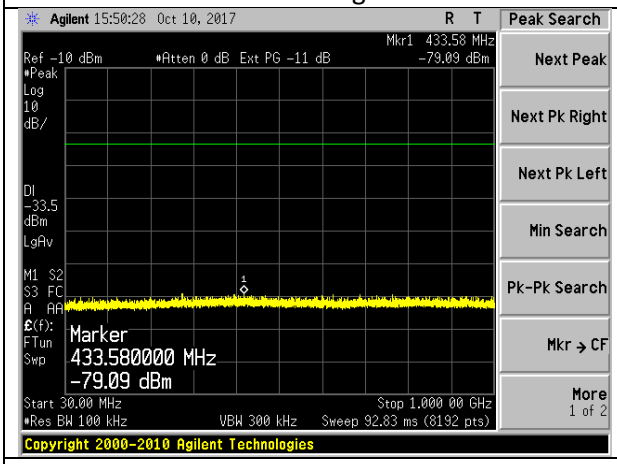
Minimum Power setting Low channel



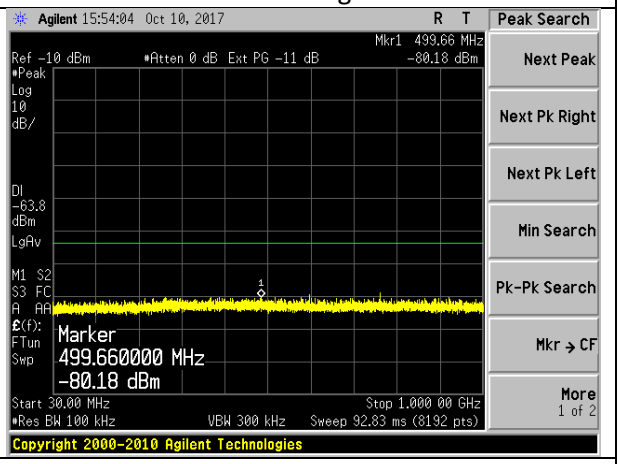
Maximum Power setting Middle channel



Minimum Power setting Middle channel

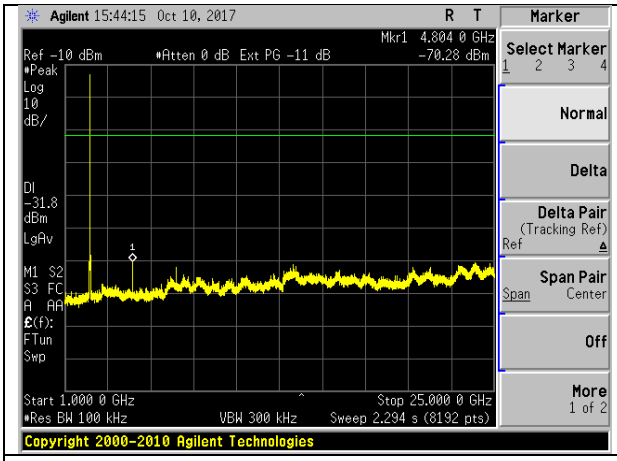


Maximum Power setting High channel

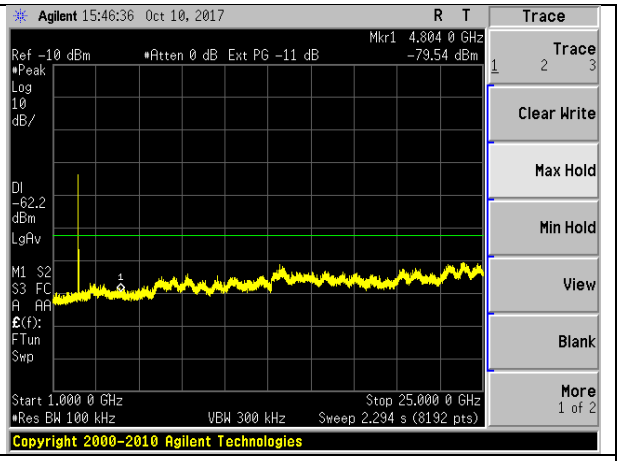


Minimum Power setting High channel

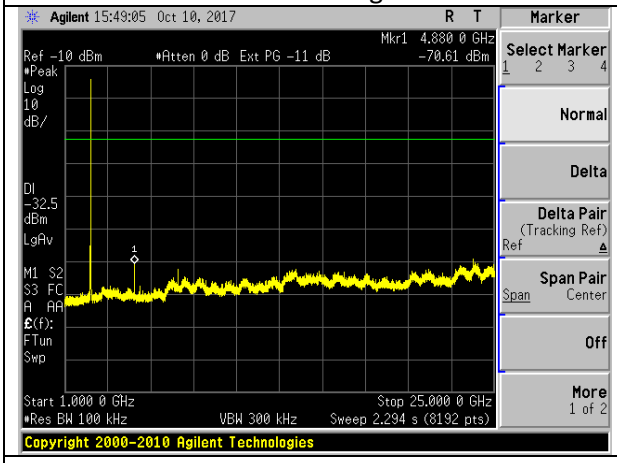
1000MHz to 25000MHz



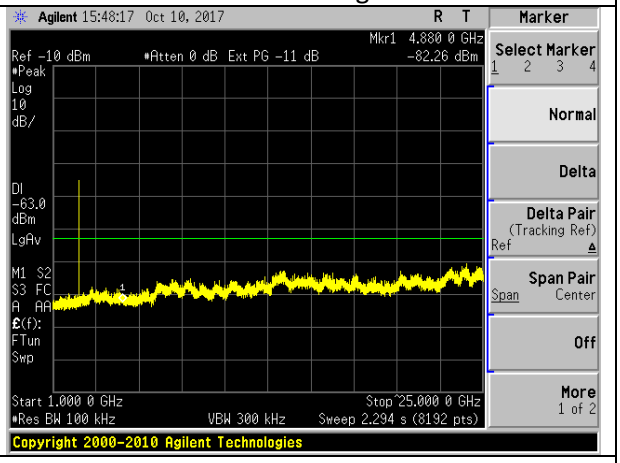
Maximum Power setting Low channel



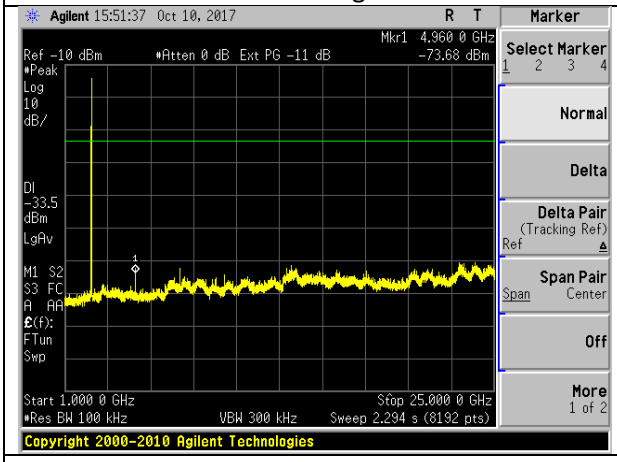
Minimum Power setting Low channel



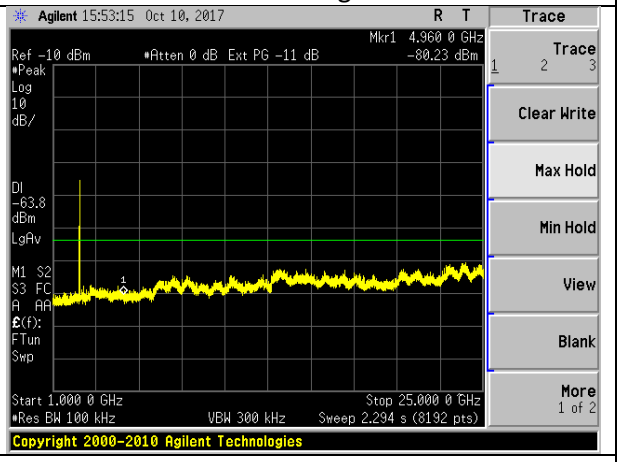
Maximum Power setting Middle channel



Minimum Power setting Middle channel

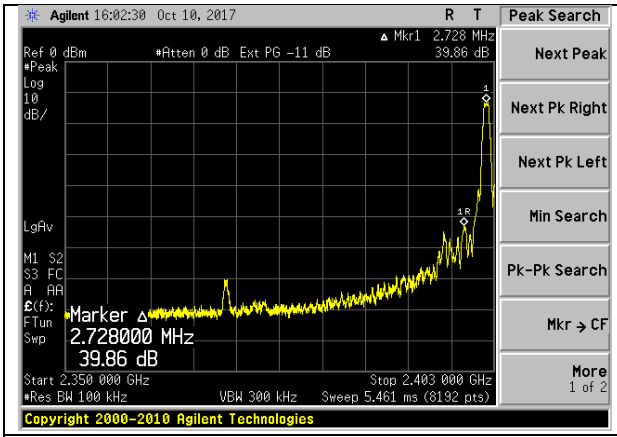


Maximum Power setting High channel

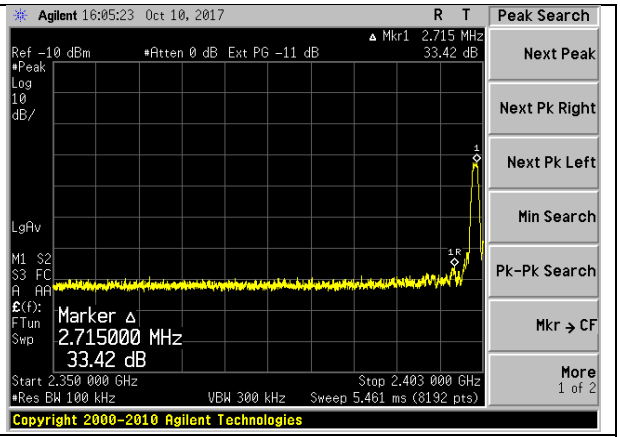


Minimum Power setting High channel

Lower band edge

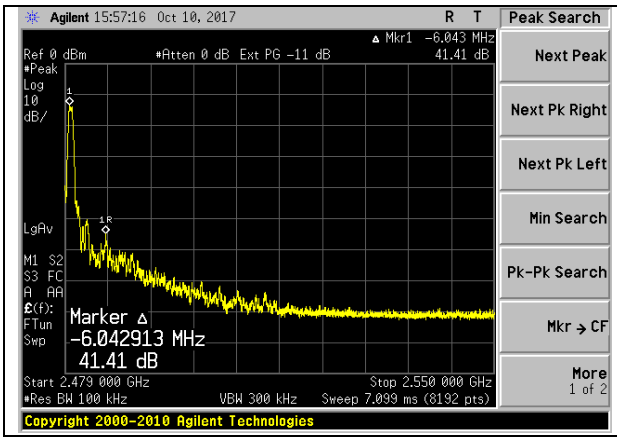


Maximum Power setting

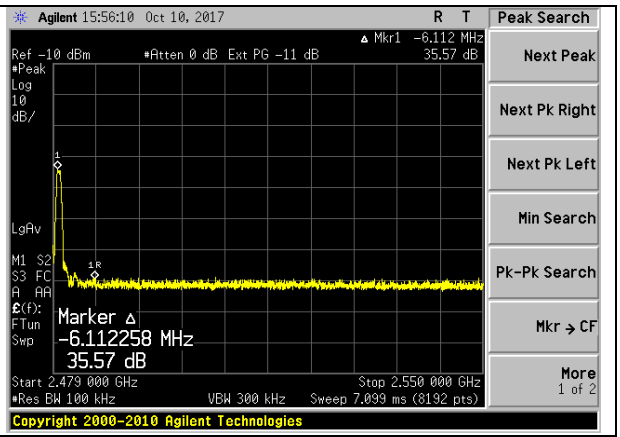


Minimum Power setting

Upper band edge



Maximum Power setting



Minimum Power setting

5.1.5 Antenna Port Conducted Emissions – Frequency Stability

Operator	Aidi Zainal
QA	Coty H.
Test Date	10/10/2017
Location	Conducted Radio Bench
Temp. / R.H.	70F / 76%
Requirement	2.1055 (d)
Method	ANSI C63.10 Section 6.8

Test Parameters

Frequency	2402, 2440, 2480 MHz
Settings	Transmit in CW mode
Notes	Frequency stability does not change when output power setting was varied between maximum and minimum.

Table

	wireless_BLE			
	Supply Voltage			
