MEASUREMENT REPORT

FCC PART 15.247 Bluetooth-LE

FCC ID:	2ALGLX2000
Applicant:	CASSIA NETWORKS INC
Application Type:	Certification
Product:	Cassia Bluetooth Router
Model No.:	X2000, X2000-10, X2000-20
Brand Name:	CASSIA
FCC Classification:	Digital Transmission System (DTS)
FCC Rule Part(s):	Part 15 Subpart C (Section 15.247)
Test Procedure(s):	ANSI C63.10-2013
Received Date:	2012.12.23
Test Date:	2021.01.20 ~ 2021.03.02

Tested By : (Kevin Ker)

Reviewed By : (Paddy Chen)

Approved By : (Chenz Ker)

Testing Laboratory
3261

The test results relate only to the samples tested.

This equipment has been shown to be capable of compliance with the applicable technical standards as indicated in the measurement report and was tested in accordance with the measurement procedures specified in ANSI C63.10. Test results reported herein relate only to the item(s) tested.

Revision History

Report No.	Version	Description	Issue Date	Note
2012TW0006-U1	1.0	Initial Report	2021-03-17	Invalid
2012TW0006-U2	2.0	Update antenna information	2021-06-17	Valid

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Description Page

General Information

Applicant	CASSIA NETWORKS INC
Applicant Address	1840 Majestic Way San Jose, CA 95132,USA
Manufacturer	CASSIA NETWORKS INC
Manufacturer Address	1840 Majestic Way San Jose, CA 95132,USA
Test Site	MRT Technology (Taiwan) Co., Ltd
Test Site Address	No. 38, Fuxing Second Rd., Guishan Dist., Taoyuan City 333, Taiwan (R.O.C)
MRT FCC Registration No.	291082
FCC Rule Part(s)	Part 15.247
Test Device Serial No.	N/A ☐ Production ☒ Pre-Production ☐ Engineering

Test Facility / Accreditations

1. MRT facility is a FCC registered (Reg. No. 291082) test facility with the site description report on file and is designated by the FCC as an Accredited Test Firm.
2. MRT facility is an IC registered (MRT Reg. No. 21723) test laboratory with the site description on file at Industry Canada.
3. MRT Lab is accredited to ISO 17025 by the Taiwan Accreditation Foundation (TAF Cert. No. 3261) in EMC, Telecommunications and Radio testing for FCC (Designation Number: TW3261), Industry Taiwan, EU and TELEC Rules.

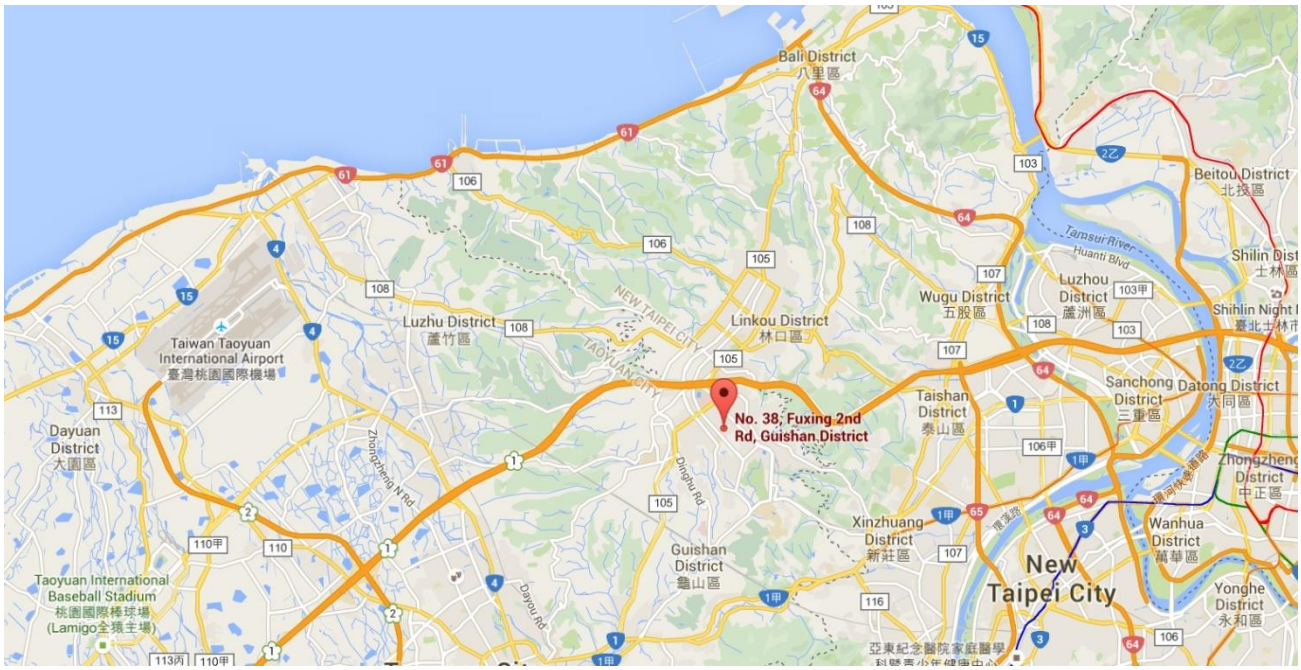
1. INTRODUCTION

1.1. Scope

Measurement and determination of electromagnetic emissions (EMC) of radio frequency devices including intentional and/or unintentional radiators for compliance with the technical rules and regulations of the Federal Communications Commission and the Innovation, Science and Economic Development Canada and Certification and Engineering Bureau.

1.2. MRT Test Location

The map below shows the location of the MRT LABORATORY, its proximity to the Taoyuan City. These measurement tests were conducted at the MRT Technology (Taiwan) Co., Ltd. Facility located at No.38, Fuxing 2nd Rd., Guishan Dist., Taoyuan City 33377, Taiwan (R.O.C).



2. PRODUCT INFORMATION

2.1. Equipment Description

Product Name	Cassia Bluetooth Router
Model No.	X2000, X2000-10, X2000-20
Chip 0 Bluetooth Version	V5.0 (Single Mode)
Chip 1 Bluetooth Version	V5.0 (Single Mode)
Wi-Fi Specification	802.11a/b/g/n/ac
Working Voltage	12Vdc 2.0A or 57Vdc 350mA (PoE)

Remark:

1. PoE adapter was selected by MRT for all testing, due to DC adapter and PoE adapter not selling with product.
2. The difference of models only for marketing different client, the other was the same. X2000 was selected for all testing.

2.2. Product Specification Subjective to this Report

Bluetooth Frequency	2402 ~ 2480MHz
Channel Number	40
Type of modulation	GFSK
Data Rate	1Mbps & 2Mbps

2.3. Working Frequencies for this report

Channel	Frequency	Channel	Frequency	Channel	Frequency
00	2402 MHz	01	2404 MHz	02	2406 MHz
03	2408 MHz	04	2410 MHz	05	2412 MHz
06	2414 MHz	07	2416 MHz	08	2418 MHz
09	2420 MHz	10	2422 MHz	11	2424 MHz
12	2426 MHz	13	2428 MHz	14	2430 MHz
15	2432 MHz	16	2434 MHz	17	2436 MHz
18	2438 MHz	19	2440 MHz	20	2442 MHz
21	2444 MHz	22	2446 MHz	23	2448 MHz
24	2450 MHz	25	2452 MHz	26	2454 MHz
27	2456 MHz	28	2458 MHz	29	2460 MHz
30	2462 MHz	31	2464 MHz	32	2466 MHz
33	2468 MHz	34	2470 MHz	35	2472 MHz
36	2474 MHz	37	2476 MHz	38	2478 MHz
39	2480 MHz	--	--	--	--

2.4. Description of Available Antennas

Antenna Type	Model No.	Manufacturer	Frequency Band (MHz)	T_X Paths	Ant Gain (dBi)
BLE (Internal Antenna)					
PCB	Q-24254M1-GHW-X2000	HL Tronics (Kunshan) Co., Ltd.	2402 ~ 2480	3	7.72
BLE (External Antenna)					
Directional	**DF24-30V14F**	DIPOLE COMMUNICATIONS LIMITED	2402 ~ 2480	1	**14.0**
Directional	DB24-40V14A				14.0
Directional	DB24-120VH14A				14.0
Directional	DB24-65V12A				12.0
Directional	DF24-60V12M				12.0
Directional	DB24-90V11A				11.0
Directional	DF24-90V11M				11.0
Directional	DF24-110V10F				10.0
Directional	DB24-120V10A				10.0
Directional	DB24-120VH09A				9.0
Directional	TDJ-2400BKC14	Kenbotong Technology Co., Ltd.			14.0
Directional	TDJ-2400BFE				14.0
Directional	KBT120VP13-24RT0				13.0
Directional	TDJ-2400BKCH70				11.0
Directional	SPDG16T2	SuperPass Company Inc.			12.2
Directional	OSCAR18	Siretta Ltd			10.0
Wi-Fi (Internal Antenna)					
PCB	N2420DTS	Airgain	2412 ~ 2462	1	3.70
			5150 ~ 5725	1	6.60
			5725 ~ 5850	1	7.30

Note 1: Bluetooth and Wi-Fi 2.4G or Wi-Fi 5G can transmit simultaneously, but it can not transmit simultaneously between the Bluetooth chips.

Note 2: Only the directional antenna (DF24-30V14F) was selected for all test, the same power setting with the different BLE external antennas.

Note 3: All messages as above are declared by manufacturer.

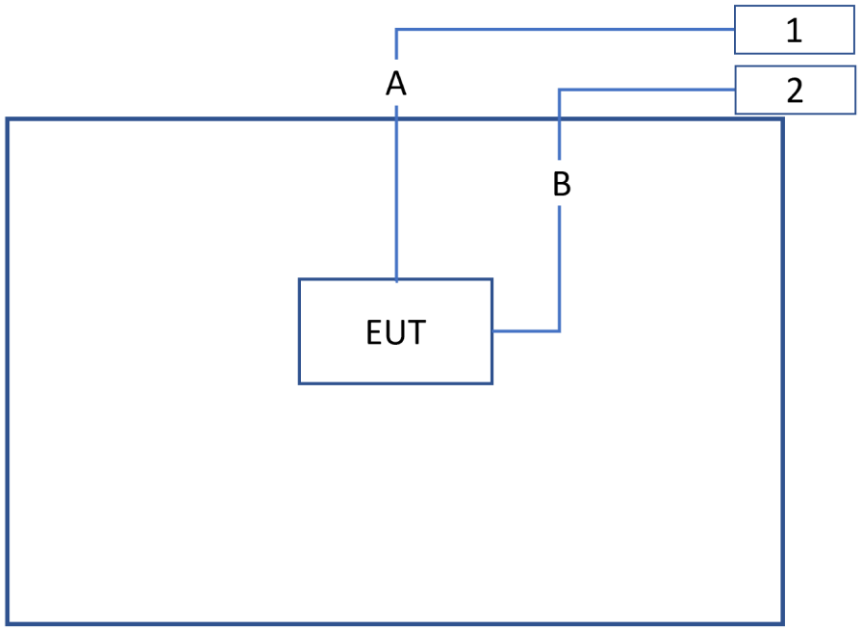
2.5. Test Mode

Test Mode	Mode 1: Transmit by BLE from chip 0 with internal antenna Mode 2: Transmit by BLE from chip 1 with internal antenna Mode 3: Transmit by BLE from chip 0 with external antenna Mode 4: Transmit by BLE from chip 1 with external antenna

2.6. Configuration of Test System

The measurement procedures and appropriate EUT setup described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013) was used in the measurement.

Connection Diagram



	Cable Type	Cable Description
A	LAN Cable	Non-Shielded, ≥10m
B	Serial port cable	Non-Shielded, ≥1.5m

2.7. Test System Details

The types for all equipments, plus descriptions of all cables used in the tested system (including inserted cards) are:

	Product	Manufacturer	Model No.
1	PoE Adapter	N/A	N/A
2	Notebook	DELL	Vostro 3300

2.8. Test Software

The test utility software used during testing was “SecureCRT”.

