

ELECTROMAGNETIC EMISSIONS COMPLIANCE REPORT

INTENTIONAL RADIATOR CERTIFICATION TO FCC PART 15 SUBPART C REQUIREMENT

OF

Applicant: Cadi Scientific Pte Ltd
31 Ubi Road 1, #07-01A Aztech Building, Singapore 408694

Product Name: SmartNODE

Brand Name: Cadi

Model No.: SMN-822W

Model Difference: N/A

Report Number: ER/2019/80074

FCC ID: VPE-SMN-822W

FCC Rule Part: §15.209

Issue Date: Oct. 17, 2019

Date of Test: Aug. 15, 2019 ~ Oct. 09, 2019

Date of EUT Received: Aug. 15, 2019

We hereby certify that:

The above equipment was tested by SGS Taiwan Ltd. 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 of FCC Part 15C and ISSED RSS-216 issue 2.

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

Approved By:

CHUN-CHIEH, CHEN

Chun Chieh Chen /
Asst. Supervisor



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Revision History

Revision	Description	Issue Date	Remark
Rev.00	Original.	Oct. 17, 2019	Revised by: Tiffany Kao

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1 GENERAL INFORMATION

1.1 Product Description

Product Name:	SmartNODE
Brand Name:	Cadi
Model No.:	SMN-822W
Model Difference:	N/A
Hardware Version:	V2.4
Software Version:	V1.0
Power Supply:	3.6Vdc from Lithium Thionyl Chloride Battery

Operating Frequency	125 kHz
Transmit Power	48.63 dBuV/m @ 3m
Number of Channels	1
Antenna Type	Loop Antenna
Modulation Type	ASK

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1.2 Test Methodology

FCC Part 15, Subpart C

ANSI C63.10:2013

1.3 Test Facility

SGS Taiwan Ltd. Electronics & Communication Laboratory No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan 24803 (TAF code 0513)

FCC Designation number: 509634 / TW0001

1.4 Special Accessories

There is no special accessory used while test was conducted.

1.5 Equipment Modifications

There was no modification incorporated into the EUT.

1.6 Radiated Emission Test Sites For Measurements From 9 kHz To 30 MHz

Radiated emission below 30MHz is measured in a 9m*9m*6m semi-anechoic chamber, the measurements correspond to those obtained at an open-field test site.

There is a comparison data of both open-field test site and semi-Anechoic chamber, and the result came out very similar.

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2 SYSTEM TEST CONFIGURATION

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

The Transmitter was operated in the normal operating mode. The Tx frequency was fixed which was for the purpose of the measurements.

2.3 Test Procedure

2.3.1 Conducted Emissions

The EUT is placed on a table which is 0.8 m above ground plane. Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz. The CISPR Quasi-Peak and Average detector mode is employed according to §15.207. The two LISNs provide 50uH/50 ohm 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 Conducted Test (RF)

The active antenna port of the unlicensed wireless device is connected to the spectrum analyzer with attenuator to protect the instrumentation. If a second antenna port is available, it is tested at one operating frequency, with other port(s) appropriately terminated, to verify it has similar output characteristics as the fully tested port.

2.3.3 Radiated Emissions

The EUT is placed on a turn table. For emissions testing at or below 1 GHz, the table height shall be 0.8 m above the reference ground plane. 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.

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- Remark 1. Emission level in dBuV/m= $20 \log (\mu\text{V/m})$
:
2. Measurement was performed at an antenna to the closed point of EUT distance of 3 meters.
 3. Distance extrapolation factor = $40 \log (\text{required distance/ test distance})$ (dB);
 4. The measurement was undertaken in closer distance at 3m, where extrapolation factor is offset to convert the limit of the measurement.
Ex. $20 \log(30) + 40 \log(30/3) = 69.54 \text{ dBuV/m}$
 5. Only spurious frequency is permitted to locate within the Restricted Bands specified in provision of §15.205 & RSS-Gen §8.10.
 6. The general radiated emission limits in §15.209 & RSS-Gen §8.9 apply for the spurious emission generate from UE, except for the fundamental emission where the respective section specifies otherwise.

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2.4 Configuration of Tested System

Fig. 2-1 Radiated Emission test set up configuration



Table 2-1 Equipment Used in Tested System

Item	Equipment	Mfr/Brand	Model/Type No.	Series No.	Data Cable	Power Cord
1.	Test software	N/A	N/A	N/A	N/A	N/A

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3 SUMMARY OF TEST RESULTS

FCC Rules	Description Of Test	Result
§15.207	AC Power Line Conducted Emission	N/A
§15.209	Radiated Emission Limits, general requirement	Compliant
§15.215 (c)	20 dB OCCUPIED BANDWIDTH	Compliant
§15.203	Antenna Requirement	Compliant

4 DESCRIPTION OF TEST MODES

The EUT stay in continuous transmitting mode. The frequency 125kHz is the default channel to test, where it is the only manipulative channel as this application supports.

