FCC Part 15.247

TEST REPORT

For

Wasp Barcode Technologies

1400, 10th Street, Plano, TX 75074 United States

FCC ID: C53WRS100SBR
Model: WRS100SBR

Report Type:	**Product Type:**
Original Report	Wireless Ring Scanner

Report Producer:	Jane Lee
Report Number:	RTWL170815002-00A
Report Date:	2017-09-04
Reviewed By:	Jerry Chang

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REVISION HISTORY

Revision	No.	Report Number	Issue Date	Description	Author/ Revised by
1.0	RTWL17815002	RTW L170815002-00A	2017.09.04	Original Report	Jane

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1 General Information

1.1 Product Description for Equipment Under Test (EUT)

Applicant:	Wasp Barcode Technologies 1400, 10th Street, Plano, TX 75074 United States
Manufacturer:	Marson Technology Co., Ltd. 9F, No.108-3 Mincyuan Rd., Sindian Dist., New Taipei City 23141, Taiwan
Product:	Wireless Ring Scanner
Model:	WRS100SBR
Trade Name:	Wasp
Frequency Range:	2402-2480 MHz
Transmit Power:	BLE Mode: 3.38 dBm
Modulation Technique:	BLE Mode: GFSK
Transmit Data Rate:	BLE Mode: 1 Mbps
Number of Channels:	BLE Mode: 40 Channels
Antenna Specification:	Chip Antenna/Gain: 0.5 dBi
Voltage Range:	5Vdc from USB 3.7Vdc from Battery
Date of Test:	July 07, 2017~Sep 04, 2017

**All measurement and test data in this report was gathered from production sample serial number: 170707001 (Assigned by BACL, Taiwan) The EUT supplied by the applicant was received on 2017-07-07.*

1.2 Objective

This report is prepared on behalf of *Wasp Barcode Technologies* in accordance with Part 2, Subpart J, Part 15, Subparts A and C of the Federal Communication Commission's rules.

The objective is to determine compliance with FCC Part 15.247 rules for Output Power, Antenna Requirements, 6 dB Bandwidth, power spectral density, 100 kHz Bandwidth of Band Edges Measurement, Conducted and Radiated Spurious Emissions.

1.3 Related Submittal(s)/Grant(s)

N/A

1.4 Test Methodology

All measurements contained in this report were conducted with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.5 Test Facility

The Test site used by Bay Area Compliance Laboratories Corp. (Taiwan) to collect test data is located on
☒ 70, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.
☐ 68-3, Lane 169, Sec. 2, Datong Road, Xizhi Dist., New Taipei City 22183, Taiwan, R.O.C.

Bay Area Compliance Laboratories Corp. (Taiwan) Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3180) and the FCC designation No.TW3180 under the Mutual Recognition Agreement (MRA) in FCC Test. The facility also complies with the radiated and AC line conducted test site criteria set forth in ANSI C63.10.

The Federal Communications Commission has the reports on file and is listed under FCC Registration No.: 974454. The test site has been approved by the FCC for public use and is listed in the FCC Public Access Link (PAL) database.

2 System Test Configuration

2.1 Description of Test Configuration

For BLE mode, there are totally 40 channels.

Channel	Frequency (MHz)	Channel	Frequency (MHz)
1	2402	21	2442
2	2404	--	--
3	2406	--	--
4	2408	38	2476
--	--	39	2478
20	2440	40	2480

EUT was tested with Channel 1, 20 and 40.

The worst-case data rates are determined to be as follows for each mode based upon investigation by measuring the average power and PSD across all date rates bandwidths, and modulations

2.2 Equipment Modifications

No modification was made to the EUT

2.3 EUT Exercise Software

Used "CSR, uEnergy Tools 2.3.0" software.

Test Software Version		Engineering Mode		
Test Frequency		Low	Mid	High
Power Level Setting	BLE Mode	7	7	7

2.4 Support Equipment List and Details

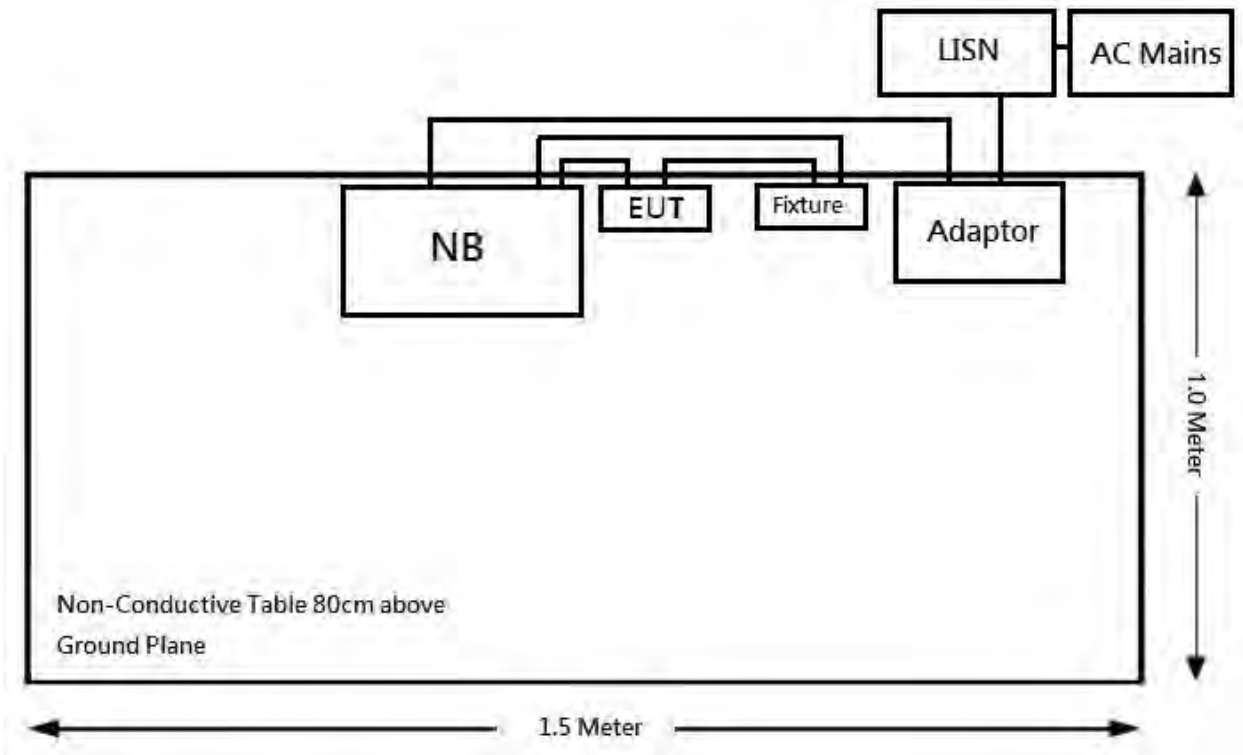
Description	Manufacturer	Model Number	BSMI	FCC ID / DOC	S/N
Notebook	DELL	P62G	N/A	PD98260NGU	36113452562

2.5 External Cable List and Details

Cable Description	Length (m)	From	To
N/A	N/A	N/A	N/A

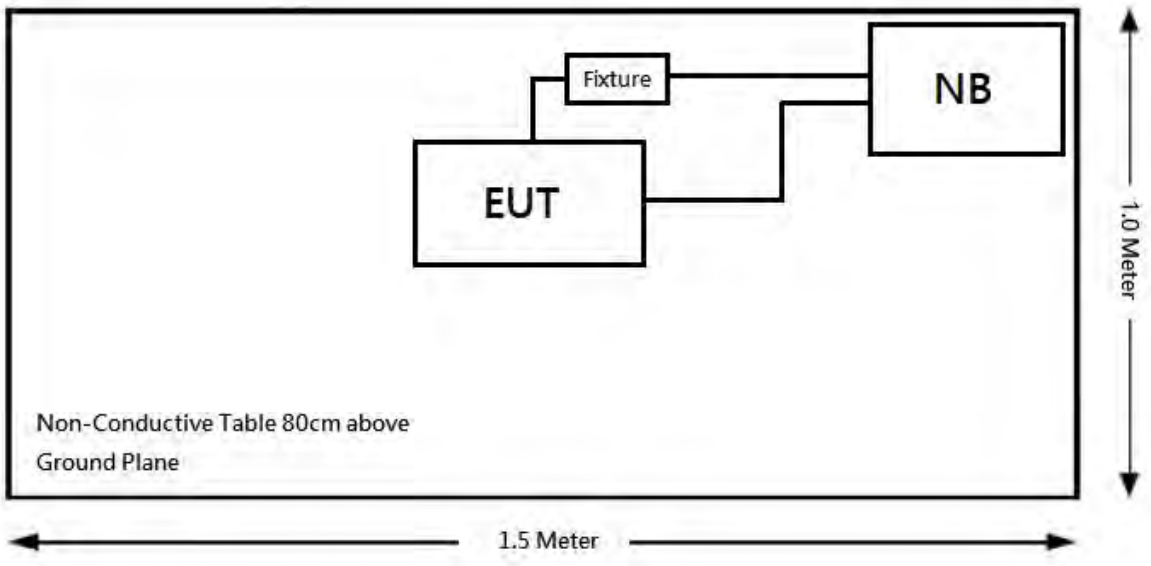
2.6 Block Diagram of Test Setup

See test photographs attached in Exhibit A for the actual connections between EUT and support equipment.
Conduction:

