

# ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

# INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

	OF
Applicant:	MITSUMI ELECTRIC CO.,LTD.
••	2-11-2, Tsurumaki, Tama-Shi, TOKYO, 206-8567
	JAPAN
Product Name:	Bluetooth Low Energy Module (BLE)
Brand Name:	MITSUMI
Model No.:	WML-C103
Model Difference:	N/A
FCC ID:	EW4-WC103
Report Number:	E2/2018/80055
FCC Rule Part:	§15.247, Cat: DTS
Issue Date:	Aug. 22, 2018
Date of Test:	Aug. 13, 2018~ Aug. 15, 2018
Date of EUT Re- ceived:	Aug. 13, 2018

#### We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. Electronics & Communication Laboratory The test data, data evaluation, test procedures, and equipment configurations shown in this report were made in accordance with the procedures given in ANSI C63.10:2013 and the energy emitted by the sample EUT tested as described in this report is in compliance with conducted and radiated emission limits.

The test results of this report relate only to the tested sample identified in this report.

Tested By:

Vito Pei / Engineer

Approved By:

Jim Chang / Manager



0513

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# **Revision History**

Re	port Number	Revision	Description	Effected Page	Issue Date	Revised By
Eź	2/2018/80055	Rev.00	Initial creation of docu- ment	All	Aug. 22, 2018	Stefanie Yu / Clerk

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#### **GENERAL INFORMATION** 1

### **1.1 Product Description**

General:

Product Name:	Bluetooth Low Energy Module (BLE)
Brand Name:	MITSUMI
Model No.:	WML-C103
Model Difference:	N/A
Hardware Version (Product):	N/A
Power Supply:	3V from DC Power Supply

#### Bluetooth Low Energy:

Bluetooth Version:	Bluetooth V5.0 LE mode
Channel number:	40 channels
Modulation type:	GFSK
Transmit Power:	3.74 dBm
Frequency Range:	2402 – 2480MHz
Antenna Designation:	<ol> <li>PIFA Antenna, Antenna Gain: -1.2 dBi</li> <li>PIFA Antenna, Antenna Gain: 0.61dBi</li> </ol>

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#### 1.2 Test Methodology of Applied Standards

FCC Part 15, Subpart C §15.247

FCC KDB 558074 D01 DTS Meas. Guidance v04.

ANSI C63.10:2013

Note: All test items have been performed and record as per the above standards.

### 1.3 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory No.2, Keji 1st Rd., Guishan District, Taoyuan City, Taiwan 333 (TAF code 0513)

FCC Registration Number and Designation number are: 735305 / TW 0002

#### **1.4 Special Accessories**

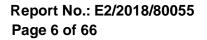
There are no special accessories used while test was conducted.

#### **1.5 Equipment Modifications**

There was no modification incorporated into the EUT.

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#### SYSTEM TEST CONFIGURATION 2

### 2.1 EUT Configuration

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner which intends to maximize its emission characteristics in a continuous normal application.

#### 2.2 EUT Exercise

An engineering test mode (software/firmware) that applicant provided was utilized to manipulate the EUT into transmit, selection of the test channel, and modulation scheme.

#### 2.3 Test Procedure

#### 2.3.1 Conducted Emissions

The EUT is a placed on as turn table which is 0.8 m above ground plan. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30 MHz,. The CISPR Quasi-Peak and Average detector mode is employed according to §15.207. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

#### 2.3.2 Radiated Emissions

The EUT is a placed on as turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plan. For emission measurements above 1 GHz, the table height shall be 1.5 m. The turn table shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emission. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this transmitter (EUT) was rotated through three orthogonal axes and measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.

#### 2.4 Measurement Results Explanation Example

#### For all conducted test items:

The offset level is set in the spectrum analyzer to compensate the RF cable loss and attenuation factor between EUT conducted port and spectrum analyzer. With the offset compensation, the spectrum analyzer reading level is exactly EUT RF output level.

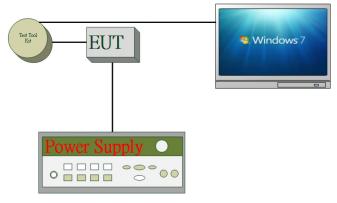
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### 2.5 Configuration of Tested System

# Fig. 2-1 Radiated & Conducted (Antenna Port) Emission Configuration



#### Table 2-1 Equipment Used in Tested System

ltem	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Ca- ble	Power Cord
1.	Bluetooth Test Software	N/A	N/A	N/A	N/A	N/A
2.	Notebook	Lenovo	T420	S0012599	Shielded	Unshielded
3.	DC Power Supply	Agilent	E3640A	MY53130054	N/A	Unshielded
4.	Test Tool Kit	N/A	N/A	N/A	N/A	N/A



#### SUMMARY OF TEST RESULTS 3

FCC Rules	Description Of Test	Result
§15.207(a)	AC Power Line Conducted Emission	N/A
§15.247(b) (3)	Peak Output Power	Compliant
§15.247(a)(2)	6dB Bandwidth	Compliant
§15.247(d)	Conducted Band Edge and Spurious Emission	Compliant
§15.247(d)	Radiated Band Edge and Spurious Emission	Compliant
§15.247(e)	Peak Power Density	Compliant
§15.203 §15.247(b)	Antenna Requirement	Compliant

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#### **DESCRIPTION OF TEST MODES** 4

### 4.1 Operated in 2400 ~ 2483.5MHz Band

40 channels are provided for Bluetooth LE

CHANNEL	FREQUENCY	CHANNEL	FREQUENCY	CHANNEL	FREQUENCY
1	2402 MHz	15	2430 MHz	29	2458 MHz
2	2404 MHz	16	2432 MHz	30	2460 MHz
3	2406 MHz	17	2434 MHz	31	2462 MHz
4	2408 MHz	18	2436 MHz	32	2464 MHz
5	2410 MHz	19	2438 MHz	33	2466 MHz
6	2412 MHz	20	2440 MHz	34	2468 MHz
7	2414 MHz	21	2442 MHz	35	2470 MHz
8	2416MHz	22	2444 MHz	36	2472 MHz
9	2418 MHz	23	2446 MHz	37	2474 MHz
10	2420 MHz	24	2448 MHz	38	2476 MHz
11	2422 MHz	25	2450 MHz	39	2478 MHz
12	2424 MHz	26	2452 MHz	40	2480 MHz
13	2426 MHz	27	2454 MHz		
14	2428 MHz	28	2456 MHz		



# 4.2 The Worst Test Modes and Channel Details

- 1. The EUT has been tested under operating condition.
- 2. Test program used to control the EUT for staying in continuous transmitting and receiving mode is programmed.

#### **RADIATED EMISSION TEST:**

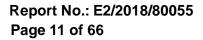
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	DATA RATE (Mbps)	
	RADIA	TED EMISSION TEST (	(BELOW 1 GHz)		
Bluetooth LE	2402 to 2480	2402, 2442, 2480	GFSK	1	
	RADIATED EMISSION TEST (ABOVE 1 GHz)				
Bluetooth LE	2402 to 2480	2402, 2442, 2480	GFSK	1	
<b>Note:</b> The field strength of radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode) for Bluetooth LE Transmitter for channel Low, Mid and High, the					

### ANTENNA PORT CONDUCTED MEASUREMENT:

worst case E2 position was reported.

CONDUCTED TEST				
MODE	AVAILABLE FREQUENCY (MHz)	TESTED FREQUENCY (MHz)	MODULATION	DATA RATE (Mbps)
Bluetooth LE	2402 to 2480	2402, 2442, 2480	GFSK	1

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#### **MEASUREMENT UNCERTAINTY** 5

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.586 dB
Peak Output Power	+/- 0.84 dB
6dB Bandwidth	+/- 51.33 Hz
100 KHz Bandwidth Of Frequency Band Edges	+/- 0.84 dB
Peak Power Density	+/- 1.3 dB
Temperature	+/- 0.65 °C
Humidity	+/- 4.6 %
DC / AC Power Source	DC= +/- 0.13%, AC= +/- 0.2%

Radiated Spurious Emission:

Measurement uncertainty (Polarization : <b>Vertical</b> )	9kHz – 30MHz: +/- 2.87 dB
	30MHz - 180MHz: +/- 3.37dB
	180MHz -417MHz: +/- 3.19dB
	0.417GHz-1GHz: +/- 3.19dB
	1GHz - 18GHz: +/- 4.04dB
	18GHz - 40GHz: +/- 4.04dB

	9kHz – 30MHz: +/- 2.87 dB
	30MHz - 167MHz: +/- 4.22dB
Measurement uncertainty	167MHz -500MHz: +/- 3.44dB
(Polarization : Horizontal)	0.5GHz-1GHz: +/- 3.39dB
	1GHz - 18GHz: +/- 4.08dB
	18GHz - 40GHz: +/- 4.08dB

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

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#### 6 CONDUCTED EMISSION TEST

### 6.1 Standard Applicable:

Frequency range within 150kHz to 30MHz shall not exceed the Limit table as below.

Frequency range	Lin dB(	
MHz	Quasi-peak	Average
0.15 to 0.50	66 to 56	56 to 46
0.50 to 5	56	46
5 to 30	60	50
Note 1.The lower limit shall apply at th 2.The limit decreases linearly wit MHz.	e transition frequencies h the logarithm of the frequency ir	the range 0.15 MHz to 0.50

#### 6.2 Measurement Equipment Used:

Conducted Emission Test Site						
EQUIPMENT	MFR	MODEL	SERIAL	LAST	CAL DUE.	
TYPE		NUMBER	NUMBER	CAL.		
LISN	TESEQ	NNB 51	36076	2018/02/14	2019/2/13	
EMI Test Receiver	R&S	ESCI	101300	2017/11/02	2018/11/1	
Notebook	Lenovo	L420	S0012467	N/A	N/A	

### 6.3 EUT Setup:

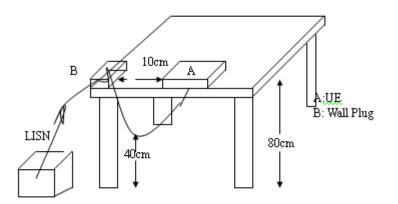
- 1. The conducted emission tests were performed in the test site, using the setup in accordance with the ANSI C63.10:2013.
- 2. The AC/DC Power adaptor of EUT was plug-in LISN. The EUT was placed flushed with the rear of the table.
- 3. The LISN was connected with 120Vac/60Hz power source.