The field strength of spurious radiation emission was measured as EUT stand-up position (H mode) and lie down position (E1, E2 mode), the worst case H position was reported.

The data rate as the lowest supported is selected while tests are conducted.

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5 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
AC Power Line Conducted Emission	+/- 2.586 dB
Frequency Stability	+/- 123.36 Hz
20 dB OCCUPIED BANDWIDTH	+/- 123.36 Hz
Temperature	+/- 0.8 °C
Humidity	+/- 4.7 %
DC / AC Power Source	DC= +/- 1%, AC= +/- 0.2%

Radiated Spurious Emission Measurement Uncertainty	
Polarization: Vertical	9kHz~30MHz: +2.3dB
	30MHz - 180MHz: +/- 3.37dB
	180MHz -417MHz: +/- 3.19dB
	0.417GHz-1GHz: +/- 3.19dB
	1GHz - 18GHz: +/- 4.04dB
	18GHz - 40GHz: +/- 4.04dB
Polarization: Horizontal	9kHz~30MHz: +2.3dB
	30MHz - 167MHz: +/- 4.22dB
	167MHz -500MHz: +/- 3.44dB
	0.5GHz-1GHz: +/- 3.39dB
	1GHz - 18GHz: +/- 4.08dB
	18GHz - 40GHz: +/- 4.08dB

Note:

1. This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.
2. The conformity assessment statement in this report is based solely on the test results, measurement uncertainty is excluded.

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6 CONDUCTED EMISSIONS TEST

6.1 Limitation

Conducted Emission

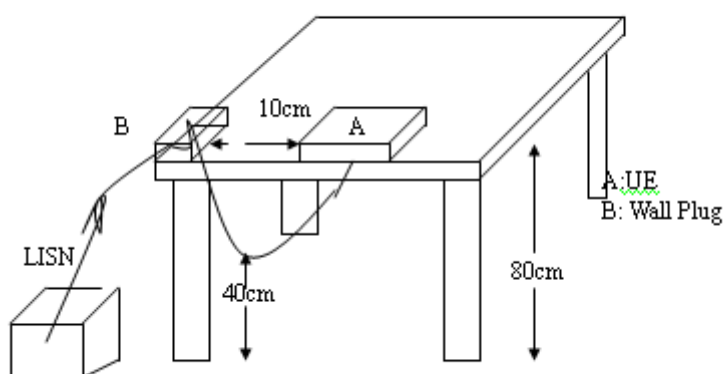
According to section RSS-Gen §8.8 Conducted Emission Limits is as following.

Frequency range MHz	Limits dB (uV)	
	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 the transition frequencies 2.The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.50 MHz.		

6.2 Measurement Procedure:

1. The EUT was placed on a table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. Sweep frequency starting from 150 kHz to 30 MHz for phase L1.
4. Repeating the measurement as lists above for phase neutral.

6.3 Test SET-UP (Block Diagram of Configuration)



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6.4 Measurement Equipment Used:

N/A

6.5 Measurement Result:

N/A; Powered from Lithium Thionyl Chloride Battery.

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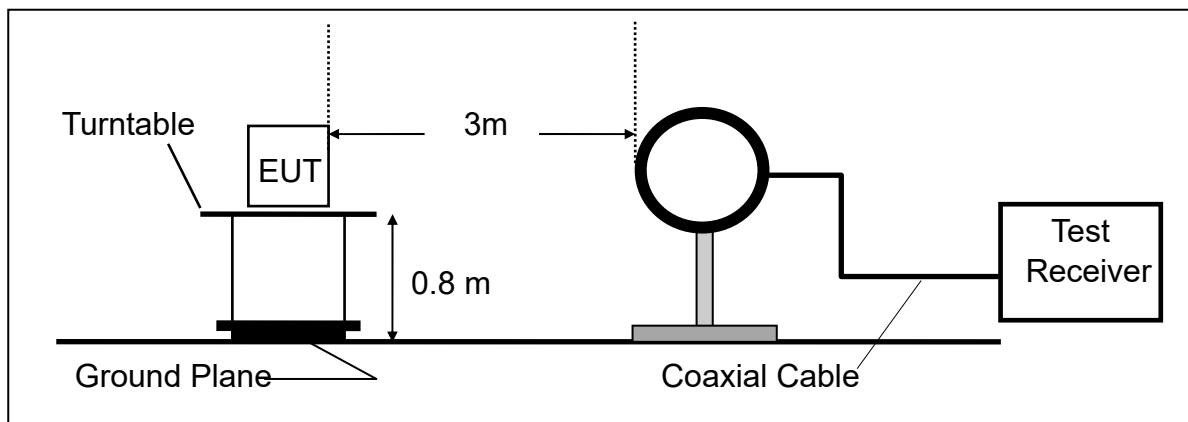
7 RADIATED EMISSION TEST