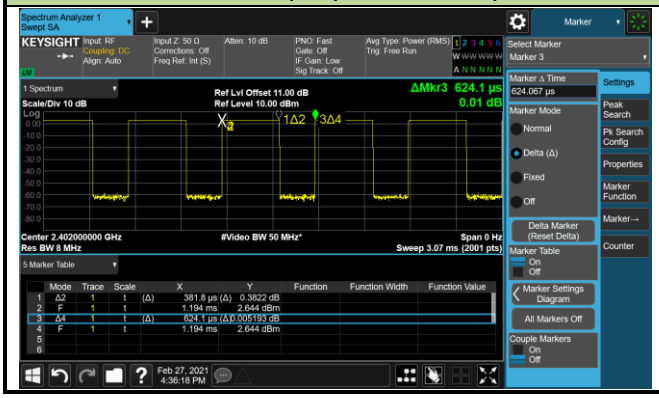
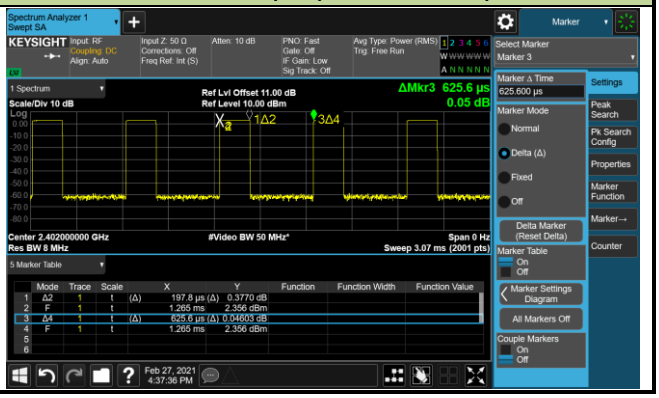
2.9. Applied Standards

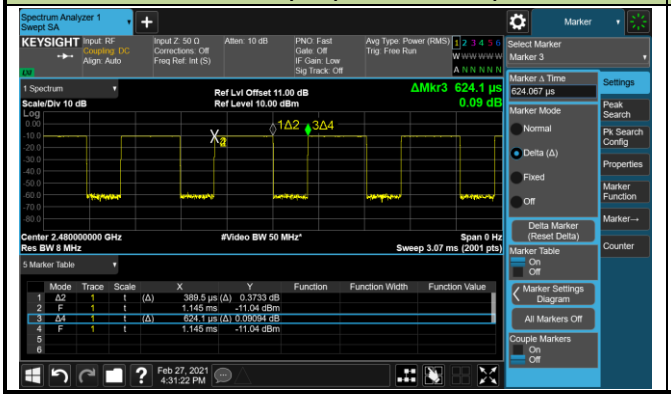
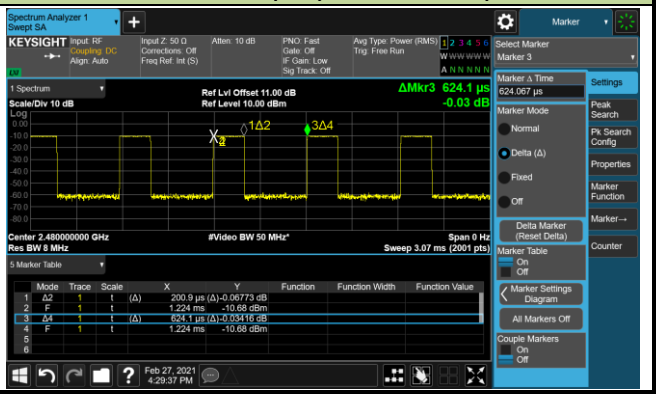
According to the specifications of the manufacturer, the EUT must comply with the requirements of the following standards:

- FCC Part 15.247
- KDB 558074 D01v05r02
- KDB 662911 D01v02r01
- ANSI C63.10-2013

2.10. Duty Cycle

The maximum achievable duty cycles for all modes were determined based on measurements performed on a spectrum analyzer in zero-span mode with RBW = 8MHz, VBW = 50MHz. The RBW and VBW were both greater than 50/T, where T is the minimum transmission duration, and the number of sweep points across T was greater than 100. The duty cycles are as follows:

Test Mode	Duty Cycle
Bluetooth Chip 0	
BLE 1Mbps	62.41%
BLE 2Mbps	31.62%
Bluetooth Chip 1	
BLE 1Mbps	62.41%
BLE 2Mbps	32.19%
Duty Cycle (T = Transmission Duration)	
Bluetooth Chip 0	
BLE 1Mbps (T = 381.8us)	BLE 2Mbps (T = 197.8ms)
	

Bluetooth Chip 1	
BLE 1Mbps (T = 389.5us)	BLE 2Mbps (T = 200.9ms)
	

2.11. Test Configuration

The device was tested per the guidance of ANSI C63.10-2013. ANSI C63.10-2013 was used to reference the appropriate EUT setup for radiated spurious emissions testing and AC line conducted testing.

2.12. EMI Suppression Device(s)/Modifications

No EMI suppression device(s) were added and/or no modifications were made during testing.

2.13. Labeling Requirements

Per 2.1074 & 15.19; Docket 95-19

The label shall be permanently affixed at a conspicuous location on the device; instruction manual or pamphlet supplied to the user and be readily visible to the purchaser at the time of purchase. However, when the device is so small wherein placement of the label with specified statement is not practical, only the FCC ID must be displayed on the device per Section 15.19(a)(5). Please see attachment for FCC ID label and label location.

3. DESCRIPTION of TEST

3.1. Evaluation Procedure

The measurement procedures described in the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices (ANSI C63.10-2013), and the guidance was used in the measurement.

3.2. AC Line Conducted Emissions

The line-conducted facility is located inside an 8'x4'x4' shielded enclosure. A 1m x 2m wooden table 80cm high is placed 40cm away from the vertical wall and 80cm away from the sidewall of the shielded room. Two 10kHz-30MHz, 50Ω/50uH Line-Impedance Stabilization Networks (LISNs) are bonded to the shielded room floor. Power to the LISNs is filtered by external high-current high-insertion loss power line filters. These filters attenuate ambient signal noise from entering the measurement lines. These filters are also bonded to the shielded enclosure.
The EUT is powered from one LISN and the support equipment is powered from the second LISN. All interconnecting cables more than 1 meter were shortened to a 1 meter length by non-inductive bundling (serpentine fashion) and draped over the back edge of the test table. All cables were at least 40cm above the horizontal reference ground-plane. Power cables for support equipment were routed down to the second LISN while ensuring that that cables were not draped over the second LISN.
Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The RF output of the LISN was connected to the receiver and exploratory measurements were made to determine the frequencies producing the maximum emission from the EUT. The receiver was scanned from 150kHz to 30MHz. The detector function was set to peak mode for exploratory measurements while the bandwidth of the analyzer was set to 9kHz. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Each emission was also maximized by varying power lines, the mode of operation or data exchange speed, or support equipment whichever determined the worst-case emission. Once the worst-case emissions have been identified, the one EUT cable configuration/arrangement and mode of operation that produced these emissions are used for final measurements on the same test site. The analyzer is set to CISPR quasi-peak and average detectors with a 9kHz resolution bandwidth for final measurements.
An extension cord was used to connect to a single LISN which powered by EUT. The extension cord was calibrated with LISN, the impedance and insertion loss are compliance with the requirements as stated in ANSI C63.10-2013.

3.3. Radiated Emissions

The radiated test facilities consisted of an indoor 3 meter semi-anechoic chamber used for final measurements and exploratory measurements, when necessary. The measurement area is contained within the semi-anechoic chamber which is shielded from any ambient interference. For measurements above 1GHz absorbers are arranged on the floor between the turn table and the antenna mast in such a way so as to maximize the reduction of reflections. For measurements below 1GHz, the absorbers are removed. A MF Model 210SS turntable is used for radiated measurement. It is a continuously rotatable, remote controlled, metallic turntable and 2 meters (6.56 ft.) in diameter. The turn table is flush with the raised floor of the chamber in order to maintain its function as a ground plane. An 80cm high PVC support structure is placed on top of the turntable. For all measurements, the spectrum was scanned through all EUT azimuths and from 1 to 4 meter receive antenna height using a broadband antenna from 30MHz up to the upper frequency shown in 15.33(b)(1) depending on the highest frequency generated or used in the device or on which the device operates or tunes. For frequencies above 1GHz, linearly polarized double ridge horn antennas were used. For frequencies below 30MHz, a calibrated loop antenna was used. When exploratory measurements were necessary, they were performed at 1 meter test distance inside the semi-anechoic chamber using broadband antennas, broadband amplifiers, and spectrum analyzers to determine the frequencies and modes producing the maximum emissions. Sufficient time for the EUT, support equipment, and test equipment was allowed in order for them to warm up to their normal operating condition. The test set-up for frequencies below 1GHz was placed on top of the 0.8 meter high, 1 x 1.5 meter table; and test set-up for frequencies 1-40GHz was placed on top of the 1.5 meter high, 1 x 1.5 meter table. The EUT, support equipment, and interconnecting cables were arranged and manipulated to maximize each emission. Appropriate precaution was taken to ensure that all emissions from the EUT were maximized and investigated. The system configuration, clock speed, mode of operation or video resolution, if applicable, turntable azimuth, and receive antenna height was noted for each frequency found.

Final measurements were made in the semi-anechoic chamber using calibrated, linearly polarized broadband and horn antennas. The test setup was configured to the setup that produced the worst case emissions. The spectrum analyzer was set to investigate all frequencies required for testing to compare the highest radiated disturbances with respect to the specified limits. The turntable containing the EUT was rotated through 360 degrees and the height of the receive antenna was varied 1 to 4 meters and stopped at the azimuth and height producing the maximum emission. Each emission was maximized by changing the orientation of the EUT through three orthogonal planes and changing the polarity of the receive antenna, whichever produced the worst-case emissions. According to 3dB Beam-Width of horn antenna, the horn antenna should be always directed to the EUT when rising height.

4. ANTENNA REQUIREMENTS

Excerpt from §15.203 of the FCC Rules/Regulations:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

Device is defined as a professional installation device that declared by manufacturer.

Conclusion:

The device unit complies with the requirement of §15.203.

5. TEST EQUIPMENT CALIBRATION DATE

Conducted Emissions

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
Two-Line V-Network	R&S	ENV216	MRTTWA00019	1 year	2021/03/26
Two-Line V-Network	R&S	ENV216	MRTTWA00020	1 year	2021/04/24
EMI Test Receiver	R&S	ESR3	MRTTWA00045	1 year	2021/05/26
Temperature/Humidity Meter	TFA	35.1078.10.IT	MRTTWA00033	1 year	2021/05/28

Radiated Emissions

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
Broadband TRILOG Antenna	SCHWARZBECK	VULB 9162	MRTTWA00001	1 year	2021/10/05
Acitve Loop Antenna	SCHWARZBECK	FMZB 1519B	MRTTWA00002	1 year	2021/04/27
Broadband Hornantenna	SCHWARZBECK	BBHA 9120D	MRTTWA00003	1 year	2021/04/24
Breitband Hornantenna	SCHWARZBECK	BBHA 9170	MRTTWA00004	1 year	2021/04/24
Broadband Preamplifier	SCHWARZBECK	BBV 9718	MRTTWA00005	1 year	2021/04/24
Broadband Amplifier	SCHWARZBECK	BBV 9721	MRTTWA00006	1 year	2021/04/24
Signal Analyzer	R&S	FSV40	MRTTWA00007	1 year	2021/03/24
EMI Test Receiver	R&S	ESR3	MRTTWA00009	1 year	2021/03/25
EXA Signal Analyzer	KEYSIGHT	N9010A	MRTTWA00012	1 year	2021/11/02
Antenna Cable	HUBERSUHNER	SF106	MRTTWE00010	1 year	2021/06/16
Temperature/Humidity Meter	TFA	35.1078.10.IT	MRTTWA00032	1 year	2021/05/28

Conducted Test Equipment

Instrument	Manufacturer	Type No.	Asset No.	Cali. Interval	Cali. Due Date
X-Series USB Peak and Average Power Sensor	KEYSIGHT	U2021XA	MRTTWA00014	1 year	2021/04/24
EXA Signal Analyzer	KEYSIGHT	N9010A	MRTTWA00012	1 year	2021/11/02
EXA Signal Analyzer	KEYSIGHT	N9010B	MRTTWA00074	1 year	2021/07/11
Attenuator	WTI	218FS-20	MRTTWE00026	1 year	2021/05/30
Attenuator	WTI	218FS-10	MRTTWE00027	1 year	2021/05/30
Attenuator	WTI	218FS-06	MRTTWE00028	1 year	2021/05/30
Temperature & Humidity Chamber	TEN BILLION	TTH-B3UP	MRTTWA00036	1 year	2021/06/10
Temperature/Humidity Meter	TFA	35.1078.10.IT	MRTTWA00033	1 year	2021/05/28

Software	Version	Function
e3	9.160520a	EMI Test Software

6. MEASUREMENT UNCERTAINTY

Where relevant, the following test uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k = 2.