	102VAC	120VAC	138VAC	Freq Deviation
Low channel (Hz)	2401977094	2401977108	2401977088	20
Middle channel (Hz)	2439976707	2439976747	2439976661	86
High channel (Hz)	2479976358	2479976326	2479976353	32

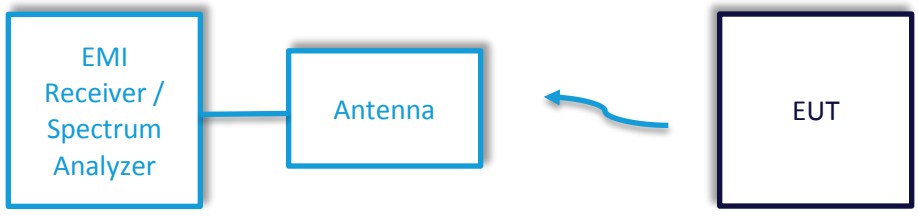
	wireless_BLE2			
	Supply Voltage			
	102VAC	120VAC	138VAC	Freq Deviation
Low channel (Hz)	2401976249	2401976171	2401976282	111
Middle channel (Hz)	2439975855	2439975796	2439975853	59
High channel (Hz)	2479975464	2479975400	2479975395	69

EUT frequency stability found to be better than 100PPM

5.2 Radiated Emissions

Description of Measurement	The frequency spectrum is investigated for intentional and / or unintentional signals emanating from the EUT by use of a standardized test site and measurement antenna. 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 allowing the data to be gathered and reported as corrected values. The maximum emissions from the EUT are determined by turn-table azimuth rotation (360°) and scanning of the measurement antenna. Maximized levels are noted at degree values of azimuth, measurement antenna height, and measurement antenna polarity.
Example Calculations	Measurement (dBµV) + Cable factor (dB) + Other (dB) + Antenna Factor (dB/m) = Corrected Reading (dBµV/m) Margin (dB) = Limit (dBµV/m) - Corrected Reading (dBµV/m) Example at 4000 MHz: Reading = 40 dBµV + 3.4 dB + 0.9 dB + 6.5 dB/m = 50.8 dBµV/m Average Limit = 20 log (500) = 54 dBµV/m Margin = 54 dBµV/m - 50.8 dBµV/m = 3.2 dB

Block Diagram



Instrumentation

Smart Technology. Delivered.

