BWS Testing Laboratory
IECEE CBTL, KOLAS

COMPLIANCE
For FCC PART 15 Subpart C

Applicant Name:	Date of Testing
CanTops	March 02, 2016 to May 3, 2016
	Test Site/Location
Address:	#23, Gokhyeon-ro 480 Beon-gil, Mohyeon-myeon, Cheoin-gu, Yongin-si, Gyeonggi-do 449-853, South Korea
A-1208 Digital Empire, 16, Deogyeong-daero 1556 beon-gil, Yeongtong-gu, Suwon-si, Gyeonggi-do 443-702, South Korea	**Test Report No.:** BWS-16-RF-0002
	BWS FRN: 0009936881
FCC ID:	**RMNCTS-HCOM**

Equipment :	**Hybrid PIO**
Model(s) :	**CTS-HCOM-AA01, CTS-HCOM-AB01**
Frequency Range :	**2403-2480 MHz**
Modulation Type :	**GFSK**
FCC Classification :	**Digital Transmission System (DTS)**
FCC Rule Part(s) :	**FCC Part 15 Subpart C §15.247**

The product was received on March 02, 2016 and testing was completed on April 18, 2016. We, BWS TECH Inc. would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The test results in this report apply exclusively to the tested model / sample. Without written approval of BWS TECH Inc. the test report shall not be reproduced except in full.

(Date) 05/04/2016
Tested by **Hyun-Yong, Seol**

(Date)05/04/2016
Reviewed by **Bang-Hyun, Nam**

BWS TECH INC.

#23, Gokhyeon-ro 480 Beon-gil, Mohyeon-myeon, Cheoin-gu, Yongin-si, Gyeonggi-do 449-853, South Korea
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FCC TEST REPORT

Scope – *Measurement and determination of electromagnetic emission(EME) of radio frequency devices including intentional radiators and/or unintentional radiators for compliance with the technical rules and regulations of the U.S Federal Communications Commission(FCC)*

1. General Information

1.1 Applicant

- **Company Name** : CanTops
- **Company Address** : A-1208 Digital Empire,16, Deogyeong-daero 1556 beon-gil, Yeongtong-gu, Suwon-si, Gyeonggi-do 443-702, South Korea
- **Phone/Fax** : Tel No. : +82-31-303-5231 Fax No. : +82-31-303-5233

1.2 Manufacturer

- **Company Name** : CanTops
- **Company Address** : A-1208 Digital Empire,16, Deogyeong-daero 1556 beon-gil, Yeongtong-gu, Suwon-si, Gyeonggi-do 443-702, South Korea
- **Phone/Fax** : Tel No. : +82-31-303-5231 Fax No. : +82-31-303-5233

1.3 Eut Description

- **Equipment** : Hybrid PIO
- **Model(s)** : CTS-HCOM-AA01, CTS-HCOM-AB01
- **S/N** : Prototype
- **Freq. Range** : 2403-2480 MHz
- **Number of Channels** : 78
- **Modulation Method** : GFSK
- **Input Voltage** : DC 24 V ±10 %
- **Antenna Peak Gain** : 2.1 dBi

1.4 Other Information

- **FCC Rule Part(s)** : Part 15 Subpart C §15.247
- **FCC ID** : RMNCTS-HCOM
- **Test Procedure** : ANSI C63.10-2013
  KDB 558074 D01 DTS Meas Guidance v03r02
- **Date of Test** :March 02, 2016 to April 18, 2015
- **Place of Test** : BWS TECH Inc.(FCC Registration Number : 287786)
  #23, Gokhyeon-ro 480 Beon-gil, Mohyeon-myeon,
  Cheoin-gu, Yongin-si, Gyeonggi-do 449-853, South Korea
  TEL: +82 31 333 5997 FAX: +82 31 333 0017

2. Description of Test Facility

Site Description

Test Lab. :

Accredited by Industry Canada, February 10, 2015
The Certificate Registration Number is 4963A-2.

Accredited by FCC, September 03, 2013
The Certificate Registration Number is 287786.

Accredited by VCCI, September 11, 2015
The Certificate Registration Number is C-4326

Accredited by RRA(EMC,RF, SAR), December 16, 2016
The Certificate Registration Number is KR0017

Accredited by KOLAS(KS Q ISO/IEC 17025), April 08, 2016
The Certificate Registration Number is KT174

Name of Firm : BWS TECH Inc.

Site Location : #23, Gokhyeon-ro 480 Beon-gil, Mohyeon-myeon, Cheoin-gu, Yongin-si, Gyeonggi-do 449-853, South Korea

3. Test Methodology

The tests documented in this report were performed in accordance with ANSI C63.10: 2013 and the requirements of FCC Rules Part 15.207, 15.209 and 15.247.
Radio testing was performed according to KDB 558074 D01.

3.1 EUT Configuration

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

3.2 EUT Exercise

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C.

3.3 FCC Part 15.205 Restricted Bands Of Operations

(a) Except as shown 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	16.42 - 16.423	399.9 - 410	4.5 - 5.15
[1]0.495 - 0.505	16.69475 - 16.69525	608 - 614	5.35 - 5.46
2.1735 - 2.1905	16.80425 - 16.80475	960 - 1240	7.25 - 7.75
4.125 - 4.128	25.5 - 25.67	1300 - 1427	8.025 - 8.5
4.17725 - 4.17775	37.5 - 38.25	1435 - 1626.5	9.0 - 9.2
4.20725 - 4.20775	73 - 74.6	1645.5 - 1646.5	9.3 - 9.5
6.215 - 6.218	74.8 - 75.2	1660 - 1710	10.6 - 12.7
6.26775 - 6.26825	108 - 121.94	1718.8 - 1722.2	13.25 - 13.4
6.31175 - 6.31225	123 - 138	2200 - 2300	14.47 - 14.5
8.291 - 8.294	149.9 - 150.05	2310 - 2390	15.35 - 16.2
8.362 - 8.366	156.52475 - 156.52525	2483.5 - 2500	17.7 - 21.4
8.37625 - 8.38675	156.7 - 156.9	2655 - 2900	22.01 - 23.12
8.41425 - 8.41475	162.0125 - 167.17	3260 - 3267	23.6 - 24.0
12.29 - 12.293	167.72 - 173.2	3332 - 3339	31.2 - 31.8
12.51975 - 12.52025	240 - 285	3345.8 - 3358	36.43 - 36.5
12.57675 - 12.57725	322 - 335.4	3600 - 4400	([2])
13.36 - 13.41			

1 Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.
2 Above 38.6

(b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

3.4 Description Of Test Modes

The EUT has been tested under operating condition.
After verification, all tests were carried out with the worst case test modes as shown below GFSK(1Mbps) Channel Low (2403MHz), Middle (2442MHz) and High (2480MHz), these were chosen for full testing.

4. Summary of Test Results

Clause	TEST Description	Standard Section	Requirements	Result
5.1	**6dB Bandwidth**	§15.247(a)(2)	≥500 kHz	Pass
5.2	**Maximum Peak Conducted Output Power**	§15.247(b)(3)	≤30 dBm	Pass
5.3	**Power Spectral Density**	§15.247(e)	≤8 dBm/3 kHz	Pass
5.4	**Conducted Spurious Emission**	§15.247(d)	≥20 dBc/100 kHz	Pass
5.5	**Radiated Spurious Emission**	§15.247(d)	§15.209(a)	Pass
5.6	**Band Edge Measurement**	§15.247(d)	§15.209(a)	Pass
5.7	**Power Conducted Emission**	§15.207	§15.207(a)	Pass
5.8	**Antenna Application**	§15.247(b), §15.203	§15.247(b), §15.203	Pass

5. Test Data

5.1 6dB Bandwidth

5.1.1 Test Equipment

EQUIPMENT	MODEL	MANUFACTURE	SERIAL NUMBER	Calibration Due date (year/month/date)
Spectrum analyzer	N9020A	Agilent	US46220101	2016/09/14

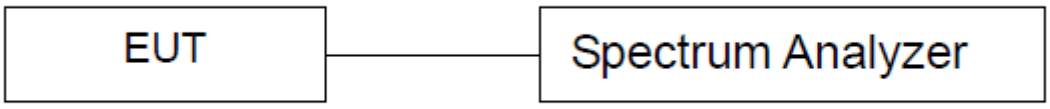
5.1.2 Test Limit

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

5.1.3 Measurement Procedure

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r02.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set (RBW = 100 kHz, VBW = 300 kHz, Detector = Peak, Trace mode = Max Hold, Sweep = Auto).
5. Measure and record the results in the test report.

5.1.4 Test SET-UP (Block Diagram of Configuration)



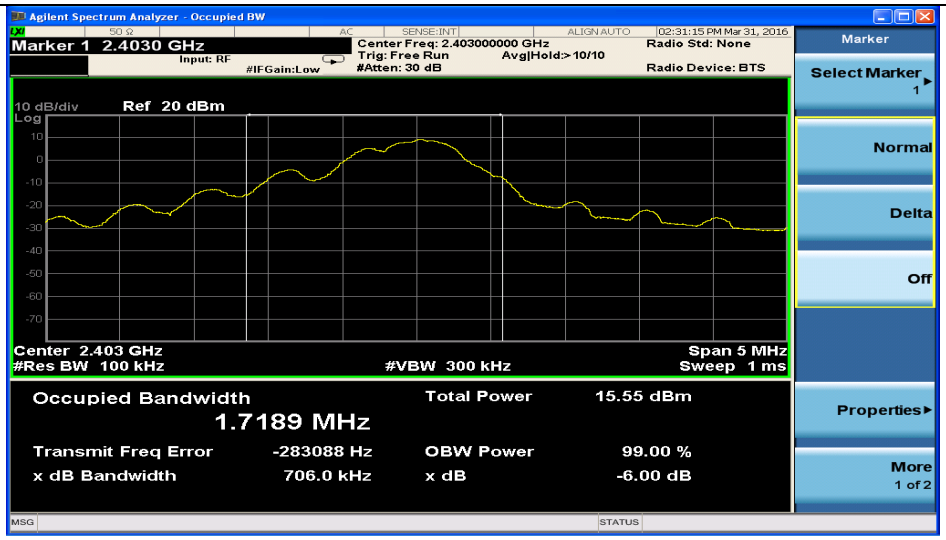
5.1.5 Test Result

Modulation	Frequency (MHz)	Bandwidth (MHz)	Limit (MHz)	Test Result
GFSK	2403	0.71	≥ 0.5	PASS
	2442	0.68		PASS
	2480	0.61		PASS