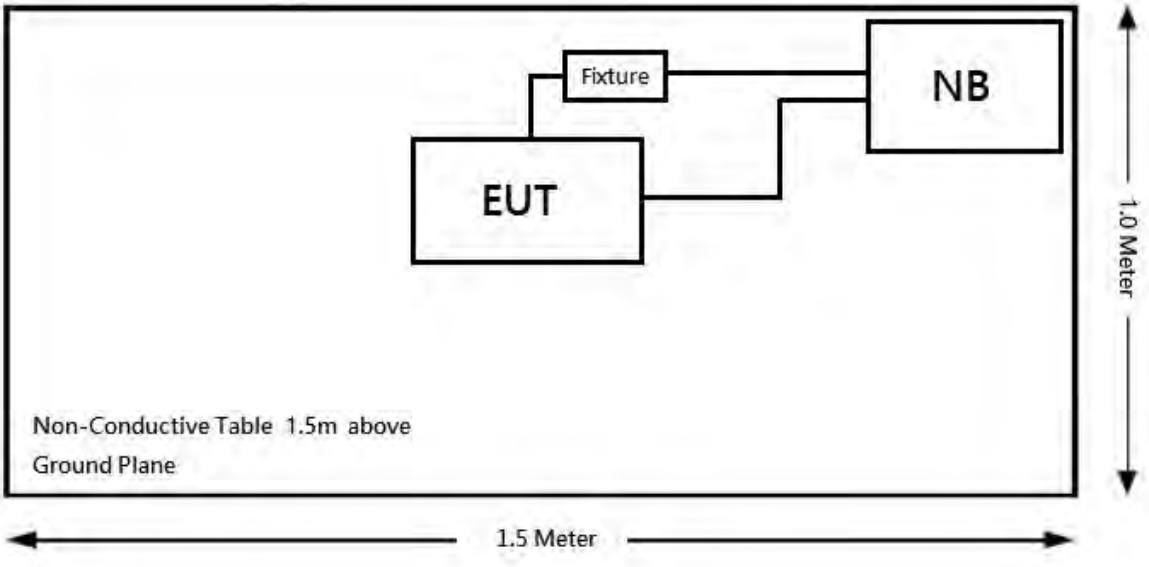


Radiation

Below 1GHz:

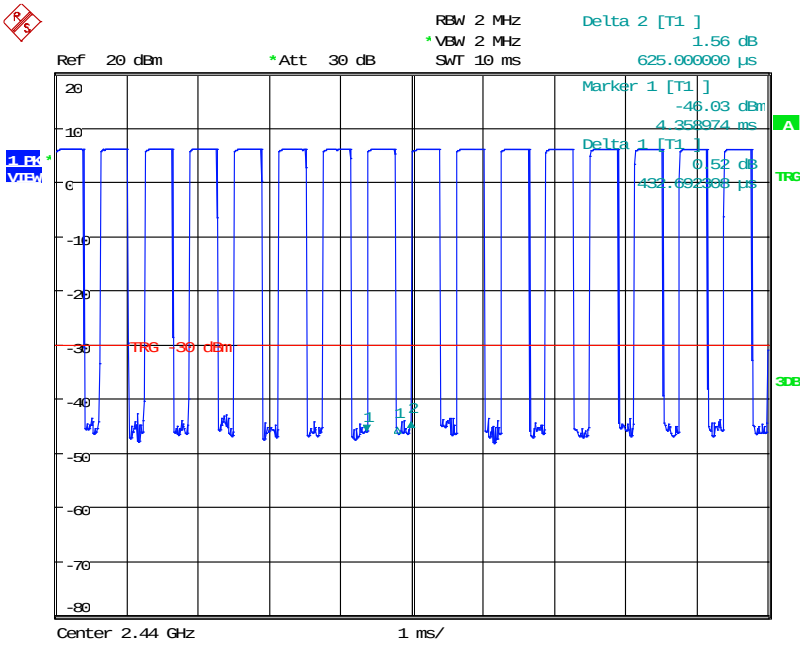


Above 1GHz:


Fixture
NB
EUT
1.0 Meter
Non-Conductive Table 1.5m above
Ground Plane
1.5 Meter

2.7 Duty Cycle

Radio Mode	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
BLE	0.432	0.625	69	1.61



3 Summary of Test Results

FCC Rules	Description of Test	Result
§15.247(i), §2.1093	RF Exposure	Compliance
§15.203	Antenna Requirement	Compliance
§15.207(a)	AC Line Conducted Emissions	Compliance
§15.205, §15.209, §15.247(d)	Spurious Emissions	Compliance
§15.247(a)(2)	6 dB Emission Bandwidth	Compliance
§15.247(b)(3)	Maximum Peak Output Power	Compliance
§15.247(d)	100 kHz Bandwidth of Frequency Band Edge	Compliance
§15.247(e)	Power Spectral Density	Compliance

4 FCC §15.247(i) & 2.1093 - RF Exposure

4.1 Applicable Standard

According to FCC §2.1093 and §1.1307(b) (1), systems operating under the provisions of this section shall be operated in a manner that ensure that the public is not exposed to radio frequency energy level in excess of the Commission's guideline.

According to KDB 447498 D01 General RF Exposure Guidance v06
The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] ·
[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
1. f(GHz) is the RF channel transmit frequency in GHz.
2. Power and distance are rounded to the nearest mW and mm before calculation.
3. The result is rounded to one decimal place for comparison.
4. 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

The test exclusions are applicable only when the minimum *test separation distance* is ≤ 50 mm, and for transmission frequencies between 100 MHz and 6 GHz. When the minimum *test separation distance* is < 5 mm, a distance of 5 mm according to 4.1 f) is applied to determine SAR test exclusion.

4.2 RF Exposure Evaluation Result

Frequency (MHz)	Tune-up Power		Evaluation Distance (mm)	SAR Exclusion Result	SAR Exclusion Limit (1g SAR)
	(dBm)	(mW)			
2480	3.5	2.24	5	0.7	3

So the stand-alone SAR evaluation for BLE is not necessary.

5 FCC §15.203 – Antenna Requirements

5.1 Applicable Standard

According to § 15.203,

An intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the user of a standard antenna jack or electrical connector is prohibited.

And according to FCC 47 CFR section 15.247 (b), if the transmitting antennas of directional gain greater than 6dBi are used, the power shall be reduced by the amount in dB that the directional gain of the antenna does not exceed 6 dBi

5.2 Antenna List and Details

Manufacturer	Type	Antenna Gain	Result
Wasp Barcode Technologies	Chip Antenna	0.5 dBi	Compliance

6 FCC §15.207 - AC Line Conducted Emissions

6.1 Applicable Standard

FCC §15.207

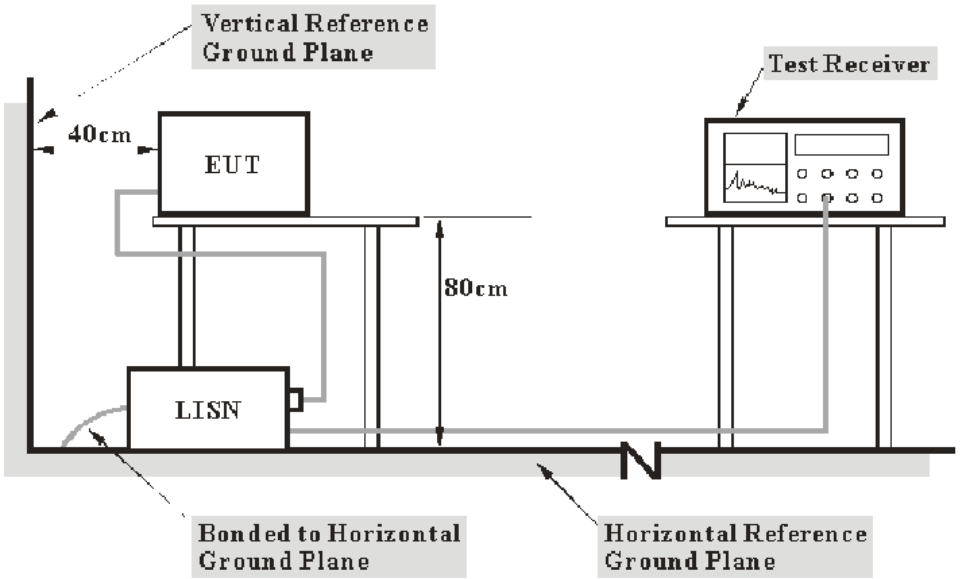
6.2 Measurement Uncertainty

Input quantities to be considered for conducted disturbance measurements maybe receiver reading, attenuation of the connection between LISN/ISN and receiver, LISN/ISN voltage division factor, LISN/ISN VDF frequency interpolation and receiver related input quantities, etc.

