



Test Report

Date : 2019-02-27
No. : HM18120052

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Applicant: Gatekeeper Systems (HK) Ltd.
36/F, Tower 2, Times Square, 1 Matheson Street, Causeway Bay,
Hong Kong

Manufacturer: Gatekeeper Systems (HK) Ltd.
36/F, Tower 2, Times Square, 1 Matheson Street, Causeway Bay,
Hong Kong

Description of Sample(s): Product: Carttronics CRFII
Brand Name: Gatekeeper Systems
Model Number: CRFII
FCC ID: W3Z-CRFII

Date Sample(s) Received: 2018-12-20

Date Tested: 2019-01-05 to 2019-01-20

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.

Conclusion(s): 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.

Remark(s): ---


CHEUNG Chi, Kenneth
Authorized Signatory



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1.0 General Details

1.1 Equipment Under Test [EUT] Description of Sample(s)

Product:	Carttronics CRFII
Manufacturer:	Gatekeeper Systems (HK) Ltd. 36/F, Tower 2, Times Square, 1 Matheson Street, Causeway Bay, Hong Kong
Brand Name:	Gatekeeper Systems
Model Number:	CRFII
Rating:	100-240Va.c, 0.5A

1.2 Description of EUT Operation

The Equipment Under Test (EUT) is transmitter of Gatekeeper Systems (HK) Ltd., which is 2.4GHz transceiver.

The CRFII Operational mode transmissions are modulated at O-QPSK &FSK. The EUT was tested under test mode which was set in maximum output power and transmit continuously.

1.3 Date of Order

2018-12-20

1.4 Submitted Sample(s):

2 Samples

1.5 Test Duration

2019-01-05 to 2019-01-20

1.6 Country of Origin

China

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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.

2.2 Test Standards and Results Summary Tables

EMISSION Results Summary					
Test Condition	Test Requirement	Test Method	Class / Severity	Test Result	
				Pass	Fail
Field Strength of Fundamental & Harmonics Emissions	FCC 47CFR 15.249	ANSI C63.10:2013	N/A	☒	☐
AC power-line conducted emissions	FCC 47CFR 15.207	ANSI C63.10:2013	N/A	☒	☐
Radiated Emissions	FCC 47CFR 15.209	ANSI C63.10:2013	N/A	☒	☐

Note: N/A - Not Applicable

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3.0 Test Results

3.1 Emission

3.1.1 Field Strength of Fundamental & Harmonics Emissions

Test Requirement:	FCC 47CFR 15.249
Test Method:	ANSI C63.10:2013
Test Date:	2019-02-28
Mode of Operation:	1. Tx Mode : CC2430 2. Tx Mode : CC2500

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. In the frequency range of 9kHz to 30MHz, The center of the loop antenna shall be 1 meter above the ground and rotated loop axis for maximum reading. The emissions worst-case are shown in Test Results of the following pages.

Remark: 3 orthogonal axis apply to hand-held device only.

*: Semi-anechoic chamber located on the G/F of The Hong Kong Standards and Testing Centre Ltd.
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Designation Number HK0001

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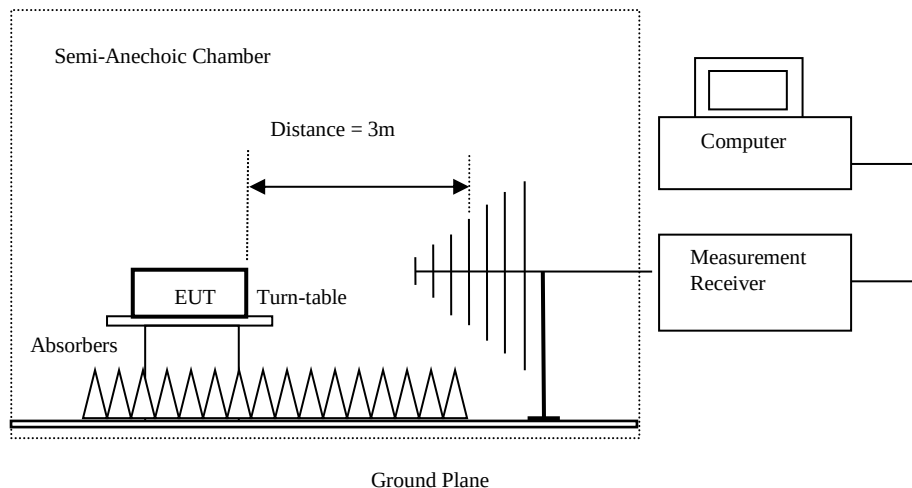
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Spectrum Analyzer Setting:

9KHz – 30MHz (Pk & Av)	RBW: 10kHz
	VBW: 30kHz
	Sweep: Auto
	Span: Fully capture the emissions being measured
	Trace: Max. hold
30MHz – 1GHz (QP)	RBW: 120kHz
	VBW: 120kHz
	Sweep: Auto
	Span: Fully capture the emissions being measured
	Trace: Max. hold
Above 1GHz (Pk & Av)	RBW: 3MHz
	VBW: 3MHz
	Sweep: Auto
	Span: Fully capture the emissions being measured
	Trace: Max. hold

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.
- For emissions testing at or below 1 GHz, the table height shall be 80 cm above the reference ground

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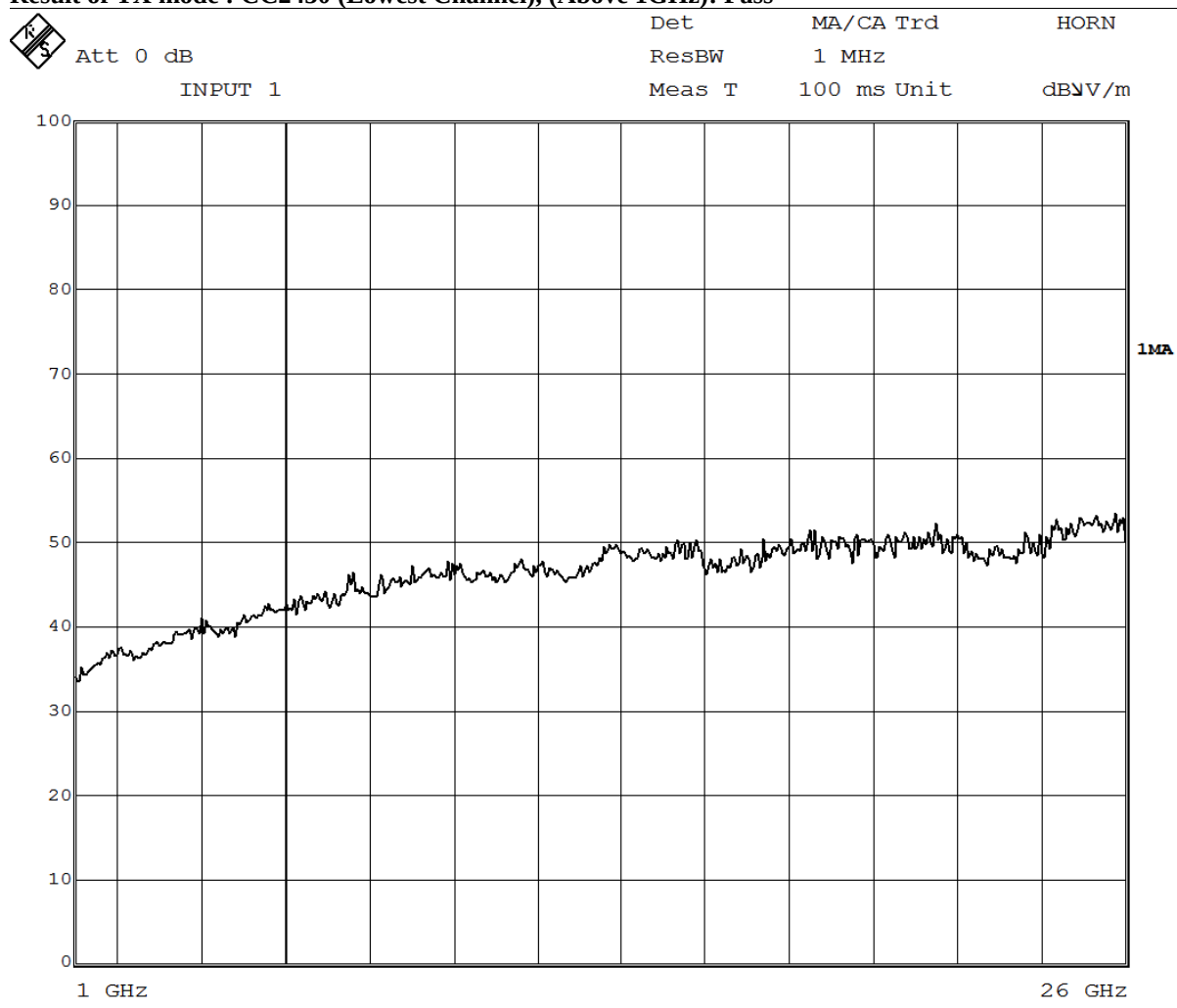
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Limits for Field Strength of Fundamental & Harmonics Emissions [FCC 47CFR 15.249]:

Fundamental frequency [MHz]	Field strength of fundamental (millivolts/meter)	Field strength of harmonics (microvolts/meter)
902-928 MHz	50	500
2400-2483.5 MHz	50	500
5725-5875 MHz	50	500
24.0-24.25 GHz	250	2500

Result of TX mode : CC2430 (Lowest Channel), (Above 1GHz): Pass



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Field Strength of Fundamental and Harmonics Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dB μ V/m	Correction Factor dB μ V/m	Field Strength dB μ V/m	Field Strength μ V/m	Limit @3m μ V/m	E-Field Polarity
2405.0	58.1	27.9	105.7	192,752.5	500,000	Vertical
* 4810.0	12.1	32.1	40.3	103.5	5,000	Vertical
7215.0	3.1	38.6	47.4	234.4	5,000	Vertical
9620.0	Emissions detected are more than 20 dB below the FCC Limits				5,000	Vertical
* 12025.0					5,000	Vertical
14430.0					5,000	Vertical
16835.0					5,000	Vertical
* 19240.0					5,000	Vertical
21645.0					5,000	Vertical
24050.0					5,000	Vertical

Field Strength of Fundamental and Harmonics Emissions						
Average Value						
Frequency MHz	Measured Level @3m dB μ V/m	Correction Factor dB μ V/m	Field Strength dB μ V/m	Field Strength μ V/m	Limit @3m μ V/m	E-Field Polarity
2405.0	46.9	27.9	76.9	6,998.4	50,000	Vertical
* 4810.0	2.3	32.1	34.3	51.9	500	Vertical
7215.0	-1.2	38.6	35.3	58.2	500	Vertical
9620.0	Emissions detected are more than 20 dB below the FCC Limits				500	Vertical
* 12025.0					500	Vertical
14430.0					500	Vertical
16835.0					500	Vertical
* 19240.0					500	Vertical
21645.0					500	Vertical
24050.0					500	Vertical

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Result of TX mode: CC2430 (Middle Channel), (Above 1GHz): Pass



Att 0 dB

INPUT 1

Det

MA/CA Trd

HORN

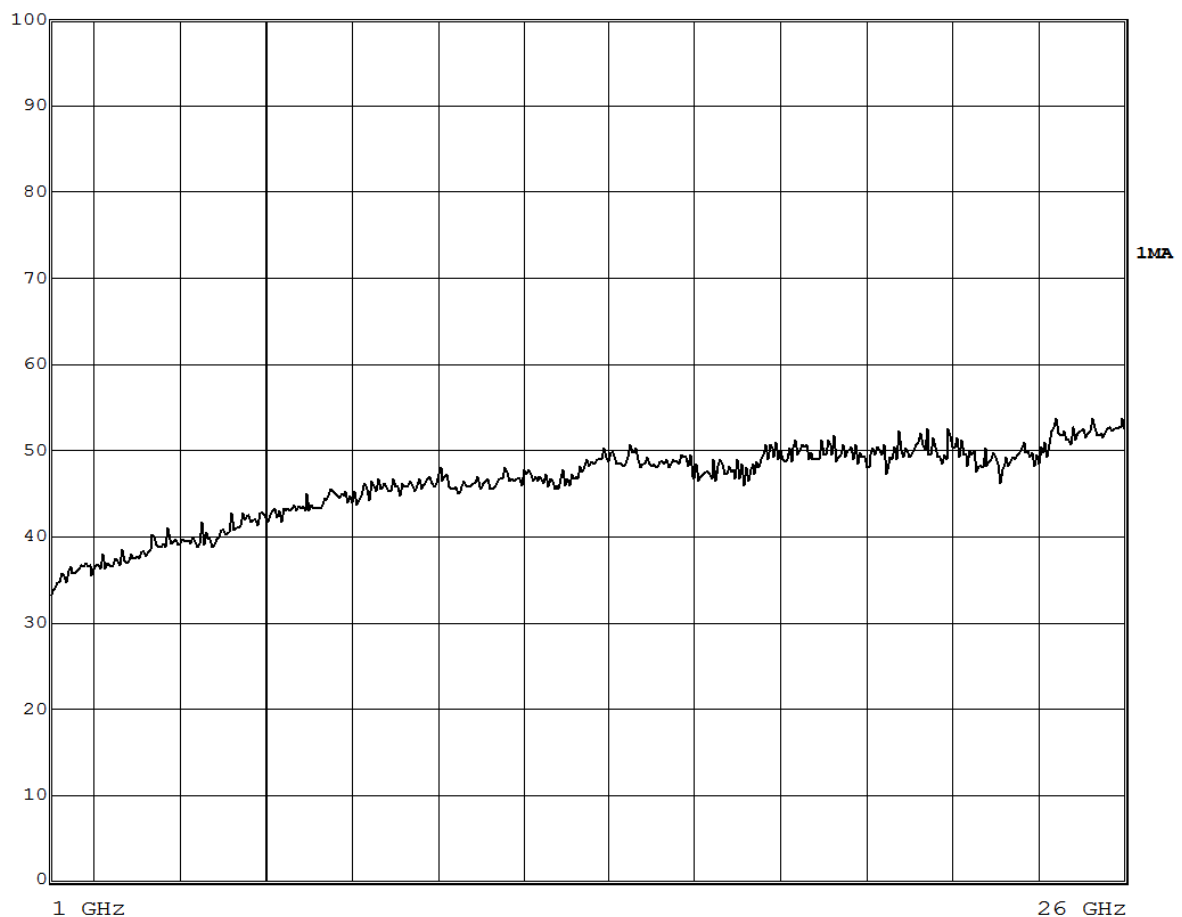
ResBW

1 MHz

Meas T

100 ms Unit

dB μ V/m



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Result of TX mode : CC2430 (Middle Channel), (Above 1GHz): Pass

Field Strength of Fundamental and Harmonics Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dBμV/m	Correction Factor dBμV/m	Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarity
2445.0	57.4	27.9	104.9	175,792.4	500,000	Vertical
* 4890.0	9.9	32.1	41.3	116.1	5,000	Vertical
* 7335.0	2.8	38.6	46.2	204.2	5,000	Vertical
9780.0	Emissions detected are more than 20 dB below the FCC Limits				5,000	Vertical
* 12225.0					5,000	Vertical
14670.0					5,000	Vertical
17115.0					5,000	Vertical
* 19560.0					5,000	Vertical
22005.0					5,000	Vertical
24450.0					5,000	Vertical

Field Strength of Fundamental and Harmonics Emissions						
Average Value						
Frequency MHz	Measured Level @3m dBμV/m	Correction Factor dBμV/m	Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarity
2440.0	45.1	27.9	73.0	4,466.8	50,000	Vertical
* 4880.0	2.4	32.1	34.5	53.1	500	Vertical
* 7320.0	-1.4	38.6	37.2	72.4	500	Vertical
9760.0	Emissions detected are more than 20 dB below the FCC Limits				500	Vertical
* 12200.0					500	Vertical
14640.0					500	Vertical
17080.0					500	Vertical
* 19520.0					500	Vertical
21960.0					500	Vertical
24400.0					500	Vertical

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Result of TX mode : CC2430 (Highest Channel), (Above 1GHz): Pass