6dB Bandwidth

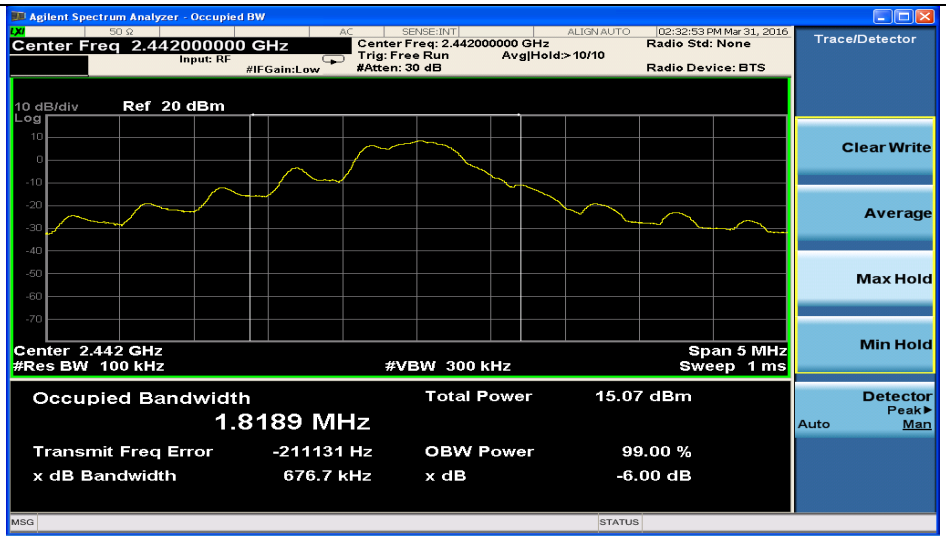
GFSK - 2403 MHz

(Low Channel)



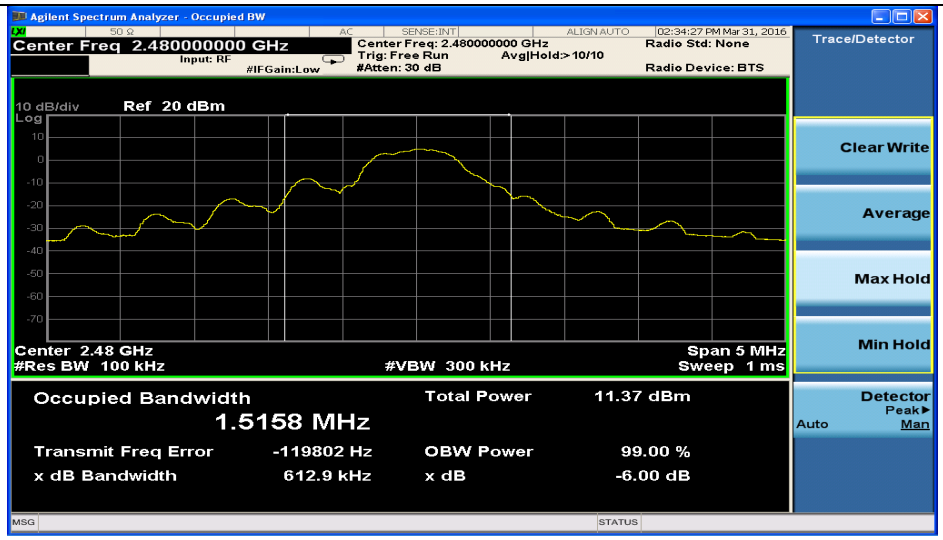
GFSK - 2442 MHz

(Middle Channel)



GFSK - 2480 MHz

(High Channel)



5.2 Maximum Peak Conducted Output Power

5.2.1 Test Equipment

EQUIPMENT	MODEL	MANUFACTURE	SERIAL NUMBER	Calibration Due date (year/month/date)
Power Meter	RPR3006W	D.A.R.E!! Insrtuments	14I00048SNO09	2017/04/25

5.2.2 Test Limit

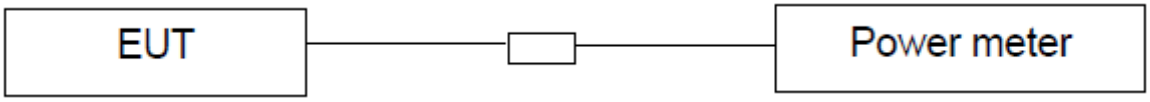
The maximum peak power shall be less than 1 Watt (30dBm).

Note: If transmitting antenna of directional gain greater than 6dBi is used, the peak output power from the intentional radiator shall be reduced below the above stated value by the amount in dB that the direction gain of the antenna exceeds 6dBi, In case of point-to-point operation, the limit has to be reduced by 1dB for every 3dB that the directional gain of the antenna exceeds 6dBi.

5.2.3 Measurement Procedure

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r02.
2. The RF output of EUT was connected to the power meter by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum output power setting and enable the EUT transmit continuously.
4. Measure the conducted output power with cable loss and record the results in the test report.

5.2.4 Test SET-UP (Block Diagram of Configuration)



5.2.5 Test Result

Modulation	Frequency (MHz)	Output Power (dBm)	Limit (dBm)	Test Result
GFSK	2403	7.22	≤ 30	PASS
	2442	6.41		PASS
	2480	3.61		PASS

5.3 Power Spectral Density

5.3.1 Test Equipment

EQUIPMENT	MODEL	MANUFACTURE	SERIAL NUMBER	Calibration Due date (year/month/date)
Spectrum analyzer	N9020A	Agilent	US46220101	2016/09/14

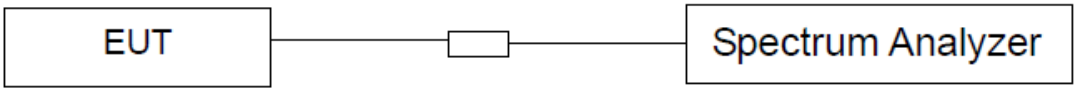
5.3.2 Test Limit

For digitally modulated systems, the power spectral density conducted from the intentional radiated to the Antenna shall not be greater than 8dBm in any 3kHz band during any time interval of continuous transmission.

5.3.3 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r02.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set (RBW = 3 kHz, VBW = 10 kHz, Detector = Peak, Span = 1.5 times DTS Channel Bandwidth, Trace mode = Max Hold, Sweep = Auto).
5. Measure and record the results in the test report.

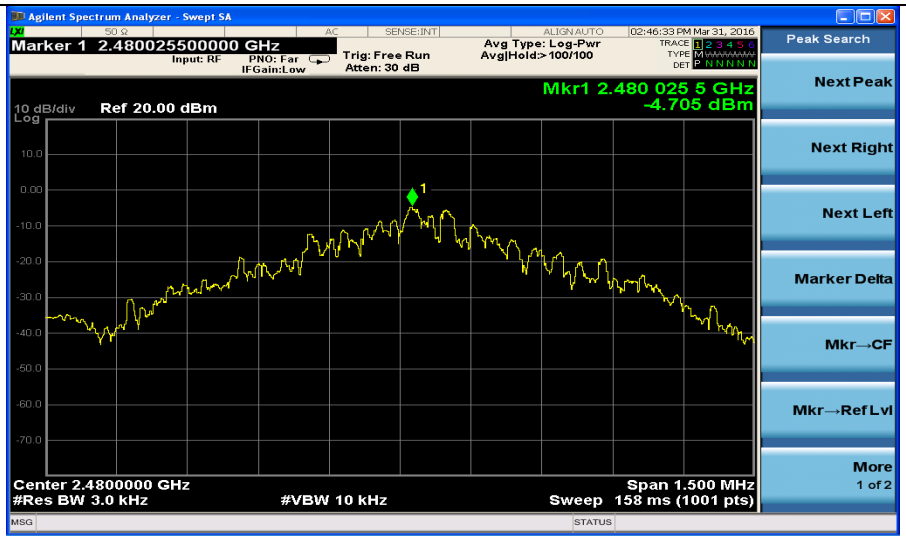
5.3.4 Block Diagram of Test Setup



5.3.5 Test Result

Modulation	Frequency (MHz)	PPSD (dBm/3kHz)	Limit (dBm/3kHz)	Test Result
GFSK	2403	-0.805	≤ 8	PASS
	2442	-2.133		PASS
	2480	-4.705		PASS

Power Spectral Density

GFSK - 2403 MHz (Low Channel)	
GFSK - 2442 MHz (Middle Channel)	
GFSK - 2480 MHz (High Channel)	

5.4 Conducted Spurious Emission

5.4.1 Test Equipment

EQUIPMENT	MODEL	MANUFACTURE	SERIAL NUMBER	Calibration Due date (year/month/date)
Spectrum analyzer	N9020A	Agilent	US46220101	2016/09/14

5.4.2 Test Limit

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the FCC section 15.209 limits as below.

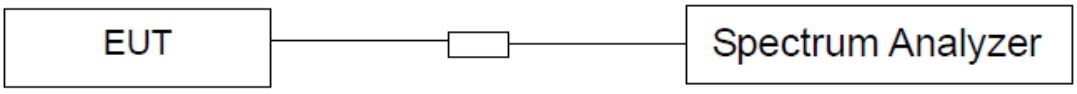
Note: Wireless charger configuration was evaluated.