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# 6.4 Test SET-UP (Block Diagram of Configuration)



#### 6.5 Measurement Procedure:

- 1. The EUT was placed on a table which is 0.8m above ground plan.
- 2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 3. Repeat above procedures until all phases of power being supplied by given UE are completed

### 6.6 Measurement Result:

N/A, the EUT powered from 3V DC Power Supply.

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#### PEAK OUTPUT POWER MEASUREMENT 7

# 7.1 Standard Applicable:

For systems using digital modulation in the 2400-2483.5 MHz bands, the limit for peak output power is 1Watt.

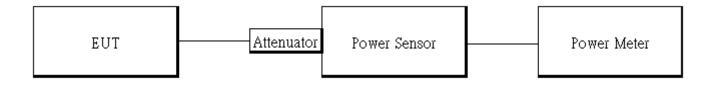
If the transmitting antenna of directional gain greater than 6dBi are used the peak output power form the intentional radiator shall be reduced below the above stated value by the amount in dB that the directional gain of the Antenna exceeds 6dBi.

In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of Antenna exceeds 6dBi.

#### 7.2 Measurement Equipment Used:

	Conducted Emission Test Site						
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.		
Power Meter	Anritsu	ML2496A	1326001	2018/08/09	2019/8/2		
Power Sensor	Anritsu	MA2411B	1315048	2018/08/09	2019/8/2		
Power Sensor	Anritsu	MA2411B	1315049	2018/08/09	2019/8/2		
DC Power Supply	Agilent	E3640A	MY53130054	2017/09/04	2018/9/3		
Attenuator	Marvelous	MVE2213-10	RF30	2017/12/26	2018/12/25		
Notebook	Lenovo	L430	P0000195	N/A	N/A		

### 7.3 Test Set-up:



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# 7.4 Measurement Procedure:

- 1.Place the EUT on the table and set it in transmitting mode.
- 2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- 3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the power meter.

### **Power Meter:**

It is used as the auxiliary test equipment to conduct the output power measurement.

4. Record the max. Reading as observed from Power Meter.

5.Repeat above procedures until all test default channel measured was complete.

# Formula:

Duty Cycle = Ton / (Ton+Toff)

# **Duty Factor:**

	Duty Cycle (%)	Duty Factor (dB)	1/T (kHz)	VBW setting (kHz)
BLE	68.54	1.64	1.47	2.00

	trum Analyzer - Sw										
XI R	RF 50 Ω eq 2.44200		GH7		SENS	SE:INT		ALIGN AUTO		MAug 10, 2018	Frequency
			PNO: Fast IFGain:Low		Trig: Free #Atten: 20				TY D	<sup>PE</sup> P NNNN <b>527.2 μs</b>	Auto Tun
10 dB/div	Ref Offset 10 Ref 20.00							,		0.98 dB	
10.0				_		Δ2					Center Fre
0.00	<u></u>										2.442000000 GH
20.0							1				Start Fre
-30.0	ļ										2.442000000 GH
50.0	d film way	June				-law.Man-law	ы. 		h	- MANAGARANA	
-60.0				_							Stop Fre
-70.0				_							2.442000000 GH
Center 2.4 Res BW 8	42000000 C MHz	GHz	#V	BW 8.	0 MHz			Sweep 1		Span 0 Hz (1001 pts)	CF Ste 8.00000 M
MKR MODE TRO		Х			Y	FUNC	TION FL	JNCTION WIDTH	FUNCTI	ON VALUE	<u>Auto</u> Ma
1 Δ2 1 2 F 1	t (Δ) t		424.0 µs 361.6 µs		1.15 d 2.40 dB						
3 ∆4 1 4 F 1	t (Δ)		627.2 µs 361.6 µs	Δ)	0.98 d 2.40 dB						Freq Offs
5			301.0 µ3		2.40 00					=	01
6 7											
8						-					
10						-					
11	+ +				m						
SG								STATU	5		E

# Duty Cycle Factor:10\*log(1/(68.54/100))=1.64

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#### 7.5 **Measurement Result:**

BLE mo	ode:		
СН	Frequency (MHz)	Peak Power Output (dBm)	Required Limit
0	2402	3.74	1 Watt = 30 dBm
20	2442	3.59	1 Watt = 30 dBm
39	2480	3.43	1 Watt = 30 dBm
BLE mo	ode:		
•	Fraguanay	Max. Avg. Output include	
СН	Frequency (MHz)	tune up tolerance Power (dBm)	Required Limit
<b>СН</b> 0		•	Required Limit 1 Watt = 30 dBm
_	(MHz)	(dBm)	•

\*Note: Measured by power meter, cable loss as 10.6 dB that offsets on the power meter in Peak \*Note: Measured by power meter, as cable loss+ Duty cycle factor that offsets on the power meter \*Note: Max. Output include tune up tolerance Power is average power



#### 8 6DB BANDWIDTH MEASUREMENT

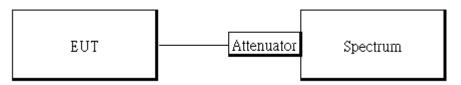
### 8.1 Standard Applicable

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

### 8.2 Measurement Equipment Used

Conducted Emission Test Site						
EQUIPMENT TYPE			-	LAST CAL.	CAL DUE.	
Spectrum Analyzer	Agilent	N9010A	MY5144011 3	2018/06/20	2019/6/19	
DC Power Supply	Power Supply Agilent E3640A MY5		MY5313005 4	2017/09/04	2018/9/3	
Attenuator	Marvelous	MVE2213-10	RF30	2017/12/26	2018/12/25	
DC Block	PASTERNACK	PE8210	RF29	2017/12/26	2018/12/25	
Notebook	Lenovo	L430	P0000195	N/A	N/A	

# 8.3 Test Set-up:



### 8.4 Measurement Procedure:

- 1. Place the EUT on the table and set it in transmitting mode.
- 2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- 3. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
- 4. For 6dB Bandwidth:

Set the spectrum analyzer as RBW=100 kHz, VBW= 3\*RBW, Span = 5MHz, Detector=Peak, Sweep=auto.

- 5. Mark the peak frequency and -6dB (upper and lower) frequency.
- 6. For 99% Bandwidth:

Set the spectrum analyzer as RBW=1%, VBW=3\*RBW, Span = 2MHz, Detector=Sample, Sweep=auto.

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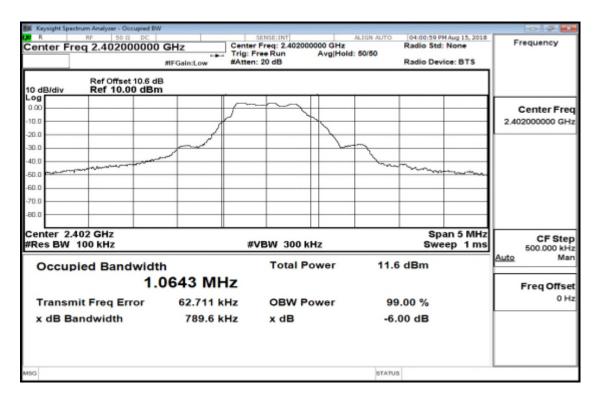
- 7. Turn on the 99% bandwidth function, max reading.
- 8. Repeat above procedures until all test default channel is completed

# 8.5 Measurement Result:

BLE mode			
Frequency (MHz)	6dB BW (MHz)	BW (MHz)	Result
2402	0.79	> 0.5	PASS
2442	0.723	> 0.5	PASS
2480	0.713	> 0.5	PASS

Note: Refer to next page for plots.

# 6dB Band Width Test Data CH-Low

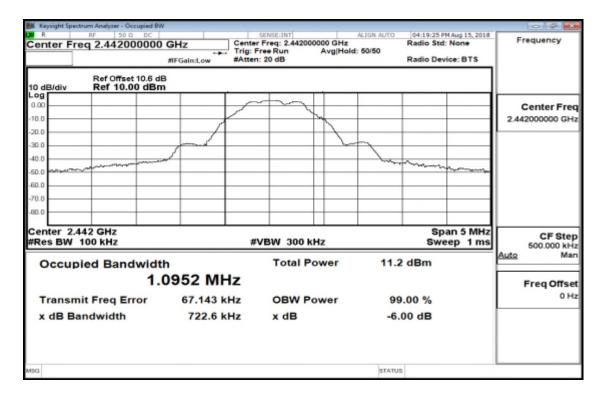


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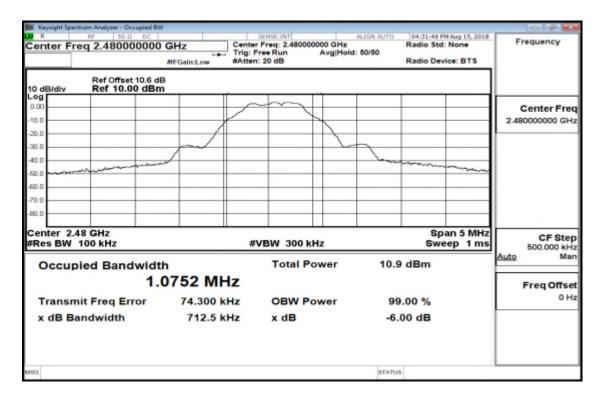
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# 6dB Band Width Test Data CH-Mid



# 6dB Band Width Test Data CH-High



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#### CONDUCTED BAND EDGES AND SPURIOUS EMISSION MEASUREMENT 9

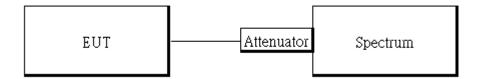
#### 9.1 Standard Applicable

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a).

