Test Report

Date : 2018-06-05
No. : HM18050007

Applicant:	LINKHIGH INTERNATIONAL LIMITED Room 202B, 2/F, Building 9, Dong Yi Ind, Zhong Huan Rd, Shang Tang, Long Hua, Shenzhen, China 518131
Supplier / Manufacturer:	LINKHIGH INTERNATIONAL LIMITED Room 202B, 2/F, Building 9, Dong Yi Ind, Zhong Huan Rd, Shang Tang, Long Hua, Shenzhen, China 518131
Description of Sample(s):	Submitted sample(s) said to be Product: Temperature & Humidity Sensor Brand Name: N/A Model No.: EN00106001 FCC ID: 2APRCEN01
Date Samples Received:	2018-05-03
Date Tested:	2018-05-10 to 2018-05-18
Investigation Requested:	Perform ElectroMagnetic Interference measurement in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15: 2017 and ANSI C63.10:2013 for FCC Certification.
Conclusions:	The submitted product COMPLIED with the requirements of Federal Communications Commission [FCC] Rules and Regulations Part 15. The tests were performed in accordance with the standards described above and on Section 2.2 in this Test Report.
Remarks:	IEEE 802.15.4 (2.4GHz)

CHEUNG Chi, Kenneth
Authorized Signatory
ElectroMagnetic Compatibility Department
For and on behalf of
The Hong Kong Standards and Testing Centre Ltd.

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1.0 General Details

1.1 Test Laboratory

The Hong Kong Standards and Testing Centre Ltd.
EMC Laboratory
Head Office: 10 Dai Wang Street, Taipo Industrial Estate, Tai Po, N.T., Hong Kong
Telephone: 852 2666 1888
Fax: 852 2664 4353

1.2 Equipment Under Test [EUT]

Description of Sample(s)

Product:	Temperature & Humidity Sensor
Additional Product Name:	Touch Sensor, Entry Sensor
Manufacturer:	LINKHIGH INTERNATIONAL LIMITED Room 202B, 2/F, Building 9, Dong Yi Ind, Zhong Huan Rd, Shang Tang, Long Hua, Shenzhen, China 518131
Brand Name:	N/A
Model Number:	EN00106001
Additional Model Number:	MV00106001, DW00106001
Rating:	3.0[V] (2.4~ 3.6V, Coin Cell Battery CR2032 1ea)

1.2.1 Description of EUT Operation

The Equipment Under Test (EUT) is a 2.4GHz Sensor. The transmission signal is digital modulated with channel frequency range 2405-2475MHz. The R.F. signal was modulated by IC; the type of modulation used was O-QPSK.

1.3 Date of Order

2018-05-03

1.4 Submitted Sample(s):

2 Samples

1.5 Test Duration

2018-05-10 to 2018-05-18

1.6 Country of Origin

China

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1.7 RF Module Details

Module Model Number:
Module FCC ID: N/A
Module Transmission Type: ZigBee
Modulation: O-QPSK
Data Rates: 1Mbps
Frequency Range: 2400-2483.5MHz
Carrier Frequencies: 2405MHz – 2475MHz

Module Specification (specification provided by manufacturer)

1.8 Antenna Details

Antenna Type: Internal Metal antenna
Antenna Gain: 2.5dBi

1.9 Channel List

Channel	Frequency (MHz)
11	2405
12	2410
13	2415
14	2420
15	2425
16	2430
17	2435
18	2440
19	2445
20	2450
21	2455
22	2460
23	2465
24	2470
25	2475
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2.0 Technical Details

2.1 Investigations Requested

Perform Electromagnetic Interference measurements in accordance with FCC 47CFR [Codes of Federal Regulations] Part 15: 2017 Regulations and ANSI C63.10:2013 for FCC Certification.
According FCC KDB 558074 DTS Measurement Guidance, Duty cycle ≧98%.
The device was realized by test software.

2.2 Test Standards and Results Summary Tables

EMISSION Results Summary						
Test Condition	Test Requirement	Test Method	Class / Severity	Test Result		
				Pass	Failed	N/A
Maximum Peak Output Power	FCC 47CFR 15.247(b)(3)	ANSI C63.10: 2013	N/A	☒	☐	☐
Radiated Spurious Emissions	FCC 47CFR 15.209	ANSI C63.10: 2013	N/A	☒	☐	☐
AC Mains Conducted Emissions	FCC 47CFR 15.207	ANSI C63.10: 2013	N/A	☐	☐	☒
Power Spectral Density	FCC 47CFR 15.247(e)	ANSI C63.10: 2013	N/A	☒	☐	☐
6dB Bandwidth	FCC 47CFR 15.247(a)(2)	ANSI C63.10: 2013	N/A	☒	☐	☐
Band Edge Emissions (Radiated)	FCC 47CFR 15.247(d)	ANSI C63.10: 2013	N/A	☒	☐	☐
Antenna requirement	FCC 47CFR 15.203	N/A	N/A	☒	☐	☐
RF Exposure	FCC 47CFR 15.247(i)	N/A	N/A	☒	☐	☐

Note: N/A - Not Applicable

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3.0 Test Results

3.1 Emission

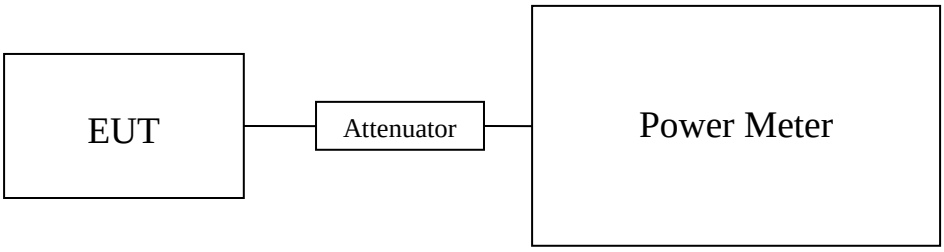
3.1.1 Maximum Peak Output Power

Test Requirement:	FCC 47CFR 15.247(b)(2)
Test Method:	ANSI C63.10:2013
Test Date:	2018-05-10
Mode of Operation:	Tx mode

Test Method:

The RF output of the EUT was connected to the spectrum analyzer. All the attenuation or cable loss will be added to the measured maximum output power. The results are recorded in Watt.

Test Setup:



Note: a temporary antenna connector was soldered to the RF output.

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Limits for Peak Output Power of Fundamental & Harmonics Emissions [FCC 47CFR 15.247]:

For Digital Transmission systems in 2400-2483.5 MHz Band: 1 Watt (30dBm)

Results of BT DTS Tx Mode (2405MHz to 2475MHz) : Pass (TX Unit) (GFSK)
Maximum conducted output power

Channel	Frequency(MHz)	Output Power(Watt)
11	2405	0.00381
18	2440	0.00277
25	2475	0.00373

Calculated measurement uncertainty : 30MHz to 1GHz 1.7dB
1GHz to 26GHz 1.7dB

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3.1.2 Radiated Emissions

Test Requirement:	FCC 47CFR 15.209
Test Method:	ANSI C63.10:2013
Test Date:	2018-05-10
Mode of Operation:	Tx mode