Att 0 dB

INPUT 1

Det

MA/CA Trd

HORN

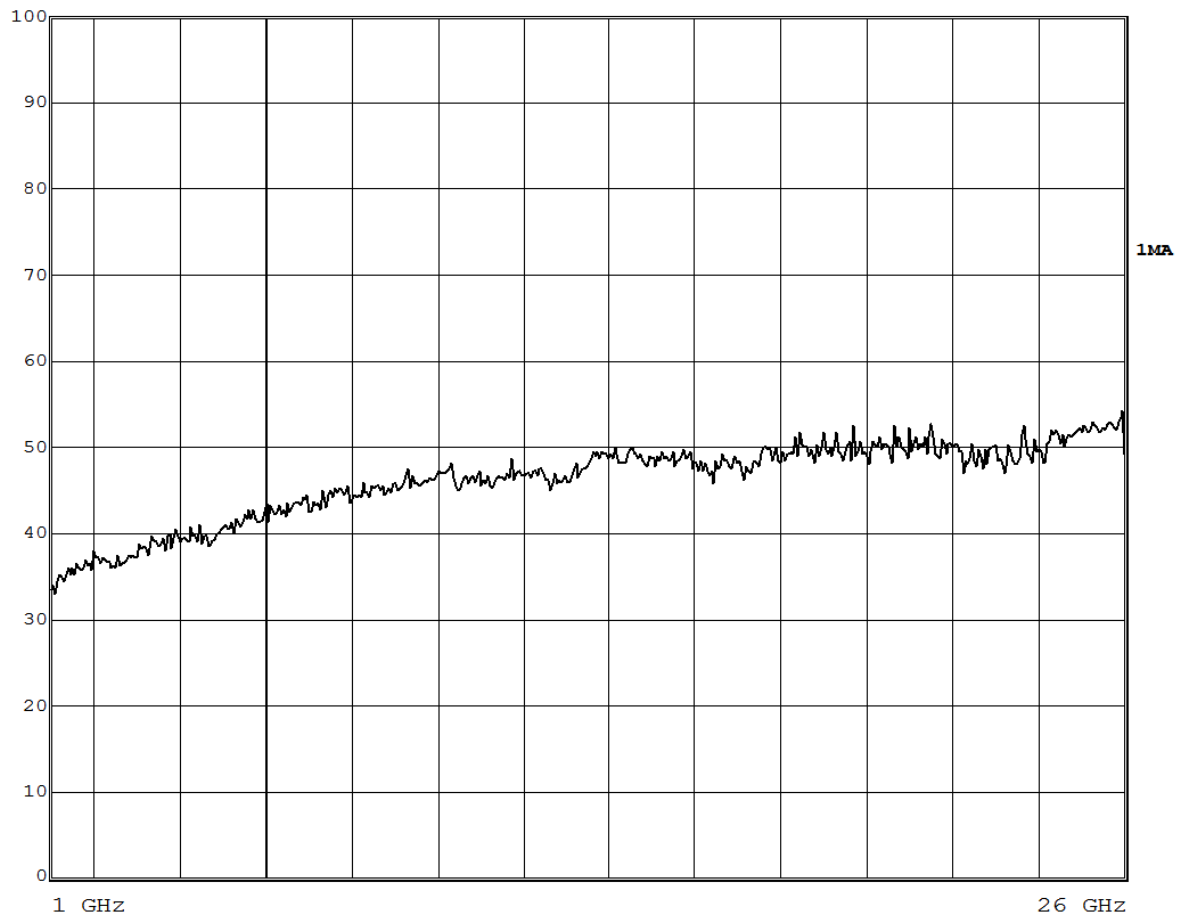
ResBW

1 MHz

Meas T

100 ms Unit

dB μ V/m



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Result of TX mode: CC2430 (Highest Channel), (Above 1GHz): Pass

Field Strength of Fundamental and Harmonics Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dBμV/m	Correction Factor dBμV/m	Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarity
2480.0	57.9	27.9	105.3	184,077.2	500,000	Vertical
* 4960.0	11.1	32.1	46.3	206.5	5,000	Vertical
* 7440.0	2.1	38.6	49.2	288.4	5,000	Vertical
9920.0	Emissions detected are more than 20 dB below the FCC Limits				5,000	Vertical
* 12400.0					5,000	Vertical
14880.0					5,000	Vertical
17360.0					5,000	Vertical
* 19840.0					5,000	Vertical
22320.0					5,000	Vertical
24800.0					5,000	Vertical

Field Strength of Fundamental and Harmonics Emissions						
Average Value						
Frequency MHz	Measured Level @3m dBμV/m	Correction Factor dBμV/m	Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarity
2480.0	45.7	27.9	76.8	6,918.3	50,000	Vertical
* 4960.0	3.2	32.1	33.7	48.4	500	Vertical
* 7440.0	-0.8	38.6	37.2	72.4	500	Vertical
9920.0	Emissions detected are more than 20 dB below the FCC Limits				500	Vertical
* 12400.0					500	Vertical
14880.0					500	Vertical
17360.0					500	Vertical
* 19840.0					500	Vertical
22320.0					500	Vertical
24800.0					500	Vertical

Remarks: The fundamental frequency was not included in the pre-scan plot, a 2.4G notch filter was added prior to the Receiver, please refer the band-edge plot for the level of fundamental frequency.

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Result of TX mode:CC2500, (Above 1GHz): Pass



Att 0 dB

INPUT 1

Det

MA/CA Trd

HORN

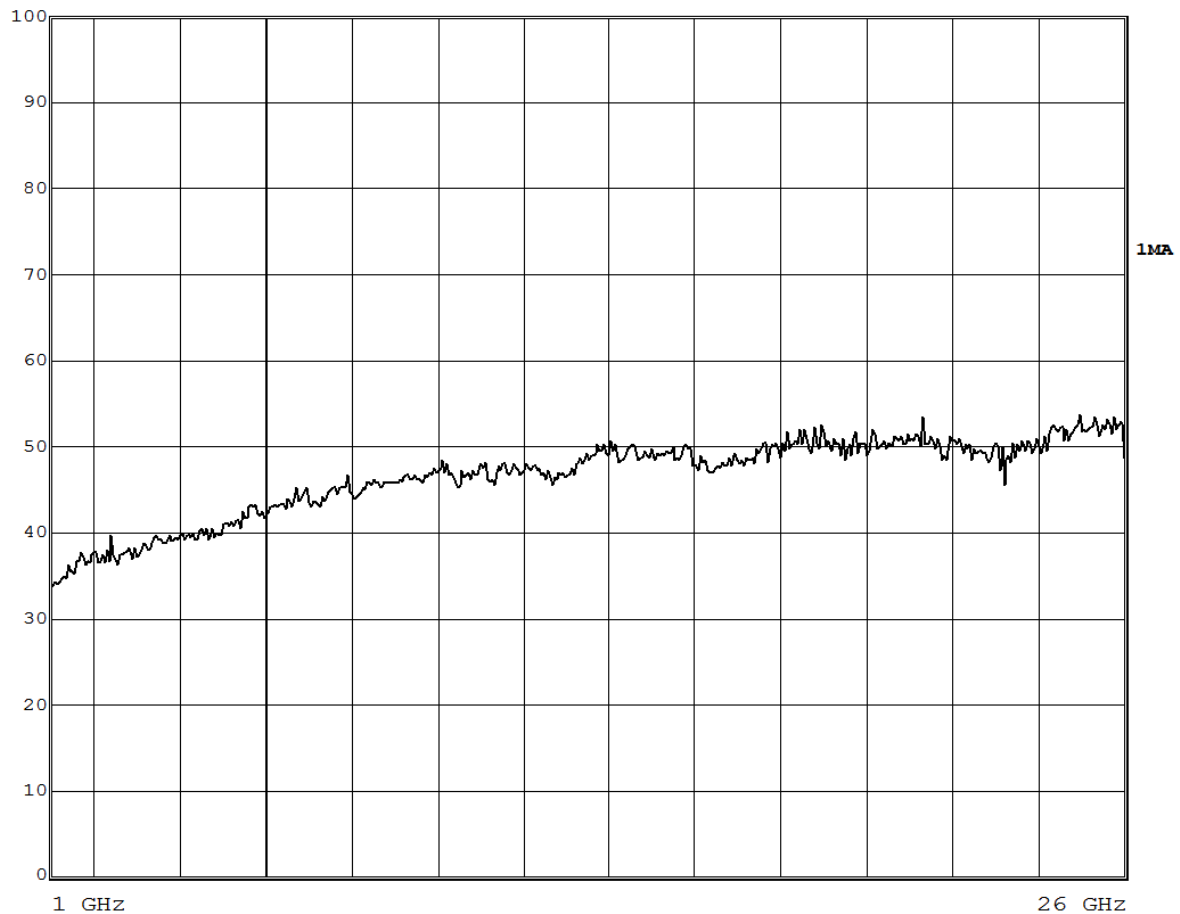
ResBW

1 MHz

Meas T

100 ms Unit

dB μ V/m



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Result of TX mode : CC2500, (Above 1GHz): Pass

Field Strength of Fundamental and Harmonics Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dBμV/m	Correction Factor dBμV/m	Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarity
2433.0	58.4	27.9	87.3	23,173.9	500,000	Vertical
* 4866.0	11.6	32.1	41.3	116.1	5,000	Vertical
7299.0	2.4	38.6	42.7	136.5	5,000	Vertical
9732.0	Emissions detected are more than 20 dB below the FCC Limits				5,000	Vertical
* 12165.0					5,000	Vertical
14598.0					5,000	Vertical
17031.0					5,000	Vertical
* 19464.0					5,000	Vertical
21897.0					5,000	Vertical
24330.0					5,000	Vertical

Field Strength of Fundamental and Harmonics Emissions						
Average Value						
Frequency MHz	Measured Level @3m dBμV/m	Correction Factor dBμV/m	Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarity
2433.0	47.3	27.9	58.9	881.0	50,000	Vertical
* 4866.0	2.1	32.1	32.9	44.2	500	Vertical
7299.0	-0.8	38.6	37.1	71.6	500	Vertical
9732.0	Emissions detected are more than 20 dB below the FCC Limits				500	Vertical
* 12165.0					500	Vertical
14598.0					500	Vertical
17031.0					500	Vertical
* 19464.0					500	Vertical
21897.0					500	Vertical
24330.0					500	Vertical

Remarks: The fundamental frequency was not included in the pre-scan plot, a 2.4G notch filter was added prior to the Receiver, please refer the band-edge plot for the level of fundamental frequency.