#### 9.2 Measurement Equipment Used:

Conducted Emission Test Site						
EQUIPMENT	MFR	MFR MODEL SERIAL		LAST	CAL DUE.	
TYPE		NUMBER	NUMBER	CAL.		
Spectrum Analyzer	Agilent	N9010A	MY51440113	2018/06/20	2019/6/19	
DC Power Supply	Agilent	E3640A	MY53130054	2017/09/04	2018/9/3	
Attenuator	Marvelous	MVE2213-10	RF30	2017/12/26	2018/12/25	
DC Block	PASTERNACK	PE8210	RF29	2017/12/26	2018/12/25	
Notebook	Lenovo	L430	P0000195	N/A	N/A	

#### 9.3 Test SET-UP:



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# 9.4 Measurement Procedure

# **Reference Level of Emission Limit:**

- 1. Set analyzer center frequency to DTS channel center frequency.
- 2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- Set the span to 1.5 times the DTS channel bandwidth.
- 4. Set the RBW = 100kHz & VBW = 300 kHz.
- 5. Detector = peak.
- Sweep time = auto couple.
- 7. Trace mode = max hold.
- 8. Allow trace to fully stabilize.
- 9. Use the peak marker function to determine the maximum amplitude level.

# **Conducted Band Edge:**

- 1. To connect Antenna Port of EUT to Spectrum.
- 2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to the spectrum analyzer.
- 4. Set start to edge frequency, and stop frequency of spectrum analyzer so as to encompass the spectrum to be examined.
- 5. Set the spectrum analyzer as RBW=100 kHz, VBW=300 kHz, Detector = Peak, Sweep = auto
- 6. Mark the highest reading of the emission as the reference level measurement.
- Marker on frequency, 2.3999GHz and 2.4836GHz, and examine shall 100 kHz immediately outside the authorized (2400~2483.5 MHz) be attenuated by 20dB at least relative to the maximum emission of power.
- 8. Repeat above procedures until all default test channel (low, middle, and high) was complete.

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# **Conducted Spurious Emission:**

- 1. To connect Antenna Port of EUT to Spectrum.
- 2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- Set RBW = 100 kHz & VBW=300 kHz, Detector =Peak, Sweep = Auto
- 4. Allow trace to fully stabilize.
- 5. Use the peak marker function to determine the maximum power level in any 100 kHz band segment within the fundamental EBW.
- 6. Repeat above procedures until all default test channel measured were complete.

#### 9.5 Measurement Result

Frequency (MHz)	RF Power Density (dBm)	Reference Level of Limit = PSD - 20dB (dBm)
2402	3.85	-16.15
2442	3.61	-16.39
2480	3.41	-16.59

#### **Reference Level of Limit**

NOTE: cable loss as dB that offsets in the spectrum NOTE: Refer to next page for plots.

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#### Reference Level of Emission Limit (CH-Low)

					ctrum Analyzer - Swept S	
Frequency	04:01:13 PM Aug 15, 2018 TRACE 1 2 3 4 5 6 TVPE MWWWWW DET P NNNNN	Aug Type: Log-Pwr	Trig: Free Run	PNO: Wide	req 2.4020000	R Center Fi
Auto Tune	#Atten: 20 dB DETP NNNN Mkr1 2.402 063 0 GHz 3.85 dBm				Ref Offset 10.6 d Ref 10.00 dBr	0 dB/div
Center Fre 2.402000000 GH			•1			
Start Fre 2.401250000 GH					and warman and	20.0
Stop Fre 2.402750000 GH						30.0 menut
CF Stej 150.000 kH Auto Ma						50.0
Freq Offse 0 H						70.0
						80.0
	op 2.4027500 GHz .000 ms (1001 pts)		300 kHz	#VBW	12500 GHz 100 kHz	Res BW

#### **Reference Level of Emission Limit (CH-Mid)**

Keysight Spectrum Analyzer - Swept SA					
Center Freq 2.44200000	PNO: Wide	SENSE:INT	Aug Type: Log-Pwr Avg Hold:>50/50	04:29:11 PM Aug 15, 2018 TRACE 1 2 3 4 5 6 TYPE M WWWWW	Frequency
Ref Offset 10.5 dB 10 dB/div Ref 10.00 dBm	IFGain:Low	#Atten: 20 dB		.441 974 5 GHz 3.612 dBm	Auto Tune
0.00	_	~			Center Free 2.442000000 GH
20.0					Start Fre 2.441250000 GH
40.0					Stop Fre 2.442750000 GH
60.0					CF Ste 150.000 kH Auto Ma
70.0					Freq Offs 0 H
-80.0 Center 2.4420000 GHz #Res BW 100 kHz		300 kHz		Span 1.500 MHz .000 ms (1001 pts)	
MSG	#VDW	300 KH2	#Sweep		L

#### Reference Level of Emission Limit (CH-High)

Keysight Spect	rum Analyzer - Swept S					
	pg 2.4800000	00 GHz	Trig: Free Run	Avg Type: Log-Pv		Frequency
10 dB/div	Ref Offset 10.6 d Ref 10.00 dBr	PNO: Wide IFGain:Low B	#Atten: 20 dB	Mkr1	2.480 232 5 GH 3.41 dBn	Z Auto Tun
0.00		-		• <sup>1</sup>	u.	Center Fre 2.480000000 GH
-10.0						Start Fre 2.479250000 GH
40.0						Stop Fre 2.480750000 GH
50.0						CF Ste 150.000 ki Auto M
70.0						Freq Offs 01
80.0 Start 2.479	2500 GHz				Stop 2.4807500 GH	z
Res BW 1	00 kHz	#VE	W 300 kHz		1.000 ms (1001 pts	9
15G				81/	TUS	

#### **Band Edges Test Data CH-Low**

									nalyzar - Sive		ght Spec	L Key
Frequency	123456	04:10:34 PM/ TRACE	ALIGN AUTO	Avg	NSE:3NT	1	z	0000 GH	.36000	eq 2	er Fr	en
Auto Tur	PNNNNN	r3 2.390				#Atten: 2	IO: Fast G	P) IFC				
	dBm		MK						0ffset 10 10.00 c		div	0 dE
Center Fre	1											og 1.00
2.360000000 GH	-16.15 dBm			-						-		0.0
StartFre				_								0,0
2.310000000 GH		3		+						-		0.0
	Jun 1	Margaret 10	une man	Jam	Aura	readingence		·	ب. مربواسید	-	direct calif	0.0
Stop Fre 2.410000000 GH												0,0 0,0
CF Ste 10.000000 MH		Stop 2.410								000 0		
Auto Ma		600 ms (1	Sweep 9.	NOTION		300 kHz	#VBN	×	(HZ	_	BW	-
					Bm	3.94 d		2.402		1	1	1
Freq Offs 0 F					Bm	-68.18 di	GHz	2.390		1		
					-					$\square$	+	67
	-				+		-				+	9
					-	19						11
			lerer.e.									-

#### Band Edges Test Data CH-High

						ctrum Analyzar - Swe	
Frequency	04:38:00 PM Aug 15, 2018 TRACE 1 2 3 4 5 6 Type Middle 1	ALIGH AUTO	Av	Trig: Free Rur	0000 GHz	eq 2.48750	R Center F
Auto Tun	2,483 600 GHz -51.39 dBm	Mkr3		#Atten: 20 dB		Ref Offset 10 Ref 10.00 d	10 dB/div
Center Fre 2.487500000 GH	-16.53 d5n					1	0.00 10.0
Start Fre 2.475000000 GH					3		40.0
Stop Fre 2.50000000 GH	and and an and a	25/1842-0-0-018	hanning and	Martin and and a star			50.0 50.0 70.0
CF Ste 2.500000 MH Auto Ma	Stop 2.50000 GHz 100 ms (1001 pts)		-	V 300 kHz	#VB	500 GHz 100 kHz	
Freq Offse 0 H			PONCTION	3,61 dBm -50,92 dBm -61,39 dBm	2,480 075 GHz 2,483 600 GHz 2,483 600 GHz	1 1	1 N 2 N 3 N
							4 5 7 8 9 10 11
		STATUS					93

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### **Conducted Spurious Emission Measurement Re**sult

# CH-Low 30MHz - 3GHz

							malyzar - Svo			
Frequency	04:17:03 PM Aug 15, 2018 TRACE 1 2 3 4 5 6 TYPE M 44444	ype: Log-Pwr	A	SENSE:0	NO: Fast	D MHz	.00000	q 30.		R R
Auto Tun	1 2.403 0 GHz 3.82 dBm	Mk		#Atten: 20 dB	Gain:Low	1F .6 dB	Offset 10		B/div	
Center Fre 1.515000000 GH	1 .16.15 dBn									0.00 10.0 20.0
Start Fre 30.000000 MH								-	_	30.0 40.0 50.0
Stop Fre 3.00000000 GH	The manual second	and see the		p. h., de ay a la ser a seguine			لمحمدهم			60.0 70.0 60.0
CF Ste 297.000000 MH Auto Ma	Stop 3.000 GHz 3.9 ms (1001 pts)	Sweep 28	FUNCTION	00 kHz		×	kHz	MHz 100	MOTO	Re
Freq Offse 0 H				3.82 dBm	0 GHz	2.403		1 1	N	1234567
										8 9 10 11
		STATUS								53

#### CH-Low 3GHz - 26.5GHz

R Start Freq	3.0000000	DC 00 GHz PNO: Fest ( IFGaintLow	Trig: Free Run #Atten: 20 dB	Avg Typ	ALIGH AUTO	04:18:21 PM Aug 15, 2018 TRACE 1 2 3 4 5 6 TYPE NWWWW DET P NNNNN	Frequency
	Ref Offset 10.0 Ref 10.00 d	6 dB			MK	r1 4.809 5 GHz -41.76 dBm	Auto Tun
0.00						-16.15 dBn	Center Free 14.750000000 GH
30.0 40.0	1 2		23	<b>*</b>		and an an an an an and	Start Fre 3.000000000 GH
60.0	hand	in make of the second second	ha an	~~~~	Velletakora		Stop Fre 26.50000000 GH
Start 3.00 ( Res BW 1	00 kHz	#VB	W 300 kHz			Stop 26.50 GHz 2.246 s (1001 pts)	CF Ste 2.35000000 GH Auto Ma
1 N 1 2 N 1 3 N 1 4 N 1 5 6 7	1 1 1 1	4,809 5 GHz 7,206 5 GHz 12,000 5 GHz 16,818 0 GHz	41.76 dBm 49.87 dBm 48.16 dBm -50.37 dBm	FUNCTION	MUTCH WOTH	FUNCTION VALUE	Freq Offse 0 F
8 9 10 11							
190					STATUS	5	