AC Conducted Emission Measurement
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 150kHz~30MHz: 2.53dB
Radiated Emission Measurement
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 9kHz ~ 1GHz: 4.25dB 1GHz ~ 40GHz: 4.45dB
Conducted Power
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): ± 0.84dB
Conducted Spurious Emission
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): ± 2.65 dB
Occupied Bandwidth
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): 3.3%
Temp. / Humidity
Measuring Uncertainty for a Level of Confidence of 95% (U=2Uc(y)): ±0.82°C/ ±3%

7. TEST RESULT

7.1. Summary

FCC Section(s)	Test Description	Test Limit	Test Condition	Test Result	Reference
15.247(a)(2)	6dB Bandwidth	≥ 500kHz	Conducted	Pass	Section 7.2
15.247(b)(3)	Output Power	≤ 30dBm		Pass	Section 7.3
15.247(e)	Power Spectral Density	≤ 8dBm/3kHz		Pass	Section 7.4
15.247(d)	Band Edge / Out-of-Band Emissions	≥ 30dBc (Average)		Pass	Section 7.5
15.205 15.209	General Field Strength (Restricted Bands and Radiated Emission)	Emissions in restricted bands must meet the radiated limits detailed in 15.209	Radiated	Pass	Section 7.6 & 7.7
15.207	AC Conducted Emissions 150kHz - 30MHz	< FCC 15.207 limits	Line Conducted	Pass	Section 7.8

Notes:

1) Determining compliance is based on the test results met the regulation limits or requirements declared by clients, and the test results don't take into account the value of measurement uncertainty.
2) For radiated emission test, the test results shown in the following sections represent the worst case emissions.
3) The analyzer plots shown in this section were all taken with a correction table loaded into the analyzer. The correction table was used to account for the losses of the cables and attenuators used as part of the system to connect the EUT to the analyzer at all frequencies of interest.
4) Test Items “6dB Bandwidth” showed the worst test data in this report.

7.2. 6dB Bandwidth Measurement

7.2.1.Test Limit

The minimum 6dB bandwidth shall be at least 500 kHz.

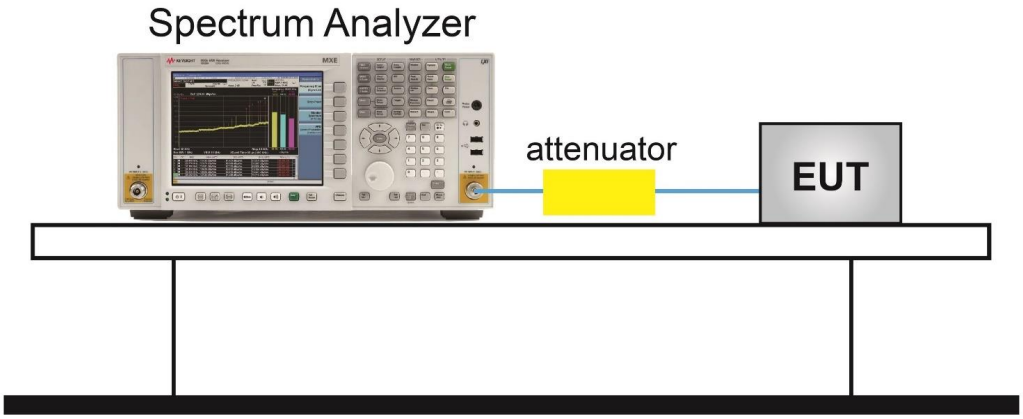
7.2.2.Test Procedure used

ANSI C63.10-2013 - Section 11.8 (6dB bandwidth)

7.2.3.Test Setting

1. The Spectrum's automatic bandwidth measurement capability was used to perform the 6dB bandwidth measurement. The "X" dB bandwidth parameter was set to X = 6. The bandwidth measurement was not influenced by any intermediate power nulls in the fundamental emission.
2. Set RBW = 100 kHz
3. VBW ≥ 3 × RBW
4. Detector = Peak
5. Trace mode = Max hold
6. Sweep = Auto couple
7. Allow the trace was allowed to stabilize

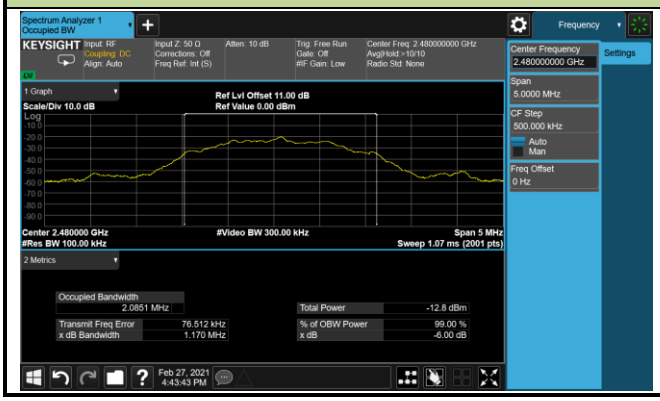
7.2.4.Test Setup

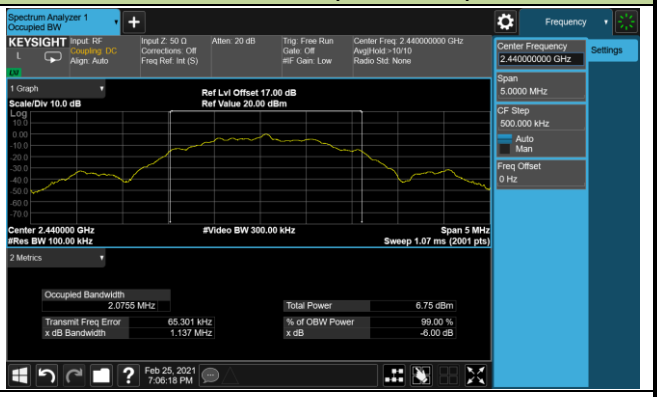


7.2.5.Test Result

Product	Cassia Bluetooth Router	Temperature	23 ~ 25°C
Test Engineer	Eric Lin	Relative Humidity	46 ~ 54%
Test Site	SR2	Test Date	2021/02/25~2021/02/27

Test Mode	Data Rate (Mbps)	Channel No.	Frequency (MHz)	6dB Bandwidth (kHz)	Limit (MHz)	Result
Bluetooth Chip 0 (Internal Antenna)						
BLE	1	00	2402	735.4	≥ 0.5	Pass
BLE	1	19	2440	727.7	≥ 0.5	Pass
BLE	1	39	2480	737.5	≥ 0.5	Pass
BLE	2	00	2402	1177.0	≥ 0.5	Pass
BLE	2	19	2440	1164.0	≥ 0.5	Pass
BLE	2	39	2480	1170.0	≥ 0.5	Pass
Bluetooth Chip 1 (Internal Antenna)						
BLE	1	00	2402	694.2	≥ 0.5	Pass
BLE	1	19	2440	690.4	≥ 0.5	Pass
BLE	1	39	2480	692.8	≥ 0.5	Pass
BLE	2	00	2402	1142.0	≥ 0.5	Pass
BLE	2	19	2440	1137.0	≥ 0.5	Pass
BLE	2	39	2480	1147.0	≥ 0.5	Pass

6dB Bandwidth - Bluetooth Chip 0 (Internal Antenna) at 1Mbps	
Channel 00 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	
6dB Bandwidth - Bluetooth Chip 0 (Internal Antenna) at 2Mbps	
Channel 00 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	

6dB Bandwidth - Bluetooth Chip 1 (Internal Antenna) at 1Mbps	
Channel 00 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	
6dB Bandwidth - Bluetooth Chip 1 (Internal Antenna) at 2Mbps	
Channel 00 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	

7.3. Output Power Measurement

7.3.1.Test Limit

The maximum out power shall be less 1 Watt (30dBm).

The conducted output power limit specified in paragraph FCC Part 15.247(b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. If transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs FCC Part 15.247(b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

7.3.2.Test Procedure Used

ANSI C63.10 – 2013 Section 11.9.1.3

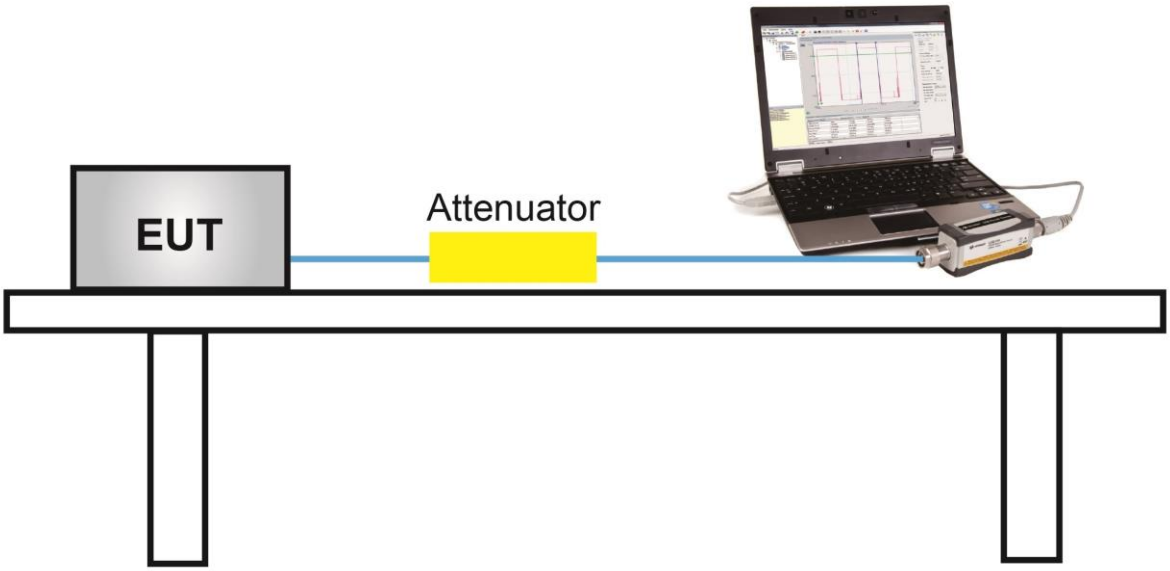
ANSI C63.10 - 2013 Section 11.9.2.3.2

7.3.3.Test Setting

Method AVGPM-G (Measurement using a gated RF average-reading power meter)

Measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

7.3.4.Test Setup



7.3.5.Test Result

Product	Cassia Bluetooth Router	Temperature	23 ~ 25°C
Test Engineer	Kevin Ker	Relative Humidity	46 ~ 54%
Test Site	SR2	Test Date	2021/02/25~2021/02/27