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 1000 MHz 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.

Calculated measurement uncertainty : 9kHz to 30MHz: 2.4dB
30MHz to 18GHz: 5.0dB
18GHz – 26.5Hz: 5.24dB

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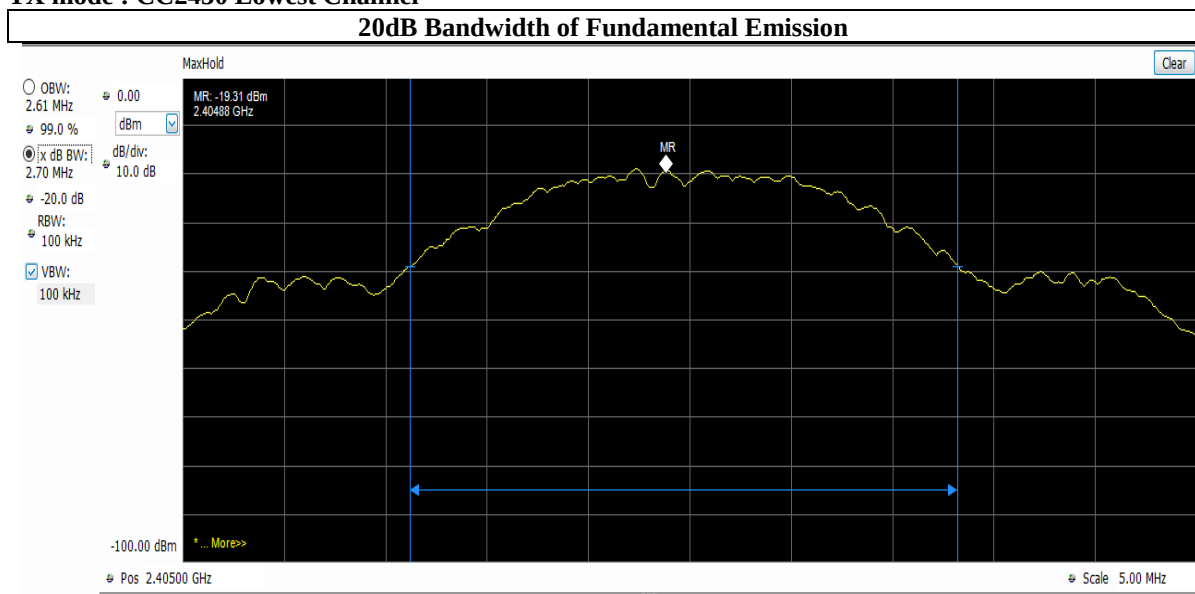
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Limits for 20dB Bandwidth of Fundamental Emission:

Frequency Range [MHz]	20dB Bandwidth [MHz]
2405.0	2.70

TX mode : CC2430 Lowest Channel



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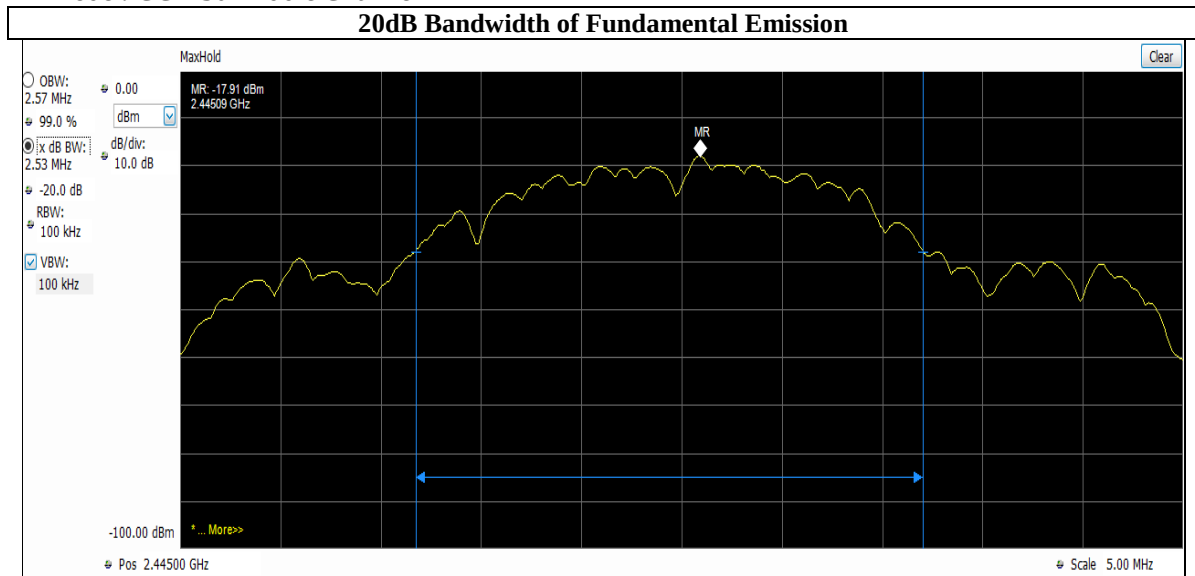
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Frequency Range [MHz]	20dB Bandwidth [MHz]
2445.0	2.53

TX mode : CC2430 Middle Channel



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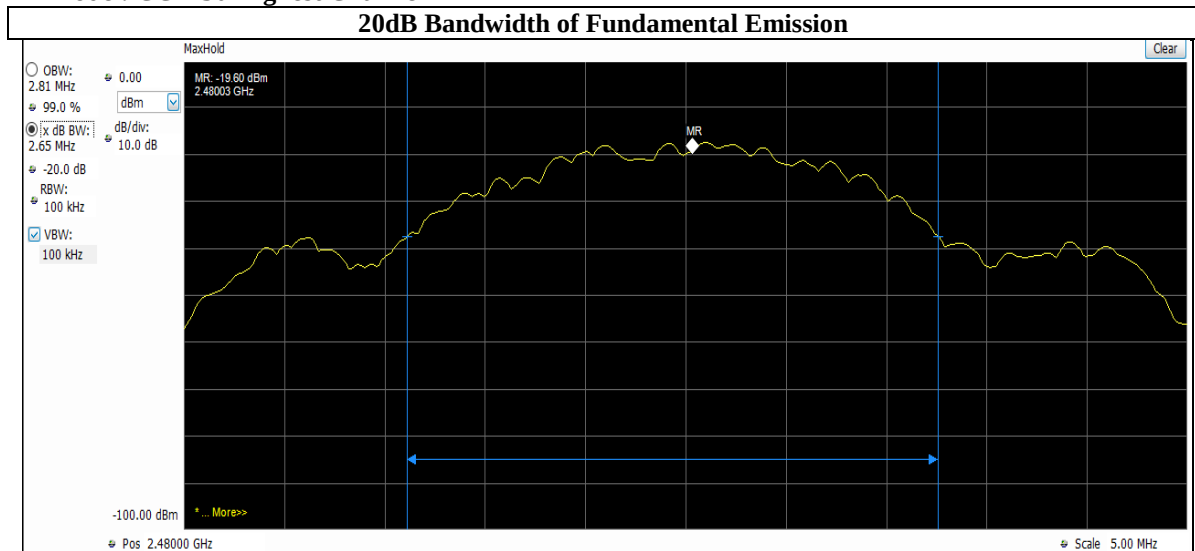
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Frequency Range [MHz]	20dB Bandwidth [MHz]
2480.0	2.65