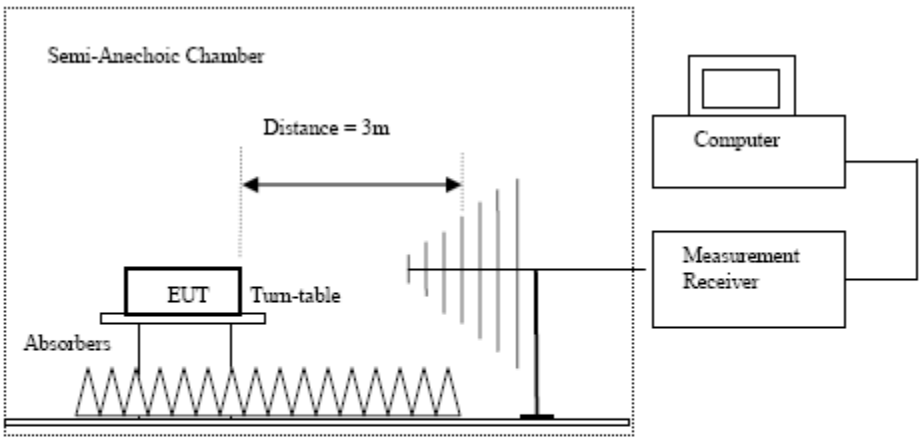
Test Method:

For emission measurements at or below 1 GHz, the sample was placed 0.8m above the ground plane of semi-anechoic Chamber*. For emission measurements above 1 GHz, the sample was placed 1.5m above the ground plane of semi-anechoic Chamber*. Measurements in both horizontal and vertical polarities were performed. During the test, each emission was maximized by: having the EUT continuously working, investigated all operating modes, rotated about all 3 axis (X, Y & Z) and considered typical configuration to obtain worst position, manipulating interconnecting cables, rotating turntable, varying antenna height from 1m to 4m in both horizontal and vertical polarizations. The emissions worst-case are shown in Test Results of the following pages.

*
The Hong Kong Standards and Testing Centre Ltd.

FCC Test Firm Registration Number 723883 Designation Number HK0001

Test Setup:



- Absorbers placed on top of the ground plane are for measurements above 1000MHz only.
- Measurements between 30MHz to 1000MHz made with Bi-log antennas, above 1000MHz horn antennas are used, 9kHz to 30MHz loop antennas are used.

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Limits for Radiated Emissions FCC 47 CFR 15.247 Class B]:

Frequency Range	Quasi-Peak Limits
[MHz]	[μV/m]
0.009-0.490	2400/F (kHz)
0.490-1.705	24000/F (kHz)
1.705-30	30
30-88	100
88-216	150
216-960	200
Above960	500

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

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Result of Tx mode (2405.0 MHz) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the Limits						

Result of Tx mode (2405.0 MHz) (Above 1GHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4810.0	3.3	32.1	35.4	74.0	38.6	Horizontal
7215.0	2.3	38.6	40.9	74.0	33.1	Horizontal
9620.0	-1.8	41.3	39.5	74.0	34.5	Vertical
12025.0	-3.1	43.5	40.4	74.0	33.6	Vertical

Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4810.0	-2.5	32.1	29.6	54.0	24.4	Horizontal
7215.0	-3.1	38.6	35.5	54.0	18.5	Horizontal
9620.0	-7.6	41.3	33.7	54.0	20.3	Vertical
12025.0	-8.5	43.5	35.0	54.0	19.0	Vertical

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Result of Tx mode (2440.0 MHz) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the Limits						

Result of Tx mode (2440.0 MHz) (Above 1GHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4880.0	2.3	32.1	34.4	74.0	39.6	Horizontal
7320.0	2.1	38.6	40.7	74.0	33.3	Horizontal
9760.0	-1.7	41.3	39.6	74.0	34.4	Vertical
12200.0	-3.5	43.5	40.0	74.0	34.0	Vertical

Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4880.0	-2.7	32.1	29.4	54.0	24.6	Horizontal
7320.0	-3.4	38.6	35.2	54.0	18.8	Horizontal
9760.0	-7.7	41.3	33.6	54.0	20.4	Vertical
12200.0	-8.3	43.5	35.2	54.0	18.8	Vertical

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Result of Tx mode (2475.0 MHz) (9kHz – 30MHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level dBuV	Correction Factor dB/m	Field Strength dBuV/m	Field Strength uV/m	Limit uV/m	E-Field Polarity
Emissions detected are more than 20 dB below the Limits						

Result of Tx mode (2475.0 MHz) (Above 1GHz): Pass

Field Strength of Spurious Emissions Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4950.0	3.3	32.2	35.5	74.0	38.5	Horizontal
7425.0	0.3	38.6	38.9	74.0	35.1	Horizontal
9900.0	-1.5	42.1	40.6	74.0	33.4	Vertical
12375.0	-3.5	44.1	40.6	74.0	33.4	Vertical

Field Strength of Spurious Emissions Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
4950.0	-2.3	32.2	29.9	54.0	24.1	Horizontal
7425.0	-3.1	38.6	35.5	54.0	18.5	Horizontal
9900.0	-7.1	42.1	35.0	54.0	19.0	Vertical
12375.0	-8.4	44.1	35.7	54.0	18.3	Vertical

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Remarks:
No additional spurious emissions found between lowest internal used/generated frequency and 30 MHz
* Denotes restricted band of operation.
Measurements were made using a peak detector. Any emission less than 1000MHz and falling within the restricted bands of FCC Rules Part 15 Section 15.205 and the limits of FCC Rules Part 15 Section 15.209 were applied.

Correction Factor included Antenna Factor and Cable Attenuation.

Calculated measurement uncertainty	:	9kHz-30MHz	3.3dB
		30MHz -1GHz	4.6dB
		1GHz -26GHz	4.4dB

Emissions in the vertical and horizontal polarizations have been investigated and the worst-case test results are recorded in this report.

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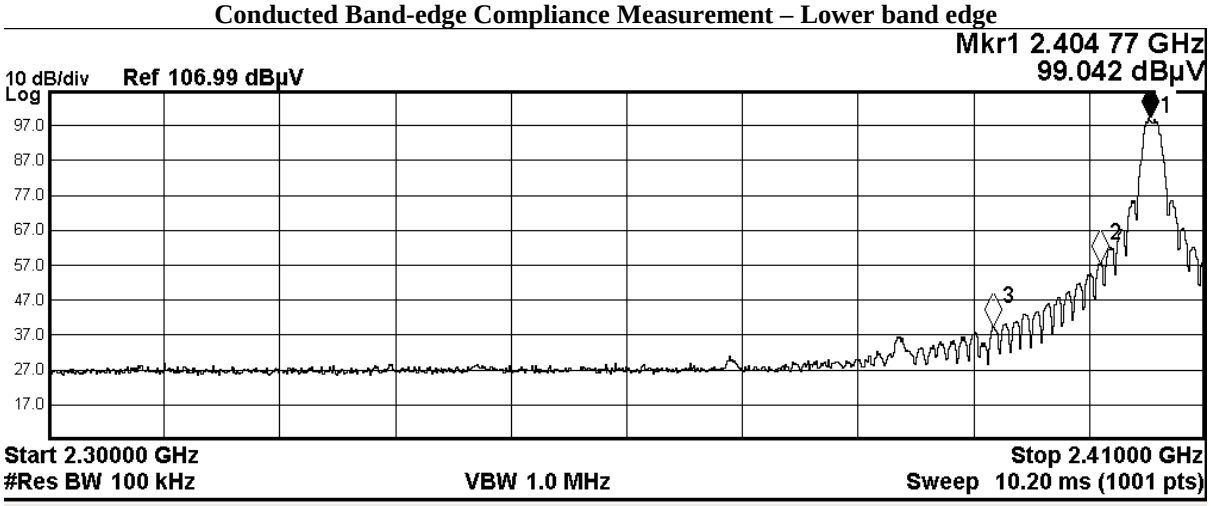
Band Edge Measurement:
Limit：
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement. Attenuation below the general limits specified in Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 5.205(c)).

