

低功率射頻電機試驗報告

申請廠商	Silicon Laboratories Finland Oy Alberga Business Park, Bertel Jungin aukio 3, 02600 Espoo, Finland
製造廠商	Silicon Laboratories Finland Oy
產品名稱	Bluetooth Low Energy Wireless Module
廠牌	Silicon Labs
型號	BGM11S22A
系列 型號	BGM11S12A
發射功率	7.98 dBm (Peak)
工作頻率	2402MHz – 2480MHz
調變方式	Bluetooth V4.2 Low Energy single-mode (GFSK)
法規	LP0002, 3.10.1節

實驗室資訊

台灣檢驗科技股份有限公司 電子通訊實驗室

新北市新北產業園區五工路134號

認證有效期間：107年06月14日起至110年06月13日止

受理日期 民國108年02月19日

完成日期 民國108年02月25日

張俊卿



報告簽署人
張俊卿 簽章

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Revision History

Report Number	Revision	Description	Effected Page	Issue Date	Revised By
E2/2019/20027	Rev.00	Initial creation of document	All	Feb. 25, 2019	Elle Chang
E2/2019/20027	Rev.01	Revised the description of Series Model, Added MPE	Page 3, 50~51	Feb. 25, 2019	Elle Chang

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測試標準

國家通訊傳播委員會低功率射頻電機技術規範

民國 107 年 1 月 10 日版本

待測裝置已於台灣檢驗科技股份有限公司電子通訊實驗室，依據國家通訊傳播委員會於中華民國一百零七年一月頒佈之低功率射頻電機技術規範測試。

台灣檢驗科技股份有限公司根據此條文規範項目測試，測試各項數據皆能符合此規範規定之限度值。

台灣檢驗科技股份有限公司依低功率射頻電機技術規範審驗要點規範製作測試結果報告，測試結果評判為合格。

備註：

1. 報告中所描述之測試結果和待測設備的架構組合，均根據實際量測情況作詳實的記錄，且本測試報告僅對上述待測設備樣品負責。
2. 此份報告未經本公司同意，不得部份摘錄複製使用。
3. 系列申請，主型號: BGM11S22A 與系列型號: BGM11S12A，除軟體變更之高功率、低功率及型號的分別，產品基本結構相同，特此說明。

測試人員：



日期：

02/25/2019

裴笛翰 / 資深工程師

報告製作：

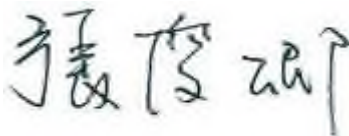


日期：

02/25/2019

張瑜健 / 行政

報告審核：



日期：

02/25/2019

張俊卿 / 經理

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測試實驗室資料:

實驗室認可登錄 : 中華民國實驗室認證體系

認可編號 : TAF 0513, 認可頻率範圍9kHz ~ 40GHz

認證有效期間 : 107年06月14日起至110年06月13日止

測試場地 : 桃園市龜山區(華亞科技園區)科技一路2號

實驗室名稱 : 台灣檢驗科技股份有限公司
電子通訊實驗室

實驗室地址 : 新北市新北產業園區五工路134號

電話 : 886-2-22993939

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實驗室之量測不確定度

量測項目	量測不確定度 (擴充不確定度)		
傳導干擾量測	電源線	0.15-30MHz	2.586 dB
輻射干擾量測 (3m測距)	水平極化	9kHz - 30MHz	2.3dB
		30-167MHz	4.22dB
		167-500MHz	3.44dB
		0.5-1GHz	3.39dB
		1-18GHz	4.08dB
		18-40GHz	4.08dB
	垂直極化	9kHz - 30MHz	2.3dB
		30-180MHz	3.37dB
		180-417MHz	3.19dB
		0.417-1GHz	3.19dB
		1-18GHz	4.04dB
		18-40GHz	4.04dB
頻率誤差量測	範例一	2.4 GHz	290 Hz
	範例二	5 GHz	724.3 Hz
輸出功率	傳導方式	2.4 GHz	1.3 dB
		5 GHz	1.55 dB
有效輻射功率 (輻射方式)	水平極化	2.4GHz	4.21 dB
		5 GHz	4.62 dB
	垂直極化	2.4 GHz	4.42 dB
		5 GHz	4.74 dB
功率頻譜密度	傳導方式	2.4GHz	1.3dB
		5GHz	1.67dB
鄰頻道功率量測 (輻射方式)	水平極化	30-167MHz	4.22dB
		167-500MHz	3.44dB
		0.5-1GHz	3.39dB
	垂直極化	30-180MHz	3.37dB
		180-417MHz	3.19dB
		0.417-1GHz	3.19dB

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1 一般資料

1.1 產品描述

產品名稱	Bluetooth Low Energy Wireless Module
型號	BGM11S22A
系列型號	BGM11S12A
產品商標	Silicon Labs
Hardware Version	rev2
Software Version	2.x
使用電源	3.3Vdc

發射頻帶	2402MHz – 2480MHz
輸出功率	7.98 dBm (Peak)
調變方式	Bluetooth V4.2 Low Energy single-mode (GFSK)
頻道數	40
天線型式/天線增益	Ultra-Miniature 2.4GHz Ceramic Chip Antenna, Gain: 1dBi P/N.: 2450AT07A0100; Supplier: Johanson Technology, Inc

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1.2 測試方法之依據

本測試報告之所有項目皆依據國家通訊傳播委員會低功率射頻電機技術規範(LP0002, 107.1.10 版本)如無國家標準可適用者, 得依美國 EIA、IEEE ANSI 檢驗法檢驗, 及美國 FCC 47 CFR Part 2 有關檢驗之規定及參考 ANSI 63.10:2013、FCC CFR 47 15.247 之檢驗法。

低功率射頻電機技術規範3.10節

項次	測試項目	適用規範	測試結果	量測設備	備註
1	場強輻射	低功率射頻電機技術規範 3.10.1.5節	請參閱6.5節	請參閱4.1節	合格
2	電源線傳導干擾	低功率射頻電機技術規範 2.3節	請參閱5.5節	請參閱4.3節	合格
3	天線增益之要求	低功率射頻電機技術規範 3.10.1.3 (1) 節	請參閱7.2節	-----	合格
4	發頻頻寬	低功率射頻電機技術規範 3.10.1.6(2) (A) 節	請參閱8.3節	請參閱4.2節	合格
5	輸出峰值功率	低功率射頻電機技術規範 3.10.1.2(1) (C) 節	請參閱9.3節	請參閱4.2節	合格
6	開放頻帶邊緣之發射	低功率射頻電機技術規範 3.10.1.5節	請參閱10.3節	請參閱4.2節	合格
7	功率密度	低功率射頻電機技術規範 3.10.1.6(2) (B) 節	請參閱11.3節	請參閱4.2節	合格

*測試模式

RADIATED EMISSION TEST:

RADIATED EMISSION TEST (BELOW 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Bluetooth LE	0 to 39	0,20,39	GFSK	1
RADIATED EMISSION TEST (ABOVE 1 GHz)				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Bluetooth LE	0 to 39	0,20,39	GFSK	1

ANTENNA PORT CONDUCTED MEASUREMENT:

CONDUCTED TEST				
MODE	AVAILABLE CHANNEL	TESTED CHANNEL	MODULATION	DATA RATE (Mbps)
Bluetooth LE	0 to 39	0,20,39	GFSK	1

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2 適用規範

2.1 規範要求 (一般規定)

(1) 傳導之規定

依據NCC低功率射頻電機技術規範之2.3節，以市電為電源之低功率射頻電機，其傳導回電源線上頻率自 150 kHz 至 30MHz 之射頻電壓 (在電源端子每一電源線對接地點) 不得超過下表所列之限值。測量時應經過 50 μ H 及50 Ω 之電源線阻抗模擬網路 (LISN)。頻率重疊處，以較低限值為準。

頻率(MHz)	傳導限制值 (dBuV)	
	準峰值 (Quasi – peak)	平均值 (Average)
0.15 – 0.5	66 – 56	56 - 46
0.5 – 5	56	46
5 - 30	60	50

(2) 輻射之規定

依據NCC低功率射頻電機技術規範3.10.5之要求，其他開放頻帶外不必要之輻射需符合2.8節之一般限制要求，其電場強度不得超過下表之限值，且其不必要之發射皆不得大於主波發射強度。各頻段重疊處，以較嚴格之限制值為準。

頻率 MHz	測試距離 m	干擾限制 μ V/m	干擾限制 dB μ V/m
0.009 – 0.490	300	2,400/頻率 (kHz)	
0.490 – 1.705	30	24,000/頻率 (kHz)	
1.705 - 30	30	30	
30 - 88	3	100	40.0
88 – 216	3	150	43.5
216 – 960	3	200	46.0
960以上	3	500	54.0

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(3) 禁用頻帶限制之規定

依據NCC低功率射頻電機技術規範2.7節之要求，任何低功率射頻電機之主波皆不得使用下表所列各頻帶內之頻率；低功率射頻電機落於下表所列頻帶內之混附發射，其電場強度必須符合第2.8節的限制規定。

頻率 (MHz)	頻率 (MHz)	頻率 (MHz)
0.090~0.110	240.00~285.00	3332.0~3339.0
0.490~0.510	322.00~335.40	3345.8~3358.0
2.172~2.198	399.90~410.00	3500.0~4400.0
3.013~3.033	485.00~510.00	4500.0~5250.0
4.115~4.198	608.00~614.00	5350.0~5460.0
5.670~5.690	703.00~748.00	7250.0~7750.0
6.200~6.300	758.00~803.00	8025.0~8500.0
8.230~8.400	825.00~915.00	9000.0~9200.0
12.265~12.600	930.00~1240.0	9300.0~9500.0
13.340~13.430	1300.0~1427.0	10600~12700
14.965~15.020	1435.0~1626.5	13250~13400
16.700~16.755	1660.0~1785.0	14470~14500
19.965~20.020	1805.0~1880.0	15350~16200
25.500~25.700	1885.0~1900.0	17700~21400
37.475~38.275	1905.0~1985.0	22010~23120
73.500~75.400	2010.0~2025.0	23600~24000
108.00~138.00	2110.0~2170.0	31200~31800
149.90~150.05	2200.0~2300.0	36430~36500
156.70~156.90	2310.0~2390.0	38600 以上
162.01~167.17	2483.5~2900.0	
167.72~173.20	3260.0~3267.0	

(4) 依據NCC低功率射頻電機技術規範2.11節之要求，收、發信機為成套銷售者，收、發信機應一併送審或提供經型式認證合格之對應收、發信機之送審資料；送信機之輻射電場強度不得超過第2.8節之發射規定，且不得接收、解調第2.7節所列之頻率。

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2.2 規範要求 (特殊規定)

依據NCC低功率射頻電機技術規範3.10節 數位調變 (Digitally Modulated) 之要求，使用頻率為2.4 G至2.4835 GHz 及 5.725 GHz 至5.850 GHz

(A) 峰值輸出功率之要求

依據 NCC 低功率射頻電機技術規範 3.10.1.2(1) (A)(C)之規定，操作於 2400-2483.5 兆赫 (MHz)與 5725-5850 兆赫(MHz)之所有數位調變技術系統：1 瓦(W)以下。

除使用附件二之峰值輸出功率量測方式外，並得使用以最大傳導輸出功率(Maximum Conducted Output Power)作為量測方式。

最大傳導輸出功率，定義為發射器操作在最大功率時，輸出至所有天線及天線單元 (antenna elements) 之總發射功率對信號集 (signaling alphabet) 所有符號 (symbol) 之平均值。此平均值不含發射器停止或已降低發射功率位準之任何時間區段。器材可操作於不同調變模式等多種模式時，最大傳導輸出功率為各模式之總發射功率其中最高者。

(B) 天線增益之要求

依據NCC低功率射頻電機技術規範3.10.1.3之規定，進行固定式點對點操作時，應符合下列情現之一：依據NCC低功率射頻電機技術規範3.10.1.3 (1)之規定，操作頻率為2400-2483.5 兆赫(MHz)者，其發射天線之方向性增益超過6dBi，每超過3dB應降低1dB之最大傳導輸出功率。

依據NCC低功率射頻電機技術規範3.10.1.3 (2)之規定，操作頻率為5725-5850兆赫(MHz)者，其發射天線之方向性增益超過6dBi，不需降低最大傳導輸出功率。

依據NCC低功率射頻電機技術規範3.10.1.3 (3)之規定，用於點對多點操作時，如其發射天線之方向性增益超過 6dBi，應依所超過之dB數等量降低最大傳導輸出功率。

(C) 發射限制之要求

依據NCC低功率射頻電機技術規範3.10.1.5之規定，帶外發射限制：操作頻帶範圍外之任意100 kHz 內，發射機所產生的射頻功率相較於使用頻帶範圍中包含最高所需功率之100 kHz 內的射頻功率，其衰減值限制如下：

(1) 輸出功率以附件二之峰值輸出功率方式測量者，至少須衰減20 dB，可使用射頻傳導或輻射方式測量。

(2) 輸出功率以3.10.1.2(1)(C)之最大傳導輸出功率測量方式者，至少須衰減30 dB。

此外，落於2.7 禁用頻段之輻射發射，應符合2.8 之規定。

(D) 頻寬之要求

依據NCC低功率射頻電機技術規範3.10.1.6(2) (A)規定，6dB之頻寬至少應500kHz。

(E) 功率密度之要求

依據NCC低功率射頻電機技術規範3.10.1.6(2) (B)規定，在使用頻率範圍之任意3千赫(kHz)頻寬內，由發射機傳導至天線之峰值發射電功率密度在任意期間內，皆不得大於8dBm。

註：此產品為點對多點操作。

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3 受測裝置之系統說明

裝置名稱	製造者/申請者	型號
* Bluetooth Low Energy Wireless Module	Silicon Laboratories Finland Oy / Silicon Laboratories Finland Oy	BGM11S22A

標記：“*”表欲申請之受測物。

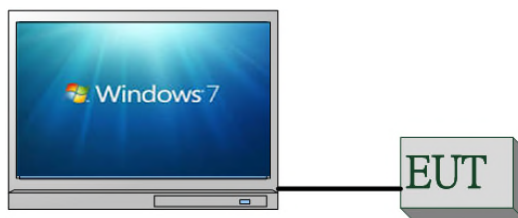
3.1 待測物與測試設備系統圖

3.1.1 量測配置圖

Conducted (Antenna Port) & Radiated Emission



Conduction (AC power line) Emission



3.1 輔助測試週邊設備名稱描述

編號	產品別	商標	型號	序號	信號線	電源線
1.	Bluetooth Test Software	N/A	N/A	N/A	N/A	N/A
2.	Notebook	Lenovo	L420	LR-6MEX0	Shielded	Un-shielded