Frequency (MHz)	Field Strength (microvolts/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

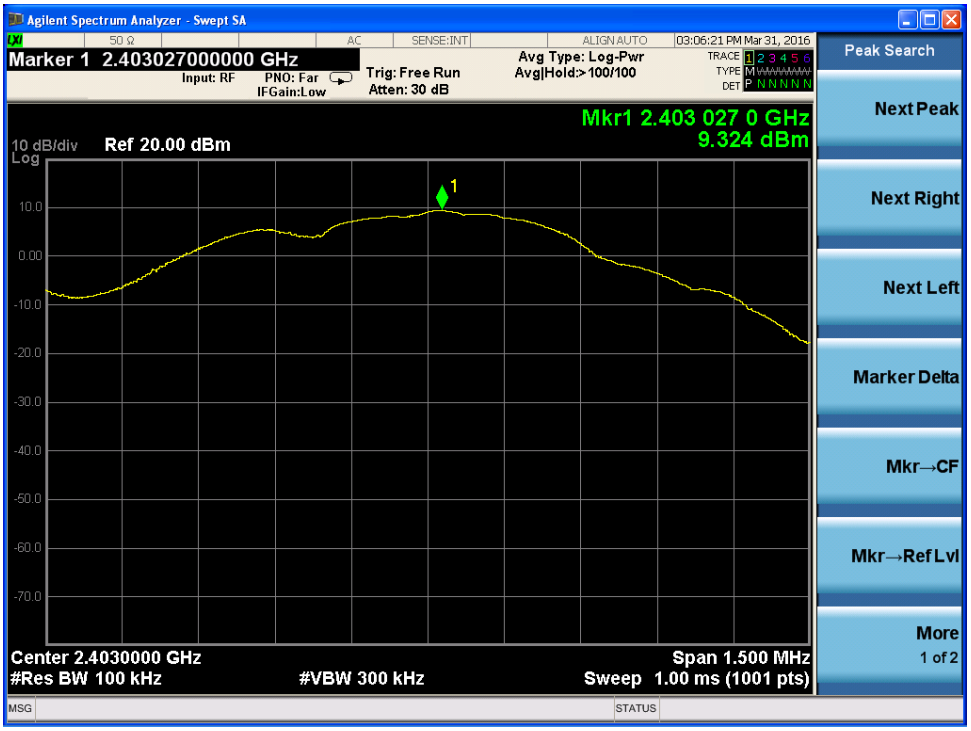
5.4.3 Test Procedures

1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r02.
2. The RF output of EUT was connected to the spectrum analyzer by RF cable and attenuator. The path loss was compensated to the results for each measurement.
3. Set to the maximum power setting and enable the EUT transmit continuously.
4. Set (RBW = 100 kHz, VBW = 300 kHz, Detector = Peak, Trace mode = Max Hold, Sweep = Auto).
5. Measure and record the results in the test report.

5.4.4 Block Diagram of Test setup.

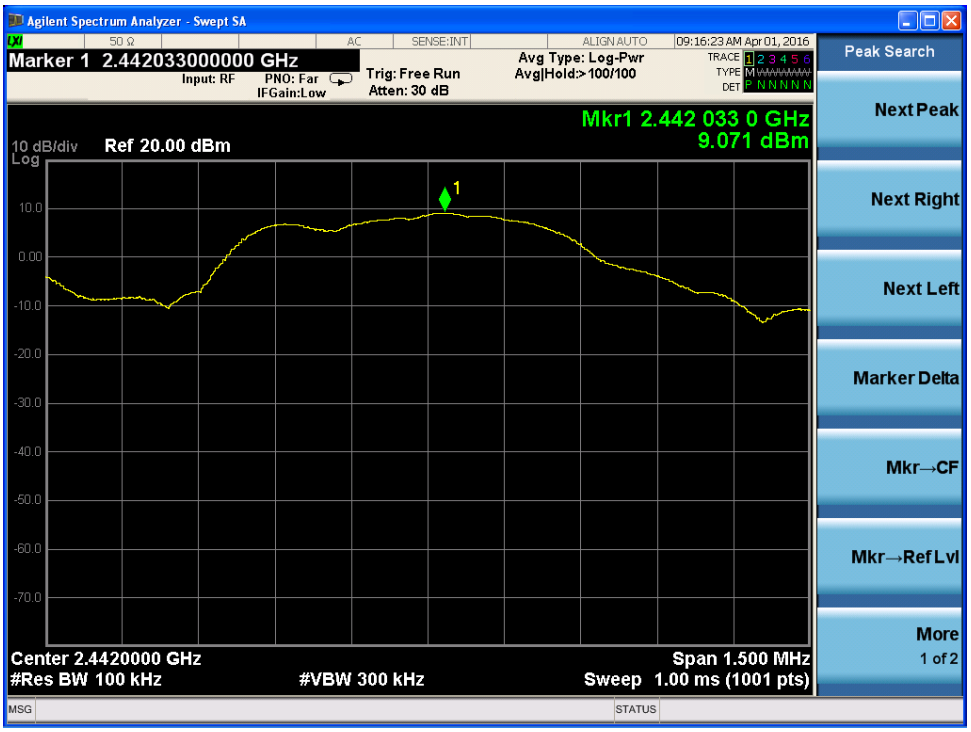


5.4.5 Test Result

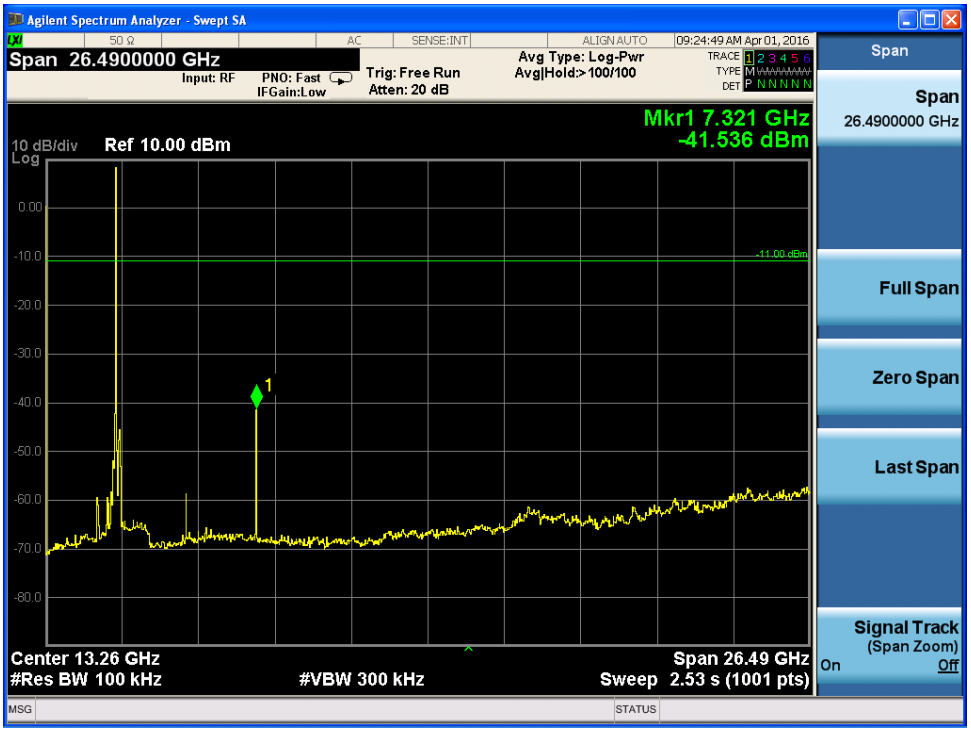
Conducted Spurious Emission (2403MHz)	
PSD Level	
Conducted Spurious Emission	

Conducted Spurious Emission (2442MHz)

PSD Level

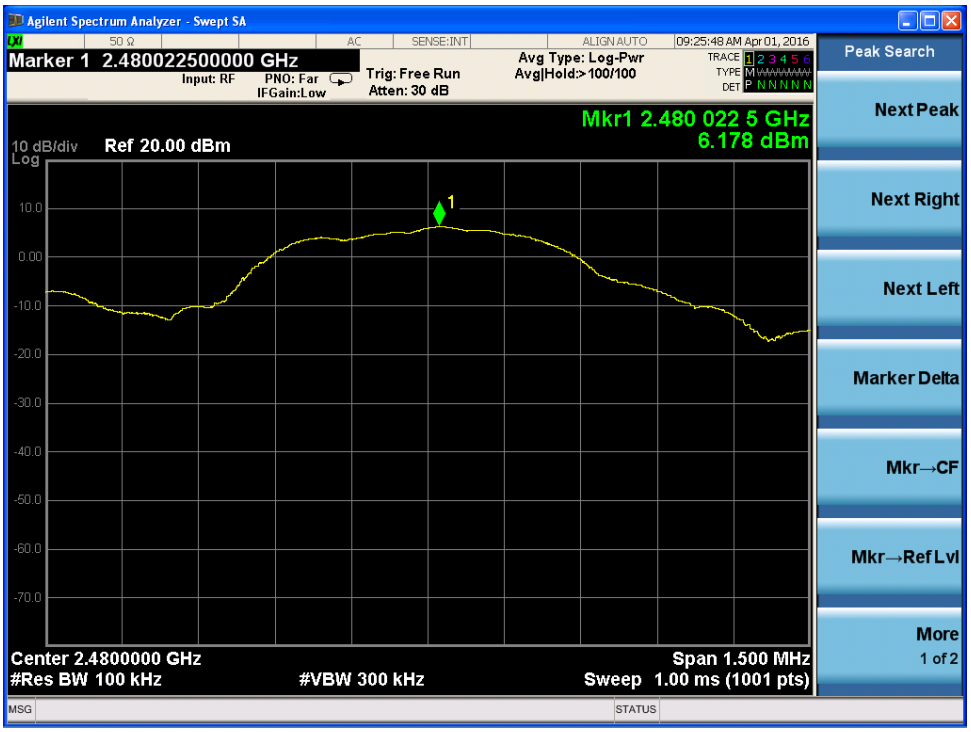


Conducted Spurious Emission



Conducted Spurious Emission (2480MHz)

PSD Level



Conducted Spurious Emission

5.5 Radiated Spurious Emission

5.5.1 Test Equipment

EQUIPMENT	MODEL	MANUFACTURE	SERIAL NUMBER	Calibration Due date (year/month/date)
EMI Receiver	ESR	Rohde & Schwarz	101320	2017/03/25
Bilog Antenna	VULB9160	Schwarzbeck	9160-3052	2017/10/06
Antenna Mast(4m)	AM-4.0	MATURO	AM4.0/225/17240915	-
Antenna Mast(2m)	AM-2.5	MATURO	AM2.5/226/17240915	-
Turn Table Controller	CO2000	MATURO	NCU/459/17240915	
Loop Antenna	HEH2-Z2	Rohde & Schwarz	881056/6	2017/01/06
Horn Antenna	BBHA 9120 D	SCHWARZBECK MESS-ELEKTRONIK	BBHA 9120 D 234	2017/09/03
RF Amplifier	LPA-10-20	RF Bay	11160801	2017/03/25
RF Amplifier	PAM-118A	COM-POWER	551019	2016/07/20
RE_10 m CHAMBER #1	N/A	SY Corp.	N/A	N/A

5.5.2 Test Limit

In any 100 kHz bandwidth outside the intentional radiator frequency band, all harmonics/spurious must be at least 20 dB below the highest emission level within the authorized band. If the output power of this device was measured by spectrum analyzer, the attenuation under this paragraph shall be 30 dB instead of 20 dB. In addition, radiated emissions which fall in the restricted bands must also comply with the FCC section 15.209 limits as below.