Based on CISPR 16-4-2:2011, the expended combined standard uncertainty of conducted disturbance test at Bay Area Compliance Laboratories Corp. (Taiwan) is shown as below. And the uncertainty will not be taken into consideration for the test data recorded in the report

Port	Expanded Measurement uncertainty
AC Mains	4.64 dB (k=2, 95% level of confidence)

6.3 EUT Setup



Note: 1. Support units were connected to second LISN.
2. Both of LISNs (AMN) 80 cm from EUT and at the least 80 cm from other units and other metal planes support units.

The setup of EUT is according with per ANSI C63.10-2013 measurement procedure. The specification used was with the FCC Part 15.207 limits.

6.4 EMI Test Receiver Setup

The EMI test receiver was set to investigate the spectrum from 150 kHz to 30 MHz. During the conducted emission test, the EMI test receiver was set with the following configurations

Frequency Range	IF B/W
150 kHz - 30 MHz	9 kHz

6.5 Test Procedure

During the conducted emission test, the adapter was connected to the outlet of the LISN. Maximizing procedure was performed on the six (6) highest emissions of the EUT. All data was recorded in the Quasi-peak and average detection mode.

6.6 Corrected Factor & Margin Calculation

The factor is calculated by adding LISN/ISN VDF (Voltage Division Factor), Cable Loss and Transient Limiter Attenuation. The basic equation is as follows:

Factor = LISN VDF + Cable Loss + Transient Limiter Attenuation

The "Over Limit" column of the following data tables indicates the degree of compliance with the applicable limit. For example, an over limit of -7 dB means the emission is 7 dB below the limit. The equation for Over Limit calculation is as follows:

Over Limit = Level – Limit Line

6.7 Test Equipment List and Details

Manufacturers	Descriptions	Models	Serial Numbers	Calibration Date	Calibration Due Date
LISN	Rohde & Schwarz	ENV216	101248	2017/07/20	2018/07/19
LISN	EMCO	3816/2	00075848	2017/08/02	2018/08/01
EMI Test Receiver	Rohde & Schwarz	ESR7	101419	2016/11/03	2017/11/02
Pulse Limiter	Rohde & Schwarz	ESH3Z2	TXZEM025	2017/08/11	2018/08/10
RF Cable	EMEC	EM-CB5D	001	2017/07/24	2018/07/23
Software	AUDIX	E3	V9.150826k	N.C.R	N.C.R

**** Statement of Traceability:*** BACL Corp. attests that all calibrations have been performed according to TAF requirements, traceable to the ETC.

6.8 Test Environmental Conditions

Temperature:	25 ℃
Relative Humidity:	58 %
ATM Pressure:	1020 hPa

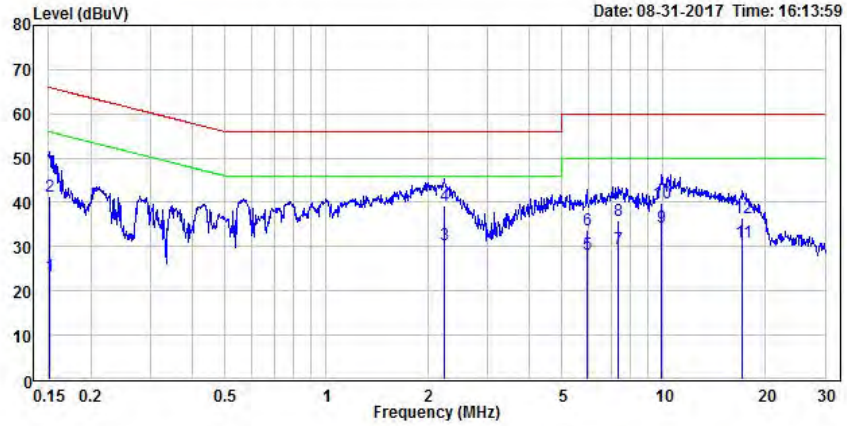
The testing was performed by Andy Shih on 2017-08-31.

6.9 Test Results

Please refer to the following plots and tables.

Test mode: Charge + Transmitting mode

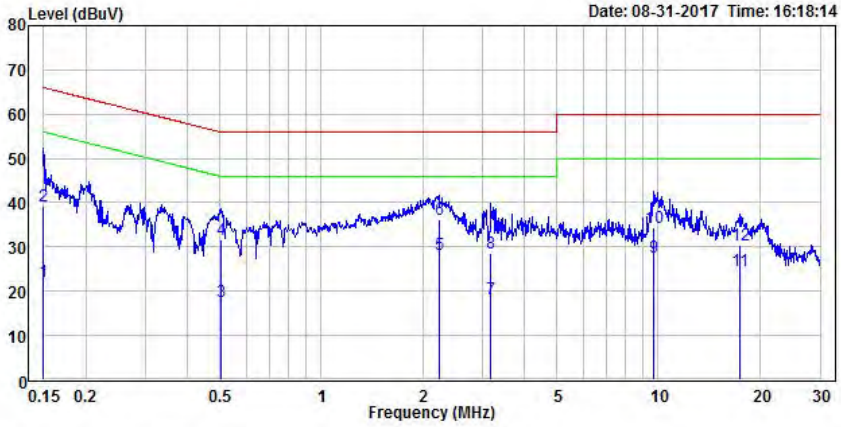
Main: AC 120V/60 Hz, Line



Condition: limit\FCC\FCC Conduction Clsaa-B QP.csv Line
EUT :
Mode :
Note :

	Freq	Level	Limit Line	Over Limit	Factor	Read Level	Remark	Pol/Phase
	MHz	dBuV	dBuV	dB	dB	dBuV		
1	0.151	23.31	55.93	-32.62	19.51	3.80	Average	Line
2	0.151	41.39	65.93	-24.54	19.51	21.88	QP	Line
3	2.239	30.55	46.00	-15.45	19.59	10.96	Average	Line
4	2.239	39.16	56.00	-16.84	19.59	19.57	QP	Line
5	5.931	28.14	50.00	-21.86	19.69	8.45	Average	Line
6	5.931	33.90	60.00	-26.10	19.69	14.21	QP	Line
7	7.387	29.52	50.00	-20.48	19.72	9.80	Average	Line
8	7.387	35.96	60.00	-24.04	19.72	16.24	QP	Line
9	9.927	34.29	50.00	-15.71	19.77	14.52	Average	Line
10	9.927	39.86	60.00	-20.14	19.77	20.09	QP	Line
11	17.085	31.04	50.00	-18.96	19.82	11.22	Average	Line
12	17.085	36.49	60.00	-23.51	19.82	16.67	QP	Line

Main: AC 120V/60 Hz, Neutral



Condition: Neutral
EUT :
Mode :
Note :

	Freq	Level	Limit Line	Over Limit	Factor	Read Level	Remark	Pol/Phase
	MHz	dBuV	dBuV	dB	dB	dBuV		
1	0.150	22.13	56.00	-33.87	19.64	2.49	Average	Neutral
2	0.150	39.28	66.00	-26.72	19.64	19.64	QP	Neutral
3	0.503	17.71	46.00	-28.29	19.65	-1.94	Average	Neutral
4	0.503	31.66	56.00	-24.34	19.65	12.01	QP	Neutral
5	2.239	28.38	46.00	-17.62	19.73	8.65	Average	Neutral
6	2.239	36.30	56.00	-19.70	19.73	16.57	QP	Neutral
7	3.181	18.26	46.00	-27.74	19.77	-1.51	Average	Neutral
8	3.181	28.56	56.00	-27.44	19.77	8.79	QP	Neutral
9	9.730	27.69	50.00	-22.31	19.92	7.77	Average	Neutral
10	9.730	34.28	60.00	-25.72	19.92	14.36	QP	Neutral
11	17.291	24.67	50.00	-25.33	20.01	4.66	Average	Neutral
12	17.291	30.51	60.00	-29.49	20.01	10.50	QP	Neutral

7 FCC §15.209, §15.205 , §15.247(d) – Spurious Emissions

7.1 Applicable Standard

As per FCC §15.35(d): Unless otherwise specified, on any frequency or frequencies above 1000 MHz, the radiated emission limits are based on the use of measurement instrumentation employing an average detector function. Unless otherwise specified, measurements above 1000 MHz shall be performed using a minimum resolution bandwidth of 1 MHz.