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4 量測儀器設備

4.1 AC 電源端傳導干擾之量測儀器

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
LISN	TESEQ	NNB 51	36076	2019/02/13	2020/02/12
EMI Test Receiver	R&S	ESCI	101343	2018/07/31	2019/07/30
Notebook	Lenovo	L420	S0012467	N/A	N/A

4.2 天線端傳導測試之量測儀器

SGS Conducted Room					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Spectrum Analyzer	Agilent	N9010A	MY53400256	2018/11/21	2019/11/20
Attenuator	Marvelous	MVE2213-10	RF31	2018/12/25	2019/12/24
DC Block	PASTERNAK	PE8210	RF81	2018/12/25	2019/12/24
Notebook	Lenovo	L420	S0011721	N/A	N/A
Power Meter	Anritsu	ML2496A	5530/06/19	2018/08/09	2019/08/02
Power Sensor	Anritsu	MA2411B	5500/06/23	2018/08/09	2019/08/02
Power Sensor	Anritsu	MA2411B	5500/06/24	2018/08/09	2019/08/02

4.3 量測場強輻射之量測儀器

966 Chamber					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Broadband Antenna	SCHWAZBECK	VULB 9168	9168-617	2018/10/30	2019/10/29
Horn Antenna	Schwarzbeck	BBHA9120D	1341	2018/06/07	2019/06/06
Horn Antenna	SCHWAZBECK	BBHA9170	185	2018/08/02	2019/08/01
Loop Antenna	ETS.LINDGREN	6502	143303	2018/04/19	2019/04/18
3m Site NSA	SGS	966 chamber D	N/A	2018/07/06	2019/07/05
EMI Test Receiver	R&S	ESU 40	100363	2018/04/11	2019/04/10
Pre-Amplifier	EMC Instruments	EMC184045B	980135	2018/12/25	2019/12/24
Pre-Amplifier	EMC Instruments	EMC9135	980234	2018/12/25	2019/12/24
Pre-Amplifier	EMC Instruments	EMC12630SE	980271	2018/12/25	2019/12/24
Attenuator	Marvelous	WATT-218FS-10	RF246	2018/12/25	2019/12/24
Highpass Filter	Micro Tronics	BRM50701-01	G008	2018/12/25	2019/12/24
Coaxial Cable	Huber Suhner	EMC106-SM-SM-7200	150703	2018/12/25	2019/12/24
Coaxial Cable	Huber Suhner	RG 214/U	W22.03	2018/12/25	2019/12/24
Notebook	Lenovo	L420	S0012467	N/A	N/A

註: 以上部份設備跟量測值沒有影響, 且沒有直接關聯, 因此不需要進行校正。

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5 電源線傳導干擾之量測

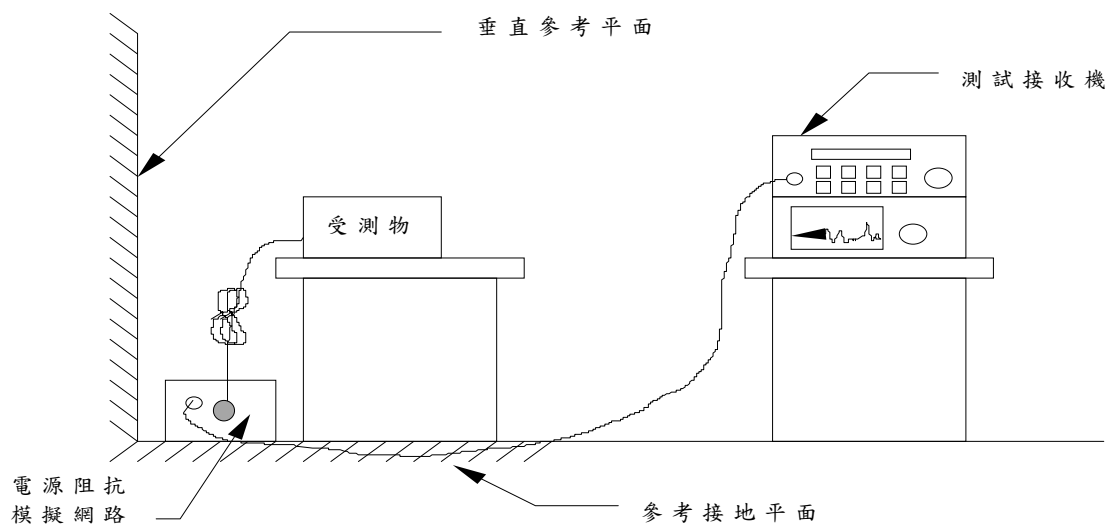
5.1 適用標準

依據NCC低功率射頻電機技術規範2.3節之要求。

5.2 測試方法

將待測物置於0.8米高的非金屬桌面，使其在工作狀態，待測物電源線接至電源線阻抗穩定網路上，從測試接收機記錄頻率由 0.15MHz 至 30MHz 之間之電源線傳導放射強度。

5.3 測試配置



5.4 干擾值之計算

電源傳導干擾電壓之計算公式如下

$$\text{結果值} = \text{儀器讀值}(QP/AV) + \text{校正因子}$$

其中校正因子為：

$$\text{饋線損失} + \text{電源阻抗模擬網路損失}$$

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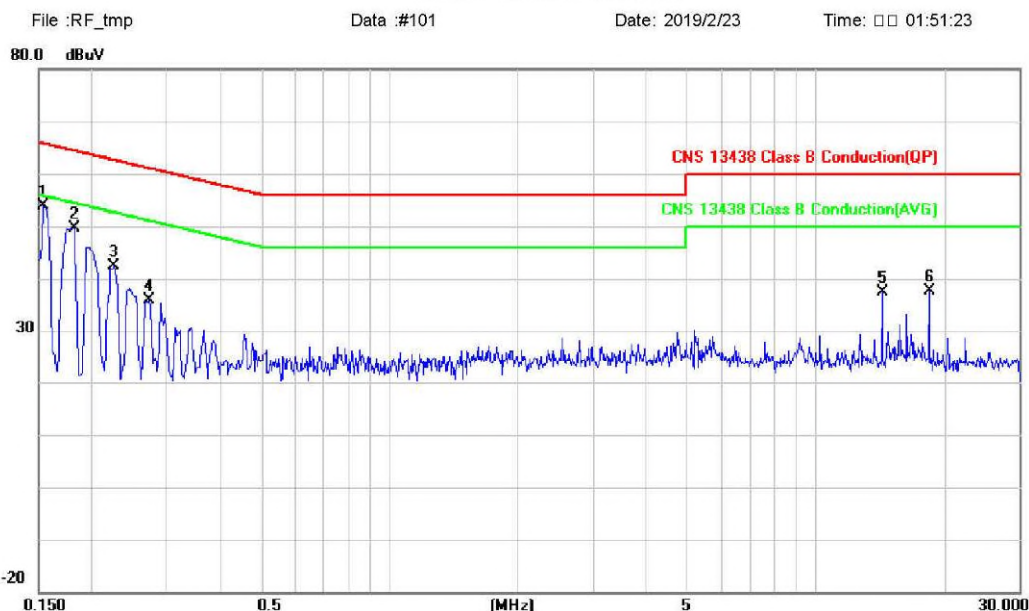
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5.5 傳導干擾之量測結果:

測試設備: Bluetooth Low Energy Wireless 型號: BGM11S22A
Module
6dB 頻寬: 10 kHz 視訊頻寬: 10 kHz
量測天線: N/A 檢測器: Average/Quasi-Peak
測試者: 裴笛翰/資深工程師 Adapter Model No.: N/A

Site : Conduction Room B Phase: **L1** Temperature: 23 °C
Limit: CNS 13438 Class B Conduction(QP) Power: AC 110V/60Hz Humidity: 57 %
Mode:
Note:

Conducted Emission



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over	Detector	Comment
		MHz	dBuV	dB	dBuV	dBuV	dB		
1	*	0.1540	34.54	19.37	53.91	65.78	-11.87	peak	
2		0.1820	30.29	19.41	49.70	64.39	-14.69	peak	
3		0.2260	22.91	19.49	42.40	62.60	-20.20	peak	
4		0.2740	16.21	19.57	35.78	61.00	-25.22	peak	
5		14.3380	17.73	19.72	37.45	60.00	-22.55	peak	
6		18.4340	17.91	19.77	37.68	60.00	-22.32	peak	

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Site : Conduction Room B

Phase: **N**

Temperature: 23 °C

Limit: CNS 13438 Class B Conduction(QP)

Power: AC 110V/60Hz

Humidity: 57 %

Mode:

Note:

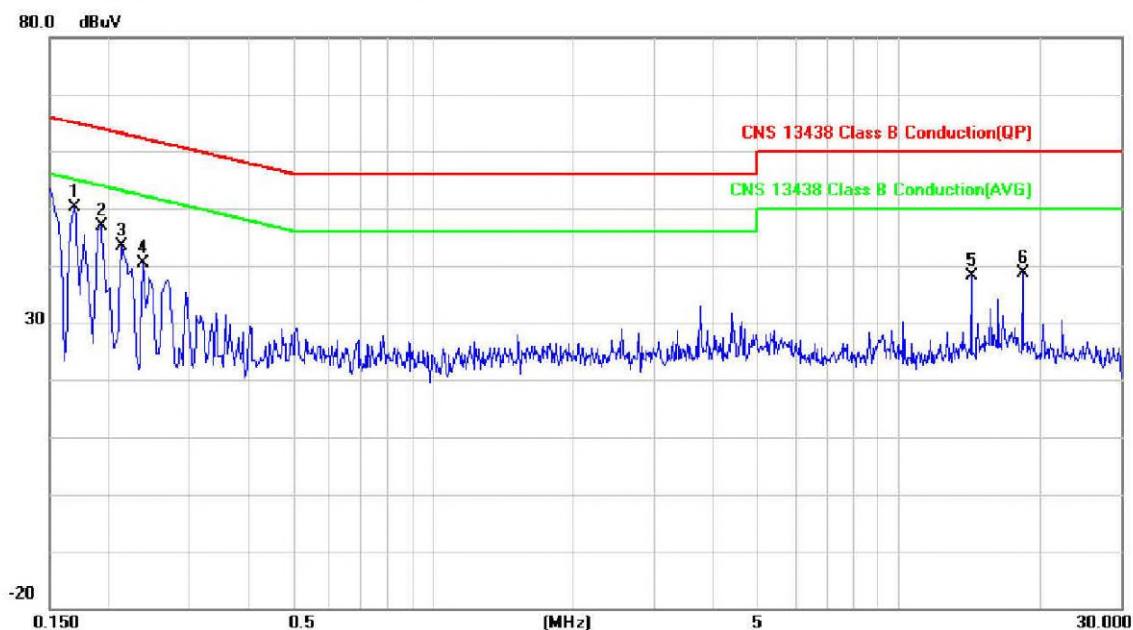
Conducted Emission

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Data :#102

Date: 2019/2/23

Time: 01:52:37



No.	Mk.	Freq.	Reading Level	Correct Factor	Measurement	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1700	30.41	19.63	50.04	64.96	-14.92	peak	
2		0.1940	27.25	19.67	46.92	63.86	-16.94	peak	
3		0.2140	23.59	19.70	43.29	63.05	-19.76	peak	
4		0.2380	20.71	19.74	40.45	62.17	-21.72	peak	
5		14.3380	18.17	19.96	38.13	60.00	-21.87	peak	
6		18.4340	18.73	20.01	38.74	60.00	-21.26	peak	

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6 場強輻射之量測

6.1 適用標準

依據NCC低功率射頻電機技術規範3.10.1.5之要求，其他開放頻帶外不必要之輻射干擾需符合2.8節之一般限制要求。

6.2 量測方法

將待測物置於非金屬桌面，測試頻率1GHz以下時，使用桌高0.8 米，1GHz以上時，使用桌高1.5米，使其在工作狀態，接收天線置於 3 米外相同的高度。待測物分別要垂直或水平放置，而且桌面要 360 度旋轉，另外接收天線也要從 1.0 米至 4.0 米升降變化，以找出最大的輻射電場強度，接收天線置於水平、垂直極向各執行測試一次。

1GHz 以下先進行Peak 值量測，若Peak 以低於QP 限制值將不在進行QP 量測，否則，則進行QP 值量測，1GHz 以上先進行Peak 值量測，若Peak 以低於AV 限制值將不在進行AV值量測，否則，則進行AV 值量測。

9kHz~150kHz 測試

解析頻寬:	300Hz	視訊頻寬:	300Hz
量測天線:	6502	檢測器:	Quasi-Peak

150kHz~30MHz 測試

解析頻寬:	10kHz	視訊頻寬:	10kHz
量測天線:	6502	檢測器:	Quasi-Peak

1GHz 以下測試

解析頻寬:	100kHz	視訊頻寬:	100kHz
量測天線:	VULB9168	檢測器:	Quasi-Peak

1GHz 以上測試

量測天線:	BBHA9120D BBHA9170	檢測器:	Peak, Average
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頻譜分析儀設定 Peak: RBW: 1MHz ; VBW: 1MHz , Average: RBW: 1MHz ; VBW: 10Hz

註: 輻射量測僅放最差模式 (30MHz 以上)。

註: 經評估後，9kHz ~ 30MHz 之輻射量測皆低於限制值 20dB 以上，依據 LP0002 5.13 規定混附發射無須記錄

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6.3 場強度之計算

場強之計算公式如

$$\text{結果值} = \text{讀值} + \text{校正因子}$$

其中校正因子為：

天線因子+ 饋線損失 + 濾波器損失（若有使用） - 放大器增益（若有使用）
量測結果請見下頁。

註:比較H Plane、E1 Plane和E2 Plane測試值後，附上最差模式 E2 Plane 數據。

Note: Actual FS(dBμV/m) = SPA. Reading level(dBμV) + Factor(dB)

Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

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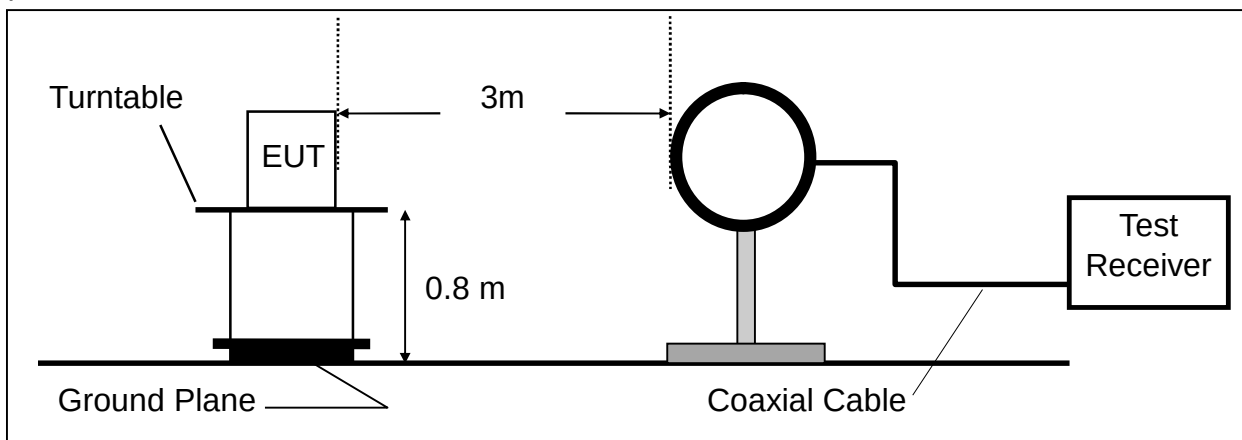
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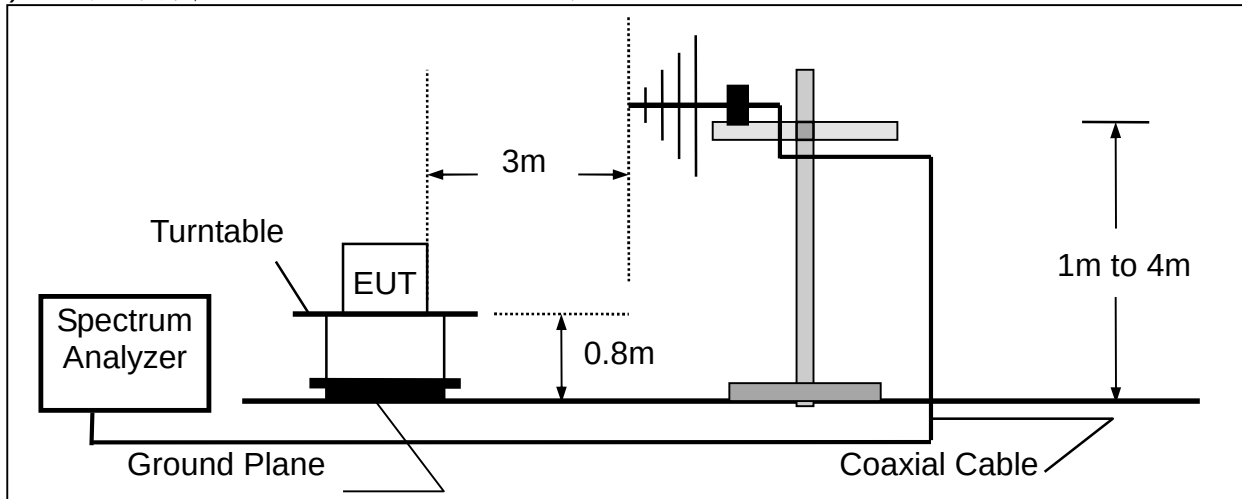
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6.4 輻射之測試配置

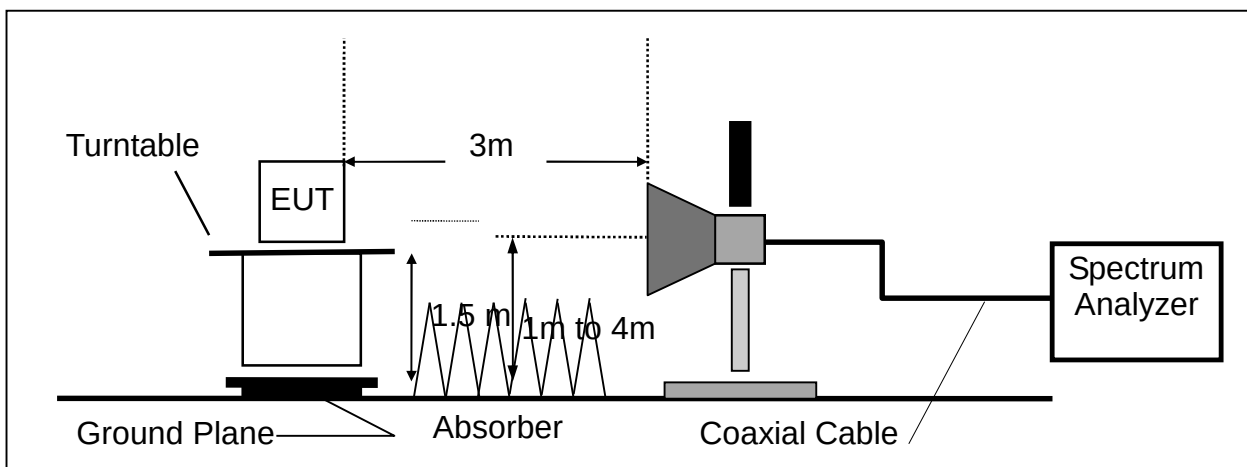
(A) 量測頻率低於 30MHz 以下之測試配置



(B) 量測頻率 30MHz 至 1000MHz 之測試配置



(C) 量測頻率 1000MHz 以上之測試配置



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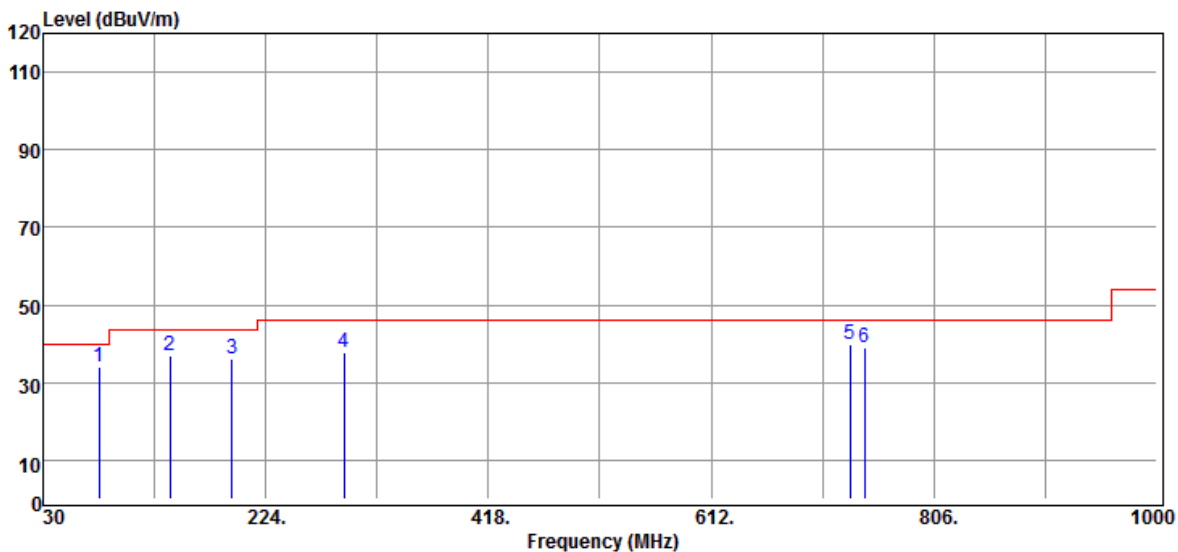
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6.5 場強輻射之量測結果

6.5.1 發射機場強輻射之量測結果(1GHz 以下)

Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:TX CH LOW	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2402 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
78.50	Peak	55.17	-21.22	33.95	40.00	-6.05
140.58	Peak	54.00	-16.85	37.15	43.50	-6.35
194.90	Peak	54.29	-18.29	36.00	43.50	-7.50
291.90	Peak	53.37	-15.63	37.74	46.00	-8.26
733.25	Peak	47.12	-7.13	39.99	46.00	-6.01
745.86	Peak	46.03	-6.84	39.19	46.00	-6.81

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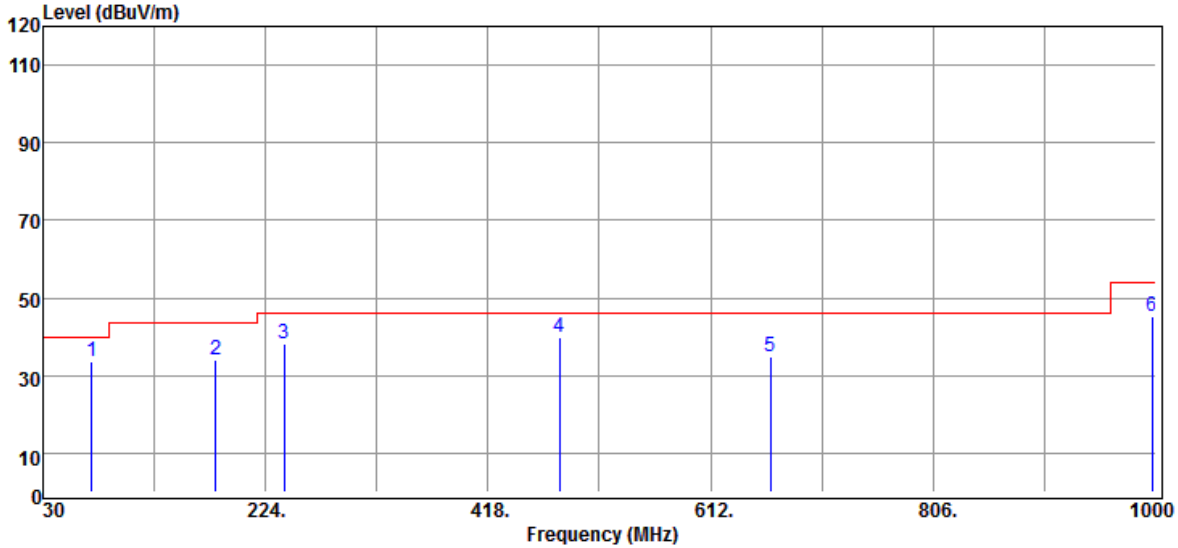
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Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:TX CH LOW	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2402 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dB μ V	Factor dB	Actual FS dB μ V/m	Limit @3m dB μ V/m	Margin dB
72.68	Peak	53.62	-19.91	33.71	40.00	-6.29
180.35	Peak	51.73	-17.61	34.12	43.50	-9.38
240.49	Peak	55.54	-17.17	38.37	46.00	-7.63
480.08	Peak	50.83	-11.09	39.74	46.00	-6.26
664.38	Peak	43.40	-8.60	34.80	46.00	-11.20
997.09	Peak	48.90	-3.51	45.39	54.00	-8.61

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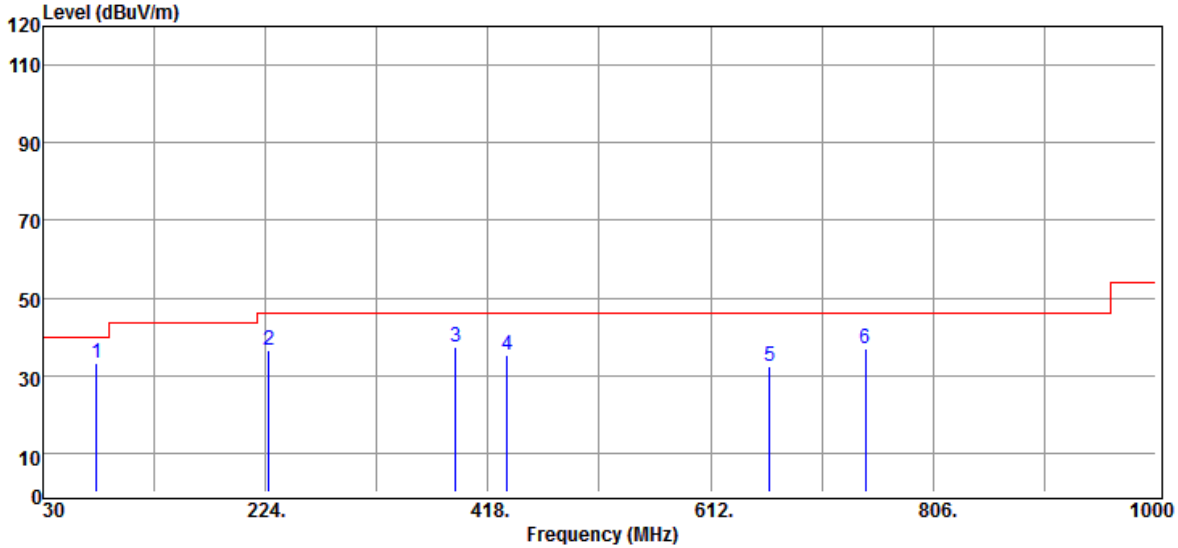
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Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:TX CH MID	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2442 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
76.56	Peak	54.19	-20.80	33.39	40.00	-6.61
226.91	Peak	54.41	-17.69	36.72	46.00	-9.28
389.87	Peak	50.46	-13.12	37.34	46.00	-8.66
434.49	Peak	47.29	-12.11	35.18	46.00	-10.82
663.41	Peak	41.15	-8.62	32.53	46.00	-13.47
746.83	Peak	43.92	-6.83	37.09	46.00	-8.91