Date : 3-Oct-2017 Test : Radiated measurement Job : C-2848

PE : Aidi Customer : Midmark Quote : 317126

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960085	EMI Receiver	Agilent	N9038A	MY51210148	5/12/2017	5/12/2018	Active Calibration
2	AA 960176	Cable - low loss 6m	A.H. Systems, Inc.	SAC-26G-6	395	5/15/2017	5/15/2018	Active Verification
3	AA 960007	Double Ridge Horn Antenna	EMCO	3115	9311-4138	8/30/2017	8/30/2018	Active Calibration
4	AA 960154	High Pass Filter 2.4 GHz	KWM	HPF-L-14186	7272-02	8/30/2017	8/30/2018	Active Calibration
5	EE 960160	Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	977711030	8/30/2017	8/30/2018	Active Calibration
6	AA 960174	Small Horn Antenna	ETS Lindgren	3116C-PA	00206880	5/1/2017	5/1/2018	Active Calibration
7	AA 960128	Biconical Antenna	ETS Lindgren	3110B	00062899	4/13/2017	4/13/2018	Active Calibration
8	AA 960158	Double Ridge Horn Antenna	ETS Lindgren	3117	109300	10/13/2016	10/13/2017	Active Calibration
9	EE 960159	Low Noise Amplifier	Mini-Circuits	ZVA-213X-S+	462101702	4/12/2017	4/12/2018	Active Calibration

5.2.1 Radiated Emissions

Operator	Zach Wilson, Aidi Zainal
QA	Aidi Zainal, Adam Alger
Test Date	10/3/2017-10/10/2017
Location	Chamber 5 and Chamber 3
Temp. / R.H.	71/48%
Requirement	15.247 (d)
Method	ANSI C63.10 Sections 6.3, 6.5, 6.6

Limits:

	30-88 MHz	88-216 MHz	216 – 960 MHz	960+ MHz
Field Strength (µV/m)	100	150	200	500
Field Strength (dBµV/m)	40.0	43.5	46.0	54.0

Test Parameters

Frequency	30MHz to 25000MHz
Distance	3 meters
RBW	1 MHz Above 1 GHZ, 120kHz below 1 GHz
VBW	Avg= 30Hz, Peak=50 MHz Above 1 GHZ, 1.2MHz below 1 GHz
Notes	EUT tested in three orthogonal orientations
Example Calculation	Limit (dBµV) = 20* Log[Limit (µV)] 40 = 20* log (100) Raw Data + Antenna Factor + Cable Factor = Reported Data 19.77 dBµV + 12.50 dB/m + 0.93 dB = 38.80 dBµV/m

Table

Wireless_BLE:

Emissions in the 30MHz to 1000MHz range

Frequency (MHz)	Antenna Polarity	EUT orientation	Height (cm)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)
996.8	H	V	100.00	0	35.7	54.0	18.3
683.1	H	V	100.00	0	33.4	46.0	12.6
982.6	V	V	100.00	179.5	35.82	54.0	18.2
239.1	V	V	100.00	179.5	25.9	46.0	20.1
335.3	V	V	100.00	179.5	24.73	46.0	21.3

Note:

1. H: Horizontal; V:Vertical
2. Emissions did not change between maximum power setting and minimum power setting.
3. Emissions seen in the table does not change between Wireless_BLE and Wireless_BLE2

Emissions in the 1000 to 25000 MHz range

Frequency (MHz)	EUT orientation	Polarization	Azimuth (degrees)	Height(cm)	Peak (dBuV/m)	Peak limit (dBuV/m)	Peak margin (dB)	Average (dBuV/m)	Average limit (dBuV/m)	Average margin (dB)
5000.0	V	V	0.0	100.0	37.8	74.0	36.2	27.9	54.0	26.1
10000.0	H	V	0.0	100.0	42.5	74.0	31.5	33.4	54.0	20.6
19000.0	H	V	0.0	100.0	46.0	74.0	28.0	36.5	54.0	17.5
22000.0	V	V	0.0	100.0	45.9	74.0	28.1	36.4	54.0	17.6

Note:

1. H: Horizontal; V:Vertical
2. Emissions listed in the table is that of the system noise floor

Band-edge measurements

Lower band-edge Peak measurements

Frequency (GHz)	EUT Orientation	Polarization	Azimuth (degrees)	Height(cm)	Peak (dBuV/m)	Peak limit (dBuV/m)	Peak margin (dB)	Notes
2.3808	Flat	Horizontal	278.3	150.0	51.7	74.0	22.3	1
2.3840	Flat	Horizontal	278.3	150.0	51.5	74.0	22.5	2

Notes:

1. Maximum power setting
2. Minimum power setting

Lower band-edge Average measurements

Frequency (GHz)	EUT Orientation	Polarization	Azimuth (degrees)	Height(cm)	Average (dBuV/m)	Average limit (dBuV/m)	Average margin (dB)	Notes
2.3887	Flat	Horizontal	278.3	150.0	39.7	54.0	14.3	1
2.3887	Flat	Horizontal	278.3	150.0	39.4	54.0	14.6	2

Notes:

1. Maximum power setting
2. Minimum power setting

Upper band-edge Peak measurements

Frequency (GHz)	EUT Orientation	Polarization	Azimuth (degrees)	Height(cm)	Peak (dBuV/m)	Peak limit (dBuV/m)	Peak margin (dB)	Notes
2.4835	Flat	Horizontal	278.3	150.0	53.4	74.0	20.6	1
2.4850	Flat	Horizontal	278.3	150.0	52.2	74.0	21.8	2

Notes:

1. Maximum power setting
2. Minimum power setting

Upper band-edge Average measurements

Frequency (GHz)	EUT Orientation	Polarization	Azimuth (degrees)	Height(cm)	Average (dBuV/m)	Average limit (dBuV/m)	Average margin (dB)	Notes
2.4850	Flat	Horizontal	278.3	150.0	41.5	54.0	12.5	1
2.4850	Flat	Horizontal	278.3	150.0	39.8	54.0	14.2	2

Notes:

1. Maximum power setting
2. Minimum power setting

Wireless_BLE2:

Emissions in the 30MHz to 1000MHz range

Frequency (MHz)	Antenna Polarity	EUT orientation	Height (cm)	Azimuth (degree)	Quasi Peak Reading (dBµV/m)	Quasi Peak Limit (dBµV/m)	Margin (dB)
996.8	H	V	100.00	0	35.7	54.0	18.3
683.1	H	V	100.00	0	33.4	46.0	12.6
982.6	V	V	100.00	179.5	35.82	54.0	18.2
239.1	V	V	100.00	179.5	25.9	46.0	20.1
335.3	V	V	100.00	179.5	24.73	46.0	21.3

Note:

4. H: Horizontal; V:Vertical
5. Emissions did not change between maximum power setting and minimum power setting.
6. Emissions seen in the table does not change between Wireless_BLE and Wireless_BLE2

Emissions in the 1000 to 25000 MHz range

Frequency (MHz)	EUT orientation	Polarization	Azimuth (degrees)	Height(cm)	Peak (dBuV/m)	Peak limit (dBuV/m)	Peak margin (dB)	Average (dBuV/m)	Average limit (dBuV/m)	Average margin (dB)
5000.0	V	V	0.0	100.0	37.8	74.0	36.2	27.9	54.0	26.1
10000.0	H	V	0.0	100.0	42.5	74.0	31.5	33.4	54.0	20.6
19000.0	H	V	0.0	100.0	46.0	74.0	28.0	36.5	54.0	17.5
22000.0	V	V	0.0	100.0	45.9	74.0	28.1	36.4	54.0	17.6

Note:

3. H: Horizontal; V:Vertical
4. Emissions listed in the table is that of the system noise floor

Band-edge measurements

Lower band-edge Peak measurements

Frequency (GHz)	EUT Orientation	Polarization	Azimuth (degrees)	Height(cm)	Peak (dBuV/m)	Peak limit (dBuV/m)	Peak margin (dB)	Notes
2.3381	Side	Vertical	256.9	153.8	52.5	74.0	21.5	1
2.3768	Side	Vertical	256.9	153.8	51.1	74.0	22.9	2

Notes:

3. Maximum power setting
4. Minimum power setting

Lower band-edge Average measurements

Frequency (GHz)	EUT Orientation	Polarization	Azimuth (degrees)	Height(cm)	Average (dBuV/m)	Average limit (dBuV/m)	Average margin (dB)	Notes
2.3820	Side	Vertical	256.9	153.8	35.3	54.0	18.7	1
2.3823	Side	Vertical	256.9	153.8	35.3	54.0	18.7	2

Notes:

3. Maximum power setting
4. Minimum power setting

Upper band-edge Peak measurements

Frequency (GHz)	EUT Orientation	Polarization	Azimuth (degrees)	Height(cm)	Peak (dBuV/m)	Peak limit (dBuV/m)	Peak margin (dB)	Notes
2.4842	Side	Vertical	256.9	153.8	53.4	74.0	20.6	1
2.4863	Side	Vertical	256.9	153.8	51.9	74.0	22.1	2

Notes:

3. Maximum power setting
4. Minimum power setting

Upper band-edge Average measurements

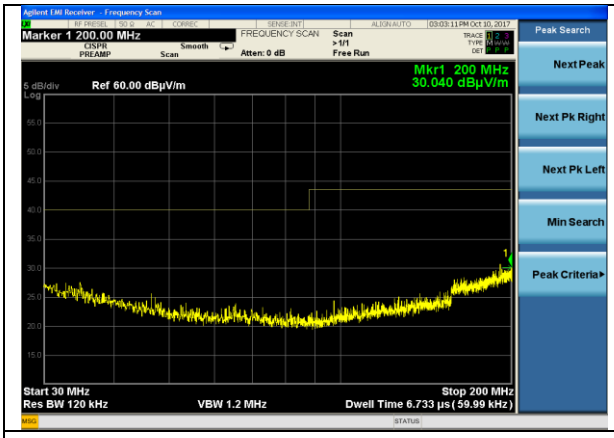
Frequency (GHz)	EUT Orientation	Polarization	Azimuth (degrees)	Height(cm)	Average (dBuV/m)	Average limit (dBuV/m)	Average margin (dB)	Notes
2.4836	Side	Vertical	256.9	153.8	36.0	54.0	18.0	1
2.4841	Side	Vertical	256.9	153.8	35.7	54.0	18.3	2

Notes:

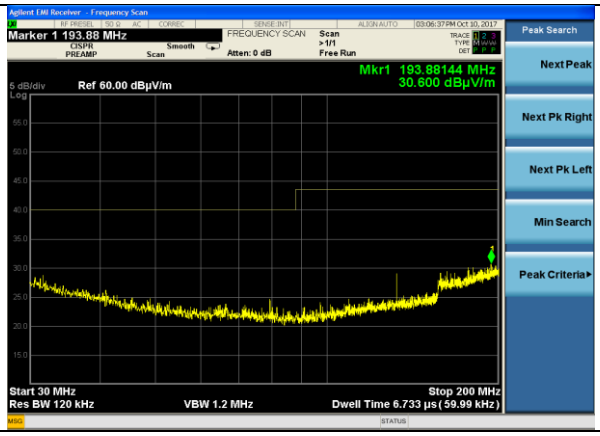
3. Maximum power setting
4. Minimum power setting