As Per FCC §15.205(a) and RSS-Gen except as show in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

MHz	MHz	MHz	GHz
0.090 – 0.110 0.495 – 0.505 2.1735 – 2.1905 4.125 – 4.128 4.17725 – 4.17775 4.20725 – 4.20775 6.215 – 6.218 6.26775 – 6.26825 6.31175 – 6.31225 8.291 – 8.294 8.362 – 8.366 8.37625 – 8.38675 8.41425 – 8.41475 12.29 – 12.293 12.51975 – 12.52025 12.57675 – 12.57725 13.36 – 13.41	16.42 – 16.423 16.69475 – 16.69525 25.5 – 25.67 37.5 – 38.25 73 – 74.6 74.8 – 75.2 108 – 121.94 123 – 138 149.9 – 150.05 156.52475 – 156.52525 156.7 – 156.9 162.0125 –167.17 167.72 – 173.2 240 – 285 322 – 335.4 399.9 – 410 608 – 614	960 – 1240 1300 – 1427 1435 – 1626.5 1645.5 – 1646.5 1660 – 1710 1718.8 – 1722.2 2200 – 2300 2310 – 2390 2483.5 – 2500 2690 – 2900 3260 – 3267 3.332 – 3.339 3 3458 – 3 358 3.600 – 4.400	4. 5 – 5. 15 5. 35 – 5. 46 7.25 – 7.75 8.025 – 8.5 9.0 – 9.2 9.3 – 9.5 10.6 – 12.7 13.25 – 13.4 14.47 – 14.5 15.35 – 16.2 17.7 – 21.4 22.01 – 23.12 23.6 – 24.0 31.2 – 31.8 36.43 – 36.5 Above 38.6

As per FCC §15.209(a): Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

** Except as provided in paragraph (g), fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections 15.231 and 15.241.

As per FCC §15.247 (d) 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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. 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) (see §15.205(c).

7.2 Measurement Uncertainty

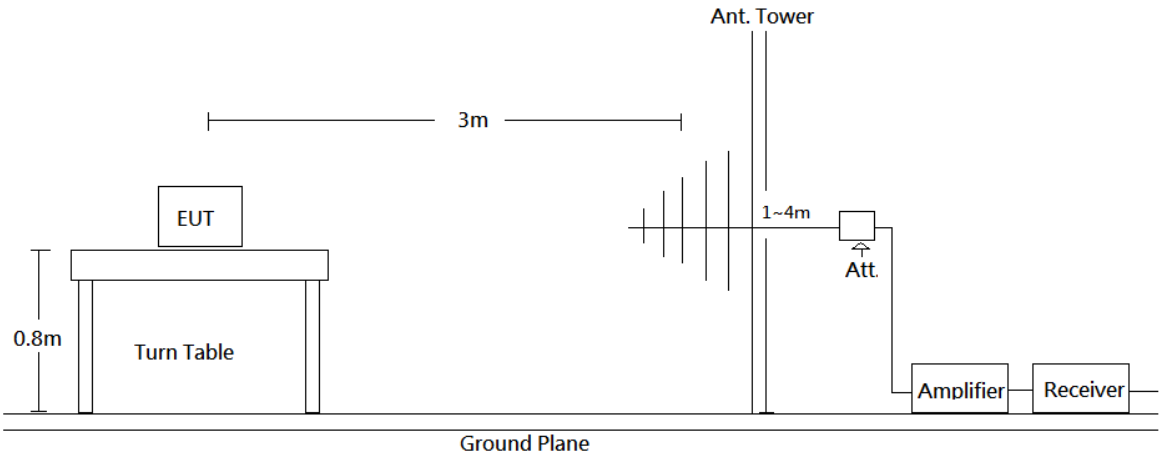
All measurements involve certain levels of uncertainties, especially in field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Based on CISPR 16-4-2:2011, the expended combined standard uncertainty of radiation emissions at Bay Area Compliance Laboratories Corp. (Taiwan) is shown in below table. And the uncertainty will not be taken into consideration for the test data recorded in the report.

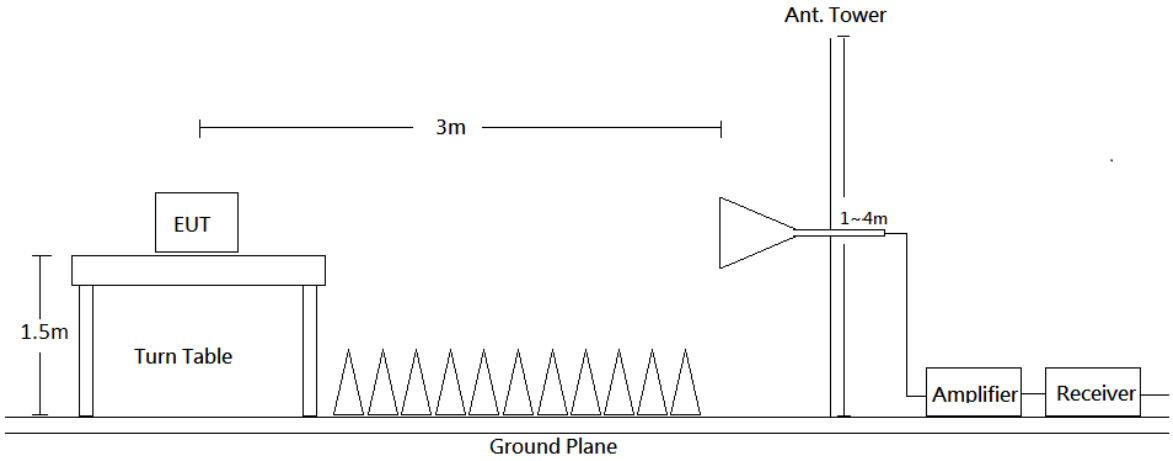
Frequency	Measurement uncertainty
30 MHz~200 MHz	3.76 dB (k=2, 95% level of confidence)
200 MHz~1 GHz	4.12 dB (k=2, 95% level of confidence)
1 GHz~6 GHz	4.84 dB (k=2, 95% level of confidence)
6 GHz~18 GHz	5.16 dB (k=2, 95% level of confidence)
18 GHz~26 GHz	4.84 dB (k=2, 95% level of confidence)
26 GHz~40 GHz	4.30 dB (k=2, 95% level of confidence)

7.3 EUT Setup

Blow 1 GHz:



Above 1 GHz:



Radiated emission tests were performed in the 3 meters chamber test site, using the setup accordance with the ANSI C63.10-2013. The specification used was the FCC Part 15.209 and FCC 15.247 Limits.

7.4 EMI Test Receiver & Spectrum Analyzer Setup

The system was investigated from 30 MHz to 26.5 GHz. During the radiated emission test, the EMI test receiver was set with the following configurations measurement method 6.3 in ANSI C63.10.

Frequency Range	RBW	VBW	IF BW	Detector	Duty cycle
30-1000 MHz	100 kHz	300 kHz	120 kHz	QP	
Above 1 GHz	1 MHz	3 MHz	/	PK	
	1 MHz	10 Hz	/	Ave	>98%
	1 MHz	1/T	/	Ave	<98%

7.5 Test Procedure

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

All data was recorded in the Quasi-peak detector mode from 30 MHz to 1 GHz and PK and average detector modes for frequencies above 1 GHz.