7.1 Measurement Procedure

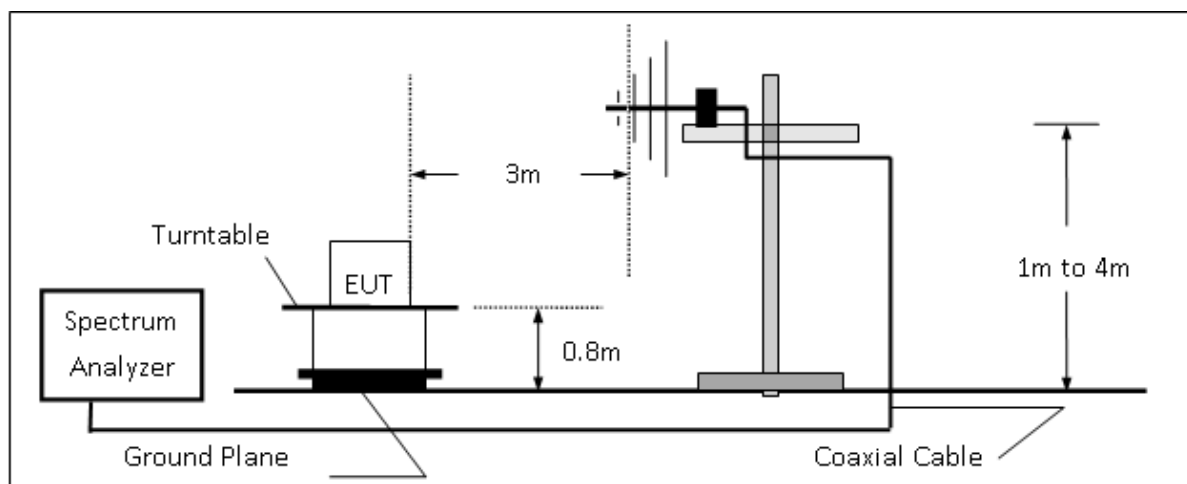
1. The EUT was placed on a turn table which is 0.8m above ground plane.
2. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
3. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.

7.2 Test SET-UP (Block Diagram of Configuration)

(A) Radiated Emission Test Set-Up, Frequency Below 30MHz



(B) Radiated Emission Test Set-Up, Frequency Below 1000MHz



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7.3 Measurement Equipment Used:

SGS 966 Chamber No.C					
Name of Equipment	Manufacturer	Model	Serial Number	Calibration Date	Calibration Due
Bi-log Antenna	SCHWAZBECK	VULB9168	378	01/04/2019	01/03/2020
3m Site NSA	SGS	966 chamber	N/A	01/02/2019	01/01/2020
Loop Antenna	ETS.LINDGRE N	6502	148045	10/08/2018	10/07/2019
PXA Spectrum Analyzer	Agilent	N9030A	MY53120760	04/22/2019	04/21/2020
EMI Test Receiver	R&S	ESCI 3	100335	02/12/2019	02/11/2020
Pre-Amplifier	HP	8447D	1937A02774	01/02/2019	01/01/2020
Low Loss Cable	Huber Suhner	966_RX	9	01/02/2019	01/01/2020

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7.4 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:

$$FS = RA + AF + CL - AG$$

Where FS = Field Strength	CL = Cable Attenuation Factor (Cable Loss)
RA = Reading Amplitude	AG = Amplifier Gain
AF = Antenna Factor	

7.5 Field Strength of Fundamental Emission

7.5.1 Limit

Below 30MHz

Frequency (MHz)	Limit (μV/m)	Measurement distance (meters)	Remark
0.009-0.490	2400/F(kHz)	300	Quasi-Peak Value
0.490-1.705	24000/F(kHz)	30	Quasi-Peak Value
1.705-30.0	30	30	Quasi-Peak Value