Plots

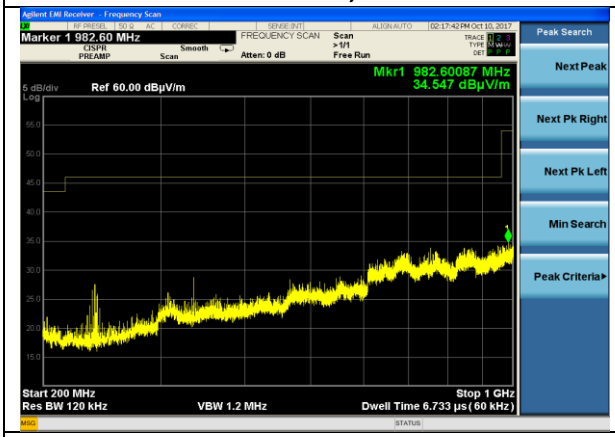
30MHz to 1000 MHz



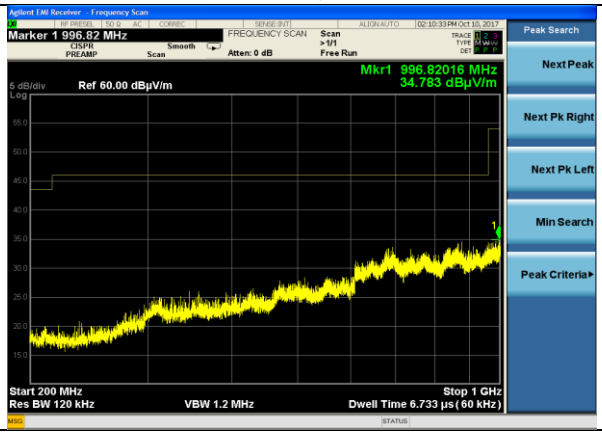
30 to 200 MHz, Vertical



30 to 200 MHz, Horizontal



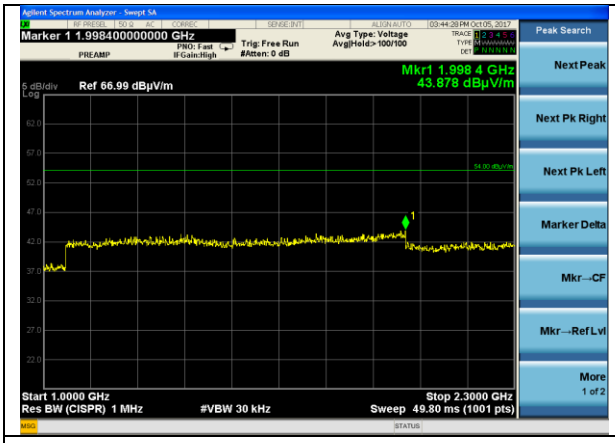
200 to 1000 MHz, Vertical



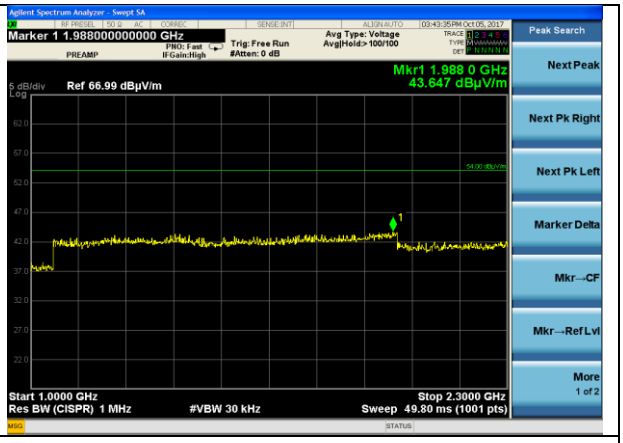
200 to 1000 MHz, Horizontal

The plots above represent both Wireless_BLE and Wireless_BLE2

1000 to 4000 MHz (Not including band-edges)



1000 to 2300MHz, Vertical



1000 to 2300MHz, Horizontal

2500 to 4000MHz, Vertical

2500 to 4000MHz, Horizontal

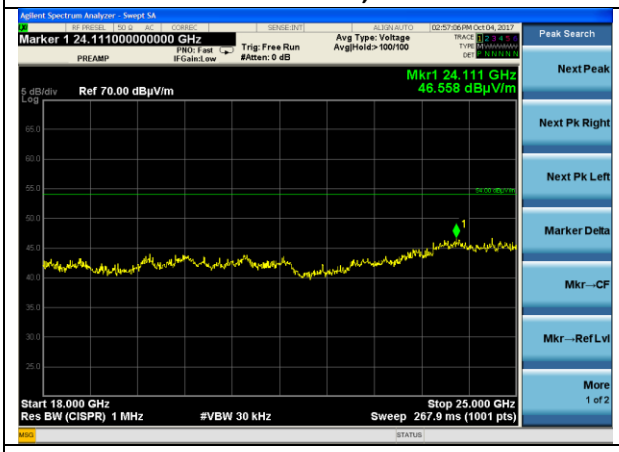
Notes:

1. The plots above represent both Wireless_BLE and Wireless_BLE2
2. Plots are taken with reduced video bandwidth in the interest of dynamic range

4000 to 25000MHz

4000 to 18000 MHz, Horizontal

4000 to 18000 MHz, Vertical



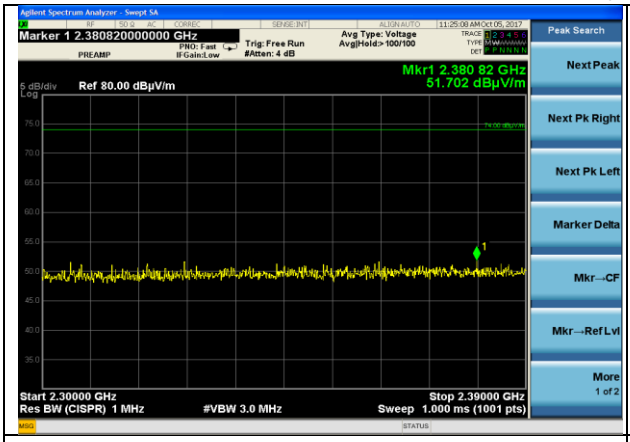
18000 to 25000 MHz, Horizontal

18000 to 25000 MHz, Vertical

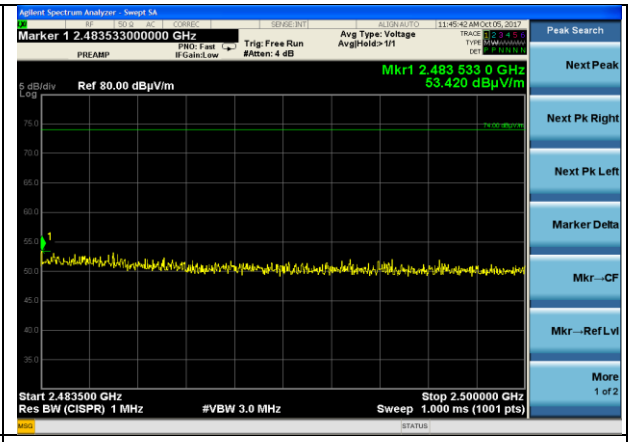
Notes:

1. The plots above represent both Wireless_BLE and Wireless_BLE2
2. Plots are taken with reduced video bandwidth in the interest of dynamic range

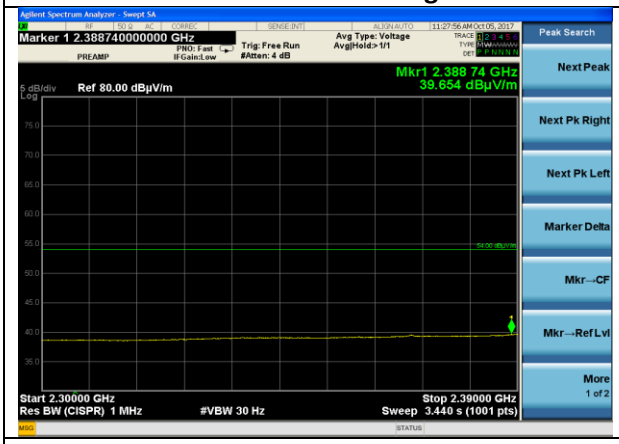
Wireless_BLE Band-edges
Maximum power setting
2300 to 2390 MHz, 2483.5 to 2500 MHz