Note: Wireless charger configuration was evaluated.

Frequency (MHz)	Field Strength (microvolts/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

5.5.3 Test Procedure

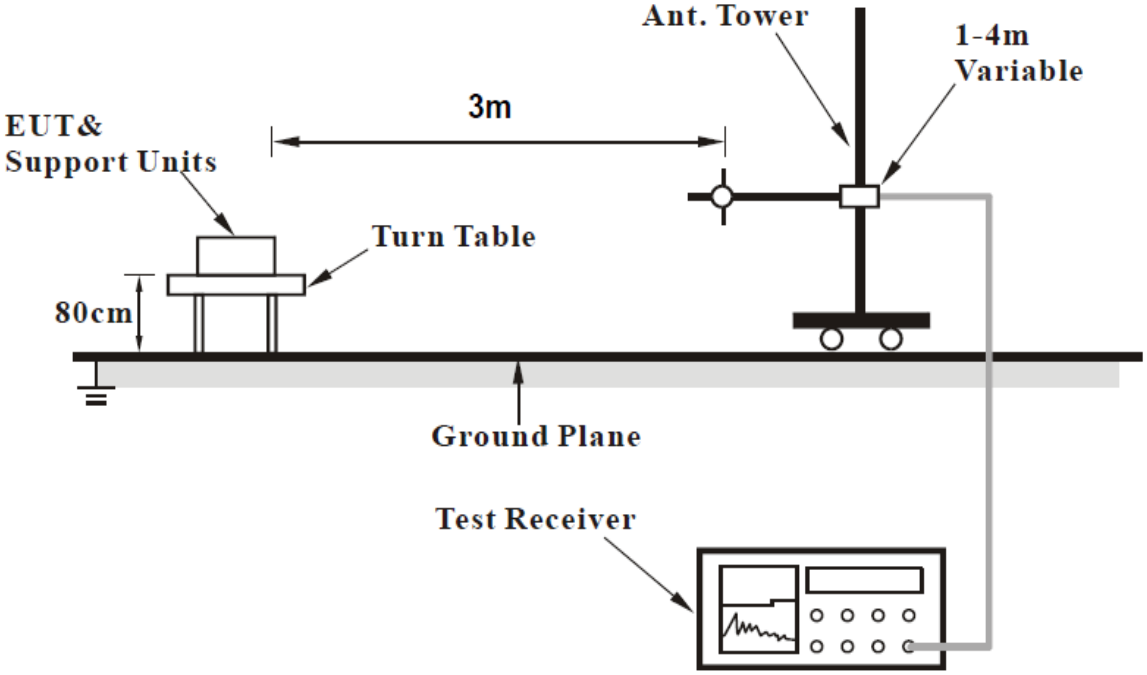
1. The testing follows FCC KDB Publication No. 558074 D01 DTS Meas. Guidance v03r02.
2. The EUT was arranged to its worst case and then tune the antenna tower (from 1 m to 4 m) and turntable (from 0 degree to 360 degrees) to find the maximum reading. A pre-amp and a high pass filter are used for the test in order to get better signal level.
3. The EUT was placed on a turntable. For emissions testing at or below 1 GHz, the table height was 80cm above the reference ground plane. For emission measurements above 1 GHz, the table height was 1.5m.
4. The EUT was set 3 meters from the interference receiving antenna, which was mounted on the top of a variable height antenna tower.
5. Corrected Reading: Antenna Factor + Cable Loss + Read Level - Preamp Factor = Level
6. For measurement below 1GHz, If the emission level of the EUT measured by the peak detector is 3 dB lower than the applicable limit, the peak emission level will be reported. Otherwise, the emission measurement will be repeated using the quasi-peak detector and reported.
7. Use the following spectrum analyzer settings and peak emission levels are measured :
   (1) Span shall wide enough to fully capture the emission being measured;
   (2) Set RBW (9-150kHz: 200Hz, 0.15-30MHz: 9kHz, 30-1000MHz: 120kHz, above 1GHz: 1MHz).
   (3) VBW ≥ 3 x RBW ; Sweep = auto; Detector function = peak; Trace = max hold

   For average measurement:
   • VBW = 10 Hz, when duty cycle is no less than 98 percent.
   • VBW ≥ 1/T, when duty cycle is less than 98 percent where T is the minimum transmission duration over which the transmitter is on and is transmitting at its maximum power control level for the tested mode of operation.

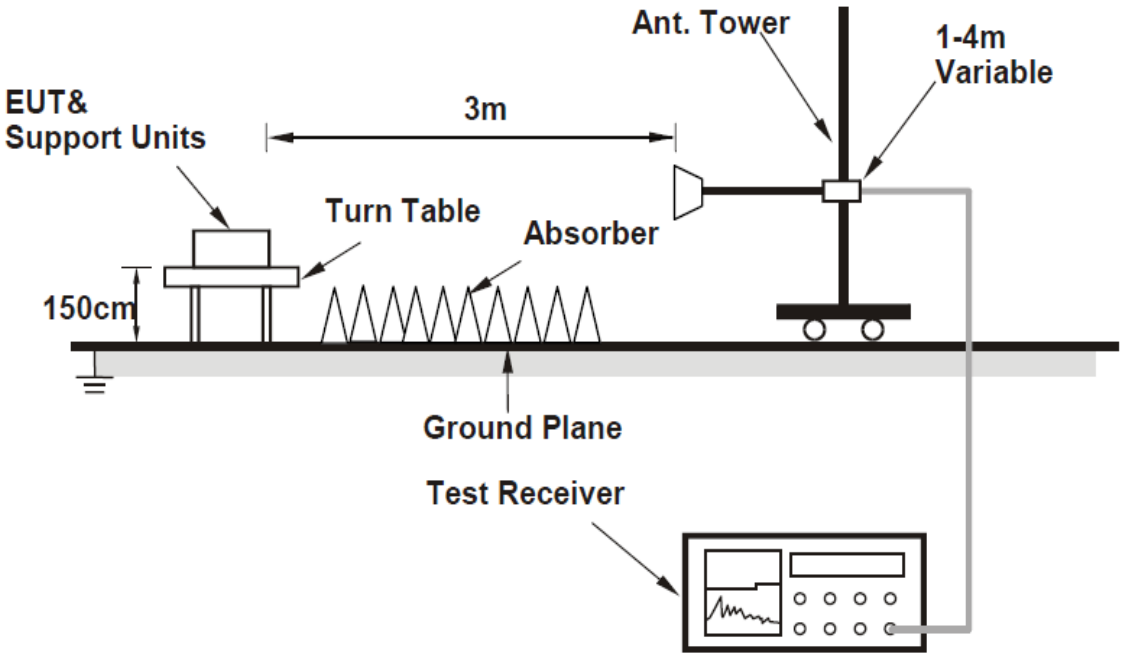
8. Measure and record the results in the test report.

5.5.4 Test SET-UP (Block Diagram of Configuration)

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



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



5.5.5 Test Result

5.5.5.1 0.009–30 MHz

Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	State
-	-	-	-	-	-	-	PASS

Remark: §15.31(o)_The amplitude of spurious emissions from intentional radiators and emissions from unintentional radiators which are attenuated more than 20 dB below the permissible value need not be reported unless specifically required elsewhere in this part.

5.5.5.2 30–1000 MHz

GFSK - 2403 MHz(Low)

Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
31.254	50.4	V	-14.5	35.9	40	4.1	QP
49.047	45.5	V	-18.7	26.8	40	13.2	QP
57.066	47.8	V	-19.3	28.5	40	11.5	QP
63.985	53.9	H	-19.5	34.4	40	5.6	QP
69.297	53.9	H	-19.5	34.4	40	5.6	QP
81.448	49.8	H	-20.8	29.0	40	11	QP

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m]

GFSK - 2442 MHz(Middle)

Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
31.714	50.7	V	-13.7	37.0	40	3.0	QP
49.004	45.5	V	-17.5	28.0	40	12.0	QP
57.369	46.9	V	-18.0	28.9	40	11.1	QP
63.924	52.1	V	-18.1	34.0	40	6.0	QP
68.937	54.9	H	-18.1	36.8	40	3.2	QP
81.717	48.7	H	-19.2	29.5	40	10.5	QP

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m]

GFSK - 2480 MHz(High)

Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
31.424	47.9	V	-13.6	34.3	40	5.7	QP
47.754	45.1	V	-17.4	27.7	40	12.3	QP
57.570	46.9	V	-18.0	28.9	40	11.1	QP
63.337	51.9	H	-18.1	33.8	40	6.2	QP
69.161	55.6	H	-18.1	37.5	40	2.5	QP
81.791	49.7	H	-19.2	30.5	40	9.5	QP

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m]

5.5.5.3 Above 1 GHz

GFSK - 2403 MHz(Low)_Vertical

Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
2601.400	55.8	V	-6.4	49.4	74.0	24.6	Peak
2601.400	36.6	V	-6.4	30.2	54.0	23.8	AVG
2999.200	50.3	V	-4.6	45.7	74.0	28.3	Peak
2999.200	45.2	V	-4.6	40.6	54.0	13.4	AVG
3148.800	45.1	V	-4.3	40.8	74.0	33.2	Peak
3148.800	24.8	V	-4.3	20.5	54.0	33.5	AVG
7208.400	44.5	V	5.8	50.3	74.0	23.7	Peak
7208.400	27.4	V	5.8	33.2	54.0	20.8	AVG
13457.600	43.6	V	12.9	56.5	74.0	17.5	Peak
13457.600	24.7	V	12.9	37.6	54.0	16.4	AVG

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m]