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400 – Lowest Fundamental (2405)	41.6

Conducted Band-edge Compliance Measurement – Lower band edge



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.404 77 GHz	99.042 dBµV			
2	N	1	f	2.400 00 GHz	57.469 dBµV			
3	N	1	f	2.389 87 GHz	39.395 dBµV			
4								

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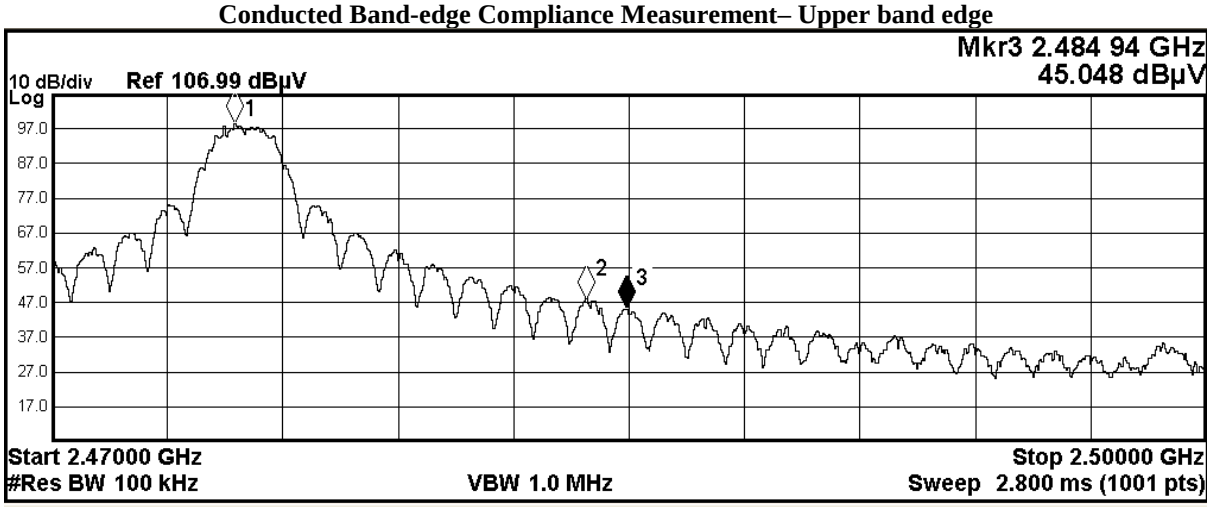
Band-edge Compliance of RF Conducted Emissions Measurement:

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2483.5 - Highest Fundamental (2475)	50.6

Conducted Band-edge Compliance Measurement– Upper band edge



MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.474 74 GHz	98.482 dBµV			
2	N	1	f	2.483 89 GHz	47.917 dBµV			
3	N	1	f	2.484 94 GHz	45.048 dBµV			
4								

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Radiated Emissions Band-edge and Restricted Band Result:

Field Strength of Band-edge Compliance Peak Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
2389.9	14.7	27.9	42.6	74.0	31.4	Horizontal
2389.9	13.2	27.5	40.7	74.0	33.3	Vertical
2489.9	19.4	27.9	47.3	74.0	26.7	Horizontal
2489.9	17.8	27.5	45.3	74.0	28.7	Vertical

Field Strength of Band-edge Compliance Average Value						
Frequency MHz	Measured Level @3m dBuV	Correction Factor dB/m	Field Strength dBuV/m	Limit @3m dBuV/m	Margin dBuV/m	E-Field Polarity
2389.9	3.4	27.9	31.3	54.0	22.7	Horizontal
2389.9	2.3	27.5	29.8	54.0	24.2	Vertical
2489.9	9.3	27.9	37.2	54.0	16.8	Horizontal
2489.9	8.0	27.5	35.5	54.0	18.5	Vertical

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Limits for Radiated Emissions FCC 47 CFR 15.247 Class B]:

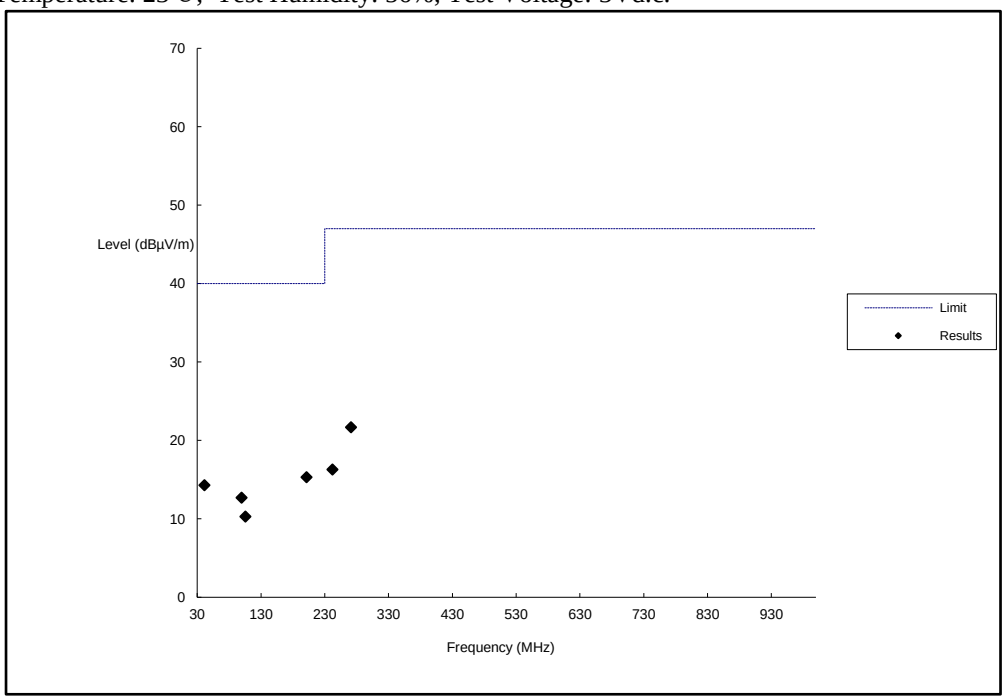
Frequency Range	Quasi-Peak Limits
[MHz]	[μV/m]
0.009-0.490	2400/F (kHz)
0.490-1.705	24000/F (kHz)
1.705-30	30
30-88	100
88-216	150
216-960	200
Above960	500

The emission limits shown in the above table are based on measurement employing a CISPR quasi-peak detector and above 1000MHz are based on measurements employing an average detector.

Results of Tx Mode (30MHz – 1GHz): Pass

Please refer to the following table for result details(The data is the worst cases)

Test Temperature: 23℃, Test Humidity: 56%, Test Voltage: 3Vd.c.



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Radiated Emissions Quasi-Peak					
Emission Frequency MHz	E-Field Polarity	Level @3m dBμV/m	Limit @3m dBμV/m	Level @3m μV/m	Limit @3m μV/m
41.3	Vertical	14.3	40.0	5.2	150
99.6	Horizontal	12.7	43.5	4.3	150
105.6	Horizontal	10.3	43.5	3.3	150
201.3	Horizontal	15.3	43.5	5.8	200
242.3	Horizontal	16.3	46.0	6.5	200
271.4	Horizontal	21.7	46.0	12.2	200

Remarks:
Calculated measurement uncertainty (30MHz – 1GHz): 4.6dB
Emissions in the vertical and horizontal polarizations have been investigated and the worst-case test results are recorded in this report.

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3.1.3 Power Spectral Density

Test Requirement:	FCC 47CFR 15.247(e)
Test Method:	ANSI C63.10:2013
Test Date:	2018-05-10
Mode of Operation:	Tx mode

Test Method:

The RF output of the EUT was connected to the spectrum analyzer. Set the fundamental frequency as the center frequency of the spectral analyzer. Use RBW=3kHz , VBW= 10kHz , Set the span to 1.5 times the DTS channel bandwidth. Detector = peak, Sweep time = auto couple , Trace mode = max hold. The Measured values are using RBW = 30kHz, the correction factor is, 10Log(3k/30kHz) = -10dB

Test Setup:

As Test Setup of clause 3.1.1 in this test report.