7.6 Corrected Factor & Margin Calculation

The Correct Factor is calculated by adding the Antenna Factor and Cable Loss, and subtracting the Amplifier Gain from the Meter Reading. The basic equation is as follows:

Correct Factor = Antenna Factor + Cable Loss - Amplifier Gain

The "Margin" column of the following data tables indicates the degree of compliance with the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:

Margin = Result –Limit

7.7 Test Results Summary

According to the data in the following table, the EUT complied with the FCC §15.209 Limit. Refer to CISPR16-4-2:2011 and CISPR 16-4-1:2009, the measured level complies with the limit if

$Lm + U(Lm) \leq Llim + Ucispr$

In BACL, U(Lm) is less than Ucispr, if Lm is less than Llim, it implies that the EUT complies with the limit.

7.8 Test Equipment List and Details

Description	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due Date
966A Room					
Bilog Antenna	Sunol & Mini-Circuits	JB6/ UNAT-6+	A050115 / 15542_01	2016/11/16	2017/11/15
Horn Antenna	EMCO	3115	9311-4158	2017/05/31	2018/05/30
Horn Antenna	ETS-Lindgren	3116	00062638	2017/09/02	2018/09/01
Preamplifier	Sonoma	310N	130602	2017/07/03	2018/07/02
Preamplifier	EMEC	EM01G18G	060697	2017/04/14	2018/04/16
Preamplifier	EMEC	EM18G40G	060656	2016/12/13	2017/12/12
EMI Test Receiver	R & S	ESR7	101419	2016/11/03	2017/11/03
Spectrum Analyzer	Rohde & Schwarz	FSV40	101203	2017/07/13	2018/07/12
Microflex Cable	UTIFLEX	UFB311A-Q-1440-300300	220490-006	2016/11/02	2017/11/01
Microflex Cable	UTIFLEX	UFA210A-1-3149-300300	MFR64639 226389-001	2016/11/29	2017/11/28
Microflex Cable	ROSNOL	K1K50-UP0264-K1K50-450CM	160309-1	2017/03/24	2018/03/23
Microflex Cable	ROSNOL	K1K50-UP0264-K1K50-80CM	160309-2	2017/01/20	2018/01/19
Turn Table	Champro	TT-2000	060772-T	N.C.R	N.C.R
Antenna Tower	Champro	AM-BS-4500-B	060772-A	N.C.R	N.C.R
Controller	Champro	EM1000	060772	N.C.R	N.C.R
Software	Farad	EZ_EMC	BACL-03A1	N.C.R	N.C.R
Conducted Room					
Spectrum Analyzer	Rohde & Schwarz	FSU26	200268	2017/05/08	2018/05/07
Cable	WOKEN	SFL402	S02-160323-07	2017/02/22	2018/02/21

***Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Taiwan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

7.9 Test Environmental Conditions

Temperature:	25° C
Relative Humidity:	58 %
ATM Pressure:	101.0 kPa

The testing was performed by Ian Tu on 2017-09-04.

7.10 Test Results

Mode: *Transmitting Mode*

Below 1 GHz, BLE Mode *(Pre-scan with three orthogonal axis, and worse case as Z axis and BLE Mode high channel)*

Horizontal

Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Degree (˚)	Remark
157.5800	36.23	-11.25	24.98	43.50	-18.52	100	204	QP
293.5100	37.41	-9.86	27.55	46.00	-18.45	100	166	QP
462.1740	33.29	-6.34	26.95	46.00	-19.05	100	72	QP
553.9200	40.19	-4.91	35.28	46.00	-10.72	100	319	QP
615.4800	34.87	-3.78	31.09	46.00	-14.91	100	261	QP
832.6100	35.67	0.07	35.74	46.00	-10.26	100	206	QP

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported

Vertical

Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Degree (˚)	Remark
276.1800	40.76	-10.17	30.59	46.00	-15.41	100	162	QP
319.7600	36.15	-9.41	26.74	46.00	-19.26	100	57	QP
481.6200	29.48	-6.02	23.46	46.00	-22.54	100	274	QP
567.5800	33.49	-4.64	28.85	46.00	-17.15	100	174	QP
648.1200	35.91	-3.37	32.54	46.00	-13.46	100	326	QP
716.5200	34.37	-2.49	31.88	46.00	-14.12	100	291	QP

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported

Above 1 GHz

Horizontal

Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Degree (˚)	Remark
BLE Low Channel								
2390.000	61.85	-4.89	56.96	74.00	-17.04	167	167	peak
2390.000	51.87	-4.89	46.98	54.00	-7.02	167	167	AVG
2402.000	90.11	-4.86	85.25	N/A	N/A	167	346	peak
2402.000	85.34	-4.86	80.48	N/A	N/A	167	346	AVG
4804.000	43.39	0.98	44.37	74.00	-29.63	151	193	peak
4804.000	30.46	0.98	31.44	54.00	-22.56	151	193	AVG
BLE Mid Channel								
2440.000	94.34	-4.78	89.56	N/A	N/A	169	337	peak
2440.000	89.47	-4.78	84.69	N/A	N/A	169	337	AVG
4880.000	44.51	1.24	45.75	74.00	-28.25	153	243	peak
4880.000	29.73	1.24	30.97	54.00	-23.03	153	243	AVG
BLE High Channel								
2480.000	96.57	-4.68	91.89	N/A	N/A	159	143	peak
2480.000	89.83	-4.68	85.15	N/A	N/A	159	143	AVG
2483.500	64.40	-4.69	59.71	74.00	-14.29	159	205	peak
2483.500	51.97	-4.69	47.28	54.00	-6.72	159	205	AVG
4960.000	42.37	1.51	43.88	74.00	-30.12	140	118	peak
4960.000	28.83	1.51	30.34	54.00	-23.66	140	118	AVG

Vertical

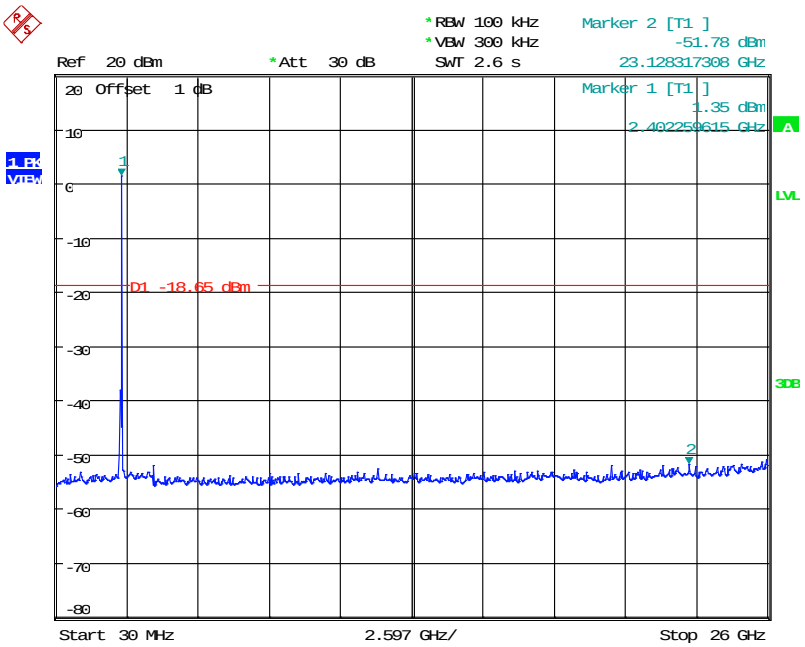
Frequency (MHz)	Reading (dBuV)	Correct Factor(dB/m)	Result (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Height (cm)	Degree (˚)	Remark
BLE Low Channel								
2370.315	62.21	-4.93	57.28	74.00	-16.72	132	167	peak
2370.315	50.38	-4.93	45.45	54.00	-8.55	132	167	AVG
2402.000	95.94	-4.86	91.08	N/A	N/A	132	257	peak
2402.000	90.09	-4.86	85.23	N/A	N/A	132	257	AVG
4804.000	42.31	0.98	43.29	74.00	-30.71	146	204	peak
4804.000	30.71	0.98	31.69	54.00	-22.31	146	204	AVG
BLE Mid Channel								
2440.000	98.69	-4.78	93.83	N/A	N/A	144	182	peak
2440.000	92.97	-4.78	88.19	N/A	N/A	144	182	AVG
4880.000	41.71	1.24	42.95	74.00	-31.05	147	347	peak
4880.000	29.56	1.24	30.80	54.00	-23.20	147	347	AVG
BLE High Channel								
2480.000	100.19	-4.68	95.51	N/A	N/A	140	82	peak
2480.000	95.24	-4.68	90.56	N/A	N/A	140	82	AVG
2483.910	64.76	-4.68	60.08	74.00	-13.92	140	168	peak
2483.910	54.82	-4.68	50.14	54.00	-3.86	140	168	AVG
4960.000	44.25	1.51	45.76	74.00	-28.24	134	183	peak
4960.000	28.17	1.51	29.68	54.00	-24.32	134	183	AVG