Above 30MHz

Frequency (MHz)	Limit (dBμV/m @3m)	Remark
30-88	40	Quasi-Peak Value
88-216	43.5	Quasi-Peak Value
216-960	46	Quasi-Peak Value
Above 960	54	Quasi-Peak Value
Above 1GHz	54	Average Value
	74	Peak Value

Note:

- The measurement was undertaken in closer distance at 3m, where extrapolation factor is offset to convert the limit of the measurement. Ex. $20 \cdot \log(30) + 40 \cdot \log(30/3) = 69.54 \text{ dBuV/m}$
- The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.
- Actual FS(dBμV/m) = Spectrum. Reading level(dBμV) + Factor(dB)
Factor(dB) = Antenna Factor(dBμV/m) + Cable Loss(dB) – Pre_Amplifier Gain(dB)

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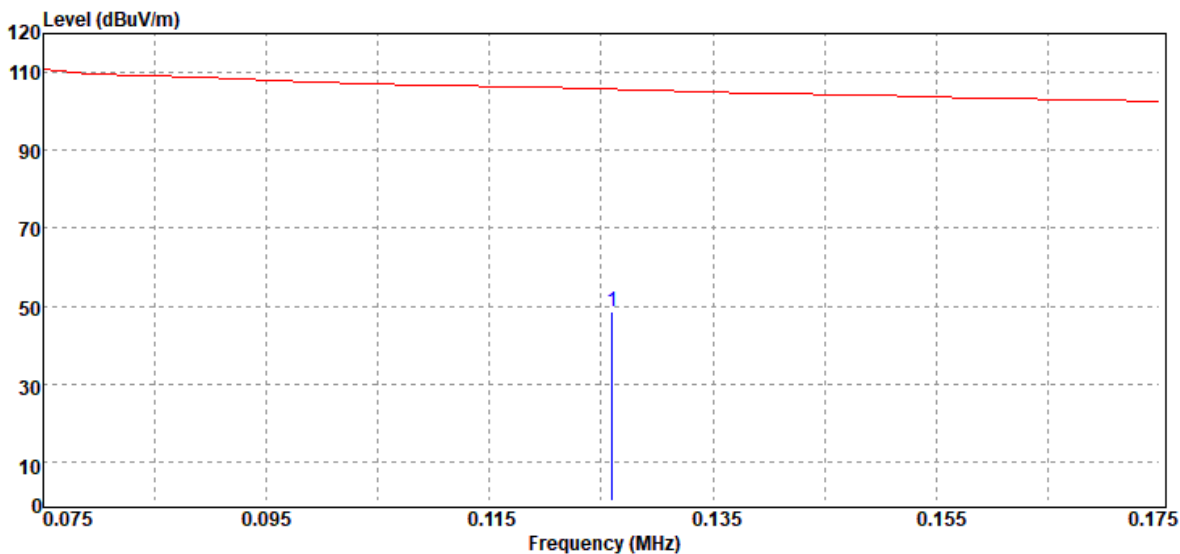
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7.5.2 Below 30 MHz test result

Report Number :ER/2019/80074
Operation Mode :125K
Test Channel :125KHz
Test Mode :Main
EUT Pol :H Plane