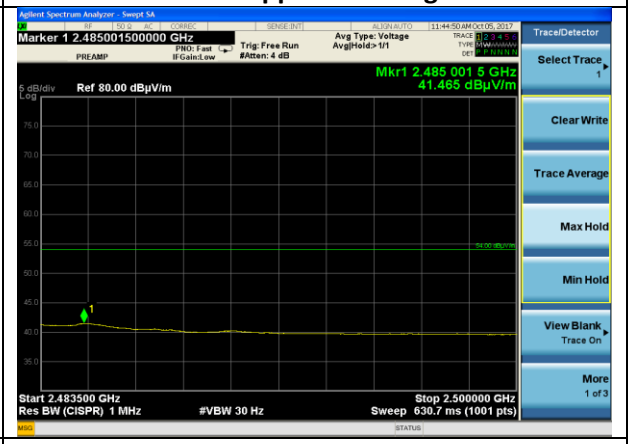
Peak Lower Band Edge



Peak Upper Band Edge

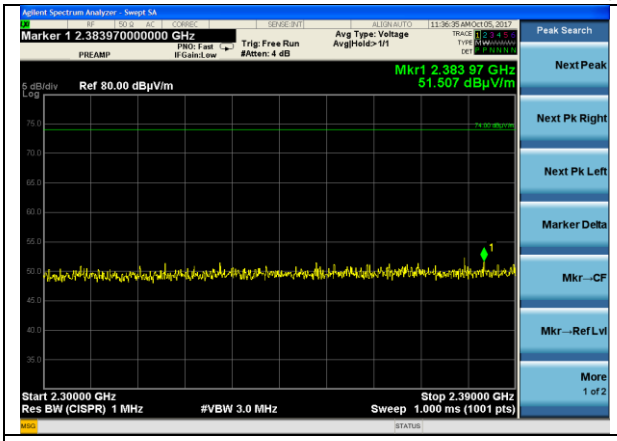


Average Lower Band Edge

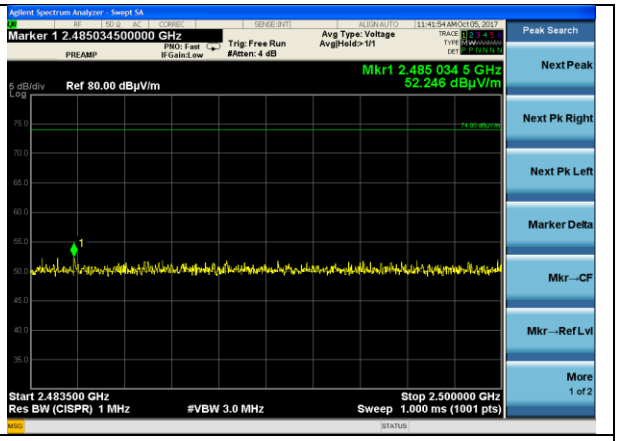


Average Upper Band Edge

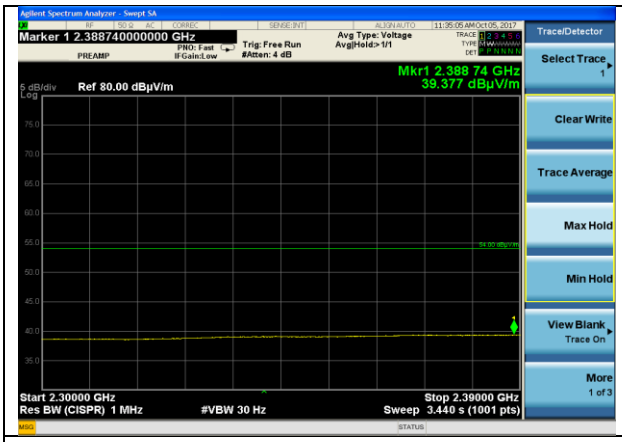
Minimum power setting
2300 to 2390 MHz, 2483.5 to 2500 MHz