Result = Reading + Correct Factor
Margin = Result – Limit
Correct Factor = Antenna Factor + Cable Loss – Amplifier Gain
Spurious emissions more than 20 dB below the limit were not reported

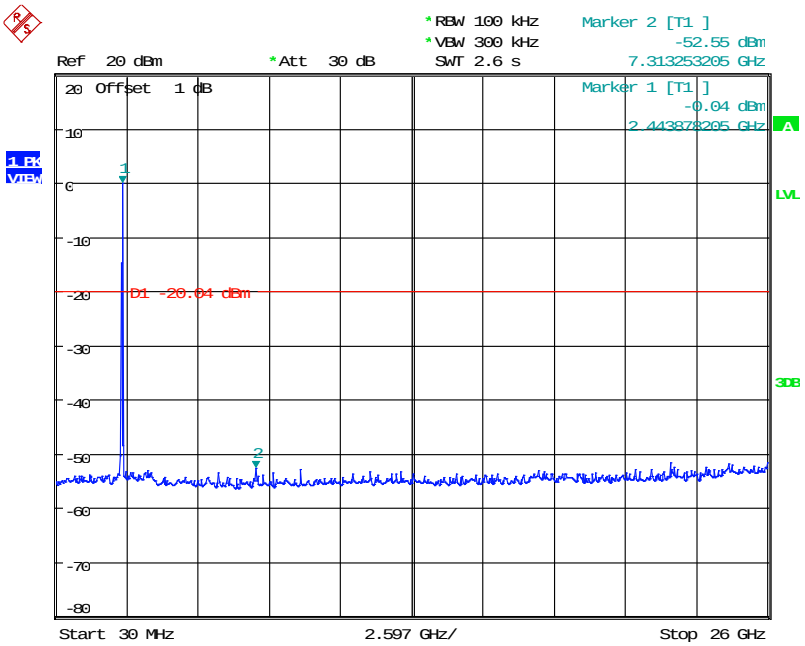
Conducted Spurious Emissions:

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	RESULT
Low	2402	53.13	≥ 20	PASS
Mid	2440	52.51	≥ 20	PASS
High	2480	53.07	≥ 20	PASS

Low Channel



Middle Channel



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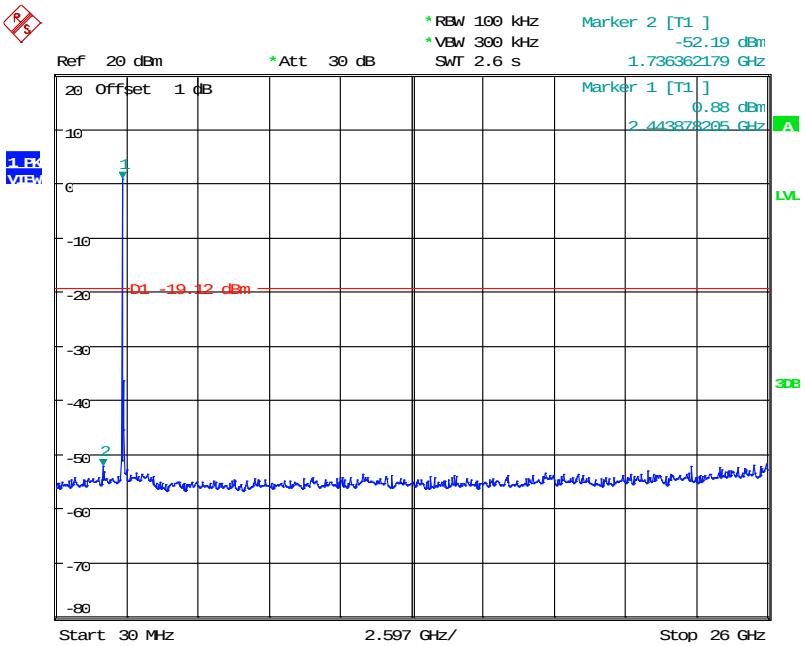
High Channel



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8 FCC §15.247(a)(2) – 6 dB Emission Bandwidth

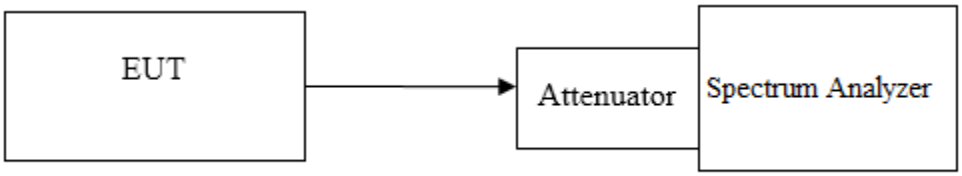
8.1 Applicable Standard

According to FCC §15.247(a) (2).

Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

8.2 Test Procedure

According to ANSI C63.10-2013



6 dB Emission Bandwidth
The steps for the first option are as follows:
a) Set RBW = 100 kHz.
b) Set the VBW ≥ [3 × RBW].
c) Detector = peak.
d) Trace mode = max hold.
e) Sweep = auto couple.
f) Allow the trace to stabilize.
g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

8.3 Test Equipment List and Details

Descriptions	Manufacturers	Models	Serial Numbers	Calibration Date	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSU26	200268	2017/05/08	2018/05/07
Cable	WOKEN	SFL402	S02-160323-07	2017/02/22	2018/02/21

***Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Taiwan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

8.4 Test Environmental Conditions

Temperature:	26° C
Relative Humidity:	58 %
ATM Pressure:	101.0 kPa

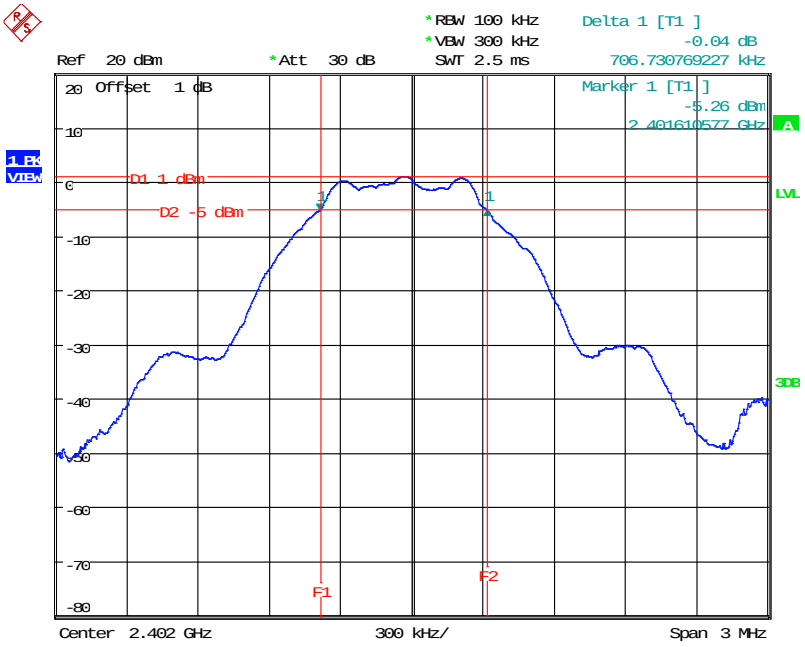
The testing was performed by Ian Tu on 2017-09-04.