# CH-Mid 30MHz – 3GHz

Keysight	Spectru	m Analyzer -									-0- 49- 23
R Start Fr	req -		000 MHz		1	SE:3NT	Avg Typ	e: Log-Pwr	TRU	PM Aug 15, 2018	Frequency
0 dB/div	, F	ef Offset	10.6 dB	PNO: Fast G	#Atten: 20	dB		Mk	r1 2.44	1 6 GHz	Auto Tune
0.00									▼1 	*	Center Fre 1.460000000 GH
20.0 30.0 40.0											Start Fre -80.000000 MH
0.0	- و بدا دی	<sup>رين</sup> باموهد وام.		****		kaa and shina	ne din ne mede	manuel	Uhan	of maximum of	Stop Fre 3.000000000 GH
tart -8 Res Bi				#VBV	V 300 kHz			Sweep 2	Stop 3 83.9 ms	3.000 GHz (1001 pts)	CF Ste 306.000000 MH Auto Mit
	1		2.44*	6 GHz	3.69 dE		NCTION FU	NCTION WOTH	FUNCT	ION VALUE	C1912
2 3 4 5											Freq Offse
6 7 8 9											
10											
-								and the second s			

### CH-Mid 3GHz – 26.5GHz

	Aug 15, 2018	04:10:57 85	ALIGN AUTO	-	SE-INT	50		pc	nalyzer - Swe	117	
Frequency	123456 NWWWW	TRAC	: Log-Pwr	Avg		Trig: Free	Hz	DC 00000 0	4.7500	req 1	ter F
Auto Tur	Bet Offert 10.6 dB Mkr1 12.212 0 GHz										
	2 dBm	-43.5						IBm	10.00 c	Ref	3/div
Center Fre				-	_					-	_
14.750000000 GH	-16.29 dBm			-						-	
Start Fre 3.00000000 GH			-			1	•				
	Jund Mar	- Million and a	the second strength		a		-Aunder			+	_
Stop Fre				and the second	al a grand	When a start of the start of th		and the second second	وقصيرهم	distance of	4000
26.50000000 GH											
CF Ste 2.35000000 GH	3.50 GHz	Span 23 2.246 s (1	Sweep			300 kHz	#VBW		Hz	4.75 0	ter 1 s BW
Auto Ma		EUNOTO	INTONIWOTH	CTION		Ý		х		RC SCL	NUDE
Freq Offs	_				im	-43.52 dE	0 GHZ	12.212		1 1	N
01				_	-		_				=
					-						-
	_				-						-
						**					

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#### CH-High 30MHz – 3GHz

Frequency	MAug 15, 2018	04:38:48 PF	LIGN AUTO		ESE:SNT	50		D DC	UF 501	1	R.
Frequency	CE 123456 PE NWWWW	TYP	Avg Type: Log-Pwr Trig: Free Run #Atten: 20 dB		IZ NO: Fast 😱 Sain:Low	00000 GH	1.5150	Freq	nter		
Auto Tur	0 3 GHz 38 dBm		Mki				Anneon	0.6 dB	of Offset 1 ef 10.00		B/div
Center Fre 1.515000000 GH	-16.55 dDm	▼1									
Start Fre 30.000000 MH											0
Stop Fre 3.00000000 GH	a marcara	Whendow	aboy and low	- Andrew Street and				-		namon M	
CF Ste 297.000000 Mi Auto Ma	2.970 GHz (1001 pts)	3.9 ms (	weep 28			300 kHz	#VBW		) kHz	1.515 W 10	es B
Freq Offs		FUNCTIO				3,38 d	3 GHz	2.480			
01											
							-				

#### CH- High 3GHz – 26.5GHz

						am Analyzar - Swept			
Frequency	04:40:09 PM Aug 15, 2018 TRACE 1 2 3 4 5 6 TVPE MUMUUM DET P NNNNN	Avg Type: Log-Pwr	SENSE:INT	Trig: Fre	PNO: Fast	q 14.75000	nter Free		
Auto Tur	ricalinitow #Atten: 20 dB Der P NAMA Ref Offset 10.6 dB AKr3 4.950 5 GH2 10 dB/div Ref 10.00 dBm -49.70 dBm								
Center Free 14.750000000 GH	-16.53 dBm								
Start Fre 3.000000000 GH				¢1	2	3 O <sup>2</sup>			
Stop Fre 26.50000000 GH	- pil of the planet of the	ل <sup>ىرىلى</sup> بىرى مىللىكى الريميني مىلى	an me free free	ner en ser ser der	un al la constant de		1 mart		
CF Ste 2.350000000 GH Auto Ma	Span 23.50 GHz 2.246 s (1001 pts)	Sweep		W 300 kH	#VB	00 kHz	ter 14.7 s BW 10		
Freq Offse 0 H			dBm	-41.55 d -51.10 d -49.70 d	12.400 0 GHz 7.441 5 GHz 4.950 5 GHz	1 1	N 1		
				17					
		STATUS							

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# 10 RADIATED BANDEDGE AND SPURIOUS EMISSION MEASUREMENT

#### **Standard Applicable** 10.1

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. In addition, radiated emissions which fall in the restricted bands must also comply with the §15.209 limit as below.

And according to §15.33(a) (1), for an intentional radiator operates below 10GHz, the frequency range of measurements: to the tenth harmonic of the highest fundamental frequency or to 40GHz, whichever is lower.

Frequency (MHz)	Field strength (microvolts/meter)	Distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

#### Note:

- 1. The lower limit shall apply at the transition frequencies.
- 2. Emission level  $(dB\mu V/m) = 20 \log Emission level (dB\mu V/m)$

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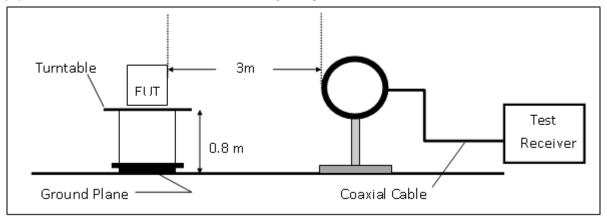
#### 10.2 **Measurement Equipment Used**

		966 Chamber			
EQUIPMENT	MFR	MODEL	SERIAL	LAST	CAL DUE.
TYPE		NUMBER	NUMBER	CAL.	
Broadband Antenna	TESEQ	CBL 6112D	35243	2017/11/10	2018/11/09
Horn Antenna	Schwarzbeck	BBHA9120D	1187	2018/01/04	2019/01/03
Horn Antenna	SCHWAZBECK	BBHA9170	184	2017/12/12	2018/12/11
Loop Antenna	ETS.LINDGREN	6502	148045	2017/09/26	2018/09/25
EMI Test Receiver	R&S	ESU 40	100363	2018/04/11	2019/04/10
Pre-Amplifier	EMC Instru- ments	EMC330	980096	2017/12/26	2018/12/25
Pre-Amplifier	EMC Instru- ments	EMC0011830	980199	2017/12/26	2018/12/25
Pre-Amplifier	EMC Instru- ments	EMC184045B	980135	2017/10/27	2018/10/26
Attenuator	Marvelous	WATT-218FS-10	RF246	2017/12/26	2018/12/25
Highpass Filter	Micro Tronics	BRM50701-01	G008	2017/12/26	2018/12/25
Coaxial Cable	Huber+Suhner	RG 214/U	W21.01	2017/12/26	2018/12/25
Coaxial Cable	Huber Suhner	EMC106-SM-SM -7200	150703	2017/12/26	2018/12/25
Coaxial Cable	Huber Suhner	SUCOFLEX 104	MY17388/4	2017/12/26	2018/12/25
Coaxial Cable	Huber Suhner	RG 214/U	W22.03	2017/12/26	2018/12/25
Notebook	Lenovo	T470	P0001293	N/A	N/A

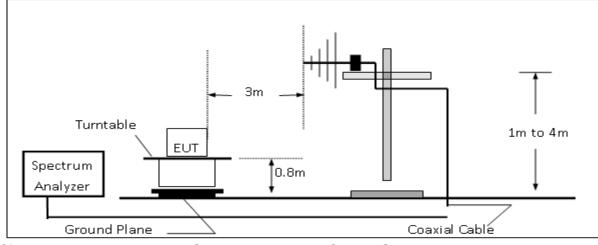


# 10.3 Test SET-UP

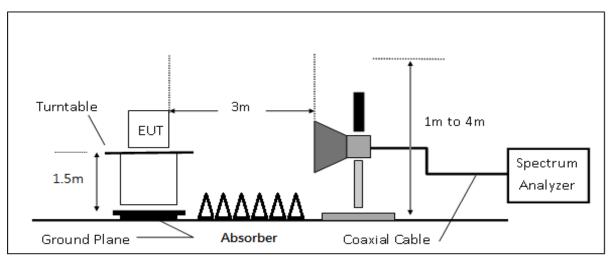
(A) Radiated Emission Test Set-UP Frequency Below 30MHz.



