FCC Test Report

Report No.:	RFBCFP-WTW-P21050667A
FCC ID:	PPQ-MS4
Test Model:	MS4
Received Date:	2023/6/29
Test Date:	2023/7/21 ~ 2023/8/10
Issued Date:	2023/10/24
Applicant:	LITE-ON Technology Corp.
Address:	Bldg. C, 90, Chien 1 Rd., Chung-Ho,New Taipei City,23585,Taiwan
Issued By:	Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch Hsin Chu Laboratory
Lab Address:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan
Test Location:	E-2, No.1, Li Hsin 1st Road, Hsinchu Science Park, Hsinchu City 300, Taiwan
FCC Registration / Designation Number:	723255 / TW2022

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Release Control Record

Issue No.	Description	Date Issued
RFBCFP-WTW-P21050667A	Original release.	2023/10/24

1 Certificate of Conformity

Product:	MS4 Module
Test Model:	MS4
Sample Status:	Engineering sample
Applicant:	LITE-ON Technology Corp.
Test Date:	2023/7/21 ~ 2023/8/10
Standards:	47 CFR FCC Part 15, Subpart C (Section 15.249) ANSI C63.10: 2013

The above equipment has been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's EMC characteristics under the conditions specified in this report.

Prepared by : _____ , **Date:** 2023/10/24

Phoenix Huang / Specialist

Approved by : _____ , **Date:** 2023/10/24

May Chen / Manager

2 Summary of Test Results

47 CFR FCC Part 15, Subpart C (SECTION 15.249)			
FCC Clause	Test Item	Result	Remarks
15.207	AC Power Conducted Emission	Pass	Meet the requirement of limit. Minimum passing margin is -15.36 dB at 0.15000 MHz.
15.209 15.249 15.249 (d)	Radiated Emission Test Band Edge Measurement Limit: 50dB less than the peak value of fundamental frequency or meet radiated emission limit in section 15.209	Pass	Meet the requirement of limit. Minimum passing margin is -4.7 dB at 39.41 MHz
15.215 (c)	20dB Bandwidth	Pass	Meet the requirement of limit
15.203	Antenna Requirement	Pass	No antenna connector is used.

Note: Determining compliance based on the results of the compliance measurement, not taking into account measurement instrumentation uncertainty.

2.1 Measurement Uncertainty

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

Measurement	Frequency	Expanded Uncertainty (k=2) (±)
AC Power Conducted Emissions	150 kHz ~ 30 MHz	1.9 dB
Radiated Emissions up to 1 GHz	9 kHz ~ 30 MHz	3.1 dB
	30 MHz ~ 1 GHz	5.5 dB
Radiated Emissions above 1 GHz	1 GHz ~ 18 GHz	5.1 dB
	18 GHz ~ 40 GHz	5.3 dB

2.2 Modification Record

There were no modifications required for compliance.

3 General Information

3.1 General Description of EUT

Product	MS4 Module
Test Model	MS4
Status of EUT	Engineering sample
Power Supply Rating	5 Vdc from host equipment or 3.7 Vdc from rechargeable lithium ion battery
Modulation Technology	GFSK
Transfer Rate	1 Mbps
Operating Frequency	2.415 GHz ~ 2.459 GHz
Number of Channel	3
Output Power (Field Strength)	93.2 dBuV/m (Peak) at 3m
Antenna Type	Refer to Note
Antenna Connector	Refer to Note
Accessory Device	NA
Data Cable Supplied	NA

Note:

1. This is a supplementary report of Report No.: RF180718D12. The differences between them are as below information:
   - ◆ Add PCB 2nd source (same layout)
   - ◆ Add antenna 2nd source (same type)
   - ◆ Add 2nd source Change supplier (same specifications)
   - ◆ Add crystal 2nd source (same oscillating frequency)
2. The mentioned above has been approved and is electronically and mechanically identical to the original instructions and requirements. Except for the changes mentioned above, no other modification is performed.
3. The antenna information is listed as below.

Original					
Brand	Model	Antenna Gain (dBi)	Frequency Range (GHz)	Antenna Type	Connecter Type
Unictron	AA055A	2.5	2.4-2.4835	Chip	None
Newly					
Brand	Model	Antenna Gain (dBi)	Frequency Range (GHz)	Antenna Type	Connecter Type
Unictron	AA055U	3.1	2.4-2.4835	Chip	None

4. Due to radiated measurements are made and the antenna gain is already accounted for this device, so provide an antenna datasheet and/or antenna measurement report is not required. The antenna dimensions and pictures (include antenna wire length if have) are stated in EUT photo exhibit.

5. Component information is as following:

Item	1st Model	2nd Brand	2nd Model
PCB	-	KINWONG	PCB,Motor Board,4,101*28*1.2,FR4
	-	KINWONG	PCB,KEY,2,32*18*1,FR4
	-	KINWONG	PCB,Encoder Board,2,15.5*30.5*1,FR4
	-	KINWONG	PCB,Arm,2,11*22*1.0,FR4
Bead / Inductor	QT1005RL120HC060-LF	MURATA	BLM15AX121SN1D
		SPORTON	GCB1005K-121T08
	QT1608RL600HC1AFL	MURATA	BLM18KG601SN1D
		SPORTON	LCB1608K-601T10
	QT2012RL600HC2ALF	MURATA	BLM21SP601SN1D
		SPORTON	LCB2012K-601T20
	QT2012RL300HC3A-LF	SPORTON	LCB2012K-301T30
	QTLC1608-100K-LF	SPORTON	MCH1608TF-100K-T-I0.12
	QHL100505CS-15NJ-LF	MURATA	LQG15HS15NJ02D
		SPORTON	HCI1005Q-15NJ-T
	WSRPG0503-R68M-AG	SPORTON	TMPD0503HG-R68M-G4
	-	MURATA	DFE252012P-2R2M=P2
		SPORTON	LQH252012DF-2R2M-T
TVS / Diode	TPD1E10B09DPYR	Nichtek	D2315-7R0
	DFLT8V0A-7	Nichtek	D6314-8R0UA
	SBR3U30P1-7	Nichtek	S6314-400CB
	BZT52HC6V8WF-7	Nichtek	Z6114-6R8B
	PMEG4030ER	Nichtek	S6314-400C
	1N4148WT-7	Nichtek	Y4114-750
Chip Antenna	H2U34W1H1Z0400/AA055A	UNICTRON	H2U34W1H1Z0700/AA055U
Fuse	0805L260SLTHYR	PTTC	SMD0805P260SLRT
Xtal	X2C032000BC1H-HS	Hosonic	E1SB32E00000PE
	RT2012-32.768-12.5-20-EXT-TR	SIWARD	XTL741-S999-377
NTC	MTR06GTH440B104	MURATA	NCP18WF104F12RB
Photo Interrupt	RPI-0352E	LITEON	LTH-339-02
MOS	AO3401L	Nichtek	MSL3401PT2G-P
		AOS	AOSS21311C
	AO3400A	Sinpower	SM2316NSA
	MMBT3904-7-F	Nichtek	GT9921-600N
	DMN1019USN-7	Sinpower	SM2320NSA
	DMN2022UNS-7	Sinpower	SM9989DSQA
	DMG4413LSS-13	Sinpower	SM4501PSKCTRG
Connector	A1501WV-S-04PNLNT1N00L	JCTC	11502W00-04-S-HF
	USB-CON-USB00211LG	SHENG DA	122-0525NA0244
	B2B-PH-SM4-TBT(LF)(SN)	JST	B2B-PH-SM4-TB1(LF)(SN)
MOSFET	DMN1019USN-7	Sinopower	SM2320NSAC-TRG
Conn,Header	11002W00-8P-S-HF	JOINT TECH	A1001WV-S-08PN6BT1T00L

6. For Radiated Emission test, the EUT was pre-tested under following test modes:

Pre-test Mode	Power
Mode A	**5Vdc from host equipment (USB Adapter)**
Mode B	3.7 Vdc from rechargeable lithium ion battery
Note: In original report, from the above modes, the worse case was found in **Mode A**. Therefore only the test data of the mode was recorded in this report.	