Test Limit:
The maximum power spectral density (PSD) shall not exceeded 8dBm in any 3kHz band.

Results of Tx Mode (Tx:2405MHz to 2475MHz) : Pass (Tx Unit)
Maximum power spectral density

Transmitter Frequency (MHz)	Maximum Power spectral density level / 3kHz band (dBm)	Maximum Power spectral density / 3kHz band limit
2405.0	-12.7	**8dBm**
2440.0	-11.8	**8dBm**
2475.0	-12.5	**8dBm**

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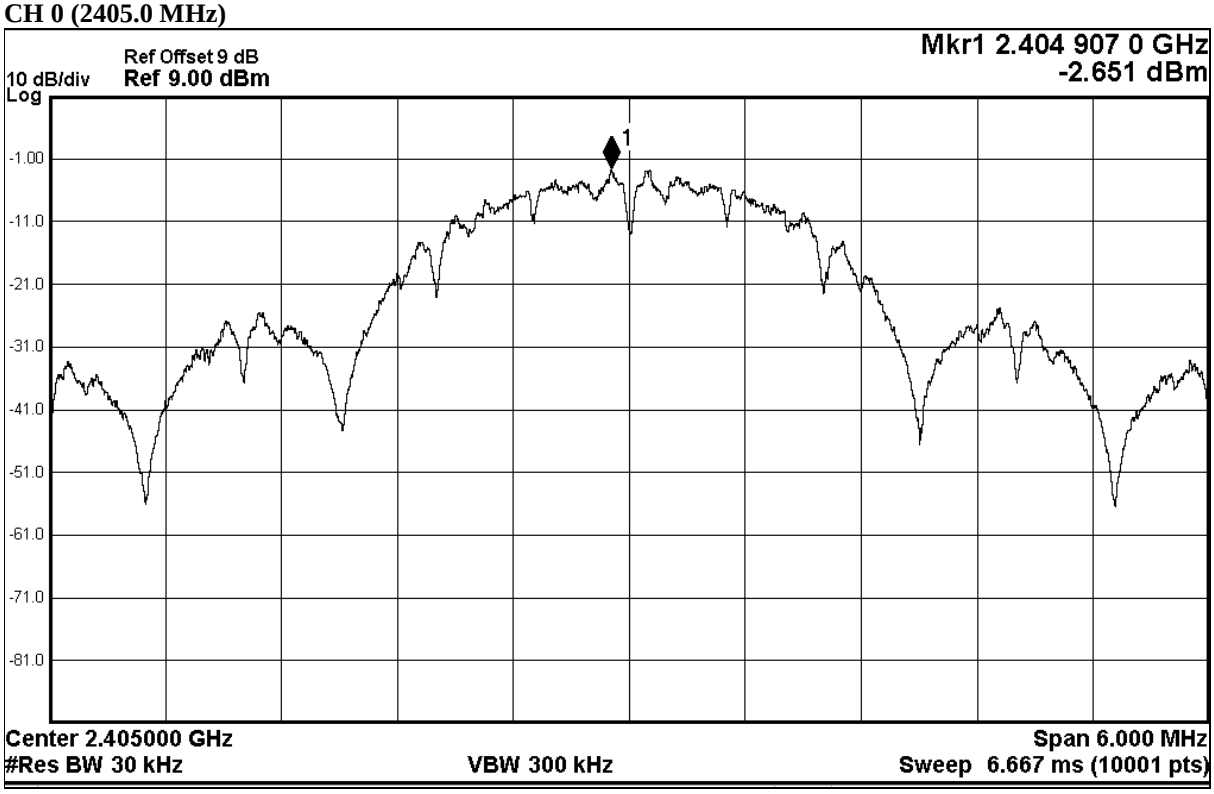
Tx mode (Tx: 2405MHz to 2475MHz)
CH 0 (2405.0 MHz)



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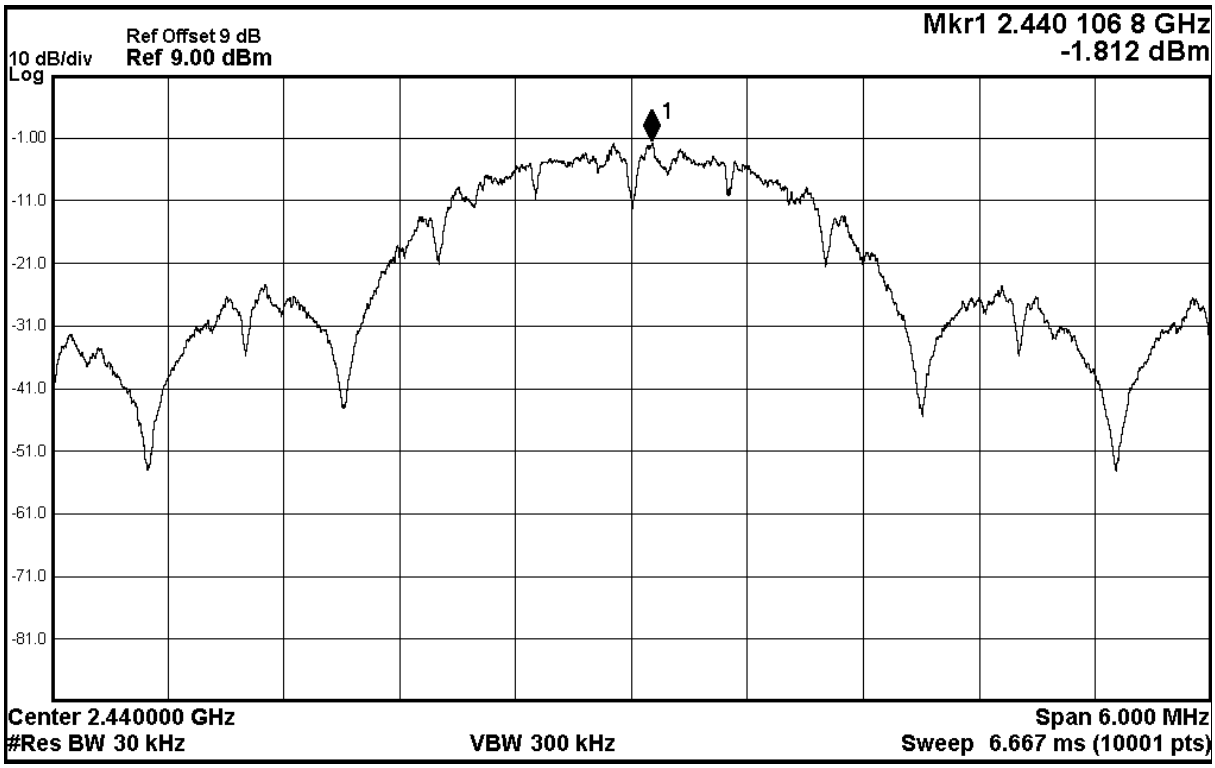
CH 19 (2440.0 MHz)