TX mode : CC2430 Highest Channel



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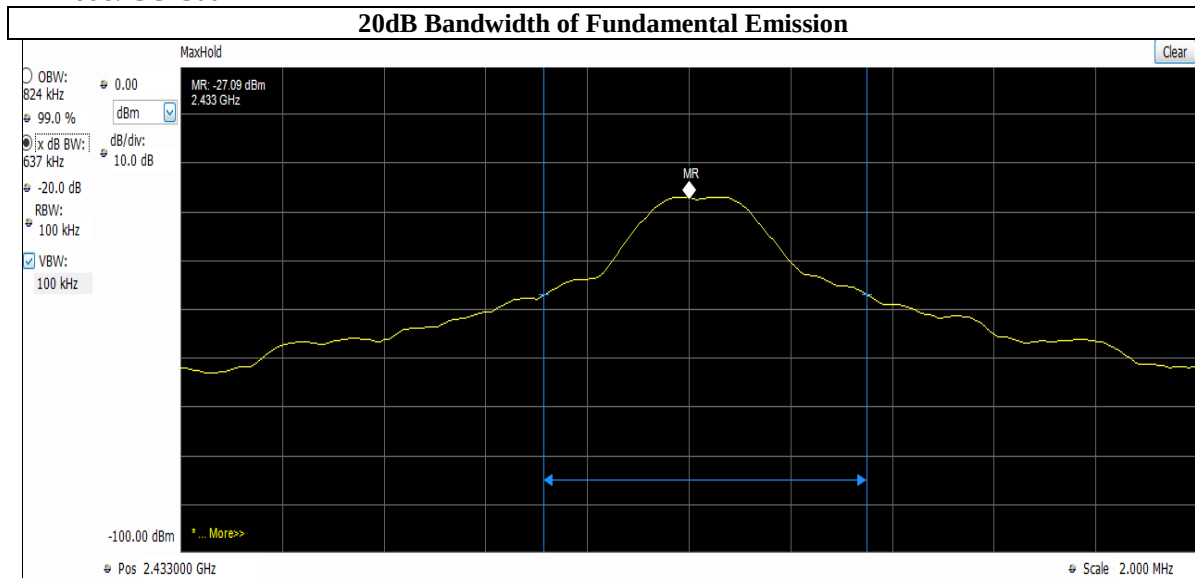
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Frequency Range [MHz]	20dB Bandwidth [MHz]
2433.0	0.637

TX mode: CC2500



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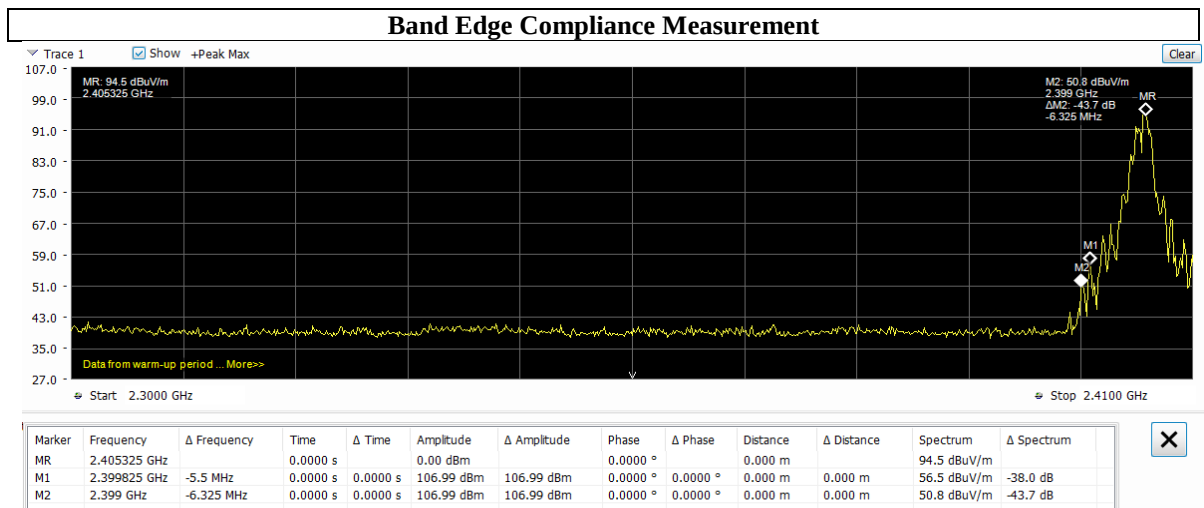
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Band Edge Measurement:

TX mode : CC2430

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400MHz – Lowest Fundamental	43.7



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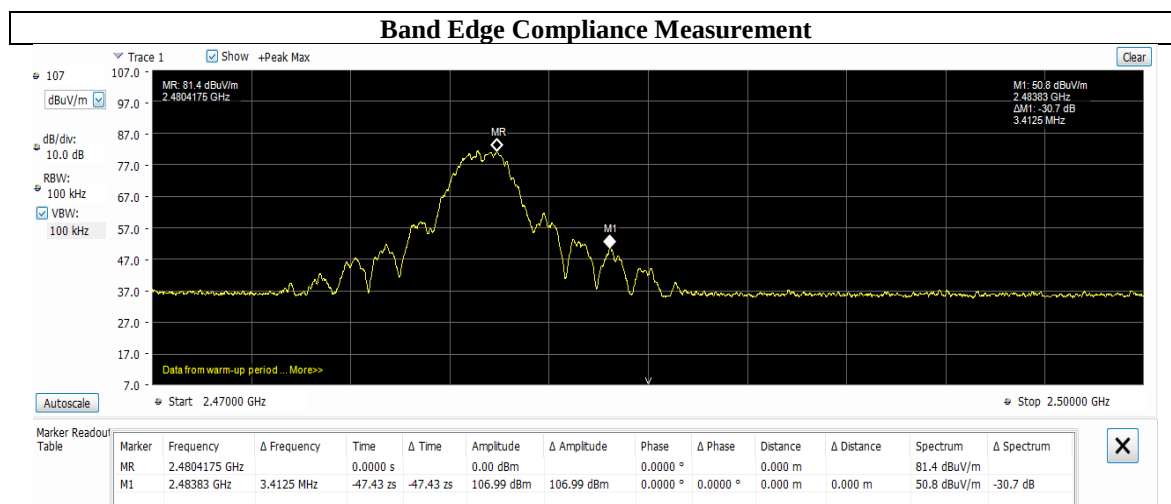
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Band Edge Measurement:

TX mode: CC2430

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
Highest Fundamental – 2483.5MHz	30.7



Result of TX mode: CC2430, Band-edge measurement: PASS

Field Strength of Fundamental and Harmonics Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dBμV/m	Correction Factor dBμV/m	Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarity
2399.8	28.6	27.9	56.5	668.3	5,000	Vertical
2483.8	22.9	27.9	50.8	346.7	5,000	Vertical

Field Strength of Fundamental and Harmonics Emissions						
Average Value						
Frequency MHz	Measured Level @3m dBμV/m	Correction Factor dBμV/m	Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarity
2399.8	3.4	27.9	31.3	36.7	500	Vertical
2483.8	2.8	27.9	30.7	34.3	500	Vertical

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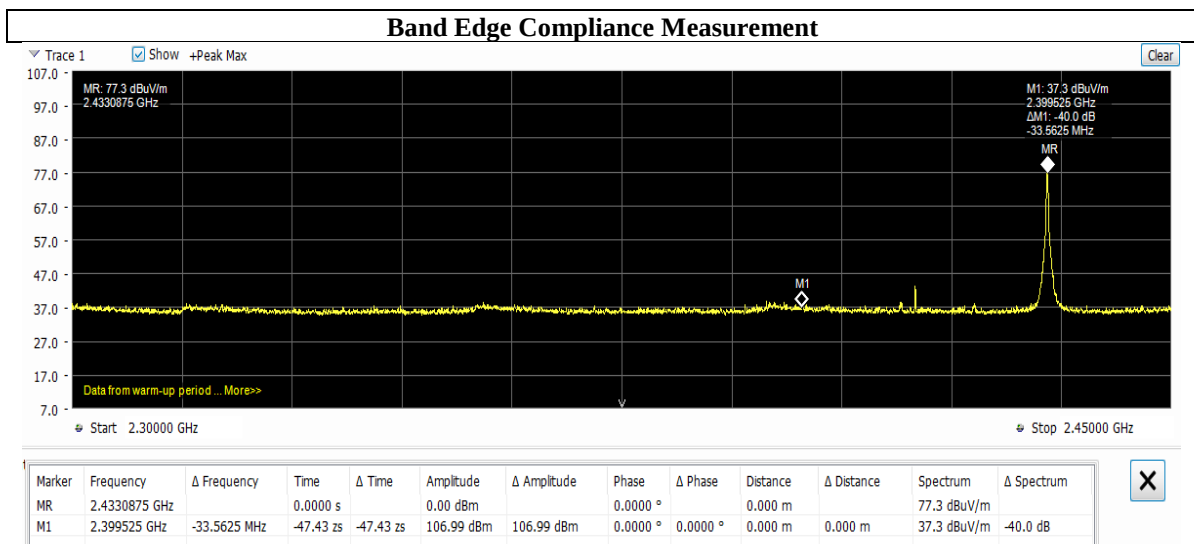
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Band Edge Measurement:

TX mode: CC2500

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
2400MHz – Lowest Fundamental	37.3



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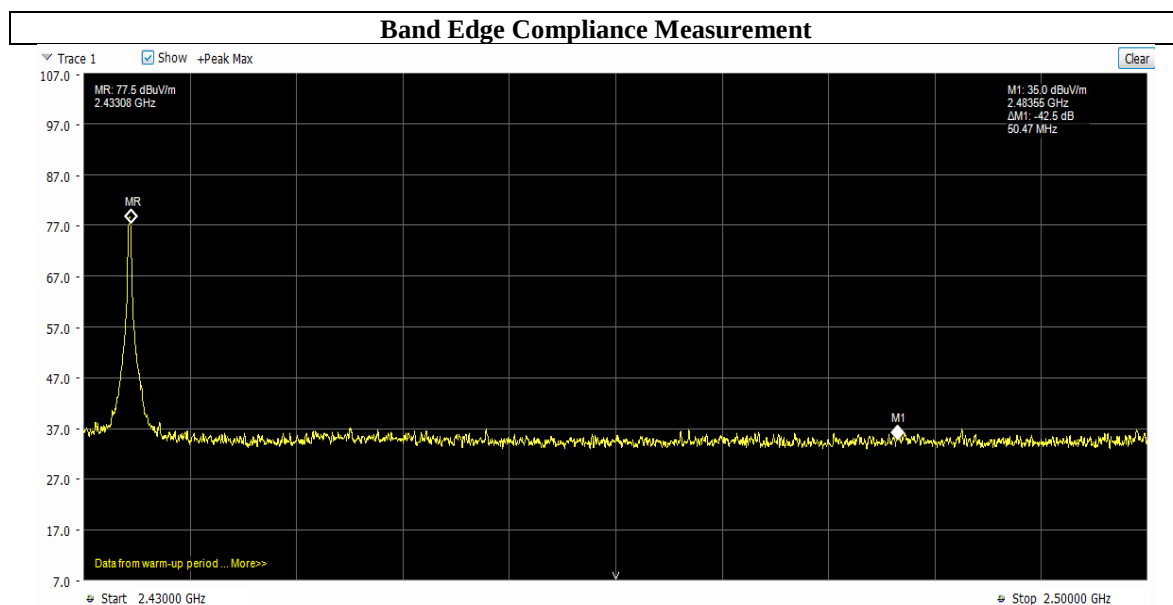
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Band Edge Measurement:

TX mode CC2500

Frequency Range [MHz]	Radiated Emission Attenuated below the Fundamental [dB]
Highest Fundamental – 2483.5MHz	42.3

Band Edge Compliance Measurement



Result of TX mode CC2500, Band-edge measurement: PASS

Field Strength of Fundamental and Harmonics Emissions						
Peak Value						
Frequency MHz	Measured Level @3m dBμV/m	Correction Factor dBμV/m	Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarity
2399.6	9.4	27.9	37.3	73.3	5,000	Vertical
2483.6	7.1	27.9	35.0	56.2	5,000	Vertical

Field Strength of Fundamental and Harmonics Emissions						
Average Value						
Frequency MHz	Measured Level @3m dBμV/m	Correction Factor dBμV/m	Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarity
2399.6	1.3	27.9	29.2	28.8	500	Vertical
2483.6	1.2	27.9	29.1	28.5	500	Vertical

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Limits for Radiated Emissions [FCC 47 CFR 15.209]:

Frequency Range [MHz]	Quasi-Peak Limits [μ V/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.

Remarks: Preliminary tests were performed in different data rate to find the worst radiated emission. The data rate in the table below is the worst case rate with respect to the specific test item.
Investigation has been done on all the possible configurations for searching the worst cases.

Result of TX mode: CC2430, (9kHz – 30MHz): PASS

Emissions detected are more than 20 dB below the FCC Limits

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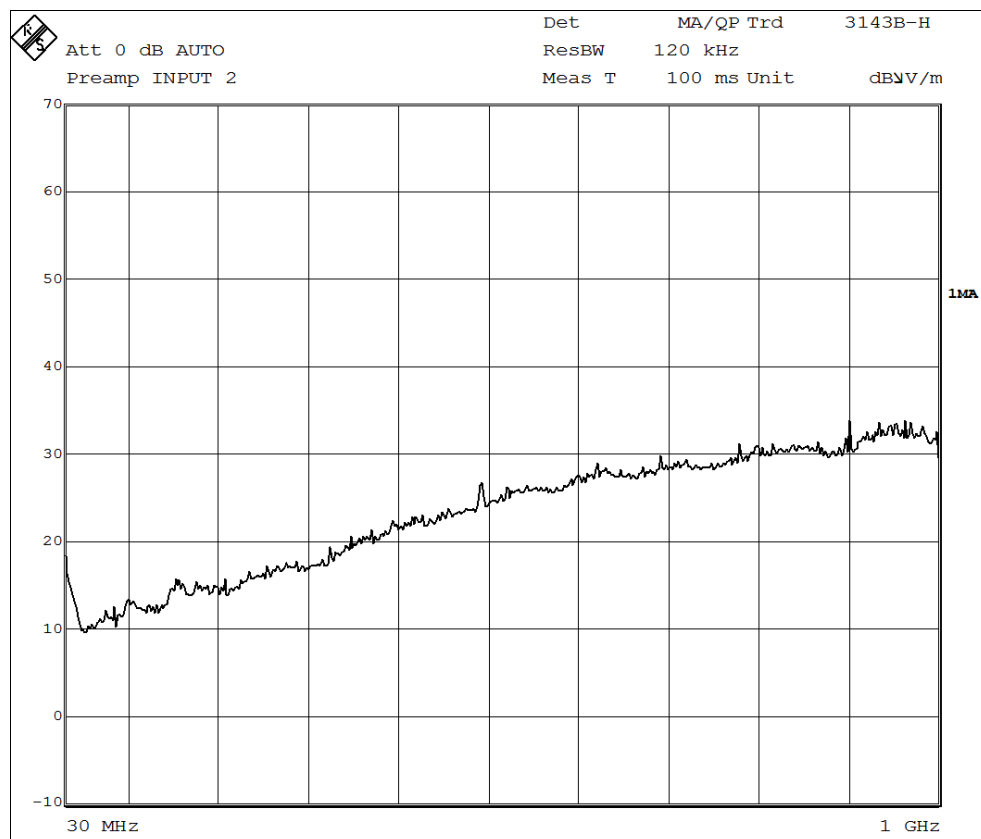


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Result of TX mode: CC2430, (30MHz – 1GHz): PASS



Field Strength of Fundamental and Harmonics Emissions						
Quasi-Peak Value						
Frequency MHz	Measured Level @3m dBμV/m	Correction Factor dBμV/m	Field Strength dBμV/m	Field Strength μV/m	Limit @3m μV/m	E-Field Polarity
48.3	0.9	7.5	8.4	2.6	100	Vertical
103.8	0.8	8.4	9.2	2.9	150	Vertical
210.7	1.2	10.5	11.7	3.8	150	Vertical
431.6	3.2	18.2	21.4	11.7	200	Vertical
557.8	0.4	21.2	21.6	12.0	200	Vertical
612.3	1.1	21.1	22.2	12.9	200	Horizontal

Remarks: Tx mode was tested in both CC2430 & CC2500, CC2500 was the worst case found in Tx mode.

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Result of Receiver mode, (9kHz – 30MHz): N/A

Result of Receiver mode, (30MHz – 1GHz): N/A

Result of Receiver mode, (1GHz – 18GHz): N/A

Remarks:

No additional spurious emissions found between lowest internal used/generated frequency and 30 MHz
Correction Factor included Antenna Factor and Cable Attenuation.

Calculated measurement uncertainty	:	(9kHz – 30MHz):	2.4dB
		(30MHz – 18GHz):	5.0dB
		(18GHz - 26GHz):	5.24dB

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3.1.2 Conducted Emissions (9kHz to 30MHz)

Test Requirement: FCC Part 15.207
Test Method: ANSI C63.10: 2013
Level: Table 1

Test Date(s): 2019-01-18

Mode of Operation: TX mode: CC2430

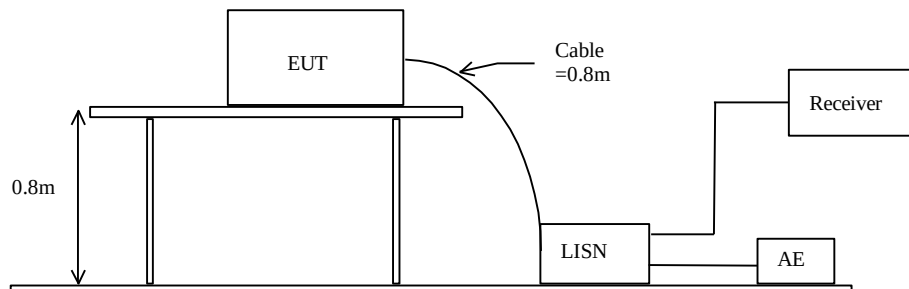
Test Method:

The test was performed in accordance with ANSI C63.10: 2013, with the following: an initial measurement was performed in peak and average detection mode on the live line, any emissions recorded within 30dB of the relevant limit line were re-measured using quasi-peak and average detection on the live and neutral lines with the worst case recorded in the table of results.