7. The above EUT information is declared by manufacturer and for more detailed features description, please refer to the manufacturer's specifications or user's manual.

3.2 Description of Test Modes

3 channels are provided to this EUT:

Channel	Frequency	Channel	Frequency
15	2415	39	2439
59	2459		

3.2.1 Test Mode Applicability and Tested Channel Detail

EUT CONFIGURE MODE	APPLICABLE TO				DESCRIPTION
	RE≥1G	RE<1G	PLC	APCM	
1	√	√	√	√	Power from USB Adapter
2	-	-	√	-	Power from Laptop

Where **RE≥1G:** Radiated Emission above 1GHz & Bandedge Measurement **RE<1G:** Radiated Emission below 1GHz
PLC: Power Line Conducted Emission **APCM:** Antenna Port Conducted Measurement

Note: The EUT had been pre-tested on the positioned of each 3 axis. The worst case was found when positioned on **X-plane**.

Radiated Emission Test (Above 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

Available Channel	Tested Channel	Modulation Type
15 to 59	15, 39, 59	GFSK

Radiated Emission Test (Below 1GHz):

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

Available Channel	Tested Channel	Modulation Type
15 to 59	15	GFSK

Power Line Conducted Emission Test:

☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

Available Channel	Tested Channel	Modulation Type
15 to 59	15	GFSK

Antenna Port Conducted Measurement:

☒ This item includes all test value of each mode, but only includes spectrum plot of worst value of each mode.
☒ Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates and antenna ports (if EUT with antenna diversity architecture).
☒ Following channel(s) was (were) selected for the final test as listed below.

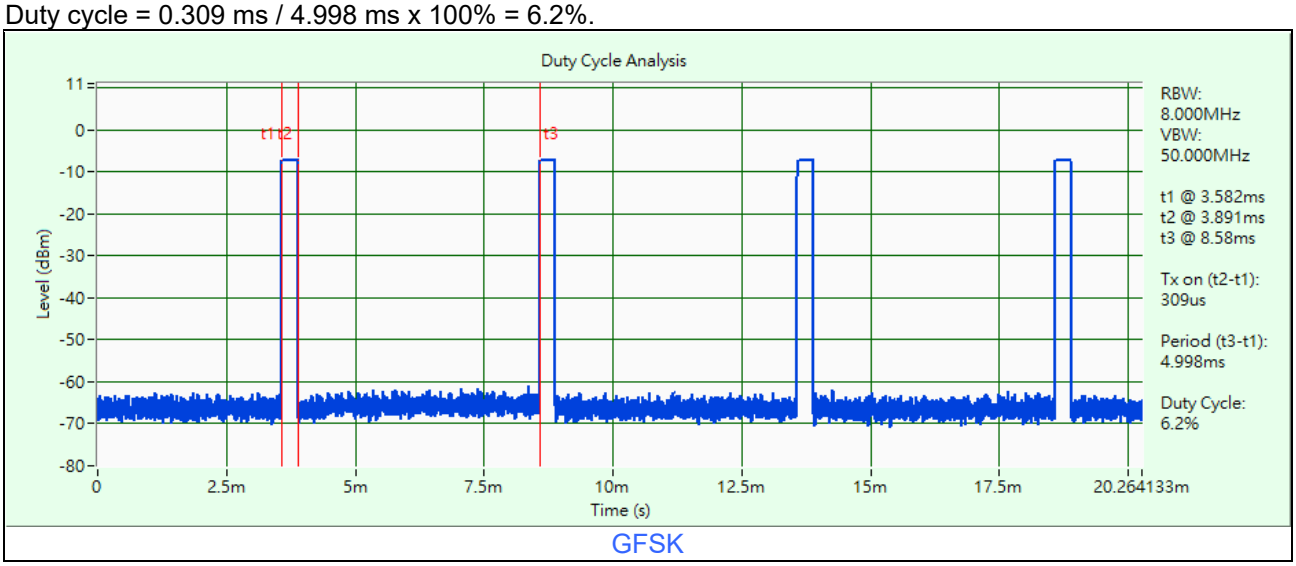
Available Channel	Tested Channel	Modulation Type
15 to 59	15, 39, 59	GFSK

Test Condition:

Applicable to	Environmental Conditions	Input Power	Tested By
RE≥1G	22deg. C, 67%RH	120Vac, 60Hz (System)	Sampson Chen
RE<1G	25deg. C, 76%RH	120Vac, 60Hz (System)	William Su
PLC	24deg. C, 73%RH	120Vac, 60Hz (System)	Andy Ho
APCM	25deg. C, 76%RH	5 Vdc	Waydi Tuan

3.3 Duty Cycle of Test Signal

Duty cycle = 0.309 ms / 4.998 ms x 100% = 6.2%.



GFSK

3.4 Description of Support Units

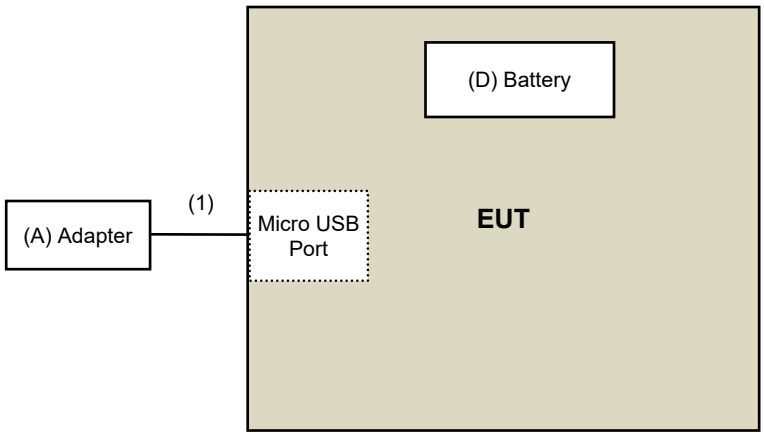
The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

ID	Product	Brand	Model No.	Serial No.	FCC ID	Remarks
A.	Adapter	Shenzhen Keyu	KA0601A-0501000USU	NA	NA	Supplied by applicant
B.	Laptop	DELL	E6420	B92T3R1	FCC Doc	Provided by Lab
C.	Adapter	DELL	LLA65NS2-01	NA	NA	Provided by Lab
D.	Battery x2	Panasonic	NCR18650BF	N/A	N/A	Supplied by applicant

ID	Cable Descriptions	Qty.	Length (m)	Shielding (Yes/No)	Cores (Qty.)	Remarks
1	USB Cable	1	1	Yes	0	Supplied by applicant
2	DC Cable	1	1.5	No	0	Provided by Lab
3	AC Cable	1	1	No	0	Provided by Lab

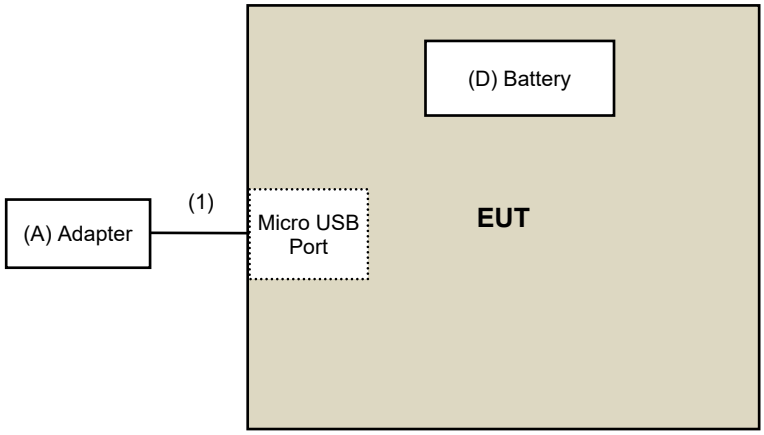
3.4.1 Configuration of System under Test