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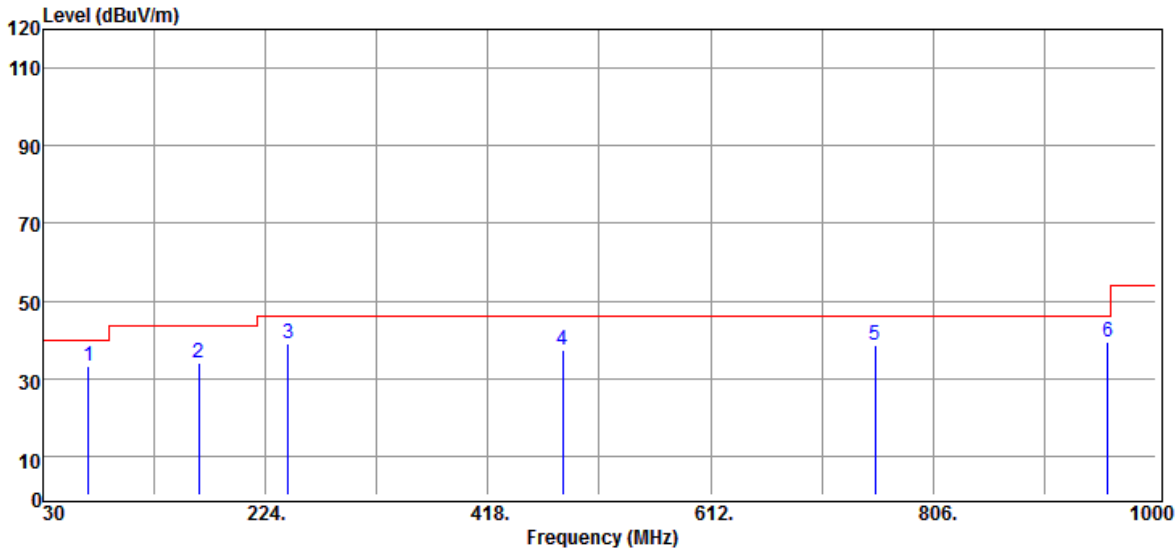
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Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:TX CH MID	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2442 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
69.77	Peak	52.48	-19.24	33.24	40.00	-6.76
165.80	Peak	51.08	-17.17	33.91	43.50	-9.59
243.40	Peak	55.95	-17.07	38.88	46.00	-7.12
482.99	Peak	48.43	-11.08	37.35	46.00	-8.65
755.56	Peak	45.41	-6.75	38.66	46.00	-7.34
958.29	Peak	43.62	-4.06	39.56	46.00	-6.44

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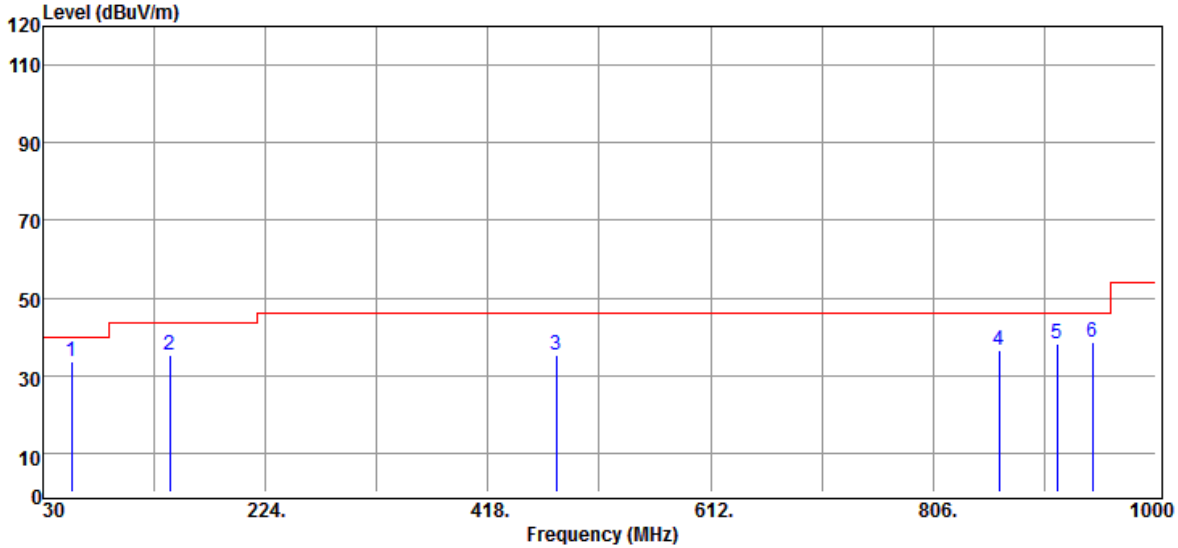
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Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:TX CH HIGH	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2480 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
55.22	Peak	50.76	-17.04	33.72	40.00	-6.28
140.58	Peak	52.11	-16.85	35.26	43.50	-8.24
477.17	Peak	46.58	-11.20	35.38	46.00	-10.62
863.23	Peak	41.73	-5.10	36.63	46.00	-9.37
913.67	Peak	42.72	-4.39	38.33	46.00	-7.67
944.71	Peak	43.13	-4.51	38.62	46.00	-7.38

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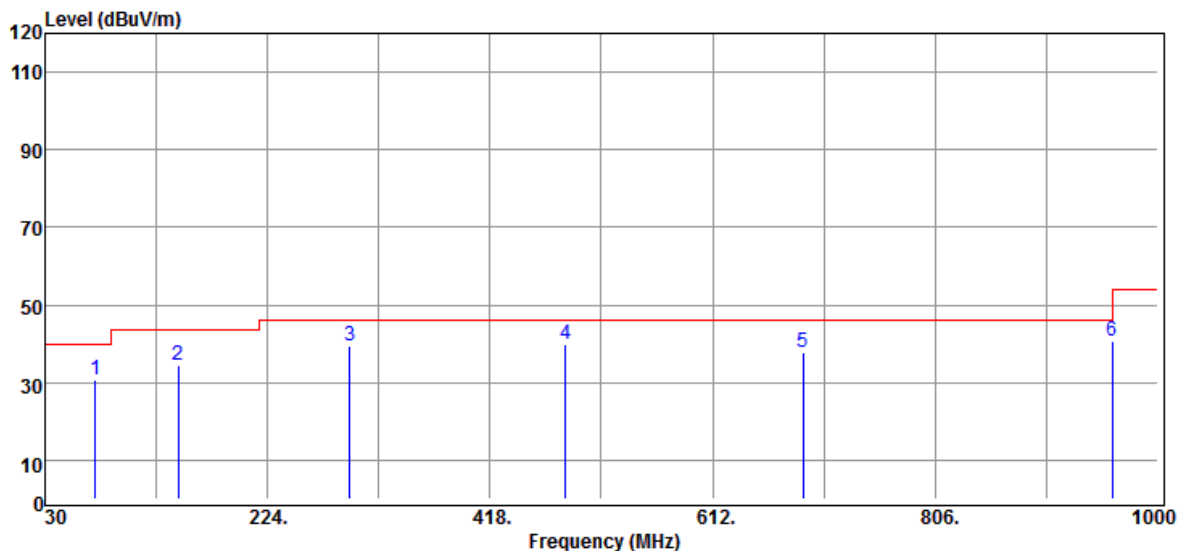
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Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:TX CH HIGH	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2480 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
73.65	Peak	50.72	-20.14	30.58	40.00	-9.42
146.40	Peak	51.01	-16.35	34.66	43.50	-8.84
295.78	Peak	54.78	-15.51	39.27	46.00	-6.73
483.96	Peak	50.91	-11.07	39.84	46.00	-6.16
690.57	Peak	45.11	-7.29	37.82	46.00	-8.18
960.23	Peak	44.75	-3.93	40.82	54.00	-13.18

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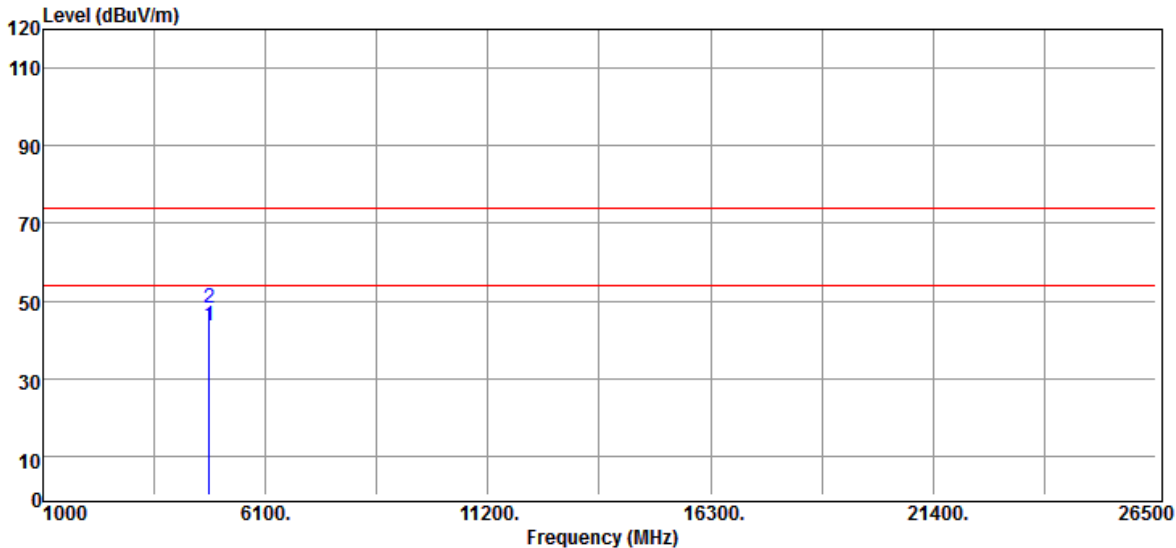
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6.5.2 發射機場強輻射之量測結果(1GHz 以上)

Operation Mode	:BLE	Test Date	:2019-02-21
Test Mode	:TX CH LOW	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2402 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4804.00	Average	43.48	0.22	43.70	54.00	-10.30
4804.00	Peak	48.05	0.22	48.27	74.00	-25.73

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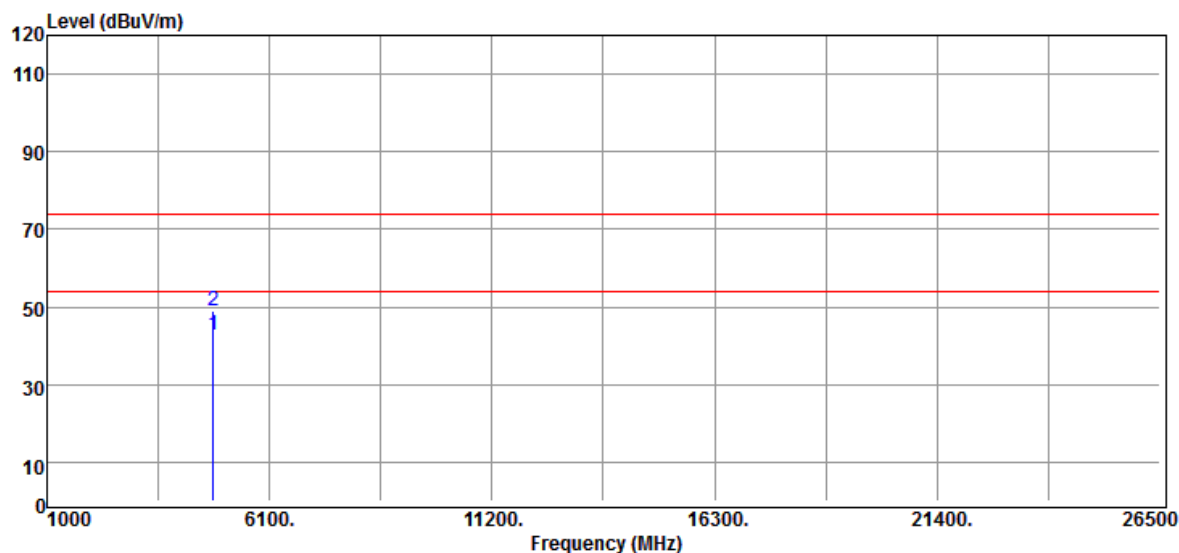
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Operation Mode	:BLE	Test Date	:2019-02-21
Test Mode	:TX CH LOW	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2402 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4804.00	Average	42.63	0.22	42.85	54.00	-11.15
4804.00	Peak	48.75	0.22	48.97	74.00	-25.03

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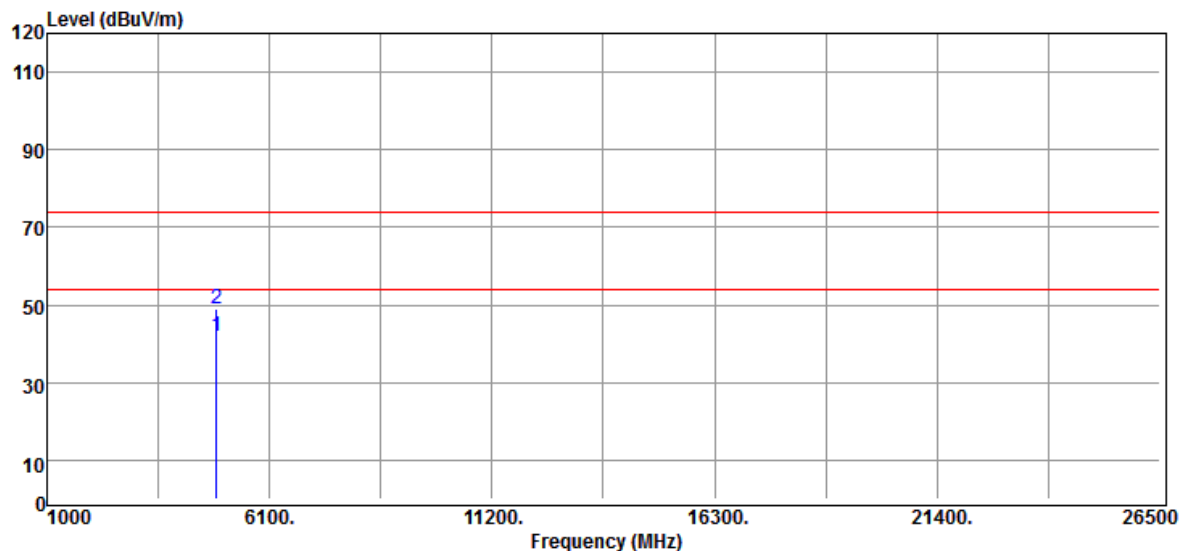
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Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:TX CH MID	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2442 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4884.00	Average	41.10	0.64	41.74	54.00	-12.26
4884.00	Peak	48.19	0.64	48.83	74.00	-25.17