Test Date :2019-09-25
Temp./Humi. :24.6/59
Antenna Pol. :VERTICAL
Engineer :Kane

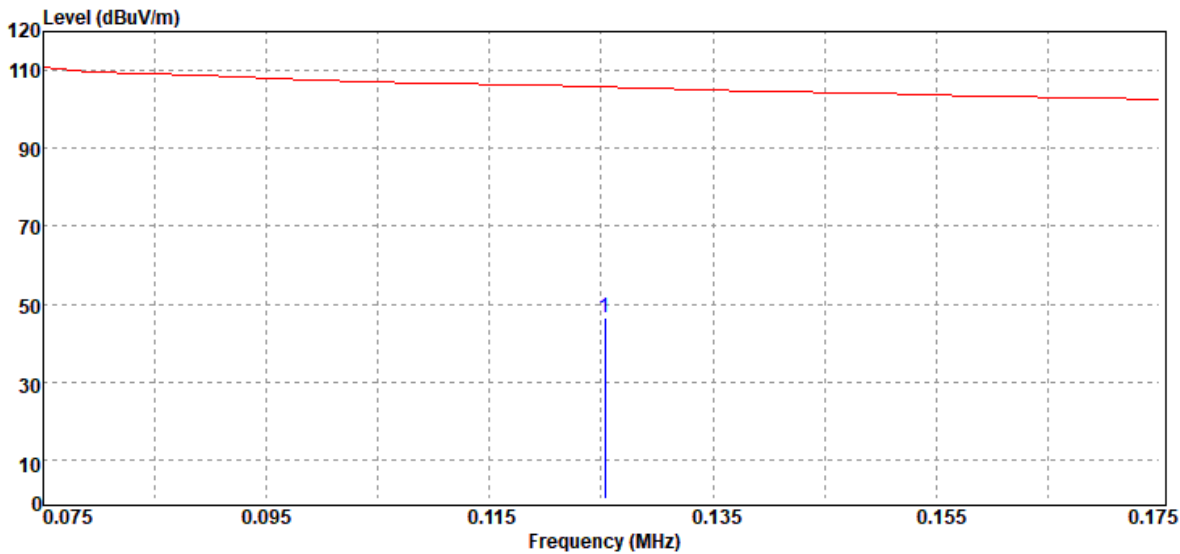


Freq.	Detector	Spectrum	Factor	Actual	Limit	Margin
MHz	Mode	Reading Level		FS	@3m	
	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
0.13	Peak	37.85	10.78	48.63	105.60	-56.97

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Report Number	:ER/2019/80074	Test Date	:2019-09-25
Operation Mode	:125K	Temp./Humi.	:24.6/59
Test Channel	:125KHz	Antenna Pol.	:HORIZONTAL
Test Mode	:Main	Engineer	:Kane
EUT Pol	:H Plane		



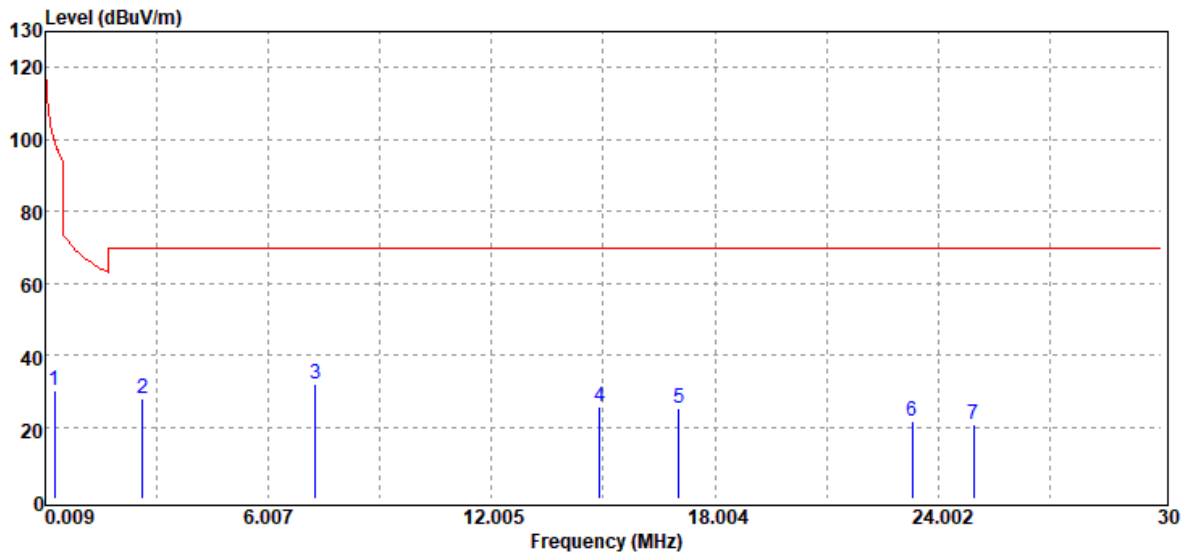
Freq.	Detector Mode	Spectrum Reading Level	Factor	Actual FS	Limit @3m	Margin
MHz	PK/QP/AV	dBμV	dB	dBμV/m	dBμV/m	dB
0.13	Peak	35.87	10.78	46.65	105.65	-59.00

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Report Number :ER/2019/80074
Operation Mode :125K
Test Channel :125KHz
Test Mode :TX
EUT Pol :H Plane