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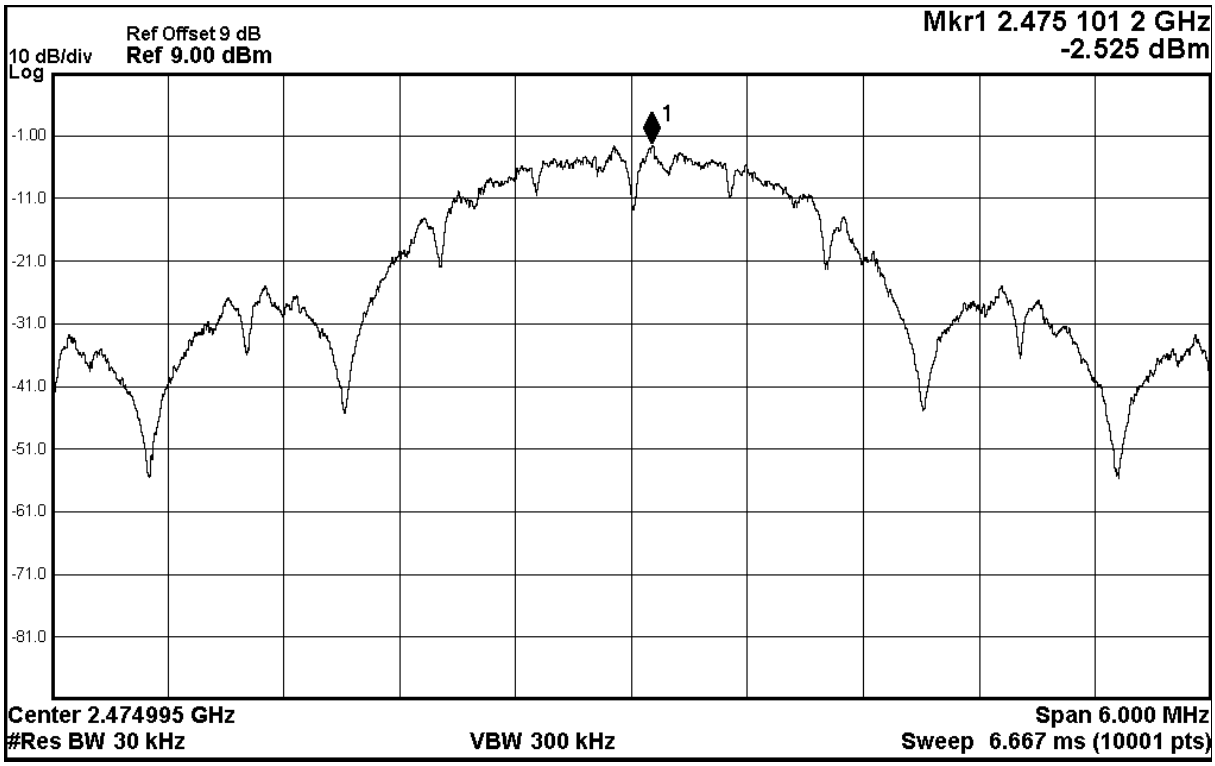
CH 39 (2475.0 MHz)



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3.1.4 6dB Spectrum Bandwidth Measurement

Test Requirement:	FCC 47CFR 15.247(a)(2)
Test Method:	ANSI C63.10:2013
Test Date:	2018-05-10
Mode of Operation:	Tx mode

Test Method:

The bandwidth is measured at an amplitude level reduced from the reference level by a specified ratio. The reference level is the level of the highest amplitude signal observed from the transmitter at the fundamental frequency. Once the reference level is established, the equipment is conditioned with typical modulating signal to produce the worst-case (i.e. the widest) bandwidth.

Test Setup:

As Test Setup of clause 3.1.1 in this test report.

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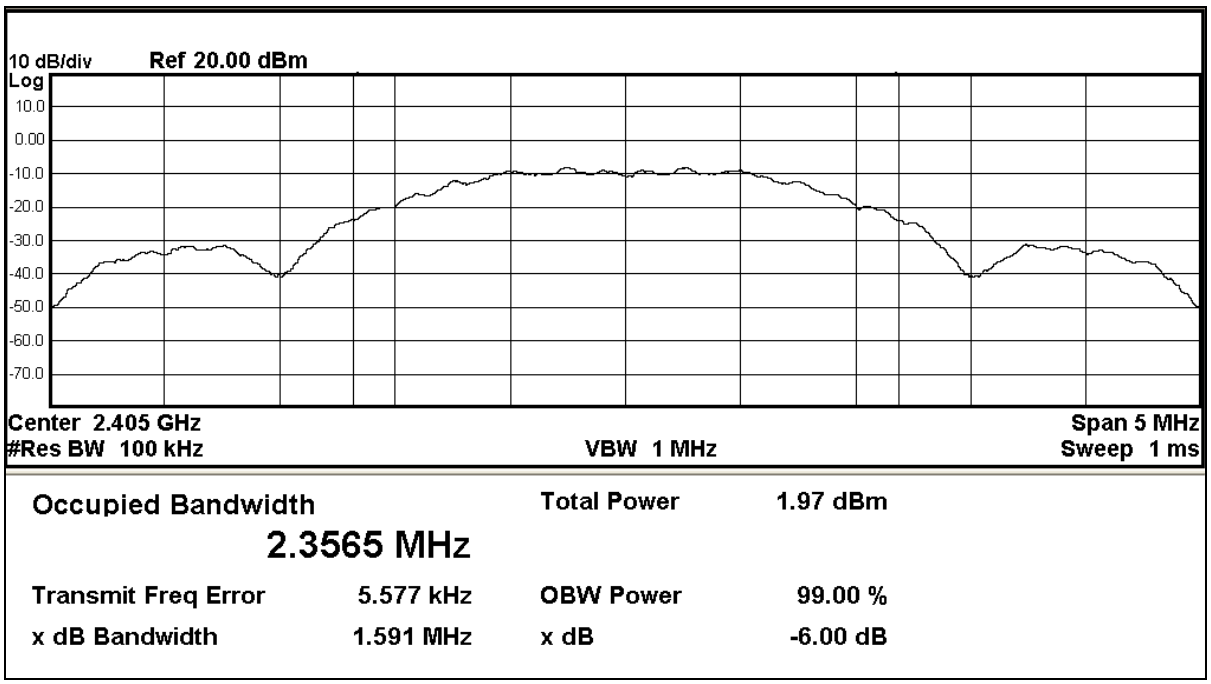
Limits for 6dB Spectrum Bandwidth Measurement:

Center Frequency [MHz]	6dB Bandwidth [kHz]	FCC Limits [kHz]
2405.0	1591	> 500

6dB Bandwidth of Fundamental Emission on (2405MHz)



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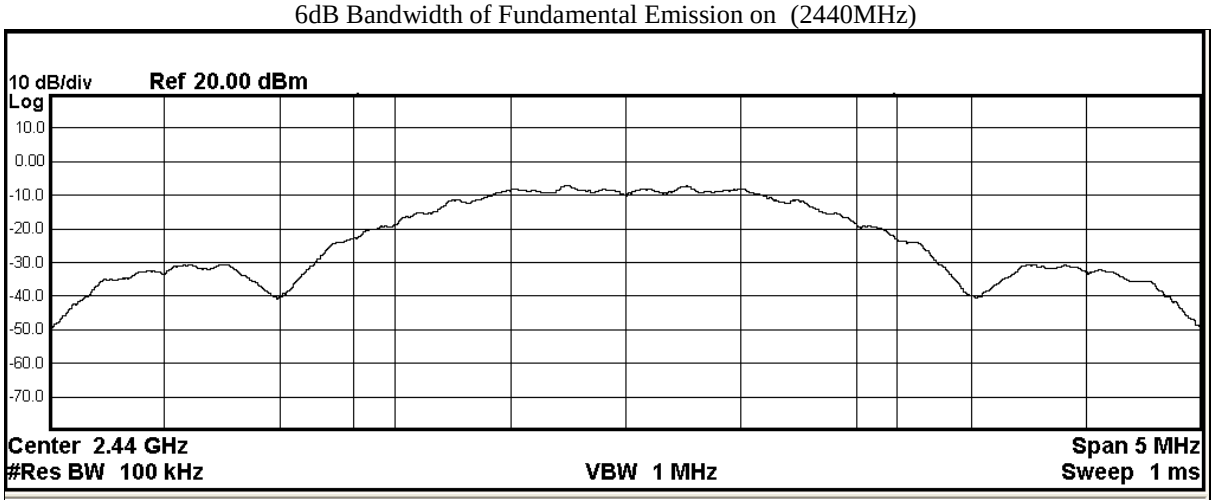
Limits for 6dB Spectrum Bandwidth Measurement:

Frequency Range [MHz]	6dB Bandwidth [kHz]	FCC Limits [kHz]
2440.0	1578	> 500

6dB Bandwidth of Fundamental Emission on (2440MHz)



Occupied Bandwidth	2.3483 MHz	Total Power	2.92 dBm
Transmit Freq Error	999 Hz	OBW Power	99.00 %
x dB Bandwidth	1.578 MHz	x dB	-6.00 dB

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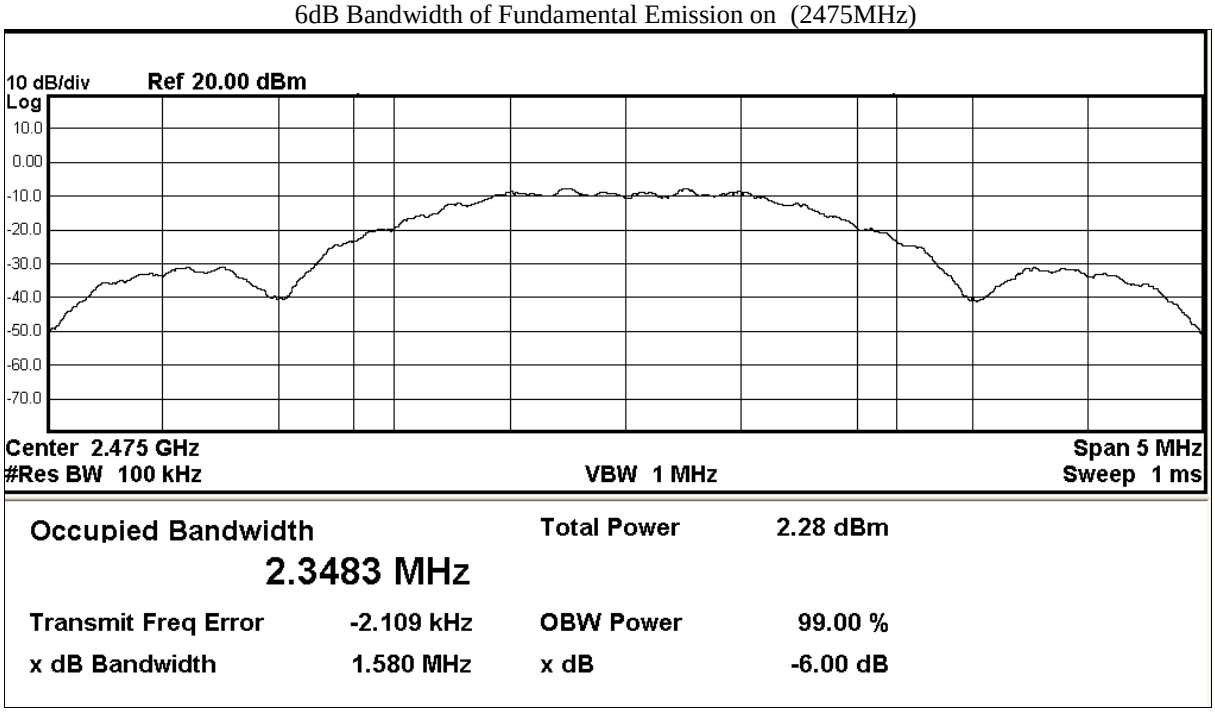
Limits for 6dB Spectrum Bandwidth Measurement:

Frequency Range [MHz]	6dB Bandwidth [kHz]	FCC Limits [kHz]
2475.0	1580	> 500

6dB Bandwidth of Fundamental Emission on (2475MHz)



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3.1.5 RF Exposure

RF Exposure

Test Requirement:	FCC 47CFR 15.247(i)
Test Date:	2018-05-18
Mode of Operation:	Tx mode

Requirements:

In 15.247(i), an equipment shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the limits in §§ 1.1310 and 2.1093 of this chapter.
Applications to the Commission for construction permits, licenses to transmit or renewals thereof, equipment authorizations or modifications in existing facilities must contain a statement confirming compliance with the limits unless the facility, operation, or transmitter is categorically excluded, as discussed below. Technical information showing the basis for this statement must be submitted to the Commission upon request.

According to KDB447498 D01 General RF Exposure Guidance v06, unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Exclusion Threshold condition.

Test Results:

RF Exposure Evaluation

The Maximum tune-up power = 6.01dBm (3.99mW)

SAR Test Exclusion Thresholds=1.98≤ 3.0 for 1-g SAR,

The test separation distances is ≤5 mm
The power tune up tolerance is 4.31±1.70dBm
Max. duty factor is 100%

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Appendix A

List of Measurement Equipment

Radiated Emission

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM215	MULTIDEVICE CONTROLLER	EMCO	2090	00024676	N/A	N/A
EM217	ELECTRIC POWERED TURNTABLE	EMCO	2088	00029144	N/A	N/A
EM218	ANECHOIC CHAMBER	ETS-LINDGREN	FACT-3	--	2018/01/24	2019/01/24
EM356	ANTENNA POSITIONING TOWER	ETS-LINDGREN	2171B	00150346	N/A	N/A
EM354	BICONILOG ANTENNA	ETS-LINDGREN	3143B	00142073	2018/03/29	2020/03/29
EM229	EMI TEST RECEIVER	R&S	ESIB40	100248	2017/06/01	2018/06/01
EM276	BROADBAND HORN ANTENNA	A-INFOMW	JXTXLB-10180-SF	J2031090903007	2018/04/27	2020/04/27
EM300	PYRAMIDAL STANDARD GAIN HORN ANTENNA	ETS-LINDGREN	3160-09	00130130	2016/05/13	2018/05/13
EM301	PYRAMIDAL STANDARD GAIN HORN ANTENNA	ETS-LINDGREN	3160-10	00130988	2016/05/13	2018/05/13
EM302	PRECISION OMNIDIRECTIONAL DIPOLE (1 – 6GHZ)	SEIBERSDORF LABORATORIES	POD 16	161806/L	2016/05/11	2018/05/11
EM303	PRECISION OMNIDIRECTIONAL DIPOLE (6 – 18GHZ)	SEIBERSDORF LABORATORIES	POD 618	6181908/L	2016/05/11	2018/05/11
EM353	LOOP ANTENNA	ETS_LINDGREN	6502	00206533	2018/04/16	2020/04/16
EM318	USB WIDEBAND POWER SENSOR	AGILENT	U2022XA	MY53470001	2017/03/05	2019/03/05