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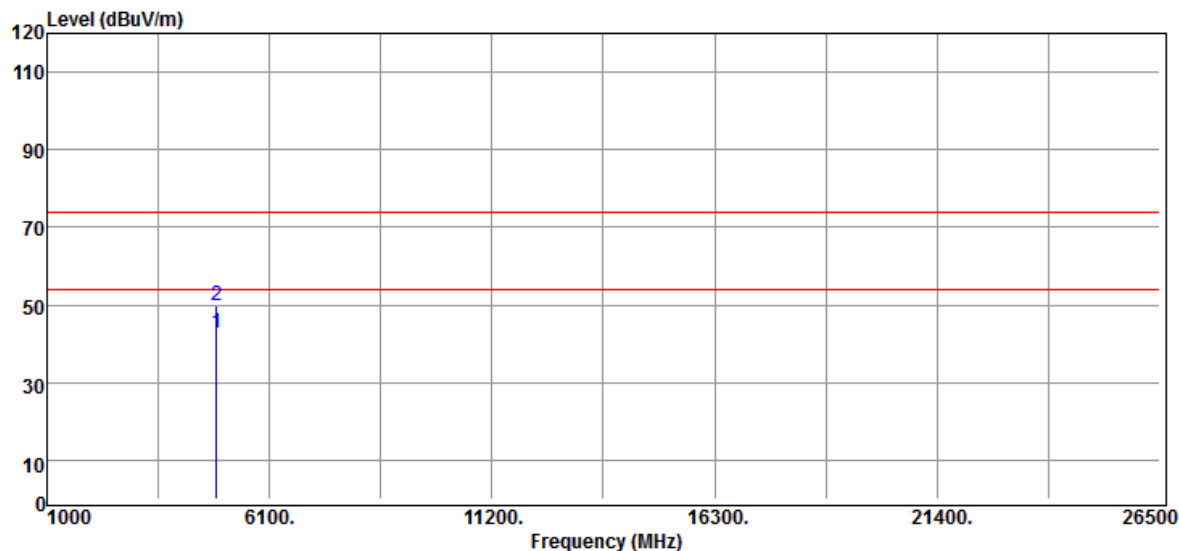
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Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:TX CH MID	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2442 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4884.00	Average	42.16	0.64	42.80	54.00	-11.20
4884.00	Peak	48.99	0.64	49.63	74.00	-24.37

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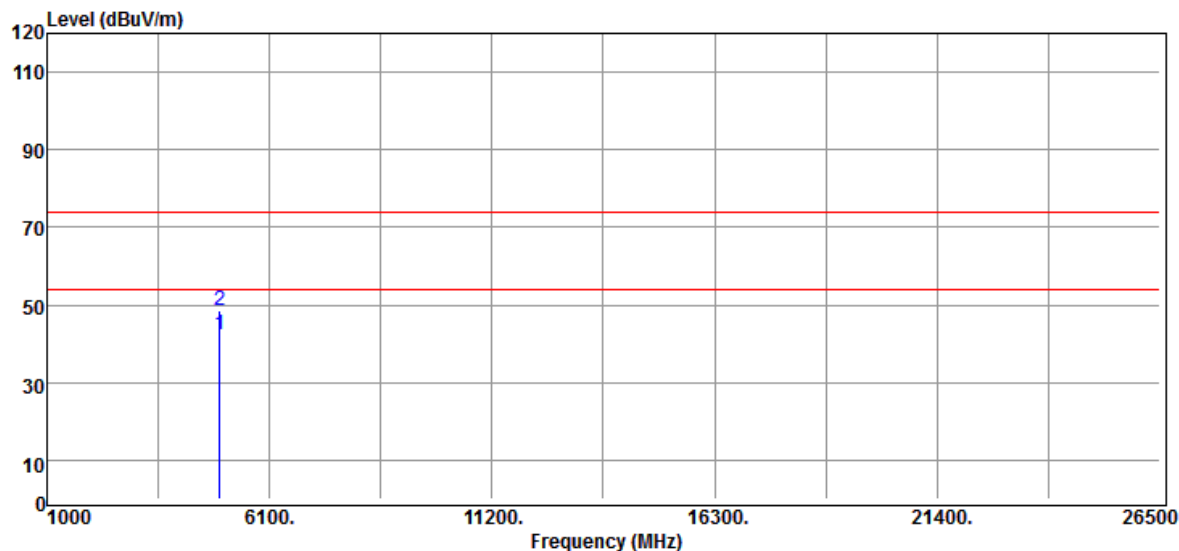
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Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:TX CH HIGH	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2480 MHz	Engineer	:Kailin



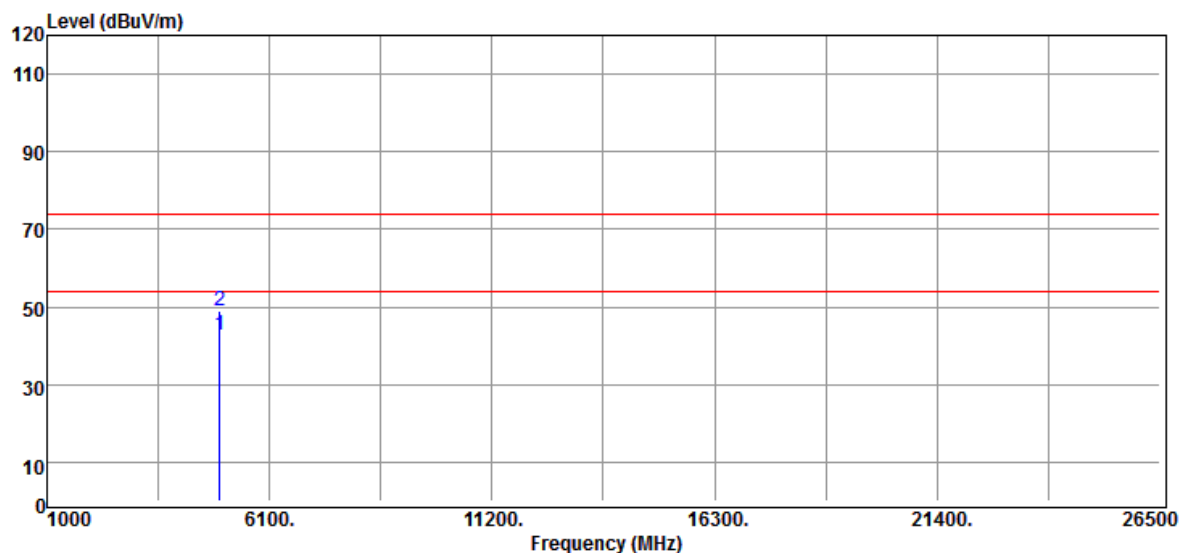
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4960.00	Average	41.26	1.15	42.41	54.00	-11.59
4960.00	Peak	47.30	1.15	48.45	74.00	-25.55

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Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:TX CH HIGH	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2480 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4960.00	Average	41.77	1.15	42.92	54.00	-11.08
4960.00	Peak	47.80	1.15	48.95	74.00	-25.05

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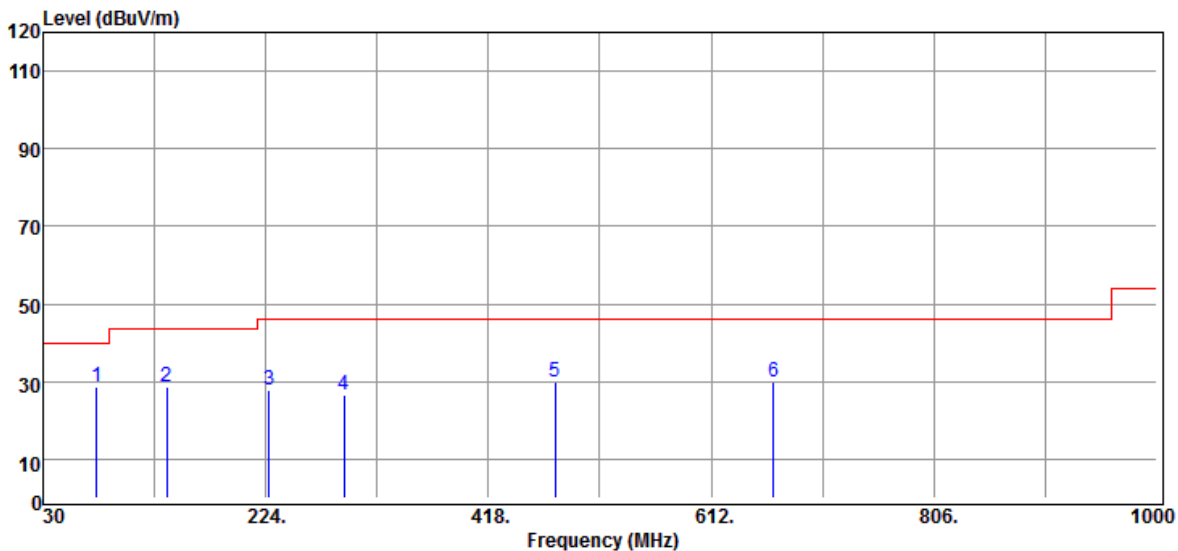
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6.5.3 接收機場強輻射之量測結果(1GHz 以下) (最差模式)

Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:RX CH MID	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2442 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
76.56	Peak	49.37	-20.80	28.57	40.00	-11.43
137.67	Peak	45.63	-17.16	28.47	43.50	-15.03
226.91	Peak	45.71	-17.69	28.02	46.00	-17.98
291.90	Peak	42.03	-15.63	26.40	46.00	-19.60
476.20	Peak	41.03	-11.23	29.80	46.00	-16.20
666.32	Peak	38.58	-8.55	30.03	46.00	-15.97

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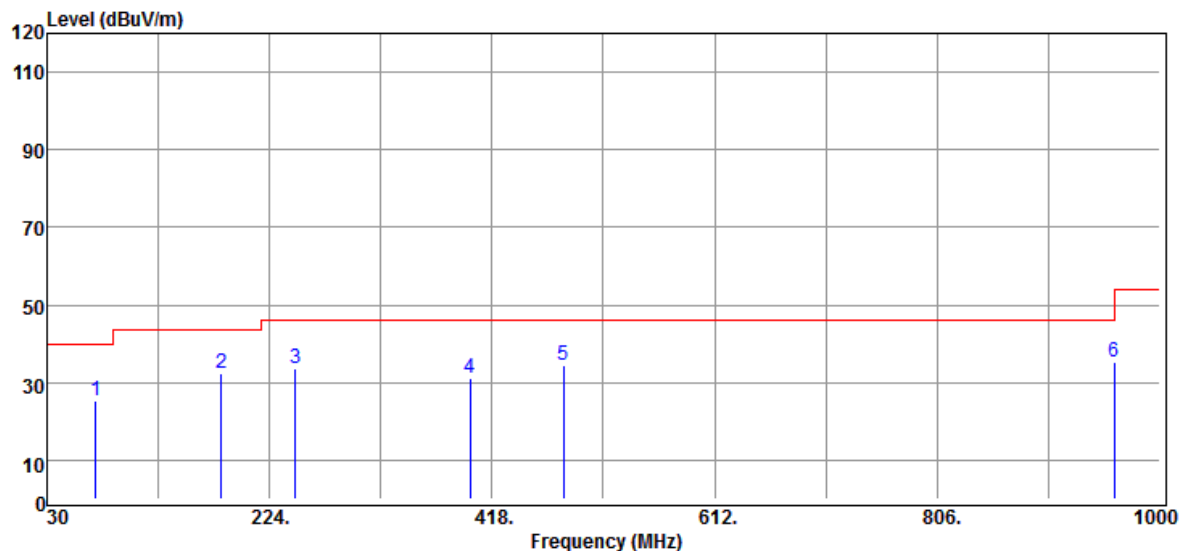
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Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:RX CH MID	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2442 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
72.68	Peak	45.41	-19.91	25.50	40.00	-14.50
182.29	Peak	49.93	-17.70	32.23	43.50	-11.27
246.31	Peak	50.62	-16.97	33.65	46.00	-12.35
398.60	Peak	43.92	-12.91	31.01	46.00	-14.99
480.08	Peak	45.59	-11.09	34.50	46.00	-11.50
960.23	Peak	39.15	-3.93	35.22	54.00	-18.78

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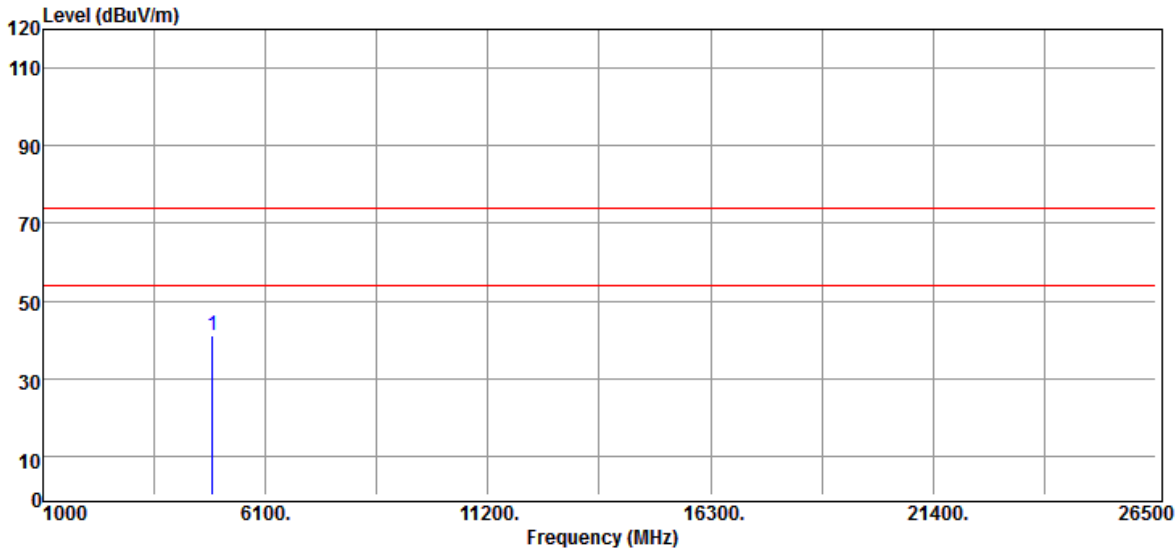
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6.5.4 接收模式場強輻射之量測結果(1GHz 以上) (最差模式)

Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:RX CH MID	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2442 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4884.00	Peak	40.35	0.64	40.99	74.00	-33.01