For Rsdiated Emission test

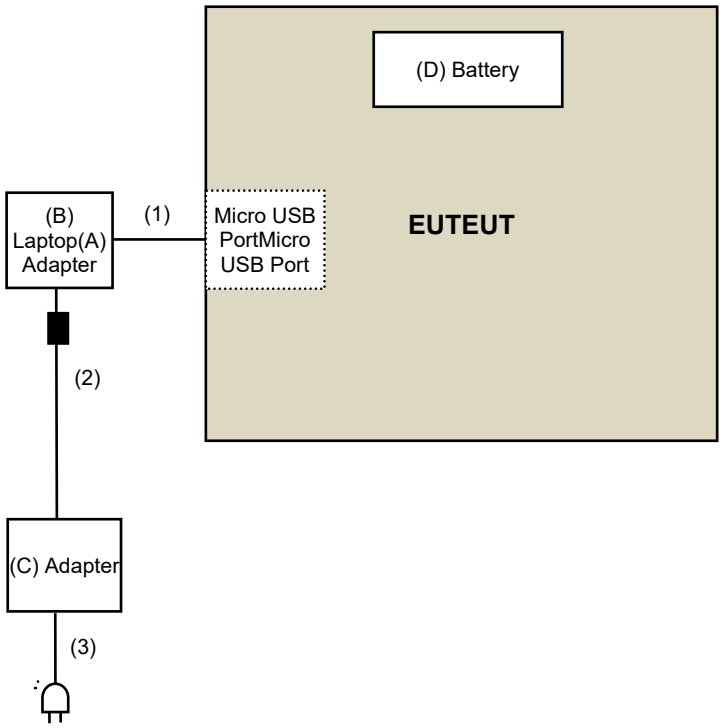


For AC Power Conducted Emission test

Adapter mode



Laptop mode



3.5 General Description of Applied Standards

The EUT is a RF Product. According to the specifications of the manufacturer, it must comply with the requirements of the following standards:

FCC Part 15, Subpart C (15.249)

ANSI C63.10-2013

All test items have been performed and recorded as per the above standards.

4 Test Types and Results

4.1 Radiated Emission and Bandedge Measurement

4.1.1 Limits of Radiated Emission and Bandedge Measurement

The field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following

Fundamental Frequency	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 ~ 24.25 GHz	250	2500

Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits as below table, whichever is the lesser attenuation

Frequencies (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

Note:

1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 log Emission level (uV/m).
3. For frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits, specified above by more than 20dB under any condition of modulation.

4.1.2 Test Instruments

For Radiated Emission test:

Description & Manufacturer	Model No.	Serial No.	Calibrated Date	Calibrated Until
MXA Signal Analyzer Keysight	N9020B	MY60112408	2023/3/6	2024/3/5
MXE EMI Receiver Keysight	N9038A	MY59050100	2023/6/13	2024/6/12
Software	ADT_Radiated_V8.7.08	NA	NA	NA
Boresight Antenna Tower & Turn Table Max-Full	MF-7802BS	MF780208530	NA	NA
Preamplifier Agilent	8447D	2944A10636	2023/3/12	2024/3/11
Loop Antenna Electro-Metrics	EM-6879	264	2023/2/21	2024/2/20
RF Coaxial Cable JYEBAO	5D-FB	LOOPCAB-001	2022/12/19	2023/12/18
RF Coaxial Cable JYEBAO	5D-FB	LOOPCAB-002	2022/12/19	2023/12/18
Preamplifier EMCI	EMC330N	980701	2023/2/18	2024/2/17
Bi_Log Antenna Schwarzbeck	VULB 9168	9168-406	2022/10/21	2023/10/20
RF Coaxial Cable PEWC	8D	966-4-1	2023/2/18	2024/2/17
RF Coaxial Cable PEWC	8D	966-4-2	2023/2/18	2024/2/17
RF Coaxial Cable PEWC	8D	966-4-3	2023/2/18	2024/2/17
Fixed Attenuator Mini-Circuits	UNAT-5+	PAD-ATT5-03	2022/12/28	2023/12/27
Horn Antenna Schwarzbeck	BBHA 9120D	9120D-783	2022/11/13	2023/11/12
Preamplifier EMCI	EMC12630SE	980688	2022/10/4	2023/10/3
RF Coaxial Cable EMCI	EMC104-SM-SM-1200	160922	2022/12/15	2023/12/14
RF Coaxial Cable EMCI	EMC104-SM-SM-2000	180502	2023/3/27	2024/3/26
RF Coaxial Cable EMCI	EMC104-SM-SM-6000	210704	2022/11/4	2023/11/3
Preamplifier EMCI	EMC184045SE	980387	2022/12/28	2023/12/27
Horn Antenna Schwarzbeck	BBHA 9170	9170-739	2022/11/13	2023/11/12
RF Coaxial Cable EMCI	EMC102-KM-KM-1200	160924	2022/12/28	2023/12/27
RF Coaxial Cable EMCI	EMC-KM-KM-4000	200214	2023/2/20	2024/2/19

Notes:

1. The test was performed in 966 Chamber No. 4.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. Tested Date: 2023/7/21 ~ 2023/8/10

For other test items:

Description & Manufacturer	Model No.	Serial No.	Calibrated Date	Calibrated Until
MXA Signal Analyzer Keysight	N9020B	MY60112409	2023/2/18	2024/2/17
Fixed Attenuator Woken	MDCS18N-10	MDCS18N-10-01	2023/3/27	2024/3/26
Software	ADT_RF Test Software V6.6.5.4	NA	NA	NA

Notes:

1. The test was performed in Oven room 2.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. Tested Date: 2023/7/21

4.1.3 Test Procedures

For Radiated emission below 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. Parallel, perpendicular, and ground-parallel orientations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to Quasi-Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.

Note:

1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 9kHz at frequency below 30MHz.

For Radiated emission above 30MHz

a. The EUT was placed on the top of a rotating table 0.8 meters (for 30MHz ~ 1GHz) / 1.5 meters (for above 1GHz) above the ground at 3 meter chamber room for test. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

f. The test-receiver system was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz. If the peak reading value also meets average limit, measurement with the average detector is unnecessary.

Note:

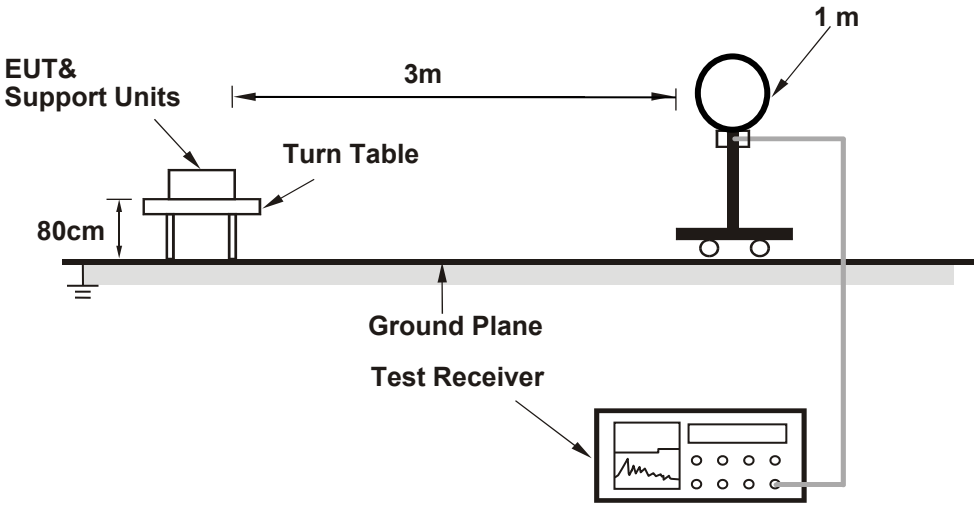
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for Peak detection (PK) at frequency above 1GHz.
3. According to ANSI C63.10 section 7.5. For fundamental and harmonic signal measurement, the average value = peak value + duty cycle correction factor. The duty cycle measurement refer to FCC 47 CFR Part 15C section 15.35 (c). For duty cycle correction factor values, see the Test Signal Duty Cycle section in this report.
4. All modes of operation were investigated and the worst-case emissions are reported.