# (B) Radiated Emission Test Set-Up, Frequency form 30MHz to 1000MHz



(C) Radiated Emission Test Set-UP Frequency Over 1 GHz



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#### 10.4 Measurement Procedure

- 1. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- 2. The EUT was placed on a turn table with 0.8m for frequency< 1GHz and 1.5m for frequency> 1GHz above ground plan.
- 3. The turn table shall rotate 360 degrees to determine the position of maximum emission level.
- 4. EUT is set 3m away from the receiving antenna which varied from 1m to 4m to find out the highest emissions.
- 5. Set the spectrum analyzer as RBW=120 kHz and VBW=300 kHz for Peak Detector (PK) and Quasi-peak (QP) at frequency below 1 GHz.
- 6. Set the spectrum analyzer as RBW=1 MHz, VBW=3 MHz for Peak Detector at frequency above 1 GHz.
- 7. Set the spectrum analyzer as RBW=1 MHz, VBW=10 Hz (Duty cycle > 98%) or VBW ≥ 1/T (Duty cycle < 98%) for Average Detector at frequency above 1 GHz.
- 8. When measurement procedures for electric field radiated emissions above 1 GHz the EUT measurement is to be made "while keeping the antenna in the 'cone of radiation' from that area and pointed at the area both in azimuth and elevation, with polarization oriented for maximum response." is still within the 3dB illumination BW of the measurement antenna.
- 9. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
- 10. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. On spectrum, change spectrum mode in linear display mode, and reduce VBW = 10Hz if average reading is measured.
- 11. Repeat above procedures until all default test channel measured were complete.

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# 10.5 Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor and subtracting the Amplifier Gain and Duty Cycle Correction Factor (if any) from the measured reading. The basic equation with a sample calculation is as follows:

# FS = RA + AF + CL - AG

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)

### 10.6 Test Results of Radiated Spurious Emissions form 9 kHz to 30 MHz

The low frequency, which started from 9 kHz to 30MHz, was pre-scanned and the result which was 20dB lower than the limit per 15.31(o) was not reported.

#### 10.7 Measurement Result:

Note: Refer to next page spectrum analyzer data chart and tabular data sheets.

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#### Ant 1

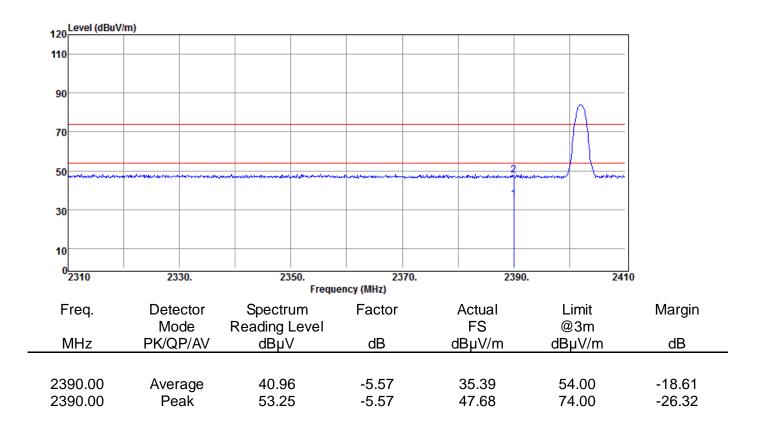
#### **Radiated Band Edge Measurement Result**

**Operation Mode** Test Mode EUT Pol Test Channel

:BLE :BE CH Low :E2 Plan :2402 MHz

Test Date Temp./Humi. Antenna Pol. Engineer

:2018-08-13 :25/60 :VERTICAL :Jerry



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Test Mode :B EUT Pol :E			LE E CH Low 2 Plan 402 MHz				Test Date Temp./Hu Antenna F Engineer			:2018-08-13 :25/60 :HORIZONTAL :Jerry	
420	Level (dBuV/m	)									
110											_
90											_
70										A	_
-							2		And and a stand of the stand	- North Marco	_
50	- Marina and Carlson	And a state of the	-an-anythermorph	adamatic and a state of the sta	pet-Inspection-c.	and and a state of the state of	alin manual	www.en.	1		
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10											_
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	2010	23.	50.	25		ency (MHz)	10.	2	550.	2-	
F	req.	Dete		Spectr		Factor		Actual		imit	Margin
	41.1_	Mo		Reading				FS		€3m	
IV	/Hz	PK/Q	P/AV	dBµ\	/	dB		dBµV/m	aв	μV/m	dB
237	72.00	Aver	ade	40.8	9	-5.56		35.33	5	4.00	-18.67
	72.00	Pe		54.94		-5.56		49.38			-24.62
	90.00	Aver		40.93		-5.57		35.36			-18.64
2390.00		Peak		55.41		-5.57		49.84 74.00		4.00	-24.16



Operation Mc Test Mode EUT Pol Test Channel	: :I :I	3LE 3E CH High E2 Plan 2480 MHz		Test Date Temp./Hun Antenna P Engineer		:2018-08-13 :25/60 :VERTICAL :Jerry
120 Level (dBuV/	m)					_
110						_
90						_
70						_
50 and	und	Warth Sprance more	an an the state of	an waa dagaa ahaa ahaa ahaa ahaa ahaa ahaa a	ter and a star and a st	
30						_
10						-
<sup>0</sup> 2475	2480.	2485. Free	2490 quency (MHz)	. 24	95. 2	500
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV		dB	dBµV/m	dBµV/m	dB
2483.50 2483.50	Average Peak	40.99 54.00	-4.90 -4.90	36.09 49.10	54.00 74.00	-17.91 -24.90

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Operation Mo Test Mode EUT Pol Test Channel	ode	:BLE :BE CH High :E2 Plan :2480 MHz			:2018-08-13 :25/60 :HORIZONTAL :Jerry				
120 Level (dBuV/	m)					1			1
110									
90									
70	$\neg \frown$								
		<u> </u>							
50 month and		and a second	hairme-be <sup>rn</sup> ittigeterbillentefbi	have a start and the second	an a	an a	an a	head and the second and the second	
30									
10									
<sup>0</sup> 2475	2480.	2	485. Freque	249 ncy (MHz)	0.	24	495.	250	io
Freq.	Detecto			Factor		Actual		Limit	Margin
MHz	Mode PK/QP/A	Mode Reading K/QP/AV dBµ\		dB		FS dBµV/m		@3m 3µV/m	dB
		ν ασμ	v	uD			UL	-μν/11	
2483.50	Average	e 40.9	92	-4.90		36.02	5	54.00	-17.98
2483.50 Peal		54.52		-4.90		49.62		74.00	-24.38

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#### Ant 2

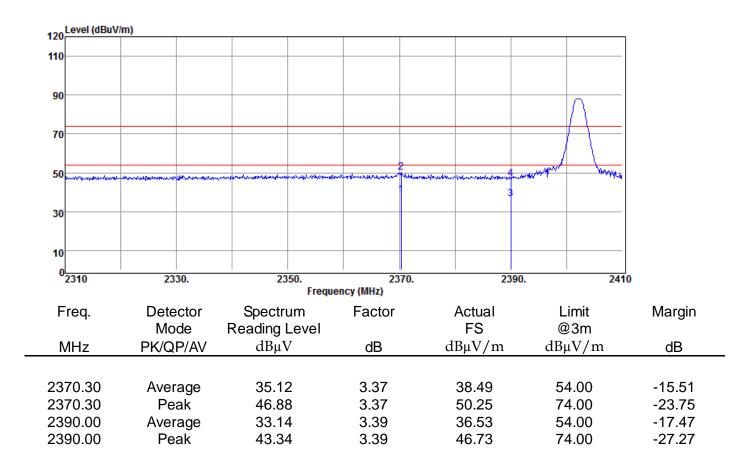
#### **Radiated Band Edge Measurement Result**

**Operation Mode** Test Mode EUT Pol Test Channel

:BLE :BE CH LOW :H Plan :2402 MHz

Test Date Temp./Humi. Antenna Pol. Engineer

:2018-09-21 :24/62 :VERTICAL :Ashton



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EUT Pol :H				LE E CH LOW Plan 402 MHz				Test Date Temp./H Antenna Enginee	lumi. 1 Pol.		:2018-09-21 :24/62 :HORIZONTAL :Ashton
120	Level (dBuV/m	)									_
110											-
90										Λ	_
70										$\uparrow$	_
50	and and for the second second	waanna kaa aagaa ah	the Barriston and the second second	Manufacture Martine Construction	alandahan kanya yakan	2	manut		- Andrew Mag Market	4 Min	-
30									3		-
10											-
U	2310	233	30.	23	50. Frequ	ency (MHz)	2370.		2390.	24	110
F	req.	Dete Moo		Spectr Reading		Fact	or	Actual FS		Limit @3m	Margin
N	ЛНz	PK/QF	P/AV	dBµV		dB		dBµV/1	n dl	βμV/m	dB
	64.70	Avera		32.9		3.37		36.36		54.00	-17.64
23	2364.70 Peak 2390.00 Average 2390.00 Peak		46.83 33.09 44.29		3.3 3.39 3.39	9	50.20 36.48 47.68	:	74.00 54.00 74.00	-23.80 -17.52 -26.32	

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Operation Mode:BLETest Mode:BE CH HEUT Pol:H PlanTest Channel:2480 MH			CH HIGH lan			Te Ar	st Date mp./Hur Itenna P Igineer			:2018-09-21 :24/62 :VERTICAL :Ashton	
120	Level (dBuV/m	1)									1
110											
90											
70		1									
	No. of		,								
50	and have governed to			mon			and and a second second second	Maria and a star and a star of the star		house and the second	
				1							
30											
50											
10											
0	2475	24	80.	24	485.		90.	24	95.	250	0
					Freque	ncy (MHz)					
F	req.	Dete	ctor	Spectr	um	Factor		Actual	L	imit	Margin
		Mo	de	Reading	Level			FS	0	23m	-
Ν	ЛНz	PK/Q	P/AV	dBµV	V	dB	d	BµV/m	dBj	ıV/m	dB
									-		
24	83.50	Aver	ane	37.1	6	3.96		41.12	5.	4.00	-12.88
	83.50	Pea		47.7		3.96		51.73		4.00	-22.27
	83.55	Aver		37.2		3.96		41.25		4.00	-12.75
	83.55	Pea	•	48.8		3.96		52.77		4.00	-21.23
27	00.00	1.60	un	-0.0	1	0.00		02.11	/ ·	1.00	-21.20