GFSK - 2403 MHz(Low)_Horizontal

Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
2623.500	50.2	H	-6.3	43.9	74.0	30.1	Peak
2623.500	32.9	H	-6.3	26.6	54.0	27.4	AVG
2999.200	53.2	H	-4.6	48.6	74.0	25.4	Peak
2999.200	50.0	H	-4.6	45.4	54.0	8.6	AVG
4262.300	46.5	H	-2.0	44.5	74.0	29.5	Peak
4262.300	23.0	H	-2.0	21.0	54.0	33.0	AVG
5547.500	44.0	H	1.5	45.5	74.0	28.5	Peak
5547.500	27.9	H	1.5	29.4	54.0	24.6	AVG
12361.100	42.1	H	11.4	53.5	74.0	20.5	Peak
12361.100	24.4	H	11.4	35.8	54.0	18.2	AVG

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m]

GFSK - 2442 MHz(Middle)_Vertical

Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
2598.000	54.4	V	-6.4	48.0	74.0	26.0	Peak
2598.000	36.8	V	-6.4	30.4	54.0	23.6	AVG
2999.200	50.4	V	-4.6	45.8	74.0	28.2	Peak
2999.200	42.9	V	-4.6	38.3	54.0	15.7	AVG
4882.800	47.2	V	0.2	47.4	74.0	26.6	Peak
4882.800	36.8	V	0.2	37.0	54.0	17.0	AVG
5131.000	45.2	V	0.8	46.0	74.0	28.0	Peak
5131.000	26.7	V	0.8	27.5	54.0	26.5	AVG
13999.900	44.0	V	13.7	57.7	74.0	16.3	Peak
13999.900	24.3	V	13.7	38.0	54.0	16.0	AVG

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m]

GFSK - 2442 MHz(Middle)_Horizontal

Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
2604.800	47.4	H	-6.4	41.0	74.0	33.0	Peak
2604.800	36.8	H	-6.4	30.4	54.0	23.6	AVG
2999.200	53.8	H	-4.6	49.2	74.0	24.8	Peak
2999.200	48.7	H	-4.6	44.1	54.0	9.9	AVG
3150.500	45.8	H	-4.3	41.5	74.0	32.5	Peak
3150.500	29.8	H	-4.3	25.5	54.0	28.5	AVG
4884.500	47.0	H	0.2	47.2	74.0	26.8	Peak
4884.500	31.8	H	0.2	32.0	54.0	22.0	AVG
7968.300	43.0	H	8.2	51.2	74.0	22.8	Peak
7968.300	26.1	H	8.2	34.3	54.0	19.7	AVG

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m]

GFSK - 2480 MHz(High)_Vertical

Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
2606.500	57.1	V	-6.4	50.7	74.0	23.3	Peak
2606.500	31.8	V	-6.4	25.4	54.0	28.6	AVG
2999.200	46.0	V	-4.6	41.4	74.0	32.6	Peak
2999.200	35.5	V	-4.6	30.9	54.0	23.1	AVG
3648.600	44.8	V	-3.5	41.3	74.0	32.7	Peak
3648.600	35.6	V	-3.5	32.1	54.0	21.9	AVG
4417.000	44.8	V	-1.5	43.3	74.0	30.7	Peak
4417.000	26.3	V	-1.5	24.8	54.0	29.2	AVG
5975.900	43.1	V	2.5	45.6	74.0	28.4	Peak
5975.900	26.5	V	2.5	29.0	54.0	25.0	AVG

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m]

GFSK - 2480 MHz(High)_Horizontal

Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
2594.600	52.4	H	-6.4	46.0	74.0	28.0	Peak
2594.600	36.2	H	-6.4	29.8	54.0	24.2	AVG
2999.200	50.5	H	-4.6	45.9	74.0	28.1	Peak
2999.200	45.3	H	-4.6	40.7	54.0	13.3	AVG
4959.300	47.4	H	0.5	47.9	74.0	26.1	Peak
4959.300	34.9	H	0.5	35.4	54.0	18.6	AVG
6819.100	43.8	H	4.8	48.6	74.0	25.4	Peak
6819.100	24.3	H	4.8	29.1	54.0	24.9	AVG
9000.200	44.1	H	8.9	53.0	74.0	21.0	Peak
9000.200	36.7	H	8.9	45.6	54.0	8.4	AVG

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m

5.6 Band Edge Measurement

5.6.1 Test Equipment

EQUIPMENT	MODEL	MANUFACTURE	SERIAL NUMBER	Calibration Due date (year/month/date)
EMI Receiver	ESR	Rohde & Schwarz	101320	2017/03/25
Bilog Antenna	VULB9160	Schwarzbeck	9160-3052	2017/10/06
Antenna Mast(4m)	AM-4.0	MATURO	AM4.0/225/17240915	-
Antenna Mast(2m)	AM-2.5	MATURO	AM2.5/226/17240915	-
Turn Table Controller	CO2000	MATURO	NCU/459/17240915	
Loop Antenna	HEH2-Z2	Rohde & Schwarz	881056/6	2017/01/06
Horn Antenna	BBHA 9120 D	SCHWARZBECK MESS-ELEKTRONIK	BBHA 9120 D 234	2017/09/03
RF Amplifier	LPA-10-20	RF Bay	11160801	2017/03/25
RF Amplifier	PAM-118A	COM-POWER	551019	2016/07/20
RE_10 m CHAMBER #1	N/A	SY Corp.	N/A	N/A

5.6.2 Test Limit

According to §15.247(d), in any 100 kHz bandwidth outside the frequency bands in which the spread spectrum intentional radiator in operating, the radio frequency power that is produced by the intentional radiator shall be at least 20dB below that in the 100kHz bandwidth within the band that contains the highest level of the desired power, 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 in15.209(a).

5.6.3 Test Procedure

The EUT is placed on a turntable, which is 0.8m above the ground plane.

The turntable shall be rotated for 360 degrees to determine the position of maximum emission level. EUT is set 3m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emission.
Set the spectrum analyzer in the following setting in order to capture the lower and upper band-edges of the emission:

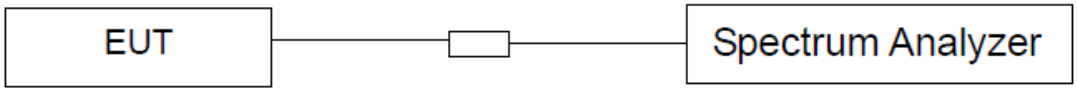
PEAK: RBW=VBW=1 MHz / Sweep=AUTO

AVERAGE: RBW=1 MHz / VBW=10 Hz / Sweep=AUTO

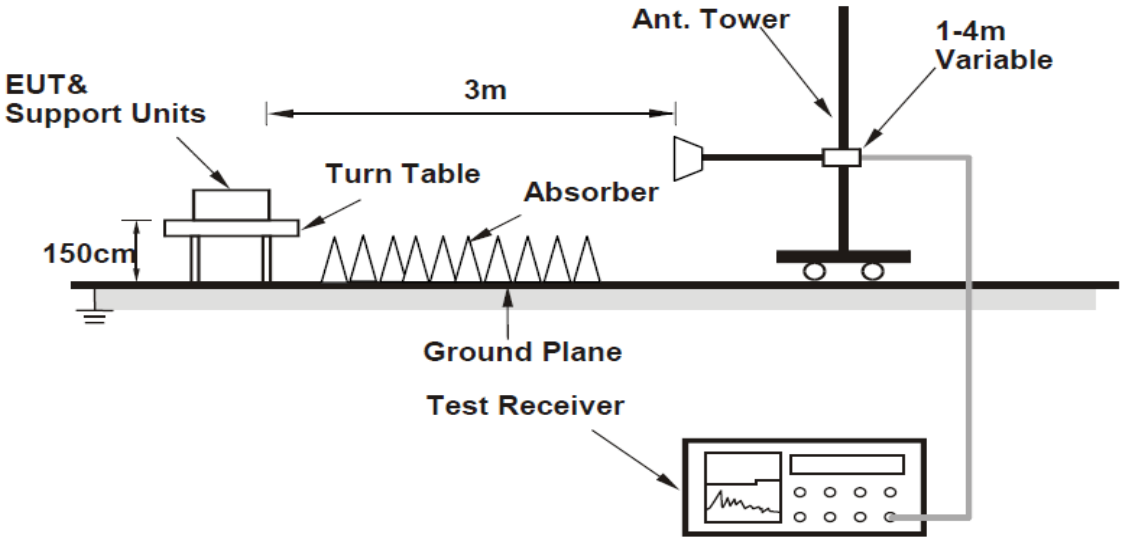
Repeat the procedures until all the PEAK and AVERAGE versus POLARIZATION are measured.

5.6.4 Test SET-UP (Block Diagram of Configuration)

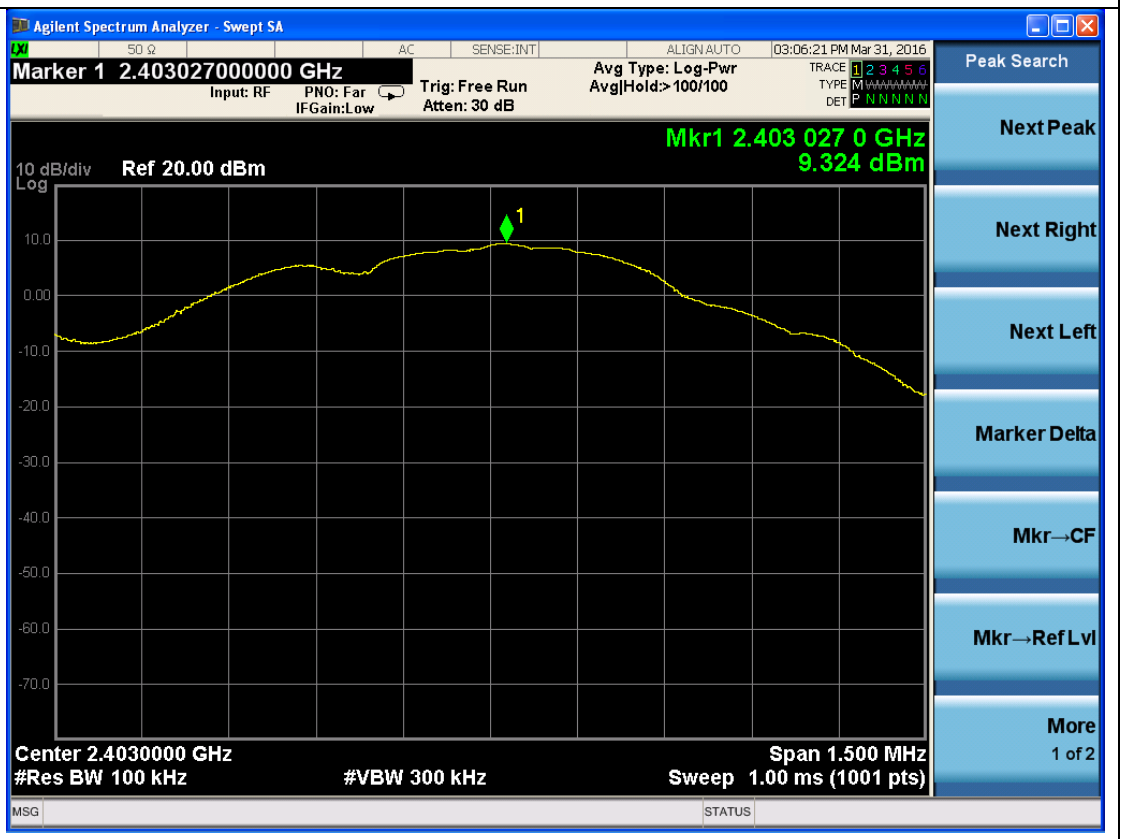
(a) Conducted Emission Test Set-Up, Frequency above 1000MHz