Remarks:-

CM Corrective Maintenance
N/A Not Applicable
TBD To Be Determined

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Appendix B

Photographs of EUT

Front View of the product

Rear View of the product

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Appendix B

Photographs of EUT

Side View of the product

Side View of the product

Side View of the product

Side View of the product

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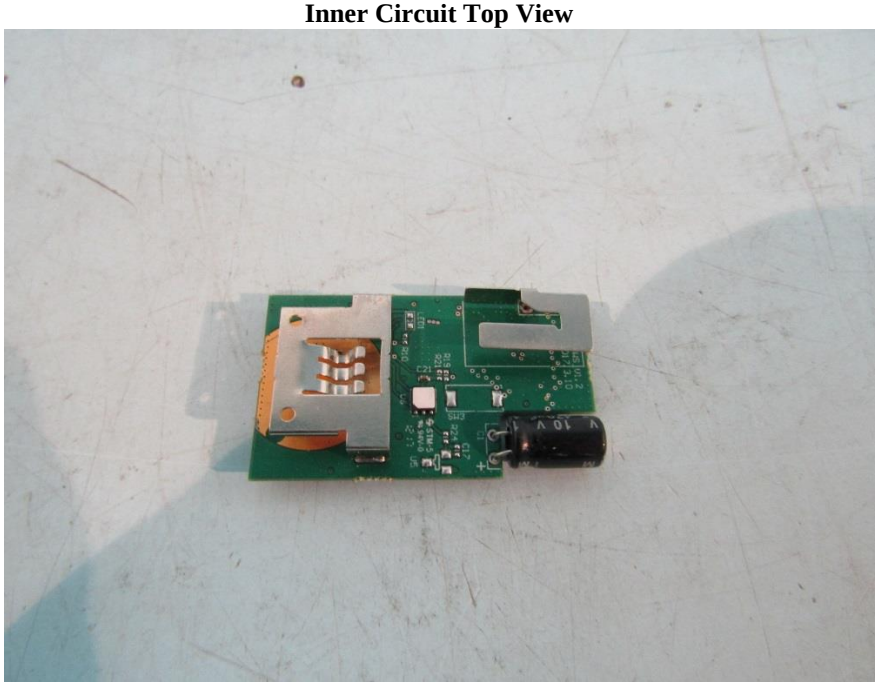
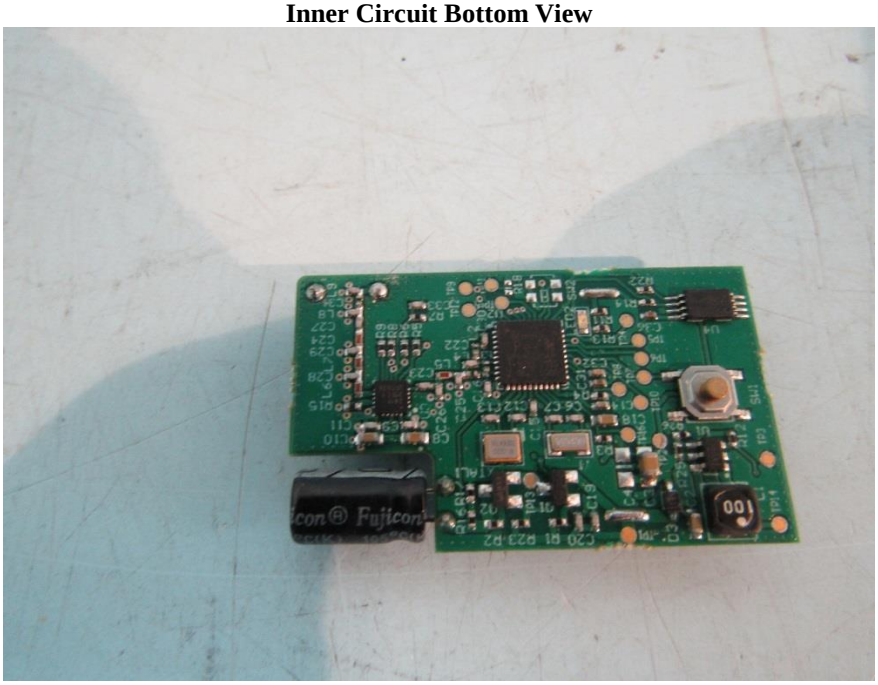
Photographs of EUT

Inner Circuit Top View



Inner Circuit Bottom View



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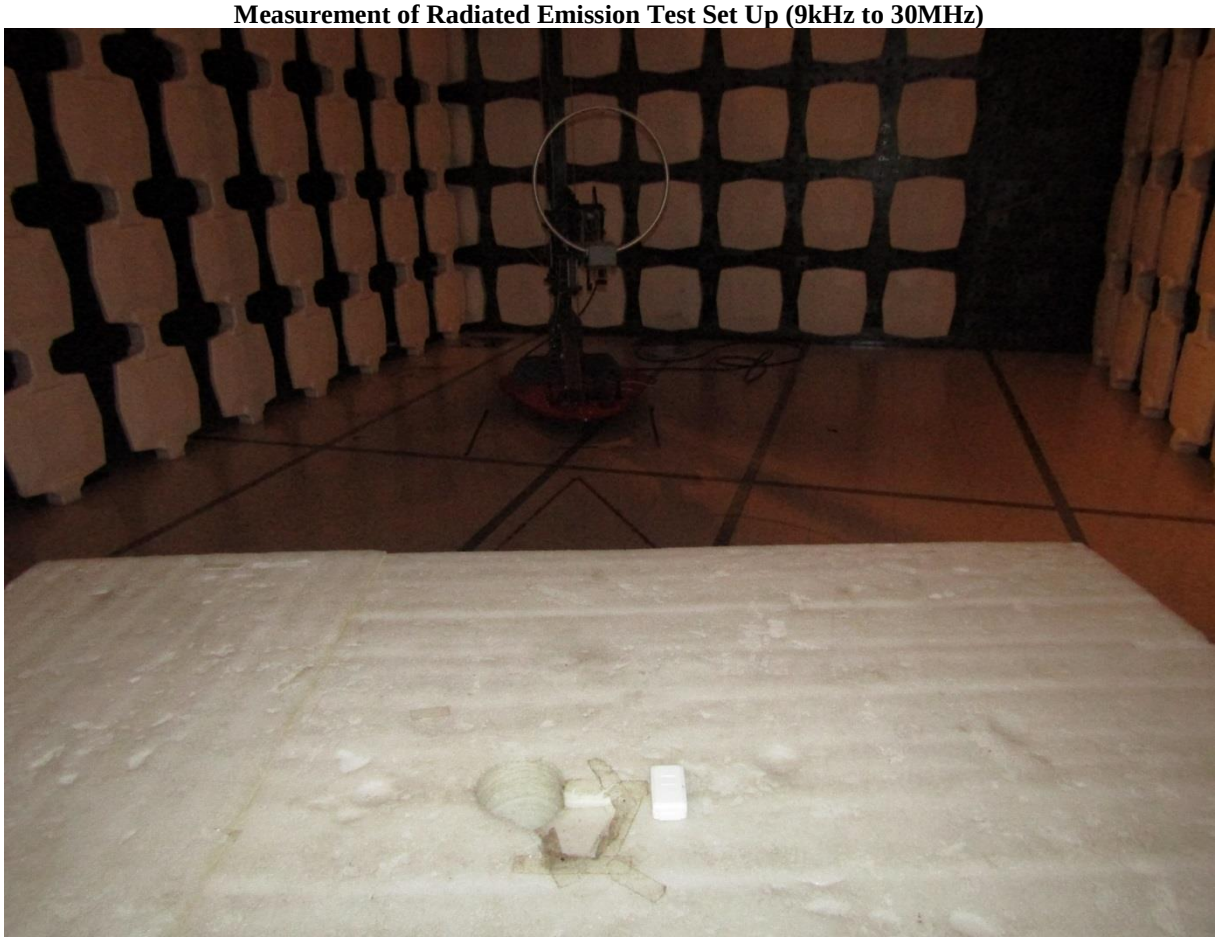
Photographs of EUT

Measurement of Radiated Emission Test Set Up (9kHz to 30MHz)