4.1.4 Deviation from Test Standard

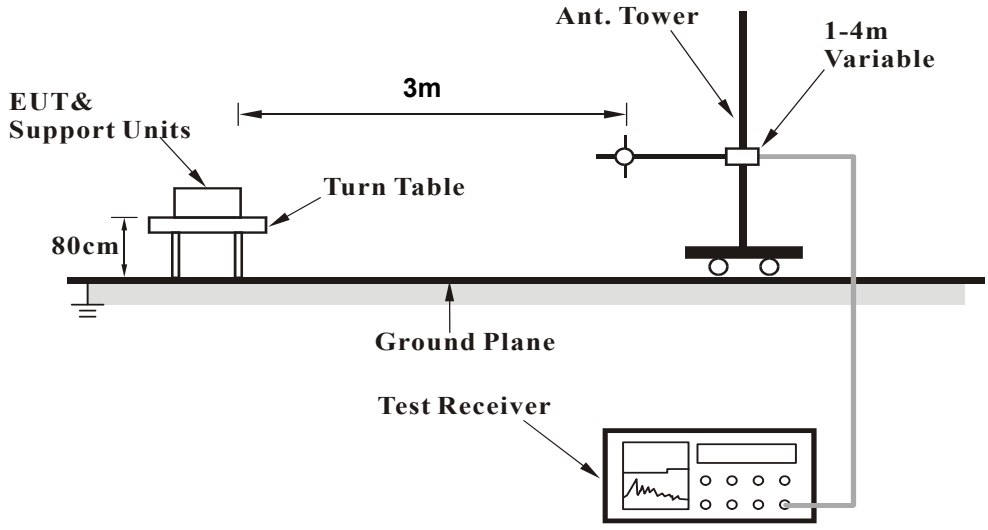
No deviation.

4.1.5 Test Setup

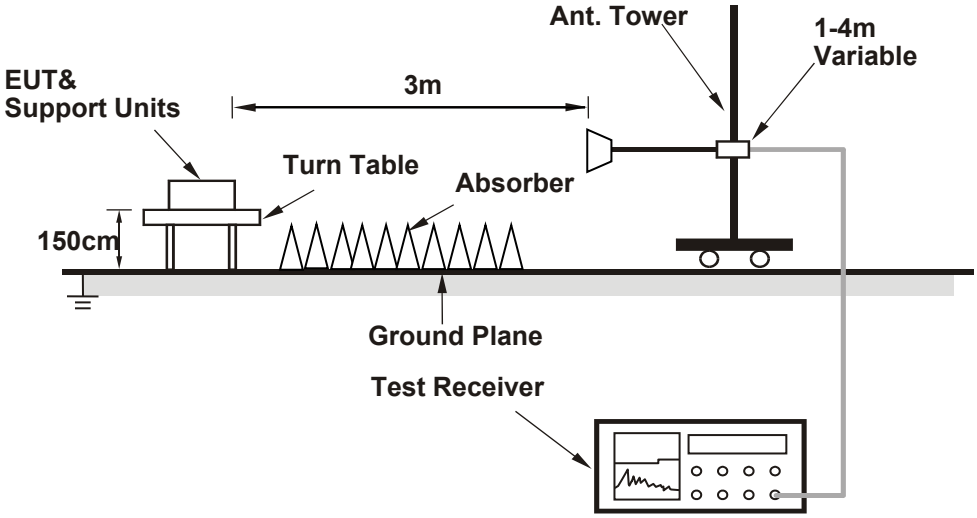
For Radiated emission below 30MHz



For Radiated emission 30MHz to 1GHz



For Radiated emission above 1GHz



For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.1.6 EUT Operating Conditions

a. Placed the EUT on the testing table.
b. Controlling software (RF Sample push the button) has been activated to set the EUT under transmission condition continuously at specific channel frequency.

4.1.7 Test Results

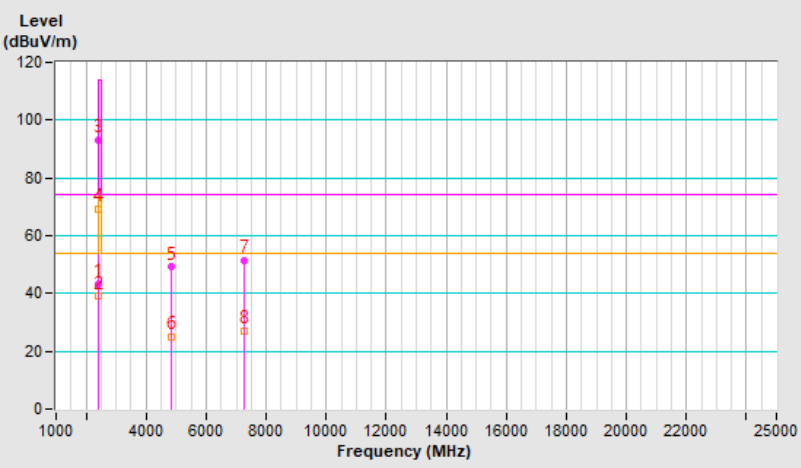
Above 1GHz Data:

RF Mode	GFSK	Channel	CH 15：2415 MHz
Frequency Range	1 GHz ~ 25 GHz	Detector Function & Bandwidth	PK: RB=1 MHz, VB=3 MHz, DET=Peak AV: RB=1 MHz, VB=3 MHz, DET=RMS

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2400.00	43.1 PK	74.0	-30.9	1.66 H	118	43.2	-0.1
2	2400.00	38.9 AV	54.0	-15.1	1.66 H	118	39.0	-0.1
3	*2415.00	93.2 PK	114.0	-20.8	1.66 H	118	93.3	-0.1
4	*2415.00	69.0 AV	94.0	-25.0	1.66 H	118	69.1	-0.1
5	4830.00	49.1 PK	74.0	-24.9	1.63 H	248	44.6	4.5
6	4830.00	24.9 AV	54.0	-29.1	1.63 H	248	20.4	4.5
7	7245.00	51.4 PK	74.0	-22.6	2.08 H	326	40.2	11.2
8	7245.00	27.2 AV	54.0	-26.8	2.08 H	326	16.0	11.2

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:
   20 log(Duty cycle) = 20 log(0.309 ms / 4.998 ms) = -24.2 dB

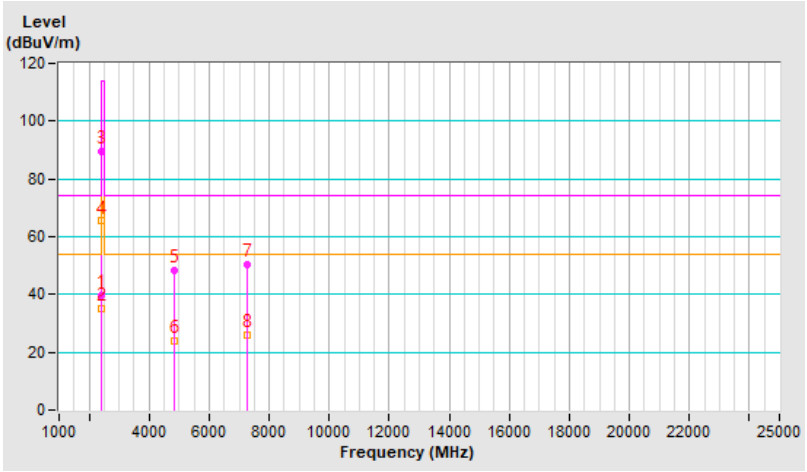


RF Mode	GFSK	Channel	CH 15：2415 MHz
Frequency Range	1 GHz ~ 25 GHz	Detector Function & Bandwidth	PK: RB=1 MHz, VB=3 MHz, DET=Peak AV: RB=1 MHz, VB=3 MHz, DET=RMS

Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	2400.00	39.5 PK	74.0	-34.5	2.61 V	271	39.6	-0.1
2	2400.00	35.3 AV	54.0	-18.7	2.61 V	271	35.4	-0.1
3	*2415.00	89.6 PK	114.0	-24.4	2.61 V	271	89.7	-0.1
4	*2415.00	65.4 AV	94.0	-28.6	2.61 V	271	65.5	-0.1
5	4830.00	48.3 PK	74.0	-25.7	1.30 V	232	43.8	4.5
6	4830.00	24.1 AV	54.0	-29.9	1.30 V	232	19.6	4.5
7	7245.00	50.2 PK	74.0	-23.8	1.53 V	88	39.0	11.2
8	7245.00	26.0 AV	54.0	-28.0	1.53 V	88	14.8	11.2