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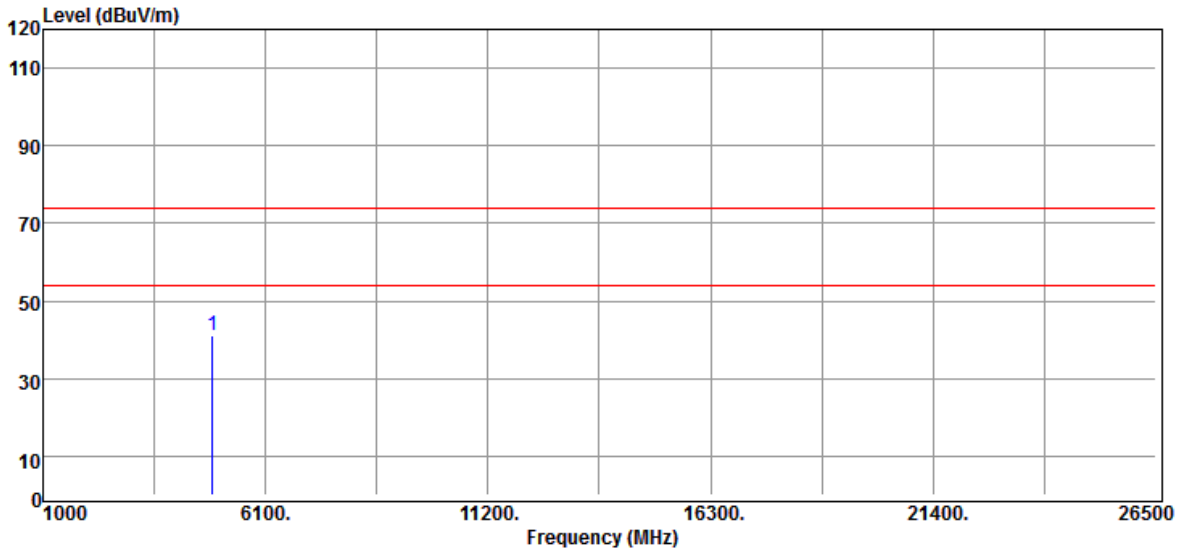
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Operation Mode	:BLE	Test Date	:2019-02-22
Test Mode	:RX CH MID	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2442 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
4884.00	Peak	40.26	0.64	40.90	74.00	-33.10

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7 天線增益之要求

7.1 適用標準

依據NCC低功率射頻電機技術規範3.10.1.3 (1)之規定，操作於2400-2483.5MHz 者，僅用於固定式點對點操作，其發射天線之方向性增益超過 6dBi，每超過3dB應降低1dB之峰值輸出功率。

依據NCC低功率射頻電機技術規範3.10.1.3 (2)之規定，操作於5725-5850MHz 者，其發射天線之方向性增益超過 6dBi，無須降低峰值輸出功率。

依據NCC低功率射頻電機技術規範3.10.1.3 (2)之規定，用於點對多點操作時，如其發射天線之方向性增益超過 6dBi，應依所超過之dB數等量降低最大傳導輸出功率。

註：固定式點對點操作使用方式，並不包括使用點對多點之系統、全向性之應用以及發射相同資訊之共同安裝的多重發射機。展頻或數位調變之發射器需要專業安裝，該設備操作者或安裝者有責任確認該系統是限用於固定式、點對點之操作，隨機所附之使用手冊必須包含此訊息以告知使用者或安裝者須負之責任。

7.2 天線增益

此裝置使用天線如下：

天線型式/天線增益	Ultra-Miniature 2.4GHz Ceramic Chip Antenna, Gain: 1dBi P/N.: 2450AT07A0100; Supplier: Johanson Technology, Inc
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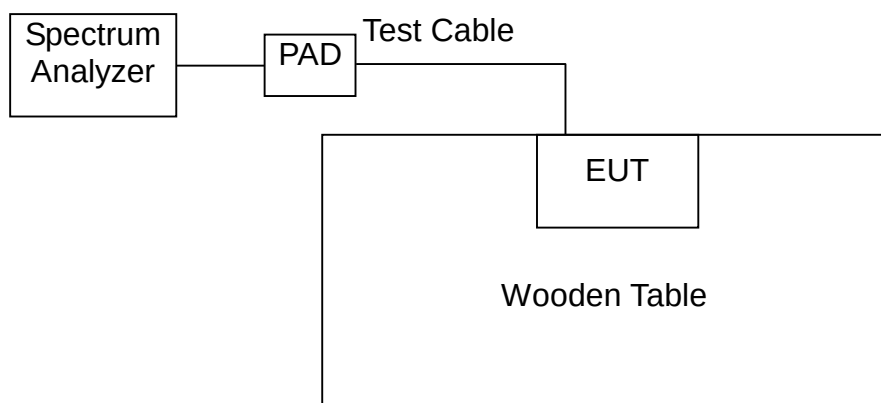
8 發射頻寬之要求

8.1 適用標準

對使用數位調變技術之低功率發射機，依據NCC低功率射頻電機技術規範3.10.1.6(2) (A)之規定，6dB之頻寬至少應有500kHz。

8.2 測試配置

圖 4: 發射頻寬之測試配置



8.3 量測結果

測試設備:	Bluetooth Low Energy Wireless Module	型號:	BGM11S22A
解析頻寬:	100 kHz	視訊頻寬:	300 kHz
Span:	5MHz	測試者:	裴笛翰/資深工程師

BT4.0 mode

頻率 (MHz)	頻寬讀值 (kHz)	限制值 (kHz)	結果
2402	766.4	> 500	PASS
2442	768.4	> 500	PASS
2480	765.4	> 500	PASS

* offset 10.8dB

Refer next page for test plots

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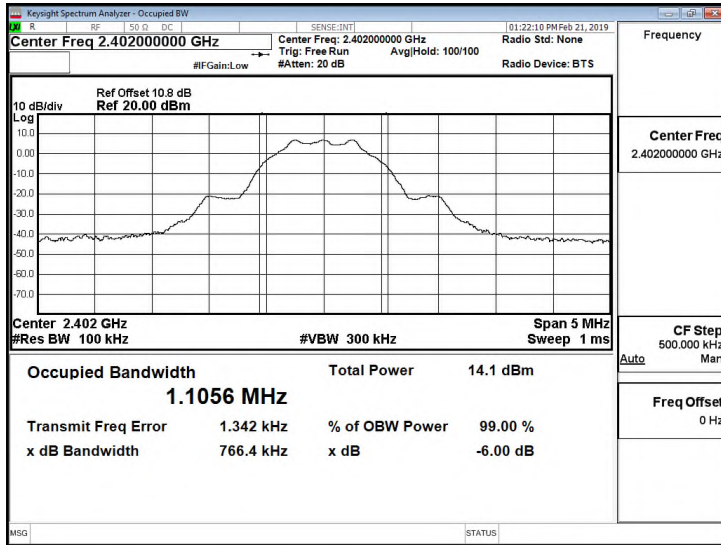
t (886-2) 2299-3279

f (886-2) 2298-0488

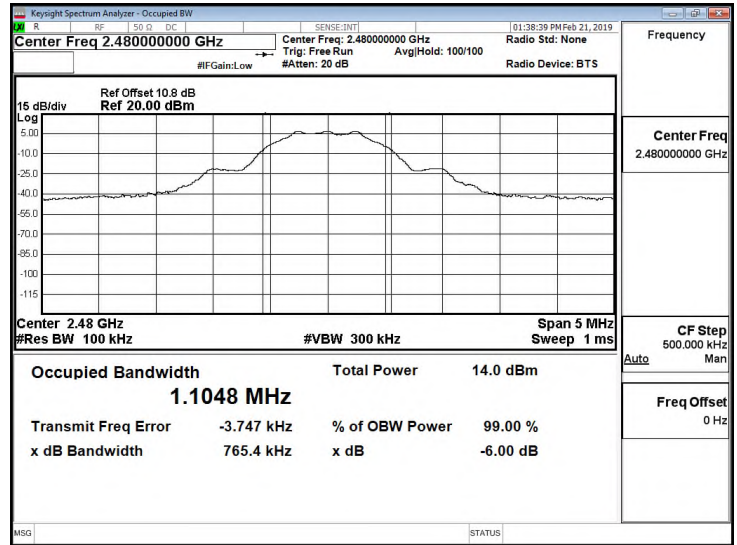
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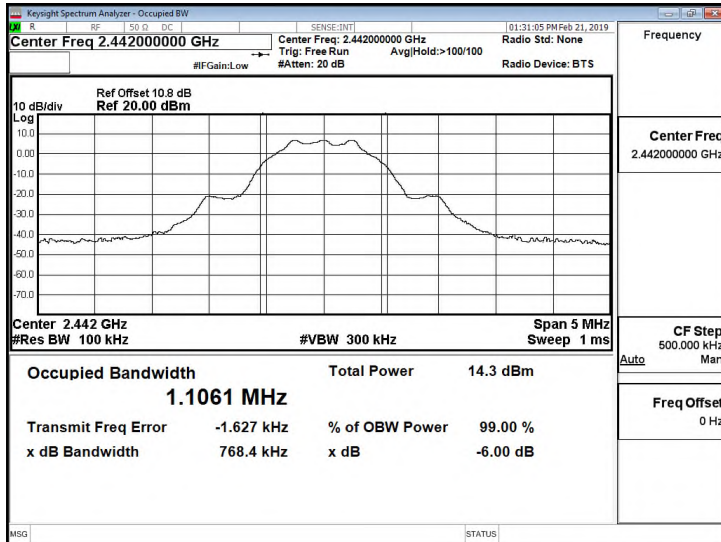
發射頻寬 6dB 之要求_BLE_1M_LowCH00-2402



發射頻寬 6dB 之要求_BLE_1M_HighCH39-2480



發射頻寬 6dB 之要求_BLE_1M_MidCH20-2442



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9 輸出峰值功率之量測

9.1 適用標準

依據 NCC 低功率射頻電機技術規範 3.10.1.2(1) (A)(C)之規定，操作於 2400-2483.5MHz 與 5725-5850MHz 之所有數位調變技術系統：1 Watt(含)以下。

依據NCC低功率射頻電機技術規範3.10.1.3之規定，用於非固定式點對點操作時，若其發射天線之方向性增益超過6dBi，應依所超過之dB數等量降低峰值輸出功率。如用於固定式點對點操作時，應符合下列情現之一：

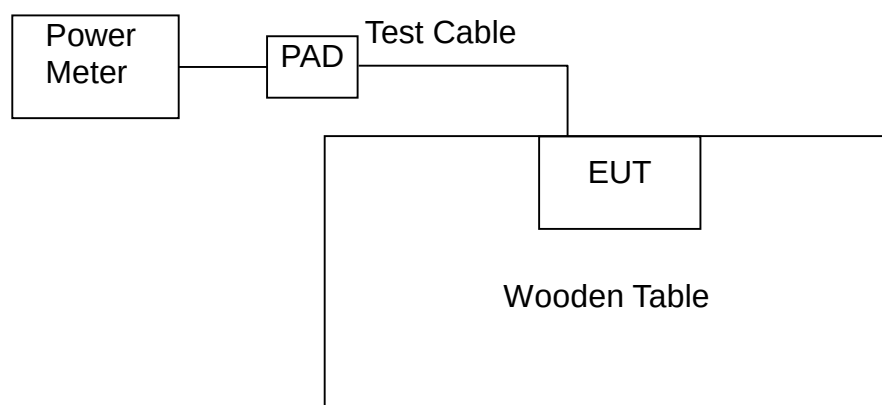
依據NCC低功率射頻電機技術規範3.10.1.3 (1)之規定，操作於2400-2483.5MHz 者，僅用於固定式點對點操作，其發射天線之方向性增益超過 6dBi，每超過3dB應降低1dB之峰值輸出功率。

依據NCC低功率射頻電機技術規範3.10.1.3 (2)之規定，操作於5725-5850MHz 者，其發射天線之方向性增益超過 6dBi，無須降低峰值輸出功率。

依據NCC低功率射頻電機技術規範3.10.1.3 (3)之規定，用於點對多點操作時，如其發射天線之方向性增益超過 6dBi，應依所超過之dB數等量降低最大傳導輸出功率。

註：固定式點對點操作使用方式，並不包括使用點對多點之系統、全向性之應用以及發射相同資訊之共同安裝的多重發射機。展頻或數位調變之發射器需要專業安裝，該設備操作者或安裝者有責任確認該系統是限用於固定式、點對點之操作，隨機所附之使用手冊必須包含此訊息以告知使用者或安裝者須負之責任。

9.2 輸出功率之測試配置



*註: 此產品為點對多點操作

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9.3 輸出功率之量測結果

測試設備: Bluetooth Low Energy Wireless Module 型號: BGM11S22A, BGM11S12A

測試日期: Feb. 25, 2019

測試者: 裴笛翰/資深工程師

BT4.0

Frequency (MHz)	Reading Power	Output Power (W)	Limit (W)
2402.00	7.87	0.00612	1
2442.00	7.98	0.00628	1
2480.00	7.84	0.00608	1
Cable loss	10.8 dB		

***Note:** 由 Power Meter 量測。

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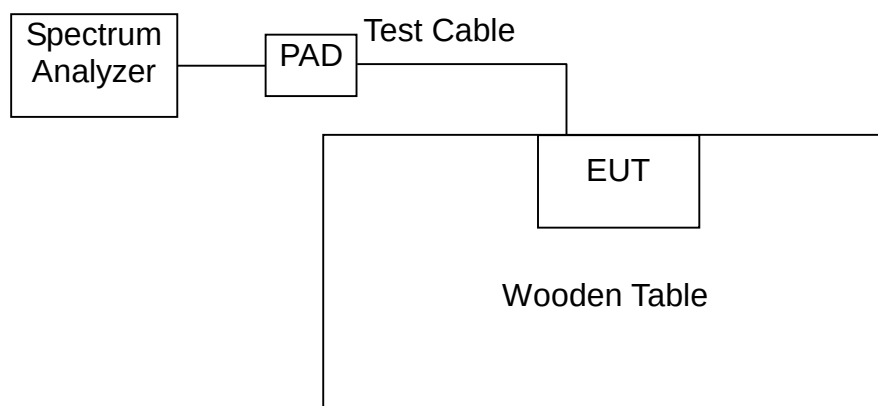
10 開放頻帶邊緣 100KHZ 頻寬內之限制