Test Mode	Data Rate (Mbps)	Channel No.	Frequency (MHz)	Average Power (dBm)			Total Average power (dBm)	Limit (dBm)	Result
				Ant 0	Ant 1	Ant 2			
Bluetooth Chip 0 (Internal Antenna)									
BLE	1	00	2402	3.30	3.16	4.80	8.59	≤ 28.28	Pass
BLE	1	19	2440	6.32	6.28	8.71	12.03	≤ 28.28	Pass
BLE	1	39	2480	-20.08	-20.02	-16.50	-13.75	≤ 28.28	Pass
BLE	2	00	2402	-17.54	-17.67	-15.98	-12.22	≤ 28.28	Pass
BLE	2	19	2440	5.94	5.83	8.27	11.60	≤ 28.28	Pass
BLE	2	39	2480	-19.66	-19.78	-16.57	-13.63	≤ 28.28	Pass
Bluetooth Chip 1 (Internal Antenna)									
BLE	1	00	2402	-0.43	-0.62	3.67	6.13	≤ 28.28	Pass
BLE	1	19	2440	-1.16	-1.29	3.31	5.62	≤ 28.28	Pass
BLE	1	39	2480	-1.96	-2.08	2.85	5.03	≤ 28.28	Pass
BLE	2	00	2402	-0.25	-0.42	3.68	6.22	≤ 28.28	Pass
BLE	2	19	2440	-1.03	-1.13	3.39	5.73	≤ 28.28	Pass
BLE	2	39	2480	-10.64	-10.78	-5.58	-3.50	≤ 28.28	Pass

Note 1: Total average power (dBm) = 10*log [($10^{(\text{Ant 0 power }/10)}$) + ($10^{(\text{Ant 1 power }/10)}$) + ($10^{(\text{Ant 2 power }/10)}$)]

Note 2: Limit (dBm) = 30dBm – [Internal Antenna Gain (dBi) – 6 (dB)] = 30 – (7.72 – 6) = 28.28dBm

Product	Cassia Bluetooth Router	Temperature	23 ~ 25°C
Test Engineer	Kevin Ker	Relative Humidity	46 ~ 54%
Test Site	SR2	Test Date	2021/02/25~2021/02/27

Test Mode	Data Rate (Mbps)	Channel No.	Frequency (MHz)	Average Power (dBm)	Limit (dBm)	Result
Bluetooth Chip 0 (External Antenna)						
BLE	1	00	2402	-11.46	≤ 22.00	Pass
BLE	1	19	2440	7.94	≤ 22.00	Pass
BLE	1	39	2480	-13.96	≤ 22.00	Pass
BLE	2	00	2402	-11.48	≤ 22.00	Pass
BLE	2	19	2440	7.84	≤ 22.00	Pass
BLE	2	39	2480	-14.79	≤ 22.00	Pass
Bluetooth Chip 1 (External Antenna)						
BLE	1	00	2402	3.30	≤ 22.00	Pass
BLE	1	19	2440	4.67	≤ 22.00	Pass
BLE	1	39	2480	4.84	≤ 22.00	Pass
BLE	2	00	2402	3.33	≤ 22.00	Pass
BLE	2	19	2440	4.68	≤ 22.00	Pass
BLE	2	39	2480	-7.38	≤ 22.00	Pass

Note: Limit (dBm) = 30dBm – [External Antenna Gain (dBi) – 6 (dB)] = 30 – (14.0 – 6) = 22.00dBm

7.4. Power Spectral Density Measurement

7.4.1.Test Limit

The maximum permissible power spectral density is 8dBm in any 3 kHz band.

The same method of determining the conducted output power shall be used to determine the power spectral density.

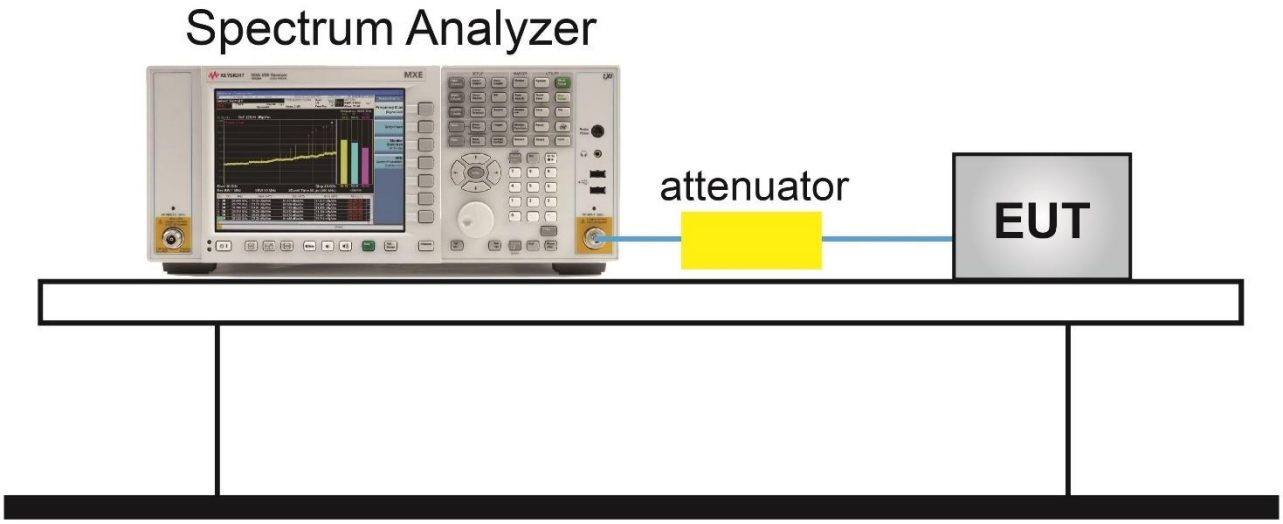
7.4.2.Test Procedure Used

ANSI C63.10-2013 Section 11.10.5.

7.4.3.Test Setting

1. Measure the duty cycle (x) of the transmitter output signal.
2. Set instrument center frequency to DTS channel center frequency.
3. Set span to at least 1.5 times the OBW.
4. RBW = 10 kHz.
5. VBW = 30 kHz.
6. Detector = RMS.
7. Ensure that the number of measurement points in the sweep ≥ 2 x span/RBW.
8. Sweep time = auto couple.
9. Don’t use sweep triggering. Allow sweep to “free run”.
10. Employ trace averaging (RMS) mode over a minimum of 100 traces.
11. Use the peak marker function to determine the maximum amplitude level.
12. Add 10 log (1/x), where x is the duty cycle measured in step (a, to the measured PSD to compute the average PSD during the actual transmission time. If measured value exceeds requirement specified by regulatory agency, then reduce RBW (but no less than 3 kHz) and repeat (note that this may require zooming in on the emission of interest and reducing the span to meet the minimum measurement point requirement as the RBW is reduced).

7.4.4.Test Setup



7.4.5.Test Result

Product	Cassia Bluetooth Router	Temperature	23 ~ 25°C
Test Engineer	Kevin Ker	Relative Humidity	46 ~ 54%
Test Site	SR2	Test Date	2021/02/25~2021/02/27

Test Mode	Data Rate (Mbps)	Channel No.	Freq. (MHz)	Average PSD (dBm/ 10kHz)			Duty Cycle (%)	10*log (1/x)	Total PSD (dBm/ 10kHz)	Limit (dBm/ 3kHz)	Result
				Ant 0	Ant 1	Ant 2					
Bluetooth Chip 0 (Internal Antenna)											
BLE	1	00	2402	-14.34	-13.67	-12.33	62.41	2.05	-6.55	≤ 6.28	Pass
BLE	1	19	2440	-10.92	-10.59	-8.41	62.41	2.05	-3.01	≤ 6.28	Pass
BLE	1	39	2480	-36.48	-36.32	-32.89	62.41	2.05	-28.07	≤ 6.28	Pass
BLE	2	00	2402	-37.97	-38.22	-35.60	31.62	5.00	-27.32	≤ 6.28	Pass
BLE	2	19	2440	-14.15	-15.01	-11.66	31.62	5.00	-3.59	≤ 6.28	Pass
BLE	2	39	2480	-37.25	-40.17	-36.66	31.62	5.00	-28.01	≤ 6.28	Pass
Bluetooth Chip 1 (Internal Antenna)											
BLE	1	00	2402	-16.19	-16.56	-12.23	62.41	2.05	-7.70	≤ 6.28	Pass
BLE	1	19	2440	-16.64	-17.34	-12.95	62.41	2.05	-8.37	≤ 6.28	Pass
BLE	1	39	2480	-17.74	-18.14	-12.98	62.41	2.05	-8.79	≤ 6.28	Pass
BLE	2	00	2402	-18.80	-19.61	-15.25	32.19	4.92	-7.76	≤ 6.28	Pass
BLE	2	19	2440	-20.24	-20.05	-15.45	32.19	4.92	-8.28	≤ 6.28	Pass
BLE	2	39	2480	-21.02	-20.12	-15.11	32.19	4.92	-8.22	≤ 6.28	Pass

Note 1: EUT duty cycle ≤ 98%, Total AVGPSD = 10*log $\{10^{(\text{Ant 0 AVGPSD}/10)} + 10^{(\text{Ant 1 AVGPSD}/10)} + 10^{(\text{Ant 2 AVGPSD}/10)}\}$ + 10*log (1/Duty Cycle).

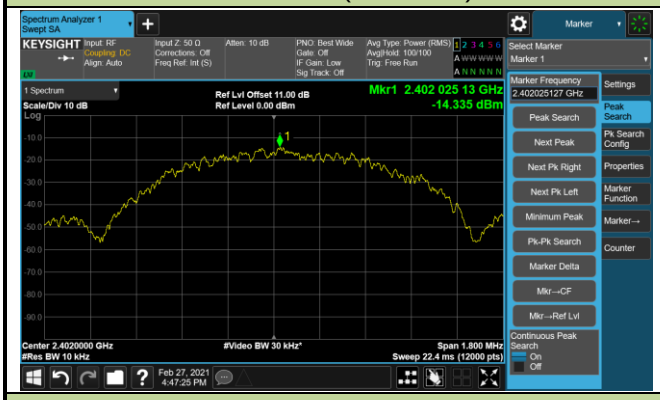
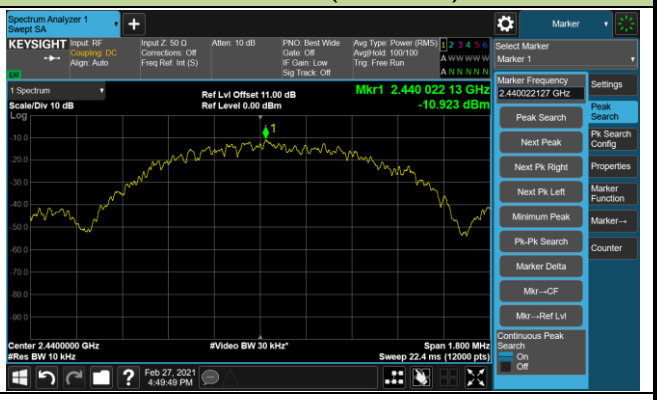
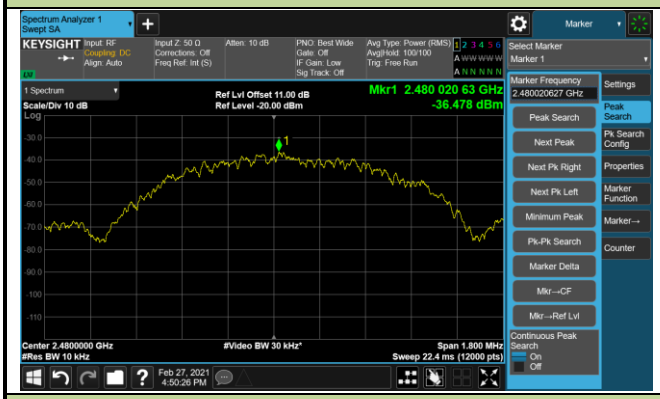
Note 2: Limit (dBm/3KHz) = 8 – (7.72 – 6) = 6.28 dBm/3KHz