Test Date :2019-09-25
Temp./Humi. :24.6/59
Antenna Pol. :VERTICAL
Engineer :Kane



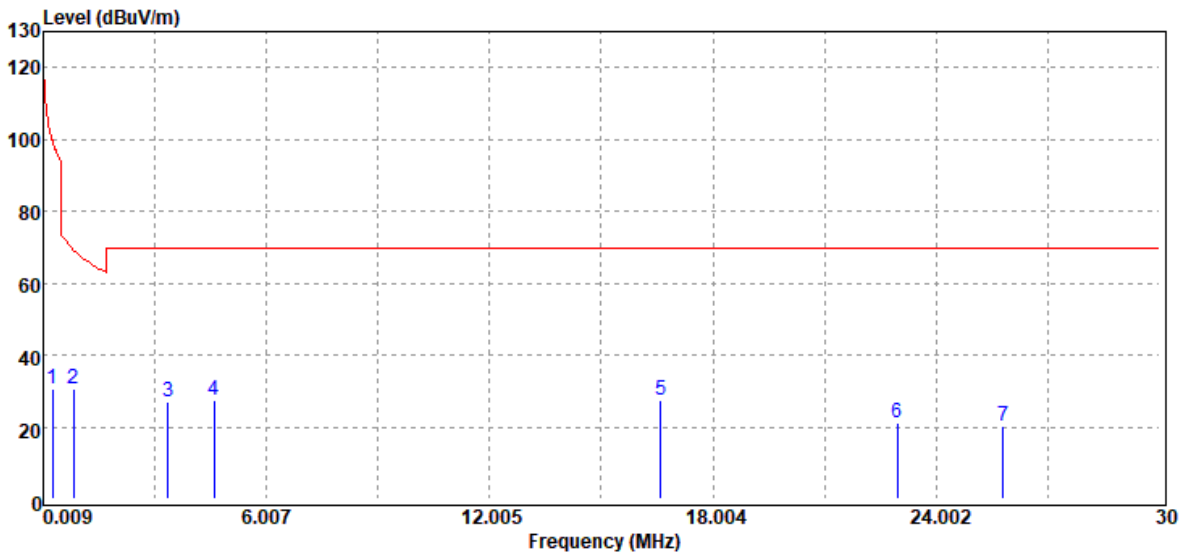
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
0.25	Peak	19.02	10.99	30.01	99.65	-69.64
2.62	Peak	17.27	10.59	27.86	69.54	-41.68
7.27	Peak	20.75	11.19	31.94	69.54	-37.60
14.92	Peak	14.49	10.99	25.48	69.54	-44.06
17.04	Peak	14.31	10.85	25.16	69.54	-44.38
23.31	Peak	11.59	9.94	21.53	69.54	-48.01
24.96	Peak	11.09	9.59	20.68	69.54	-48.86

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Report Number	:ER/2019/80074	Test Date	:2019-09-25
Operation Mode	:125K	Temp./Humi.	:24.6/59
Test Channel	:125KHz	Antenna Pol.	:HORIZONTAL
Test Mode	:TX	Engineer	:Kane
EUT Pol	:H Plane		



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
0.25	Peak	19.56	10.99	30.55	99.65	-69.10
0.82	Peak	19.41	11.02	30.43	69.34	-38.91
3.37	Peak	16.52	10.63	27.15	69.54	-42.39
4.60	Peak	16.51	10.88	27.39	69.54	-42.15
16.59	Peak	16.43	10.88	27.31	69.54	-42.23
22.95	Peak	11.24	10.02	21.26	69.54	-48.28
25.80	Peak	10.66	9.43	20.09	69.54	-49.45

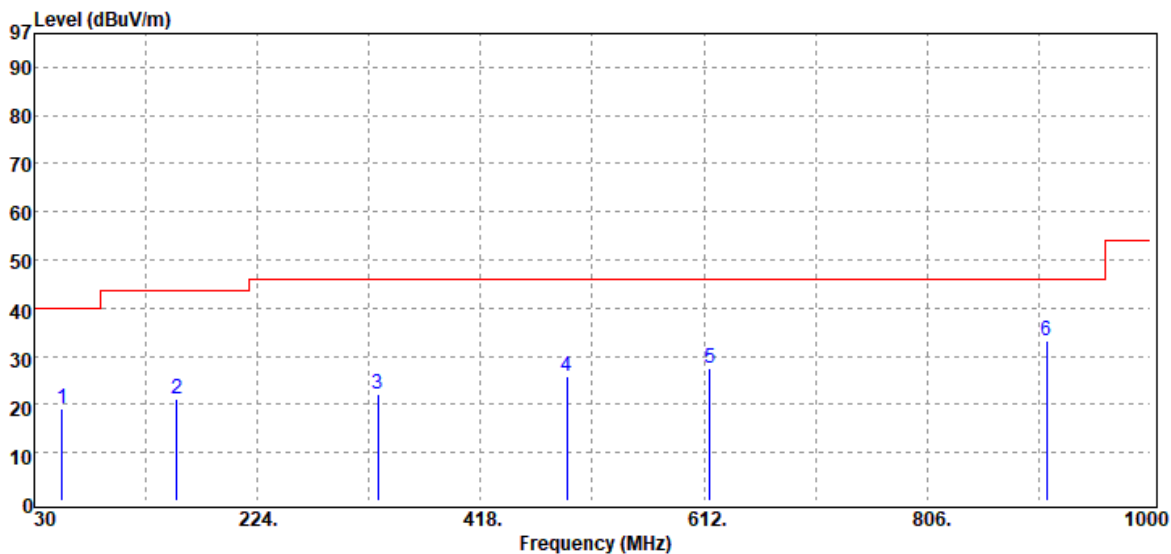
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7.5.3 Above 30MHz test result