(b) Radiated Emission Test Set-Up, Frequency above 1000MHz

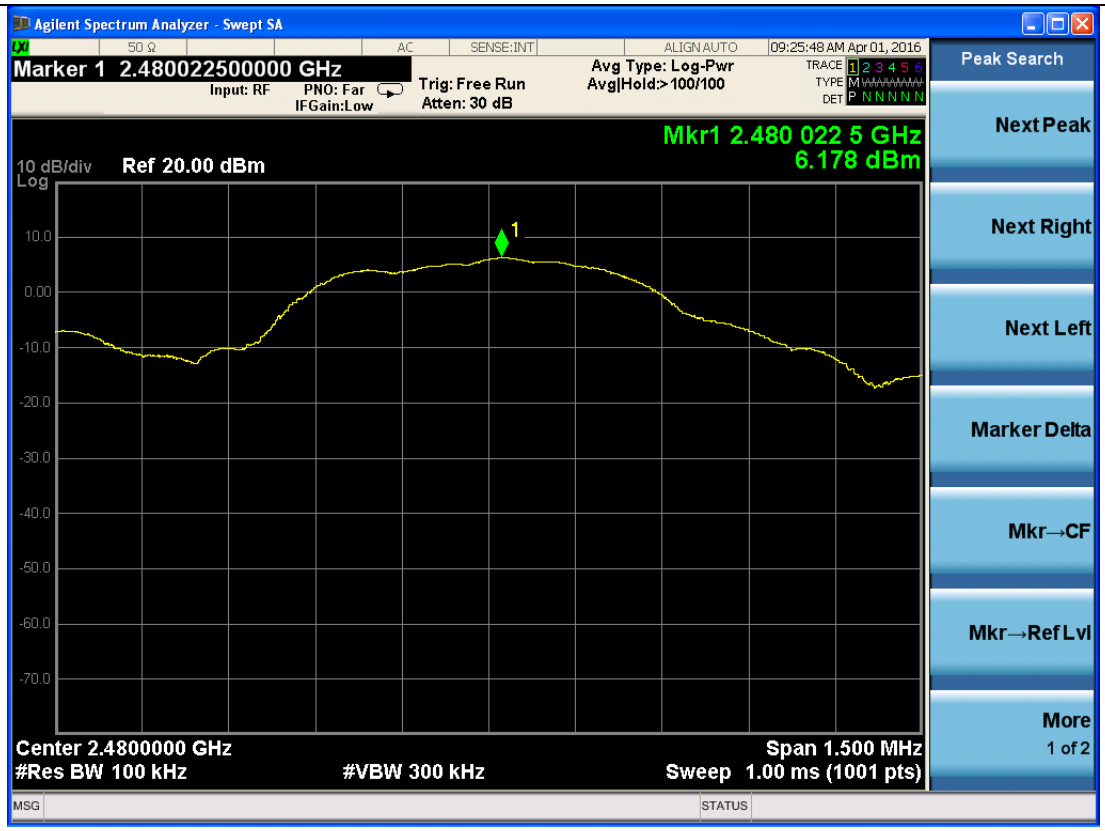


5.6.5 Test Result

Conducted Band Edges (2403MHz)	
PSD Level	
Band Edge	

Conducted Band Edges (2480MHz)

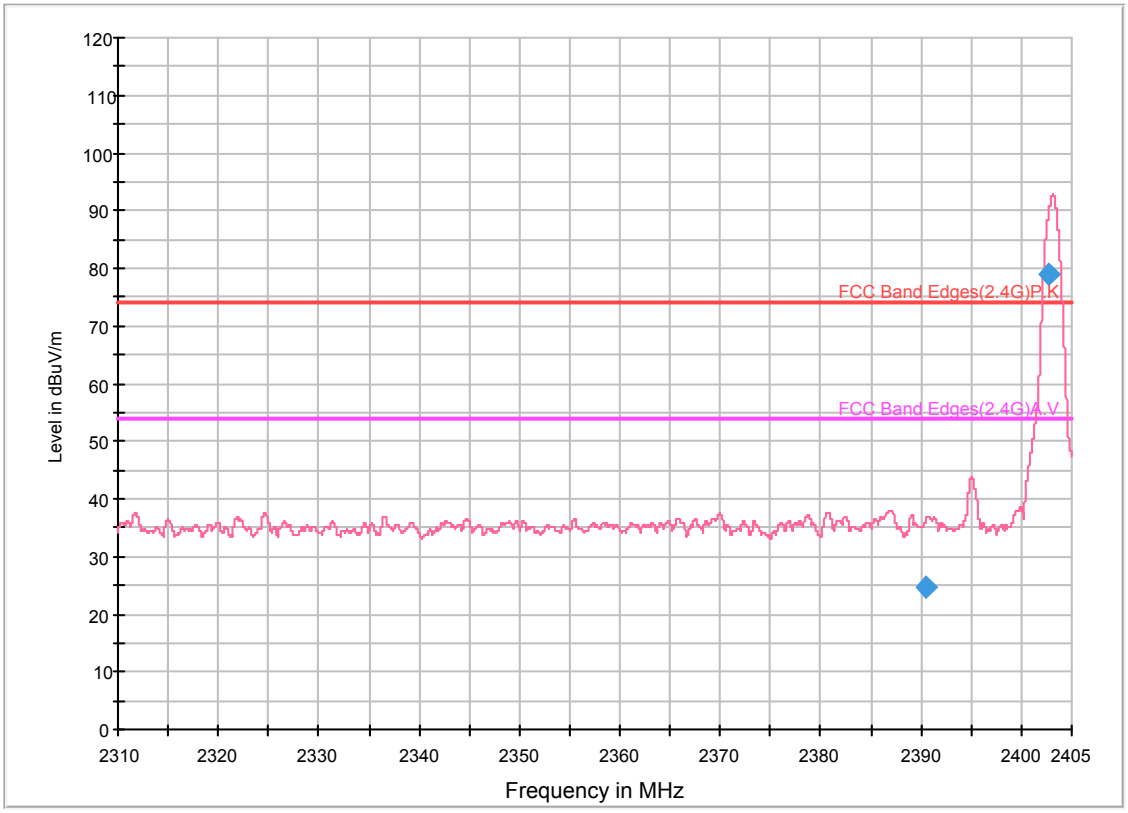
PSD Level



Band Edge

Radiated Band Edges(2403 MHz)_Vertical

EUT Name: Hybrid PIO
Manufacturer: CanTops
Model Name: CTS-HCOM
Test Mode: GFSK-2403(low)

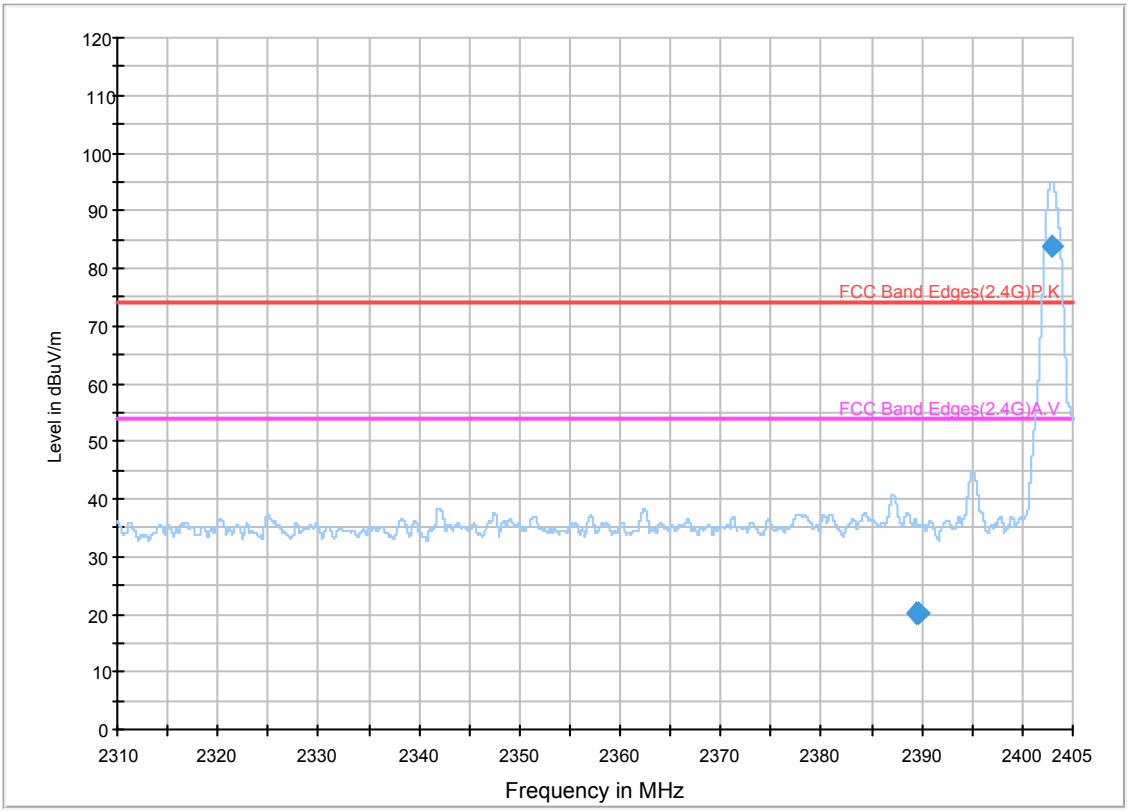


Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
2390.000	42.1	V	-7.1	35.0	74.0	39.0	Peak
2390.000	31.9	V	-7.1	24.8	54.0	29.2	AVG