Product	Cassia Bluetooth Router	Temperature	23 ~ 25°C
Test Engineer	Kevin Ker	Relative Humidity	46 ~ 54%
Test Site	SR2	Test Date	2021/02/25~2021/02/27

Test Mode	Data Rate (Mbps)	Channel No.	Frequency (MHz)	AVG PSD (dBm/ 10kHz)	Duty Cycle (%)	10*log (1/x)	Total PSD (dBm/ 10kHz)	Limit (dBm / 3kHz)	Result
Bluetooth Chip 0 (External Antenna)									
BLE	1	00	2402	-27.72	62.41	2.05	-25.67	≤ 0	Pass
BLE	1	19	2440	-8.75	62.41	2.05	-6.70	≤ 0	Pass
BLE	1	39	2480	-29.72	62.41	2.05	-27.67	≤ 0	Pass
BLE	2	00	2402	-31.45	31.62	5.00	-26.45	≤ 0	Pass
BLE	2	19	2440	-11.86	31.62	5.00	-6.86	≤ 0	Pass
BLE	2	39	2480	-34.03	31.62	5.00	-29.03	≤ 0	Pass
Bluetooth Chip 1 (External Antenna)									
BLE	1	00	2402	-12.37	62.41	2.05	-10.32	≤ 0	Pass
BLE	1	19	2440	-12.42	62.41	2.05	-10.37	≤ 0	Pass
BLE	1	39	2480	-11.27	62.41	2.05	-9.22	≤ 0	Pass
BLE	2	00	2402	-16.30	32.19	4.92	-11.38	≤ 0	Pass
BLE	2	19	2440	-13.81	32.19	4.92	-8.89	≤ 0	Pass
BLE	2	39	2480	-26.55	32.19	4.92	-21.63	≤ 0	Pass

Note 1: EUT duty cycle ≤ 98%, Total AVGPSD = AVG PSD+ 10*log (1/Duty Cycle).

Note 2: Limit (dBm/3KHz) = 8 – (14 – 6) = 0 dBm/3KHz

BLE 1Mbps AVGPSD - Bluetooth chip 0 - Ant 0	
Channel 00 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	
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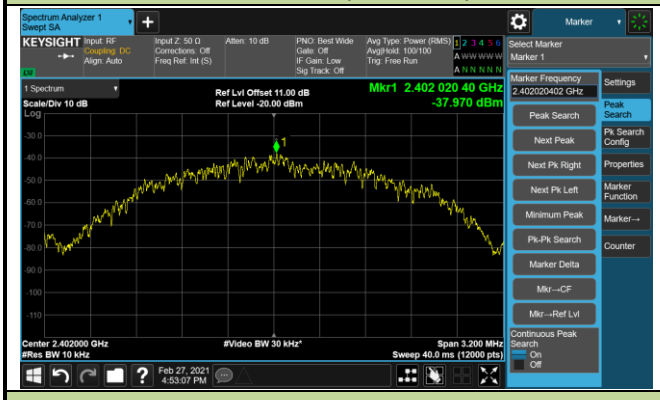
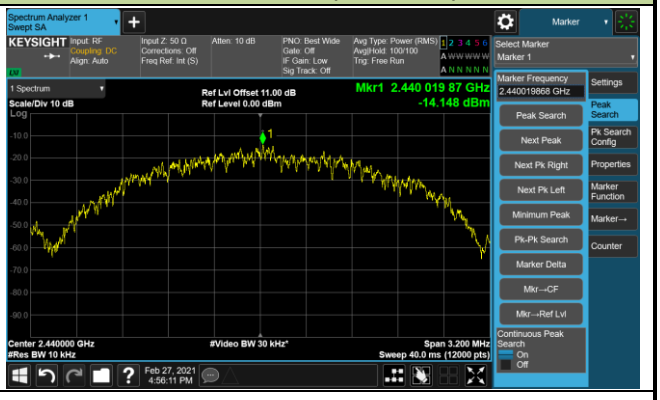
Channel 00 (2402MHz)	Channel 19 (2440MHz)
	
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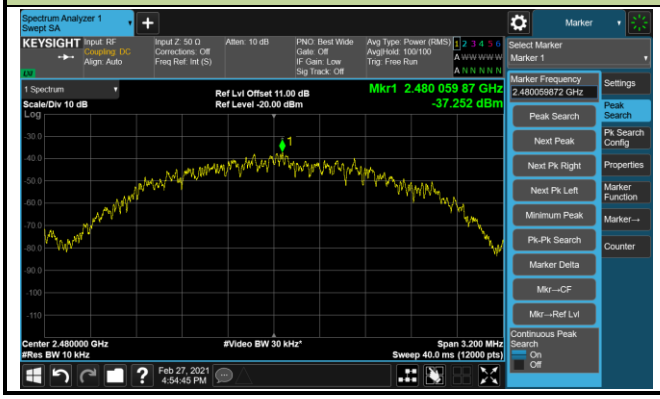	

BLE 1Mbps AVGPSD - Bluetooth chip 0 (Internal Antenna) - Ant 1	
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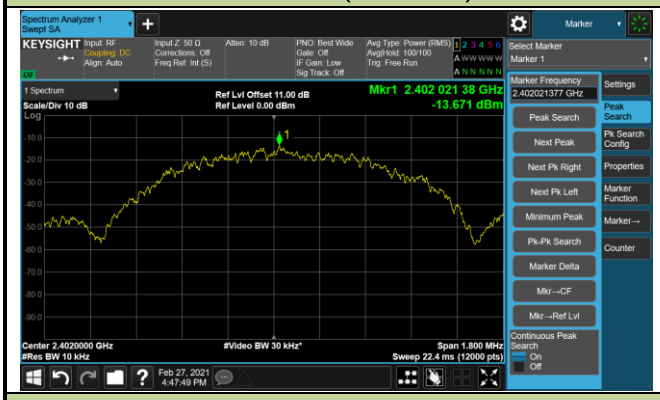	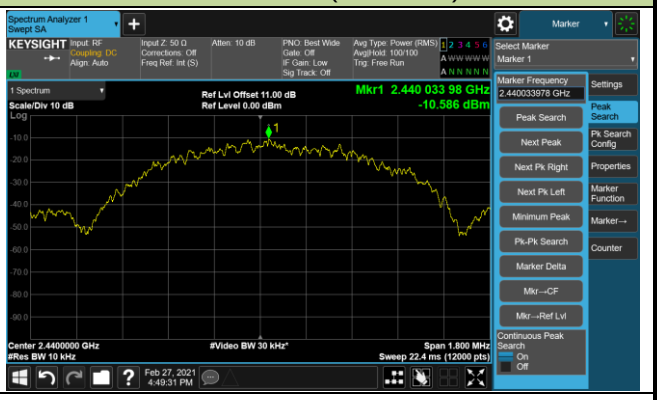
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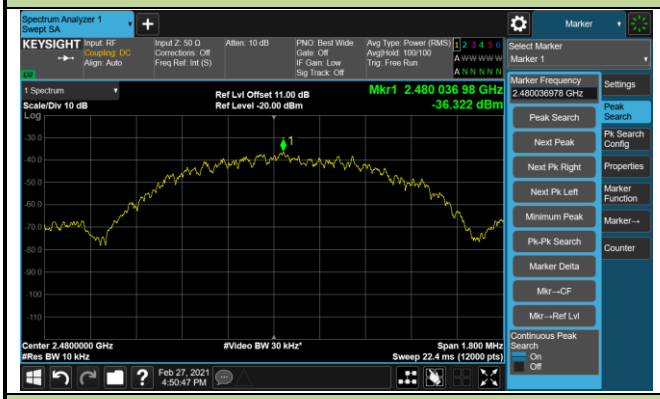
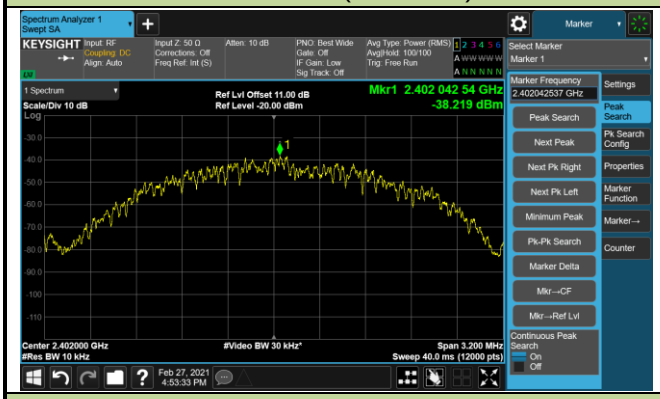
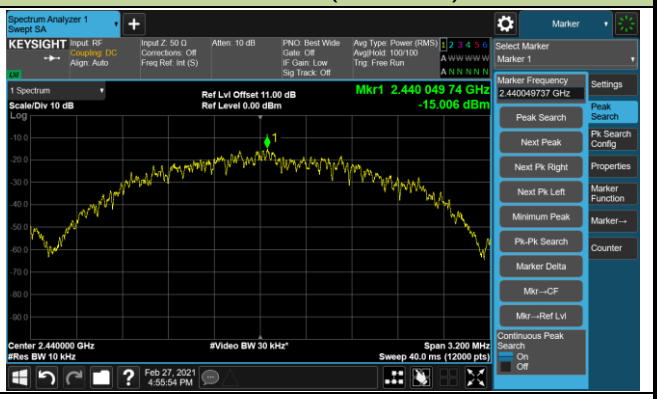
	

BLE 2Mbps AVGPSD - Bluetooth chip 0 (Internal Antenna) - Ant 1	
Channel 00 (2402MHz)	Channel 19 (2440MHz)
	
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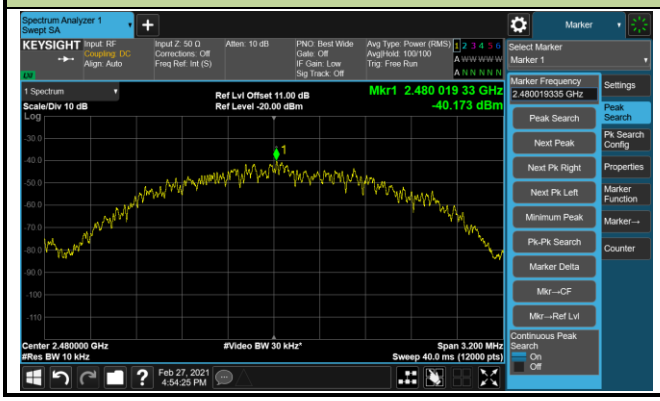	

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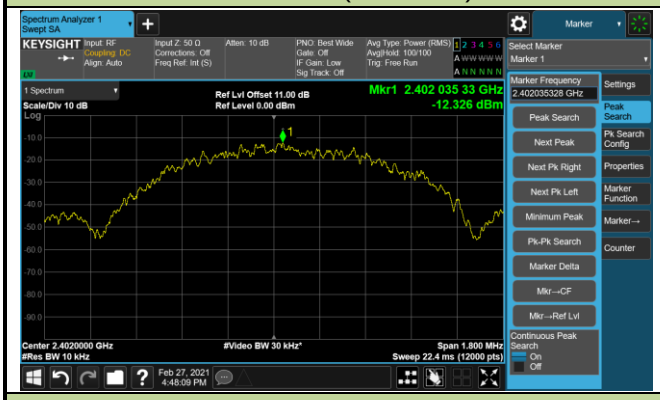
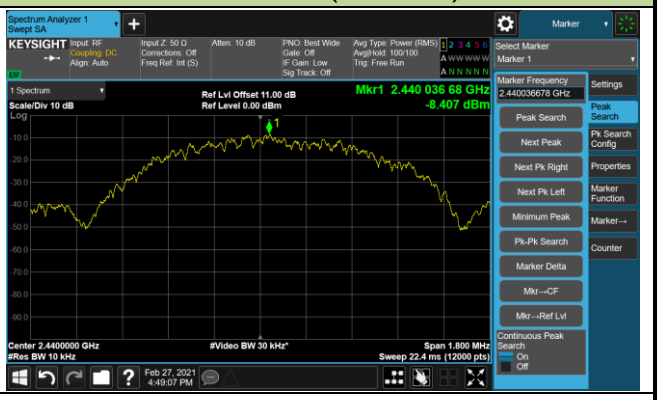
Channel 00 (2402MHz)	Channel 19 (2440MHz)
	