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:
   20 log(Duty cycle) = 20 log(0.309 ms / 4.998 ms) = -24.2 dB

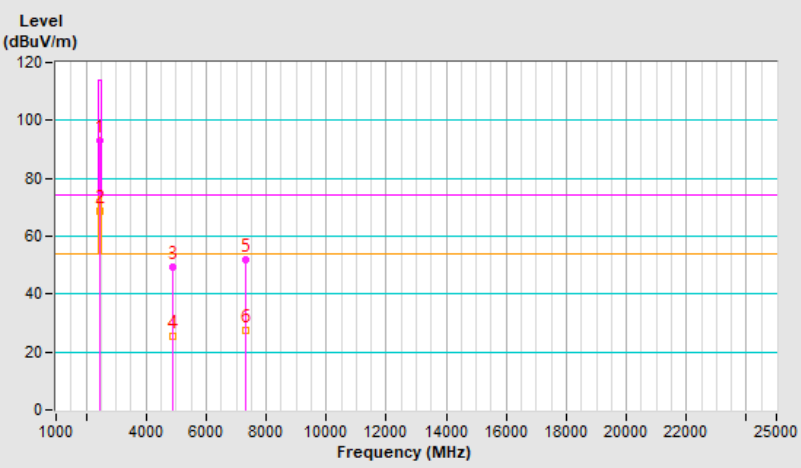


RF Mode	GFSK	Channel	CH 39：2439 MHz
Frequency Range	1 GHz ~ 25 GHz	Detector Function & Bandwidth	PK: RB=1 MHz, VB=3 MHz, DET=Peak AV: RB=1 MHz, VB=3 MHz, DET=RMS

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2439.00	92.9 PK	114.0	-21.1	1.48 H	113	93.0	-0.1
2	*2439.00	68.7 AV	94.0	-25.3	1.48 H	113	68.8	-0.1
3	4878.00	49.5 PK	74.0	-24.5	1.62 H	273	44.9	4.6
4	4878.00	25.3 AV	54.0	-28.7	1.62 H	273	20.7	4.6
5	7317.00	51.7 PK	74.0	-22.3	2.11 H	329	40.0	11.7
6	7317.00	27.5 AV	54.0	-26.5	2.11 H	329	15.8	11.7

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:
   20 log(Duty cycle) = 20 log(0.309 ms / 4.998 ms) = -24.2 dB

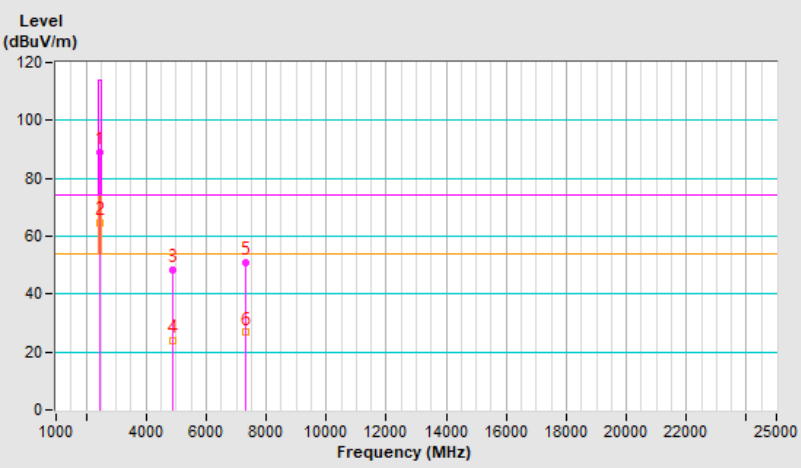


RF Mode	GFSK	Channel	CH 39：2439 MHz
Frequency Range	1 GHz ~ 25 GHz	Detector Function & Bandwidth	PK: RB=1 MHz, VB=3 MHz, DET=Peak AV: RB=1 MHz, VB=3 MHz, DET=RMS

Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2439.00	89.0 PK	114.0	-25.0	2.83 V	265	89.1	-0.1
2	*2439.00	64.8 AV	94.0	-29.2	2.83 V	265	64.9	-0.1
3	4878.00	48.3 PK	74.0	-25.7	1.68 V	255	43.7	4.6
4	4878.00	24.1 AV	54.0	-29.9	1.68 V	255	19.5	4.6
5	7317.00	50.9 PK	74.0	-23.1	1.41 V	75	39.2	11.7
6	7317.00	26.7 AV	54.0	-27.3	1.41 V	75	15.0	11.7

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:
   20 log(Duty cycle) = 20 log(0.309 ms / 4.998 ms) = -24.2 dB

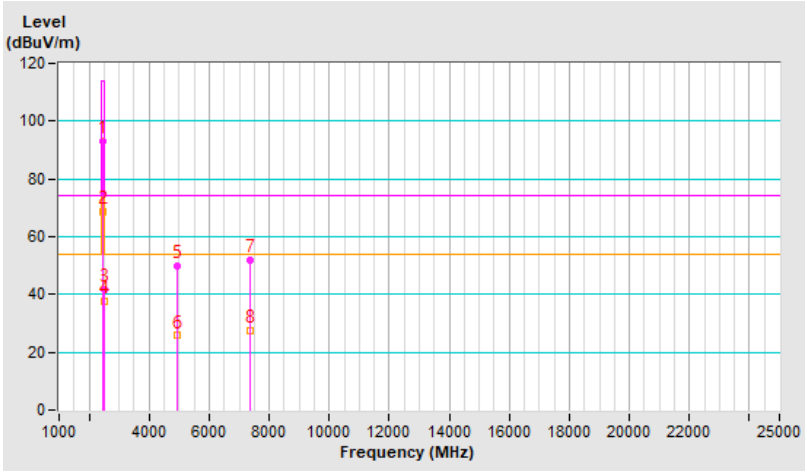


RF Mode	GFSK	Channel	CH 59：2459 MHz
Frequency Range	1 GHz ~ 25 GHz	Detector Function & Bandwidth	PK: RB=1 MHz, VB=3 MHz, DET=Peak AV: RB=1 MHz, VB=3 MHz, DET=RMS

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2459.00	93.0 PK	114.0	-21.0	1.15 H	127	93.0	0.0
2	*2459.00	68.8 AV	94.0	-25.2	1.15 H	127	68.8	0.0
3	2483.50	41.8 PK	74.0	-32.2	1.15 H	127	42.0	-0.2
4	2483.50	37.6 AV	54.0	-16.4	1.15 H	127	37.8	-0.2
5	4918.00	49.9 PK	74.0	-24.1	1.59 H	142	45.2	4.7
6	4918.00	25.7 AV	54.0	-28.3	1.59 H	142	21.0	4.7
7	7377.00	51.7 PK	74.0	-22.3	2.10 H	329	40.1	11.6
8	7377.00	27.5 AV	54.0	-26.5	2.10 H	329	15.9	11.6

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:
   20 log(Duty cycle) = 20 log(0.309 ms / 4.998 ms) = -24.2 dB

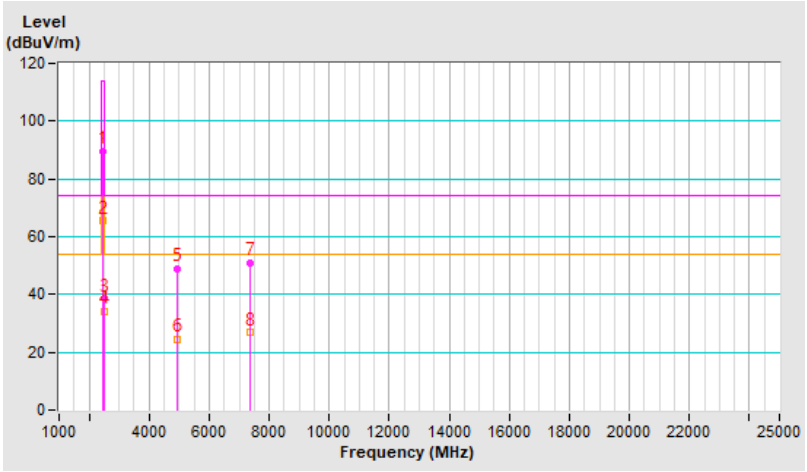


RF Mode	GFSK	Channel	CH 59：2459 MHz
Frequency Range	1 GHz ~ 25 GHz	Detector Function & Bandwidth	PK: RB=1 MHz, VB=3 MHz, DET=Peak AV: RB=1 MHz, VB=3 MHz, DET=RMS

Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	*2459.00	89.6 PK	114.0	-24.4	3.06 V	266	89.6	0.0
2	*2459.00	65.4 AV	94.0	-28.6	3.06 V	266	65.4	0.0
3	2483.50	38.4 PK	74.0	-35.6	3.06 V	266	38.6	-0.2
4	2483.50	34.2 AV	54.0	-19.8	3.06 V	266	34.4	-0.2
5	4918.00	48.7 PK	74.0	-25.3	1.16 V	212	44.0	4.7
6	4918.00	24.5 AV	54.0	-29.5	1.16 V	212	19.8	4.7
7	7377.00	50.9 PK	74.0	-23.1	1.45 V	66	39.3	11.6
8	7377.00	26.7 AV	54.0	-27.3	1.45 V	66	15.1	11.6

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit.
5. " * ": Fundamental frequency.
6. The average value of fundamental and harmonic frequency is: Average = Peak value + 20 log(Duty cycle) Where the duty cycle correction factor is calculated from following formula:
   20 log(Duty cycle) = 20 log(0.309 ms / 4.998 ms) = -24.2 dB



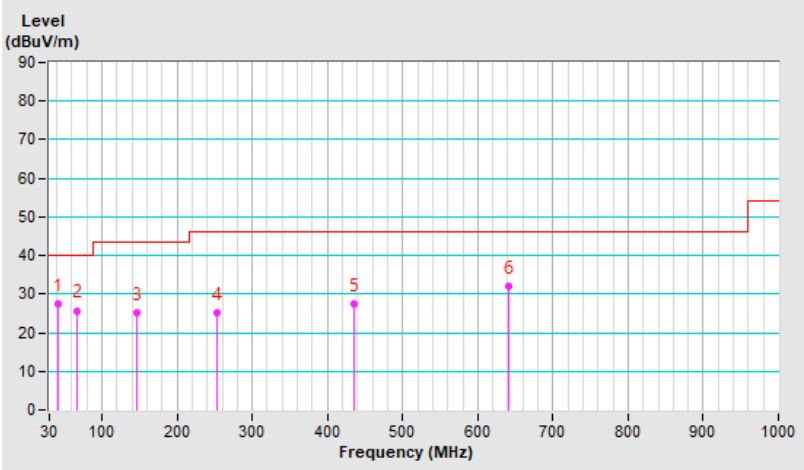
Below 1GHz Data:

RF Mode	GFSK	Channel	CH 15：2415 MHz
Frequency Range	30 MHz ~ 1 GHz	Detector Function & Bandwidth	QP: RB=120kHz, DET=Quasi-Peak

Antenna Polarity & Test Distance : Horizontal at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	40.77	27.4 QP	40.0	-12.6	1.23 H	133	40.9	-13.5
2	66.62	25.7 QP	40.0	-14.3	1.14 H	359	40.3	-14.6
3	146.21	25.1 QP	43.5	-18.4	1.05 H	186	38.2	-13.1
4	252.52	25.1 QP	46.0	-20.9	1.11 H	162	39.2	-14.1
5	434.49	27.3 QP	46.0	-18.7	1.08 H	339	36.0	-8.7
6	641.78	31.9 QP	46.0	-14.1	1.24 H	196	36.0	-4.1

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30 MHz ~ 1 GHz.
5. The frequency range 9 kHz ~ 30 MHz: all emissions are more than 20 dB below the limit, therefore do not be recorded in this report.

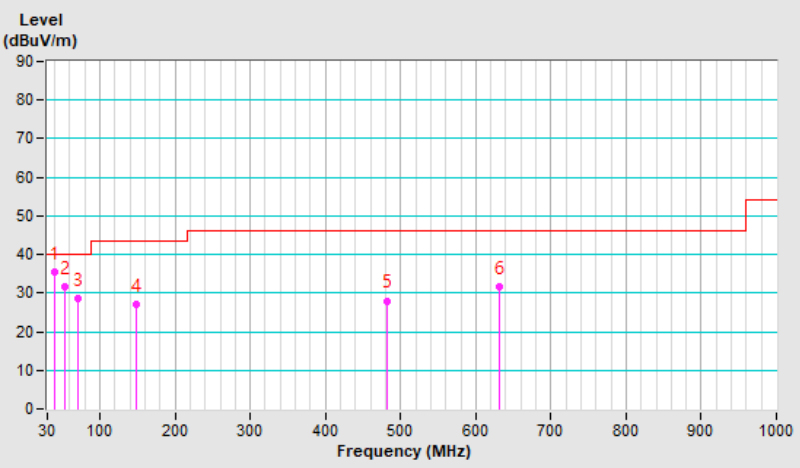


RF Mode	GFSK	Channel	CH 15：2415 MHz
Frequency Range	30 MHz ~ 1 GHz	Detector Function & Bandwidth	QP: RB=120kHz, DET=Quasi-Peak

Antenna Polarity & Test Distance : Vertical at 3 m								
No	Frequency (MHz)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (m)	Table Angle (Degree)	Raw Value (dBuV)	Correction Factor (dB/m)
1	**39.41**	**35.3 QP**	**40.0**	**-4.7**	**1.33 V**	**150**	**48.8**	**-13.5**
2	52.60	31.7 QP	40.0	-8.3	1.15 V	23	44.7	-13.0
3	71.08	28.6 QP	40.0	-11.4	1.06 V	313	44.3	-15.7
4	148.39	27.1 QP	43.5	-16.4	1.10 V	212	40.2	-13.1
5	482.36	28.0 QP	46.0	-18.0	1.04 V	5	36.1	-8.1
6	631.50	31.7 QP	46.0	-14.3	1.00 V	97	36.1	-4.4

Remarks:

1. Emission Level(dBuV/m) = Raw Value(dBuV) + Correction Factor(dB/m)
2. Correction Factor(dB/m) = Antenna Factor(dB/m) + Cable Factor(dB) – Pre-Amplifier Factor(dB)
3. Margin value = Emission Level – Limit value
4. The other emission levels were very low against the limit of frequency range 30 MHz ~ 1 GHz.
5. The frequency range 9 kHz ~ 30 MHz: all emissions are more than 20 dB below the limit, therefore do not be recorded in this report.



4.2 Conducted Emission Measurement

4.2.1 Limits of Conducted Emission Measurement

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average
0.15 - 0.5	66 - 56	56 - 46
0.50 - 5.0	56	46
5.0 - 30.0	60	50

Note: 1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50MHz.