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m]

Radiated Band Edges(2403 MHz)_Horizontal

EUT Name: Hybrid PIO
Manufacturer: CanTops
Model Name: CTS-HCOM
Test Mode: GFSK-2403(low)

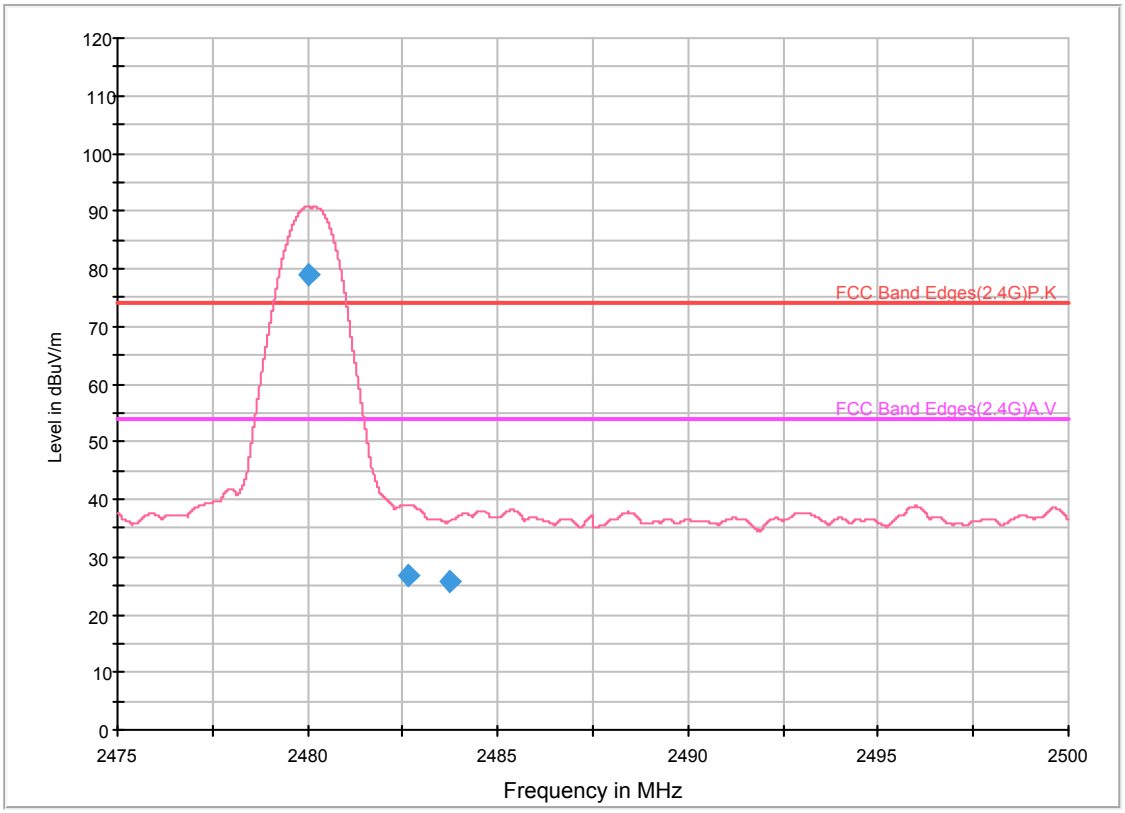


Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
2390.000	42.2	H	-7.1	35.1	74.0	38.9	Peak
2390.000	27.3	H	-7.1	20.2	54.0	33.8	AVG

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m]

Radiated Band Edges (2480 MHz)_Vertical

EUT Name:	Hybrid PIO
Manufacturer:	CanTops
Model Name:	CTS-HCOM
Test Mode:	GFSK-2480(High)

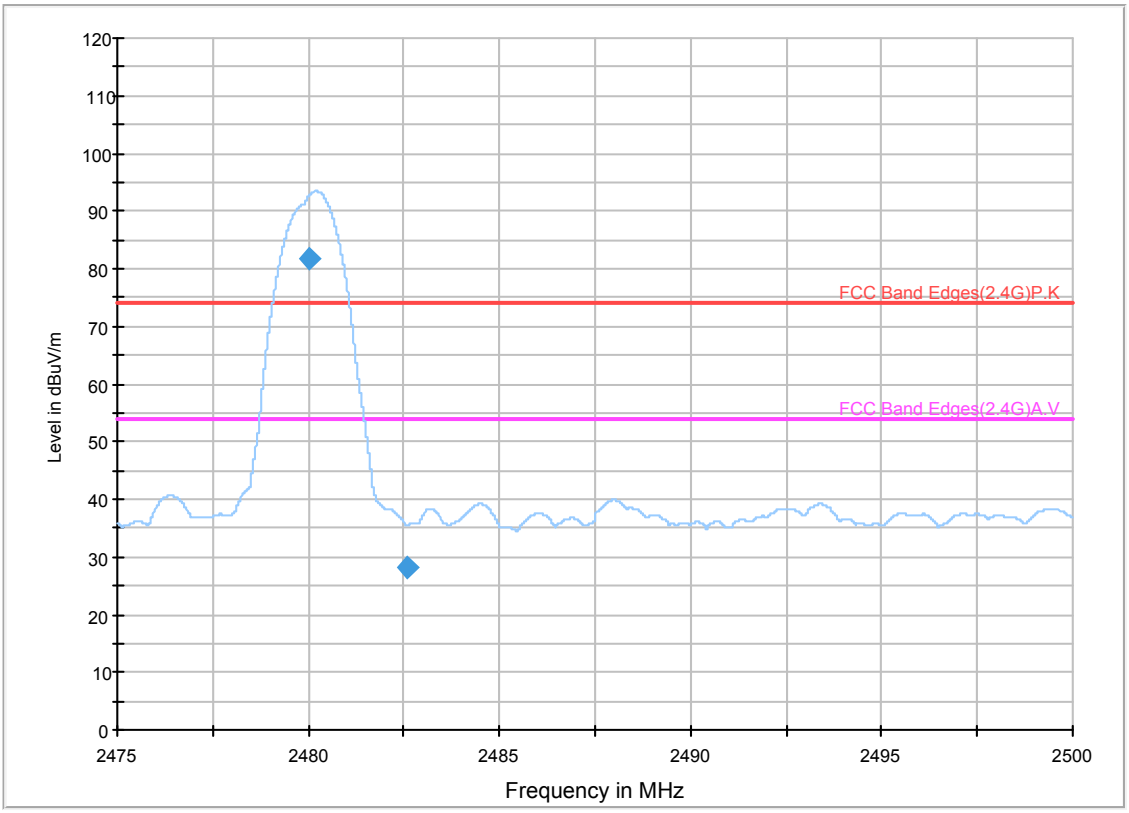


Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
2483.500	43.1	V	-6.7	36.4	74.0	37.6	Peak
2483.500	33.4	V	-6.7	26.7	54.0	27.3	AVG

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m]

Radiated Band Edges (2480 MHz)_Horizontal

EUT Name: Hybrid PIO
Manufacturer: CanTops
Model Name: CTS-HCOM
Test Mode: GFSK-2480(High)



Frequency [MHz]	Reading [dB μV]	Polari-zation [H/V]	Correction Factor [dB]	Result [dB μV/m]	Limit [dB μV/m]	Margin [dB]	Detector
2483.500	42.9	H	-6.7	36.2	74.0	37.8	Peak
2483.500	35.0	H	-6.7	28.3	54.0	25.7	AVG

Remark: Correction Factor[dB] = Antenna Factor[dB] + Cable Factor[dB] – Pre-amplifier Factor[dB],
Result [dB μV/m] = Reading [dB μV] + Correction Factor [dB],
Margin[dB] = Limit [dB μV/m] - Result [dB μV/m]

5.7 Power Conducted Emission

5.7.1 Test Equipment

EQUIPMENT	MODEL	MANUFACTURE	SERIAL NUMBER	Calibration Due date (year/month/date)
Test Receiver	ESPI	ROHDE & SCHWARZ	100063	2017/01/08
#2 Conducted Cable_2.7m	N/A	N/A	N/A	2017/01/08
LISN	NSLK 8127	SCHWARZBECK	8127-414	2017/01/07
Impuls-Begrenzer Pulse Limiter	ESH3-Z2	ROHDE & SCHWARZ	100092	2017/01/06
CE CHAMBER	N/A	SY Corp.	N/A	N/A
DC POWER SUPPLY	IPS-30B03DD	INTERACT	00420502	2016/09/10

5.7.2 Test Limit

For equipment that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz to 30 MHz shall not exceed the limits in the following table.

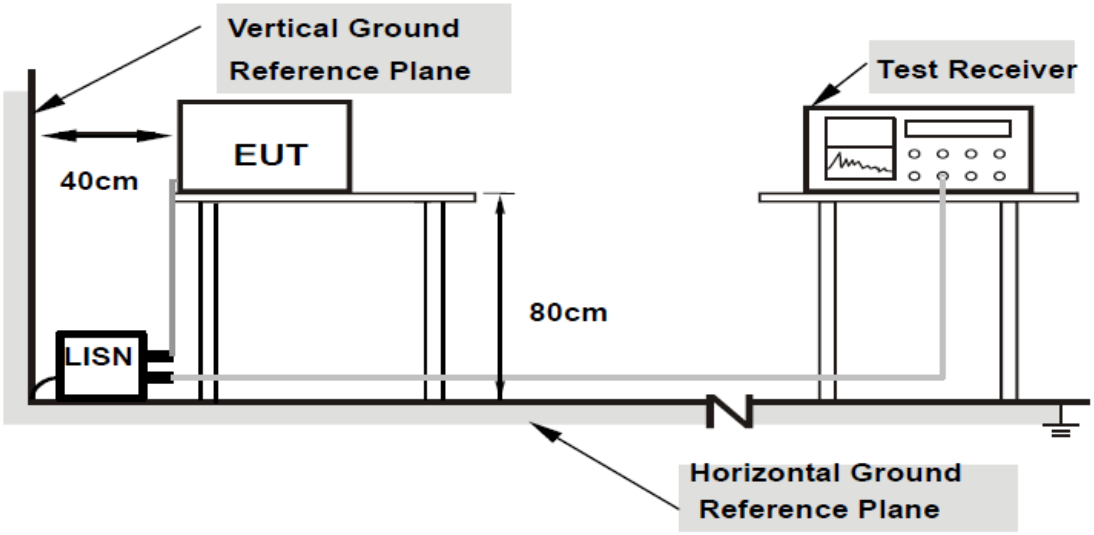
Frequency of emission(MHz)	Conducted limit(dBμV/m)	
	Quasi-peak	Average
0.15-0.5	66 to 56*	56 to 46*
0.5-5	56	46
5-30	60	50

*Decreases with the logarithm of the frequency.