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Operation Mode:BLETest Mode:BE CH HIGHEUT Pol:H PlanTest Channel:2480 MHz							Te Te Ar Er	:2018-09-2 :24/62 :HORIZONT/ :Ashton				
120	Level (dBuV/n	n)									_	
110											-	
90											-	
70		/										
50				13	n-usampteeringe	and a horal with a substance	Mana and International States	analyse and a state of the	- 102-00-0-1-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0	alphanana kana kana kana kana kana kana kan	-	
30											-	
10											-	
0	2475	24	80.	24	I85. Frequei	24 24 ncy (MHz)	90.	24	495.	25	00	
F	req.	Dete Mo		Spectr Reading		Factor		Actual FS		imit 23m	Margin	
N	ЛНz	PK/Q	P/AV	dBµV	V	dB	d	BµV/m	dBµ	ıV/m	dB	
	83.50 83.50	Aver Pe		38.5 48.6		3.96 3.96		42.50 52.63	-	4.00 4.00	-11.50 -21.37	
24	83.73	Aver	age	36.6	7	3.96		40.63	54	4.00	-13.37	
24	83.73	Pe	ak	48.9	9	3.96		52.95	74	1.00	-21.05	



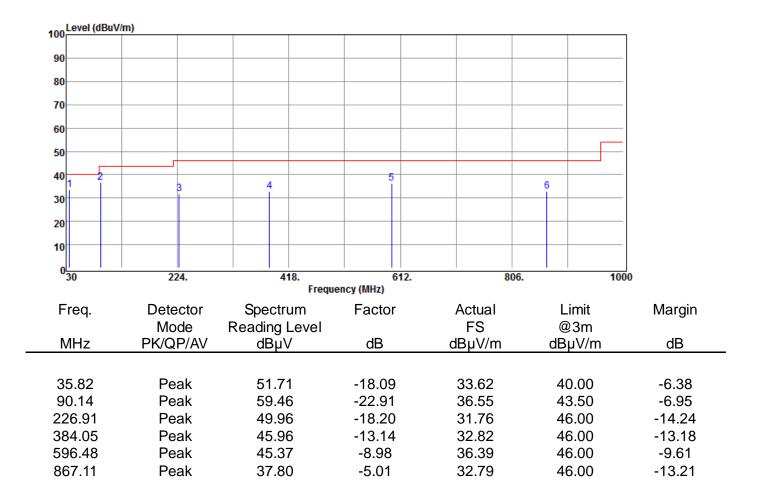
#### Ant 1 **Radiated Spurious Emission Measurement Result** For Frequency form 30MHz to 1000MHz :BLE

**Operation Mode** Test Mode EUT Pol **Test Channel** 

:Tx CH Low :E2 Plan :2402 MHz

Test Date Temp./Humi. Antenna Pol. Engineer

:2018-08-13 :25/60 :VERTICAL :Jerry



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Operation M Test Mode EUT Pol Test Channe		:BLE :Tx CH Low :E2 Plan :2402 MHz		Test Date Temp./Humi. Antenna Pol. Engineer					2018-08-13 25/60 HORIZONTAL Jerry
100 Level (dBuV/m)									
90									
80									
70									_
60									
50									
40	1	2		3	4	5	6		-
30									_
20									_
10									_
030	224.	41	8.	612.		80	6.	1	000
Freq.	Detector	Spectru	Frequency (MH	actor	Act	tual	Lim	it	Margin
	Mode	Reading I			F		@3		
MHz	PK/QP/A			dB	dBµ	V/m	dBµ∖	//m	dB
191.99	Peak	56.59		9.52	37.	-	43.5		-6.43
384.05	Peak	51.75		3.14	38.		46.0		-7.39
550.89	Peak	48.19		0.36		.83	46.0		-8.17
645.95 805.03	Peak Peak	45.78 42.49		8.43 6.20	37. 36.	.35	46.0 46.0		-8.65 -9.71
805.03 888.45	Peak	42.43		6.20 6.06	36. 36.		46.0 46.0		-9.95
000.40	roak	٦٢.١	•	0.00	50.	.00	-0.0		0.00

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Operation Mc Test Mode EUT Pol Test Channel	:T) :E:	LE x CH Mid 2 Plan 442 MHz		Test Date Temp./Humi. Antenna Pol. Engineer	:2018-08-13 :25/60 :VERTICAL :Jerry	
100 Level (dBuV/	/m)					7
90						_
80						_
70						_
						_
60						-
50						-
40 1	2	3 4	5			-
30						-
20						-
10						-
030	224.	418.	612.	806.	10	00
			ency (MHz)			
Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode	Reading Level	dB	FS	@3m	
	PK/QP/AV	dBµV	uв	dBµV/m	dBµV/m	dB
90.14	Peak	58.15	-22.91	35.24	43.50	-8.26
138.64	Peak	53.88	-16.70	37.18	43.50	-6.32
350.10	Peak	50.41	-13.95	36.46	46.00	-9.54
412.18	Peak	50.10	-12.36	37.74	46.00	-8.26
642.07	Peak	43.70	-8.24	35.46	46.00	-10.54
719.67	Peak	45.58	-7.81	37.77	46.00	-8.23

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Operation Mo Test Mode EUT Pol Test Channel	LE x CH Mid 2 Plan 442 MHz		Test Date Temp./Humi Antenna Po Engineer		:2018-08-13 :25/60 :HORIZONTAL :Jerry	
100 Level (dBuV	/m)				1	7
90						
80						
70						
60						
50		4				
<b>40</b> 2 1	3	Ĩ		5	6	
30						
20						
10						
030	224.	418. Erogu	612. iency (MHz)	806	. 100	DO
Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
1109.	Mode	Reading Level	1 dotor	FS	@3m	Margin
MHz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
60.07	Peak	49.27	-17.68	31.59	40.00	-8.41
100.81	Peak	59.00	-23.91	35.09	43.50	-8.41
143.49 384.05	Peak Peak	55.55 50.73	-18.92 -13.14	36.63 37.59	43.50 46.00	-6.87 -8.41
384.05 665.35	Peak	44.57	-13.14 -8.76	37.59 35.81	46.00	-0.41
863.23	Peak	41.13	-5.23	35.90	46.00	-10.10
000.20	1 0010		0.20	00.00	10.00	10110

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Operation Mode Test Mode EUT Pol Test Channel	:Tx :E2	₋E « CH High 2 Plan 480 MHz		Test Date Temp./Hum Antenna Po Engineer	:2018-08-13 :25/60 :VERTICAL :Jerry	
100 Level (dBuV/n	n)					7
90						-
80						_
70						-
60						-
50						-
40 2		4			6	_
30	3			5		-
20						-
10						-
0 <mark>30</mark>	224.	418.	612.	806	10	00
50	224		ency (MHz)	000		
Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode PK/QP/AV	Reading Level dBµV	dB	FS dBµV/m	@3m dBµV/m	dB
		<u>-</u>				
35.82	Peak	51.20	-18.09	33.11	40.00	-6.89
90.14	Peak	59.20	-22.91	36.29	43.50	-7.21
226.91	Peak	49.96	-18.20	31.76	46.00	-14.24
384.05 666.32	Peak Peak	46.73 39.74	-13.14 -8.72	33.59 31.02	46.00 46.00	-12.41 -14.98
861.29	Peak	38.32	-6.72 -5.35	32.97	46.00	-14.98
001.20	i oun	00.02	0.00	02.01	10.00	10.00

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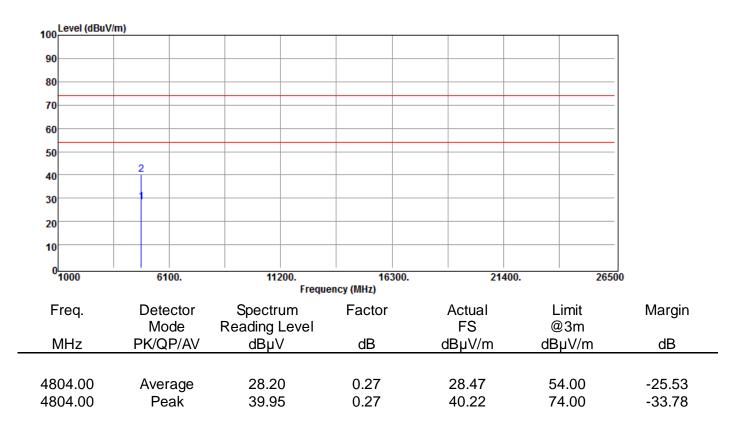


Test Mode :Tx CH High Temp./Humi. :25/60	ZONTAL
100 Level (dBuV/m)	
90	
80	
70	
60	
50	
40 2 3 4 5 6	
0 <mark></mark>	
	argin
Mode Reading Level FS @3m	
MHz PK/QP/AV dBµV dB dBµV/m dBµV/m d	dB
	1.53
	6.76 7.87
	.o7 3.23
	3.23 3.04
	5.35



#### **Radiated Spurious Emission Measurement Result**

For Frequency above 1GHz										
Operation Mode	:BLE	Test Date	:2018-08-13							
Test Mode	:Tx CH Low	Temp./Humi.	:25/60							
EUT Pol	:E2 Plan	Antenna Pol.	:VERTICAL							
Test Channel	:2402 MHz	Engineer	:Jerry							



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Test N		:	3LE Tx CH Low E2 Plan		:2018-08-13 :25/60		
EUT F			2402 MHz		Antenna Po	:HORIZONTAL :Jerry	
lest C	Channel	••			Engineer		Jeny
100	Level (dBuV/n	n)					7
90							_
80							_
70							-
60							_
50							-
40		2					_
30		-					_
20							-
10							_
0							
1	1000	6100.	11200. Frequ	16300 ency (MHz)	. 2140	0. 265	000
F	req.	Detector	Spectrum	Factor	Actual	Limit	Margin
-		Mode	Reading Level		FS	@3m	
N	/Hz	PK/QP/AV	dBµV	dB	dBµV/m	dBµV/m	dB
10			~~ ~~		00 0 <del>7</del>	= 4 0 0	05.00
	04.00	Average	28.70	0.27	28.97	54.00	-25.03
48(	04.00	Peak	40.16	0.27	40.43	74.00	-33.57