10.1 適用標準

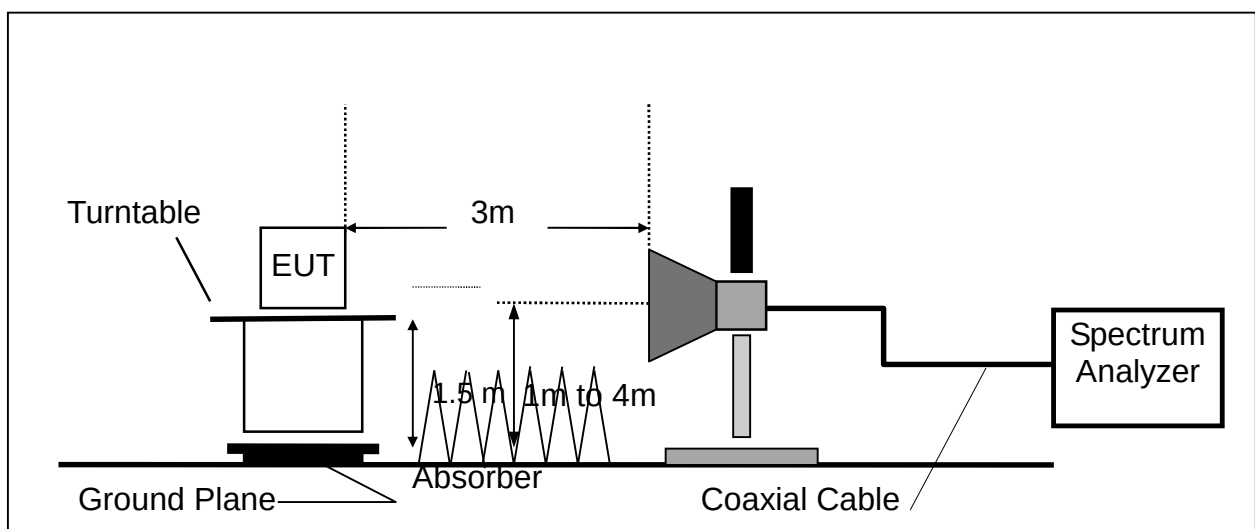
依據 NCC 低功率射頻電機技術規範 3.10.1.5 之規定，使用頻帶範圍外之任意 100kHz 內，發射器所產生的射頻功率相較於使用頻帶範圍中包含最高所需功率之 100kHz 內的射頻功率，須衰減 20 分貝 (dB)，以射頻傳導或輻射方式測量。此外，落於第 2.7 節禁用頻段之輻射發射，應符合第 2.8 節之規定。

10.2 開放頻帶邊緣之測試配置

(a) 傳導量測配置圖：



(b) 輻射量測配置圖：



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10.3 開放頻帶邊緣之量測結果

測試設備: Bluetooth Low Energy Wireless Module 型號: BGM11S22A
解析頻寬: 100 kHz 視訊頻寬: 300 kHz
Span: Low: 100MHz / High: 25MHz 測試者: 裴笛翰/資深工程師

10.3.1 頻帶外發射傳導量測值

發射限制測試值 CH Low (下邊緣頻帶): 在 2400.00MHz 之 100kHz 頻寬內最大值皆比主波低 20dB 以上。

發射限制測試值 CH High(上邊緣頻帶): 在 2483.50MHz 之 100kHz 頻寬內最大值皆比主波低 20dB 以上。

$Actual\ FS(dB\mu V/m) = SPA.\ Reading\ level(dB\mu V) + Factor(dB)$

$Factor(dB) = Antenna\ Factor(dB\mu V/m) + Cable\ Loss(dB) - Pre_Amplifier\ Gain(dB)$

Band Edge Limit

Frequency (MHz)	RF Power Density (dBm)	Bandedge Limit = PSD - 20dB
2402	6.57	-13.43
2442	6.71	-13.29
2480	6.41	-13.59

NOTE: cable loss as 10.8dB that offsets in the spectrum

NOTE: Refer to next page for plots.

Refer next page for test plots

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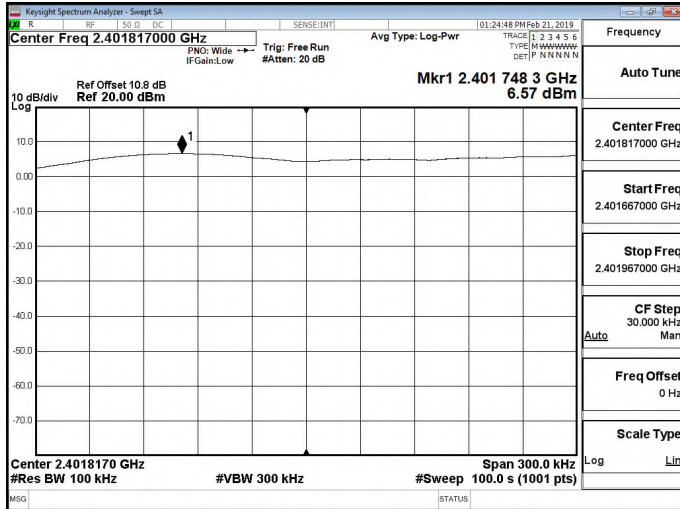
t (886-2) 2299-3279

f (886-2) 2298-0488

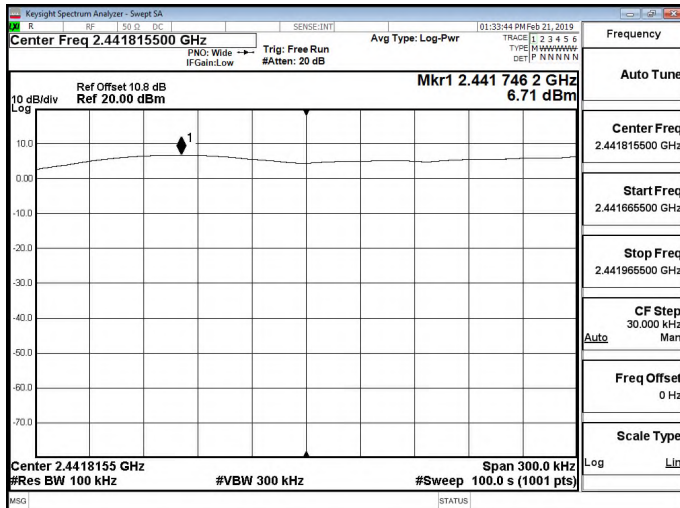
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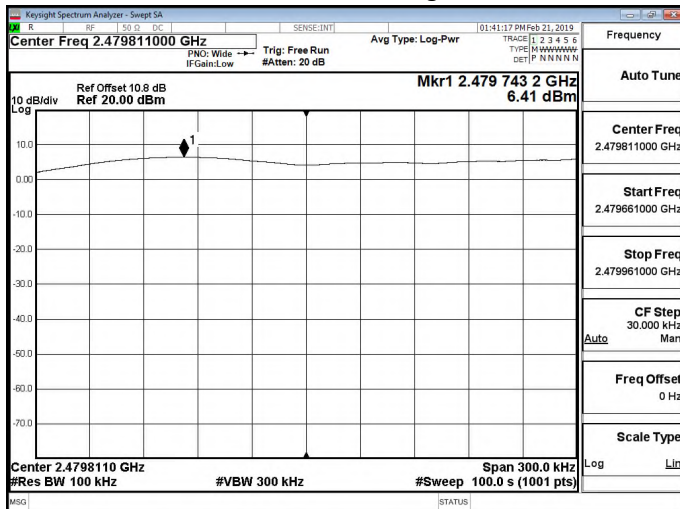
參考限制值_BLE_1M_LowCH00-2402



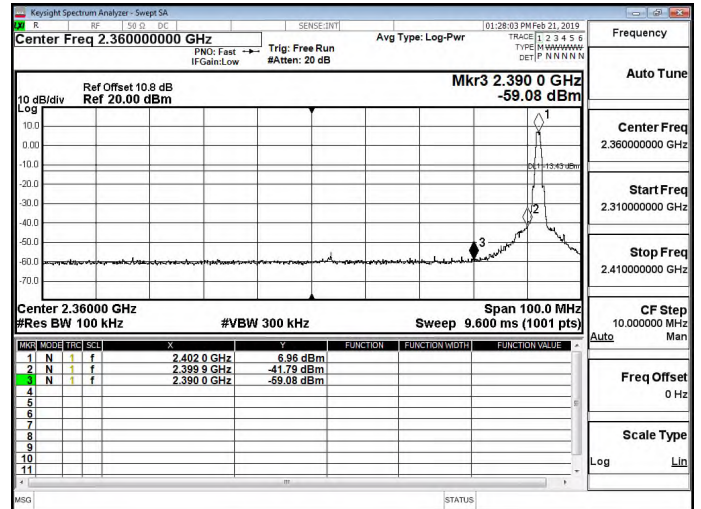
參考限制值_BLE_1M_MidCH20-2442



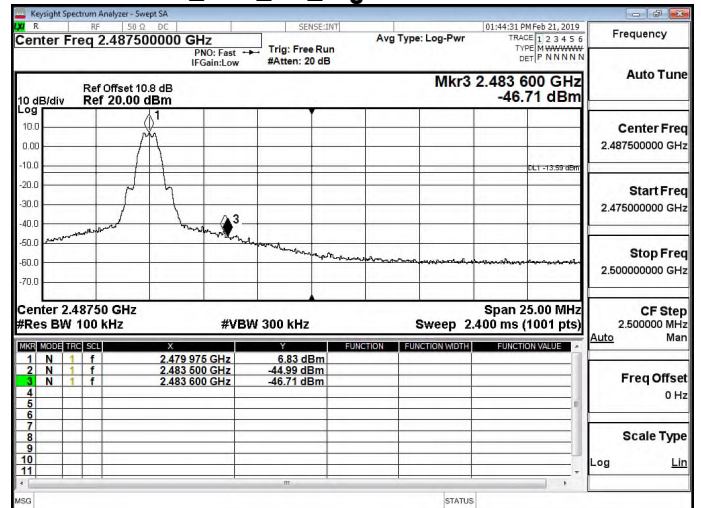
參考限制值_BLE_1M_HighCH39-2480



開放頻帶邊緣 100KHz 頻寬內之限制_BLE_1M_LowCH00-2402



開放頻帶邊緣 100KHz 頻寬內之限制_BLE_1M_HighCH39-2480



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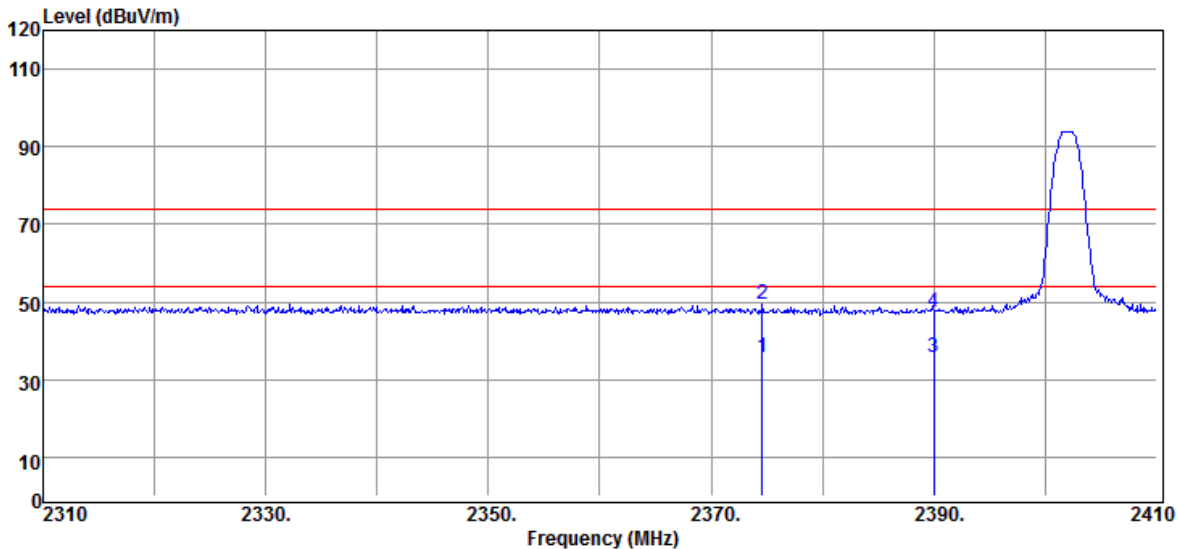
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10.3.2 禁用頻帶輻射量測值

Operation Mode	:BLE	Test Date	:2019-02-21
Test Mode	:BE CH LOW	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2402 MHz	Engineer	:Kailin



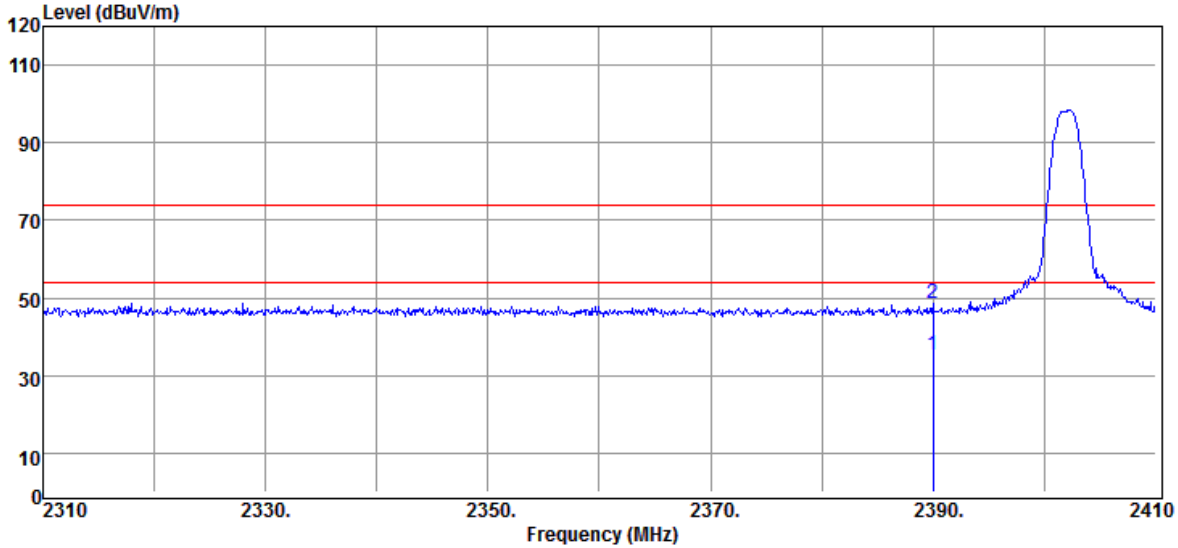
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2374.60	Average	41.06	-5.49	35.57	54.00	-18.43
2374.60	Peak	55.01	-5.49	49.52	74.00	-24.48
2390.00	Average	41.13	-5.50	35.63	54.00	-18.37
2390.00	Peak	52.74	-5.50	47.24	74.00	-26.76