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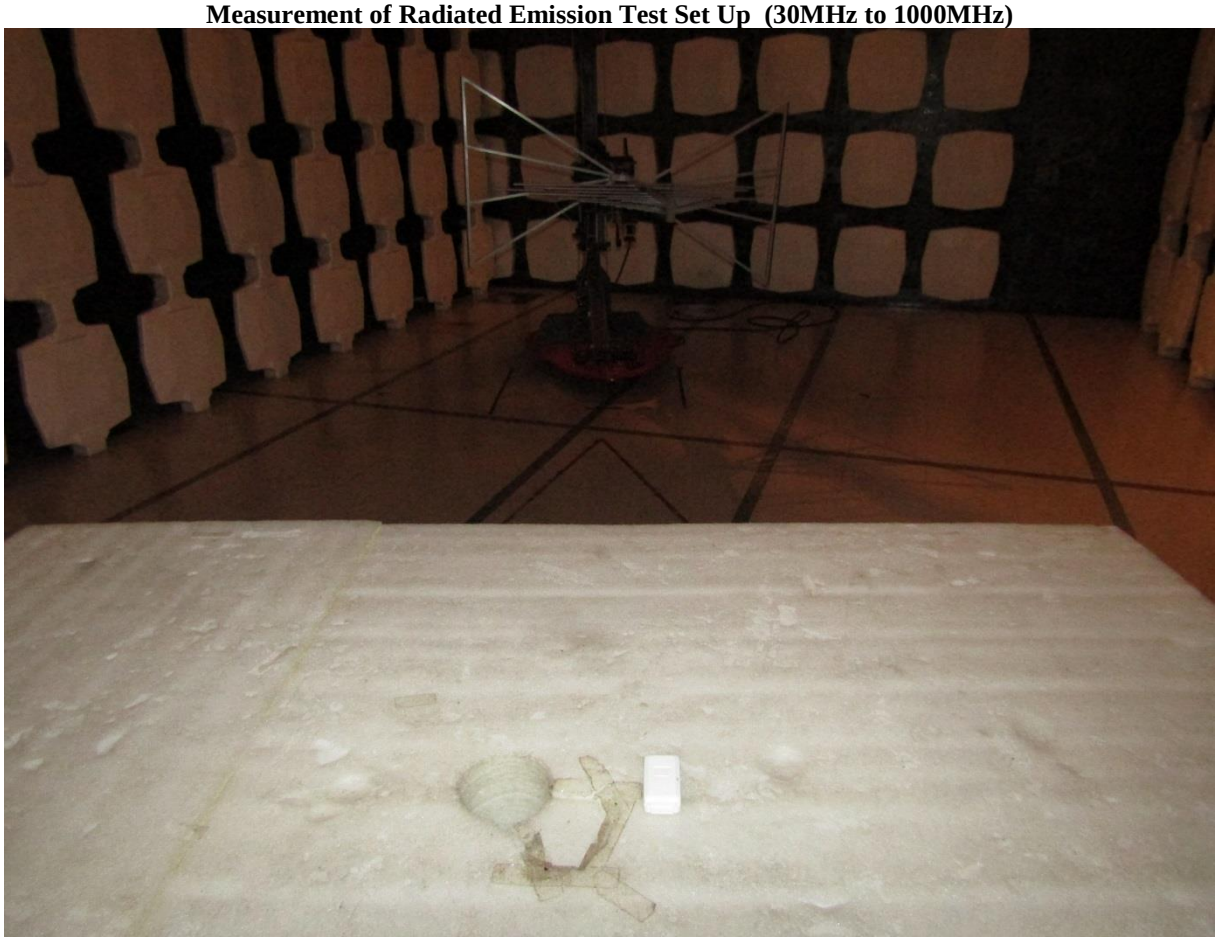
Measurement of Radiated Emission Test Set Up (30MHz to 1000MHz)



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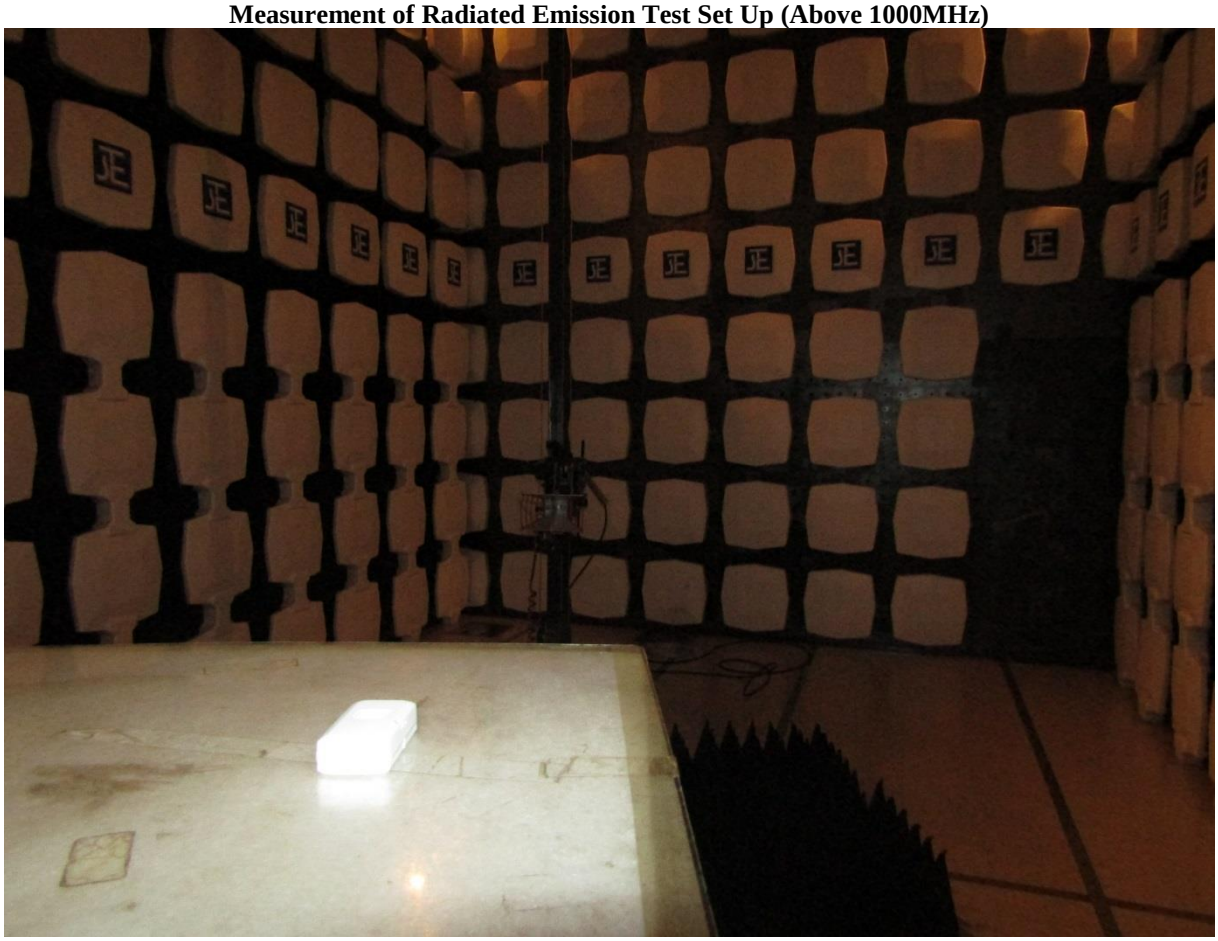
Photographs of EUT

Measurement of Radiated Emission Test Set Up (Above 1000MHz)



******* End of Test Report *******

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