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Operation Mo Test Mode EUT Pol Test Channel	:T) :E:	LE x CH Mid 2 Plan 442 MHz		Test Date Temp./Humi. Antenna Pol. Engineer		:2018-08-13 :25/60 :VERTICAL :Jerry
100 Level (dBuV	/m)				1	7
90						_
80						_
70						-
60						-
50						-
40	2					-
30						-
20						-
10						-
0 <mark></mark>	6100.	11200. Freque	16300. ency (MHz)	21400.	265	500
Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode PK/QP/AV	Reading Level dBµV	dB	FS dBµV/m	@3m dBµV/m	dB
4884.00	Average	27.88	0.71	28.59	54.00	-25.41
4884.00	Peak	39.27	0.71	39.98	74.00	-34.02

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Operation Mode:BLETest Mode:Tx CH MidEUT Pol:E2 PlanTest Channel:2442 MHz							T A	est Date emp./Hu ntenna F ngineer			:2018-08-1 :25/60 :HORIZON <sup>-</sup> :Jerry	
100	.evel (dBuV/m	)										
90-												
80-												
70												
60												
50												
40		2										
30		1										
20												
10												
0_ 1	000	6100	•	112	200. Freque	163 ncy <mark>(</mark> MHz)	300.	21	1400.	2	6500	
Fr	req.	Detect		Spectr		Factor		Actual		Limit	Margin	
M	lHz	Mode PK/QP/		l eading؟ \dBu		dB		FS dBµV/m	d	@3m IBµV/m	dB	
488	34.00	Avera	ge	29.13	3	0.71		29.84		54.00	-24.16	
488	34.00	Peak		41.36	6	0.71		42.07		74.00	-31.93	



Operation Mo Test Mode EUT Pol Test Channel	:T :E	LE x CH High 2 Plan 480 MHz		:2018-08-13 :25/60 :VERTICAL :Jerry		
100 Level (dBuV	m)		1			7
90						_
80						_
70						-
60						_
50						-
40	2					-
30	1					-
20						-
10						-
0 <mark></mark> 1000	6100.	11200. Freque	16300. ency (MHz)	21400.	265	 00
Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode PK/QP/AV	Reading Level dBµV	dB	FS dBµV/m	@3m dBµV/m	dB
4960.00	Average	28.52	1.24	29.76	54.00	-24.24
4960.00	Peak	39.63	1.24	40.87	74.00	-33.13

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Operation Mo Test Mode EUT Pol Test Channel	:T) :E:	_E < CH High 2 Plan 480 MHz		:2018-08-13 :25/60 :HORIZONTAL :Jerry		
100 Level (dBuV/	m)					7
90						_
80						_
70						-
60						-
50	2					-
40						-
30						-
20						-
10						-
0 1000	6100.	11200. Freque	16300. ency (MHz)	21400	). 265	500
Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode PK/QP/AV	Reading Level dBµV	dB	FS dBµV/m	@3m dBµV/m	dB
4960.00 4960.00	Average Peak	28.93 40.55	1.24 1.24	30.17 41.79	54.00 74.00	-23.83 -32.21



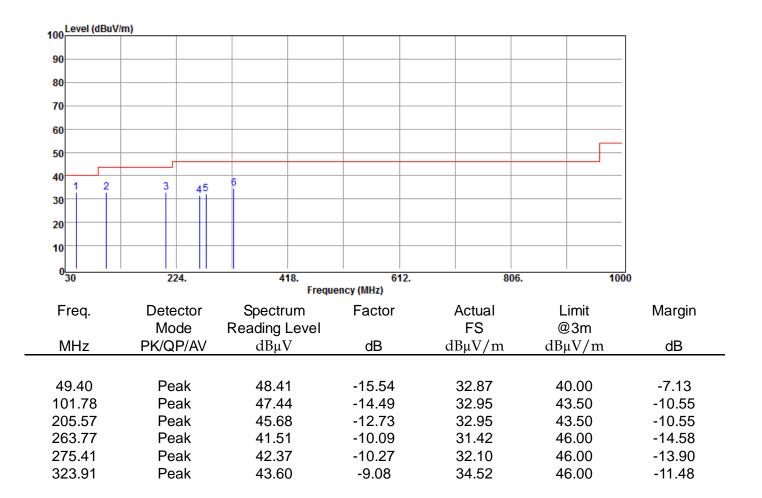
#### Ant 2 **Radiated Spurious Emission Measurement Result** For Frequency form 30MHz to 1000MHz

**Operation Mode** Test Mode EUT Pol **Test Channel** 

:BLE :TX CH LOW :H Plan :2402 MHz

Test Date Temp./Humi. Antenna Pol. Engineer

:2018-09-25 :24/62 :VERTICAL :Ashton



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Test N EUT F		uc	:BLE :TX CH LOW :H Plan :2402 MHz			:2018-09-25 :24/62 :HORIZONTAL :Ashton		
100	Level (dBuV/r	n)						
90								
80								
70								
60								
50								
40	1 2	3	45	6				·
30								
20								
10								
0		224.		418.	612.			
	30	224.			ency (MHz)		806.	1000
F	req.	Detector			Factor	Actual	Limit	Margin
N	/Hz	Mode PK/QP/A\	Reading dBj		dB	FS dBµV/n	@3m n dBµV/n	n <b>dB</b>
IV				ιv	uD	ασμ ν / Π		
60	0.07	Peak	51.	40	-19.73	31.67	40.00	-8.33
	0.81	Peak			-14.65	34.28	43.50	-9.22
	3.77	Peak	46.		-10.09	36.28	46.00	-9.72
	9.80		Peak 45.82		-7.61 -7.14	38.21	46.00	-7.79
	1.44		Peak 45.70			38.56	46.00	-7.44
40	8.30	Peak 43.72			-5.94	37.78	46.00	-8.22

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Operation I Test Mode EUT Pol Test Chann		:BLE :TX CH :H Plan :2442 M				:2018-09-25 :24/62 :VERTICAL :Ashton				
100 Level (dB	BuV/m)								1	7
90										
80										
70										
60										
50										
40		2 4								
1	2	ĭ  _	5	6						
20										
10										
0 <mark>30</mark>	224.		41		612. ency (MHz)		8	06.	10	00
Freq.	Detect	tor	Spectru	um	Factor		Actual	L	_imit	Margin
	Mode		ading L				FS		23m	
MHz	PK/QP/	/AV	dBμV	7	dB	d	BµV/m	dB	µV/m	dB
31.94	Peak		38.06	2	-4.71		33.35	1	0.00	-6.65
101.78	Peak		44.67		-14.49		30.18		3.50	-13.32
288.02	Peak		46.57		-10.14		36.43		6.00	-9.57
312.27	Peak	Peak 47.52		2	-9.44		38.08	4	6.00	-7.92
384.05	Peak	Peak 41.41			-6.72		34.69	4	6.00	-11.31
431.58	Peak	Peak 39.61			-5.95		33.66	4	6.00	-12.34

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Test Mod EUT Pol					Test Date Temp./Humi. Antenna Pol. Engineer					:2018-09-25 :24/62 :HORIZONTAL :Ashton
100 Level	(dBuV/m)	1					1	1	1	
90										
80										
70										
60										
50										
40	2	34	5	6						
30	2									
20										
10										
0 <mark></mark> 30	2	24.	4	18. Freque	61 ncy (MHz)	2.	8	06.	100	0
Freq.	Dete	ector	Spectr	um	Factor		Actual	L	imit	Margin
			Reading				FS		23m	
MHz	PK/Q	P/AV	dBµV	/	dB	C	BµV/m	dB	µV/m	dB
55.22	) Pe	ak	49.74	4	-18.01		31.73	4	0.00	-8.27
167.74		ak	48.7		-13.81		34.95		3.50	-8.55
263.77		ak	45.73		-10.09		35.64		6.00	-10.36
275.4 <sup>-</sup>		Peak 46.15			-10.27		35.88		6.00	-10.12
371.44		eak	45.49		-7.14		38.35		6.00	-7.65
419.94	4 Pe	Peak 43.99		9	-5.82	38.17		4	6.00	-7.83

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Test N EUT I		т: Н:	LE X CH HIGH Plan 480 MHz		Test Date Temp./Humi. Antenna Pol. Engineer					
100	Level (dBuV/n	n)					_			
90							_			
80							_			
70							_			
60							_			
50							_			
40			3	1		6	_			
30	2			4 5			_			
20							_			
10							_			
0	30	224.	418		12.	806. 1	000			
	50	224.	410	Frequency (MHz)	12.	ooo. I	000			
F	req.	Detector	Spectrur		Actual	Limit	Margin			
N	/Hz	Mode PK/QP/AV	Reading Le dBµV	evel dB	FS dBµV/m	@3m dBµV/m	dB			
N	/11 12		uDμv	db	αυμ ν / Π	α ασμνγιιί	<u>up</u>			
3	1.94	Peak	37.84	-4.71	33.13	40.00	-6.87			
	)1.78	Peak	43.92	-14.49	29.43	43.50	-14.07			
	99.66	Peak	45.04	-9.90	35.14	46.00	-10.86			
	7.91	Peak	37.57	-3.82	33.75	46.00	-12.25			
	)1.33	Peak	35.43	-3.20	32.23	46.00	-13.77			
93	35.01	Peak	33.38	1.79	35.17	46.00	-10.83			

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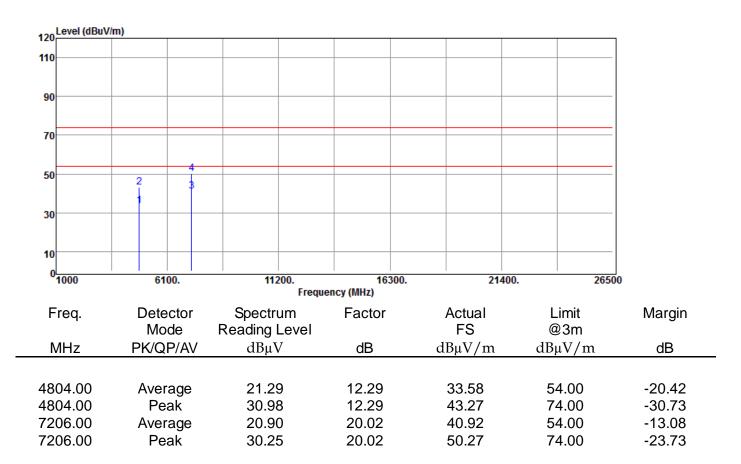