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Operation Mode	:BLE	Test Date	:2019-02-21
Test Mode	:BE CH LOW	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2402 MHz	Engineer	:Kailin



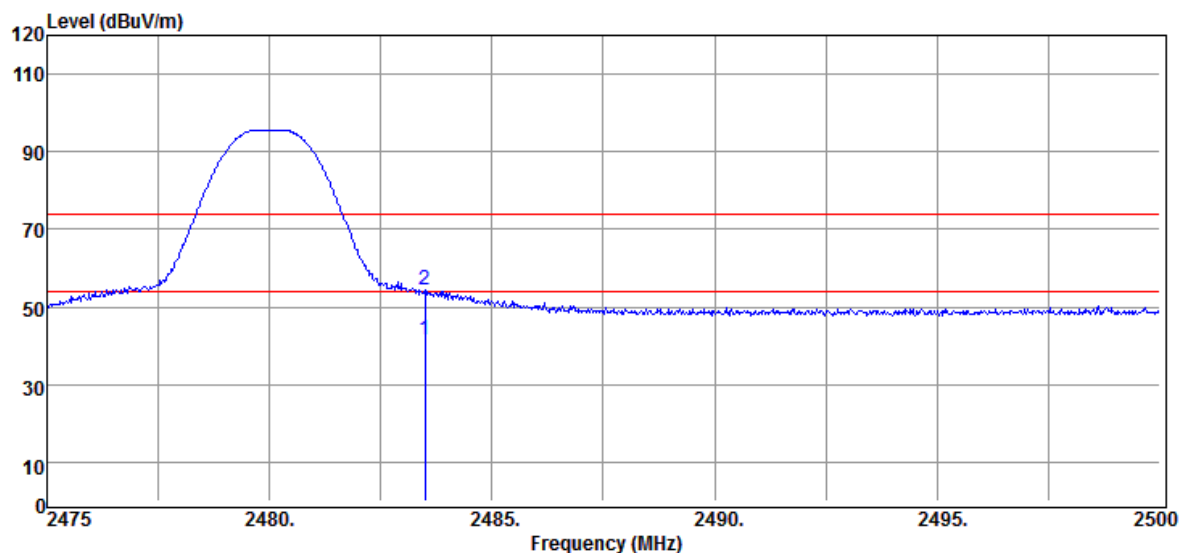
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2390.00	Average	40.92	-5.50	35.42	54.00	-18.58
2390.00	Peak	54.23	-5.50	48.73	74.00	-25.27

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Operation Mode	:BLE	Test Date	:2019-02-21
Test Mode	:BE CH HIGH	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL
Test Channel	:2480 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2483.50	Average	46.51	-4.89	41.62	54.00	-12.38
2483.50	Peak	59.17	-4.89	54.28	74.00	-19.72

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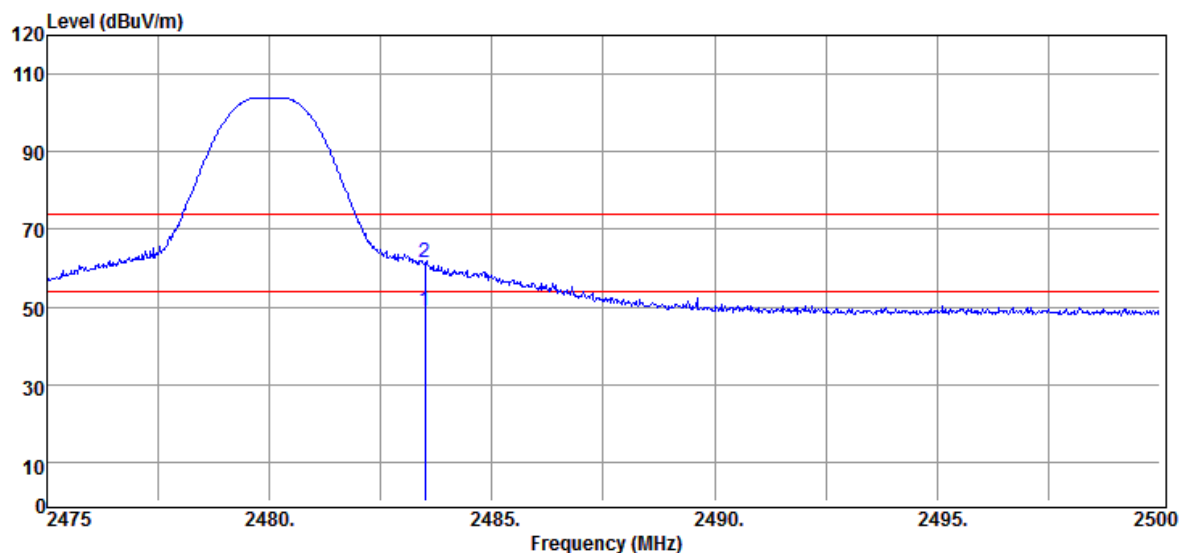
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Operation Mode	:BLE	Test Date	:2019-02-21
Test Mode	:BE CH HIGH	Temp./Humi.	:23/73
EUT Pol	:E2 Plan	Antenna Pol.	:HORIZONTAL
Test Channel	:2480 MHz	Engineer	:Kailin



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
2483.50	Average	53.90	-4.89	49.01	54.00	-4.99
2483.50	Peak	66.41	-4.89	61.52	74.00	-12.48

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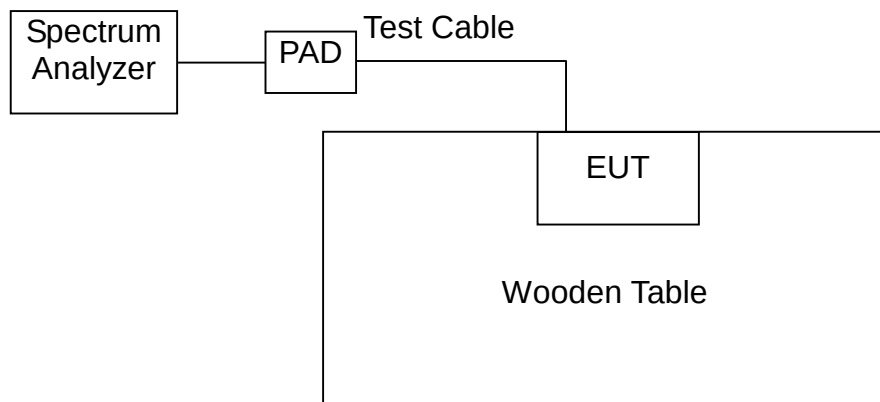
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11 功率密度之量測

11.1 適用標準

依據 NCC 低功率射頻電機技術規範 3.10.1.6(2) (B)規定，對數位調變之展頻系統，在使用頻率範圍之任意 3kHz 頻寬內，由發射機傳導至天線之峰值發射電功率密度在任意期間內，皆不得大於 8dBm。

11.2 功率密度之測試配置



11.3 功率密度量測結果

測試設備: Bluetooth Low Energy Wireless Module 型號: BGM11S22A
 解析頻寬: 3 kHz 視訊頻寬: 10 kHz
 Span: 300 kHz 測試者: 裴笛翰 / 資深工程師

BT4.0 mode

Frequency (MHz)	RF Power (dBm)	Maximum Limit (dBm)
2402	-8.21	8
2442	-8.07	8
2480	-8.35	8

* offset 10.8 dB

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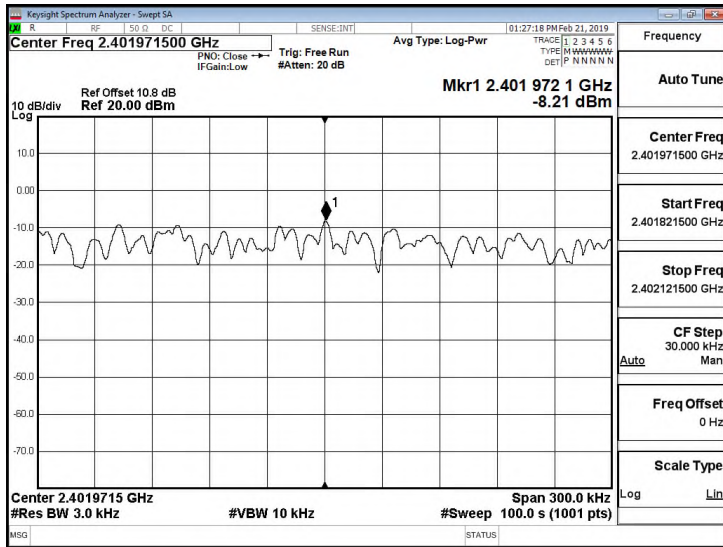
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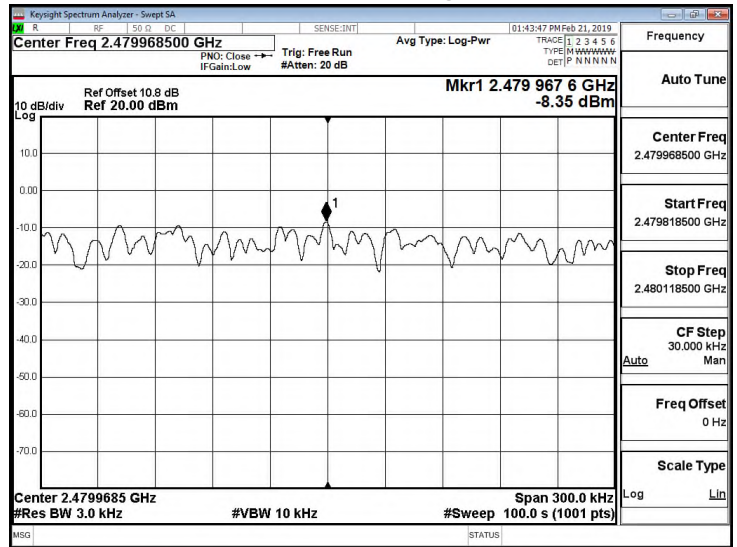
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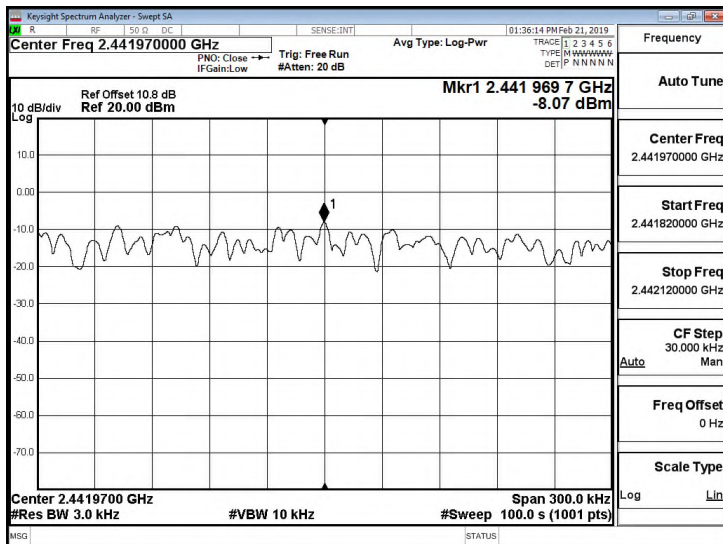
功率密度_BLE_1M_LowCH00-2402



功率密度_BLE_1M_HighCH39-2480



功率密度_BLE_1M_MidCH20-2442



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12 最大暴露允許值 (MAXIMUM PERMISSIBLE EXPOSURE, MPE)

12.1 規範要求

依據 NCC 低功率射頻電機技術規範之 5.20.2，其發射機距離人體 20 公分以上者，需證明其符合電波暴露量之要求，限制值如下：

(1) 職業性/可控制之暴露

頻率範圍 (MHz)	電場強度 (V/m)	磁場強度 (A/m)	功率密度 (mW/cm ²)	平均時間 (minutes)
0.3-3.0	614	1.63	*100	6
3-30	1842/f	4.89/f	*900/f ²	6
30-300	61.4	0.163	1.0	6
300-1,500	-----	-----	f/300	6
1,500- 100,000	-----	-----	5.0	6

註 1：標記*表平面波等效功率密度。

註 2：f 表測試頻率，單位：百萬赫(MHz)。

(2) 一般人/不可控制之暴露

頻率範圍 (MHz)	電場強度 (V/m)	磁場強度 (A/m)	功率密度 (mW/cm ²)	平均時間 (minutes)
0.3-3.0	614	1.63	*100	30
3-30	1842/f	4.89/f	*180/f ²	30
30-300	27.5	0.073	1.0	30
300-1,500	-----	-----	f/1500	30
1,500- 100,000	-----	-----	1.0	30

註 1：標記*表平面波等效功率密度。

註 2：f 表測試頻率，單位：百萬赫(MHz)。

12.2 適用種類

此待測物，為一般市面上販售，固適用表 2)之限制值

12.3 最大暴露允許值之評估

僅以最差模式進行評估，評估結果請見下頁。

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BLE mode:			
CH	Frequency (MHz)	Max. Avg. Output include tune up tolerance Power (dBm)	Required Limit
0	2402	7.77	1 Watt = 30 dBm
19	2442	7.89	1 Watt = 30 dBm
39	2480	7.71	1 Watt = 30 dBm

$$S = PG/4\pi R^2$$

S = 功率密度 P = 傳導功率 G = 天線增益值 R = 人體與天線之距離

Max. output power including tune-up tolerancel:	7.89	(dBm)
Max. output power including tune-up tolerancel:	6.151768727	(mW)
Duty cycle:	100	(%)
Maximum Pav :	6.151768727	(mW)
Peak Antenna gain (Maximum):	1	(dBi)
Peak Antenna gain (linear):	1.258925412	(numeric)
Prediction distance:	20	(cm)
Prediction frequency:	2442	(MHz)
MPE limit for uncontrolled exposure at prediction frequency:	1	(mW/cm^2)
Power density at predication frequency at 20 (cm) distance	0.002	(mW/cm^2)
運算之結果: 當功率密度在 20 cm · 其最大暴露值為 0.002 mW/cm^2. 註:工作頻率為頻率範圍1,500-100,000 (MHz), 固其對應之限制值為1.0mW/cm^2.		

~ End of Report ~

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