8.5 Test Results

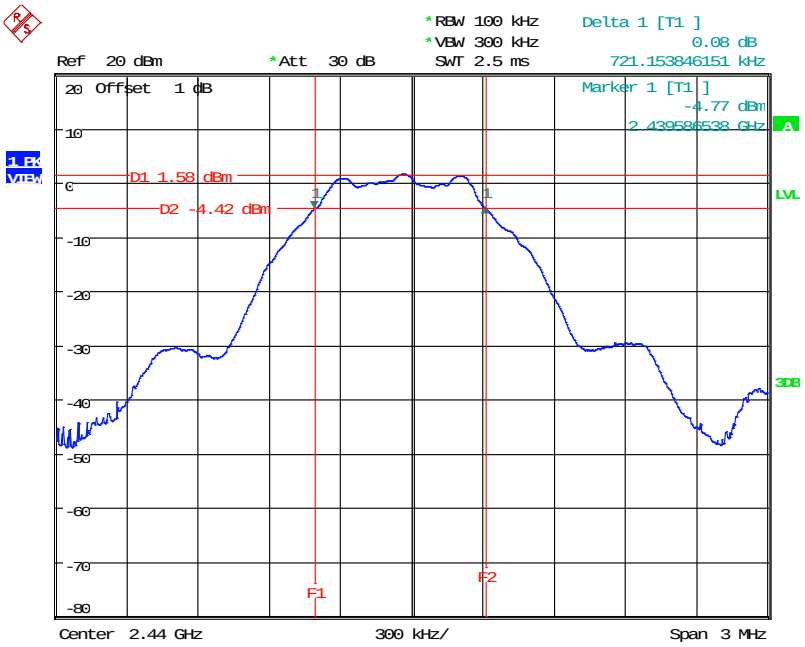
Channel	Frequency (MHz)	6 dB OBW (MHz)	Limit (MHz)	Result
Low	2402	0.706	> 0.5	Compliance
Middle	2440	0.721	> 0.5	Compliance
High	2480	0.716	> 0.5	Compliance

Please refer to the following plots

Low Channel



Middle Channel



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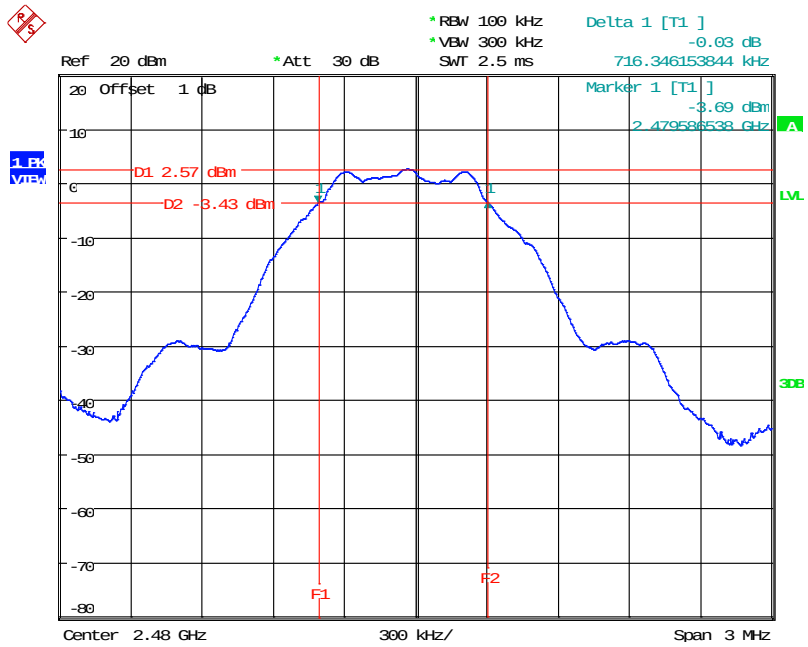
High Channel



Date: 4.SEP.2017 10:38:01

9 FCC §15.247(b)(3) – Maximum Output Power

9.1 Applicable Standard

According to FCC §15.247(b) (3).

Systems using digital modulation in the 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz bands: 1 Watt. As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

9.2 Test Procedure

1. Place the EUT on a bench and set it in transmitting mode.

2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna port to measuring equipment.

9.3 Test Equipment List and Details

Descriptions	Manufacturers	Models	Serial Numbers	Calibration Date	Calibration Due Date
Power Sensor	KEYSIGHT	U2021XA	MY54080018	2017/03/21	2018/03/20
Cable	WOKEN	SFL402	S02-160323-07	2017/02/22	2018/02/21

***Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Taiwan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

9.4 Test Environmental Conditions

Temperature:	26° C
Relative Humidity:	58 %
ATM Pressure:	101.0 kPa

The testing was performed by Ian Tu on 2017-08-29.

9.5 Test Results

Channel	Frequency (MHz)	Maximum peak Conducted Output Power (dBm)	Limit (dBm)	Result
Low	2402	2.89	30	Compliance
Middle	2440	3.07	30	Compliance
High	2480	3.38	30	Compliance

10 FCC §15.247(d) – 100 kHz Bandwidth of Frequency Band Edge

10.1 Applicable Standard

According to FCC §15.247(d).

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. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. 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) (see §15.205(c)).

10.2 Test Procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable. Then set it to any one measured frequency within its operating range, and make sure the instrument is operated in its linear range.
3. Set RBW to 100 kHz and VBW of spectrum analyzer to 300 kHz with a convenient frequency span including 100 kHz bandwidth from band edge.
4. Measure the highest amplitude appearing on spectral display and set it as a reference level. Plot the graph with marking the highest point and edge frequency.
5. Repeat above procedures until all measured frequencies were complete.

10.3 Test Equipment List and Details

Descriptions	Manufacturers	Models	Serial Numbers	Calibration Date	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSU26	200268	2017/05/08	2018/05/07
Cable	WOKEN	SFL402	S02-160323-07	2017/02/22	2018/02/21

***Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Taiwan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

10.4 Test Environmental Conditions

Temperature:	26° C
Relative Humidity:	58 %
ATM Pressure:	101.0 kPa

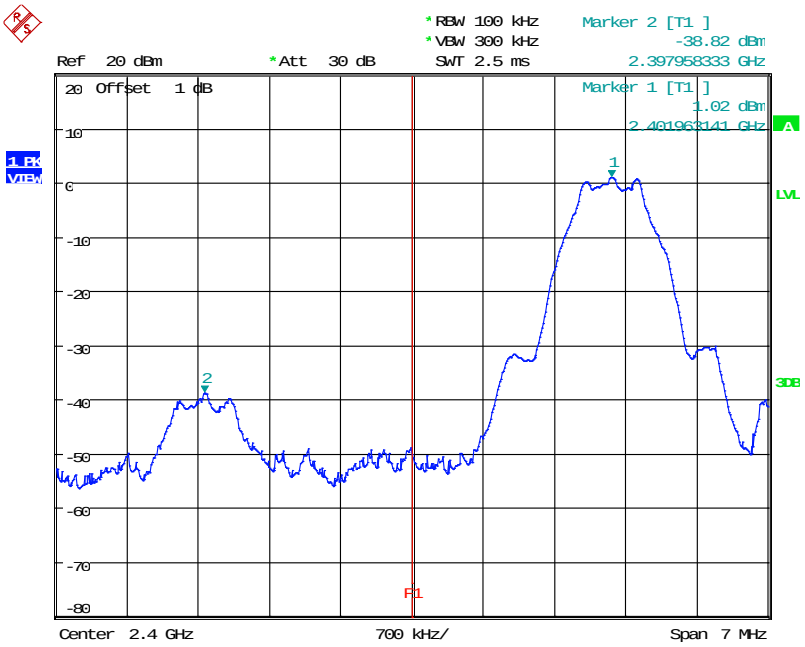
The testing was performed by Ian Tu on 2017-08-29.

10.5 Test Results

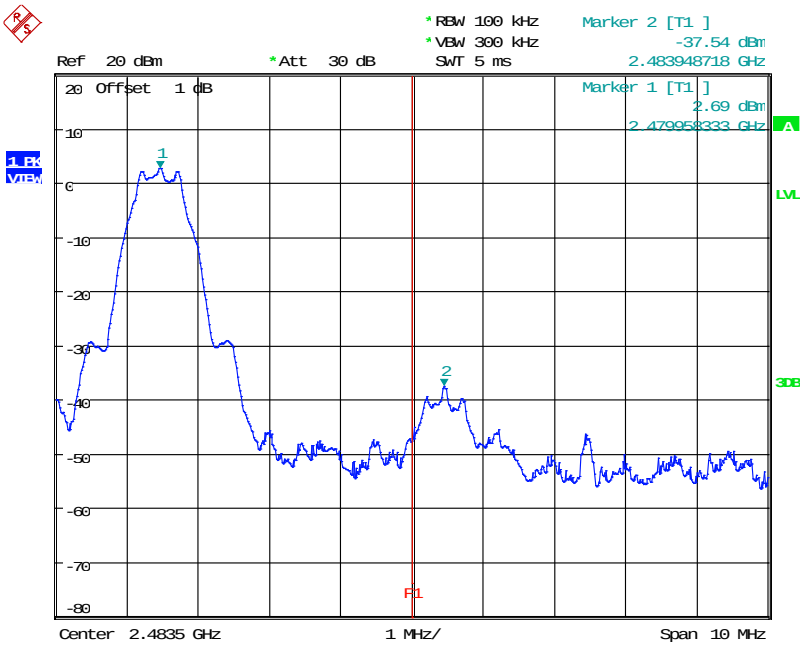
Please refer to the following plots

Channel	Frequency (MHz)	Delta Peak to Band Emission (dBc)	Limit (dBc)	RESULT
Low	2402	39.84	≥ 20	PASS
High	2480	40.23	≥ 20	PASS

Band Edge, Left Side



Band Edge, Right Side



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11 FCC §15.247(e) – Power Spectral Density

11.1 Applicable Standard

According to FCC §15.247(e).