Test Mode :TX EUT Pol :H F			:BLE :TX CH HIGH :H Plan :2480 MHz				Test Date Temp./Humi. Antenna Pol. Engineer				:2018-09-25 :24/62 :HORIZONTAL :Ashton
100 Level (dB	uV/m)	1									
90											
80											
70											
60											
50											
			4								
40	2	3	Í	5			6				
30											
20											
10								_			
0 <mark></mark>	2	<b>24.</b>	· · ·	418.	61	2.		806.	I	100	0
_	_		-	-	ncy (MHz)					_	
Freq.		ector	Spect		Factor		Actual FS		Lir @3		Margin
MHz		ode P/AV	Reading dBµ		dB	đ	го BµV/r	n	dBµV		dB
	1100		uDµ	. •	<u>ub</u>		.υμ / / Ι		ubμ	• / III	
30.97	Pe	ak	32.5	59	-4.16		28.43		40.	.00	-11.57
161.92	Pe	Peak 48.98		98	-13.38		35.60		43.	.50	-7.90
263.77		ak	45.8		-10.09		35.72		46.		-10.28
371.44		Peak 45.45			-7.14		38.31		46.		-7.69
504.33		ak	39.2		-4.12		35.10		46.		-10.90
770.11	Pe	eak	32.43		-0.95		31.48		46.	.00	-14.52



#### **Radiated Spurious Emission Measurement Result**

For Frequency above 1GHz										
Operation Mode	:BLE	Test Date	:2018-09-21							
Test Mode	:TX CH LOW	Temp./Humi.	:24/62							
EUT Pol	:H Plan	Antenna Pol.	:VERTICAL							
Test Channel	:2402 MHz	Engineer	:Ashton							



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120	
110	
90	
70 70 70 70 70 70 70 70 70 70 70 70 70 7	
50 4	
30 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	
50	
0	
	Morain
Freq. Detector Spectrum Factor Actual Limit I Mode Reading Level FS @3m	Margin
MHz PK/QP/AV $dB\mu V$ $dB = dB\mu V/m$ $dB\mu V/m$	dB
	42
4804.00 Average 21.25 12.29 33.54 54.00	-20.46
5	-30.92
	-13.10
	-23.48



Test N EUT I		de	:T) :H	BLE FX CH MID H Plan 2442 MHz				st Date mp./Hui ntenna F ngineer	:2018-09-21 :24/62 :VERTICAL :Ashton		
120	Level (dBuV/	m)									_
110											-
90											-
70											-
50		2	4								2
30											_
10											-
0	1000	61	00.	11:	200. Frequ	1630 ency (MHz)	)0.	21	<b>400.</b>	265	 00
F	req.	Dete Mo	ector de	Spectr Reading		Factor		Actual FS		₋imit ⊉3m	Margin
N	ЛНz	PK/Q	P/AV	dBµV	V	dB	ċ	lBµV/m	dB	μV/m	dB
	84.00	Aver		21.1		12.63		33.74		4.00	-20.26
	84.00 26.00		ak rade	30.4 20.9		12.63 20.08		43.03 41.01		4.00 4.00	-30.97 -12.99
	26.00	Average Peak		20.93 29.82		20.08		49.90		4.00	-24.10

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Test N EUT F	peration Mode :BLE est Mode :TX CH MID UT Pol :H Plan est Channel :2442 MHz						:2018-09-21 :24/62 :HORIZONTAL :Ashton				
420	Level (dBuV/	/m)									
											7
110											-
90											-
70											-
50			4								-
50		2 	3								
30		1									_
10											-
0	1000	64	00.	44	200.	461	300.	24	400.	265	
	1000	01	00.			ency (MHz)		21	400.	205	00
F	req.	Dete	ector	Spectr	um	Factor		Actual	L	.imit	Margin
		Mc		Reading				FS		23m	-
N	/IHz	PK/Q	P/AV	dBµV	V	dB		dBµV/m	dBj	uV/m	dB
	84.00	Ave		21.1		12.63		33.80	-	4.00	-20.20
	84.00		ak	31.2		12.63		43.83		4.00	-30.17
	26.00	Average		20.93		20.08				4.00	-12.99
732	26.00	Peak		30.28		20.08		50.36		4.00	-23.64

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Test N EUT F		:H	LE K CH HIGH Plan 480 MHz			Te Te Aı Eı	:2018-09-21 :24/62 :VERTICAL :Ashton				
120	Level (dBuV/n	n)									
110											_
90											_
											_
70											-
50			4								_
50		2	3								
30											_
10											-
0	1000	61	00.	112	200. Erogu	163 ency (MHz)	00.	21	400.	265	 600
F	req.	Dete	octor	Spectr	-	Factor		Actual		.imit	Margin
	109.	Mo		Reading		1 dotor		FS		23m	Wargin
N	ЛНz	PK/Q	P/AV	dBµV	V	dB	Ċ	lBµV/m	dB	µV/m	dB
•		-		<b>-</b>				<b>•</b> • • • -	_		· •
	62.00	Aver		21.3		12.95		34.25	-	4.00	-19.75
	62.00	Peak		31.0 <sup>°</sup>		12.95		44.02		4.00	-29.98
	40.00	Average 21.34 Peak 29.90				20.12		41.46		4.00	-12.54
744	40.00	Pe	ак	29.9	U	20.12		50.02	/	4.00	-23.98

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Test N EUT F	/lode	ol :H Plan Antenna Pol.								:2018-09-21 :24/62 :HORIZONTAL :Ashton	
120	Level (dBuV/i	m)									
110											_
90											_
											_
70											-
50			4								-
50		2	3								
30											_
10											-
0	1000	61	00.	112		163	00.	21	<b>400.</b>	265	500
_	·	Data	-1	0		ency (MHz)		A . (		1	Manusia
F	req.	Dete Mo		Spectru Reading L		Factor		Actual FS		_imit ⊉3m	Margin
Ν	/IHz	PK/Q		dBµV		dB	(	dBμV/m		μV/m	dB
	60.00	Aver		21.44		12.93		34.37	-	4.00	-19.63
	60.00		Peak 31.29			12.93		44.22		4.00	-29.78
	40.00		Average 21.29			20.12		41.41		4.00	-12.59
744	40.00	Pe	ak	30.62		20.12		50.74		4.00	-23.26



# 11 PEAK POWER SPECTRAL DENSITY

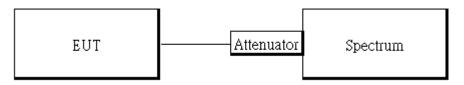
## 11.1 Standard Applicable:

The power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8dBm in any 3 kHz band during any time interval of continuous transmission.

### 11.2 Measurement Equipment Used:

Conducted Emission Test Site							
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.		
Spectrum Analyzer	Agilent	N9010A	MY5144011 3	2018/06/20	2019/6/19		
DC Power Supply	Agilent	E3640A	MY5313005 4	2017/09/04	2018/9/3		
Attenuator	Marvelous	MVE2213-10	RF30	2017/12/26	2018/12/25		
DC Block	PASTERNACK	PE8210	RF29	2017/12/26	2018/12/25		
Notebook	Lenovo	L430	P0000195	N/A	N/A		

### 11.3 Test Set-up:



## 11.4 Measurement Procedure:

- 1. Set analyzer center frequency to DTS channel center frequency.
- 2. The testing follows the Measurement Procedure of FCC KDB 558074 D01 DTS Meas. Guidance.
- 3. Set the span to 1.5 times the DTS channel bandwidth.
- 4. Set the RBW = 3 kHz. & the VBW = 10 kHz
- For defining Restricted Band Edge Limit: Set the RBW = 100kHz & VBW = 300 kHz.
- 6. Detector = peak.
- 7. Sweep time = auto couple.
- 8. Trace mode = max hold.
- 9. Allow trace to fully stabilize.
- 10. Use the peak marker function to determine the maximum amplitude level.

Unless otherwise stated the results shown in this test report refer only to the sample(s) tested and such sample(s) are retained for 90 days only.

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#### 11.5 **Measurement Result:**

BLE mode			
Frequency (MHz)	RF Power Density (dBm)	Maximum Limit (dBm)	Result
2402	-10.13	8	PASS
2442	-10.21	8	PASS
2480	-10.41	8	PASS

NOTE: cable loss as 10.6dB that offsets in the spectrum

## **BLE mode** Power Spectral Density Test Plot (CH-Low)



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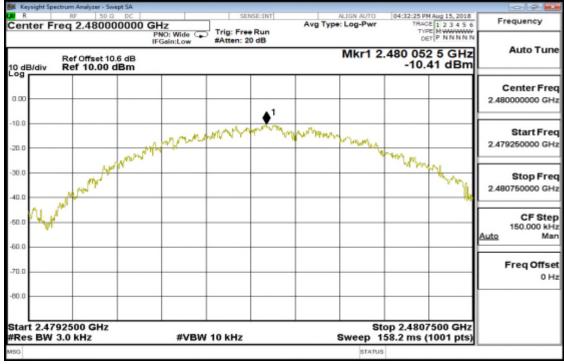
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### Power Spectral Density Test Plot (CH-Mid)



## Power Spectral Density Test Plot (CH-High)



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# **12 ANTENNA REQUIREMENT**

#### Standard Applicable: 12.1

For intentional device, according to §15.203, an intentional radiator shall be designed to ensure that no antenna other than furnished by the responsible party shall be used with the device.

If the transmitting antenna is greater than 6dBi, the power shall be reduced by the same level in dB comparing to gain minus 6dBi.

In case of point-to-point operation, the power shall be reduced by the one dB for every 3 dB that the directional gain of antenna exceeds 6dBi.

#### 12.2 **Antenna Connected Construction:**

The antenna is designed as permanently attached and no consideration of replacement. Please see EUT photo for details.

~ End of Report ~

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