Test Procedure:

The test of EUT was conducted under on mode.

Test Setup:





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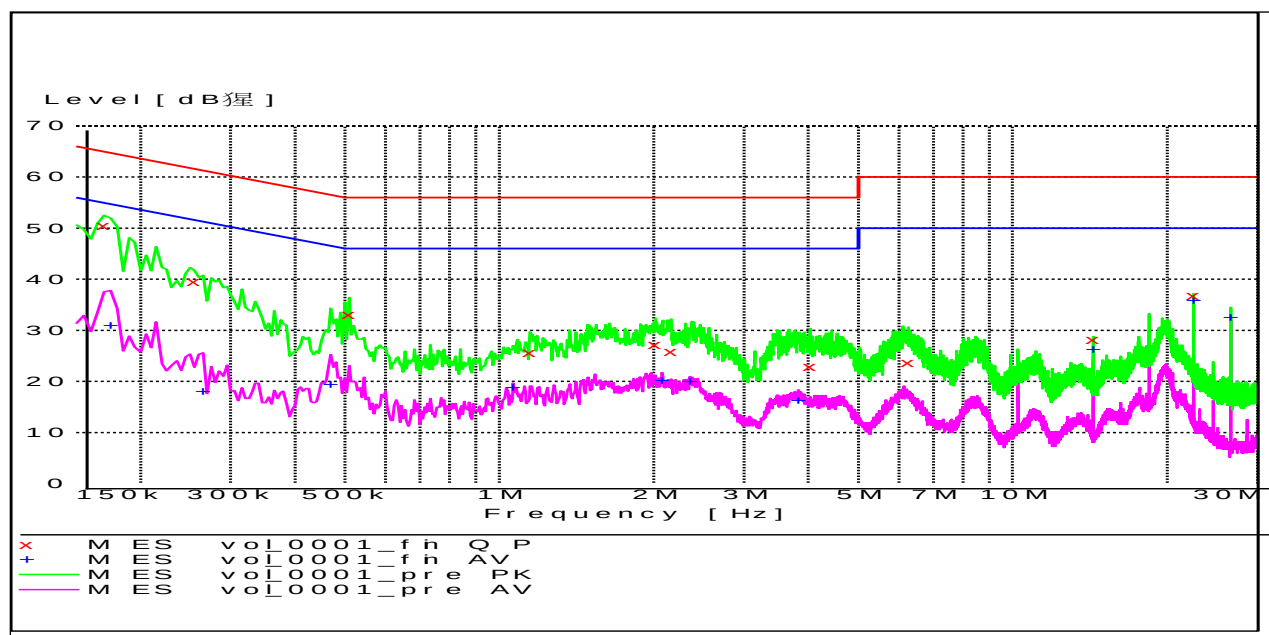
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Limit for Conducted Emissions (FCC 47 CFR 15.207):

Frequency Range [MHz]	Quasi-Peak Limits [dB μ V]	Average [dB μ V]
0.15-0.5	79	66
0.5-30.0	73	60

Limits for Conducted Emissions Test, please refer to limit lines (Quasi-Peak and Average) in the following diagram.

Results of TX mode: CC2430- Live and Neutral: PASS



Remark:

Calculated measurement uncertainty (150kHz – 30MHz): 3.25dB

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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	--	2018/04/24	2019/04/24
EM356	ANTENNA POSITIONING TOWER	ETS-LINDGREN	2171B	00150346	N/A	N/A
EM355	BICONILOG ANTENNA	ETS-LINDGREN	3143B	00201783	2017/03/15	2019/03/15
EM229	EMI TEST RECEIVER	R&S	ESIB40	100248	2018/06/01	2019/06/01
EM299	DOUBLE-RIDGED WAVEGUIDE HORN ANTENNA	ETS-LINDGREN	3115	00114120	2018/04/27	2020/04/27
EM300	PYRAMIDAL STANDARD GAIN HORN ANTENNA	ETS-LINDGREN	3160-09	00130130	2018/05/13	2020/05/13
EM353	LOOP ANTENNA	ETS_LINDGREN	6502	00206533	2018/03/16	2020/03/16

Line Conducted

EQP NO.	DESCRIPTION	MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CAL	DUE CAL
EM232	LISN	SCHAFFNER	NNB41	04/100082	2018/03/03	2019/03/03
EM181	EMI TEST RECEIVER	ROHDE & SCHWARZ	ESIB7	100072	2018/06/01	2019/06/01
EM179	IMPULSE LIMITER	ROHDE & SCHWARZ	ESH3-Z2	357- 8810.52/54	2019/01/11	2020/01/11
EM154	SHIELDING ROOM	SIEMENS MATSUSHITA COMPONENTS	N/A	803-740- 057-99A	2017/02/02	2022/02/02
N/A	MEASUREMENT AND EVALUATION SOFTWARE	ROHDE & SCHWARZ	ESIB-K1	V1.20	N/A	N/A

Remarks:

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

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Appendix B

Photographs of EUT

Front View of the product



Rear View of the product



Rear View of the product



Rear View of the product



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Photographs of EUT

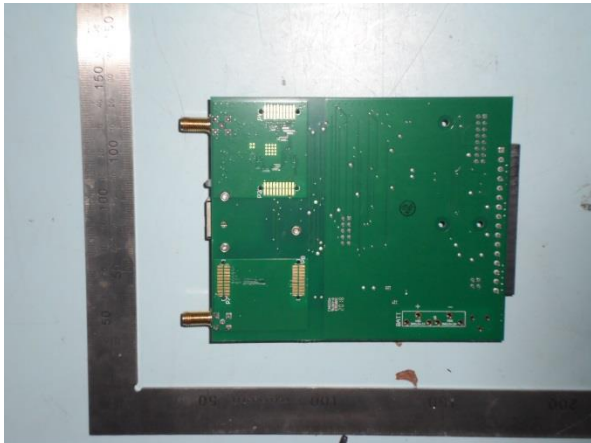
Inner View of the Product



Inner View of the Product



Inner View of the Product



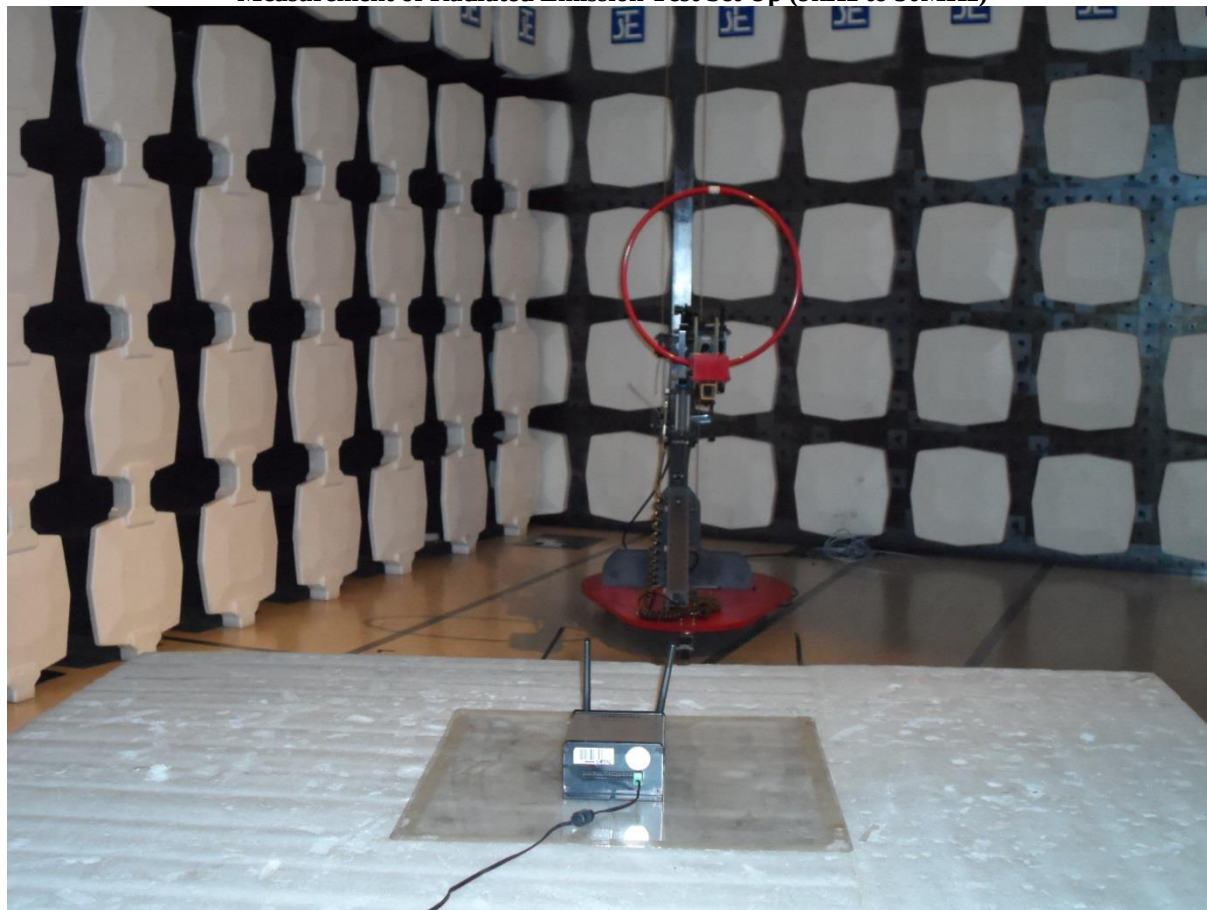
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Photographs of EUT