4.2.2 Test Instruments

Description & Manufacturer	Model No.	Serial No.	Calibrated Date	Calibrated Until
EMI Test Receiver R&S	ESCS 30	847124/029	2022/10/14	2023/10/13
LISN R&S	ESH3-Z5	848773/004	2022/10/18	2023/10/17
50 ohm terminal resistance NA	NA	EMC-01	2022/9/27	2023/9/26
RF Coaxial Cable JYEBAO	5D-FB	COCCAB-001	2022/8/24	2023/8/23
Fixed Attenuator STI	STI02-2200-10	005	2022/8/24	2023/8/23
Software BVADT	BVADT_Cond_V7.3.7.4	NA	NA	NA

Notes:
1. The test was performed in Conduction 1.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to NML/ROC and NIST/USA.
3. Tested Date: 2023/8/10

4.2.3 Test Procedures

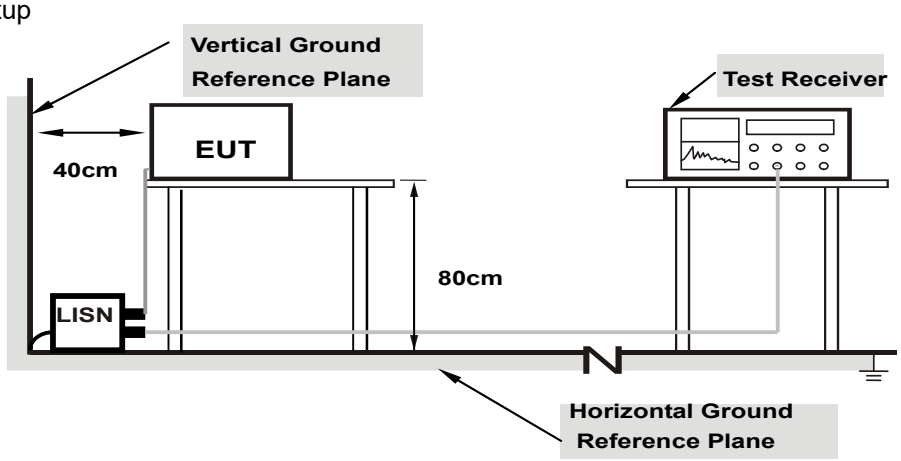
a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.
c. The frequency range from 150kHz to 30MHz was searched. Emission levels under (Limit - 20dB) was not recorded.

Note: The resolution bandwidth and video bandwidth of test receiver is 9kHz for quasi-peak detection (QP) and average detection (AV) at frequency 0.15MHz-30MHz.

4.2.4 Deviation from Test Standard

No deviation.

4.2.5 Test Setup



Note: 1.Support units were connected to second LISN.

For the actual test configuration, please refer to the attached file (Test Setup Photo).

4.2.6 EUT Operating Conditions

Same as 4.1.6.

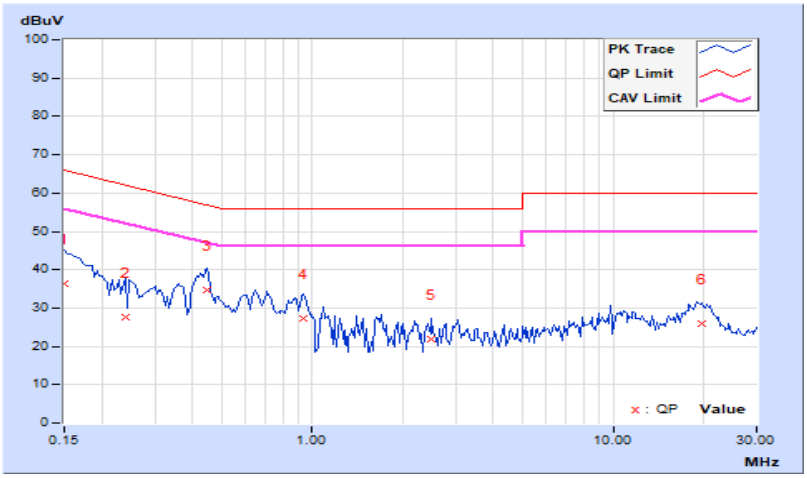
4.2.7 Test Results (Mode 1)

RF Mode	GFSK	Channel	CH 15 : 2415 MHz
Frequency Range	150 kHz ~ 30 MHz	Detector Function & Resolution Bandwidth	Quasi-Peak (QP) / Average (AV), 9 kHz

Phase Of Power : Line (L)										
No	Frequency (MHz)	Correction Factor (dB)	Reading Value (dBuV)		Emission Level (dBuV)		Limit (dBuV)		Margin (dB)	
			Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15000	9.95	26.56	1.05	36.51	11.00	66.00	56.00	-29.49	-45.00
2	0.23984	9.94	17.56	-5.09	27.50	4.85	62.10	52.10	-34.60	-47.25
3	0.44688	9.95	24.68	4.11	34.63	14.06	56.93	46.93	-22.30	-32.87
4	0.93516	9.98	17.13	-2.49	27.11	7.49	56.00	46.00	-28.89	-38.51
5	2.49219	10.04	11.76	-6.54	21.80	3.50	56.00	46.00	-34.20	-42.50
6	19.71484	10.97	14.91	-4.36	25.88	6.61	60.00	50.00	-34.12	-43.39

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

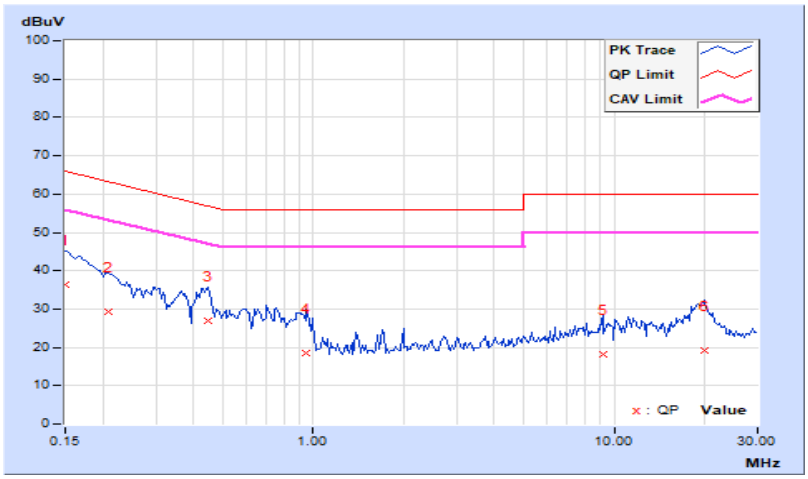


RF Mode	GFSK	Channel	CH 15 : 2415 MHz
Frequency Range	150 kHz ~ 30 MHz	Detector Function & Resolution Bandwidth	Quasi-Peak (QP) / Average (AV), 9 kHz

Phase Of Power : Neutral (N)										
No	Frequency (MHz)	Correction Factor (dB)	Reading Value (dBuV)		Emission Level (dBuV)		Limit (dBuV)		Margin (dB)	
			Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15000	9.99	26.46	0.49	36.45	10.48	66.00	56.00	-29.55	-45.52
2	0.20861	9.99	19.26	-2.12	29.25	7.87	63.26	53.26	-34.01	-45.39
3	0.44686	10.00	16.91	-2.43	26.91	7.57	56.93	46.93	-30.02	-39.36
4	0.95075	10.03	8.55	-6.35	18.58	3.68	56.00	46.00	-37.42	-42.32
5	9.21874	10.41	7.75	-7.30	18.16	3.11	60.00	50.00	-41.84	-46.89
6	19.88280	10.78	8.36	-9.61	19.14	1.17	60.00	50.00	-40.86	-48.83

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value



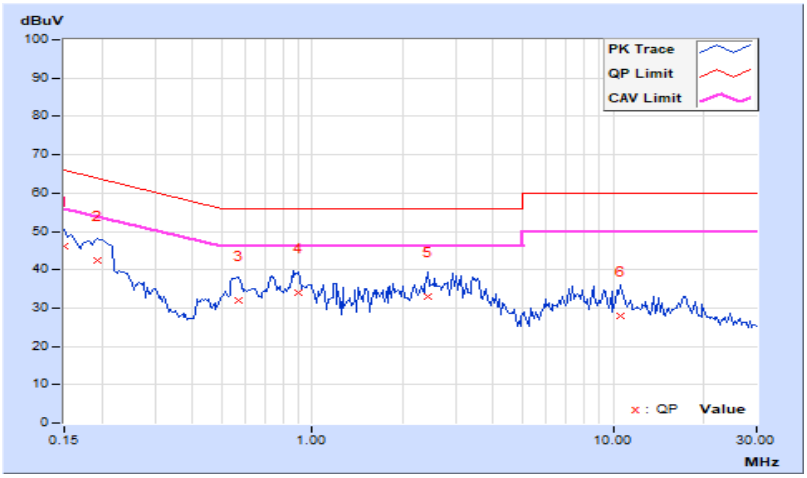
4.2.8 Test Results (Mode 2)

RF Mode	GFSK	Channel	CH 15 : 2415 MHz
Frequency Range	150 kHz ~ 30 MHz	Detector Function & Resolution Bandwidth	Quasi-Peak (QP) / Average (AV), 9 kHz