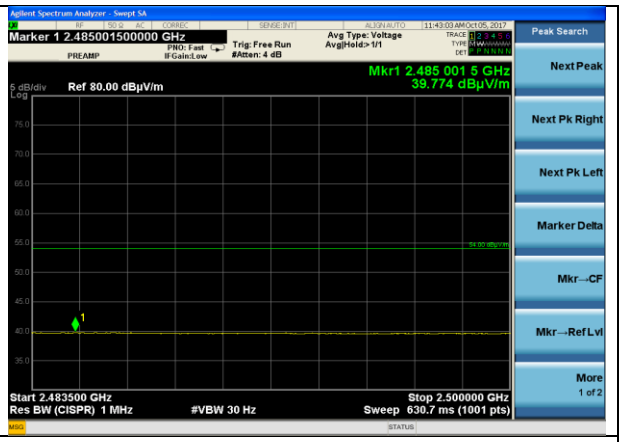
Peak Lower Band Edge



Peak Upper Band Edge



Average Lower Band Edge

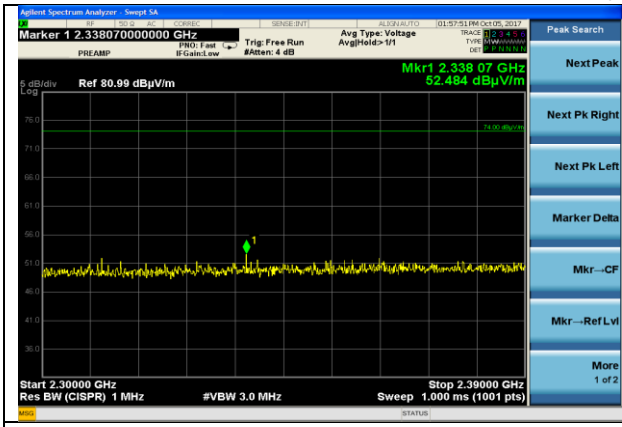


Average Upper Band Edge

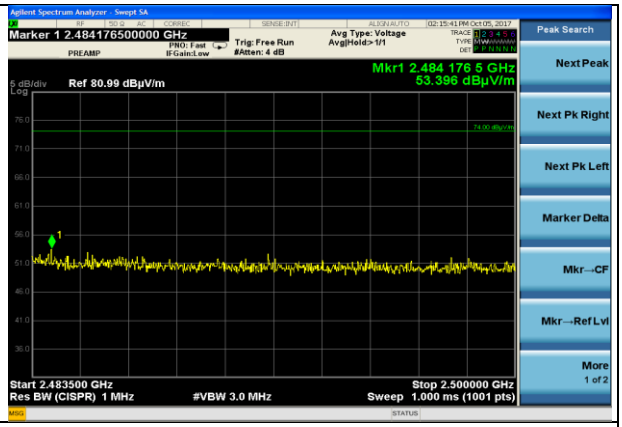
Wireless_BLE2 Band-edges

Maximum power setting

2300 to 2390 MHz, 2483.5 to 2500 MHz

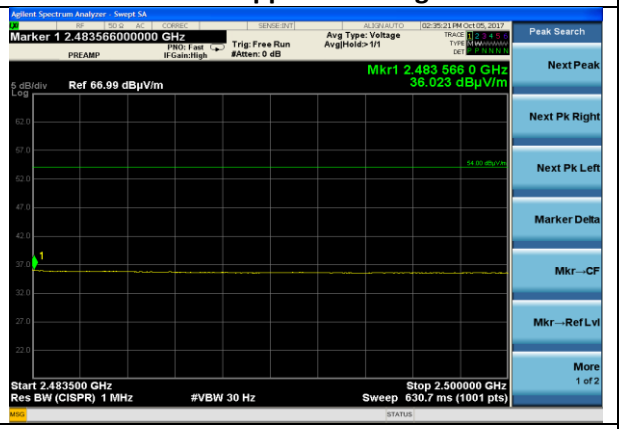


Peak Lower Band Edge



Peak Upper Band Edge

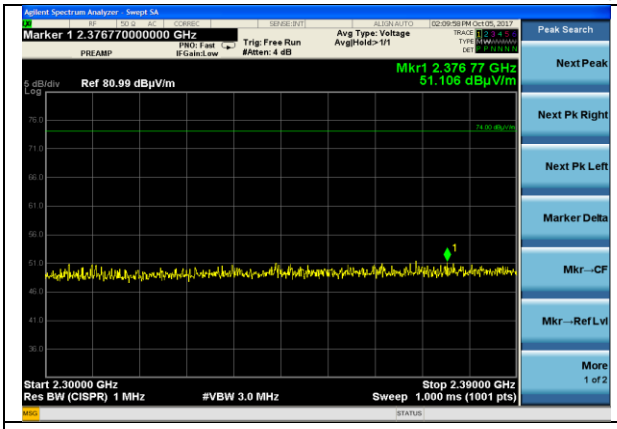
Average Lower Band Edge



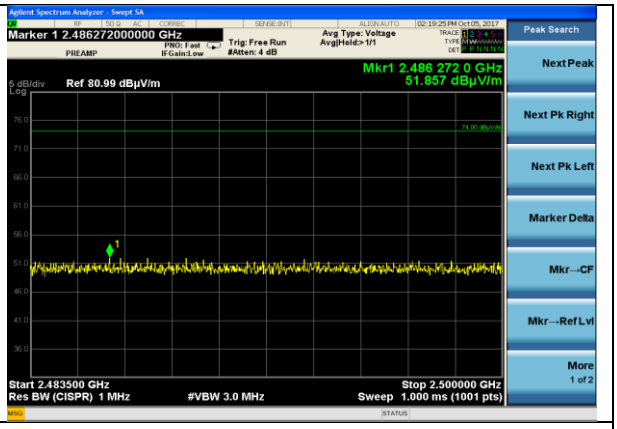
Average Upper Band Edge

Minimum power setting

2300 to 2390 MHz, 2483.5 to 2500 MHz

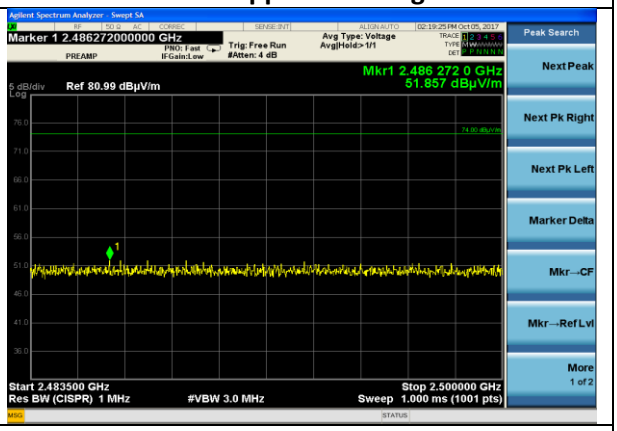


Peak Lower Band Edge



Peak Upper Band Edge

Average Lower Band Edge

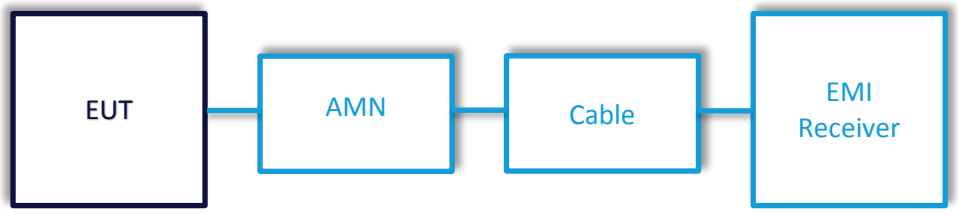


Average Upper Band Edge

5.3 AC Mains Conducted Emissions

	A line impedance stabilization network (LISN) or artificial mains network (AMN) allows the emissions of the power supply conductors to be measured while isolating the EUT from the supply mains.
Description of Measurement	The AMN, cable, and other necessary measurement system correction factors are loaded onto the EMI receiver when the measurements are performed. The data is gathered and reported as the corrected values. Maximum emissions are determined with a peak max hold trace then measurements at a selection of the highest points are made with quasi-peak and average detectors. Results are recorded and compared to limit for each line. (e.g. line and neutral)
Example Calculations	Measurement (dBµV) + Cable factor (dB) + Other (dB) = Corrected Reading (dBµV) Margin (dB) = Limit (dBµV) - Corrected Reading (dBµV)

Block Diagram



5.3.1 AC Mains Conducted Emissions

Operator	Zach Wilson
QA	Adam Alger
Test Date	10/4/2017
Location	Conducted Emissions GRP
Temp. / R.H.	70F / 56%
Requirement	FCC: 15.207 IC: RSS-GEN 8.8
Method	ANSI C63.10 section 6.2

Limits:

Frequency (MHz)	Quasi Peak (dBµV)	Average (dBµV)
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5.0	56	46
5.0 – 30.0	60	50

*Decreases with the logarithm of the frequency

Test Parameters

Frequency	0.150-30 MHz
Distance	40cm from vertical ground plane and 80cm above horizontal ground plane
RBW	9 kHz
VBW	90 kHz
EUT Power	120VAC/60Hz Wallwart providing the EUT with 5 VDC
EUT Mode	See data tables
Note	1. Generic wall DC power supply used. 2. No change in emissions between maximum power setting and minimum power setting for both radio.

Instrumentation

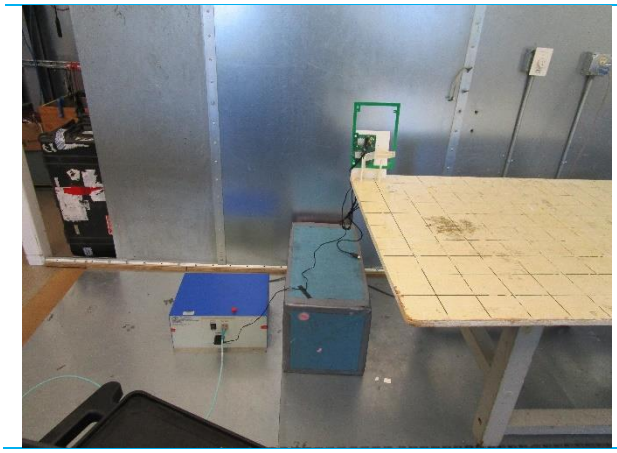
Laird
Smart Technology. Delivered.