Report Number :ER/2019/80074
 Operation Mode :125K
 Test Channel :125KHz
 Test Mode :TX
 EUT Pol :H Plane

Test Date :2019-09-25
 Temp./Humi. :24.6/59
 Antenna Pol. :VERTICAL
 Engineer :Kane



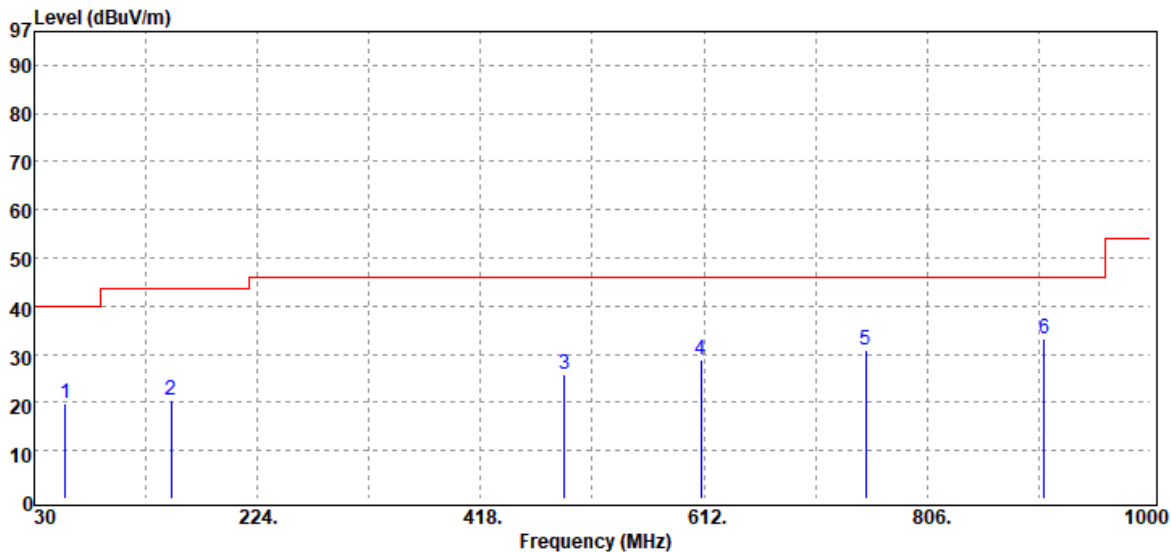
Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
54.25	Peak	27.07	-7.83	19.24	40.00	-20.76
154.16	Peak	28.14	-6.99	21.15	43.50	-22.35
328.76	Peak	27.11	-4.98	22.13	46.00	-23.87
492.69	Peak	28.40	-2.45	25.95	46.00	-20.05
616.85	Peak	28.11	-0.51	27.60	46.00	-18.40
909.79	Peak	27.49	5.65	33.14	46.00	-12.86

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Operation Mode	:125K	Temp./Humi.	:24.6/59
Test Channel	:125KHz	Antenna Pol.	:HORIZONTAL
Test Mode	:TX	Engineer	:Kane
EUT Pol	:H Plane		



Freq. MHz	Detector Mode PK/QP/AV	Spectrum Reading Level dBμV	Factor dB	Actual FS dBμV/m	Limit @3m dBμV/m	Margin dB
57.16	Peak	27.71	-7.99	19.72	40.00	-20.28
149.31	Peak	27.42	-7.01	20.41	43.50	-23.09
490.75	Peak	28.20	-2.40	25.80	46.00	-20.20
609.09	Peak	29.13	-0.25	28.88	46.00	-17.12
752.65	Peak	28.08	2.81	30.89	46.00	-15.11
907.85	Peak	27.83	5.55	33.38	46.00	-12.62

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8 20 dB OCCUPIED BANDWIDTH MEASUREMENT