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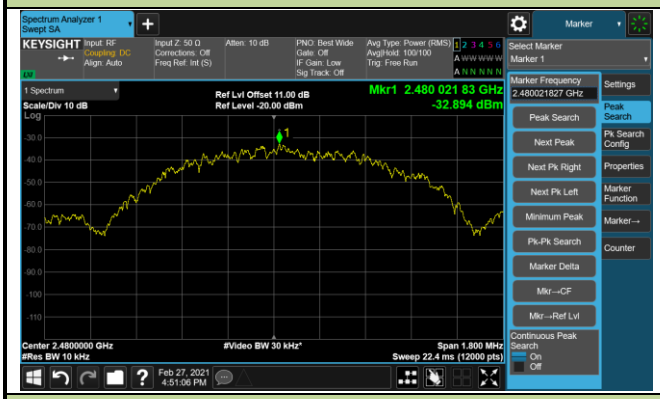	

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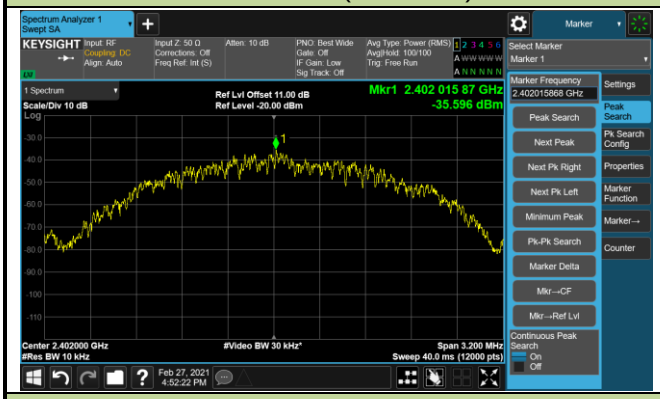	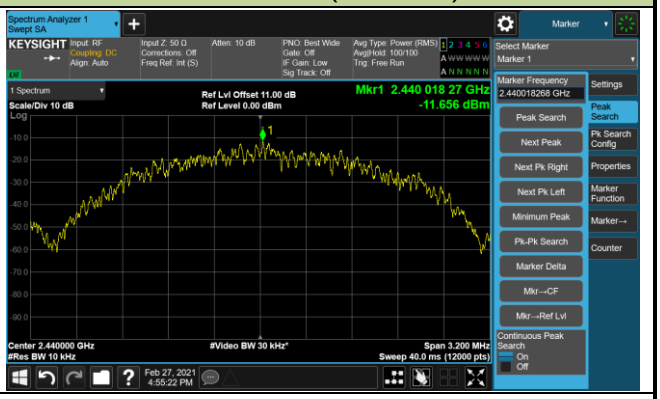
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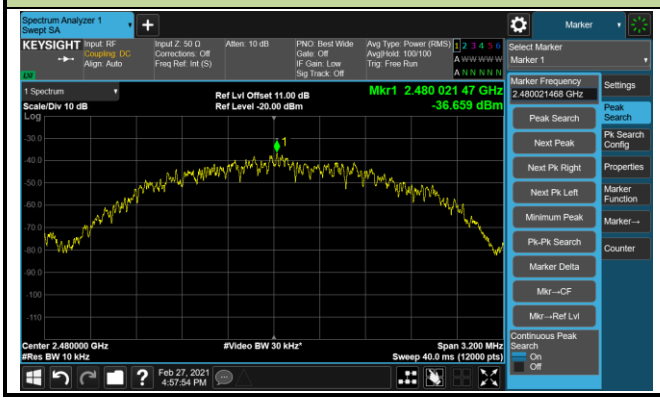	

BLE 1Mbps AVGPSD - Bluetooth chip 1 (Internal Antenna) - Ant 0	
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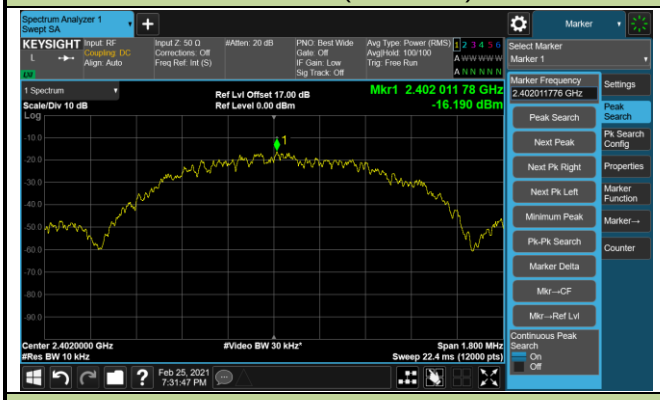	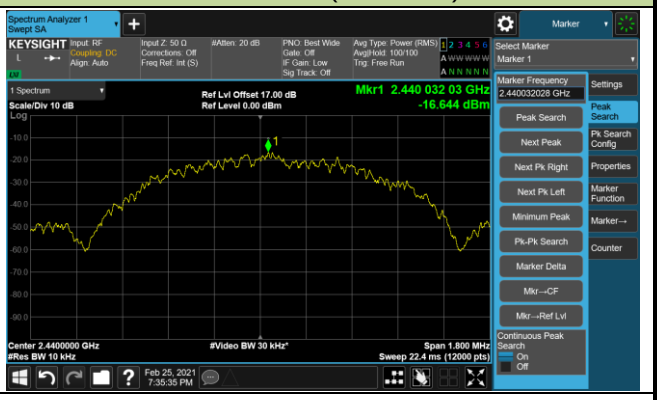
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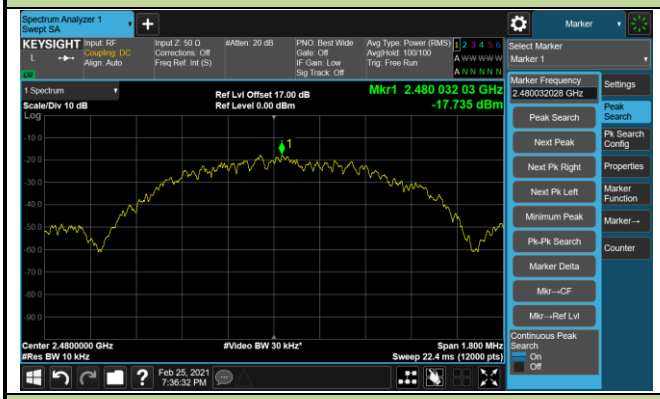	
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	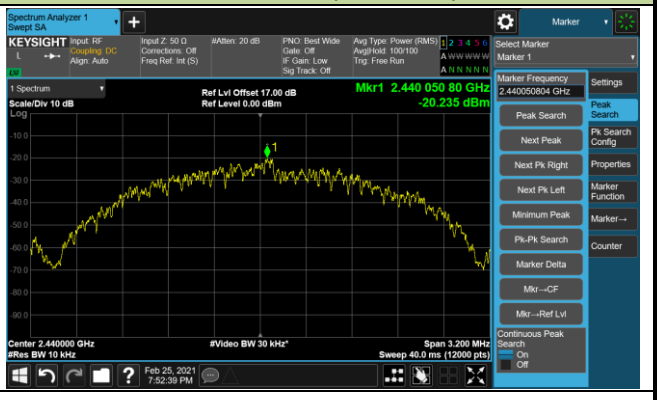
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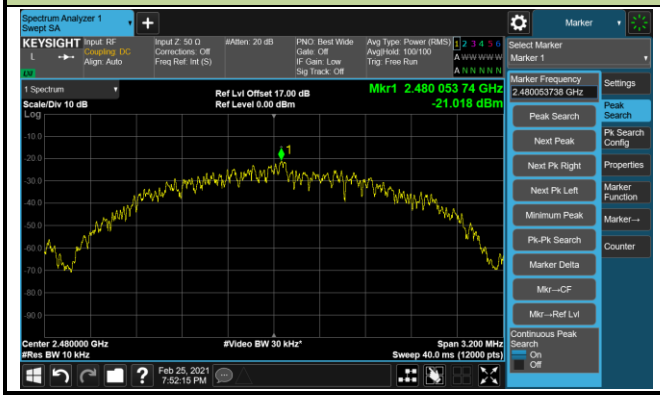	

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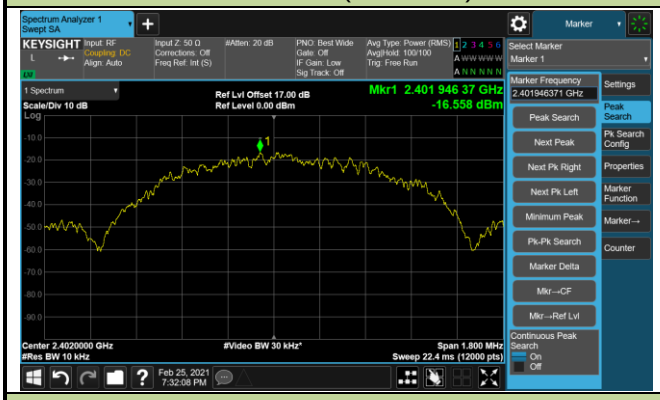	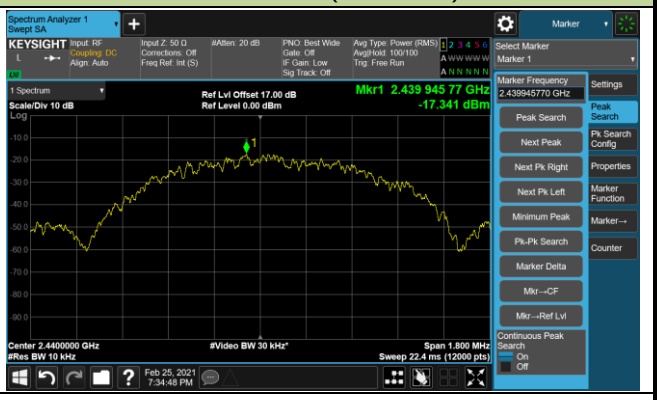
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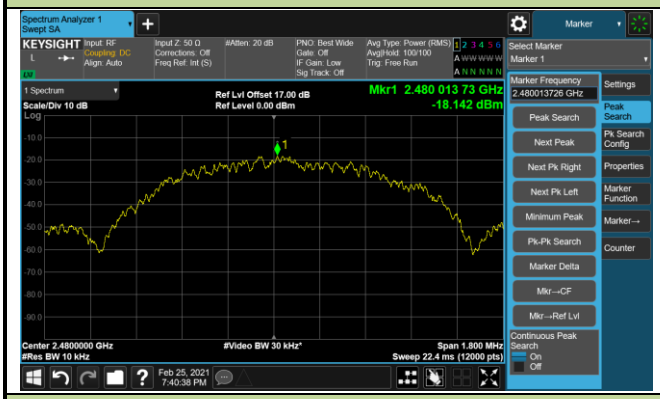	
BLE 2Mbps AVGPSD - Bluetooth chip 1 (Internal Antenna) - Ant 1	
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	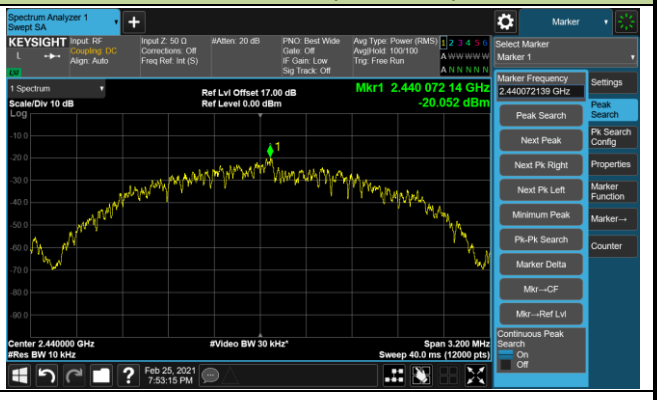
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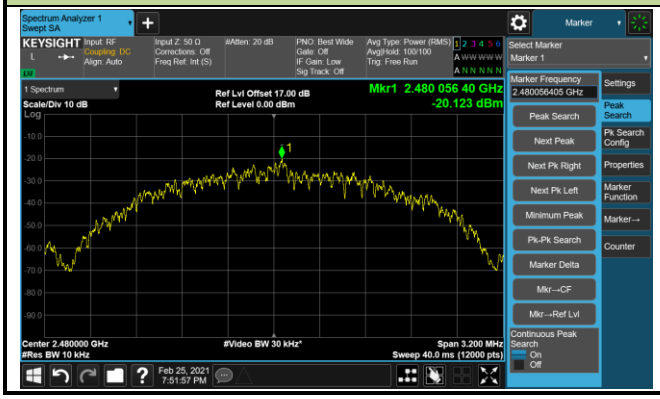	