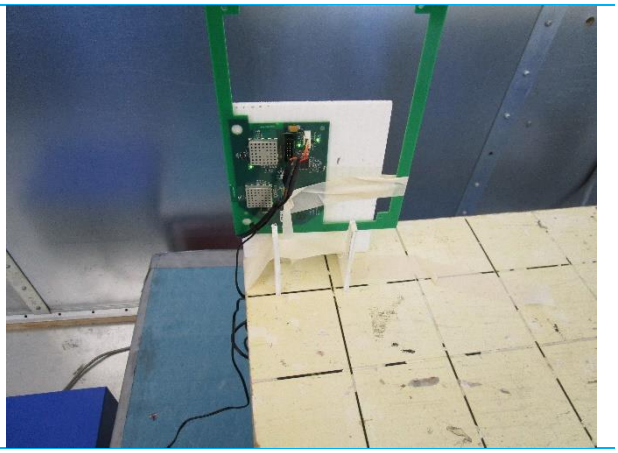
Date : 4-Oct-2017 Test : Radio 2 AC mains Job : C-2848

PE : Aidi Zainal Customer : Midmark Quote : 317126

No.	Asset	Description	Manufacturer	Model	Serial	Cal Date	Cal Due Date	Equipment Status
1	EE 960088	EMI Receiver	Agilent	N9038A	MY51210138	3/2/2017	3/2/2018	Active Calibration
2	EE 960162	LISN	COM-POWER	LI-215A	191969	8/28/2017	8/28/2018	Active Calibration

Setup Photos



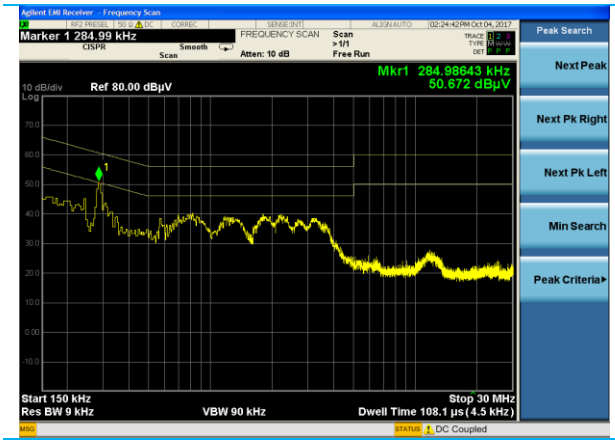


Table

A. Wireless_BLE

Wireless_BLE Enabled							
Line	Frequency (MHz)	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)
1	0.285	49.5	60.7	11.2	44.6	50.7	6.1
1	0.820	37.8	56.0	18.2	31.5	46.0	14.5
1	2.233	36.9	56.0	19.1	28.7	46.0	17.3
2	0.285	44.9	60.7	15.8	33.5	50.7	17.2
2	0.802	33.5	56.0	22.5	21.9	46.0	24.1
2	3.232	32.0	56.0	24.0	22.0	46.0	24.0

Plots

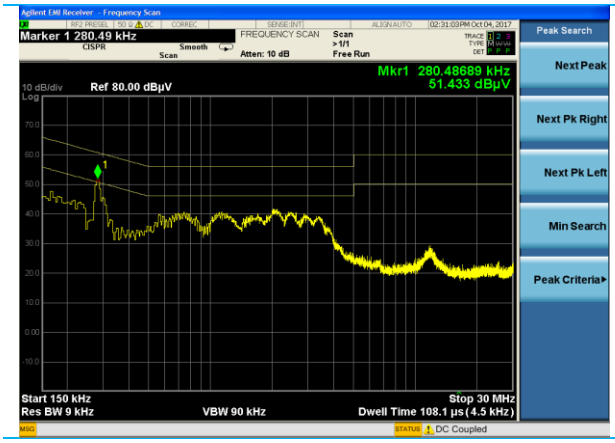


Line 1

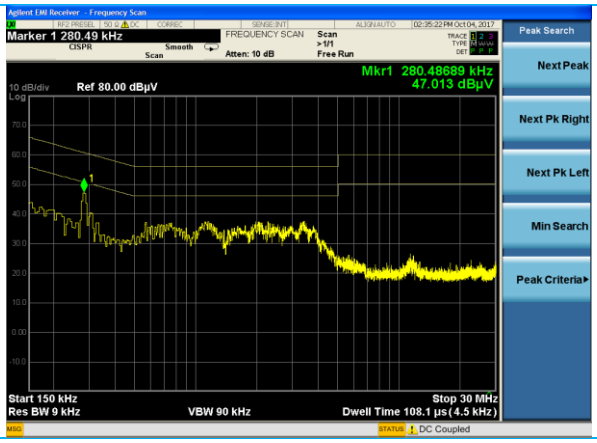
Line 2

B. Wireless_BLE2

Wireless_BLE2 Enabled							
Line	Frequency (MHz)	Q-Peak Reading (dBµV)	Q-Peak Limit (dBµV)	Quasi-Peak Margin (dB)	Average Reading (dBµV)	Average Limit (dBµV)	Average Margin (dB)
1	0.280	50.1	60.8	10.7	45.0	50.8	5.8
1	0.744	38.2	56.0	17.8	31.8	46.0	14.2
1	2.022	38.7	56.0	17.3	29.7	46.0	16.3
2	0.280	45.5	60.8	15.3	34.6	50.8	16.2
2	1.099	31.6	56.0	24.4	18.6	46.0	27.4
2	2.625	29.6	56.0	26.4	19.0	46.0	27.0


Agilent EMI Receiver - Frequency Scan
Marker 1 280.49 kHz
FREQUENCY SCAN
Scan
Atten: 10 dB
Free Run
Mkr1 280.48689 kHz
51.433 dBµV
10 dB/div
Log
Ref 80.00 dBµV
Start 150 kHz
Res BW 9 kHz
VBW 90 kHz
Stop 30 MHz
Dwell Time 108.1 µs (4.5 kHz)
DC Coupled
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Min Search
Peak Criteria

Line 1


Agilent EMI Receiver - Frequency Scan
Marker 1 280.49 kHz
FREQUENCY SCAN
Scan
Atten: 10 dB
Free Run
Mkr1 280.48689 kHz
47.013 dBµV
10 dB/div
Log
Ref 80.00 dBµV
Start 150 kHz
Res BW 9 kHz
VBW 90 kHz
Stop 30 MHz
Dwell Time 108.1 µs (4.5 kHz)
DC Coupled
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Min Search
Peak Criteria

Line 2

6 REVISION HISTORY

Version	Date	Notes	Person
V0	11/17/17	Draft	Aidi Zainal
V1	12/4/2017	Final	Aidi Zainal
V2	6/6/2018	Final with addition of FCC and IC ID number	Aidi Zainal
V2a	7/27/2018	Final with TCB response modifications	Aidi Zainal

END OF REPORT