Phase Of Power : Line (L)										
No	Frequency (MHz)	Correction Factor (dB)	Reading Value (dBuV)		Emission Level (dBuV)		Limit (dBuV)		Margin (dB)	
			Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15000	9.95	36.12	17.71	46.07	27.66	66.00	56.00	-19.93	-28.34
2	0.19297	9.94	32.65	13.36	42.59	23.30	63.91	53.91	-21.32	-30.61
3	0.56797	9.96	22.02	9.05	31.98	19.01	56.00	46.00	-24.02	-26.99
4	0.90000	9.98	23.96	8.49	33.94	18.47	56.00	46.00	-22.06	-27.53
5	2.43359	10.04	22.82	12.31	32.86	22.35	56.00	46.00	-23.14	-23.65
6	10.58984	10.49	17.44	10.41	27.93	20.90	60.00	50.00	-32.07	-29.10

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value

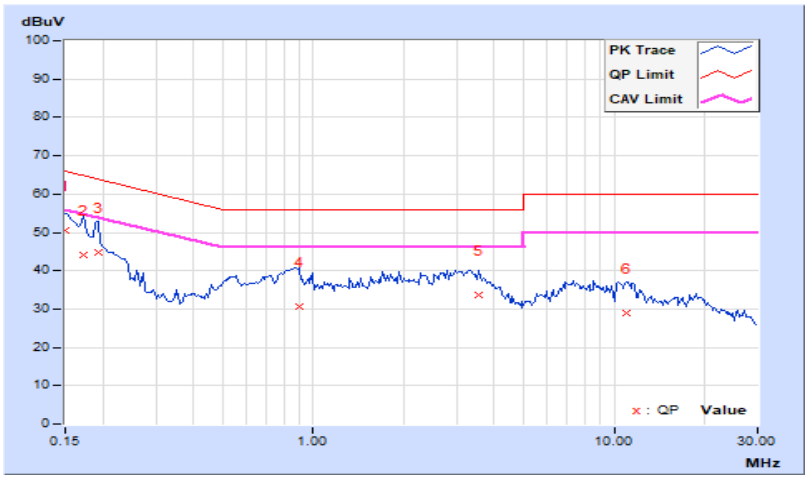


RF Mode	GFSK	Channel	CH 15 : 2415 MHz
Frequency Range	150 kHz ~ 30 MHz	Detector Function & Resolution Bandwidth	Quasi-Peak (QP) / Average (AV), 9 kHz

Phase Of Power : Neutral (N)										
No	Frequency (MHz)	Correction Factor (dB)	Reading Value (dBuV)		Emission Level (dBuV)		Limit (dBuV)		Margin (dB)	
			Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	**0.15000**	**9.99**	**40.65**	**20.66**	**50.64**	**30.65**	**66.00**	**56.00**	**-15.36**	**-25.35**
2	0.17344	9.99	34.13	10.74	44.12	20.73	64.79	54.79	-20.67	-34.06
3	0.19297	9.99	34.76	20.12	44.75	30.11	63.91	53.91	-19.16	-23.80
4	0.89609	10.02	20.49	3.72	30.51	13.74	56.00	46.00	-25.49	-32.26
5	3.53125	10.15	23.49	14.36	33.64	24.51	56.00	46.00	-22.36	-21.49
6	10.97656	10.47	18.56	8.12	29.03	18.59	60.00	50.00	-30.97	-31.41

Remarks:

1. Q.P. and AV. are abbreviations of quasi-peak and average individually.
2. The emission levels of other frequencies were very low against the limit.
3. Margin value = Emission level – Limit value
4. Correction factor = Insertion loss + Cable loss
5. Emission Level = Correction Factor + Reading Value



4.3 20dB Bandwidth Measurement

4.3.1 Limits of 20dB Bandwidth Measurement

The 20dB bandwidth shall be specified in operating frequency band.

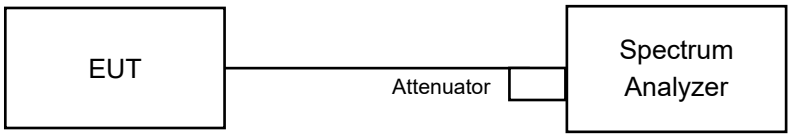
4.3.2 Test Instruments

Refer to section 4.1.2 to get information of above instrument.

4.3.3 Test Procedure

The bandwidth of the fundamental frequency was measured by spectrum analyzer with 30kHz RBW and 100kHz VBW. The 20dB bandwidth is defined as the total spectrum the power of which is higher than peak power minus 20dB.

4.3.4 Test Setup



4.3.5 Deviation from Test Standard

No deviation.

4.3.6 EUT Operating Condition

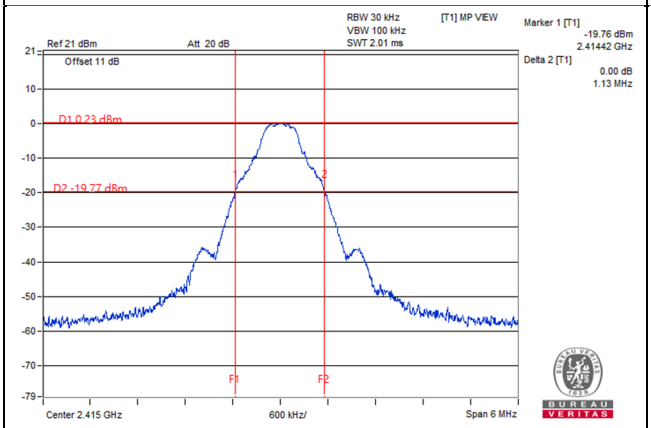
The software provided by client to enable the EUT under transmission condition continuously at lowest, middle and highest channel frequencies individually.

4.3.7 Test Results

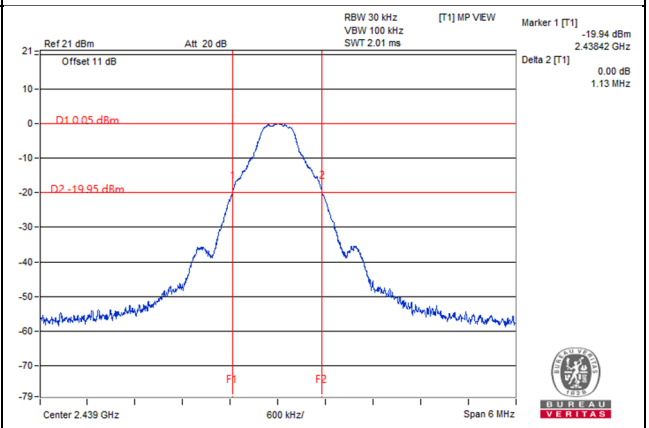
Channel	Frequency (MHz)	20dB Bandwidth (MHz)
15	2415	1.13
39	2439	1.13
59	2459	1.14

Spectrum Plot

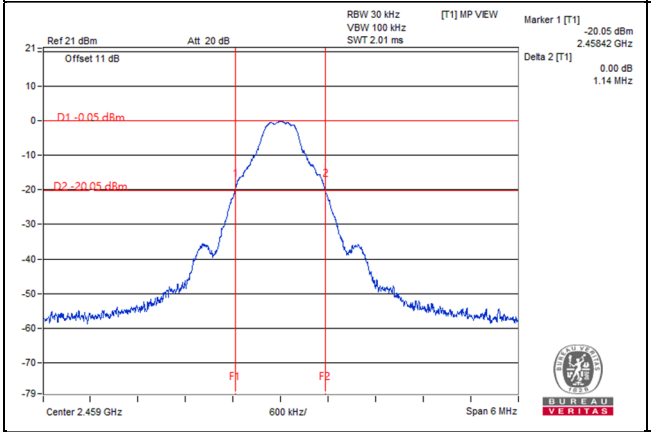
CH15



CH39



CH59



5 Pictures of Test Arrangements

Please refer to the attached file (Test Setup Photo).

Appendix – Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are FCC recognized accredited test firms and accredited according to ISO/IEC 17025.

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Web Site: www.bureauveritas-adt.com

The address and road map of all our labs can be found in our web site also.

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