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



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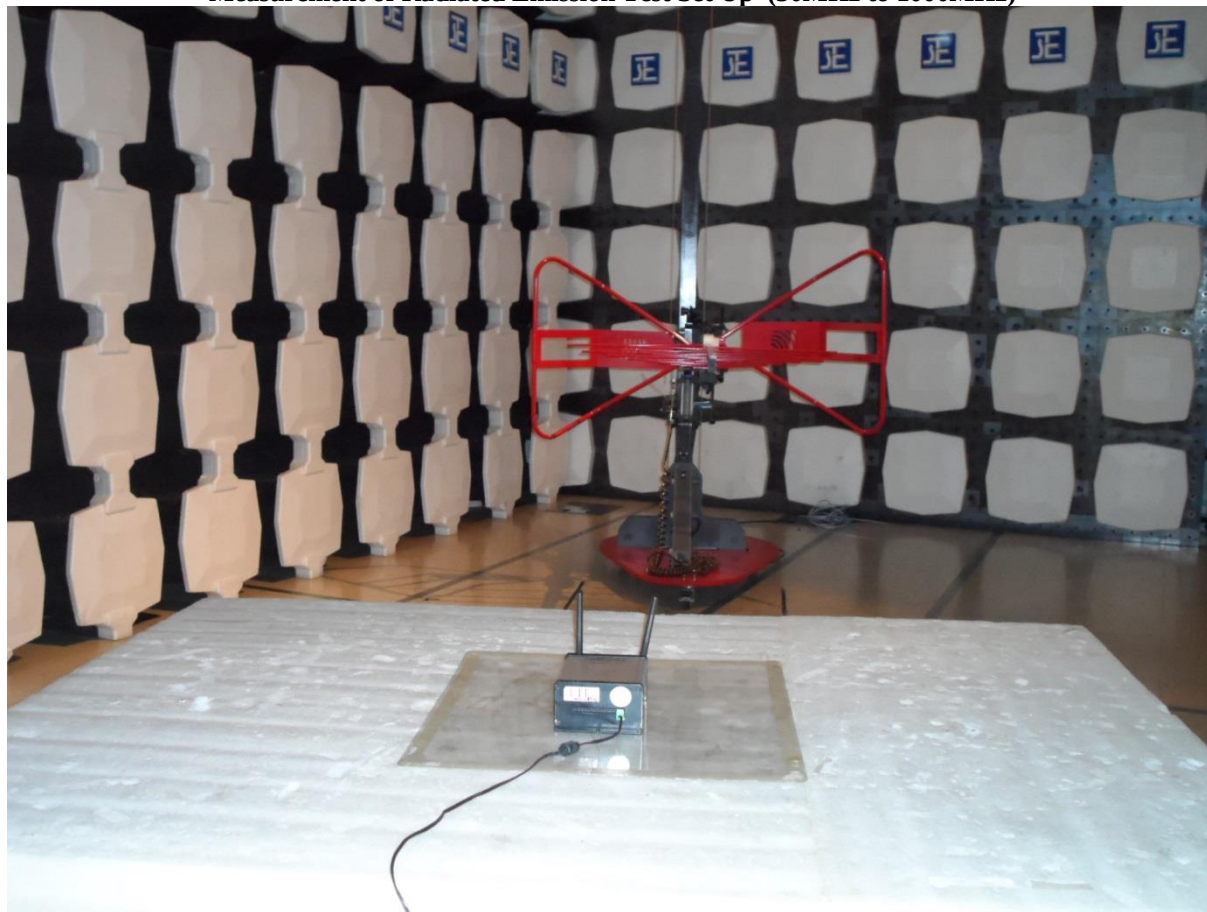
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Photographs of EUT

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



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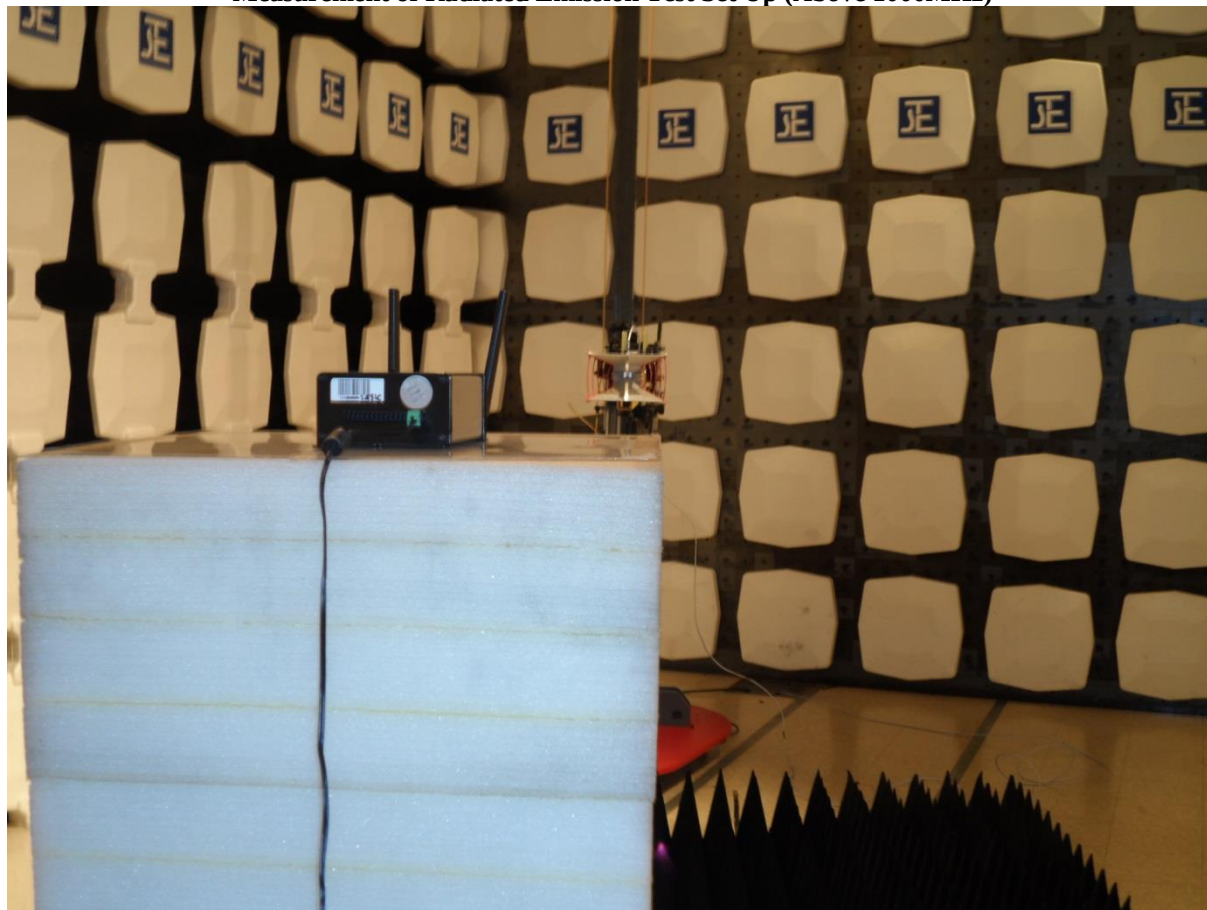
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Photographs of EUT

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



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