For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

11.2 Test Procedure

According to ANSI C63.10-2013

a) Set analyzer center frequency to DTS channel center frequency.

b) Set the span to 1.5 times the DTS bandwidth.

c) Set the RBW to 3 kHz ≤ RBW ≤ 100 kHz.

d) Set the VBW ≥ [3 × RBW].

e) Detector = peak.

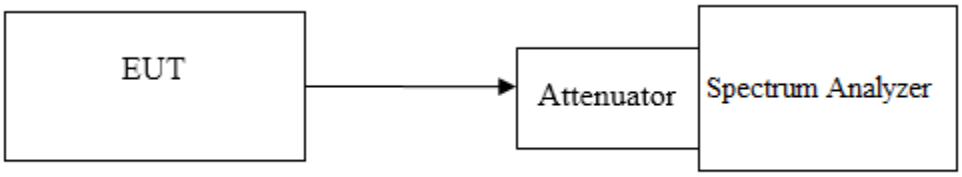
f) Sweep time = auto couple.

g) Trace mode = max hold.

h) Allow trace to fully stabilize.

i) Use the peak marker function to determine the maximum amplitude level within the RBW.

j) If measured value exceeds requirement, then reduce RBW (but no less than 3 kHz) and repeat



11.3 Test Equipment List and Details

Descriptions	Manufacturers	Models	Serial Numbers	Calibration Date	Calibration Due Date
Spectrum Analyzer	Rohde & Schwarz	FSU26	200268	2017/05/08	2018/05/07
Cable	WOKEN	SFL402	S02-160323-07	2017/02/22	2018/02/21

***Statement of Traceability:** Bay Area Compliance Laboratories Corp. (Taiwan) attests that all calibrations have been performed in accordance to requirements that traceable to National Primary Standards and International System of Units (SI).

11.4 Test Environmental Conditions

Temperature:	26° C
Relative Humidity:	58 %
ATM Pressure:	101.0 kPa

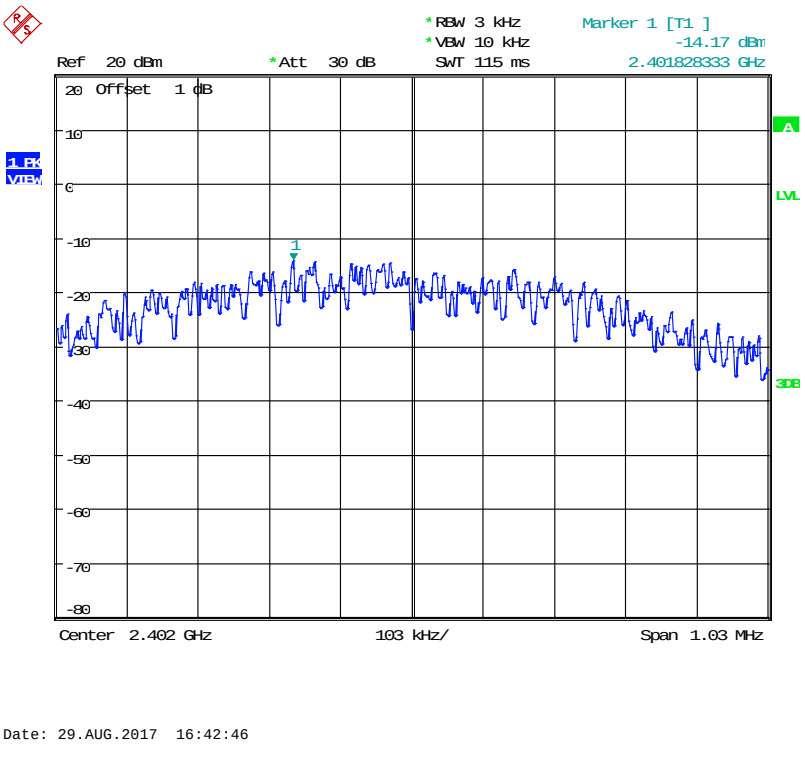
The testing was performed by Ian Tu on 2017-08-29.

11.5 Test Results

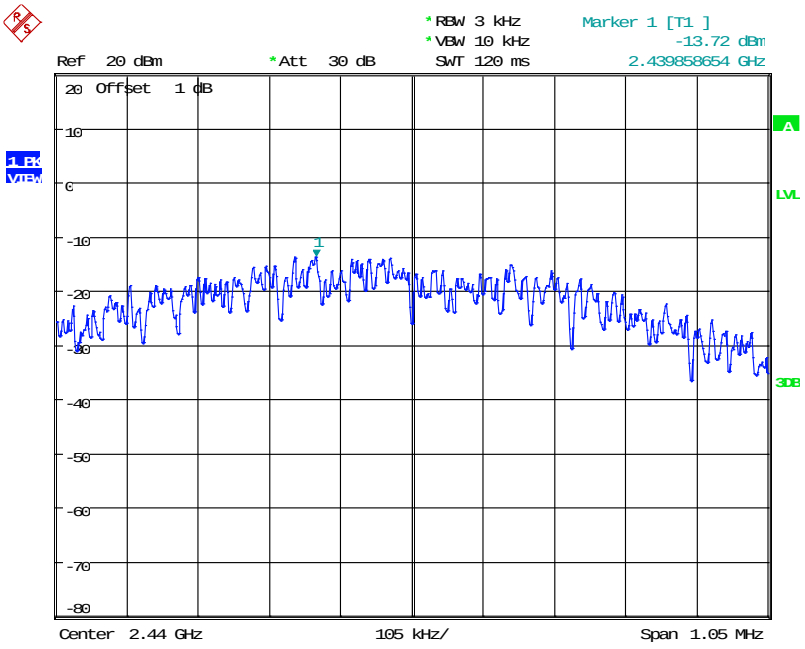
Channel	Frequency (MHz)	PSD (dBm/3 kHz)	Limit (dBm/3 kHz)	Result
Low	2402	-14.17	8	Compliance
Middle	2440	-13.72	8	Compliance
High	2480	-12.15	8	Compliance

Please refer to the following plots

Low Channel



Middle Channel



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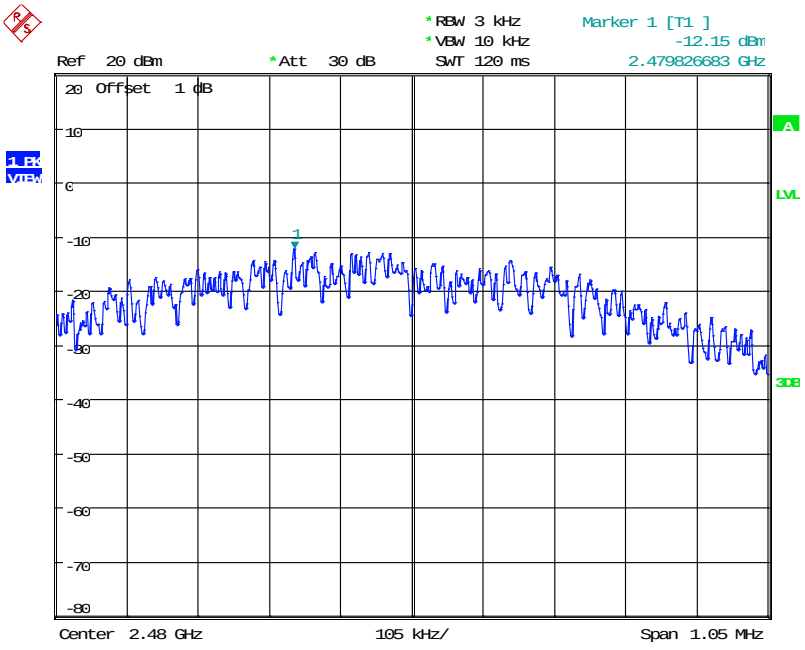
High Channel



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