5.7.3 Test Procedures

1. The EUT was placed 0.4 meter from the conducting wall of the shielding room and was kept at least 80 centimeters from any other grounded conducting surface.
2. Connect EUT to the power mains through a line impedance stabilization network(LISN).
3. All the support units are connecting to the other LISN.
4. The LISN provides 50 ohm coupling impedance for the measuring instrument.
5. The FCC states that a 50 ohm, 50 microhenry LISN should be used.
6. Both sides of AC line were checked for maximum conducted interference.
7. The frequency range from 150 kHz to 30 MHz was searched.
8. Set the test-receiver system to Peak Detect Function and specified bandwidth (IF Bandwidth = 9kHz) with Maximum Hold Mode. Then measurement is also conducted by Average Detector and Quasi-Peak Detector Function respectively.

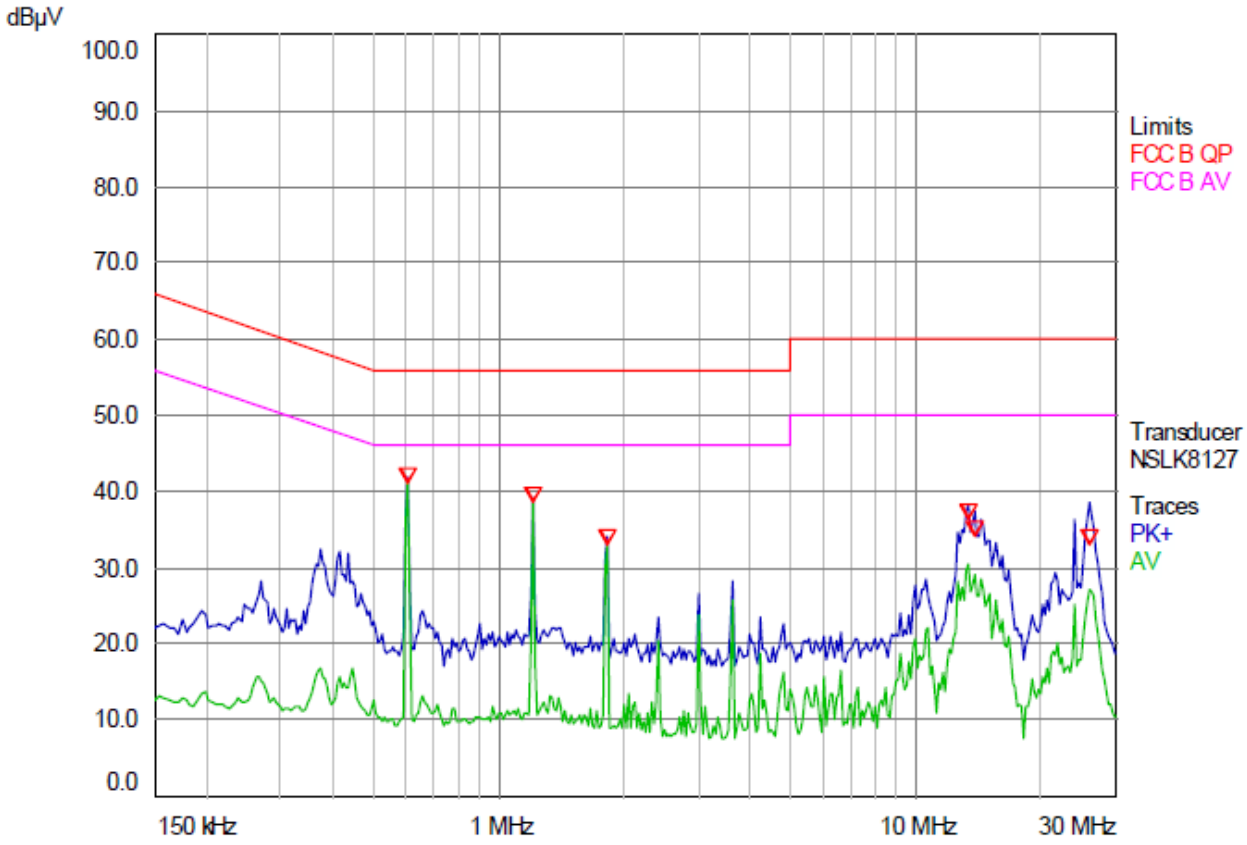
5.7.4 Block Diagram of Test Setup



5.7.5 Test Result

Direct Current +

Pre-measurement Graph



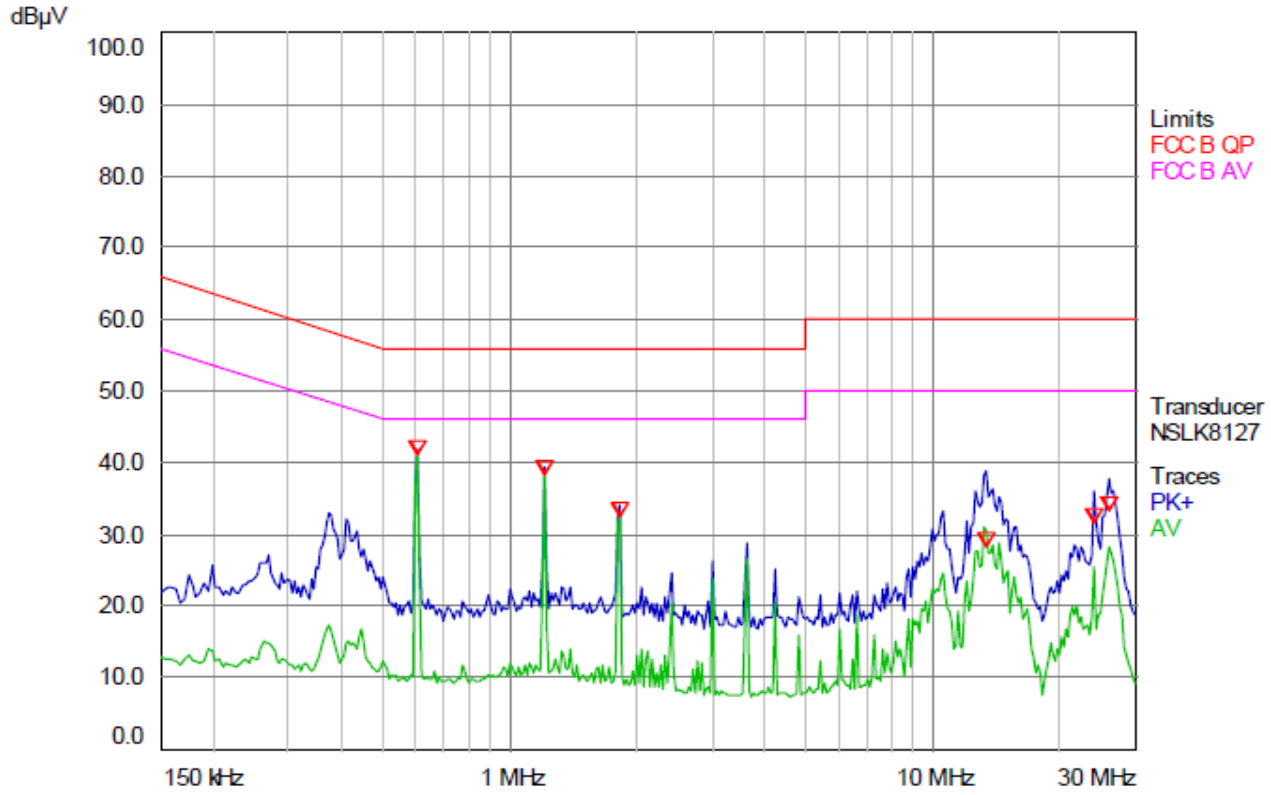
Final Measurement Results

Trace	Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Delta Limit (dB)	Delta Ref (dB)	Comment
1 QP	0.604	41.17	56.00	-14.83		
1 QP	1.208	38.46	56.00	-17.54		
1 QP	1.812	32.93	56.00	-23.07		
1 QP	13.328	36.22	60.00	-23.78		
1 QP	13.912	34.09	60.00	-25.91		
1 QP	26.196	32.85	60.00	-27.15		

* = limit exceeded

Direct Current -

Pre-measurement Graph



Final Measurement Results

Trace	Frequency (MHz)	Level (dBµV)	Limit (dBµV)	Delta Limit (dB)	Delta Ref (dB)	Comment
1 QP	0.604	41.06	56.00	-14.94		
1 QP	1.208	38.30	56.00	-17.70		
1 QP	1.812	32.37	56.00	-23.63		
1 QP	13.32	28.09	60.00	-31.91		
1 QP	24.0	31.64	60.00	-28.36		
1 QP	26.192	33.11	60.00	-26.89		

* = limit exceeded

5.8 Antenna Application

5.8.1 Antenna Requirement

Standard	Requirement
FCC CFR Part 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 use of a standard antenna jack or electrical connector is prohibited. This requirement does not apply to carrier current devices or to devices operated under the provisions of §15.211, §15.213, §15.217, §15.219, or §15.221. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded.

For intentional device, according to FCC 47 CFR Section 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. And according to FCC 47 CFR Section 15.247 (b), if 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 exceeds 6dBi.

Antenna Type	Frequency	Antenna Gain	Limit
Chip Antenna	2.4 GHz	2.1 dBi	≤6 dBi

5.8.2 Result

PASS