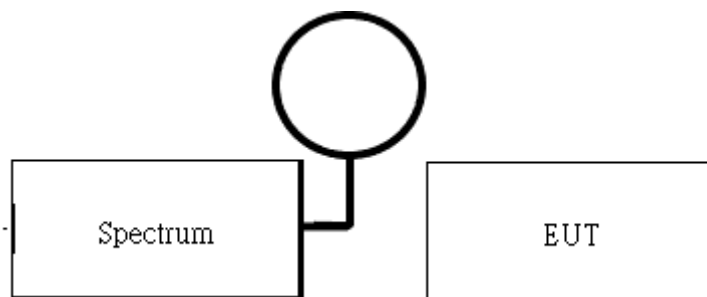
8.1 Standard Applicable:

§2.1049 & §15.215 (c)

8.2 Limit:

None

8.3 Test Set-up



8.4 Measurement Procedure

20dB bandwidth

1. The transmitter output (antenna port) was connected to the spectrum analyzer in peak mode.
2. 20dB Bandwidth the resolution bandwidth of 200 Hz and the video bandwidth of 1 kHz were used.
3. Measured the spectrum width with power higher than 20dB below carrier

8.5 Measurement Equipment Used:

Conducted Emission Test Site					
EQUIPMENT TYPE	MFR	MODEL NUMBER	SERIAL NUMBER	LAST CAL.	CAL DUE.
Loop Antenna	ETS.LINDGREN	6502	143303	04/25/2019	04/24/2020
PXA Spectrum Analyzer	Agilent	N9030A	MY53120760	04/22/2019	04/21/2020

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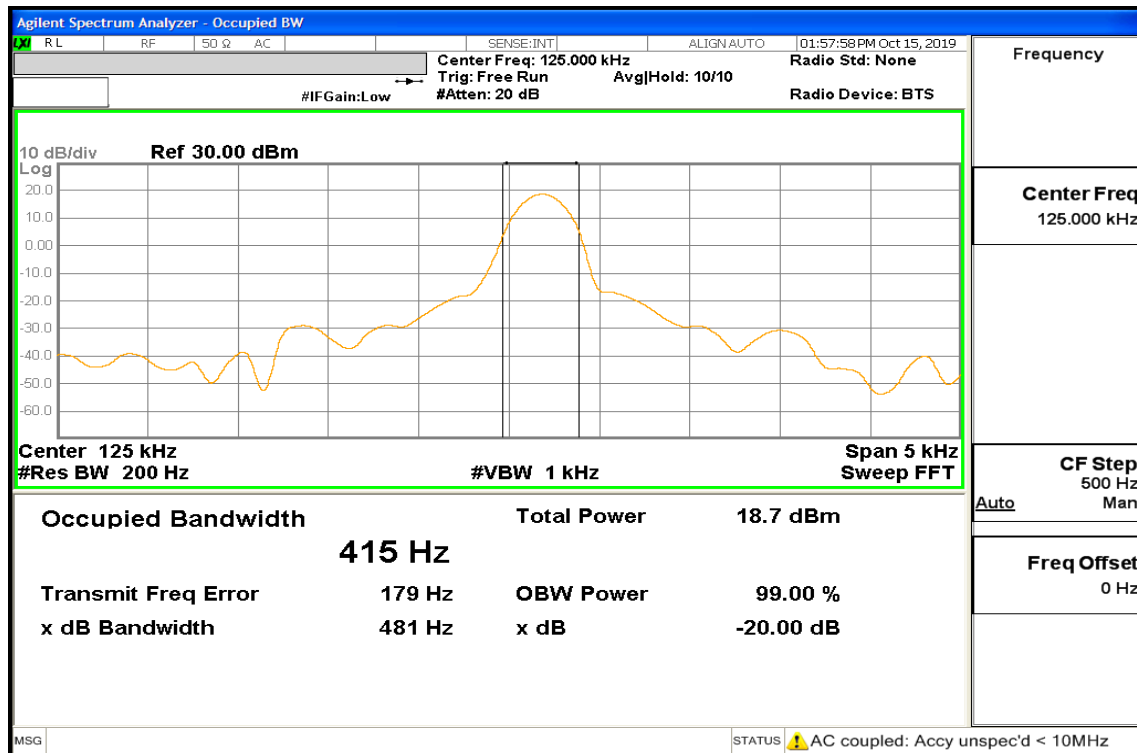
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8.6 Measurement Result

-20dB Bandwidth

20dB Bandwidth	Limit
481kHz	No requirement



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9 ANTENNA REQUIREMENT

9.1 Standard Applicable:

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.

9.2 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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