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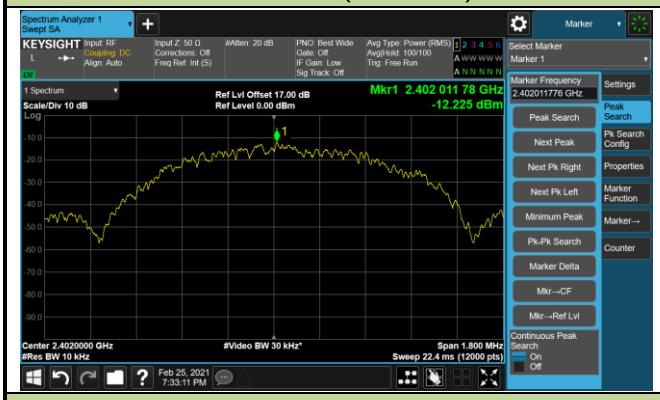	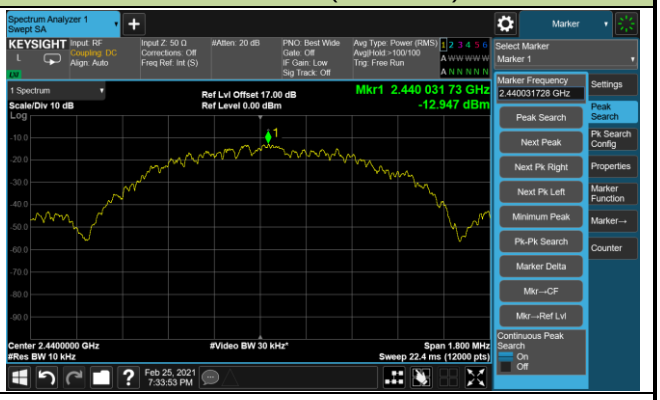
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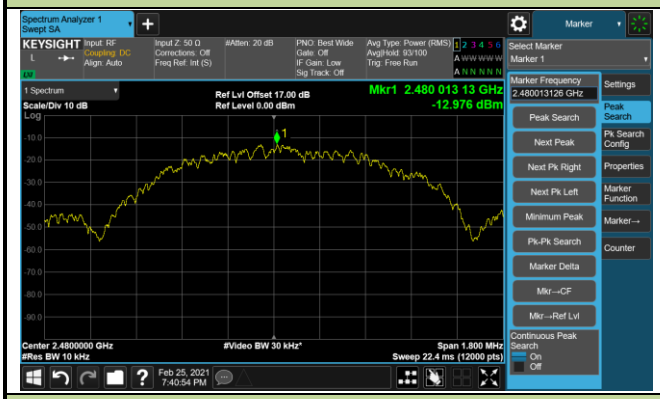	

BLE 2Mbps AVGPSD - Bluetooth chip 1 (Internal Antenna) - Ant 2	
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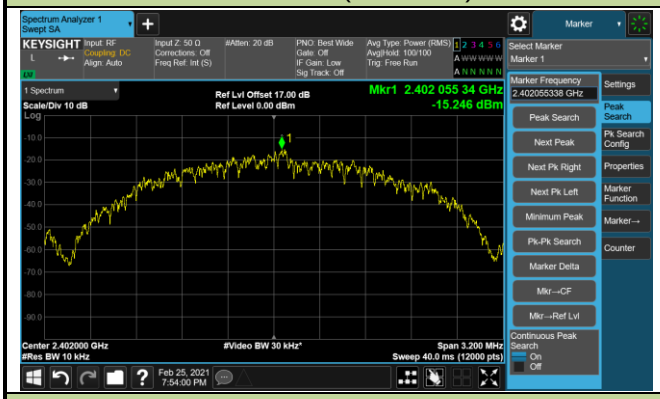	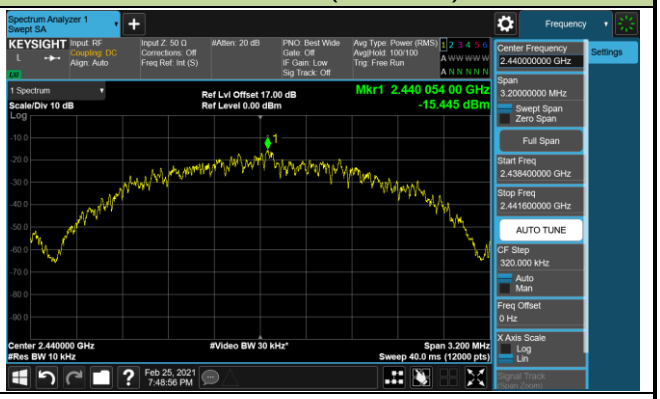
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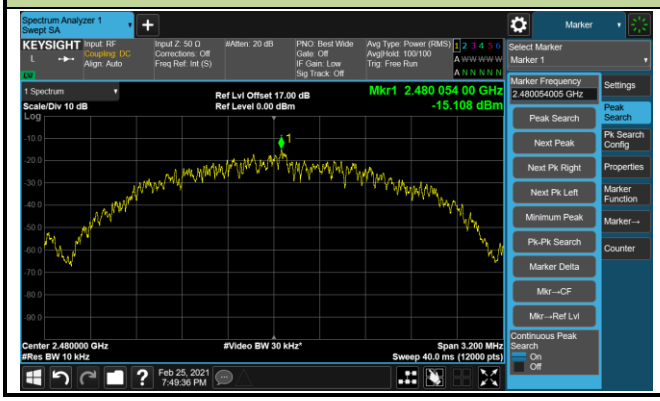
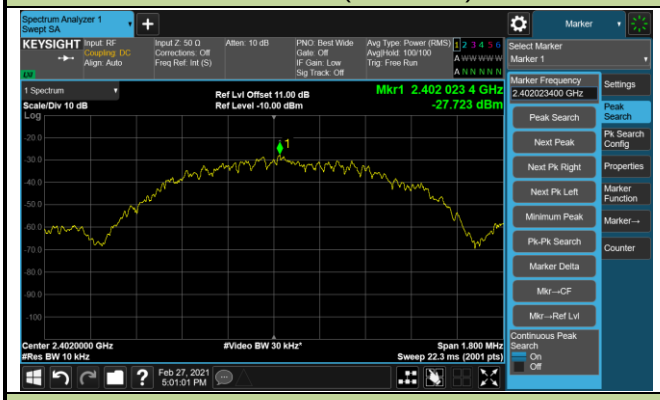
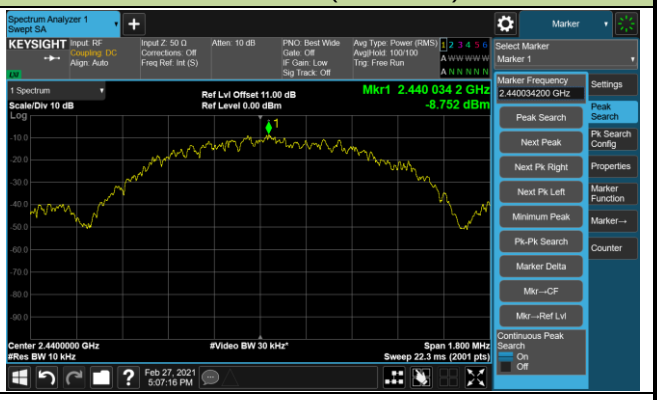
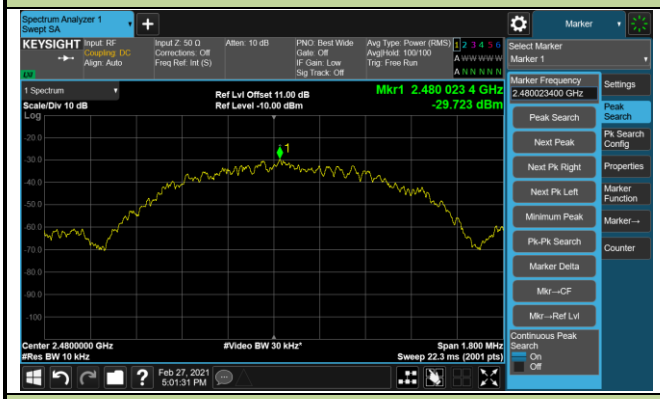
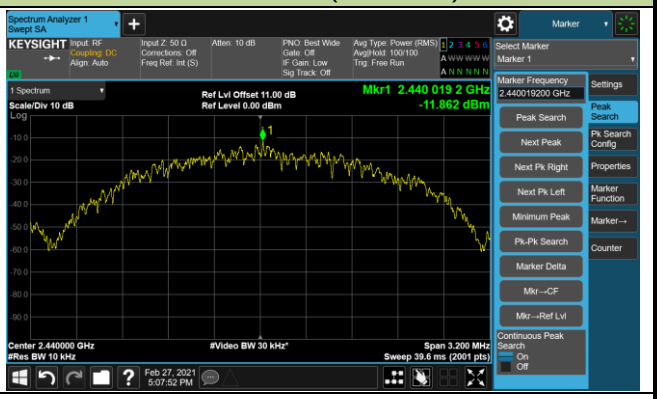
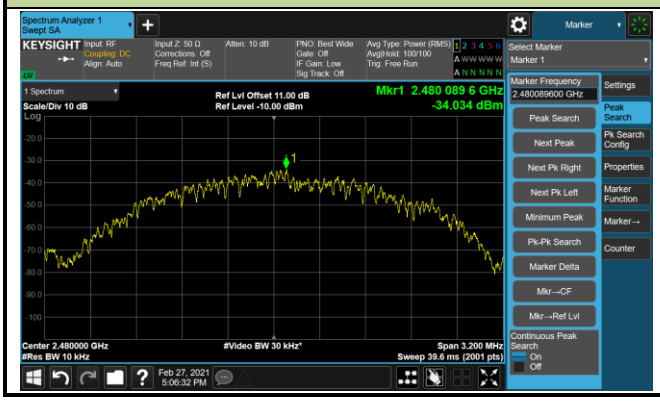
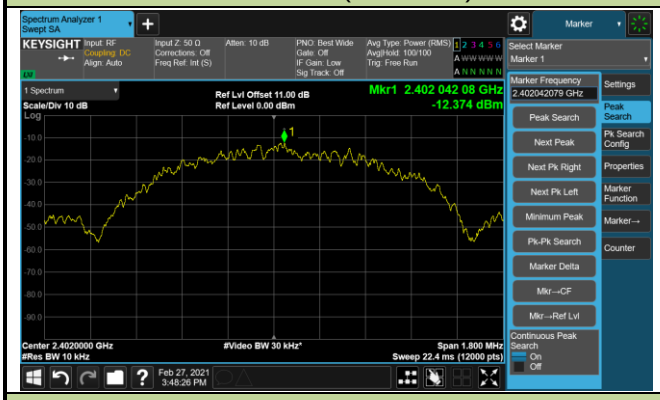
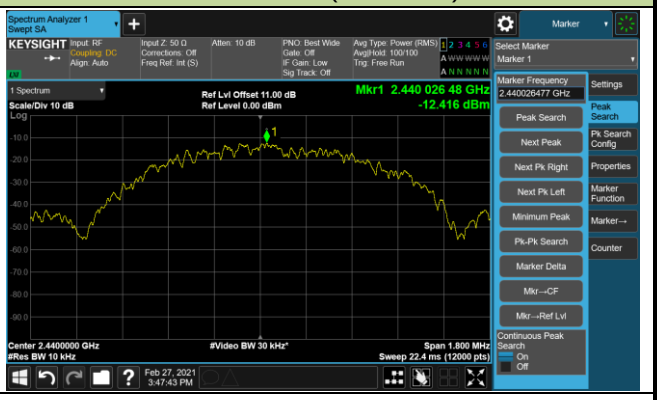
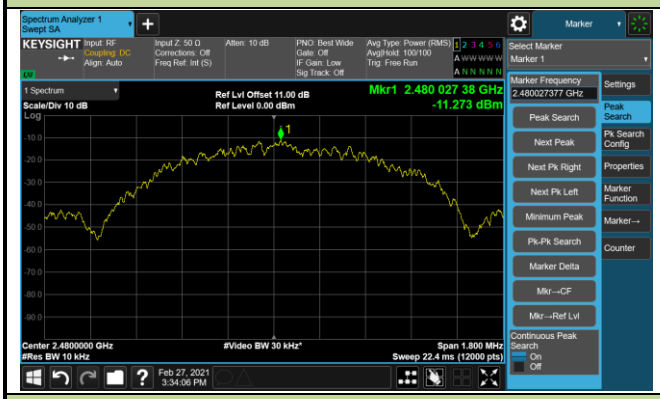
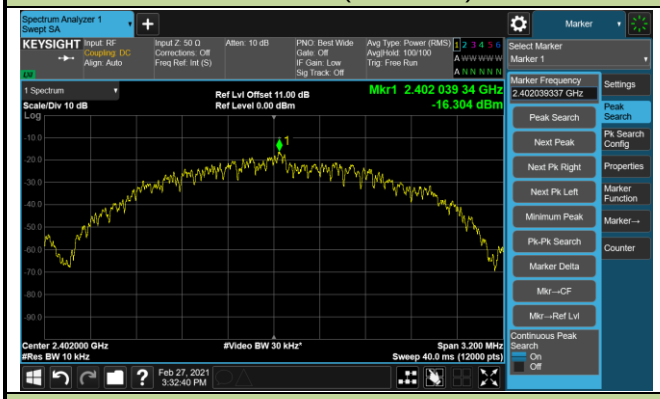
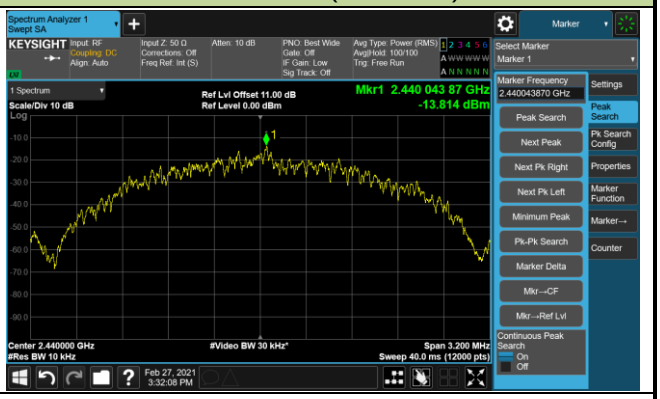
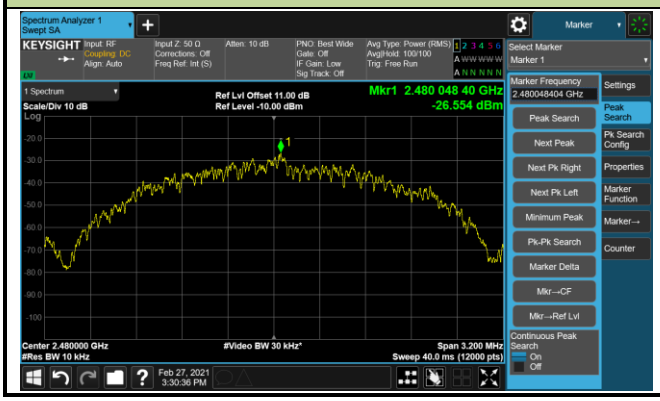
	

BLE 1Mbps AVGPSD - Bluetooth chip 0 (External Antenna)	
Channel 00 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	

BLE 2Mbps AVGPSD - Bluetooth chip 0 (External Antenna)	
Channel 00 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	

BLE 1Mbps AVGPSD - Bluetooth chip 1 (External Antenna)	
Channel 00 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	

BLE 2Mbps AVGPSD - Bluetooth chip 1 (External Antenna)	
Channel 00 (2402MHz)	Channel 19 (2440MHz)
	
Channel 39 (2480MHz)	
	

7.5. Conducted Band Edge and Out-of-Band Emissions

7.5.1.Test Limit

The limit for out-of-band spurious emissions at the band edge is 30dB below the fundamental emission level, as determined from the in-band power measurement of the DTS channel performed in a 100kHz bandwidth per the PSD procedure.

7.5.2.Test Procedure Used

ANSI C63.10-2013 Section 11.11

7.5.3.Test Settitng

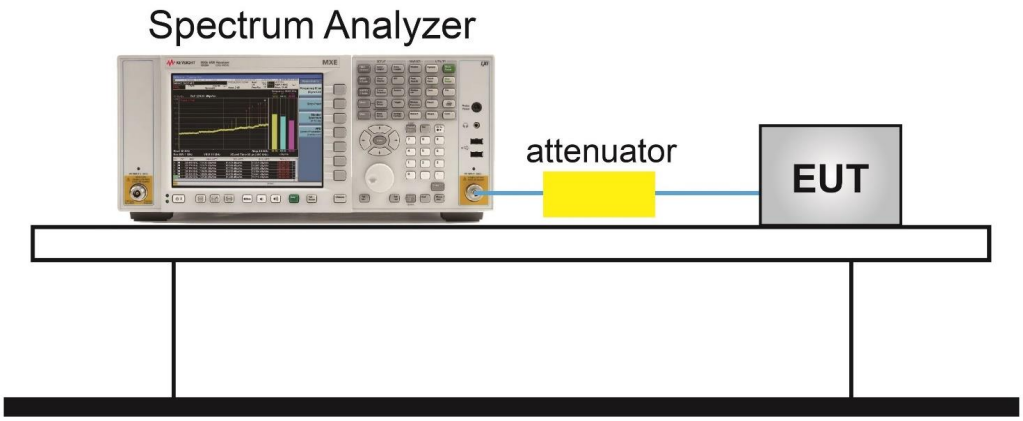
Reference level measurement

1. Set instrument center frequency to DTS channel center frequency
2. Set the span to ≥ 1.5 times the DTS bandwidth
3. Set the RBW = 100 kHz
4. Set the VBW ≥ 3 x RBW
5. Detector = peak
6. Sweep time = auto couple
7. Trace mode = max hold
8. Allow trace to fully stabilize

Emission level measurement

1. Set the center frequency and span to encompass frequency range to be measured
2. RBW = 100kHz
3. VBW = 300kHz
4. Detector = Peak
5. Trace mode = max hold
6. Sweep time = auto couple
7. The trace was allowed to stabilize

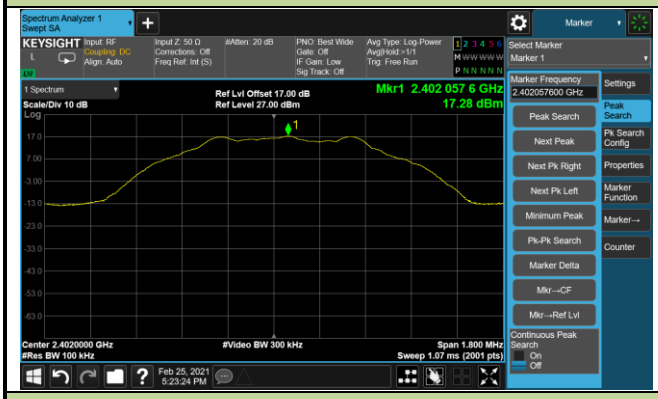
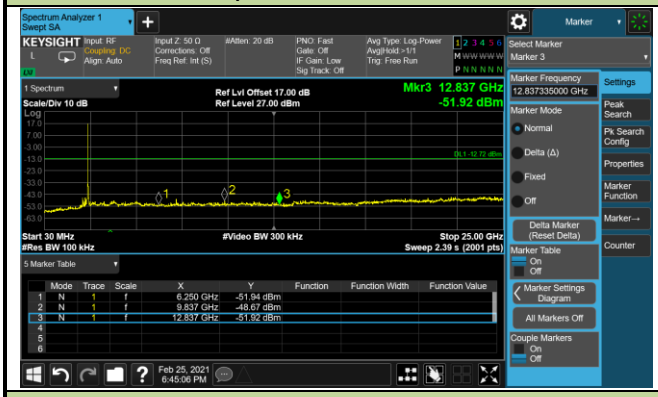
7.5.4.Test Setup



7.5.5.Test Result

Product	Cassia Bluetooth Router	Temperature	23 ~ 25°C
Test Engineer	Kevin Ker	Relative Humidity	46 ~ 54%
Test Site	SR2	Test Date	2021/02/24~2021/02/27

Test Mode	Data Rate (Mbps)	Channel No.	Frequency (MHz)	Limit	Result
Bluetooth chip 0 (Internal Antenna)					
BLE	1	00	2402	30dBc	Pass
BLE	1	19	2440	30dBc	Pass
BLE	1	39	2480	30dBc	Pass
BLE	2	00	2402	30dBc	Pass
BLE	2	19	2440	30dBc	Pass
BLE	2	39	2480	30dBc	Pass
Bluetooth chip 1 (Internal Antenna)					
BLE	1	00	2402	30dBc	Pass
BLE	1	19	2440	30dBc	Pass
BLE	1	39	2480	30dBc	Pass
BLE	2	00	2402	30dBc	Pass
BLE	2	19	2440	30dBc	Pass
BLE	2	39	2480	30dBc	Pass
Bluetooth chip 0 (External Antenna)					
BLE	1	00	2402	30dBc	Pass
BLE	1	19	2440	30dBc	Pass
BLE	1	39	2480	30dBc	Pass
BLE	2	00	2402	30dBc	Pass
BLE	2	19	2440	30dBc	Pass
BLE	2	39	2480	30dBc	Pass
Bluetooth chip 1 (External Antenna)					
BLE	1	00	2402	30dBc	Pass
BLE	1	19	2440	30dBc	Pass
BLE	1	39	2480	30dBc	Pass
BLE	2	00	2402	30dBc	Pass
BLE	2	19	2440	30dBc	Pass
BLE	2	39	2480	30dBc	Pass

BLE 1Mbps Out-of-Band Emissions - Bluetooth chip 0 (Internal Antenna) - Ant 0	
Channel 00 (2402MHz)	
100kHz PSD reference Level	Low Band Edge
	
Spurious Emission	
	
Channel 19 (2440MHz)	
100kHz PSD reference Level	Spurious Emission